

Woodward-Clyde Consultants

# ATTACHMENT \* A "

EARTHWORK QUALITY CONTROL OVERVIEW

*JULY 23, 1992*

AND AS-BUILT DRAWINGS

CONSTRUCTION OF STAGE I

TAILINGS IMPOUNDMENT AND DAM

SHOOTARING CANYON URANIUM PROJECT

Garfield County, Utah

Prepared for

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## Woodward-Clyde Consultants

July 28, 1982

Project: 60255N

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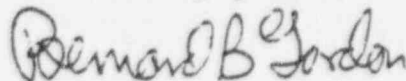
Attention: Mr. U.K. Gupta

Gentlemen:

We are submitting herewith our report on "Earthwork Quality Control Overview and As-Built Drawings." This report summarizes the quality control activities accomplished during the construction of the Tailings Dam and Impoundment for the Shootaring Canyon Uranium Project, and it presents tabulations of significant data and "as-built" drawings which have been assembled in accordance with the NRC license requirements.

We are pleased to have been able to serve you on this challenging work and would be happy to discuss further any of these matters at your request.

Sincerely yours,



Bernard B. Gordon  
Consultant

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Enclosure



TABLE OF CONTENTS

	<u>Page</u>
EXECUTIVE SUMMARY	1
INTRODUCTION	3
EARTHWORK CONSTRUCTION	4
Construction Organization	4
Sources of Construction Material	5
Chronology of Construction	6
Site Inspections by Regulatory Agencies	8
Quality Control Testing	9
Monitoring of the Impoundment Area	11
Instrumentation of the Tailings Dam	11
As-Built Drawings	11
LIMITATIONS	12
REFERENCES	
APPENDIX A - RESULTS OF LABORATORY AND FIELD TESTS	
APPENDIX B - "AS-BUILT" DRAWINGS, TABLE OF CONTENTS	

EXECUTIVE SUMMARY

The actual construction of the Stage I Tailings Impoundment and Dam started in early February 1980 and was completed in March of 1982.

The construction management was handled by Mountain States Mineral Enterprises of Tucson, Arizona (MSME) for the Owner, Plateau Resources Limited (Plateau).

The earthwork construction was subcontracted to Stafford Construction Co. of Grand Junction, Colorado, with some support provided by Craig Construction of Whitewater, Colorado. Late in 1980, MSME took over full construction responsibility utilizing the same equipment as had been used by Stafford Construction Co.

Construction engineering was the responsibility of MSME. Woodward-Clyde Consultants (WCC) of San Francisco were the designers of record for the impoundment and tailings dam, and they were retained during construction to consult for the Owner. Later they were also made responsible for the quality assurance program to see that the requirements of the NRC were met. Plans and specifications were approved by the Utah State Engineer and the NRC. Quality Control activities were subcontracted by Plateau to GARCO Testing Engineers of Salt Lake City (GARCO). At the conclusion of construction, WCC examined the jobsite files and determined that a complete record of the quality control process was available there, and that it was appropriately organized and catalogued.

This report includes a chronology of the project, including a discussion of the earthwork construction problems encountered and the means by which they were handled. A complete daily field record is on file in the mill office at the site for every day that a representative of WCC was at the site.

-2-

The dam and impoundment construction were reviewed in the field on several occasions by the Nuclear Regulatory Commission and the State of Utah. The report describes their review comments and instructions, and it details what was done to get their full concurrence.

Based on the record of observations made by the WCC and Plateau inspection staffs, and a review of quality control data as developed by GARCO, we are of the opinion that the dam and impoundment have been constructed in accordance with the approved plans and specifications.

A portion of the impoundment area has been subdivided into sub-basins, or cells, and the cells have been instrumented so that the behavior of the Stage I tailings management system can be monitored, and so that the design assumptions on behavior of the clay lining and subdrains can be checked. Data needed for completion of the impoundment will be available before the Stage II construction is designed.

Stage I tailings disposal does not contemplate that any tailings load will be in contact with the Stage I tailings dam. As a result, the dam in this mode is merely acting as an emergency barrier in the event of failure of any of the upstream cell dividers, or levees. At such time as the tailings management plan requires direct storage behind the tailings dam, consideration should be given to the need for instrumenting the tailings dam. Until then, it is merely a barrier serving the function of a second line of defense.

-3-

## INTRODUCTION

This report summarizes and documents the Woodward-Clyde (WCC) participation in the earthwork quality assurance phases of the Stage I Tailings Impoundment and Dam, including a continuing review of the earthwork quality control activities provided by GARCO Testing Laboratories (GARCO).

During the earthwork construction phase, WCC served as geotechnical and geologic consultant to Plateau Resources Limited (Plateau). WCC observed site preparations and the treatment and development of the several borrow areas. We reviewed quality control data, provided by others, as needed, to establish that there was compliance with the job specifications and contract drawings. Our services in the field included observing the soil and geologic conditions as they were exposed in the excavations to see that these conditions did not deviate appreciably from those which we had observed during the explorations which we had previously conducted.

Our personnel were present during the construction operations on a periodic basis as the demand for our services was required. Initially, we had proposed to Plateau that we be on the job an average of once every three weeks, but the time interval was varied as the pace and complexity of the work demanded. At times we provided personnel at the jobsite each week.

The scope of our consulting services during construction was originally proposed in WCC letter to Plateau dated February 1, 1980<sup>(1)</sup> and included:

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(1)

See References

-4-

- A. Review and documentation of foundation conditions as revealed during excavation and/or treatment; these services required the assistance of a Senior Project Engineering Geologist experienced in dam and water resources construction.
- B. Observation of placement procedures and moisture control for the various embankment materials. WCC did not provide the field laboratory, nor did they supply the field soils technicians.
- C. Review of quality control of placement and compaction of embankment materials and of selection of acceptable material from required excavations or borrow.
- D. Review of gradation tests and acceptability of both filter and drain materials.
- E. Consultation on proposed and adopted construction techniques and equipment.
- F. Consultation with the Owner, the Contractor(s) and the regulatory agencies on questionable materials or construction practices.
- G. Accomplishment of some special laboratory testing as authorized.

#### EARTHWORK CONSTRUCTION

##### Construction Organization

Construction of the Stage 1 tailings impoundment and dam was just one feature of the overall project which included a mill, access roads and utilities. The Owner, Plateau, had retained MSME, as the architect-engineer and as the general contractor for the entire mill facility. MSME also acted in the capacity of Construction Manager, and they retained subcontractors for various specialty areas such as earthwork construction. Mr. J.R. Thompson was initially the Construction Manager and he was later replaced by Mr. R.L. Staton. Included in the services provided by MSME were field engineering and construction surveying under the direction of Mr. Mark Bennett. As-built corrections were to be added to the construction drawings by MSME.

-5-

Stafford Construction Co. (Stafford) of Grand Junction, Colorado was selected by MSME to be the general earthwork subcontractor, while Craig Construction of Whitewater, Colorado was later added to assist in completion of the earthwork construction program.

GARCO Testing Laboratories (GARCO) of Salt Lake City, Utah were retained for quality control testing, primarily for the concrete and earthwork. GARCO provided the field laboratory which was capable of handling the soil testing needed for compaction control including routine sieve analysis, and in-situ density and moisture content testing using both nuclear and sand cone techniques. Mr. Doyle Rose and Mr. John Wellington acted as the field technicians for GARCO during the earthwork program, with supervision and home laboratory support coming from Mr. Robert Duncan in Salt Lake City.

WCC were the designers of record for both the impoundment and the tailings dam. During construction, they were retained for general consultation on earthwork design and construction matters, and for overall quality assurance. Mr. Don Poulter was the primary Field Engineer who represented WCC and he was under the supervision of Mr. Bernard B. Gordon, Associate.

#### Sources of Construction Material

Sources of locally available materials had been identified by surface geological mapping, followed by test pit explorations and hand sampling as described in two WCC reports dated September 1978 and May 1979.

The embankment design was predicated on maximum use of locally available materials. The major quantity of borrow needed was for the shell of the dam (Zone 2) and was to consist of boulders, cobbles, gravels and sand which were readily available adjacent

-6-

to the dam in Borrow Areas A through D. The same material was also to be used for waste rock cover in the impoundment. Transition, Zone 3, was designed to utilize the fine dune sands located in the upper impoundment area. Similar material was also designated as suitable for use in the impoundment subdrain.

Blanket drain and filter materials were to be processed material meeting the specification grading limits. The source was expected to be that which was selected for processing concrete aggregate for the project.

A number of locations of suitable clay materials were explored and were identified first in the September 1978 and then in the May 1979 reports; and then additional information was provided in a series of supplemental letter reports. These sources were identified by the geologists as the Brushy Basin Shale, the Mancos Shale, or selected material from the Summer-ville Formation. A source on the mesa above and to the northwest of the mill area was selected; and after considerable experimentation with excavate-haul-cure and work-cycles a satisfactory material was then produced which met the job requirements. This source was then designated for use in Zone 1 of the dam, for clay lining of the impoundment, and for the valley swale and apron (Fig. 2, Appendix B). Ample material was available at the source, but the actual yardage excavated, hauled and processed was carefully controlled for reasons of economy.

#### Chronology of Construction

An outline of significant dates in the earthwork construction chronology follows:

- Award of earthwork subcontract

Dec. 26, 1979

-7-

- First visit by WCC to site  
(Start of excavation in impoundment  
area was already underway) Feb. 20, 1980
- Start key trench excavation,  
tailings dam March, 1980
- Inspection of key trench and foundation  
bedrock in key trench by NRC and State  
of Utah April 29, 1980
- Start excavating and hauling clay  
borrow May, 1980
- WCC viewed clay borrow test pad June 16 &  
17, 1980
- Stafford Construction proposed  
method for preparing clay borrow June 30, 1980
- Stafford Construction proposed  
modification to method of pre-  
paring clay borrow July 29, 1980
- Slush grouting & backfilling was  
done in key trench Sept., 1980
- Placement of clay borrow began Sept., 1980
- Stafford Construction constructed  
test pad for Zone 2 fill using  
825B compactors (test pad was not  
acceptable) Oct., 1980
- Mountain States located acceptable  
10-ton vibratory roller for Zone 2 Oct., 1980
- All zones of embankment were under  
construction Oct., 1980
- NRC made their scheduled "10%  
inspection" Nov., 5, 1980
- Large size in-place density tests  
started in Zone 2 Nov., 1980

-8-

- At behest of NRC the following schedules were formalized:
  - Placement of fill in cold weather Nov. 11, 1980
  - Quality Control Test Frequency Nov. 12, 1980
  - Field density test in Zone 2 Nov. 13, 1980
- NRC inspection was made by Mr. J.J. Lenahan (75% embankment construction inspection) Jan. 19-21, 1981
- Meeting to establish WCC information needs for Final Quality Control Report w/MSME & Plateau Feb. 10, 1981
- Final Construction Visit by WCC March 5, 1981
- Tailings Dam Completed March 11, 1981

#### Site Visits by Regulatory Agencies

Representatives of the office of the Utah State Engineer and the NRC visited the site on April 29, 1980. At that time, representatives of both agencies inspected the key trench for the Zone 1 core. Messrs. Poulter and Weaver represented WCC during the inspection. Agreement was reached at that time for satisfying the requests by the regulatory agencies.

On November 5, 1980, NRC conducted their 10 percent completion inspection on the tailings dam construction (see NRC letter to Plateau dated 12/10/80). At that time certain deficiencies were identified by NRC. One item was handled the next day--a large scale density test procedure was developed for the Zone 2 material, and a program of testing developed. However, Plateau was notified by NRC in their letter of 11/21/80 of a license condition violation (#42-SUA 1371). WCC proposals for remedying the deficiencies were presented in a letter dated December 22, 1980 "Response to Nuclear Regulatory Commission Letter for License No. SUA-1371."

-9-

On January 9, 1981, a followup to the 10 percent inspection was scheduled by NRC, combined with the 75 percent embankment construction inspection. This trip was made by Mr. J.J. Lenahan of the Region II office on January 20-21, 1981. From January 19-21, he observed the earthwork and verified that all items noted as violations in their 10 percent progress report had been corrected.

An NRC letter of 2/18/81 discussed acceptance of the WCC proposals and close of violation of license condition. It also summarized results of the 75 percent inspection.

One final inspection of the entire mill construction was completed by NRC on April 7, 1982.

#### Quality Control Testing

For this project performance of all quality control testing was the responsibility of GARCO of Salt Lake City, Utah. During construction, WCC was assigned the additional responsibility for quality assurance of the earthwork program.

The major part of GARCO's program included determination of moisture and density of compacted soils using a Troxler Nuclear Moisture and Density Meter. At regular intervals these results were checked by use of conventional sand cone techniques. The test results were reported promptly in the field, and confirmed by formal reports issued by the Salt Lake City office of GARCO.

In addition to the routine in-place unit weight and moisture determinations, the following tests were run on a frequent basis to verify that the materials being used met specifications:

- gradation
- compaction (ASTM 698 and ASTM 1557)
- Atterberg limits

-10-

Plans and cross sections of the tailings dam have been prepared by MSME to show the location grid for all control tests in the tailings dam. Copies of the plans and approximate cross sections are included in Appendix A.

A control map has been compiled by MSME showing locations of all quality control tests in the impoundment area. A copy of this map, which shows the control grid system, is included in Appendix A.

In order to comply with comments issued by the N.R.C. inspection report of November 5, 1980, additional quality control records were prepared. These records included:

Zone 1 - Comparison of nuclear versus sand cone tests (includes both in-situ moisture content and density) (Table 1).

Zone 3 - Comparison of nuclear versus sand cone tests (includes both in-situ moisture and density) (Table 2).

Material Identification by Yardage (Table 3).

A copy of each of these tables is included in Appendix A.

#### Monitoring of the Impoundment Area

A piezometric monitoring system for the subdrain and clay lining for the impoundment area was installed. This installation was completed in February 1981 by MSME under the guidance of Messrs. Poulter and O'Connor of WCC. An operation manual was prepared for use with this system and was transmitted by WCC to PRL on April 8, 1981. Included in this manual were construction records of the installation.

-11-

#### Instrumentation of the Tailings Dam

During the development of the Tailings Management Plan, the decision was made to stage the construction of the tailings dam and impoundment in two separate phases.

The report presented herein covers only the construction of the Stage I embankment. However, the decision was made to construct the impoundment in separate phases by the inclusion of the cross valley berm. All tailings will initially be placed in the upstream section of the impoundment in several cells above the cross valley berm.

As a result, it will be some time before any tailings reach the tailings dam, and for some years the dam will only serve as an emergency dam in the event that something were to fail in the active impoundment cells. For this period, then, there will be no tailings whatsoever against the embankment.

As a result, the decision was made to locate the initial instrumentation in that portion of the impoundment area where tailings would actually be deposited.

At such time as the tailings embankment will be utilized for tailings containment, the provision of instrumentation to monitor embankment behavior should be considered. At this time, there is no reason for including any instrumentation in the embankment since the monitoring can be accomplished by visual observation.

#### As-Built Drawings

Construction Drawings and Earthwork Specifications for the Tailings Impoundment and Dam were prepared by WCC and were presented in Appendices E and F in the WCC Final Design Report (WCC 1979).

-12-

During construction, MSME observed the work and noted the "as-built" changes. Their drawings recording these items are included in Appendices A and B, where appropriate, and notes have been added to the WCC design drawings cross-referencing the relevant features of the MSME drawings. The annotated WCC drawings are presented herein in Appendix B.

#### LIMITATIONS

This report has been prepared to summarize the observations that were made by WCC field personnel while monitoring the construction activities and quality assurance procedures at the site. It also preserves for the record the field and laboratory test data which had been collected to monitor the effectiveness of the construction procedures. The quality control data that were available to WCC, together with the construction procedures that were observed by WCC personnel support our opinion that the earthwork construction, as completed, was in technical compliance with the project specifications and with supplemental modifications that were adopted during construction.

## Woodward-Clyde Consultants

### REFERENCES

- NRC (1980) Letter re results of their inspection on November 4-5 from NRC (Glenn D. Brown) to Plateau (R.B. Sewell) December 22, 1980.
- WCC (1978), "Tailings Management Plan and Geotechnical Engineering Studies," September 1978.
- WCC (1979), "Stage I - Tailings Impoundment and Dam, Final Design Report," May 1979.
- WCC (1980) "Placement of Fill During Cold Weather," WCC Letter (D. Poulter) to Plateau (U.K. Gupta), November 11, 1980.
- WCC (1980) "Quality Control Test Frequency," WCC Letter (D. Poulter) to Plateau (U.K. Gupta), November 12, 1980.
- WCC (1980) "Field Density Test in Zone 2 Material," WCC Letter (D. Poulter) to Plateau (U.K. Gupta), November 13, 1980.
- WCC (1980) "Response to the NRC Letter for License No. SUA-1371," Letter WCC (D. Poulter) to Plateau (U.K. Gupta) December 22, 1980.

APPENDIX A  
RESULTS OF LABORATORY AND FIELD TESTS

## APPENDIX A

## RESULTS OF LABORATORY AND FIELD TESTS

A complete record has been kept by GARCO Testing Laboratories of all quality control testing which has been accumulated for this project. A separate notebook which contains a record of all the tests conducted with the results is on file in the mill office at the site.

In addition, there are presented in this appendix a copy of each of three tables requested by NRC:

<u>Table</u>	<u>Description</u>
1	for Zone 1 - comparison of nuclear versus sand cone test results (includes both in-situ moisture content and density)
2	for Zone 3 - comparison of nuclear versus sand cone test results (includes both in-situ moisture content and density)
3	Material identification by yardage for Zones 1, 2, 3.

The data in Tables 1 and 2 represent a comparison of results for a sequence of 100 tests and were made at the following rates:

for oven moisture - 1 per each 4 nuclear  
for sand cone - 1 per each 10 nuclear

The comparisons showed results to be within the normal range of variability and were reduced to spot checking only questionable results.

There also are included in this appendix copies of the following MSME drawings:

1. Dam Area, Test Locations Plan and Profile (MSME Dwgs. # III-1-A, III-1-B, III-1-C).
2. Cross Valley Berm & Upper Impoundment, Zone 1, Finish Grade, Nuclear Density Locations (MSME Dwg. III-2).

TEST NO.		OVEN DRIED MOISTURE	NUCLEAR MOISTURE	VARIANCE (OVEN-NUCLEAR)	TEST NO.		SAND CONE DENSITY	NUCLEAR DENSITY	VARIANCE (SAND CONE - NUCLEAR)
OVEN	NUCLEAR				SAND	NUCLEAR			
1156	1111	25.3	26.9	-1.3	1395	1394	97.7	97.5	+0.2
1157	1123	24.1	23.6	+0.5	1398	1397	96.5	96.2	+0.3
1158	1136	25.1	26.2	-1.1	1575	1574	97.1	96.8	+0.3
1159	1144	28.2	27.5	+0.7	1576	1559	95.0	96.9	-1.9
1395	1394	25.8	28.0	-2.2	1598	1588	97.3	96.9	+0.4
1398	1397	25.7	27.6	-1.9	1599	1594	98.0	95.7	+2.3
1451	1450	24.7	25.1	-0.4	1617	1611	96.3	96.6	-0.3
1477B	1477A	25.3	27.1	-1.8	1665	1661	95.8	96.5	-0.7
1493B	1493A	26.2	28.0	-1.8	1670	1666	95.4	97.5	-2.1
1523B	1523A	26.2	27.1	-0.9	1686B	1686A	96.3	96.0	-0.3
1532B	1532A	25.8	26.4	-0.6	1708B	1708A	95.7	96.1	-0.4
1540B	1540A	26.5	27.6	-1.1	1716B	1716A	95.2	96.8	-1.6
1549B	1549A	23.7	23.8	-0.1	1768B	1768A	96.1	97.2	-1.1
1575	1574	24.2	26.7	-2.5	1741B	1741A	96.0	95.5	+0.5
1576	1559	25.6	26.5	-0.9	1830B	1830A	95.5	97.8	-2.3
1581B	1581A	24.9	25.3	-0.4	1873B	1873A	100.0	100.0	0.0
1598	1588	25.4	26.5	-1.1	1883B	1883A	100.0	98.7	+1.3
1599	1594	26.3	26.9	-0.3	1930B	1930A	100.0+	98.0	+2.0
1617	1611	25.1	25.7	-0.6	1955B	1955A	99.7	98.1	+1.6
1652A	1652	25.5	26.0	-0.5	1899B	1899A	100.0	98.5	+1.5
1657A	1657	25.8	27.2	-1.4	1995B	1995A	97.7	98.3	-0.6
1665	1661	25.1	26.8	-1.7	1973B	1973A	98.2	97.3	+0.9
1670	1666	25.6	26.1	-0.5	2033B	2033A	98.5	96.8	+1.7
1675	1675A	26.1	26.6	-0.5	2060B	2060A	98.8	97.1	+1.7
1686B	1686A	26.7	27.0	-0.3	2112B	2112A	98.7	98.4	+0.3

Note: Data provided by GARCO Testing Engineers

TEST NO.		OVEN DRIED MOISTURE	NUCLEAR MOISTURE	VARIANCE (OVEN-NUCLEAR)	TEST NO.		SAND CONE DENSITY	NUCLEAR DENSITY	VARIANCE (SAND CONE - NUCLEAR)
OVEN	NUCLEAR				SAND	NUCLEAR			
1695B	1695A	26.9	27.1	-0.2	2083	2083B	99.1	98.1	+1.0
1704B	1704A	25.4	25.7	-0.3	2089	2089B	98.2	97.8	+0.4
1708B	1708A	26.4	27.3	-0.9	2158	2153	100.0+	99.2	+0.8
1716B	1716A	26.8	27.0	-0.2	2249	2217	95.7	95.4	+0.3
1733B	1733A	26.4	27.1	-0.7					
1737B	1737A	25.3	27.1	-1.8					
1755B	1755A	25.8	26.1	-0.3					
1768C	1768B	25.2	26.4	-1.2					
1764B	1764A	26.0	26.6	-0.6					
1830B	1830A	25.8	26.3	-0.5					
1873B	1873A	25.2	25.5	-0.3					
1883B	1883B	25.7	25.7	0.0					
1899B	1899B	25.9	26.6	-0.7					
1995B	1995A	26.4	26.4	0.0					
1973B	1973A	26.4	27.5	-1.1					
2033B	2033A	26.8	27.1	-0.3					
2060B	2060A	25.6	27.0	-1.4					
2112B	2112A	25.8	26.0	-1.4					
2083A	2083B	24.1	24.8	-0.7					
2089	2089B	24.2	24.6	-0.4					
2158	2153	24.9	25.5	-0.6					
2249	2217	25.6	25.9	-0.3					

Note: Data provided by GARCO Testing Engineers

ZONE '3' SAND

TEST NO.		OVEN DRIED MOISTURE	NUCLEAR MCISTURE	VARIANCE (OVEN-NUCLEAR)	TEST NO.		SAND CONE DENSITY	NUCLEAR DENSITY	VARIANCE (SAND CONE - NUCLEAR)
OVEN	NUCLEAR				SAND	NUCLEAR			
1676B	1676A	9.6	9.8	-0.2	1676B	1676A	95.9	95.5	+0.4
1682B	1682A	10.0	9.9	+0.1	1682B	1682A	95.2	95.8	-0.6
1699B	1699A	9.0	8.9	+0.1	1718B	1718A	96.6	98.8	-2.2
1712C	1712B	9.1	9.3	-0.2	1735B	1735A	97.1	98.6	-1.5
1718B	1718A	9.7	9.4	+0.3	1739B	1739A	96.5	97.2	-0.7
1729B	1729A	9.3	9.6	-0.3	1746B	1746A	98.2	97.2	+1.0
1735B	1735A	9.6	9.9	-0.3	1750B	1750A	97.9	98.3	-0.4
1739B	1739A	9.4	9.5	-0.1	1752B	1752A	95.7	98.4	-2.7
1746B	1746A	9.4	9.2	+0.2	1756B	1756A	97.6	98.2	-0.6
1750B	1750A	9.7	10.0	-0.3	1759B	1759A	99.5	97.2	+2.3
1752B	1752A	9.7	9.9	-0.2	1766B	1766A	97.0	98.6	-1.6
1756B	1756A	9.2	9.2	0.0	1773B	1773A	97.9	97.0	+0.9
1759B	1759A	9.7	9.7	0.0	1781B	1781A	98.5	97.5	-2.0
1760B	1760A	9.7	10.0	-0.3	1826B	1826A	96.9	96.3	+0.6
1766B	1766A	9.3	9.4	-0.1	1863B	1863A	97.7	96.7	+1.0
1773B	1773A	9.5	10.4	-0.9	1870B	1870A	98.6	99.4	-0.8
1781B	1781A	9.8	9.9	-0.1	1886B	1886A	98.6	99.5	-0.9
1802B	1802A	10.0	9.9	+0.1	1903B	1903A	100.0	98.0	+2.0
1826B	1826A	9.4	9.5	-0.1	1936B	1936A	99.9	98.6	+1.3
1835B	1835A	9.3	9.6	-0.3	1958B	1958A	98.2	99.5	-1.3
1846B	1846A	9.8	9.9	-0.1	1991B	1991A	99.4	97.3	+2.1
1863B	1863A	9.6	10.0	-0.4	1968B	1968A	98.2	97.6	+0.6
1870B	1870A	9.2	9.3	-0.1	2040B	2040A	99.7	97.5	+2.2
1886B	188A	9.7	9.6	+0.1	2061B	2060A	97.8	97.4	+0.4
1903B	1903A	9.6	9.9	-0.3	2108B	2108A	97.8	97.0	+0.8

Note: Data provided by GARCO Testing Engineers

TABLE 2 (Contd.)

TEST NO.		OVEN DRIED MOISTURE	NUCLEAR MOISTURE	VARIANCE (OVEN-NUCLEAR)	TEST NO.		SAND CONE DENSITY	NUCLEAR DENSITY	VARIANCE (SAND CONE - NUCLEAR)
OVEN	NUCLEAR				SAND	NUCLEAR			
1936B	1936A	9.4	10.2	-0.8	{	No comparisons made, see discussion of results of laboratory and field tests.			
1958B	1958A	9.8	10.0	-0.2					
1991B	1991A	9.3	9.8	-0.5					
1968B	1968A	9.2	9.2	0.0					
2040B	2040A	9.6	9.8	-0.2					
2061B	2061A	9.9	9.9	0.0					
2108B	2108A	10.1	9.7	+0.4					
2129B	2129A	9.6	9.6	0.0	2129B	2129A	96.8	96.6	+0.2
2166	2163	10.3	10.6	-0.3	2166	2163	93.2	99.0	+0.2
2259	2219	10.3	9.9	+0.4	2219	2250	96.0	95.8	+0.2

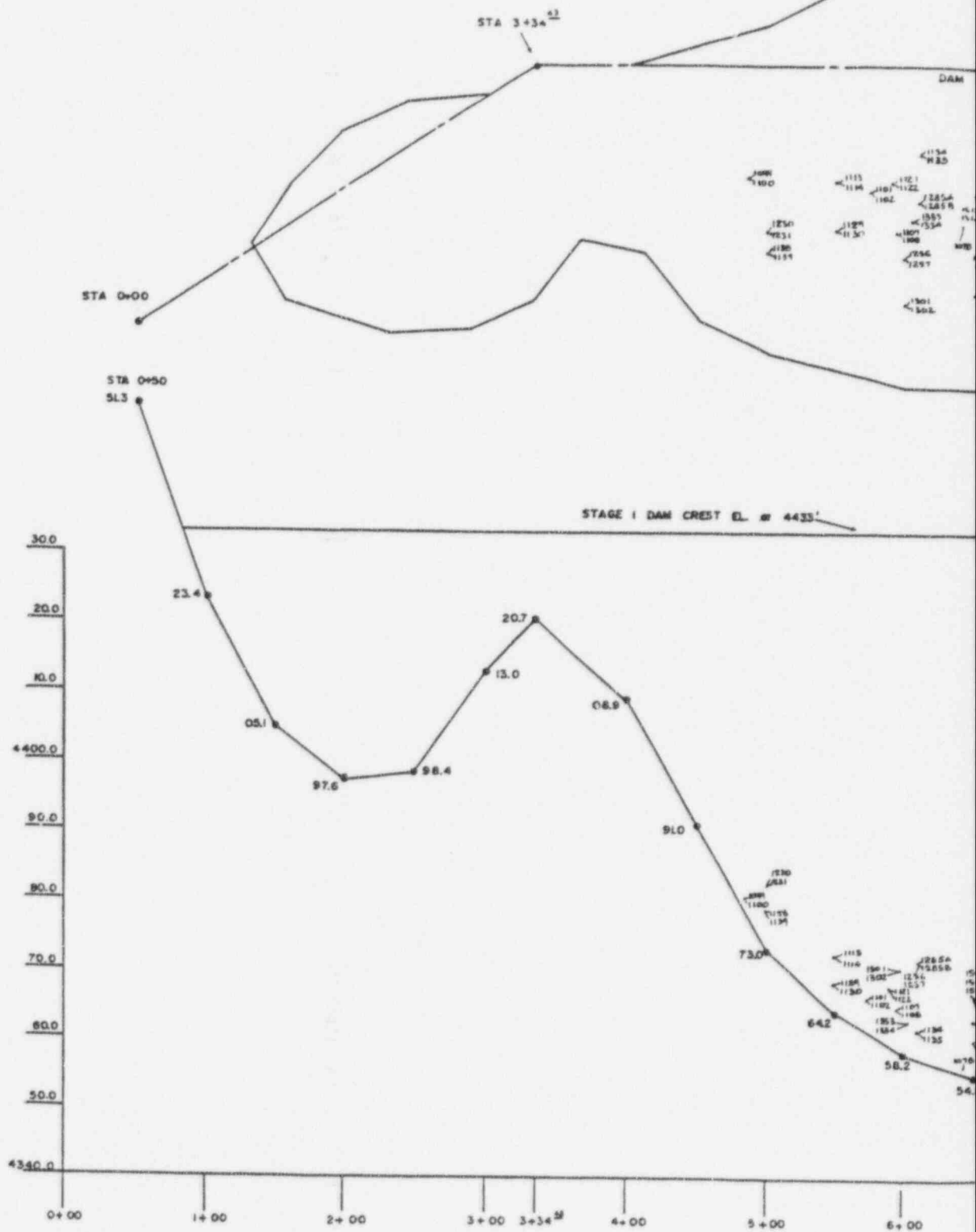
Note: Data provided by GARCO Testing Engineers

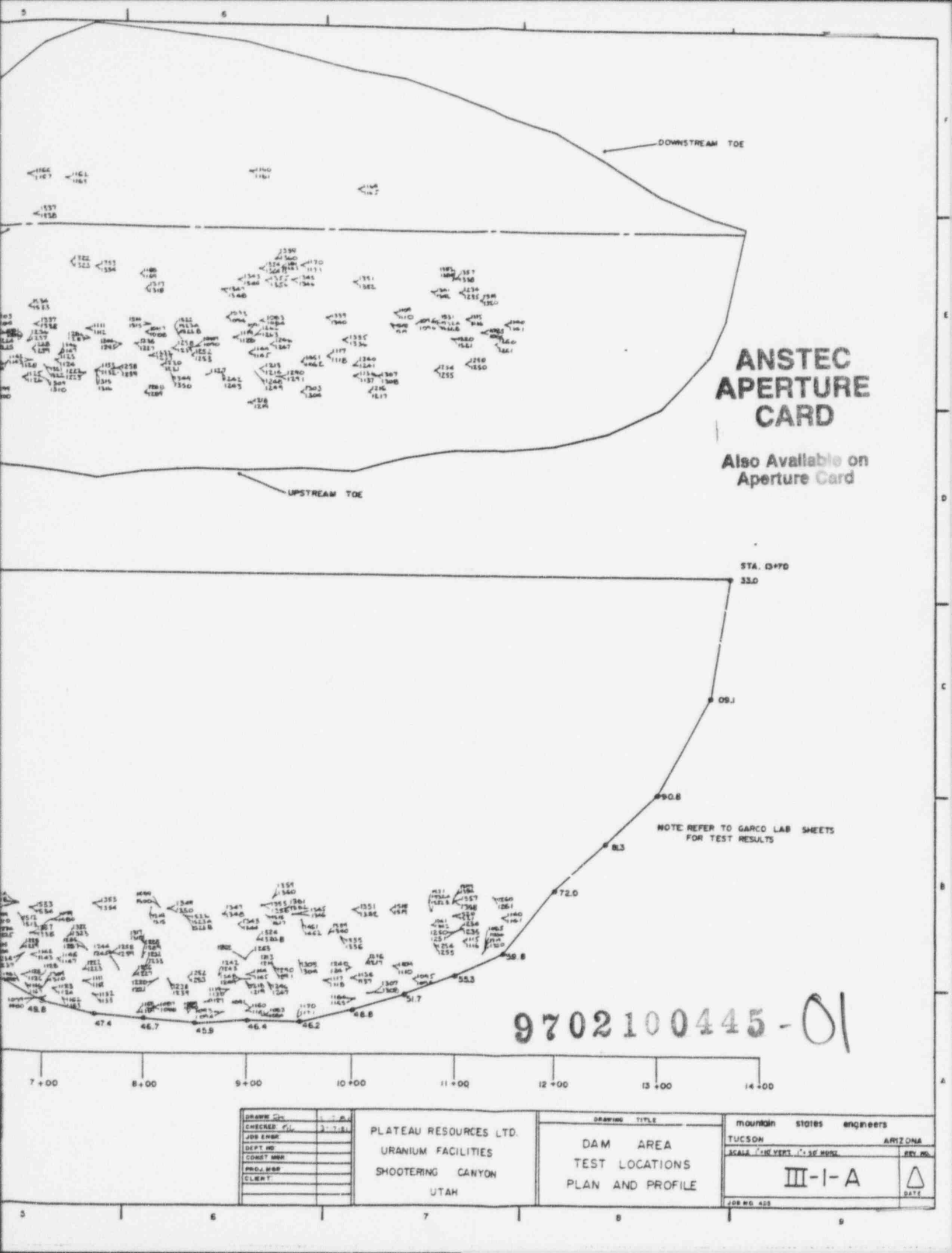
TABLE 3

## MATERIAL IDENTIFICATION TEST

ZONE 1					ZONE 2					ZONE 3				
Yardage When Test Is Required	Yardage When Test Taken	Compaction Curve	Atterberg Limits	Gradation	Yardage When Test Is Required	Yardage When Test Taken	Field Density	Yardage When Test Is Required	Yardage When Test Taken	Compaction Curve	1/6,000 Gradation	Yardage When Test Is Required	Yardage When Test Taken	1/30,000 Compaction Curve
30,000	10-1-80 30,000	Lab #9851 98.3 PCF 23.6% M	Lab #9851 LL - 67 PL - 27 PI - 40	Lab #1575 #4.4% Passing #200	50,000	11-13-80 27,000	Lab #1604 $Y_d = 130.9$ pcf $Y_m = 139.2$ pcf	6,000	5-3-80 0	Lab # 402	Lab # 402	12,000	11-16-80 12,000	Lab # 1422
60,000	11-16-80 60,000	Lab #11259 98.4 PCF 24.9% M	Lab #11259 LL - 65 PL - 26 PI - 39	Lab #11259 #4.7% Passing #200	100,000	1-13-81 120,000	Lab #1770 $Y_d = 129.7$ pcf $Y_m = 139.6$ pcf	18,000		Lab # 1423	Lab # 1530	24,000		Lab # 1801A
90,000				Lab #1577 #0.1% Passing #200	150,000	1-19-81 147,000	Lab #1834 $Y_d = 129.6$ pcf $Y_m = 138.1$ pcf	36,000		Lab # 1976	Lab # 2100	42,000		Lab # 2139
120,000				Lab #2101 #7.5% Passing #200				48,000		Lab # 2151	Lab # 2152	54,000		Lab # 2162
150,000				Lab #2157 78.4% Passing #200	200,000	1-29-81 174,000	Lab #1917 $Y_d = 128.3$ pcf	60,000		Lab # 2214	Lab # 2216	66,000		Lab # 2216
					250,000	2-11-81 225,000	Lab #2116 $Y_d = 130.6$ pcf	72,000		Lab # 2216	Lab # 2216	78,000		Lab # 2216
					300,000	3-2-81 262,000	Lab #2215 $Y_d = 146.7$	84,000		Lab # 2216	Lab # 2216	84,000		Lab # 2216

Note: Data provided by GARC Testing Engineers





# ANSTEC APERTURE CARD

Also Available on  
Aperture Card

NOTE REFER TO GARCO LAB SHEETS  
FOR TEST RESULTS

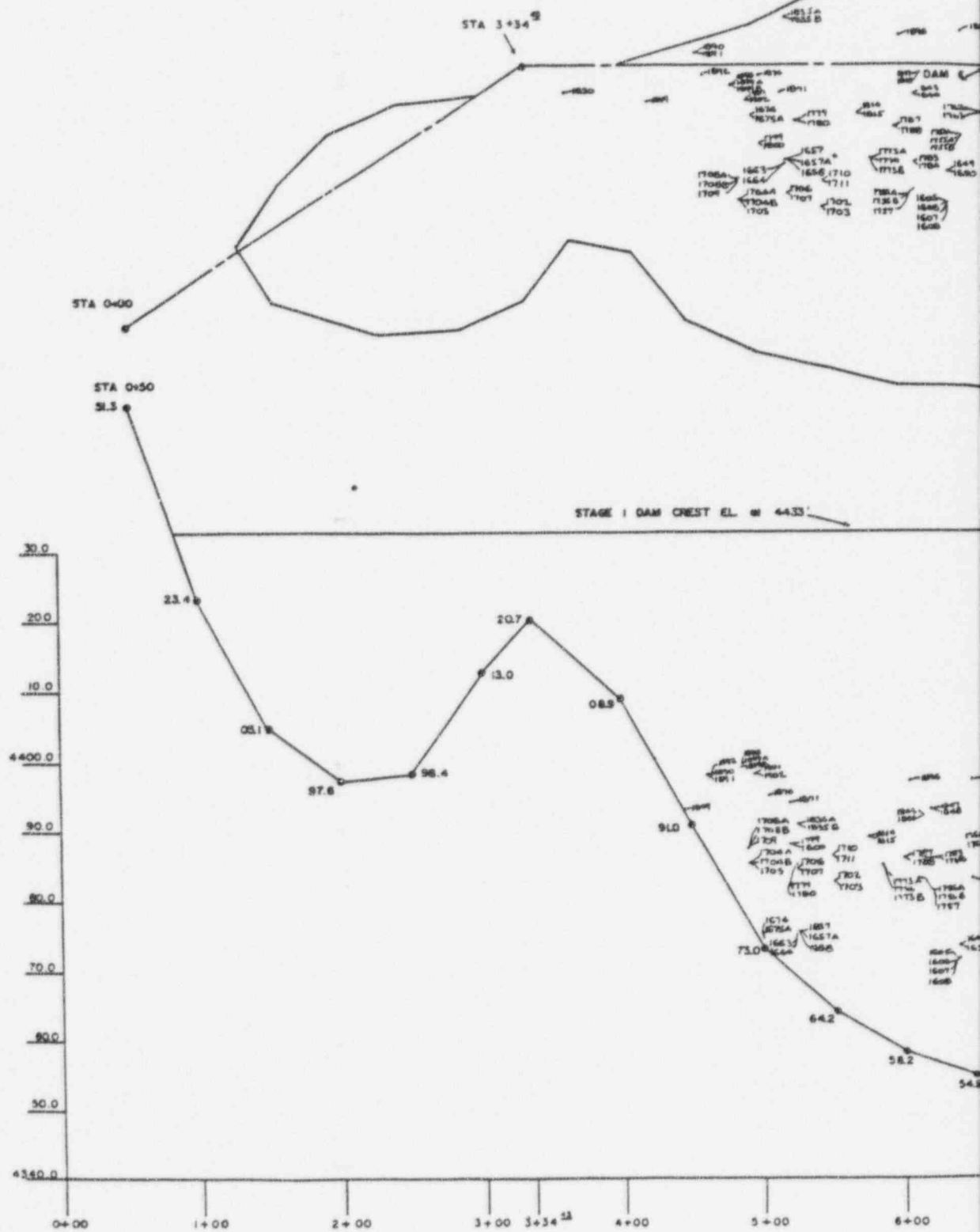
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CHECKED BY	3-7-61
JOB ENGR	
DEPT. MR	
CONSTR. MR	
PROD. MR	
CLIENT	

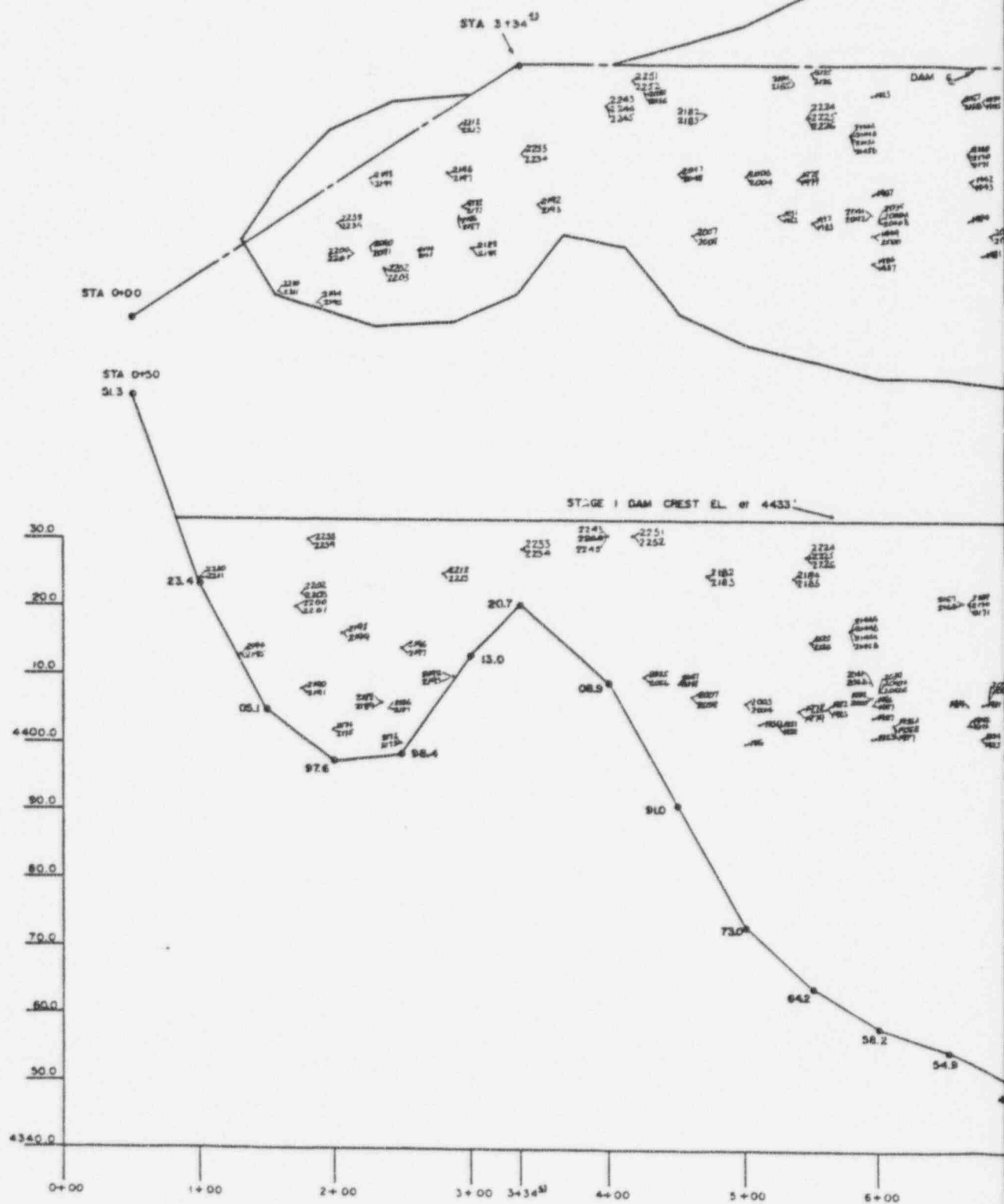
PLATEAU RESOURCES LTD.  
URANIUM FACILITIES  
SHOOTERING CANYON  
UTAH

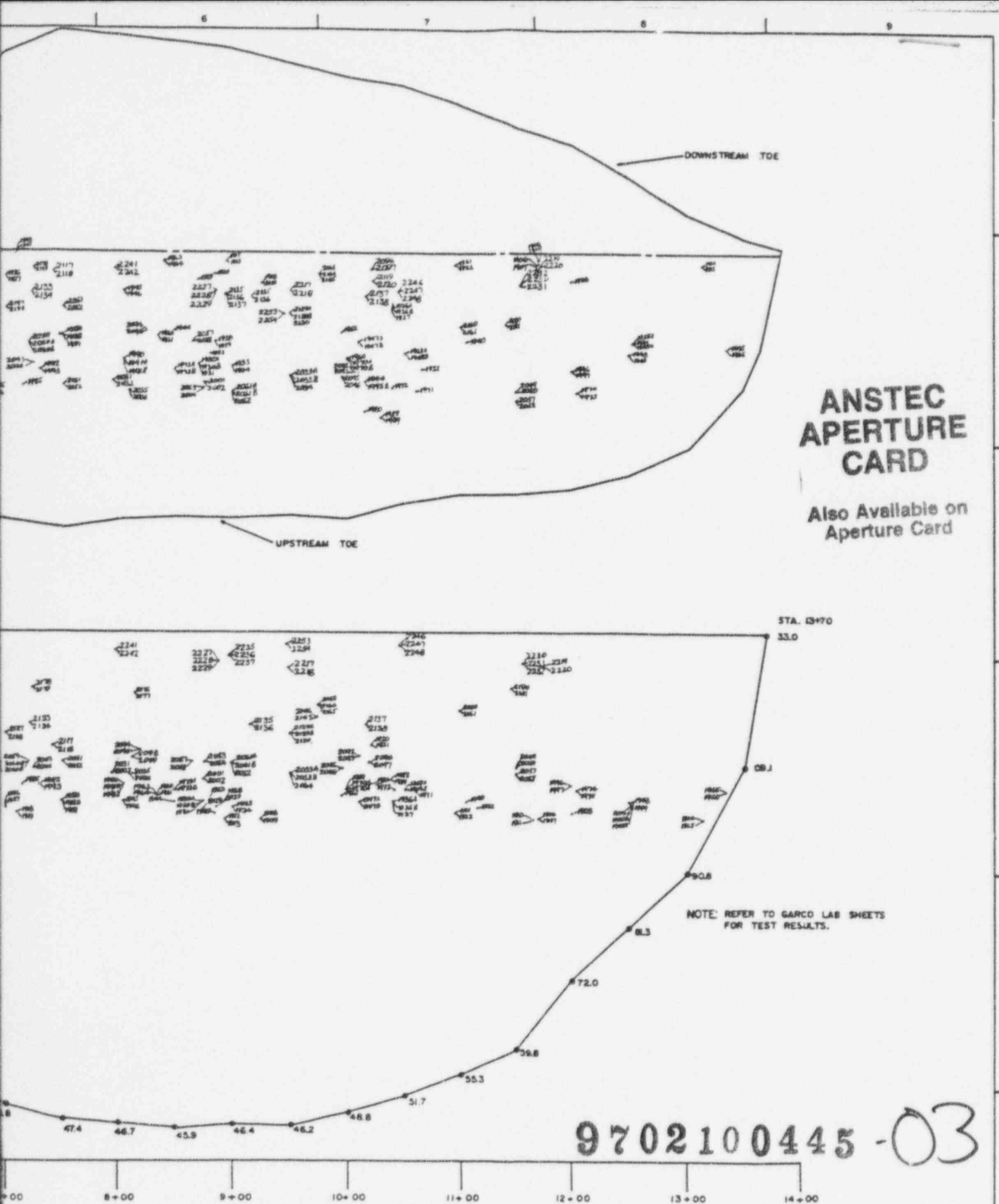
DRAWING TITLE  
DAM AREA  
TEST LOCATIONS  
PLAN AND PROFILE

mountain states engineers	
TUCSON	ARIZONA
SCALE: 1"=100'	REV. NO.
III-1-A	DATE
JOB NO. 425	





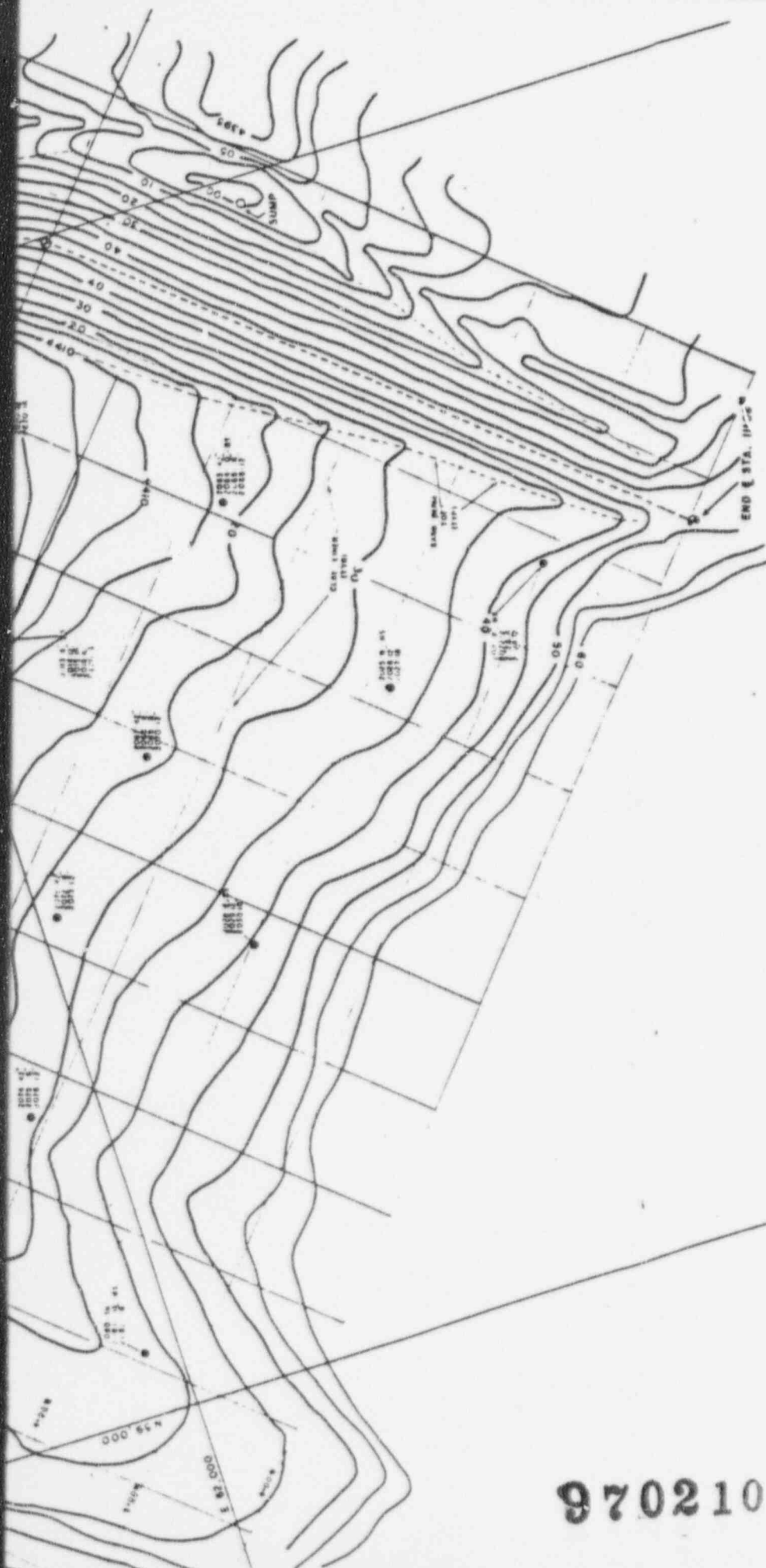




9702100445-03

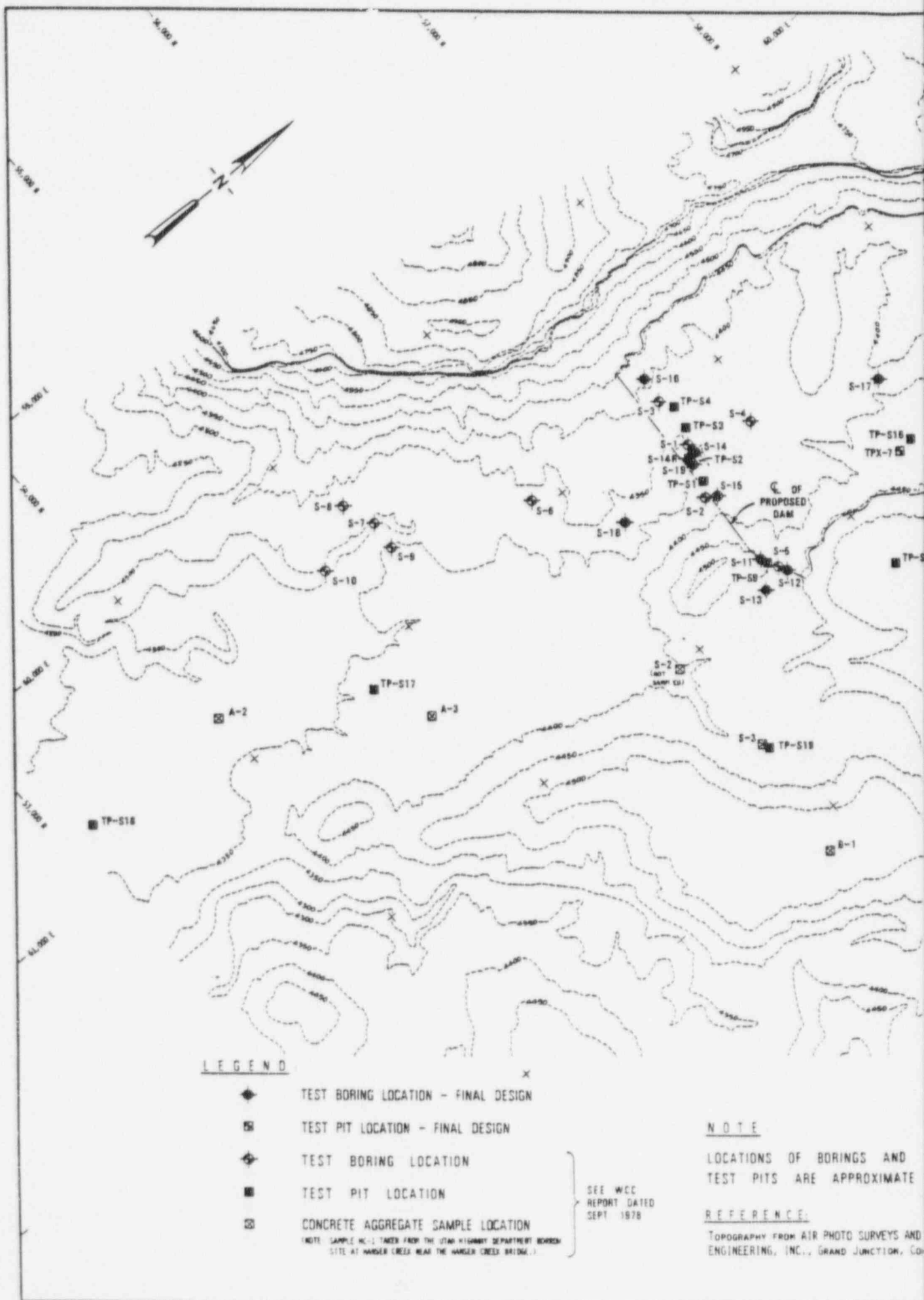
DRAWN BY CHECKED BY JOB NO. DEPT. NO. CONSULT. NO. PROJ. NO. CLIENT	PLATEAU RESOURCES LTD. URANIUM FACILITIES SHOOTING CANYON UTAH	DRAWING TITLE DAM AREA TEST LOCATIONS PLAN AND PROFILE	mountain states engineers TUCSON SCALE 1"=100' HORIZ. III-1-C JOB NO. 430
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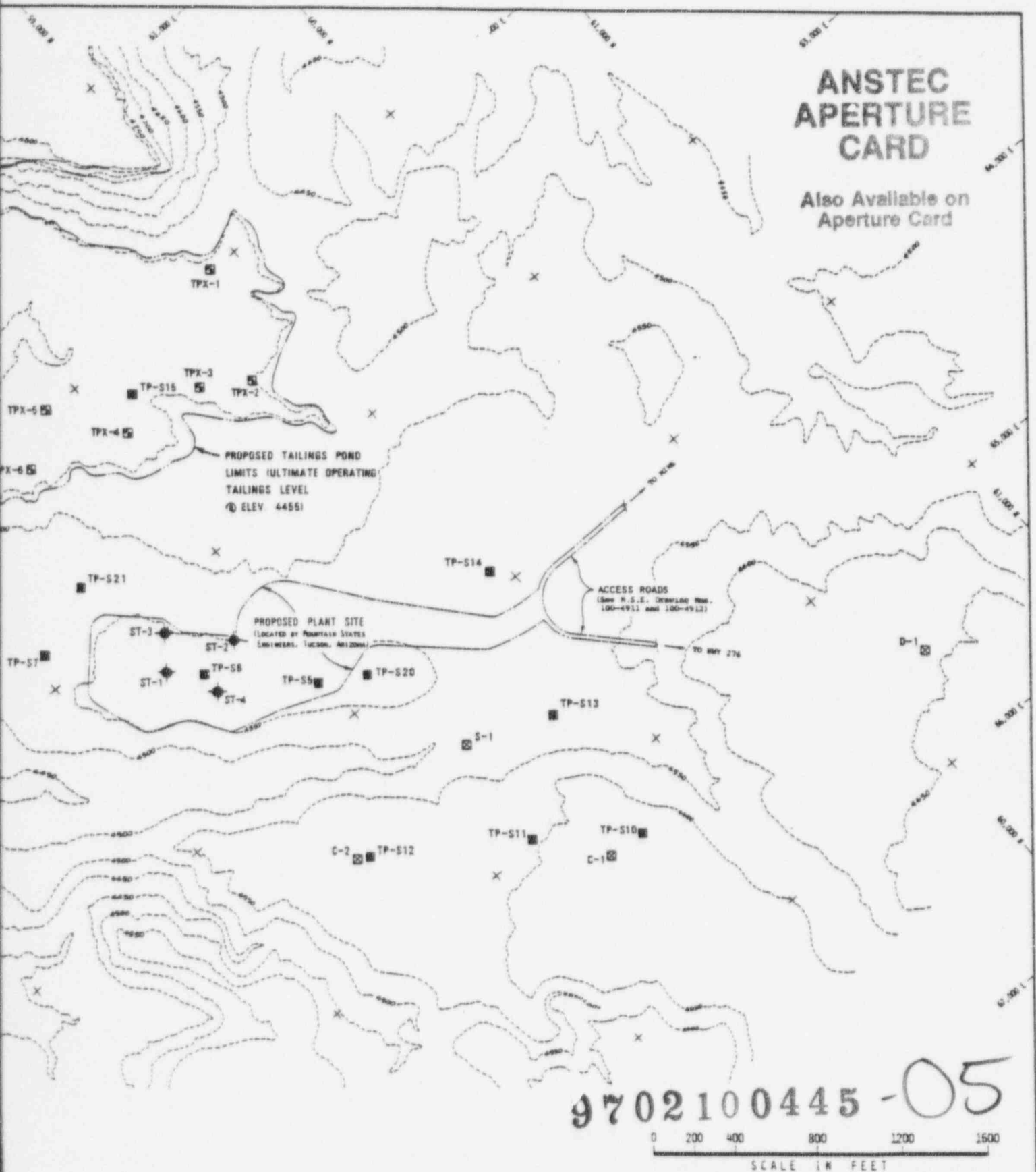
9702100445-04

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1	2	3	4	5	6	7	8	9	10	11	12	13</																																																																																							



# ANSTEC APERTURE CARD

Also Available on  
Aperture Card



9702100445-05

0 200 400 800 1200 1600  
SCALE IN FEET



1	6-23-82	No AS-BUILT Changes	BBG
No.	DATE	REVISIONS	By
R.E. NO.	1973	APPROVED:	
DATE:	5-24-79	<i>Demetrius B. Jordan</i>	

**FIELD EXPLORATION & SITE PLAN**  
PLATEAU RESOURCES LIMITED  
SHOOTING CANYON URANIUM PROJECT  
Garfield County, Utah

Project No. 60255J  
**Woodward-Clyde Consultants**

Figure 1

APPENDIX B

"AS-BUILT" DRAWINGS

Table of Contents

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WOODWARD-CLYDE CONSULTANTS

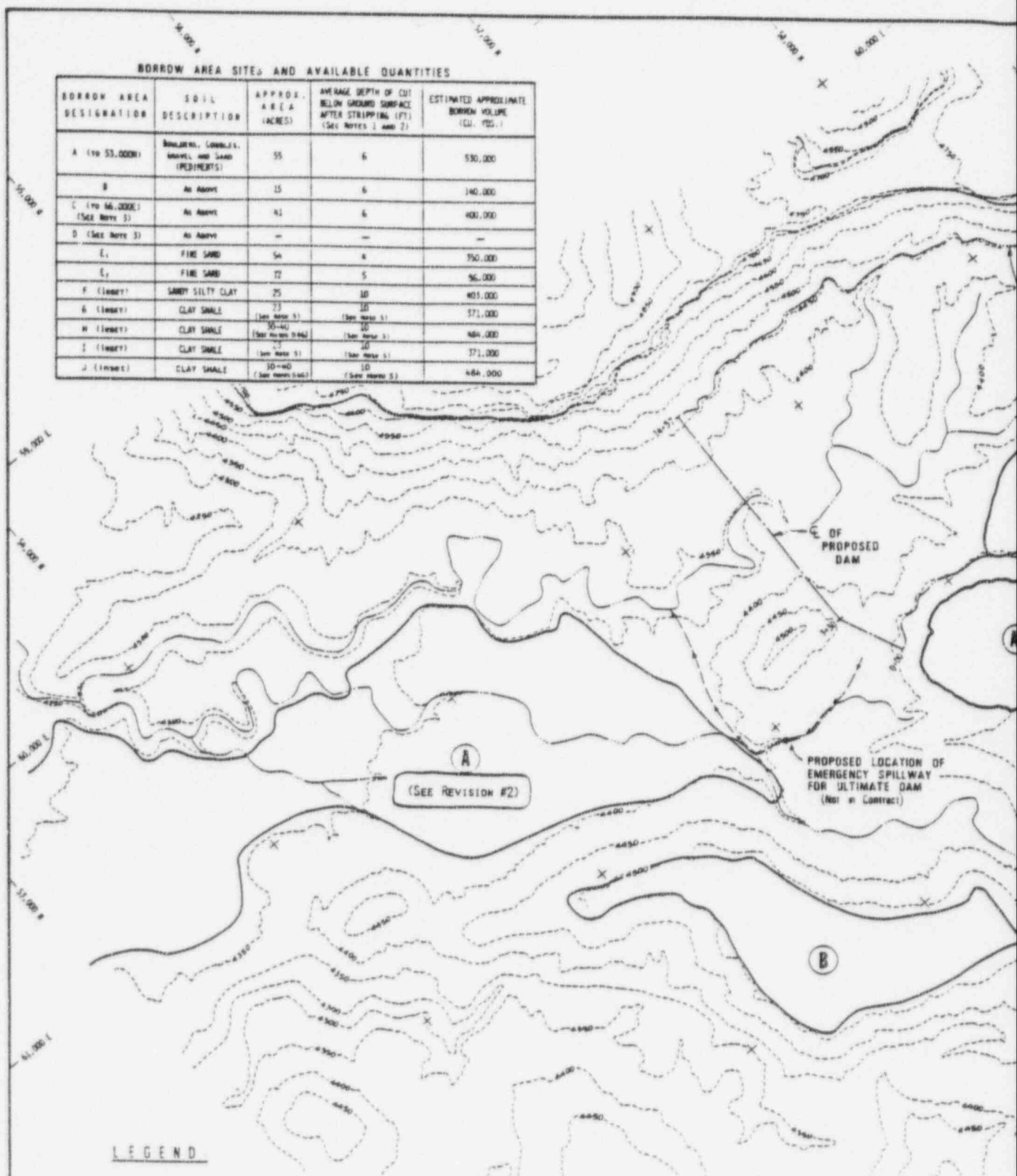
- Figure 1 - Field Exploration and Site Plan.
- Figure 2 - Borrow Area Plan
- Figure 3 - Impoundment Area Plan View
- Figure 4 - Centerline Key Trench Plan & Profile  
and Miscellaneous Details
- Figure 5 - Stage I Embankment Cross Sections and Details

MOUNTAIN STATES MINERAL ENTERPRISES

- Drawing I-1 - Dam Area Plan and Profile
- Drawing I-4 - As Built Plan, Station 2+50 to 4+00, Foundation Fill
- Drawing II-2 - Drain Pipes and Piezometers, Cross Valley Berm  
& Upper Impoundment, Zone 1 Finish Grade
- Drawing II-5-A - As Built Profiles of 4" and 6" Drain Pipe,  
Impoundment Area
- Drawing II-5-B - As Built Profiles of 4" and 6" Drain Pipe,  
Impoundment Area
- Drawing II-5-C - As Built Profiles of 4" and 6" Drain Pipe,  
Impoundment Area
- Drawing II-6 - Typical Section, Cross Valley Berm

BORROW AREA SITES AND AVAILABLE QUANTITIES

BORROW AREA DESIGNATION	SOIL DESCRIPTION	APPROX. AREA (ACRES)	AVERAGE DEPTH OF CUT BELOW GROUND SURFACE AFTER STRIPPING (FT) (See Notes 1 and 2)	ESTIMATED APPROXIMATE BORROW VOLUME (CU. YDS.)
A (TO 53,000)	BOULDERS, GRAVELS, SANDS AND SAND (BEDROCKS)	55	6	530,000
B	As Above	15	6	140,000
C (TO 56,000) (See Note 3)	As Above	41	6	400,000
D (See Note 3)	As Above	—	—	—
E <sub>1</sub>	FINE SAND	54	4	750,000
E <sub>2</sub>	FINE SAND	72	5	96,000
F (Imey)	SANDY SILTY CLAY	25	10	405,000
G (Imey)	CLAY SHALE	23 (See Note 5)	10 (See Note 5)	371,000
H (Imey)	CLAY SHALE	30-40 (See Note 5 and 6)	10 (See Note 5)	484,000
I (Imey)	CLAY SHALE	23 (See Note 5)	10 (See Note 5)	371,000
J (Imey)	CLAY SHALE	30-40 (See Note 5 and 6)	10 (See Note 5)	484,000



## LEGEND



ZONE 2 BORROW AREA  
(AREA TO BE USED SHALL BE SELECTED BY THE CONTRACTOR)



ZONE 2 BORROW AREA (BACK-UP SOURCE)



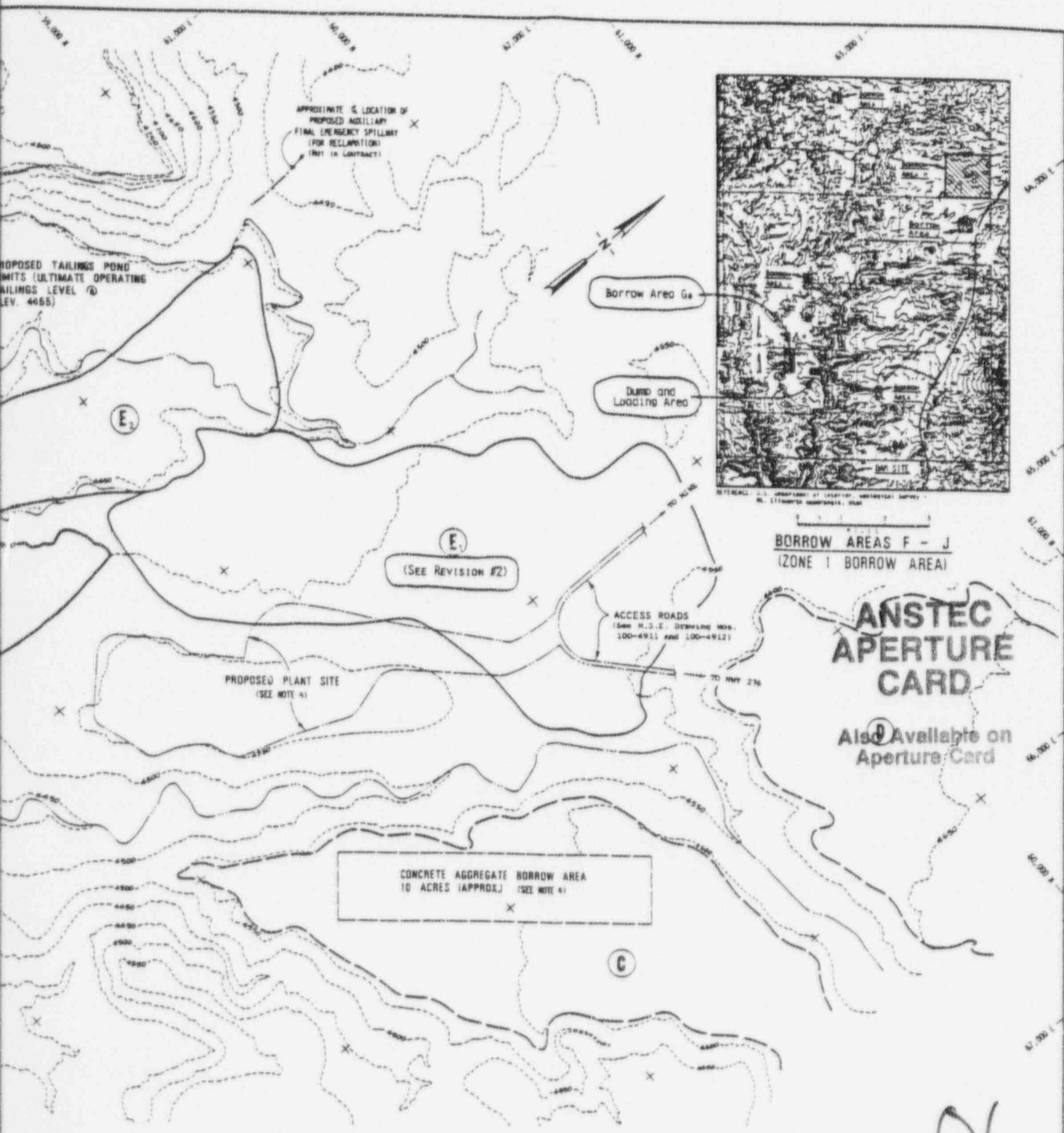
ZONE 3 BORROW AREA  
(AREA TO BE USED SHALL BE SELECTED BY THE CONTRACTOR)



ZONE 2 BORROW AREA  
(AREA APPROVED 1-7-81)

## NOTES:

- 1) CONSERVATIVELY ASSUMED DEPTHS BASED ON LIMITED FIELD EXPLORATION.
- 2) ASSUMED STRIPPING DEPTH IS 2 FEET IN BORROW AREAS A - J.
- 3) BORROW AREAS C AND D TO BE USED AS BACK-UP BORROW SOURCES.
- 4) PROPOSED PLANT SITE AND CONCRETE AGGREGATE BORROW AREA.
- 5) THESE VALUES MAY VARY WITH PARTICULAR EXCAVATION METHOD. DEPTH OF BORROW MATERIAL EXCEEDS 10 FEET.
- 6) ESTIMATED ACREAGE DOES NOT REPRESENT THE TOTAL AREA AVAILABLE IN BORROW AREAS H AND J.



# REFERENCE:

TOPOGRAPHY FROM AIR PHOTO SURVEYS AND GLOBAL ENGINEERING, INC., GRAND JUNCTION, COLORADO

9702100445-06

2	6-23-82	Added Borrow Area (C) to Site Map. Area was the actual source of Zone 1, Zone 2 was taken from Area (E). Zone 3 priority came from Area (A).	DRG
1	1-12-81	Addition of BORROW AREA A <sub>1</sub>	D.A.P.
REVISIONS			
NO.	DATE	REVISIONS	By
R.E. NO.	1983	APPROVED:	
DATE:	5-24-79	<i>Ronald B. Jordan</i>	

**BORROW AREA PLAN**  
 PLATEAU RESOURCES LIMITED  
 SHOOTING CANYON URANIUM PROJECT  
 Garfield County, Utah

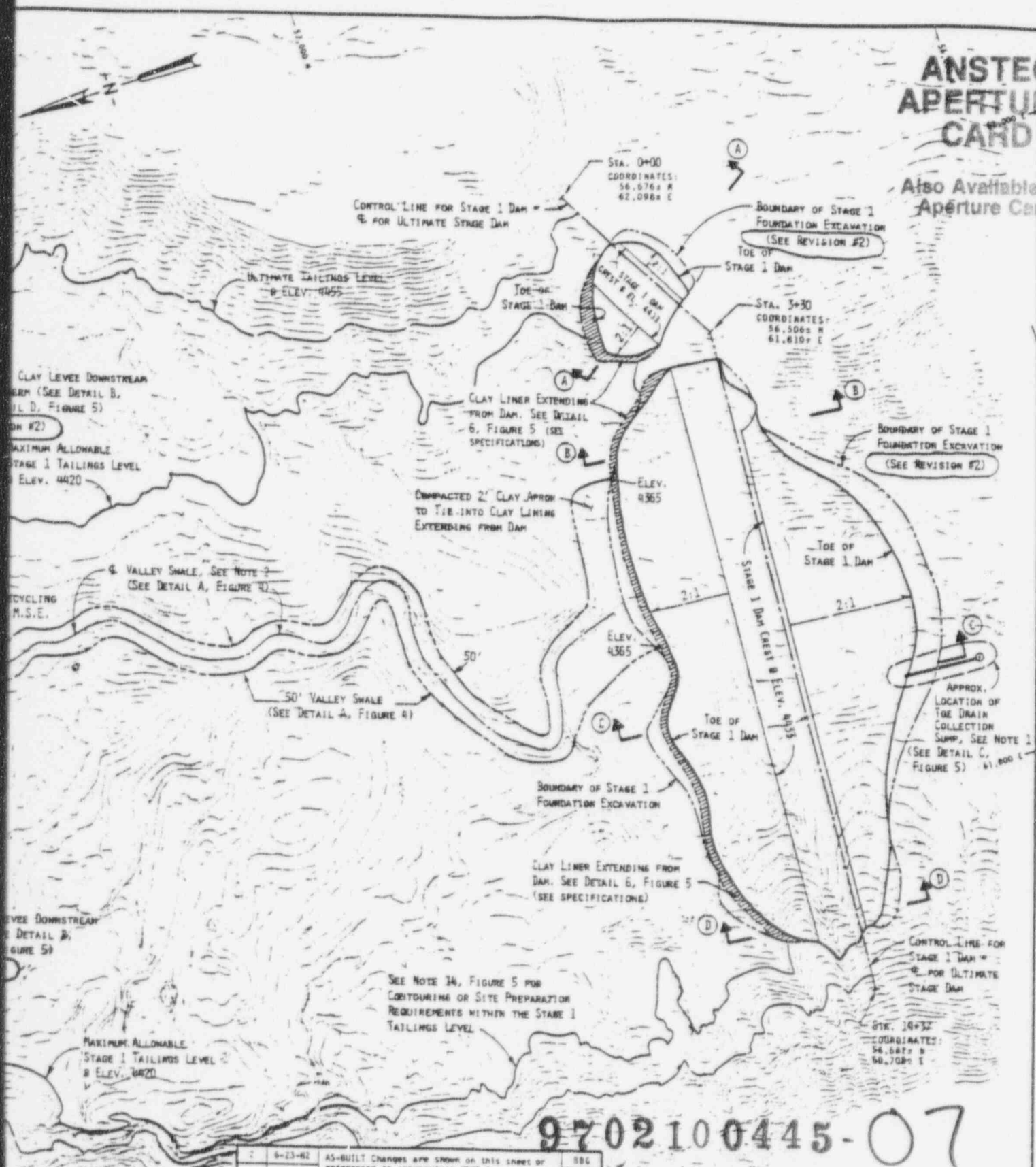
Project No. 60255J  
 Woodward-Clyde Consultants

Figure 2



# ANSTEC APERTURE CARD

Also Available on  
Aperture Card



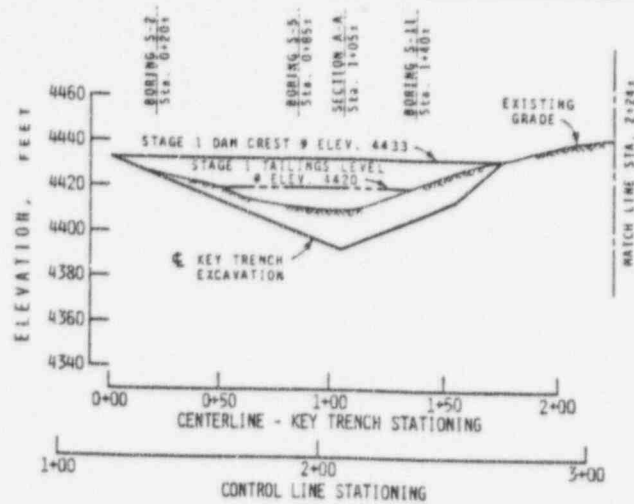
9702100445-07

2	6-23-82	AS-BUILT Changes are shown on this sheet or referenced to appropriate MSN Drawings. These include: Drawings--- 1) Dam Area Plan and Profile; 2) Impoundment Area Topo Map, Drain Pipes and Piezometers, Cross Valley Berm and Upper Impoundment, Zone 1 Finish Grade; 3) SA, 11-58, 11-5C (As-Built Profile, A' and B' Drain Pipe Impoundment Area); 4) 6 (Typical Section - Cross Valley Berm)	886
1	6-8-80	ADDED ADDITIONAL INTERIOR (VAL. DRAIN PIPE) AND COORDINATES OF THE 11-5C (As-Built Profile)	886, 887
No.	DATE	REVISIONS	BY
R.L. NO.	1933	APPROVED:	
DATE	5-24-79	<i>Donald B. Gordon</i>	

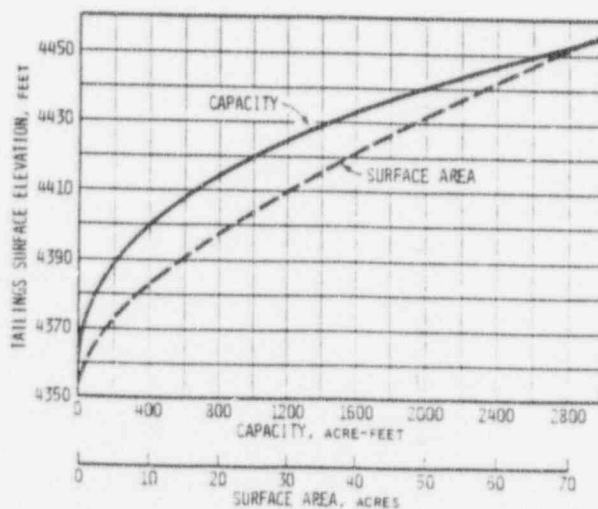
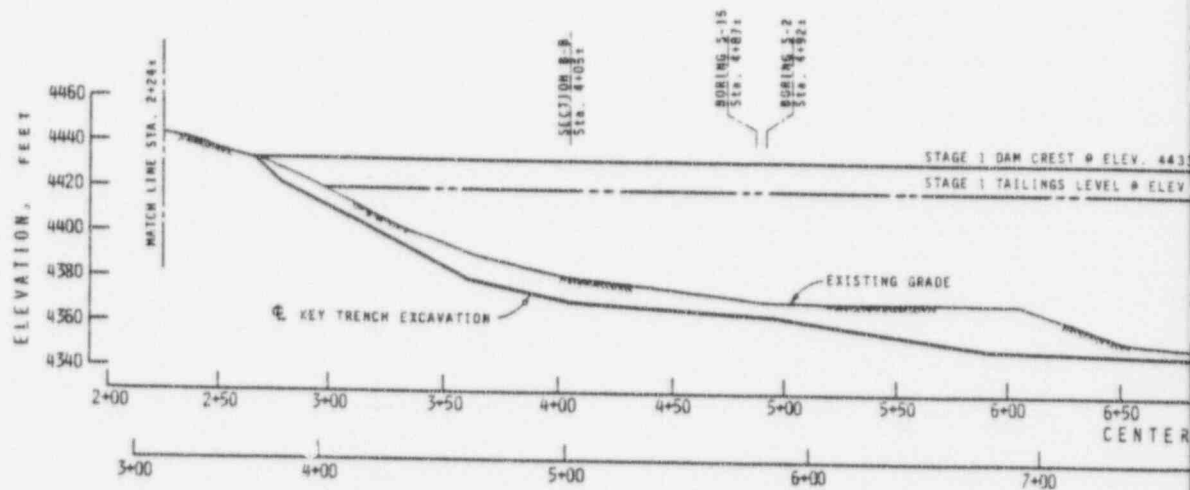
**IMPOUNDMENT AREA PLAN VIEW**  
PLATEAU RESOURCES LIMITED  
SHOSHONE CANYON URANIUM PROJECT  
Garfield County, Utah

Project No. 60255J  
Woodward-Clyde Consultants

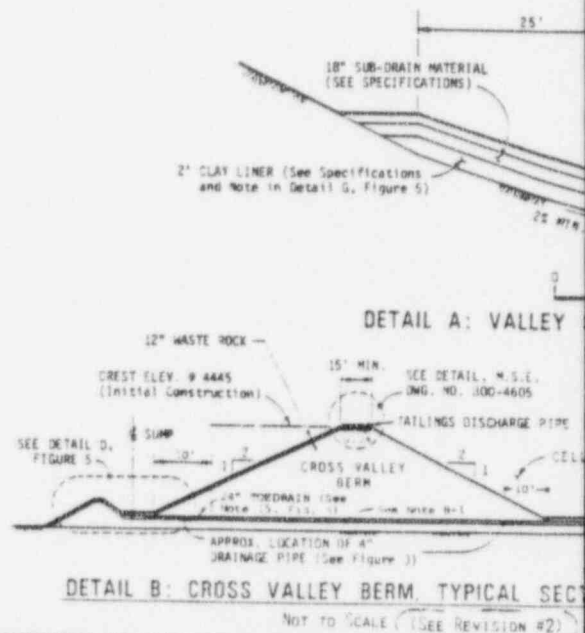
Figure 3

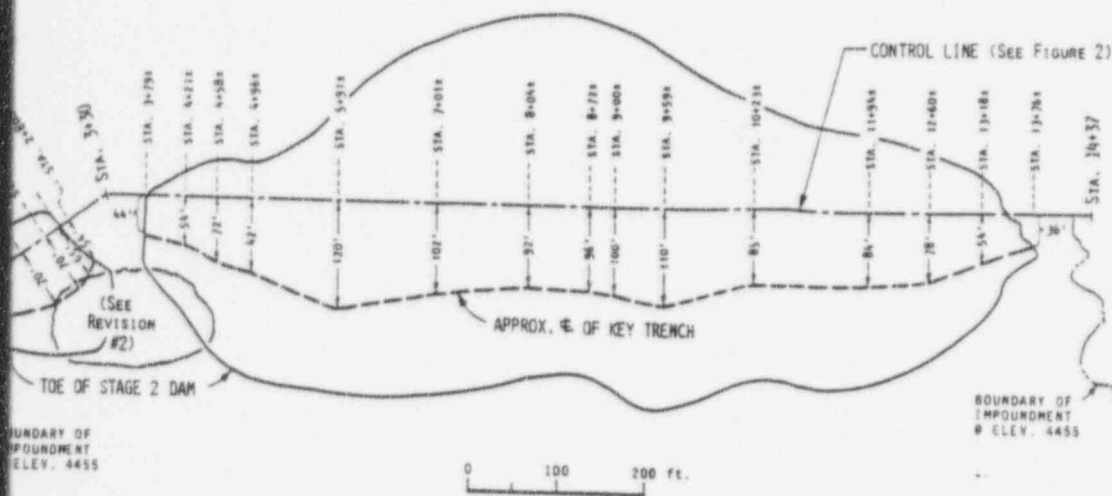


PROFILE - SADDLE SECTION  
AT KEY TRENCH  
(SEE REVISION #2)



SURFACE AREA AND CAPACITY CURVES  
(BASED ON EXISTING TOPOGRAPHY)





PLAN - CENTERLINE KEY TRENCH

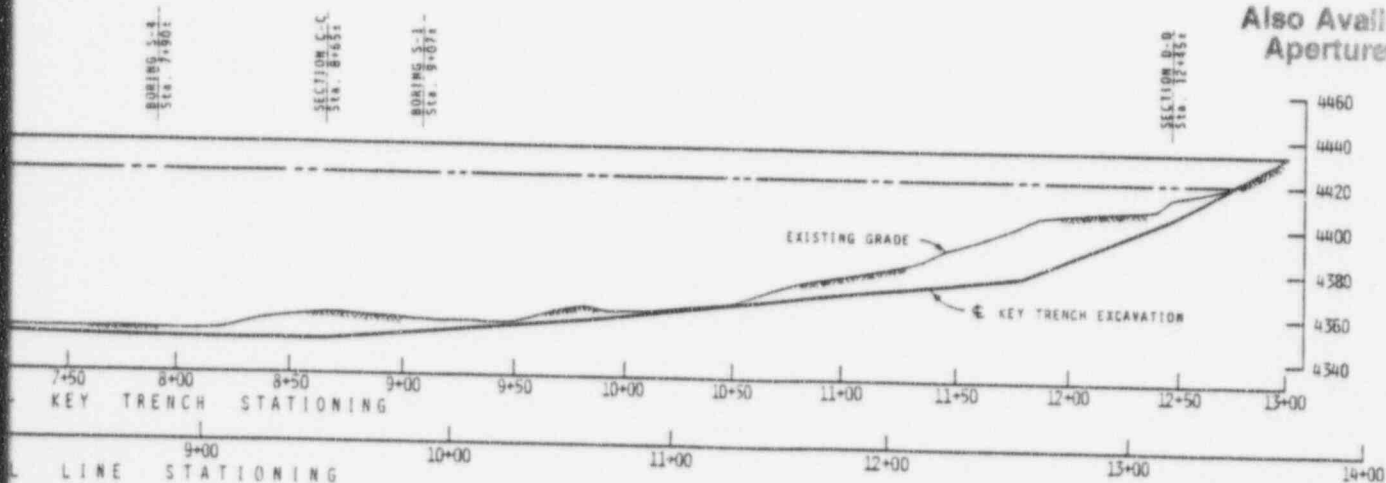
NOTE:

THE FINAL ALIGNMENT OF THE KEY TRENCH IS SUBJECT TO THE FIELD CONDITIONS AND MAY BE ADJUSTED BY THE ENGINEER.

(SEE REVISION #2)

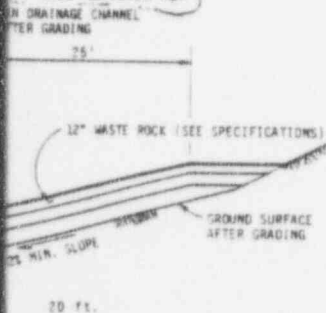
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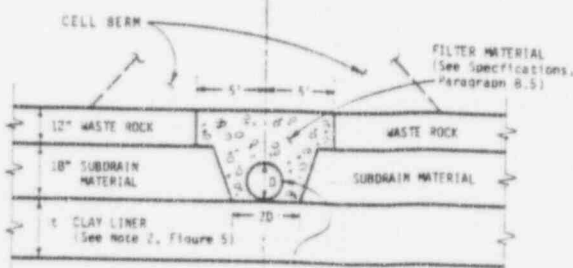
MAIN VALLEY SECTION  
AT KEY TRENCH

(SEE REVISION #2)



TYPICAL CROSS SECTION)

8-1) For all berms excluding the most downstream cross valley berm, a single 4\"/>



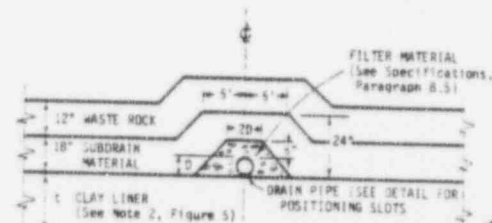
PIPE DETAIL FOR PIPES UNDER CELL BERMS

SCHEMATIC: NOT TO SCALE



SLOT POSITIONING AND DETAILS

- 1) PIPES SHALL BE SLOTTED AS FOLLOWS:  
3 ROWS OF SLOTS WITH CENTERLINES SPACED 120° AROUND THE CIRCUMFERENCE OF THE PIPE. THE SLOTS SHALL BE 0.05\"/>



PIPE DETAIL FOR PIPES NOT UNDER BERMS

SCHEMATIC: NOT TO SCALE

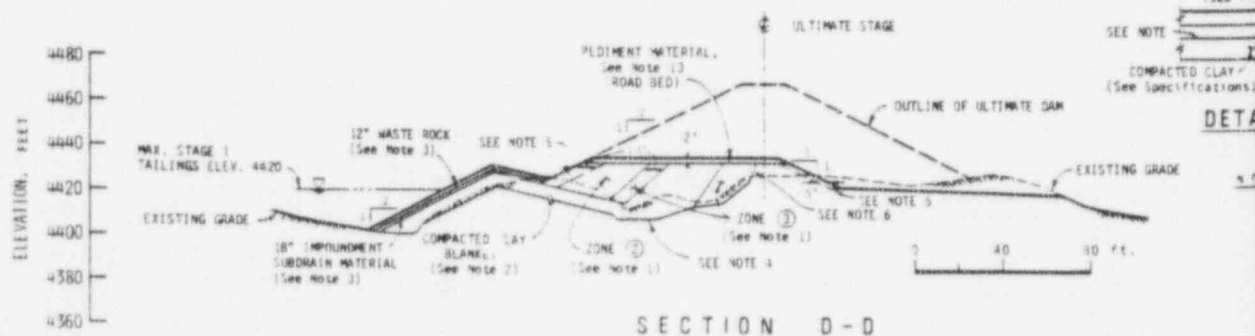
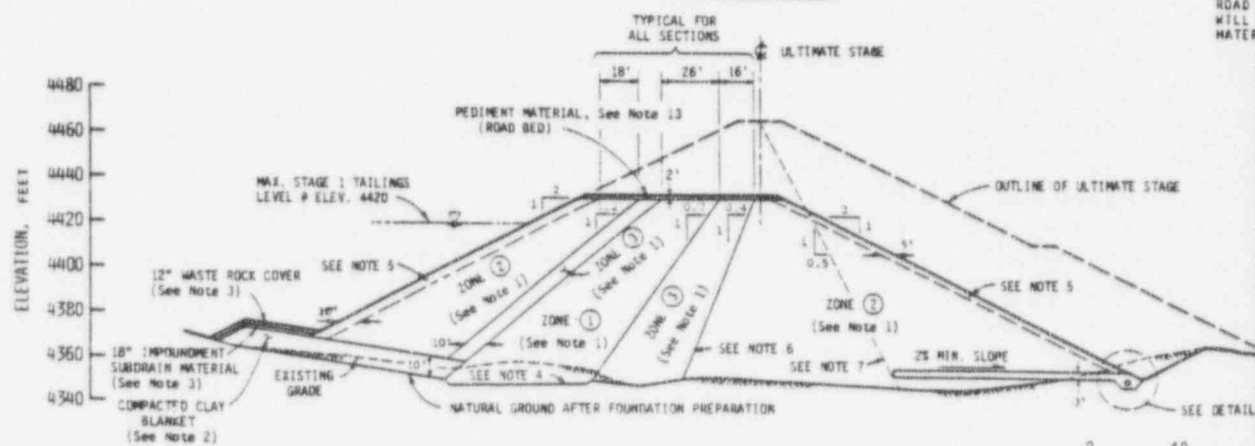
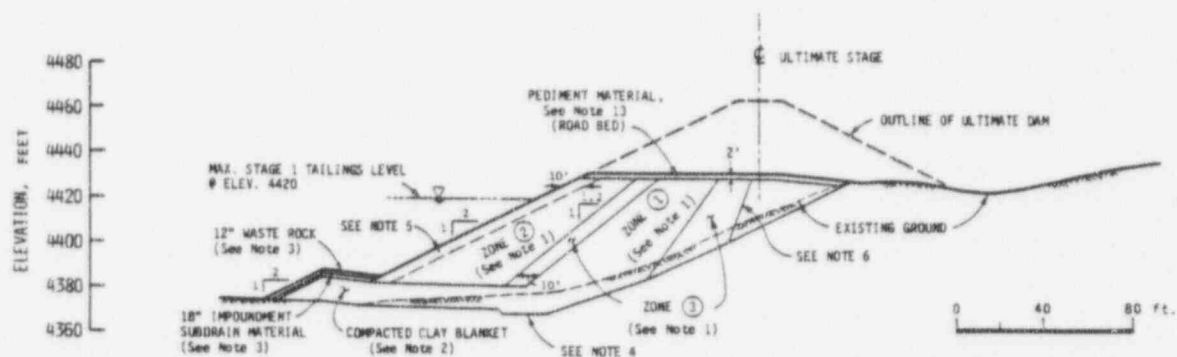
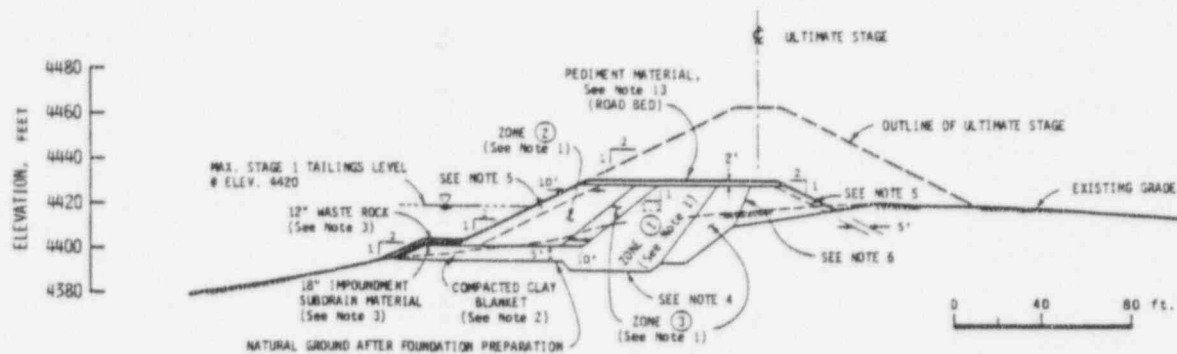
## CENTERLINE KEY TRENCH PLAN & PROFILE AND MISCELLANEOUS DETAILS

PLATEAU RESOURCES LIMITED  
SHOOTING CANYON URANIUM PROJECT  
Garfield County, Utah

No.	DATE	REVISIONS	BY
2	6-23-82	See Revision #2 on Figure 3	SBG
1	4-8-80	DIRECTED DETAILS A & B: PROVIDED NEW PIPE DETAILS UNDER CELL BERMS & NEW TRENCH BERM	DWG/DAP
APPROVED:			
DATE: 5-24-79			

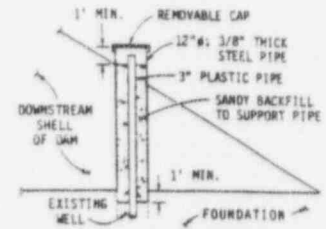
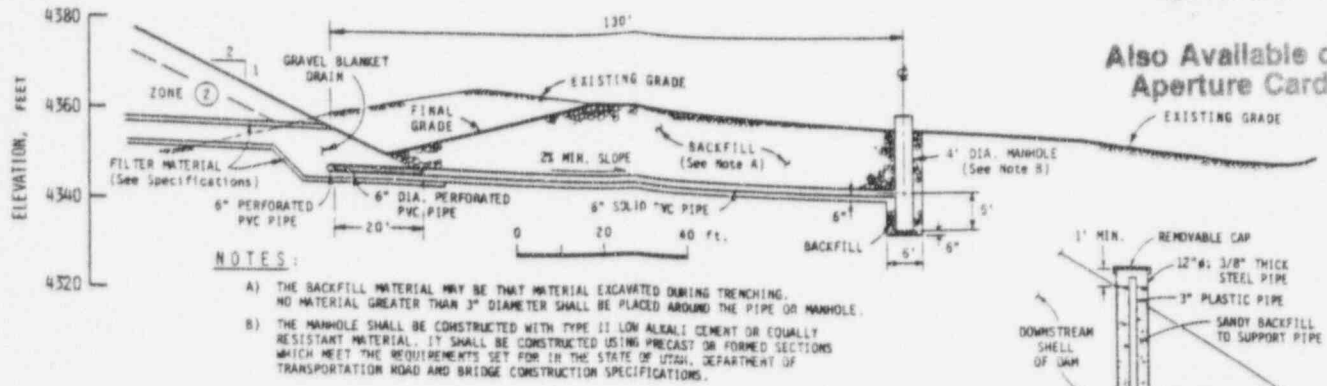
Project No. 60255J  
Woodward-Clyde Consultants

Figure 4

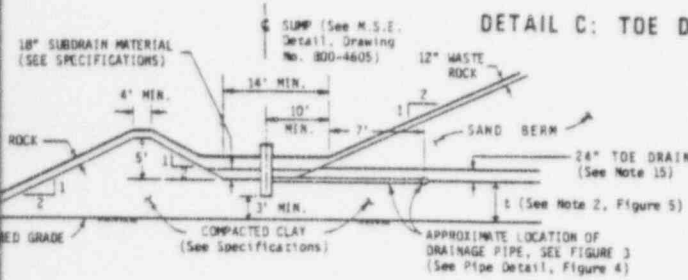


# ANSTEC APERTURE CARD

Also Available on  
Aperture Card



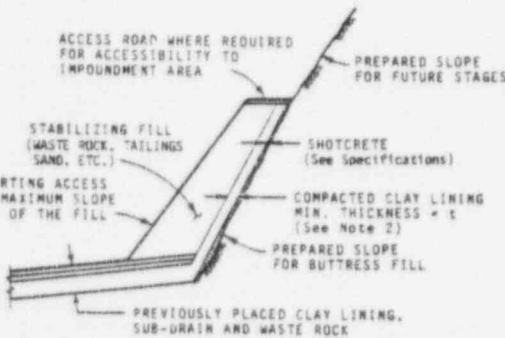
**DETAIL H: WELL EXTENSION AND PROTECTIVE CASING THROUGH DAM (NOT TO SCALE)**



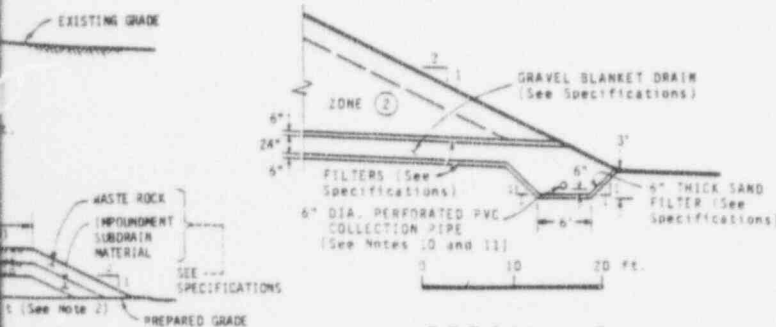
**DETAIL D: TYPICAL SECTION OF 5' CLAY LEVEE AND SUMP LOCATION (NOT TO SCALE)**

## NOTES:

1. ZONE ① - SILTY SANDY CLAYEY SOIL (SEE SPECIFICATIONS).
2. ZONE ② - BOULDERS, COBBLES, GRAVELS, SAND; THE MATERIAL OF THIS ZONE TO BE PLACED SO THAT THE FINER PORTION WILL BE ADJACENT TO ZONE ③ AND THE COARSER PORTION WILL BE AT THE OUTSIDE SLOPE SURFACES. (SEE SPECIFICATIONS).
3. ZONE ③ - FINE SAND (SEE SPECIFICATIONS; NO PROCESSING REQUIRED).
2. THICKNESS OF COMPACTED CLAYEY SOIL BLANKET TO BE 10% OF THE MAXIMUM HEAD, BUT NOT LESS THAN 2 FEET (SEE SPECIFICATIONS AND NOTE IN DETAIL G).
3. PROVIDE 18 INCHES EACH OF TRAFFIC COMPACTED WASTE ROCK AND TAILINGS SUB-DRAIN MATERIAL (SEE SPECIFICATIONS).
4. EXTEND ZONE ① TO SOUND BEDROCK AND PROVIDE SLUSH GROUT ON FOUNDATION CONTACT FOR ZONE ① (SEE SPECIFICATIONS).
5. ZONE OF UPSTREAM AND DOWNSTREAM SLOPE PROTECTION TO CONSIST OF PEDIMENT MATERIAL OF WHICH 90% IS COARSER THAN 12 INCHES (SEE SPECIFICATIONS).
6. DOWNSTREAM BOUNDARY OF ZONE ③ SHOWN IS MINIMUM REQUIREMENT.
7. EXTEND BLANKET DRAIN AND FILTERS FROM TOE TO LINE SHOWN, BUT NOT ABOVE ELEV. 4445.
8. DETAIL C: SEEPAGE THROUGH DAM TO BE COLLECTED IN SUMP; TOTAL COLLECTED SEEPAGE TO BE RETURNED TO POND (SEE M.S.E. DRAWINGS 800-4605).
9. THE CLAY BLANKET SHALL EXTEND 15' UPSTREAM OF THE TOE OF THE DAM AND THEN TAPER OFF AT A 1H:1V SLOPE. THE BLANKET WILL BE PROTECTED BY 18" OF SUB-DRAIN MATERIAL AND OF WASTE ROCK.
10. THE PERFORATED OR SLOTTED PIPE AND THE SOLID DRAIN PIPE IN THE TOE DRAIN OF THE DAM SHALL BE AT LEAST SCHEDULE 40 PVC PIPE (OR EQUAL). THE DRAIN PIPES PLACED IN THE IMPOUNDMENT AREA AND UNDER THE BERMS SHALL BE SCHEDULE 80 PVC PIPE.
11. ALL PIPES PLACED SHALL HAVE A MINIMUM SLOPE OF 1% POSITIVE TOWARDS ITS POINT OF DISCHARGE UNLESS OTHERWISE SPECIFIED. THE UPHILL END OF ALL PIPES SHALL BE CONTINUOUSLY ACCESSIBLE AND PLUGGED WITH REMOVABLE CAPS UNLESS OTHERWISE SPECIFIED.
12. ALL PIPES PLACED IN CONJUNCTION WITH THE CLAY LINER SHALL NOT EXTEND BELOW THE SURFACE OF THE CLAY LINER. THE PLACEMENT AND BACKFILL CRITERIA SHALL BE AS SHOWN IN THE PIPE DETAILS ON FIGURE 4.
13. PEDIMENT MATERIAL FOR THE ROAD BED SHALL BE THAT PORTION OF THE ZONE ② MATERIAL WHICH IS LESS THAN 4" DIAMETER.
14. INsofar AS PRACTICAL, THE MAXIMUM GRADE OF A SLOPE PREPARED TO RECEIVE A CLAY LINER SHALL BE 1H:1V UNLESS OTHERWISE APPROVED BY THE GEOTECHNICAL ENGINEER. THE CLAY LINER IS TO BE PLACED ON EXPOSED BEDROCK OR COMPACTED FILL. TRIM BLASTING TO ACHIEVE THE SLOPE CRITERIA WILL BE PERMITTED. COMPACTED FILL MATERIAL MAY BE OBTAINED FROM ADJACENT AREAS OF CUTS OR ZONE ③ AND ④ BORROW AREAS, AS NECESSARY (SEE SPECIFICATIONS).
15. THE TOE DRAIN MATERIAL IN THE CROSS VALLEY BEAM SHALL BE OBTAINED BY MIXING GRAVEL BLANKET DRAIN MATERIAL (PARAGRAPH 7.2.4) AND FILTER MATERIAL (PARAGRAPH 7.2.5) AT APPROXIMATELY A 1:1 RATIO BY WEIGHT. THE RESULTING GRADATION SHALL BE DETERMINED AND SUBMITTED TO THE GEOTECHNICAL ENGINEER FOR APPROVAL PRIOR TO CONSTRUCTION OF THE TOE DRAIN.



**DETAIL E: BUTTRESS FILL TYPICAL CROSS SECTION NOT TO SCALE**



**DETAIL F**

**CLAY LINING NOT TO SCALE**

9702100445 - 09

**STAGE I EMBANKMENT  
CROSS SECTIONS AND DETAILS  
PLATEAU RESOURCES LIMITED  
SHOOTING CANYON URANIUM PROJECT  
Garfield County, Utah**

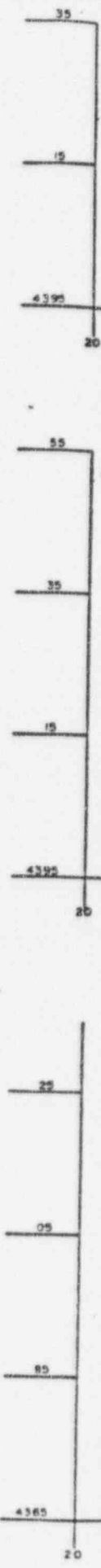
2	6-23-82	AS-BUILT Corrections are shown on HSM Drawing 1-4 or as noted in revision #2 on Figure 3.	DRG
1	4-8-80	CORRECTED DETAIL 3; ADDED NOTE 15, UPRATE 11; WHY THE DETAIL MODIFIED NOTES 2, 3, 11, 12	BBG/DAP
No.	DATE	REVISIONS	By
R.E. NO.	1933	APPROVED:	
DATE	5-24-79	<i>Bernard B. ...</i>	

Project No. 60255J  
**Woodward-Clyde Consultants**

Figure 5



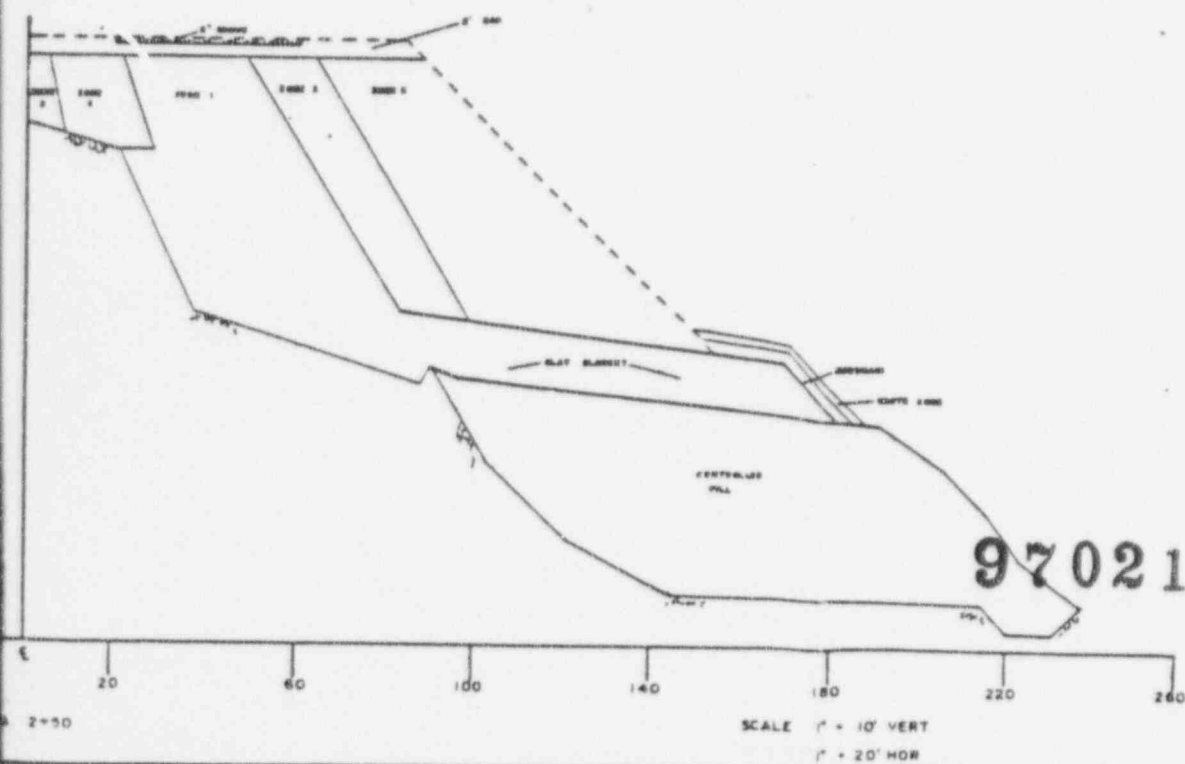
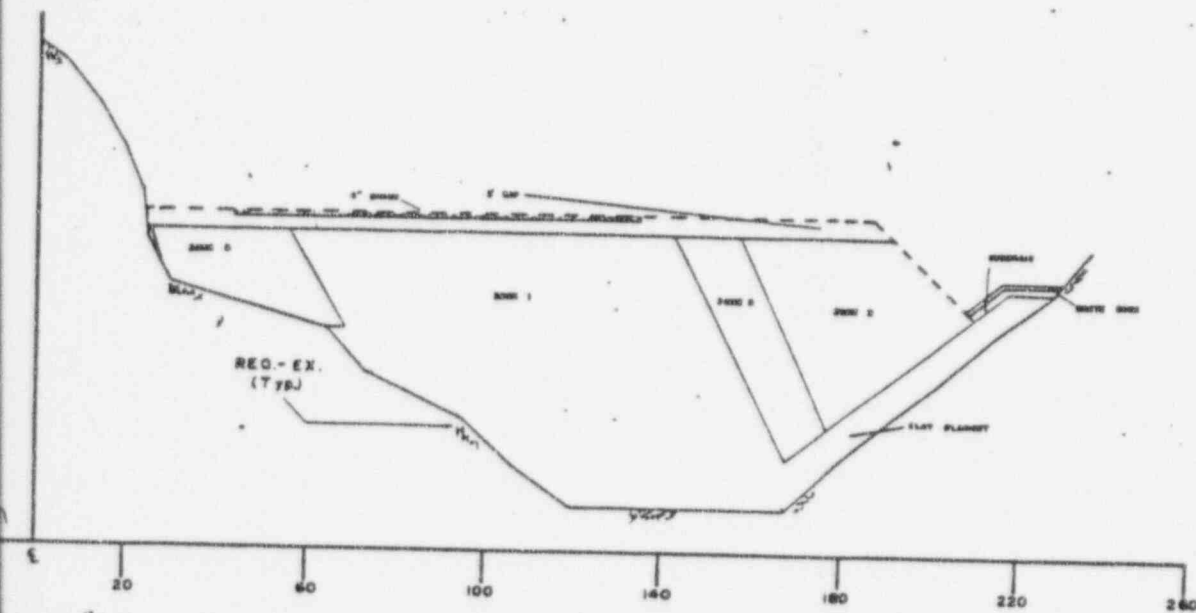
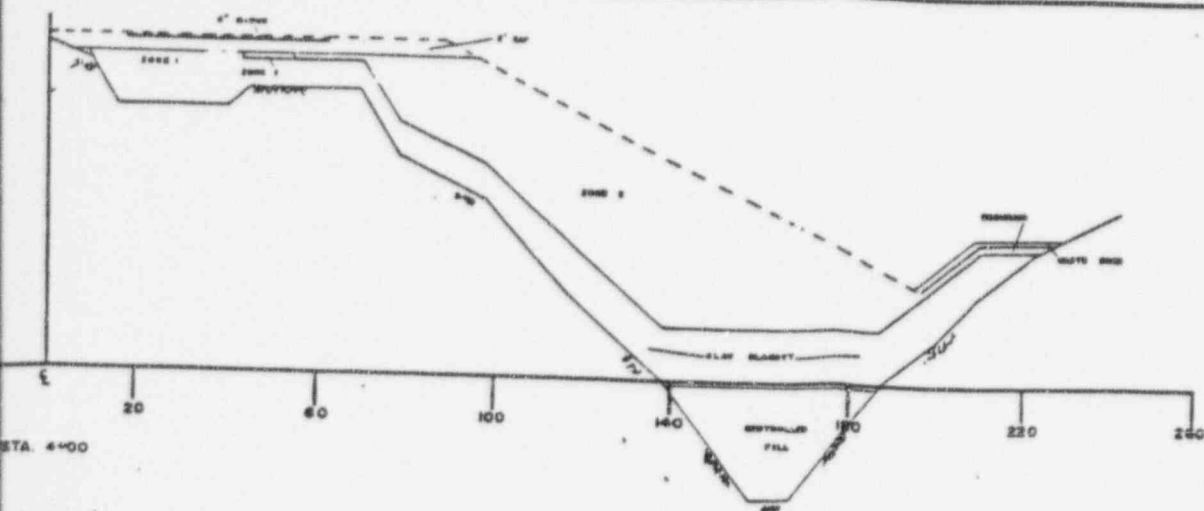
REQUIRED EXCAVATION  
TOPO  
Scale 1" = 60'



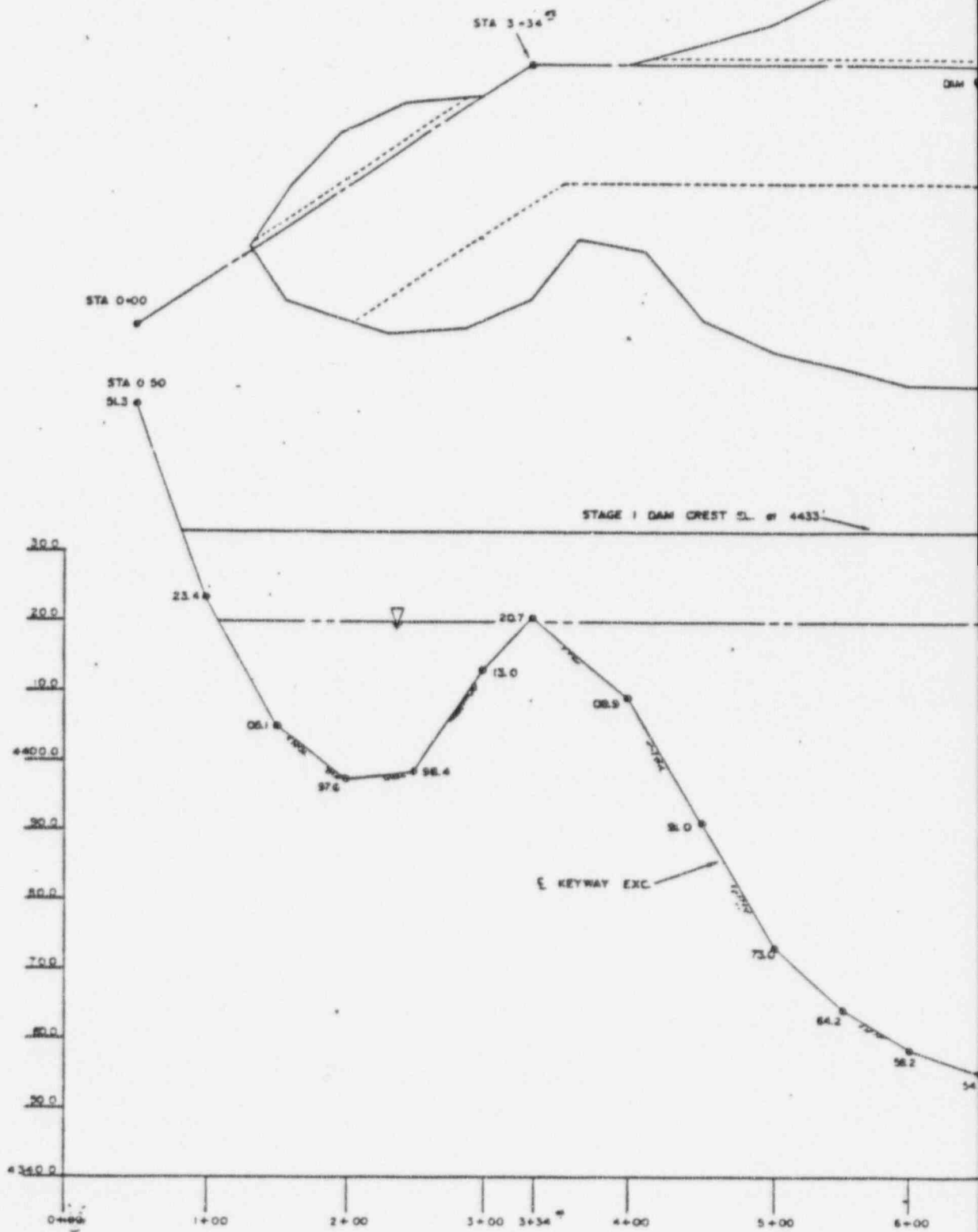
PLATEAU RESOURCES LTD URANIUM FACILITIES SHOOTING CANYON UTAH	AS-BUILT PLAN STA. 2+50 to 4+00 FOUNDATION FILL		MOUNTAIN STATES ENGINEERS TUCSON ARIZONA	
	I-4		I-4	
	I-4		I-4	
	I-4		I-4	

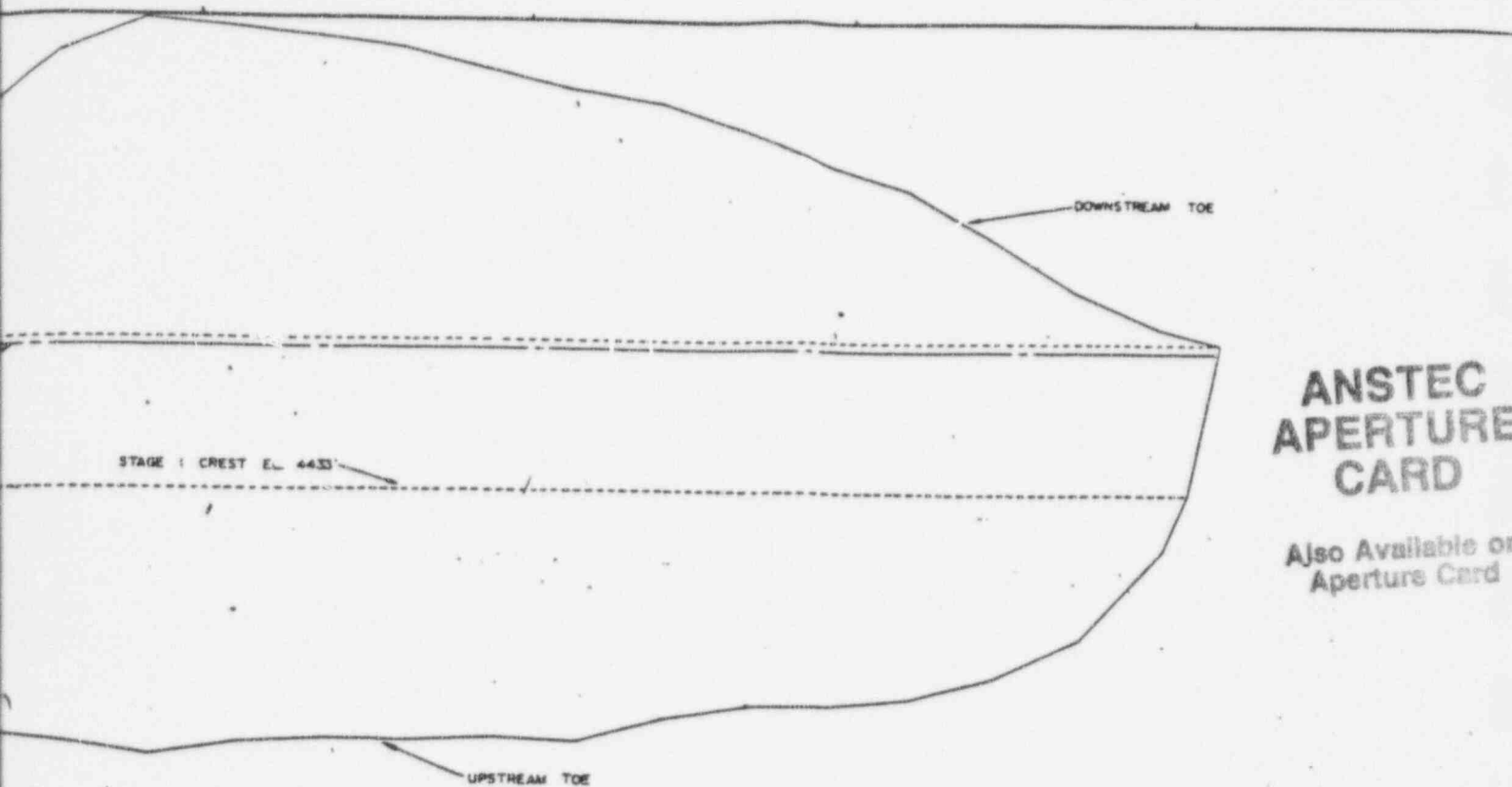
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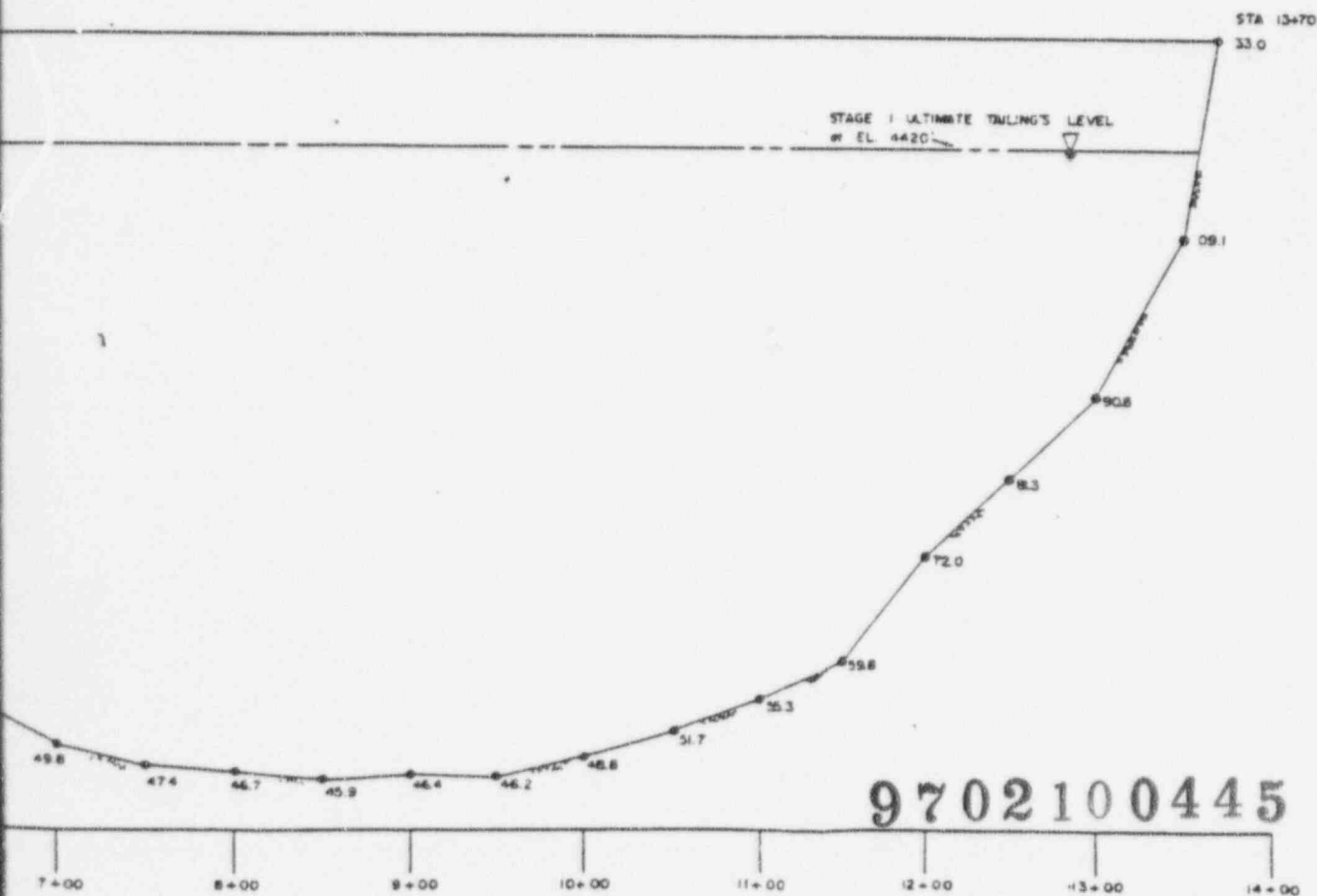
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**ANSTEC  
APERTURE  
CARD**

Also Available on  
Aperture Card



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DESIGN	DATE
CHECKED	DATE
JOB NO.	
DIST. NO.	
CONST. NO.	
ANAL. NO.	
Q. NO.	

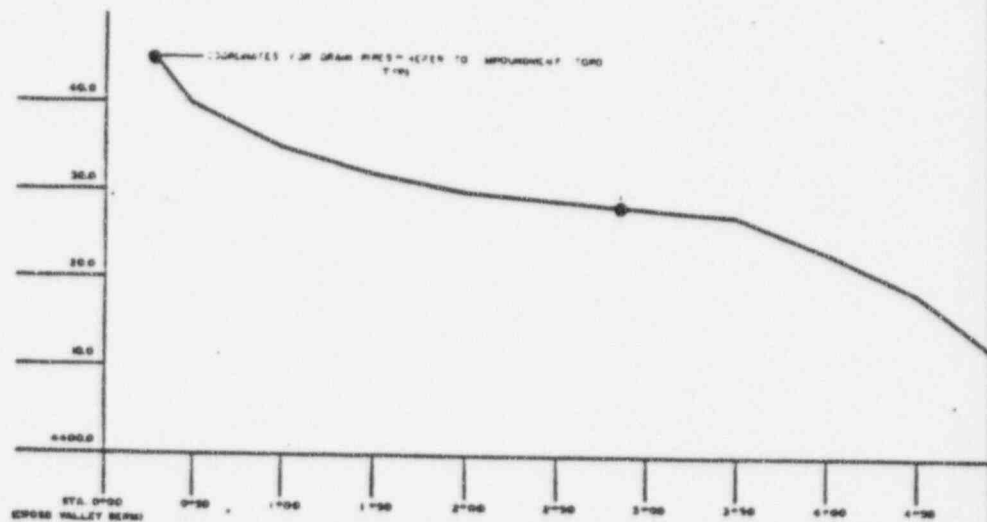
PLATEAU RESOURCES LTD.  
URANIUM FACILITIES  
SHOOTING CANYON  
UTAH

DAM AREA  
PLAN AND PROFILE

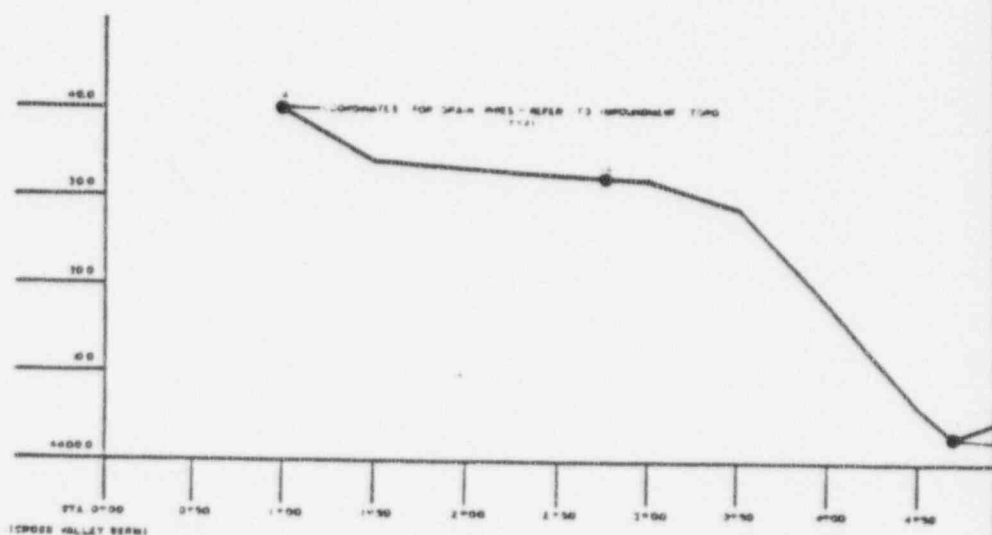
mountain states engineers	ARIZONA
TUCSON	
SCALE: 1" = 100'	
I-1	



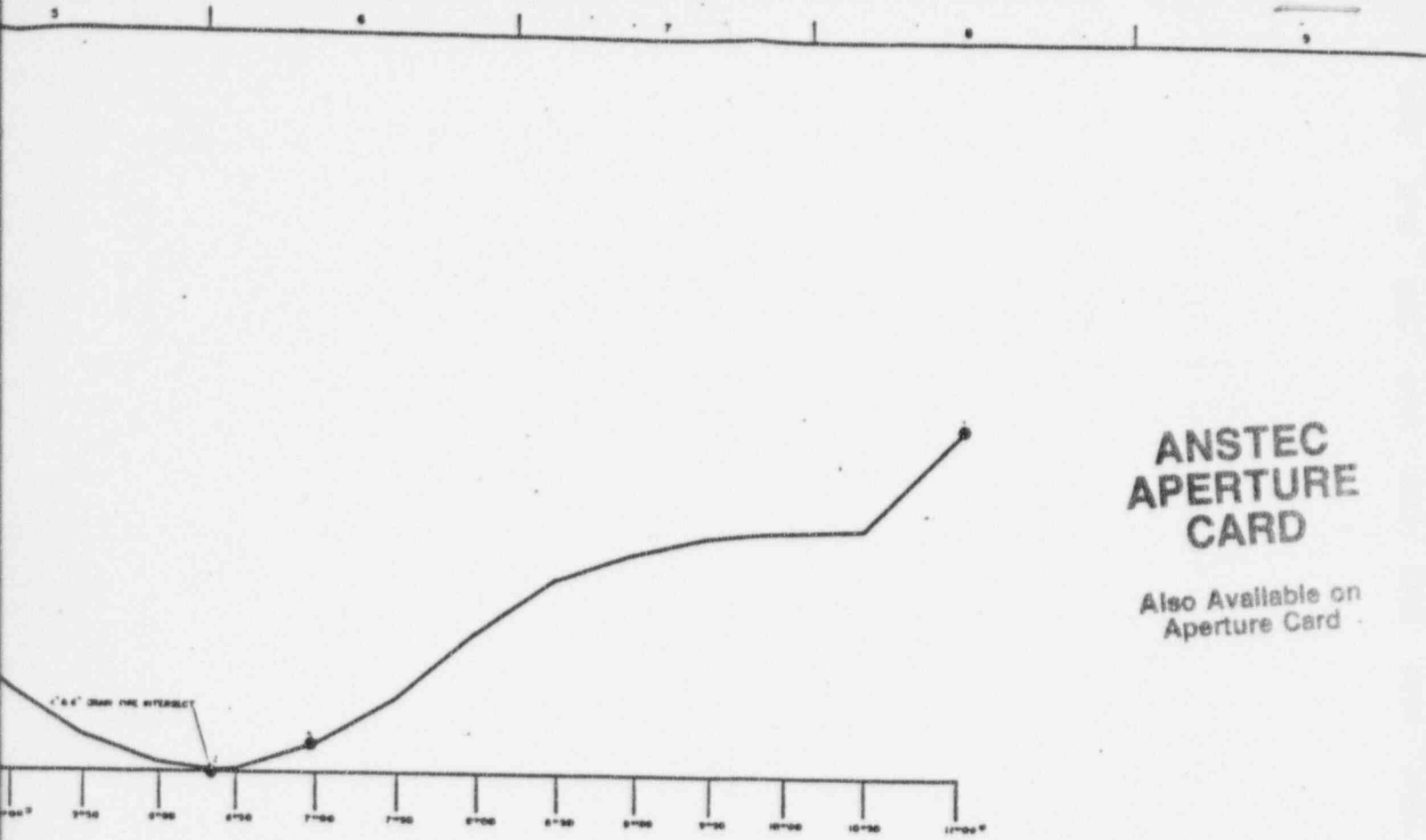




DOWNSTREAM 4'



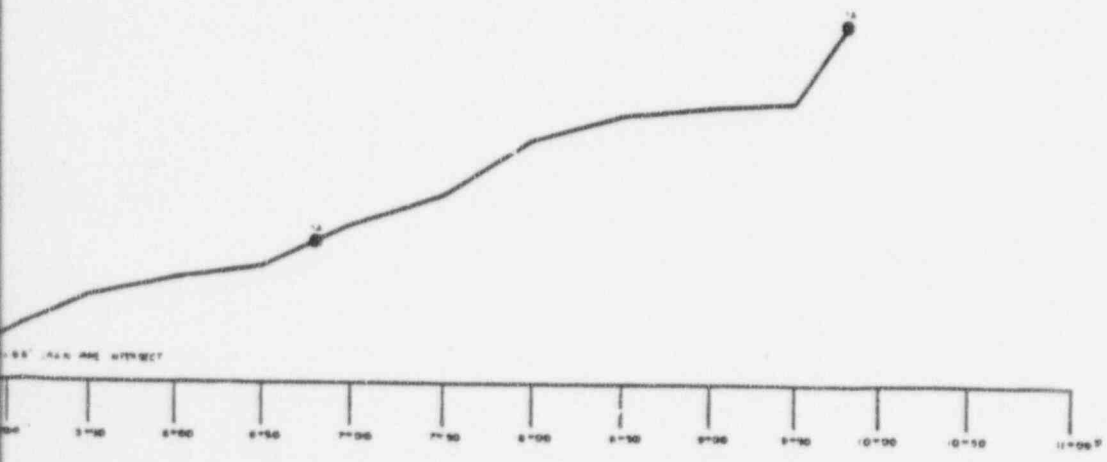
UPSTREAM 4'



# ANSTEC APERTURE CARD

Also Available on  
Aperture Card

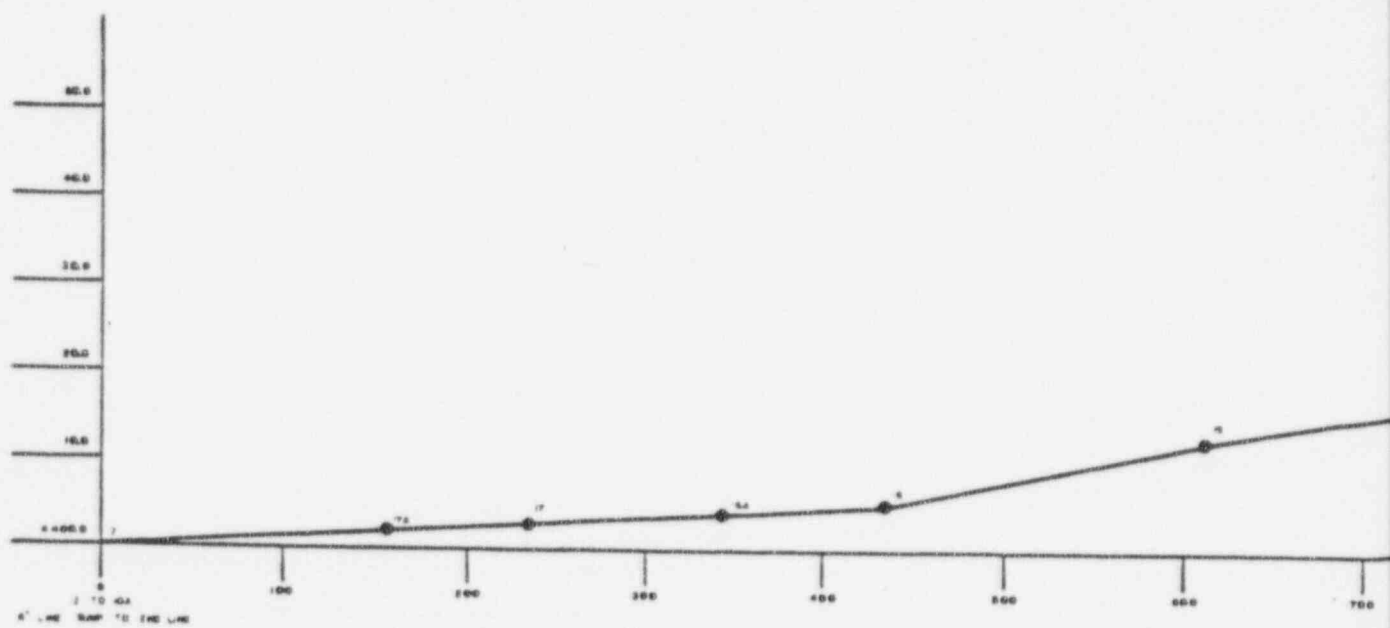
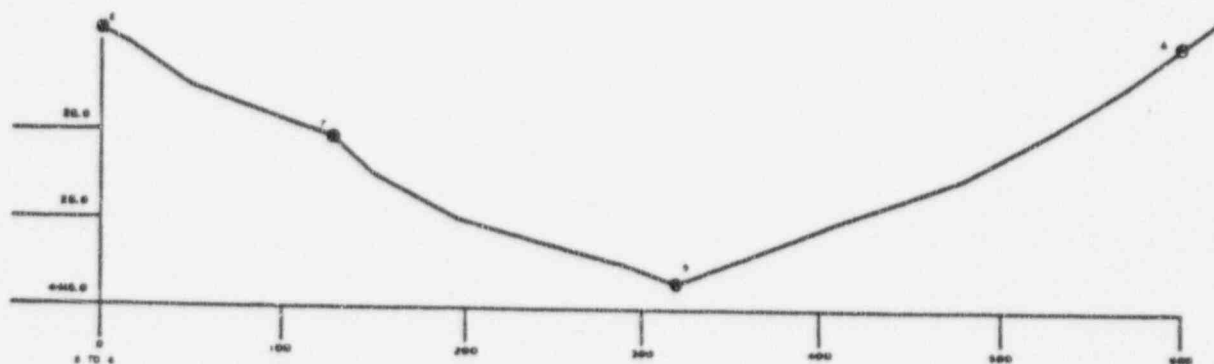
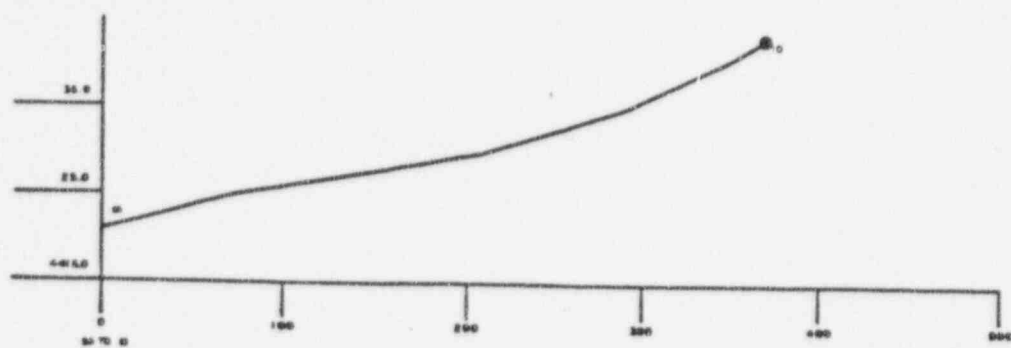
RAIN PIPE - UNDER CROSS VALLEY BERM

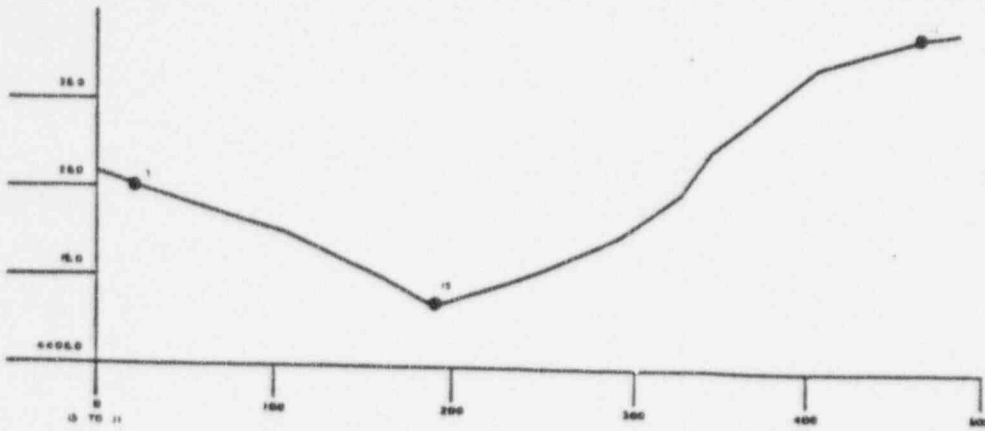


RAIN PIPE - UNDER CROSS VALLEY BERM

9702100445 -13

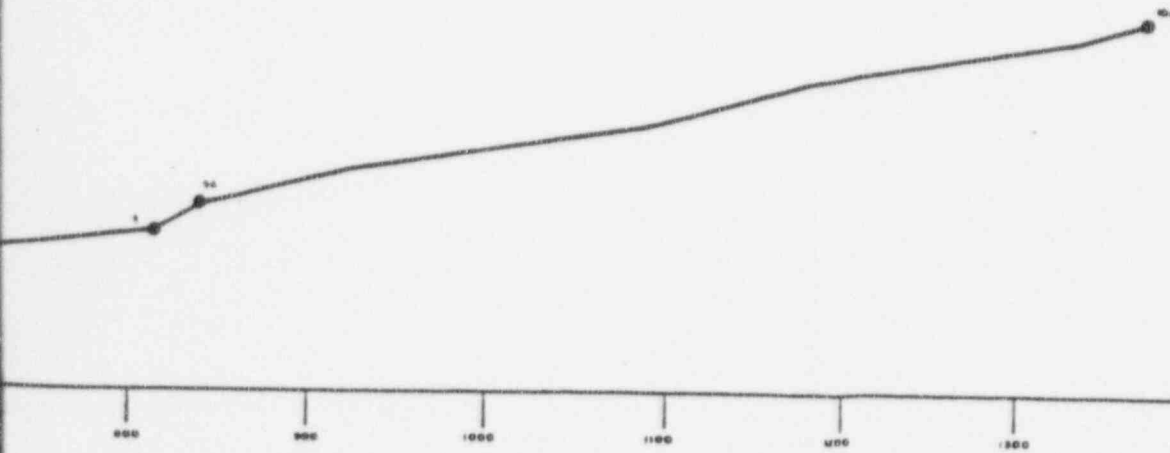
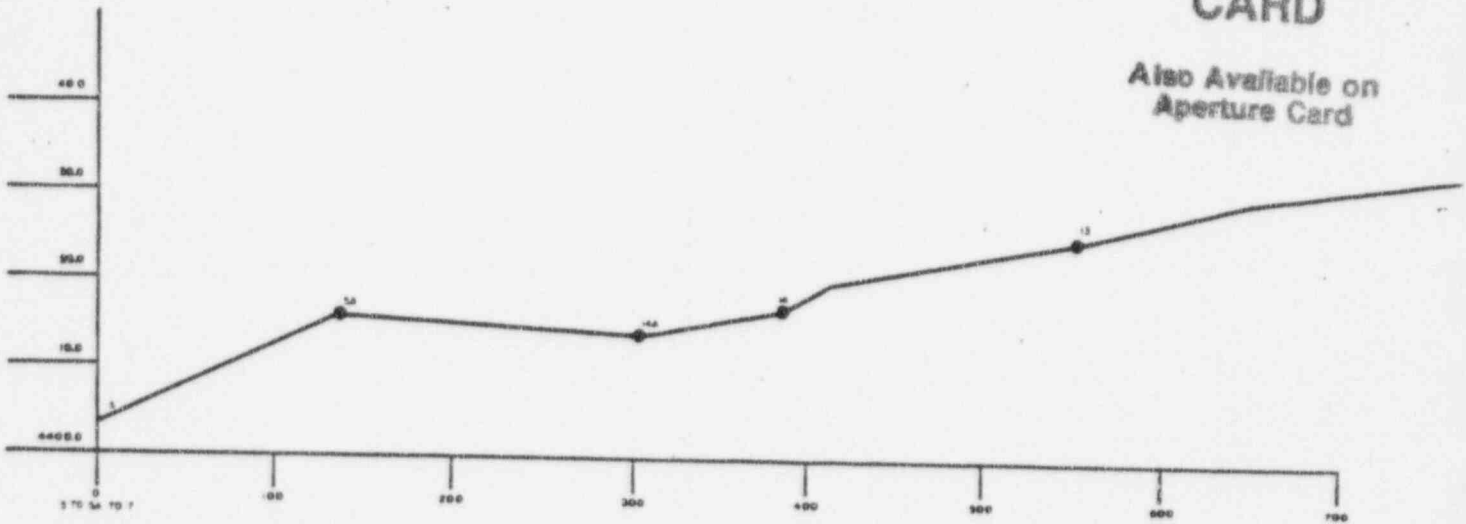
<div> <div>DATE</div> <div>1-10-68</div> </div>	PLATEAU RESOURCES LTD	<div>AS-BUILT PROFILE</div> <div>4' 8.6" DRAIN PIPE</div> <div>IMPOUNDMENT</div> <div>AREA</div>
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**ANSTEC  
APERTURE  
CARD**

Also Available on  
Aperture Card



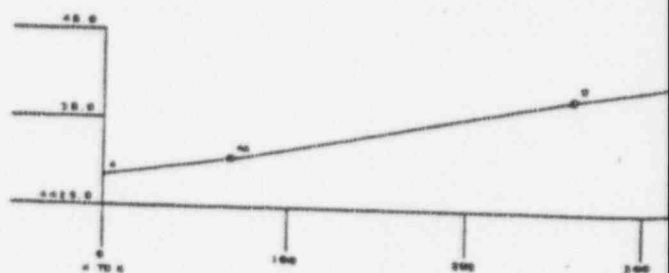
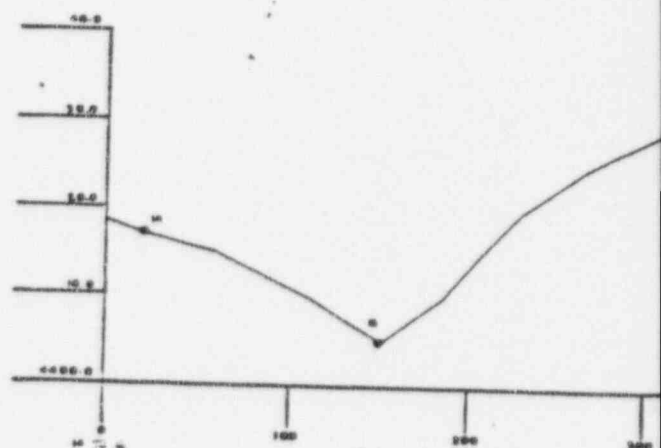
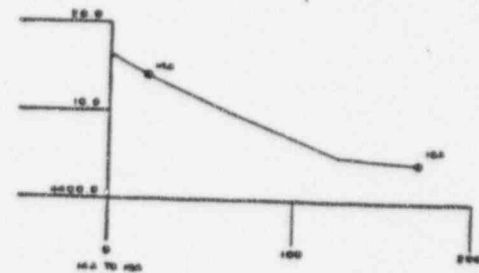
9702100445-14

DATE	
TIME	
BY	
FOR	
PROJECT	
CLIENT	

PLATEAU RESOURCES LTD.  
URANIUM FACILITIES  
SHOOTING CANYON  
UTAH

AS-BUILT PROFILE  
4" & 6" DRAIN PIPE  
IMPOUNDMENT  
AREA

mountain states engineers  
TUCSON ARIZONA  
II-5-B



# ANSTEC APERTURE CARD

Also Available on  
Aperture Card

9702100445 -15

Drawn by	1	2
Checked by	1	2
For issue	1	2
By		
For use		
Client		

PLATEAU RESOURCES LTD.  
URANIUM FACILITIES  
SHOOTING CANYON  
UTAH

AS BUILT PROFILE  
4" 86" DRAIN PIPE  
IMPOUNDMENT  
AREA

mountain states engineers

TUCSON

ARIZONA

SCALE 1" = 10'

II-5-C



4450.0

40.0

30.0

20.0

10.0

4400.0

90.0

5' CLAY LEVEE

SUMP

12" WASTE ROCK

TOE DRAIN

3' MIN.

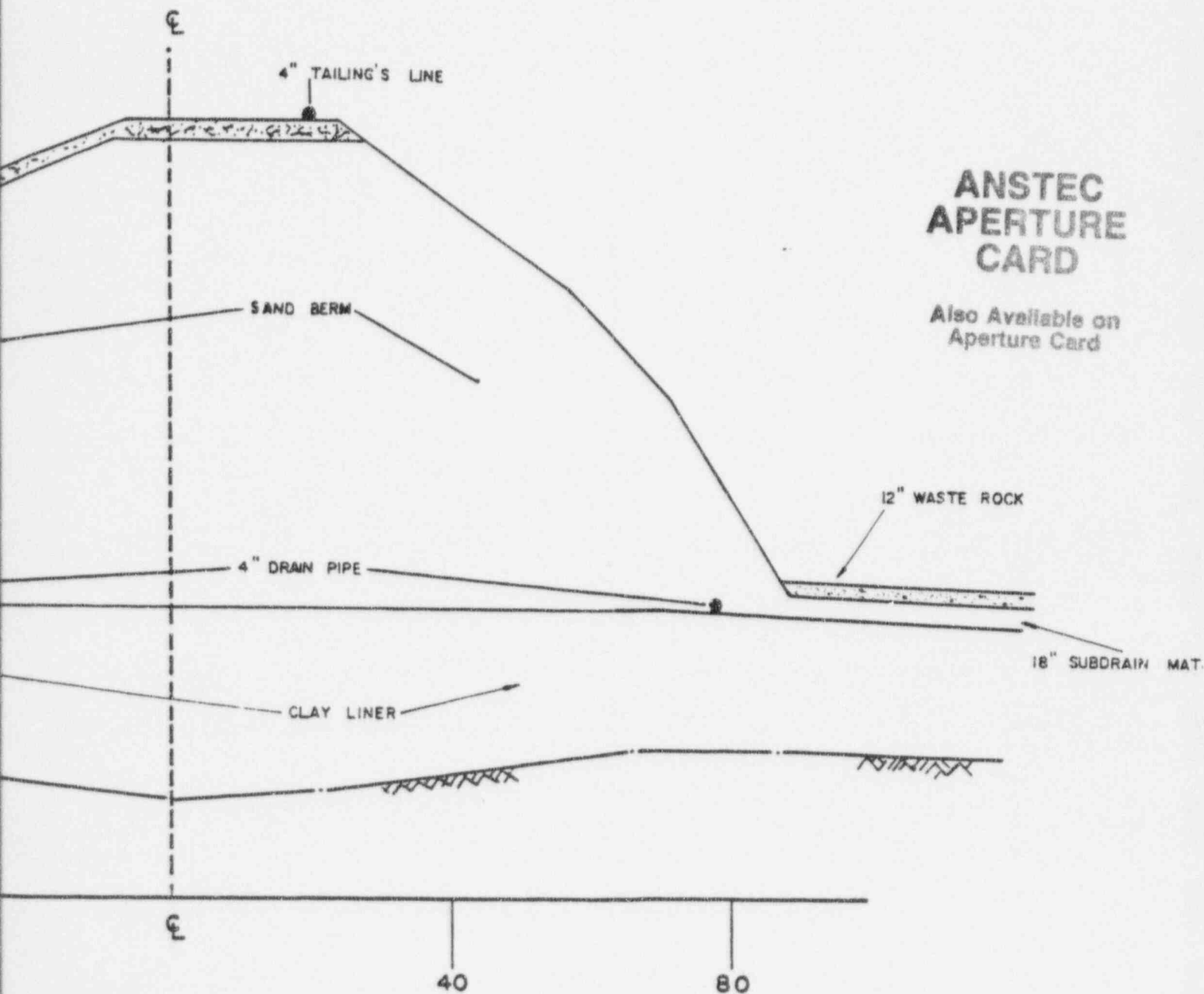
REQ. FOUNDATION EXC.

120

80

40

DRAWN
CHECKED
JOB ENG
DEPT HD
CONST M
PROJ MG



9702100445 - 16

<div> <div> <div>3-17-81</div> </div> </div>	<div> <div>PLATEAU RESC'S LTD.</div> <div>URANIUM FACILITY</div> <div>SHOOTERING CANYON</div> <div>UTAH</div> </div>	<div> <div>DRAWING TITLE</div> <div>TYPICAL SECTION</div> <div>CROSS VALLEY</div> <div>BERM</div> </div>	<div> <div>mountain states eng'rs</div> <div>TUCSON ARIZONA</div> <div>SCALE 1" = 10' V 1" = 20' H</div> <div>REV N</div> <div>II-6</div> <div>JOB NO. 435</div> <div>3-15-81</div> </div>
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