Project No. RM78-682C
May 81

4127

D'APPOLONIA

# Engineer's Report

# Second Phase Design – Cell 3 Tailings Management System

## White Mesa Uranium Project
## Blanding, Utah

Energy Fuels Nuclear, Inc.
Denver, Colorado

Engineer's Report

# Second Phase Design – Cell 3 Tailings Management System

D'APPOLONIA

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# 1.0 INTRODUCTION AND SUMMARY

This report presents the final design of the Second Phase, Cell 3 and safety dike (Cell 4 dike), of the White Mesa Uranium Project Tailings Management System. The White Mesa Uranium Project is owned and operated by Energy Fuels Nuclear, Inc. and is located in southwestern Utah about six miles south of Blanding, as shown in Figure 1.

The Tailings Management System consists of four cells for tailings solids retention and an evaporation pond for tailings water retention and evaporation. The complete system has been conceptually designed and is presented in the report entitled "Engineer's Report, Tailings Management System," June 1979 (D'Appolonia, 1979). This report contains the final designs for the Initial Phase of the system and the conceptual layout of the remainder of the system.

The Initial Phase of the Tailings Management System was constructed in late 1979 and early 1980 and became operational in May 1980. This phase of the system is designed to retain approximately 3.5 years of tailings at the maximum design production rate from the mill of 2,000 tons per day. The second phase of the system will provide an additional approximately 3.9 years of tailings storage.

This report presents the final designs of the Second Phase of the system including drawings and guideline construction specifications, results of site investigations, laboratory testing, and description of work conducted and analysis. Section 2 discusses briefly the background for the tailings system design including system requirements and site conditions. These topics are dicussed in detail in D'Appolonia 1979, and reference to this report is made for detailed information. Section 3 presents the Cell 3 design details including construction considerations, lining design, and drain system designs. Section 4 presents the design for the dikes including site investigation and testing, stability analysis, and construction considerations. Section 5 discusses the groundwater monitoring program for the Second Phase System including sealing existing wells and installation of new wells.

## 1.1 SUMMARY

The Second Phase of the Tailings Management System consists of Cell 3 and safety dike (Cell 4 dike). The design of Cell 3 is similar to the conceptual design in D'Appolonia 1979, and incorporates features included in Cell 2 design and construction. Cell 3 is a partially excavated impoundment formed by dike fills across the northern and southern cell sides and by excavation of soil and rock within the cell. The excavated material is used in fill construction.

Cell 3 is lined with 30 mil thick polyvinyl chloride (PVC) synthetic liner material. A drain system for removing excess tailings water from the pond is located above the liner in the lowest area of the cell. Water collected in the drain will be pumped back to the evaporation pond, Cell 1. As a precaution, an underdrain system including a drain layer on the upstream face of the excavation and dike fill surface will be located under the liner. This underdrain system will collect leakage through the liner, thereby minimizing tailings water contact with the dike fill material.

The safety dike for the Second Phase of the system is the Cell 4 dike. This dike is a homogeneous compacted earthfill which will be constructed of material excavated from within Cell 4. The dike has 3 to 1, horizontal to vertical, side slopes and a 20 foot wide crest at Elevation 5,595. The design of this dike is the same as the Initial Phase Dike design. It was based on site investigations and laboratory testing of the fill material within Cell 4 and the foundation material beneath the dike.

The final design of the Second Phase of the system is based on the same criteria as the Initial Phase of the system, with the exception of the tailings material density. A value of 80 pounds per cubic foot in-place density for the tailings was used in estimating the capacity of Cell 3. This density value is about 13 percent lower than the value of 92 pounds per cubic foot used in the Initial Phase design. It is based on site investigations conducted on the beached tailings in Cell 2.

The cell and dike designs incorporate the same features as the Nuclear Regulatory Commission approved designs for the Initial Phase of the system. Minor changes in the design system piping have been made to facilitate installation. No operational changes in the systems have been made. Coarse tailings are utilized as cover material over the liner to maximize cell storage capacity, provide a functional drain layer, and minimize construction costs. The operational groundwater monitoring system has been expanded to included the Second Phase with the same design criteria used as for the previous work.

Respectfully submitted,

Corwin E. Oldweiler
Project Engineer

Michael J. Taylor
Project Manager/Partner

MJT:par

# 2.0 SECOND PHASE SYSTEM DESIGN

The design of the Second Phase of the Tailings Management System consists of the final sizing of Cell 3, liner and appurtenant facilities detailing, stability analysis for Cell 3 dike, and investigation and design of the safety dike for the Second Phase (Cell 4 dike).

## 2.1 SYSTEM REQUIREMENTS

The design requirements for the Second Phase System are the same as those for the Initial Phase of the System presented in D'Appolonia, 1979. Included in these requirements are:

- o Tailings Solids and Water Storage Volumes
- o Below Grade Storage
- o Environmental Considerations
- o Construction Considerations
- o Safety and Spill Prevention Features
- o Surface Water Controls
- o Groundwater Monitoring

For discussion of these subjects, reference is made to D'Appolonia 1979. The system requirements for the tailings solids storage has been revised from the Initial Phase work based on testing of the deposited tailings in Cell 2. This work indicated an average tailings density of 80 pounds per cubic foot rather than the 92 pounds per cubic foot as previously used. At the 2000 tons per day maximum mill production rate for 340 days per year operation, the volume of tailings is 390 acre feet per year at density of 80 pounds per cubic feet.

## 2.2 SITE CHARACTERISTICS

The site conditions for the Second Phase System are discussed in D'Appolonia, 1979. Included are discussions on the following subjects:

- o Geology
- o Surface and Groundwater Hydrology
- o Precipitation and Evaporation

For discussion of these subjects, reference is made to D'Appolonia 1979. Additional geologic information was gained during the construction of Cell 2 of the Initial Phase of the System. Approximately 7 to 8 feet of rock were excavated by ripping without requiring any blasting. This information was utilized in estimating the excavation limits for Cell 3.

# 3.0 CELL 3 DESIGN

## 3.1 GENERAL

The final design plans and details are shown on the Construction Drawings contained in Appendix A. This set consists of five drawings titled as follows:

- Sheet 1 of 5 - Title Sheet
- Sheet 2 of 5 - Second Phase General Arrangement
- Sheet 3 of 5 - Sump, Drain and Underdrain Access Details
- Sheet 4 of 5 - Cell 4 Dike Profile and Cell 3 Liner Details
- Sheet 5 of 5 - Geotechnical Analysis

Guideline Construction Specifications detailing the requirements, methods, and procedures for construction of the Second Phase are contained in Appendix B.

## 3.2 STORAGE CAPACITY

The final design layout for Cell 3 is shown on Sheet 2. Cell 3 Dike was constructed as a safety dike for the Initial Phase of the System and is as shown on Sheet 2. The layout of Cell 3 is the same as the conceptual layout presented in D'Appolonia (1979), except for the cell bottom excavation contours. These contours have been adjusted based on information and experience gained during the construction of Cell 2. The bottom contours, as shown on Sheet 2, will maximize the volume of available storage for tailings without blasting of the bedrock.

The storage area capacity curve for Cell 3 is shown on Sheet 5. The storage volume at Elevation 5,605 feet, the maximum operating pool elevation, is 1,310 acre-feet. This is the maximum volume assuming level storage, however, the tailings solids will be deposited and contoured to a final sloping surface with the contours as shown on Sheet 2. These final tailings contours are the same as those in the conceptual design and maintain the required limitation of five feet below existing ground surface along the east and west sides of the cell. With this additonal storage volume from the sloped surface, the total volume of storage

available in Cell 3 is approximately 1,530 acre-feet. Based on the tailings design production volume of 390 acre-feet per year, as determined in Section 2, the life of Cell 3 is approximately 3.9 years.

## 3.3 CONSTRUCTION CONSIDERATIONS

### 3.3.1 Excavation

Excavation of Cell 3 to the lines and grades shown on Sheet 2 will consist of topsoil removal (approximately one foot thick), soil excavation and rock excavation. The estimated excavation volumes of these materials are:

- Topsoil - 113,000 cubic yards
- Soil - 633,000 cubic yards
- Rock - 667,000 cubic yards

Topsoil, soils not used for construction of dike, and rock excavation will be removed from the cell areas and stockpiled for use during reclamation. The total quantities (soil and rock) that will be excavated and used to construct the dike or stockpiled were determined by calculating the volume behind the cell dike between the existing ground surface contours, top of rock contours and the excavated cell bottom contours. Topsoil volumes were based on a thickness of 1 foot over the disturbed areas.

As discussed in the previous section, excavation of the rock will be by ripping and loading out with shovels and trucks. The elevation of the bottom contours have been laid out to avoid rock which cannot be removed by ripping. The soil and topsoil will be excavated by conventional methods utilizing scrapers and bulldozers.

The side slopes of the cell excavation are 3 to 1 (horizontal to vertical) which will permit easy placement of the synthetic liner and will grade smoothly with the dike fill slopes which are also 3 to 1. If any open fractures or joint planes are encountered in the final rock excavation

surface they will be filled with dental concrete or grout. The final cell bottom surface will be free from sharp and irregular projections and it will be rolled by a smooth drum roller prior to liner installation.

Prior to excavation in Cell 3, the existing groundwater monitoring wells 6-1, 6-2, 7-1, 7-2, 8-1 and 8-2 will be grouted closed and sealed. These wells were installed as part of the groundwater monitoring program for the Initial Phase of the system. The wells will be grouted closed prior to cell excavation as discussed in Section 5.3.

## 3.4 SAFETY FEATURES

Safety features as presented for the Initial Phase were also utilized in the design of the Second Phase. These factors consist of:

- The ability of the cells to store the required design storm without overtopping the dikes, 140 percent of the probable maximum flood series.

- The ability of the system to retain (behind the saftey dike) the overflow from a breached cell without causing downstream discharge.

### 3.4.1 Design Flood Retention

The probable maximum flood series was used for the design flood for Cell 3. As presented in the D'Appolonia, 1979 report, this flood series is equivalent to approximately 15 inches of rainfall. As before, the cell is located such as to eliminate practically all surface runoff into the cells. Therefore, the only flood storage volume required is from direct precipitation on the cells. The total flood volume and the minimum amount of freeboard are shown on the area-capacity curve on Sheet 5. The minimum freeboard meets the design requirements of the Bureau of Reclamation (U.S. Department of Interior, 1977).

### 3.4.2 Safety Dike Analysis

The safety features as incorporated in the Initial Phase of the system were also utilized in the design of the Second Phase. One of these

features utilizes the retention dike for the subsequent phase as the safety dike for the present phase. The safety dike has sufficient storage capacity behind it (no excavation) to retain about 40 percent of the maximum Cell 3 storage volume. Since the actual volume of the tailings that would be unstable and likely to flow is small (due to the beaching method and from rapid dewatering) and the volume of water in Cell 3 is minimal at any given time; this available storage percentage is considered adequate.

Since the volumes of storage within Cell 2, Cell 3 and Cell 4 are approximately the same as presented in the D'Appolonia 1979 report, the successive cell failure analysis is still viable and will not be repeated herein.

## 3.5 LINING DESIGN

### 3.5.1 General

Analysis and selection of the liner for containment was presented in D'Appolonia 1979. The conditions for selection of a lining are the same for the Second Phase of the system and the recommended liner for use is the same as for the Initial Phase, namely a 30 mil (0.030 inches), nominal thickness polyvinyl chloride (PVC) synthetic lining. A planned tailings or soil cover on the lining is also recommended.

### 3.5.2 Installation Details

Installation details are shown on Sheet 4. Detailed specifications covering preparation, installation, maintenance, and quality assurance of the lining are included in the Guideline Specifications in Appendix B. The major points of the lining system are:

- A prepared bedding layer approximately six inches thick will be placed for lining subgrade in all areas where lining is placed on the excavated rock surface. This layer will consist of bedrock material which is broken up and compacted to form a smooth surface by the excavation equipment. For fill and excavated soil surface installations the surface will be inspected to insure that it is smooth and meets the specifications.

- The lining will be covered by 12 to 18 inches of coarse tailings obtained from Cell 2. The extent of the cover and details of the constructed cover are shown on Sheets 3 and 4. Since the tailings will be moist and constructed of only coarse tailings and after placement will be kept moist, it is not expected that this operation will cause any adverse environmental affects.

- The lining is anchored in a trench which is back-filled with compacted soil. It is located above both the tailings cover and the design flood storage level.

- Installation will be overseen by a lining representative.

## 3.6 APPURTENANT SYSTEM FEATURES

### 3.6.1 Tailings Water System

Tailings water that forms the slimes pool will be pumped to Cell 1, the evaporation cell, for storage and evaporation. The transport system involves a floating barge with a sump and a pipeline. The floating barge is shown schematically on Sheet 3. It consists of a barge, pump, and skimming sump. Details and exact system, including materials to be used for decanting the water will be determined in the field.

### 3.6.2 Slimes Pool Drain System

The slimes pool drain system will provide drainage for the bottom of the cell for water trapped in the slimes and beached tailings. This will facilitate consolidation of the tailings, increasing density and enhance reclamation. This system consists of slotted, PVC pipes wrapped in filter cloth installed on a grid pattern over the lowest part of the cell, as shown on Sheet 3. It also utilizes dewatered coarse tailings obtained from Cell 2 as both cover and as a blanket drain to transport water from all areas of the cell to the locations of the slotted pipes. Typical details of the system are shown on Sheet 3. This drain system will reduce the time required for drying and stabilization of the slimes

area and increase the density of the tailings by providing drainage at the bottom of the deposit.

The drainage will be collected in a sump installed at the toe of the upstream slope of Cell 3 dike. A float switch or a sump pump will remove the water from the sump area. The water will be discharged back into the slimes pool where it will be pumped to the evaporation cell or it will be discharged to the next active tailings cell if the cell is in operation. This system will be used to maintain the slimes pool at the operational elevation.

### 3.6.3 Underdrain System

The underdrain system will be installed on the face of the excavation and dike fill on the downstream side of Cell 3 (upstream side of the Cell 3 dike). Details of this system are shown on Sheet 3. This system consists of a sand drain layer 12 inches thick, a slotted collection pipe in the sand layer running along the toe of the excavation, and an access pipe running up the slope to the crest of the dike for pumping the underdrain system. This system is designed to prevent leakage from saturating the dike fill or its foundation and reacting with possible lenses of pockets of calcareous materials. The system is similar to that designed and approved for Cell 2.

# 4.0 DIKE DESIGN

## 4.1 GENERAL

The Second Phase of the Tailings Management System involved the design of the safety dike; i.e., Cell 4 Dike and a stability analysis of Cell 3 Dike with excavation. Cell 3 Dike was designed and constructed as part of the Initial Phase of the system. The design of Cell 4 Dike involved a site investigation to obtain subsurface information on the dike foundation conditions and fill material and obtain foundation material samples; laboratory testing to determine material properties for design and contruction; and a stability analysis. Excavation of Cell 3 for the Second Phase required that a stability analysis of Cell 3 Dike also be conducted.

Cell 4 Dike is designed as a homogeneous earthfill embankment with 3 to 1 (horizontal to vertical) slopes utilizing material from the cell excavations. This design is the same as that used for the Initial Phase dikes and the conceptual designs presented in D'Appolonia, 1979. The dike is shown in plan and section on Sheet 2 and in profile on Sheet 4. Based on these layouts, the estimated volume of fill material required is 147,000 cubic yards.

## 4.2 SITE INVESTIGATION AND RESULTS

The site investigation for the Cell 4 Dike consisted of nine test pits, TP4-1 through TP4-9, located throughout Cell 4 and three test pits, TPD-1 through TPD-3 located along the centerline of Cell 4 Dike. The approximate locations of these test pits are shown on Sheet 2. The logs for the test pits are contained in Appendix C. The test pits in Cell 4 were excavated to obtain samples of the material to be used for fill material for laboratory testing and determination of material properties. The results of the laboratory classification testing are given on Sheet 5. As shown on Sheet 5 and the test pit logs, the material in Cell 4 consists mostly of a sandy silt material. This material is similar to that encountered in the Cell 2 area.

The logs for the test pits along the centerline of Cell 4 Dike show that bedrock occurs at a depth of 4 to 10 feet. The soils are similar to those found in the other test pits. Zones of highly calcareous material, similar to those encountered during Cell 1 Dike and Cell 2 Dike construction were not found in these test pits.

## 4.3 STABILITY ANALYSIS

The stability analysis for Cell 4 Dike was performed on the section shown on Sheet 5 using the material properties also shown on this sheet. The analysis was conducted with a computer program utilizing the Modified Bishop method of slices. This program has been quality assurance verified by D'Appolonia's NRC approved quality assurance program.

The analysis was performed with regard for the NRC Regulatory Guide 3.11 (NRC, 1977) conditions and requirements. Two cases for both static and earthquake conditions were analyzed. Case 1 corresponds to the maximum flood pool water level in the cell and full steady-state seepage. This case assumes that the liner has failed, the underdrain system is ineffective in controlling seepage, and that sufficient time is available for fill saturation and development of steady-state seepage. The combination of these assumptions is an extremely conservative condition and if the system is operated as planned, sufficient time for steady-state seepage to develop will not be available. As shown on Sheet 5, the minimum factor of safety for this conservative case is 1.4 for static and 1.1 for earthquake conditions. These values are considered acceptable given the conservative combination of assumptions made for this case.

Case 2 corresponds to the end of construction condition with no water in the cells. The results of the analysis for this case are minimum factors of safety of 2.0 for static conditions and 1.5 for earthquake conditions.

Stability of the Cell 3 Dike with cell excavation was also analyzed as part of the Second Phase design of the system. The analysis was conducted for the same two cases described above and using the same material properties. The minimum factors of safety are shown on Sheet 5 and are

1.4 and 1.8 for Case 1 and Case 2, respectively for static conditions, and 1.1 and 1.3 for Case 1 and Case 2, respectively for earthquake conditions. These values are comparable with the results of the previous analysis and are considered acceptable.

## 4.4 FREEBOARD ANALYSIS

The freeboard that will be maintained for Cell 3 is consistent with the analysis of the condition in the Initial Phase and will be maintained at a 5 foot minimum.

## 4.5 CONSTRUCTION CONSIDERATIONS

As presented, the design of Cell 3 and Cell 4 dikes are based on the material properties of the proposed borrow areas. These dikes will be constructed by placing an approved material in layers of specified thickness and compacting them to a minimum specified density. The details of the fill specifications and other earthwork specifications are contained in the Guideline Specifications for the Second Phase - Construction, Appendix B.

# 5.0 GROUNDWATER MONITORING PROGRAM

## 5.1 GENERAL

Regular monitoring of the groundwater in the area of the tailings cell is required by NRC regulations to monitor for excursions which could result in contamination of groundwater by seepage from tailings disposal operations. Pertinent site groundwater hydrology features have been presented in D'Appolonia, 1979. The program discussed herein is an expansion of essentially the program previously presented with only details relative to the Second Phase of the disposal system described in detail.

The groundwater monitoring program is designed to (a) allow groundwater sample procurement for analysis for operational groundwater quality monitoring and (b) allow detection of tailings cell leakage in near surface and intermediate depth non-aquifer strata. The program consists of utilizing the five deep wells Number 1 through 5 completed as part of the preoperational and operational programs installed into the existing groundwater aquifer; two of the five twin (shallow and intermediate depth) wells Numbers 9 and 10 installed during the Initial Phase operational program; three additional twin (shallow and intermediate depth) wells Number 11, 12 and 13 installed downgradient of Cell 3; and an additional deep well, Number 14, installed on the crest of Cell 4 Dike in the existing groundwater aquifer wells, Numbers 11, 12, and 13, installed downgradient of Cell 3. The location of the three additional twin wells will be in monitoring zones in (a) the surface soils and top of the weathered rock and fractured rock, (b) zone of unweathered rock below the top of the rock and above the water table. The location of these wells are shown on Sheet 2. Figures B1, B2, and B3, Appendix B, illustrates typical installation details for these wells.

## 5.2 OPERATIONAL PROGRAM - SECOND PHASE

As mentioned above, the Second Phase operational monitoring program will incorporate most of the wells installed during the preoperational program and the Initial Phase operational program. Well 14 is a deep well installed into the existing groundwater aquifer. It is located on Cell 4 dike crest and will be installed after completion of the dike. It

will provide additional downgradient monitoring capability near the active tailings cell.

Wells 11-13 are each a double level installation: one well to be installed in the near surface strata and the other in the intermediate depth strata above the existing groundwater table. They are located in areas where possible leakage on, near, or within the upper part of the bedrock will be concentrated. Well 12 is located at the low point of the bedrock surface immediately downstream of Cell 3. Wells 11 and 13 are located in minor bedrock troughs on either side of the low point for detection of leakage moving along these areas of the bedrock surface. Wells 9 and 10 installed during the Initial Phase are located to the west of Cell 1 to detect leakage moving either near the bedrock surface or at a depth within the bedrock along the joint planes. Both these wells will remain in operation during the Second Phase.

Operational procedures for sampling, testing, installing, and maintaining all wells were reported in Initial Phase and these methods and details are viable during the Second Phase and are not reiterated herein.

## 5.3 SEALING EXISTING WELLS

Existing Wells 6-1, 6-2, 7-1, 7-2, 8-1, and 8-2 located in Cell 3 area will be sealed prior to excavation. These wells are twin (shallow and intermediate depth) installations, completed as part of the Initial Phase monitoring system. The location of these wells is shown on Sheet 2. These wells will be sealed by tremie backfilling each well with an cement-water grout slurry. This slurry will be pumped into the wells with a tremie pipe according to the method specified in the Guideline Specifications in Section 5, Appendix B.

# LIST OF REFERENCES

Dames and Moore, 1978, "Environmental Report, White Mesa Uranium Project, San Juan County, Utah, for Energy Fuels Nuclear, Inc.", January 30, 1978, revised May 15, 1978.

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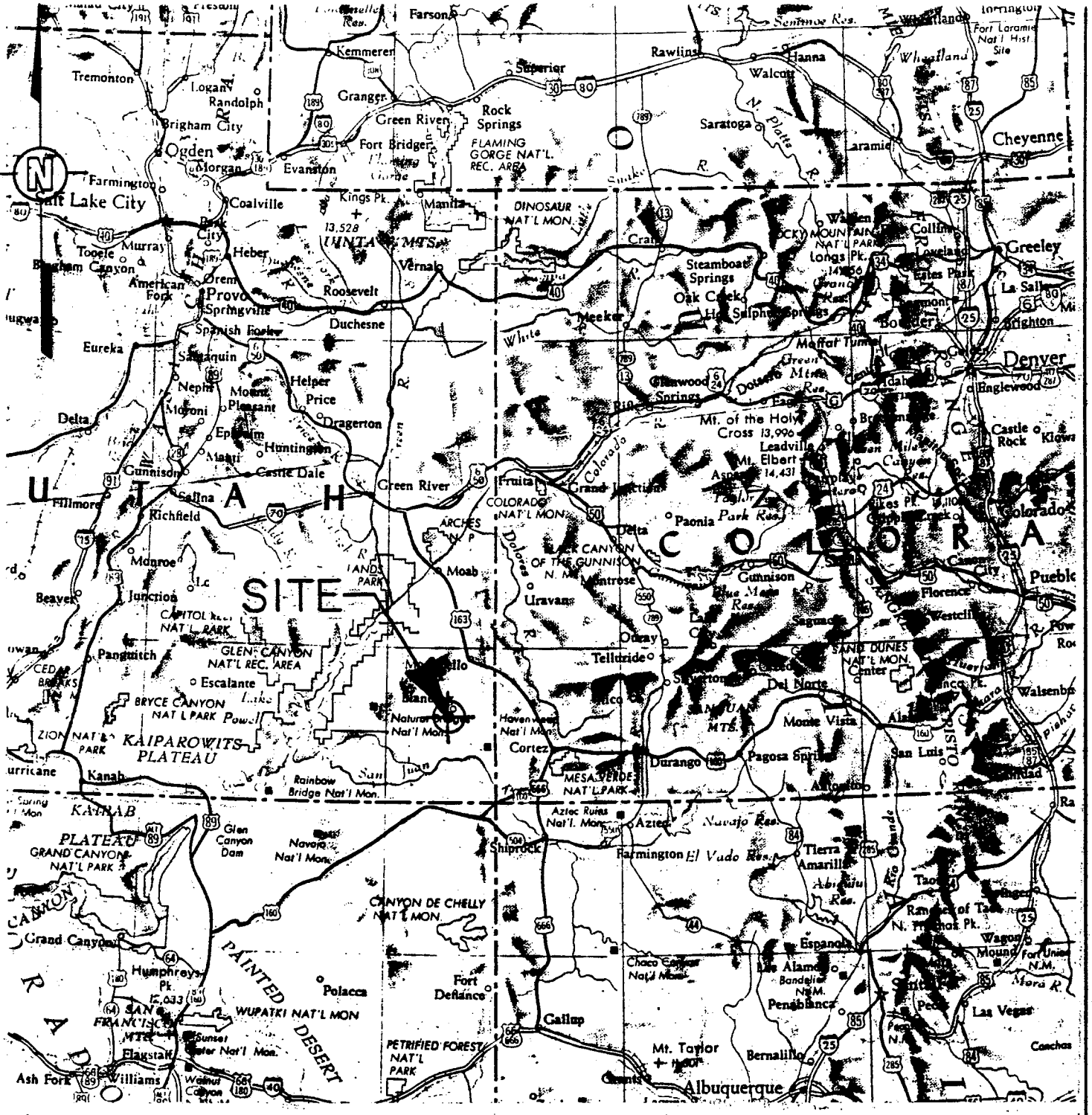


SCALE

50 0 50 100 MI.

FIGURE 1

SITE LOCATION MAP

PREPARED FOR

ENERGY FUELS NUCLEAR, INC.

DENVER, COLORADO

REFERENCE: ROAD MAP OF WESTERN UNITED STATES SCALE: 1:4,000,000.

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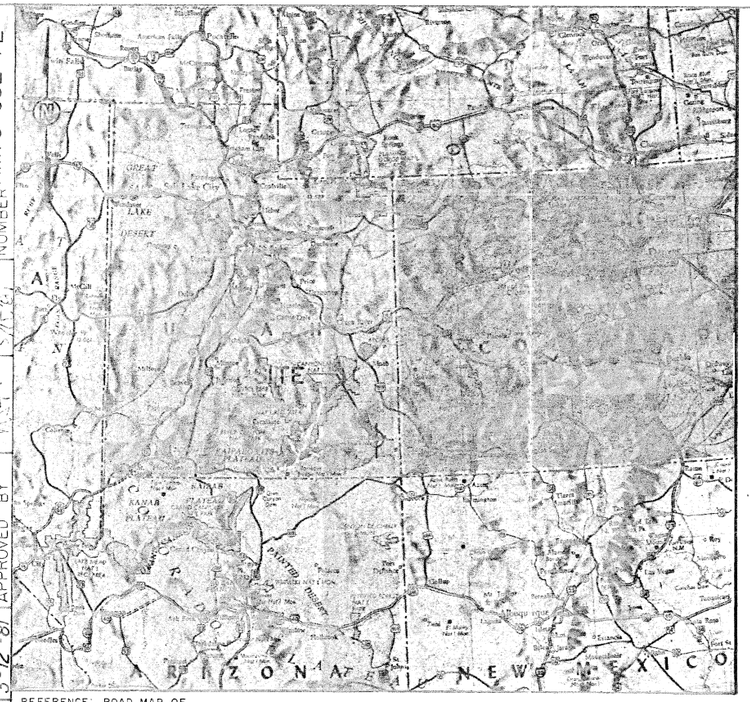
SECOND PHASE CONSTRUCTION DRAWINGS
TAILINGS MANAGEMENT SYSTEM

WHITE MESA URANIUM PROJECT
BLANDING, UTAH

| DRAWN BY | CHECKED BY | APPROVED BY | DRAWING NUMBER |
|---|---|---|---|
| D.B.T. | C.E.O. | V.L.C. | RM78-682-T2 |
| 3-12-81 | 5/15/81 | 5/15/81 | |



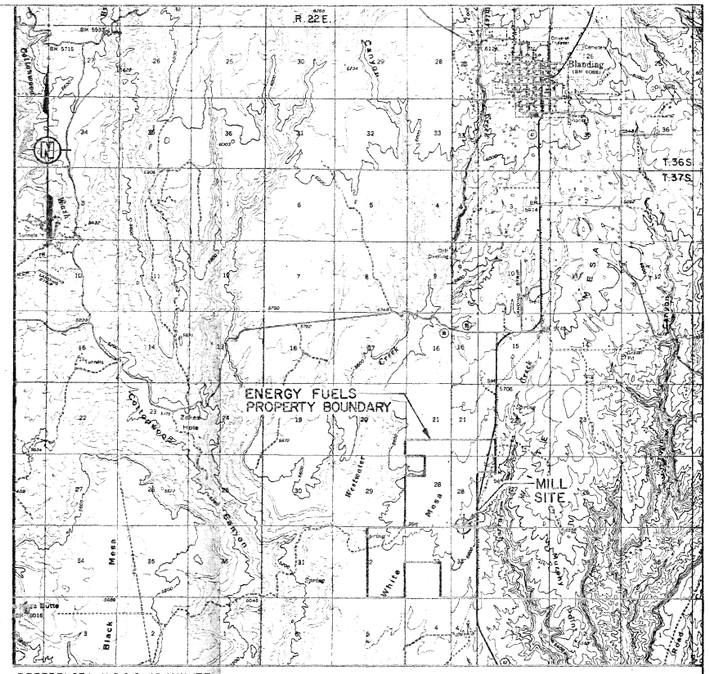

REFERENCE: ROAD MAP OF WESTERN UNITED STATES. SCALE: 1: 4,000,000

LOCATION MAP

SCALE

50 0 50 100 MILES

| INDEX OF DRAWINGS | |
|---|---|
| SHEET NO. | TITLE |
| 1 OF 5 | TITLE SHEET |
| 2 OF 5 | SECOND PHASE GENERAL ARRANGEMENT |
| 3 OF 5 | SUMP, DRAIN AND UNDERDRAIN ACCESS DETAILS |
| 4 OF 5 | CELL 4 DIKE PROFILE AND CELL 3 LINER DETAILS |
| 5 OF 5 | GEOTECHNICAL ANALYSIS |




REFERENCE: U.S.G.S. 15 MINUTE SERIES TOPOGRAPHIC MAPS OF BRUSHY BASIN WASH, UTAH (1957) AND BLANDING, UTAH (1957).

VICINITY MAP

SCALE

1 0 1 2 MILES

# CONSTRUCTION DRAWINGS
# SECOND PHASE
# TAILINGS MANAGEMENT SYSTEM
# WHITE MESA URANIUM PROJECT

BLANDING, UTAH

PREPARED FOR

## ENERGY FUELS NUCLEAR, INC.
## DENVER, COLORADO

SHEET 1 OF 5

TITLE SHEET

PREPARED FOR

ENERGY FUELS NUCLEAR, INC.
DENVER, COLORADO

D'APPOLONIA

DRAWING NUMBER RM78-682-E23

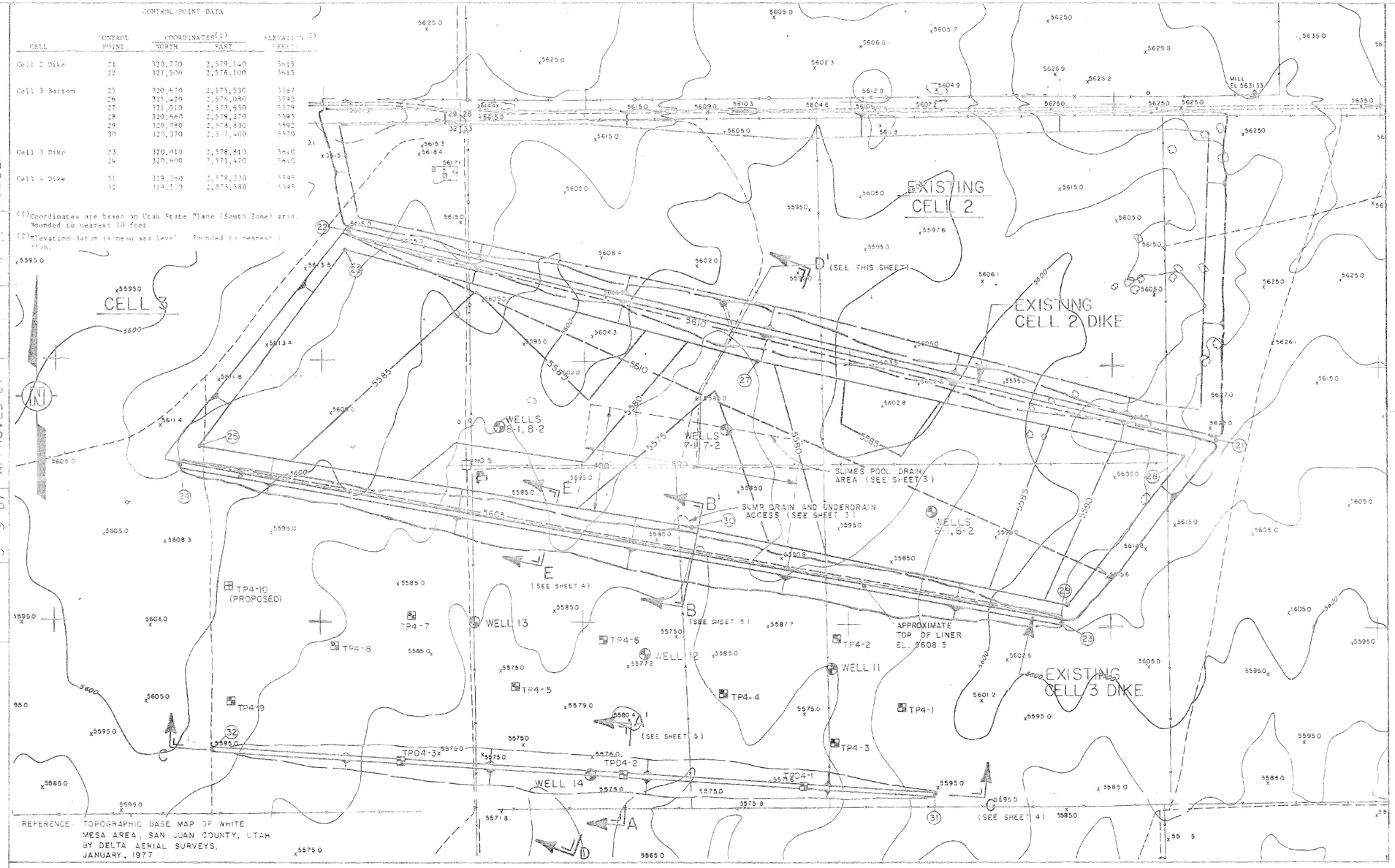
| | | | |
|---|---|---|---|
| DRAWN BY | D J R | CHECKED BY | |
| | 3-9-81 | APPROVED BY | |

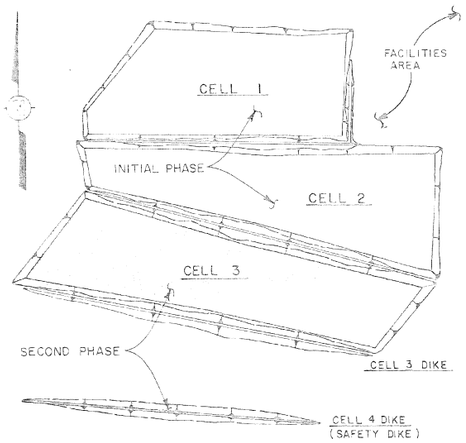
CONTROL POINT DATA

| CELL | CONTROL POINT | COORDINATES(1) NORTH | COORDINATES(1) EAST | ELEVATION (2) (FEET) |
|---|---|---|---|---|
| Cell 2 Dike | 21 | 320,770 | 2,579,140 | 5615 |
| | 22 | 321,590 | 2,576,100 | 5615 |
| Cell 3 Bottom | 25 | 320,670 | 2,575,530 | 5587 |
| | 26 | 321,420 | 2,576,080 | 5592 |
| | 27 | 321,010 | 2,577,650 | 5579 |
| | 28 | 320,660 | 2,579,270 | 5595 |
| | 29 | 320,090 | 2,578,830 | 5592 |
| | 30 | 320,370 | 2,577,460 | 5570 |
| Cell 3 Dike | 23 | 320,010 | 2,578,810 | 5610 |
| | 24 | 320,600 | 2,575,470 | 5610 |
| Cell 4 Dike | 31 | 319,300 | 2,578,330 | 5595 |
| | 32 | 319,510 | 2,575,580 | 5595 |

(1) Coordinates are based on Utah State Plane (South Zone) grid. Rounded to nearest 10 feet.

(2) Elevation datum is mean sea level. Rounded to nearest 1 foot.




KEY PLAN

N. T. S.

LEGEND:

- 5585 — APPROXIMATE EXCAVATION LINE AND ELEVATION ON CELL BOTTOM
- TP4-2 — TEST PIT NUMBER AND LOCATION
- WELL 13 — WELL NUMBER AND LOCATION (SEE NOTE 4
- 5610 — APPROXIMATE MAXIMUM TAILINGS SURFACE LINE

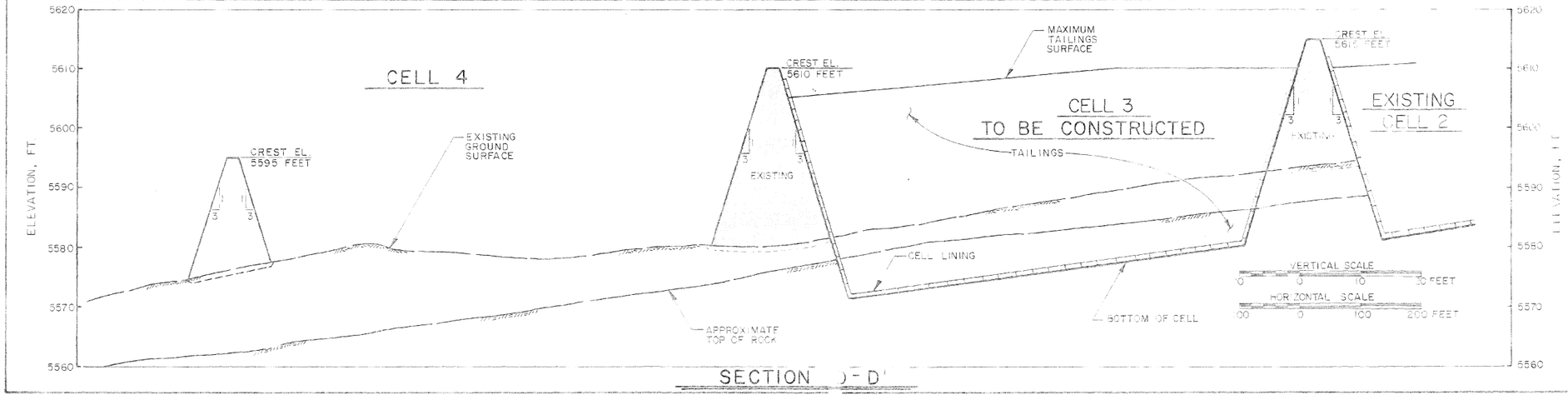
NOTES:

1. STABILITY ANALYSIS FOR CELL 3 AND CELL 4 DIKES ARE PRESENTED ON SHEET 5 OF 5.
2. LINING AND COVER DETAILS ARE PRESENTED ON SHEET 4 OF 5.
3. SUMP, DRAIN AND UNDERDRAIN ACCESS AND DETAILS ARE PRESENTED ON SHEET 3 OF 5.
4. EXISTING WELLS 6,7 AND 8 TO BE PLUGGED PRIOR TO EXCAVATION OF CELL 3. WELLS 11, 12 AND 13 TO BE INSTALLED AS PART OF SECOND PHASE CONSTRUCTION.

SCALE

200 0 200 400 FEET

CONTOUR INTERVAL = 10 FEET




SECTION C - D'

SHEET 2 OF 5

SECOND PHASE
GENERAL ARRANGEMENT

PREPARED FOR

ENERGY FUELS NUCLEAR, INC.
DENVER, COLORADO

D'APPOLONIA

| DRAWN BY | CHECKED BY | APPROVED BY | DRAWING NUMBER |
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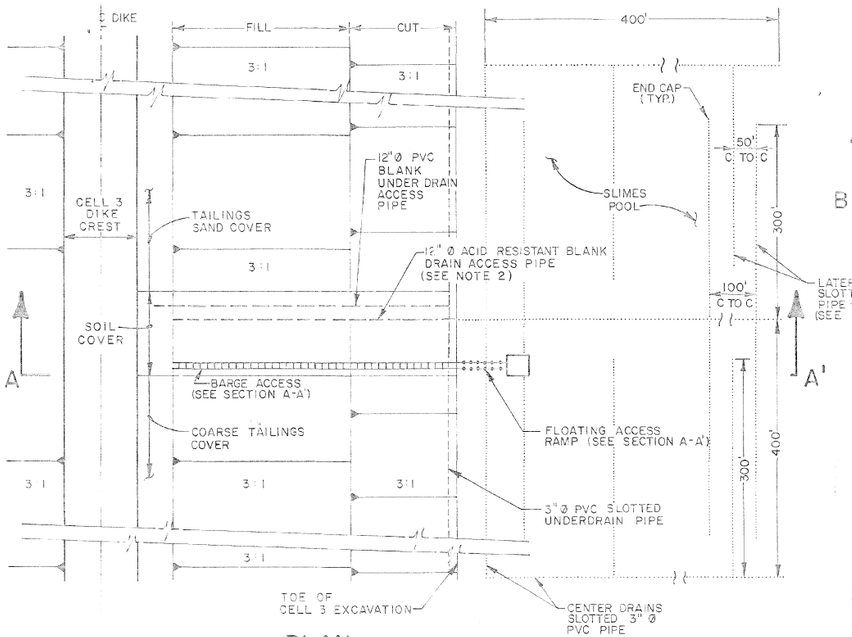
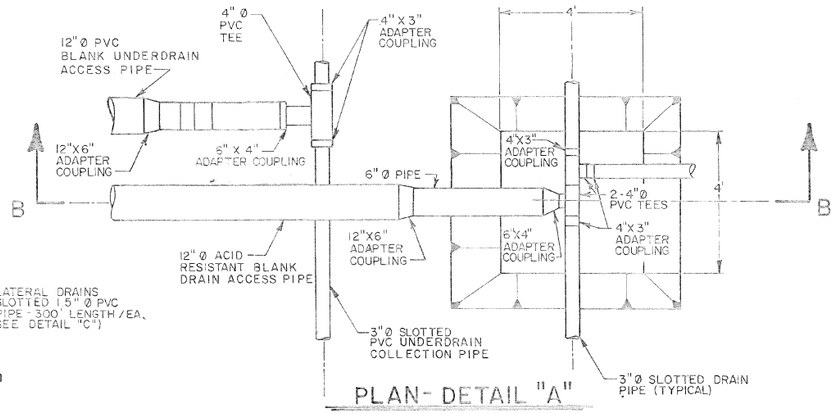
| D. J. R. | CEB | MJT | RM78-682-E20 |
| 2-23-81 | | | 5/18/81 |




PLAN

SUMP, DRAIN AND UNDERDRAIN COLLECTION SYSTEM

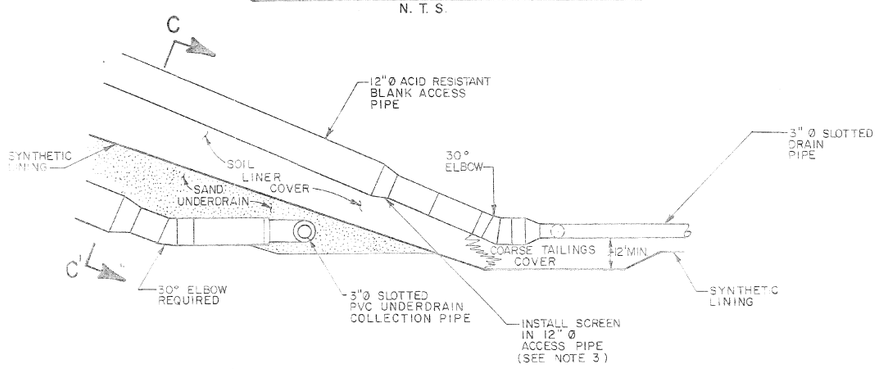
N. T. S.




PLAN- DETAIL "A"

DRAIN COLLECTION SYSTEM

N. T. S.




SECTION B-B'

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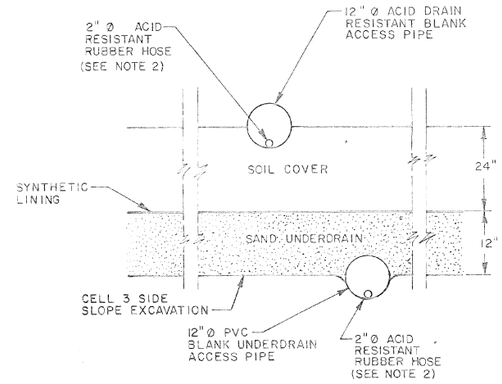
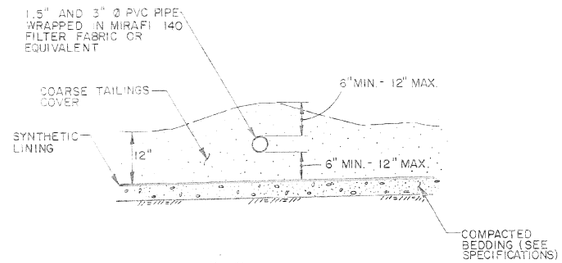


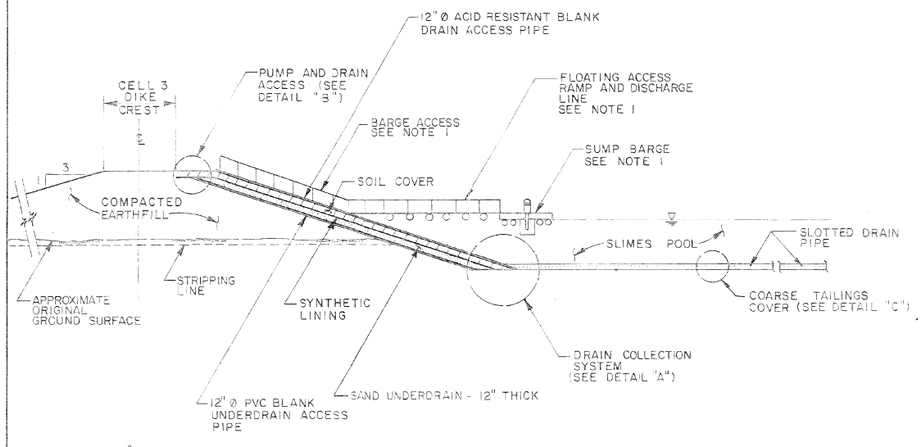

SECTION C-C'

N. T. S.



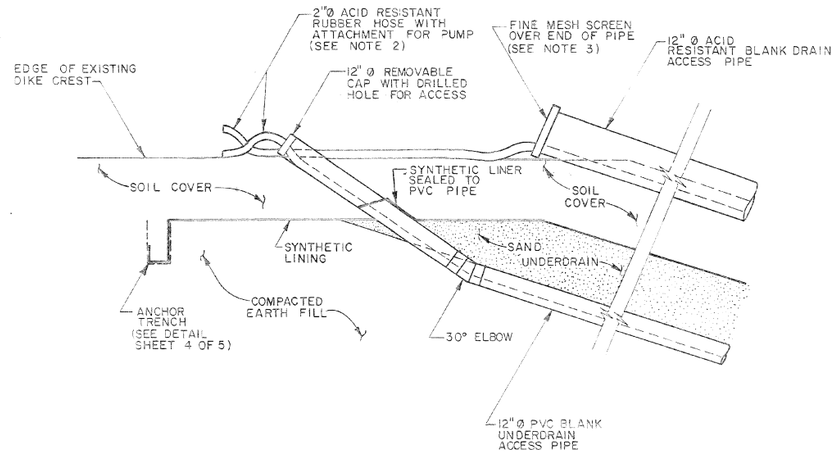

DETAIL "C" - TYPICAL SECTION

(FOR SLOTTED DRAIN PIPE ONLY)




SECTION A-A'

N. T. S.




PUMP AND DRAIN ACCESS DETAIL "B"

N. T. S.

NOTES:

1. FLOATING ACCESS RAMP, DISCHARGE LINE AND SUMP BARGE OR ALTERNATIVE METHOD OF DECANTING WATER TO BE SUPPLIED BY ENERGY FUELS NUCLEAR, INC..
2. METHOD OF SUMP ACCESS ie., RUBBER HOSE AS SHOWN, IN LINE SUBMERSIBLE PUMP OR ALTERNATE METHOD TO BE APPROVED BY ENGINEER.
3. FINE MESH SCREEN TO BE INSTALLED IN ENDS OF 12" Ø PIPE TO PREVENT LARGE SOIL PARTICLES FROM ENTERING PIPE AND TO PREVENT LOSS OF SUMP LINE.

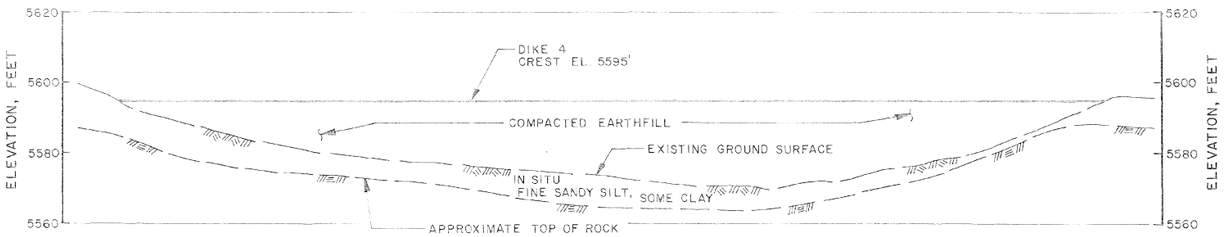
SHEET 3 OF 5

SUMP, DRAIN AND UNDERDRAIN ACCESS DETAILS

ENERGY FUELS NUCLEAR, INC.
DENVER, COLORADO

D'APPOLONIA

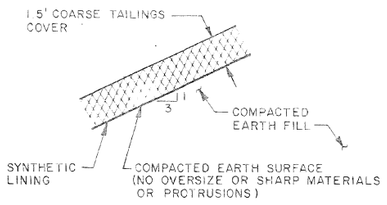
| DRAWN BY | B.K.H. | CHECKED BY | CES | DRAWING NUMBER | RM78-682-E22 |
|---|---|---|---|---|---|
| | 2-23-81 | APPROVED BY | | | |




## SECTION C-C' – PROFILE CELL 4 DIKE

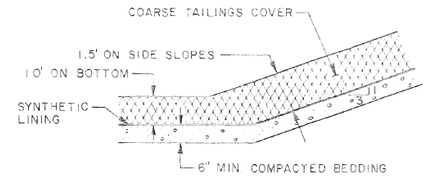
HORIZONTAL SCALE
200 0 200 400 FEET

VERTICAL SCALE
20 0 20 40 FEET



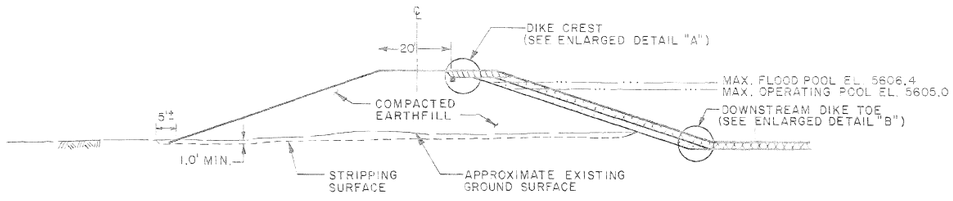

## FILL SECTION

N.T.S.



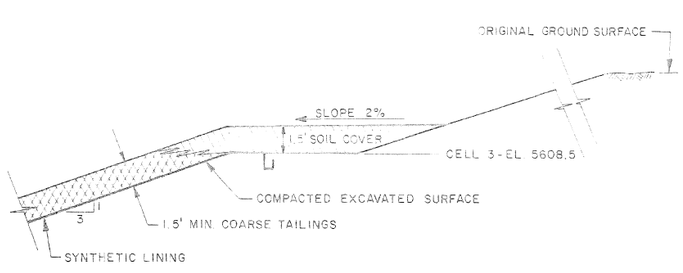

## EXCAVATION SECTION

N.T.S.



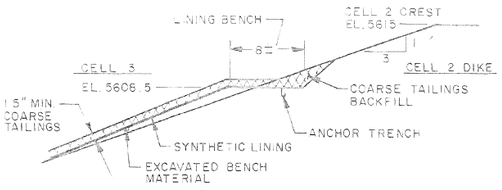

## SECTION E-E' – CELL 3 DIKE

N.T.S.




## LINING & ACCESS BENCH DETAIL EXCAVATED SLOPE

N.T.S

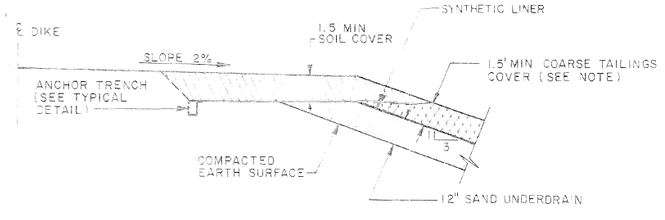



## DETAIL - LINING TIE-IN TO CELL 2 DIKE (DOWNSTREAM SLOPE)

N.T.S.

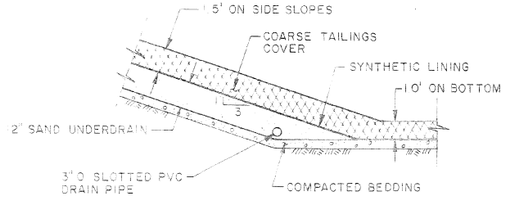
NOTE:

COARSE TAILINGS ARE TO BE PLACED BELOW TOP OF LINING AND COVERED WITH APPROVED SOIL COVER AT TOP OF SLOPE.



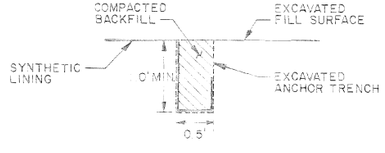

## ENLARGED DETAIL "A" DIKE CREST DETAIL

N.T.S




## ENLARGED DETAIL "B" DOWNSTREAM DIKE TOE

N.T.S.




## ANCHOR TRENCH

N.T.S.

SHEET 4 OF 5

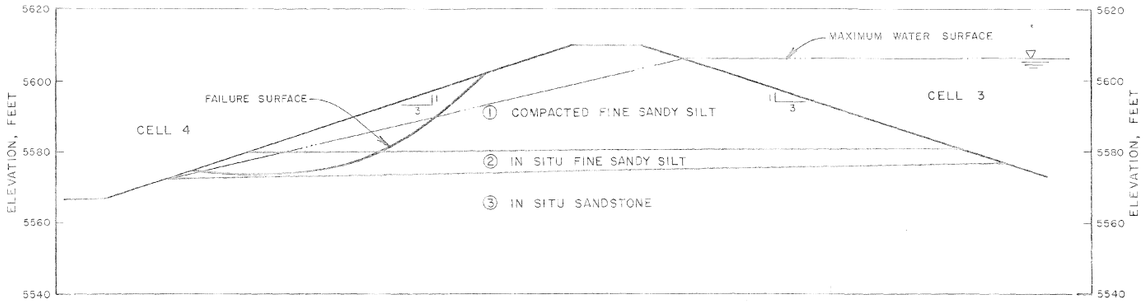
# CELL 4 DIKE PROFILE AND CELL 3 LINER DETAILS

PREPARED FOR

ENERGY FUELS NUCLEAR, INC.
DENVER, COLORADO

D'APPOLONIA

| | | |
|---|---|---|
| DRAWN BY | | DRAWING NUMBER RM78-682-E21 |
| CHECKED BY | R. Bricker | |
| APPROVED BY | 3 Mar. 81 | |

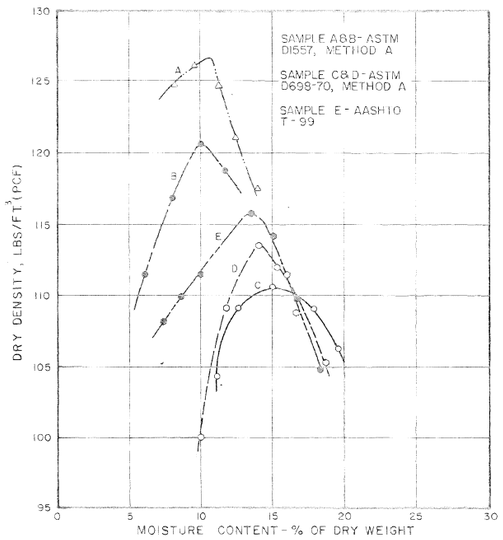



| LOADING CONDITION | MINIMUM FACTOR OF SAFETY CASE 1 | CASE 2 |
|---|---|---|
| STATIC | 1.4 | 1.8 |
| EARTHQUAKE (0.10g) | 1.1 | 1.3 |

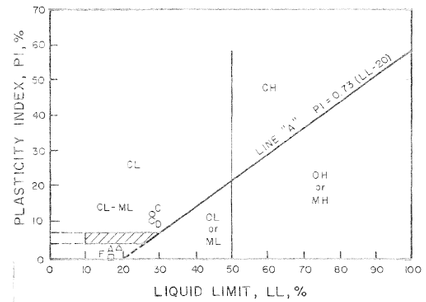
DESIGN SECTION B - B'

CELL 3 DIKE

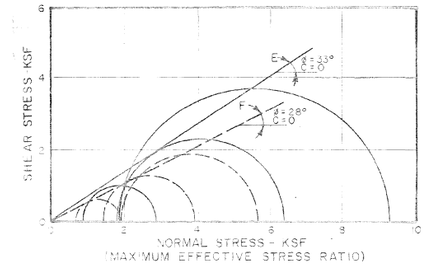
SCALE 20 0 20 FEET

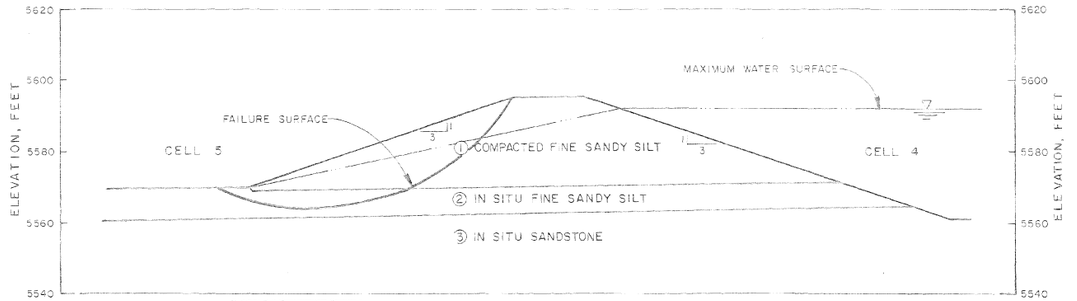



COMPACTION TEST RESULTS




PLASTICITY CHART




| LOADING CONDITION | MINIMUM FACTOR OF SAFETY CASE 1 | CASE 2 |
|---|---|---|
| STATIC | 1.4 | 2.0 |
| EARTHQUAKE (0.10g) | 1.1 | 1.5 |

DESIGN SECTION A-A'

CELL 4 DIKE

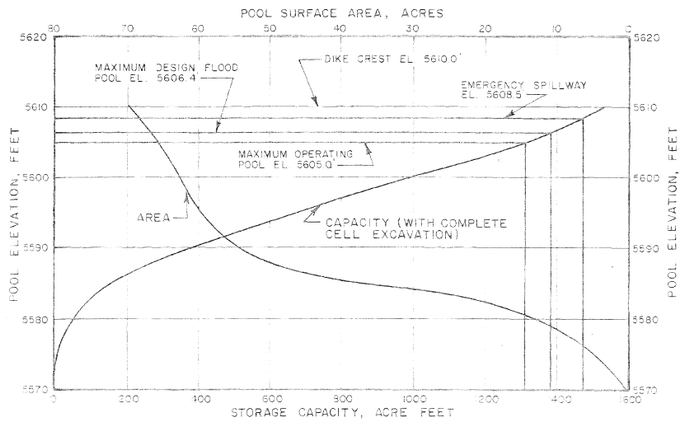
SCALE 20 0 20 FEET

NOTES:

CASE 1 ANALYSIS ASSUMES:
COMPLETELY FAILED TAILINGS, MAXIMUM FLOOD WATER LEVEL AND TOTAL FILL SATURATION.

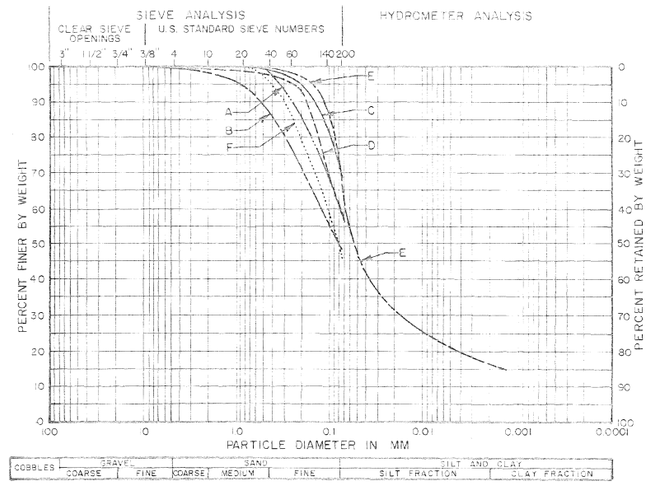
CASE 2 ANALYSIS ASSUMES:
NO WATER IN CELLS OR PIEZOMETRIC SURFACE IN DIKES.

| DIKE MATERIALS PROPERTIES | | | |
|---|---|---|---|
| NO. | γM (pcf) | ϕ (DEGREES) | C (psf) |
| 1 | 123 | 30 | 0 |
| 2 | 120 | 28 | 0 |
| 3 | 130 | 45 | 0.000 |




AREA - CAPACITY CURVE

CELL 3




GRAIN SIZE ANALYSES

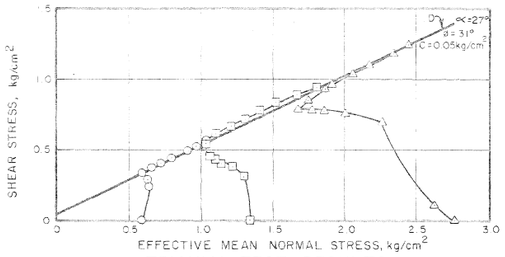
TEST SAMPLE DATA(1)

| SAMPLE DESIGNATION | SAMPLE NUMBER | DESCRIPTION | REFERENCE |
|---|---|---|---|
| A | 3-1 | Sandy silt and some clay | D'Appolonia May, 1981 |
| B | 3-5 | Crushed sandstone-red sandy silt | D'Appolonia May, 1981 |
| C | Composite A(2) | Red sandy silt with some claystone | - |
| D | Composite B(3) | Red sandy silt | - |
| E | 19A (Bulk) | Silt with fine sand and some clay | Dames and Moore January, 1978 |
| F | 14 | Brown silt and fine sand | Dames and Moore January, 1978 |

(1) All sample data (except sample designation) and test results from the reference reports as noted. Sample designations by D'Appolonia apply to this report only.

(2) Composite A consists of equal amounts of samples 4-1B, 4-2A, 4-4A and 4-6A (see test pit logs, Appendix C).

(3) Composite B consists of equal amounts of samples 4-6A, 4-5A and 4-8A (see test pit logs, Appendix C).




TRIAXIAL TEST RESULTS

(CONSOLIDATED-UNDRAINED WITH PORE PRESSURE MEASUREMENTS)

SAMPLE E - COMPACTED TO 95% AASH TO T-99 MAXIMUM DRY DENSITY

SAMPLE F - TESTED AT NATURAL DENSITY

SAMPLE D - COMPACTED TO 95% ASTM D698-70 (METHOD A) MAXIMUM DRY DENSITY

SHEET 5 OF 5

GEOTECHNICAL ANALYSIS

PREPARED FOR

ENERGY FUELS NUCLEAR, INC.
DENVER, COLORADO

D'APPOLONIA

# GUIDELINE SPECIFICATIONS

SECOND PHASE CONSTRUCTION
TAILINGS MANAGEMENT SYSTEM
WHITE MESA URANIUM PROJECT
BLANDING, UTAH

TABLE OF CONTENTS

SECTION 5 - GROUNDWATER MONITORING WELLS

# LIST OF TABLES

# LIST OF FIGURES

LIST OF APPENDICES

# INTRODUCTION

## WORK DESCRIPTION

These Guideline Specifications were prepared for use during the Second Phase Construction of the Tailings Management System, White Mesa Uranium Project, Blanding, Utah, by Energy Fuels Nuclear, Inc., Denver, Colorado. The Second Phase construction consists of the following major items:

- Cell 3 excavation, lining installation, operational facilities
- Dike 4 construction

Specific features, concerning the construction of the above items, that are covered by these Guideline Specifications are:

- Site clearing and grubbing
- Earthwork, soil and rock excavation
- Earthfill and rockfill requirements
- Synthetic lining installation
- Miscellaneous construction items
- Groundwater monitoring well installation

## DRAWINGS

The Drawings illustrating the above items and referred to in these Specifications are the 5-sheet set entitled "Second Phase Construction Drawings, Tailings Management System, White Mesa Project, Blanding, Utah.

## DEFINITION OF TERMS

For the purposes of these specifications, the Owner shall mean Energy Fuels Nuclear, Inc., Denver, Colorado. The Engineer shall be a designated representative of the Owner.

SITE CONDITIONS

Conditions at the site and cross sections shall be examined by the contractor and he shall verify to his satisfaction the contours and the character of the earth, rock, water and other items that may be encountered during the execution of this work. The interpretation of the top of rock or other subsurface conditions were determined for design purposes only. Logs from previous borings are available for viewing at the Owners office in Blanding, Utah and in Denver, Colorado.

# SECTION 1

# CLEARING AND GRUBBING

## PART 1 - GENERAL

### 1.01 DESCRIPTION

A. Scope of Work

1. The Work covered by this Section consists of furnishing all plant, labor and equipment and performing all operations in connection with clearing and grubbing in accordance with the Drawings and these Specifications.

B. Limits of Clearing and Grubbing

1. The limits for clearing and grubbing shall be five (5) feet outside the limit of work for the construction as indicated on the Drawings, unless an archaeological site exists within this limit, in which case clearing and grubbing shall not be conducted in the archaeological site.

## PART 2 - PRODUCTS

Not required

## PART 3 - EXECUTION

### 3.01 CLEARING

A. General

1. Clearing shall consist of the removal and disposition of boulders, trees, brush, down timber, logs, trash and other growth and objects on or above the ground surface. Within the limits of excavation, brush may be removed during the excavation operations. Brush at the top of cut slopes, the roots or parts of which are exposed by the excavation operations, shall be removed completely.

2. Brush, stumps, down timber, and partially buried logs and snags shall be removed completely from all areas to be occupied by fill and these areas shall be stripped. On areas outside of and contiguous to the top of the cut slopes and the toe lines of fill sections, brush shall be cut off and the areas shall be grubbed as specified for areas to be occupied by fill. Cleared material shall be disposed of as specified hereafter. Cleared materials shall not be placed in the fill sections or left on the Work area.

## 3.02 GRUBBING

### A. General

1. Grubbing shall be done in all areas to be occupied by fill. Grubbing shall consist of the removal and disposition of stumps, roots, buried logs, boulders, and other objectionable material below the ground surface. Stumps, roots over 1-1/2 inches in diameter, buried logs and boulders shall be removed completely. Roots 1-1/2 inches and under in diameter shall be removed to a depth of 2 feet below the surface of the ground in the area. Excavations made for removal of stumps, roots, and buried material shall be backfilled to the ground surface with suitable material, and the areas shall be graded to present a neat and pleasing appearance. Within the limits of excavations, grubbing may be done during excavation operations.

## 3.03 WASTE MATERIAL DISPOSAL

### A. General

1. All brush, logs, roots, trash and other combustible debris from the clearing, and grubbing operations shall be disposed of by burning (with an approved permit) and/or hauling to an approved disposal site as designated by the Engineer. No such material shall be placed in the fill sections. All durable stone and boulders from clearing and grubbing may be salvaged for use in construction.

# SECTION 2

# EARTHWORK

## PART 1 - GENERAL

### 1.01 DESCRIPTION

A. Scope of Work

1. The Work covered under this section includes the furnishing of labor, materials, required equipment and performing all operations for the following items of work:

   a. Removal of plants and stripping and stockpiling topsoil, where appropriate.

   b. All excavation, stockpiling, filling and rough grading for site work required by the Drawings and Specifications.

   c. Placing and compacting fills as required.

   d. Placing and compacting synthetic lining subgrade layer as required.

   e. All dewatering and/or diversion required by the Work.

B. Project Survey Layout

1. The project work shall be staked out by a qualified surveyor, including establishing elevations and all other layout work required. He shall also establish a datum point from which all grades are to be taken.

C. Safety Precautions

1. All barricades, fences, red lights, torches and enclosures necessary to protect construction and mill personnel from injury due to the Work set forth herein shall be erected, maintained as required and removed when the need for them no longer exists.

D. Haul Roads

1. All haul roads or other disturbance to areas outside the limits of the Work shall be carefully planned to avoid archaeological sites as shown on the Drawings, and as may be designated by the Engineer.

## PART 2 - PRODUCTS

Not required

## PART 3 - EXECUTION

### 3.01 STRIPPING AND SITE PREPARATION

A. General

1. All topsoil in the area of work shall be stripped to its full depth, where appropriate, and stockpiled in areas as directed by the Owner, where it will not interfere with the Work. Topsoil shall be reused in reclamation work.

2. Topsoil is defined as that material having a significant organic content which will readily support vegetation and is approximately 12 inches thick at this site.

### 3.02 EXCAVATION

A. General

1. All open-cut excavations shall be performed to the lines, grades, and dimensions shown on the Drawings or established by the Engineer. All necessary precautions shall be taken to preserve the material below and beyond the lines of all excavations in the soundest possible condition. Where required to complete the Work, all excess excavation and overexcavation shall be refilled with suitable materials acceptable to the Engineer as specified herein.

2. Rock excavation shall be achieved by mechanical means unless blasting of hard lenses or areas of rock is approved by the Engineer. A detailed blasting plan must be submitted to the Engineer prior to issuance of approval for blasting. Furthermore, all blasting shall be conducted in accordance with applicable federal, state, and local laws and regulations.

3. All suitable materials removed from all types of excavations embraced in the Specification shall be used appropriately in the formation of fills, as cover material for synthetic lining, as reclamation cover material or other uses as indicated on the Drawings or as directed. Material suitability for these various uses is discussed in these Specifications. Materials to be used as reclamation cover shall be placed in stockpile areas as designated by owner.

4. Excavated material which will be suitable for dike construction or other fills when dry, shall be taken from the excavation, dried, and then placed in the fill area.

5. Where practical, suitable materials shall be excavated separately from unsuitable materials. All materials removed from all excavations which are considered unsuitable shall be disposed of in a suitable manner as discussed in these Specifications.

6. Final excavated rock surfaces shall be thoroughly cleaned. The cleaned surfaces shall be inspected and approved by the Engineer. All open joints or fractures (greater than 1/2 inch wide) shall be thoroughly cleaned as directed by the Engineer. All open joints or fractures designated by the Engineer shall be backfilled with mass concrete such that a smooth, flat surface is formed.

B. Unsuitable Material

1. Excavated materials shall be considered unsuitable for use in fills if they have expansive properties, are highly calcareous, or other unsuitable properties. Materials with these properties may be mixed with other material and used as suitable material only with the approval of the Engineer. Materials not so mixed shall be stockpiled in the soil stockpile area separately from suitable materials. These materials shall be considered suitable for use as reclamation cover.

2. Excavated materials containing rubbish or other foreign material shall be considered unsuitable for any use and shall be wasted as directed by the Engineer.

C. Stockpiling

1. Excess excavated materials or materials considered unsuitable shall be hauled to stockpile areas as designated by the Owner. This applies to reclamation cover material and suitable material for other uses as discussed above.

2. Material excavated as rock which breaks down rapidly so it does not meet the requirements for rockfill material shall be considered soil and stockpiled accordingly.

3.03 PREPARATION OF FILL AREAS

A. Stripping

1. The areas to be filled shall be stripped of all topsoil, frozen soil, organic material, rubbish and other foreign material prior to filling. These materials shall be stockpiled or wasted as directed by the Engineer.

B. Fill Foundations

1. Prior to the placement of any fill the stripped areas shall be inspected by the Engineer for wet materials, soft spots, small local zones or pockets of soft silts or clays, or other unsuitable materials that were not defined during the course of the exploration program. Areas of unsuitable materials shall be overexcavated and replaced with suitable earthfill compacted in accordance with the Specifications. The determination of unsuitable materials shall be made by the Engineer.

3.04 FILLS

A. Earthfill

1. The fills shall be constructed to the lines, grades and cross-sections indicated on the Drawings.

2. All fills shall be constructed of suitable material from the excavations. All excavated material is considered suitable unless it has unsuitable properties as discussed in Paragraph 3.02. Also, the material shall contain no large rocks, frozen or organic material, topsoil, rubbish or other foreign material.

3. All earthfills shall be compacted as specified in Paragraphs 3.05 or 3.06 depending on type of materials.

4. The distribution of materials throughout the compacted earthfill shall be such that it will be free from lenses, pockets, streaks, and layers of material differing substantially in texture or gradation from surrounding fill material.

5. Where fill is to be placed on natural slopes steeper than one vertical to seven horizontal, the existing slope shall be benched prior to placing fill. The width of any bench should not be greater than 25 feet or less than 5 feet. The width of each bench should be maintained within the specified limits, and the height of the cut face varied in accordance with the slope of the natural ground surface. The height of cut at the face should not exceed 5 feet. The slope of the temporary cut face should be no steeper than one vertical to one horizontal. All benches should be sloped at a minimum of 1 percent away from the cut face to maintain proper drainage.

6. After specified benches have been cut, the fill should proceed. The lowest elevations shall be filled first, in horizontal layers with a thickness no greater than specified limits and sloped to the outer edge of the fill. As each layer is spread it shall be thoroughly compacted with proper rollers. The top and bottom of all fills shall be rounded or eased to form a pleasing transition in change of grade.

7. Particles larger than 5 inches, but less than 10 inches in maximum dimensions shall be worked into the fill in such a manner as will disintegrate friable material and orient and distribute resistant particles to effect a compact well-knit mass with spaces between larger particles thoroughly choked with compact finer

materials. To aid in accomplishing this, material containing more than 20 percent (by volume) of particles exceeding 5 inches in maximum dimensions, shall be spread in lifts not exceeding 8 inches in thickness (loose measure), and tracked with at least four passes of the treads of a crawler type tractor which, by means of sufficient overlap, will assure complete coverage of an entire layer by the tractor treads. Second and subsequent passes of the treads shall not be made until each pass, as defined above, is completed. If the size and content of resistant particles in the fill material precludes proper compaction, the material shall be disposed of or mixed with finer materials before placement.

8. The fill on each side of structures shall be kept at approximately the same level as placement of the fill progresses.

## 3.05 COMPACTION SPECIFICATION - EARTHFILL-GRANULAR MATERIAL

### A. General

1. All granular fill placed at the site shall be spread in one-foot lifts (loose material) and each lift compacted to 75 percent relative density (ASTM-D2049-69) as defined by:

$$D_D = \frac{E_1 - E_N}{E_1 - E_D} \text{ (percent)}$$

where:

$D_D$ = relative density in percent

$E_1$ = void ratio of the granular soil in its loosest state (minimum dry density)

$E_D$ = void ratio of the granular soil in its densest state (maximum dry density)

$E_N$ = void ratio of the soil in its natural state

2. All granular fill shall be clean, nonexpansive, free of trash, rubble, debris, frozen, and other foreign materials.

3. For uniformity, a minimum of five passes of a 10-ton vibratory roller or its equivalent shall be required on each lift of fill.

## 3.06 COMPACTION SPECIFICATION - EARTHFILL-COHESIVE MATERIAL

### A. General

1. All cohesive fill placed at the site shall be spread uniformly in six- to eight-inch lifts (loose material) and compacted to approximately 95 percent of the Standard Proctor density (ASTM-D698-70). Upon placement and compaction of a lift of cohesive material, the surface shall be scarified to a depth of 2 inches prior to the placement of the next lift unless the compaction equipment leaves a surface sufficiently roughened to tie the two lifts together. Cohesive earth embankment material shall be compacted at a water content of between 1 below and 2 percent above optimum water content as determined by the Standard Proctor method (ASTM-D698-70).

2. All cohesive fill shall be free of trash, rubble, debris, roots, organic, frozen, and other foreign material. Fill shall not be placed on any subgrade that is under water, muddy, frozen, or contains frost.

3. For uniformity, a minimum of four passes of a sheeps-foot or segmented wheel roller in the 20- to 30-ton class shall be required on each lift.

## 3.07 WORK AREA DRAINAGE

### A. Fill Protection

1. To protect the surface of the fill, the top of all fill areas shall be crowned and sealed at the end of each working day to minimize the infiltration of water in the event of rainfall.

2. All fill saturated due to precipitation shall be dried or removed prior to placement of additional fill.

3. All impervious fills which become dried and/or cracked due to exposure, shall be wetted and reworked prior to application of additional fill.

### B. Slope Protection

1. As interim protection of the cut and fill slopes, adequate surface drains shall be provided at both the top and bottom of slopes to intercept and conduct runoff from the developed areas and to reduce saturation and erosion of the slopes.

## 3.08 ACCURACY OF COMPLETED GRADING

### A. General

1. The grades as shown on the Drawings or as specified shall be met within 3 inches at the completion of the site grading.

## 3.09 SYNTHETIC LINING SUBGRADE

### A. General

1. The synthetic lining subgrade shall be prepared or placed as specified below after excavations and fills have been completed and approved by the Engineer.

2. The subgrade shall consist of a specially inspected and prepared surface for fill sections and shall consist of a specially placed and compacted bedding layer for excavated sections.

### B. Preparation of Subgrade on Fill Sections

1. The fills shall be constructed to the lines, grades, and cross sections indicated on the Drawings and as specified under Section 2, Paragraph 3.04 of these Specifications.

2. The fill surface in areas to be covered by a synthetic lining shall be free from loose earth, ruts, sharp breaks in slope, rubbish, roots, vegetation or other foreign material, and all cobbles or rock fragments protruding from the final smooth surface.

3. All areas that do not meet these requirements shall be corrected to the satisfaction of the Engineer.

4. The fill surface shall be maintained in an acceptable condition during installation of the synthetic lining. Any areas that are disturbed shall be corrected prior to lining installation in that area.

### C. Preparation and Placement of Subgrade on Excavated Sections (Excluding Bedrock Surfaces)

1. The excavations shall be constructed to the lines, grades, and cross-sections indicated on the Drawings and as specified in Section 2, Paragraph 3.02 of these Specifications.

2. The excavated surface in areas to be covered by a synthetic lining shall be free from all loose earth and rock fragments over 6 inches in size, rubbish, roots, vegetation, or other foreign material. The excavated surface shall also be free from sharp breaks in slope and shall be fairly smooth with no pieces or fragments protruding from the general plane of excavation.

3. The excavated surface shall be compacted with a, smooth drawn roller or equivalent to insure that the surface is smooth and meets the other requirements as set forth herein.

D. Preparation of Subgrade on Excavated Rock Surface

1. The excavations shall be constructed to the lines, grades, and cross-sections indicated on the Drawings and as specified in Section 2, Paragraph 3.02 of these Specifications.

2. The excavated surface in areas to be covered by a synthetic lining shall be free from all loose earth and rock fragments over 6 inches in size, rubbish, roots, vegetation, or other foreign material. The excavated surface shall also be free from sharp breaks in slope and shall be fairly smooth with no pieces or fragments protruding more than 4 inches from the general plane of excavation.

3. The subgrade on the excavated bedrock surface shall be formed by ripping and crushing down the rock to the consistency of a fine sand. The rock surface shall be ripped completely and then rolled by a smooth drawn vibratory roller to form a minimum 6 inch compacted thickness, bedding layer. In addition, suitable bedding material shall consist of on-site soils of sand, silt, clay materials and combinations thereof, with a maximum particle size of 1 inch and a minimum clay content of 20 percent. Suitable bedding material shall contain no calcarerous soils.

# SECTION 3

# SYNTHETIC LINING

## PART 1 - GENERAL

### 1.01 DESCRIPTION

A. Scope of Work

1. The work covered under this section includes the furnishing of all labor, materials, and equipment to perform all operations required under the following items of work:

   a. Provide a technical representative experienced in PVC lining handling and installation.

   b. Installation of the synthetic lining.

   c. Digging of the anchor trenches.

   d. Placement of lining cover material.

## PART 2 - PRODUCTS

### 2.01 SYNTHETIC LINING

A. General

1. The synthetic lining shall be manufactured from sheet roll goods, factory fabricated into large panels for field seaming into a single impermeable tailings cell lining. The lining shall be made from the highest quality materials and manufactured, fabricated and installed by qualified, well known companies.

B. Lining Material Requirements

1. The lining shall be manufactured from domestic virgin polyvinyl chloride (PVC) resin. Reprocessed PVC material will not be permitted.

2. The lining shall be manufactured from calendered rolls of PVC sheeting a minimum of 54 inches wide, specifically compounded for use in hydraulic facilities and specially resistant to sulfuric

acid solutions. The sheeting shall be manufactured by a reputable, well known manufacturer and shall be free of pinholes, undisposed raw materials, or blisters or other defects.

3. The lining shall be 30 mil (0.030 inch) nominal thickness. It shall be black to dark gray in color and of uniform shade throughout.

4. As a minimum, the following information shall be supplied from the lining manufacturer.

   a. Manufacturer's name

   b. Manufacturer's experience with PVC

   c. Width of calendared rolls

   d. Physical properties (average value and standard deviation) of 30 mil PVC listed in Table 1.

C. Fabricated Lining Requirements

1. The lining shall be fabricated into large panels by a reputable, well known lining fabricator.

2. The panels shall be as large as practical to minimize field seaming but not inhibit installation from excessive panel weight or size.

3. The factory fabrication shall be done under strict quality control conditions with a seaming method that produces a sheet tearing bond of at least 80% sheet strength.

4. As a minimum the following information shall be supplied from the lining fabricator:

   a. Fabricator's Name

   b. Fabricator's experience with PVC.

   c. Method of Factory Seaming

   d. Width of Factory Seam

   e. Tear Strength of Factory Seam

   f. Physical properties (average and standard deviation) of 30 mil PVC listed in Table 1.

# TABLE 1
## 30-mil PVC LINING PHYSICAL PROPERTIES

| PROPERTY | UNITS | TEST METHOD |
|---|---|---|
| Thickness (min. & max.) | inches | ASTM D-1593 |
| Specific Gravity | — | ASTM D-792-A |
| Tensile Strength | pounds/inch | ASTM D-882, Method A |
| Maximum Elongation | percent | ASTM D-882 Method A |
| Modulus at Max. Elongation | pounds/inch | ASTM D-882 Method A |
| Graves Tear | pounds | ASTM D-1004 |
| Elmendorf Tear | grams | ASTM D-1922 |
| Cold Crack | °F | ASTM D-1790 |
| Dimensional Stability | percent | ASTM D-1204 |
| Water Extraction | percent | ASTM D-1239 |
| UV Resistance | hours | — |
| Volatility | percent | ASTM D-1203 |

## PART 3 - INSTALLATION REQUIREMENTS

### 3.01 INSTALLATION SUPERVISOR

A. General

1. A technical representative from the lining fabricator or installer shall be present at all times during the installation of the lining. The representative shall be experienced in the proper handling, preparation, and installation methods for PVC lining.

B. Duties

1. The technical representative shall supervise all aspects of the lining installation including but not limited to, storage, handling, spreading, seaming, anchoring and covering.

2. The representative shall provide expert advice and recommendations to the Engineer concerning lining subgrade preparation, and other lining aspects. Field inspection of earthwork items associated with the lining shall be required as requested by the Engineer.

### 3.02 LINING SUBGRADE

A. General

1. The synthetic lining subgrade for fill and excavated sections shall be prepared or placed as specified in Section 2, Paragraph 3.09 of these Specifications.

2. The prepared subgrade surface shall be inspected by the Engineer and the technical representative and approved by the Engineer prior to placement of lining on that surface.

### 3.03 LINING HANDLING

A. Packaging

1. The fabricated lining panels shall be packaged, by the fabricator, such that damage during shipment, handling, or storage is prevented. Packaging shall prevent damage by any physical, chemical, and environmental means.

B. On-Site Storage

1. The lining shall be stored as necessary such that damage will not occur.

2. The lining shall be kept at temperatures above 50°F and out of direct sunlight except for short time periods unless covered by protective material.

## 3.04 LINING INSTALLATION

A. General

1. The fabricated lining panels shall be handled such that no damage to them will occur. The panels shall be inspected prior to placement within the cell for damage. Damaged panels shall not be placed within the cell.

2. The panels shall be located and distributed within the cell to minimize excessive lining handling and movement during spreading and seaming.

3. The lining shall be placed and spread only on subgrade surfaces that have been inspected and approved by the Engineer.

4. No lining installation shall be permitted during cold weather or high winds. No field seaming shall be permitted during any precipitation.

B. Field Seams

1. The method and procedure for field seams joining factory fabricated lining panels shall be specified by the lining installer and approved by the Engineer.

2. Field seams shall be made only on lining surfaces that are cleaned of dirt, dust, moisture, or other foreign matter. The seaming shall be made on a firm surface with the lining manufacturer's approved adhesive. Adequate adhesive shall be used to completely seal the edges of the seam.

3. Seaming when the air temperature is 50°F or below shall be by special methods and with the approval of the Engineer only. No seaming shall be permitted when the air temperature is below 35°F.

4. All field seams shall provide a film tearing bond of at least 80% of the tear strength of the parent material. All field seams shall be inspected and approved by the Engineer. Seams not approved shall be repaired to the satisfaction of the Engineer.

C. Joints to Structures

1. Lining joints to structures shall be made where indicated on the Drawings.

2. The joints shall be made with the manufacturer's approved adhesive.

3. The method of joining shall be supplied by the installer and approved by the Engineer.

D. Anchor Trenches

1. The lining shall be installed in anchor trenches as shown on the Drawings. The trench locations shall be marked by others.

2. The installation of the lining in the anchor trenches shall be inspected and approved by the Engineer.

3. The trenches shall be backfilled with suitable material as specified for the lining bedding and compacted as specified for the lining bedding.

E. Installation Restrictions

1. No lining panels shall be spread out without adequate control for wind.

2. Lining panels that will not be seamed together during that day's operation shall not be spread out without prior approval of the Engineer.

3. No lining shall be spread during high wind conditions or cold weather.

4. No lining shall be driven upon without the cover material in place.

## 3.05 LINING COVER

### A. General

1. Lining cover consisting of coarse tailings from the beached tailings in Cell 2 shall be spread over the installed lining as shown on the Drawings.

2. Coarse tailings shall not contain any sharp, angular pieces or other foreign objects. It shall meet the requirements of the earthfill as specified in Section 2, Paragraph 3.04 of these Specifications.

3. The cover shall be placed as soon as practical over completed areas of the lining.

4. The cover shall be a minimum of 12 inches compacted thickness on the cell bottoms and 18 inches compacted thickness on the side slopes.

5. The cover shall be spread and compacted by the earth moving equipment with care to avoid damage to the lining.

6. Any damage to the lining shall be repaired immediately and to the satisfaction of the Engineer.

# PART 4 - QUALITY CONTROL AND ASSURANCE

## 4.01 QUALITY CONTROL

### A. Lining Tests

1. Lining tests specified on Table 1 shall be conducted on the fabricated lining for each 250,000 $ft.^2$ of panel(s) fabricated.

2. The results of these tests shall meet or exceed the lining specifications supplied by the manufacturer and fabricator under Section 3, Paragraph 2.01 or that panel(s) of lining will be rejected.

3. The test results shall be identified by a unique designation to the panel(s) from which the tested material was taken.

4. The test results shall be supplied to the Engineer prior to the installation of the lining.

B. Field Seam Testing

1. A sample of the field seam shall be cut from the installed lining for each 100,000 ft.$^2$ of lining installed. The sample shall be tested immediately for tear strength as specified in Table 1.

2. The test results shall be supplied to the Engineer within 2 days of the test.

3. Any test which does not meet or exceed the specifications shall result in the area of that sample being reseamed. Also, additional test samples for every 50,000 ft.$^2$ of lining installed shall be taken and tested for tear strength as specified in Table 1.

4. Placement of the lining cover shall not be delayed awaiting seam test results. Seams that fail the test will require removal of the cover to repair.

C. Fabricated Lining Samples

1. The lining fabricator shall supply a sample of the fabricated lining containing at least one seam for each 250,000 ft.$^2$ of lining fabricated.

2. The sample shall be at least six foot square and shall be clearly marked by a unique designation identifying which panel the sample is from.

4.02 QUALITY ASSURANCE

A. Lining Guarantee

1. The lining manufacturer shall supply pertinent information regarding the material guarantee of its product.

2. The lining fabricator shall supply pertinent information regarding the material and workmanship guarantee of its product.

3. The lining installer shall supply pertinent information regarding the workmanship guarantee of its product.

B. Test Results

1. All lining tests shall be conducted by a qualified laboratory or personnel approved by the Engineer.

2. All test procedures and methods shall be reported as part of the test result.

3. As a minimum, the test results shall be signed, dated, and uniquely identified to the lining from which the test sample was taken.

# SECTION 4

# APPURTENANT FACILITIES

## PART 1 - GENERAL

### 1.01 DESCRIPTION

#### A. Scope of Work

1. The work covered under this section includes the furnishing of all labor and materials to install or complete the following Work items:

   a. Installing the slimes pool drain system to the limits as shown on the Drawings.

      Installing the pipe trenches as shown on the Drawings.

   b. Applying soil stabilizer to completed excavation and fill slopes as required by the Engineer.

## PART 2 - PRODUCTS

### 2.01 SLIMES POOL DRAIN SYSTEM

#### A. Drain Pipes

1. The drain pipes shall be polyvinyl chloride (PVC) plastic pipe in the sizes as shown on the Drawings. The pipe shall be Schedule 40, PVC 1220 (Type I, Grade 2) according to ASTM 1785 or equivalent as approved by the Engineer.

2. Slotted lengths of the pipe, as indicated on the Drawings, shall be factory slotted with 0.040 inch wide slots, on approximately 0.25 inch spacings along the pipe, in 3 rows equally spaced around the pipe circumference.

#### B. Drain Pipe Riser

1. The drain pipe riser shall be Driscopipe 7600, Low Pressure, industrial pipe or equivalent as approved by the Engineer. The pipe shall be 24 inch nominal size.

## 2.02 UNDERDRAIN SYSTEM

### A. Sand Underdrain Material

1. The sand underdrain material shall be clean, sound sand meeting the requirements and gradation for Fine Aggregate in ASTM C 33 with the following limits:

| Sieve Size | % Passing by Weight |
|---|---|
| 3/8 inch | 100 |
| No. 4 | 95-100 |
| No. 8 | 80-100 |
| No. 16 | 50-85 |
| No. 30 | 25-60 |
| No. 50 | 10-30 |
| No. 100 | 2-10 |

### B. Underdrain Pipes

1. The drain pipes shall be polyvinyl chloride (PVC) plastic pipe in the sizes as shown on the Drawings. The pipe shall be Schedule 40, PVC 1220 (Type I, Grade 2) according to ASTM 1785 or equivalent as approved by the Engineer.

2. Slotted lengths of the pipe, as indicated on the Drawings, shall be factory slotted with 0.040 inch wide slots, on approximately 0.25 inch spacings along the pipe, in 3 rows equally spaced around the pipe circumference.

### C. Drain Pipe Riser

1. The drain pipe riser shall be Driscopipe 7600, Low Pressure, industrial pipe or equivalent as approved by the Engineer. The pipe shall be 24 inch nominal size.

## 2.03 SOIL STABILIZER

### A. General

1. The soil stabilizer shall be a chemical spray soil binder such as Aerospray 70 or 52, or equivalent as approved by Engineer.

## PART 3 - CONSTRUCTION REQUIREMENTS

### 3.01 SLIMES POOL DRAIN SYSTEM

#### A. General

1. The slimes pool drain system shall be installed to the limits as shown on the Drawings.

   Modifications to the installation may be made in the field by the Engineer.

2. The system shall be installed only on completed cell surfaces that have been inspected and approved by the Engineer.

#### B. Drain Pipes

1. The drain pipes shall be installed as shown on Drawings. The PVC pipes shall be joined together with an approved adhesive employing manufacturer and Engineer approved methods and procedures. Appropriate fittings, including end caps and T-sections, shall be used to join pipe sections together.

2. The drain pipes shall be located on the compacted tailings cover surface so they will flow to the drain pipe riser with all slotted pipe sections wrapped in approved filter cloth. Additional coarse tailings material shall be placed, but not compacted, around the slotted pipes sections as shown on the Drawings.

#### C. Drain Pipe Riser

1. The drain pipe riser shall be installed as shown on the Drawings. The riser shall be placed vertically on the compacted fill.

2. The drain pipes shall be inserted into the riser by cutting holes in the required locations. The opening around the installed pipes shall be closed with an approved sealant or patching as required.

3. The riser shall be supported in a vertical position as fill is placed around it. The fill surface shall be kept at about the same level around the pipe as the fill is placed to avoid unequal side loads on the riser.

3.02 UNDERDRAIN SYSTEM

A. Sand Material

1. The sand underdrain material shall be placed in a controlled manner in the required thickness as shown on the Drawings. Dumping from the top of the slope down the face of the slope may result in material segregation and shall not be allowed. The material shall be compacted by the placement equipment tracking over it.

B. Drain Pipes

1. The drain pipes shall be installed as shown on Drawings. The PVC pipes shall be joined together with an approved adhesive employing manufacturer and Engineer approved methods and procedures. Appropriate fittings, including end caps and T-sections, shall be used to join pipe sections together.

2. The slotted drain pipe shall be placed in or under the sand material as shown on the Drawings. The slotted pipe shall be placed so it will flow smoothly and uniformly to the connection with the access pipe.

3.03 SOIL STABILIZER

A. Application

1. The soil stabilizer shall be mixed with water to a concentration for spray application according to the manufacturers recommendations.

2. The stabilizer shall be applied to completed excavation and fill slopes, to minimize erosion as directed by the Engineer.

3.04 CLEAN-UP

A. General

1. After the earthwork and construction specified herein is completed, the work area shall be cleaned up and any excess construction materials removed from the site or stored as designated by the Engineer. Disturbance to the work area shall be minimized by removing any excess fill or spreaidng it to maintain a uniform contoured surface. Haul roads and other disturbed areas outside the construction limits shall be regarded and revegetated to minimize surface disturbance.

# SECTION 5

# GROUNDWATER MONITORING WELLS

## PART 1 - GENERAL

### 1.01 DESCRIPTION

A. Scope of Work

1. The Work covered under this section includes the furnishing of all labor and materials to install the groundwater monitoring wells shown on the Drawings and attached Figures B1-B3, and as required by the Engineer.

## PART 2 - PRODUCTS

### 2.01 WELLS

A. Well Pipe

1. Well pipe shall be polyvinyl chloride (PVC) plastic pipe in sizes as shown on the Figures. The pipe shall be Schedule 40, PVC 1220 (Type I, Grade 2) according to ASTM 1785 or equivalent as approved by the Engineer.

2. Slotted pipe sections shall be factory produced with a 0.045 inch slot width, on 0.25 inch spacings, in 3 rows equally spaced around the pipe circumference.

## PART 3 - INSTALLATION

### 3.01 DRILLING

A. General

1. The well locations shall be specified by the Engineer.

2. The holes shall be drilled with the diameters shown on the Figures. All drilling shall be conducted with air, foam, or degradable organic polymer, drilling mud as approved by the Engineer.

## 3.02 WELL INSTALLATION

### A. General

1. The wells shall be installed as shown on the Figures and under the direction of the Engineer or their designated representative.

### B. Casing

1. The casing shall be PVC plastic pipe. The driller shall have approved elevators and slips manufactured for use with PVC pipe in the sizes specified.

2. The casing shall be joined by approved adhesive and allowed to set for sufficient time to support the weight of the casing. If screws are used for additional support, they shall not penetrate the interior of the casing. Each joint shall be inspected by the Engineer before lowering into the hole.

### C. Fittings

1. Fittings, such as centralizers and cement baskets shall be attached at locations as directed by the Engineer. These fittings shall be secured so they do not slide on the casing.

### D. Gravel Packs

1. Gravel packs shall be installed by pouring at a slow rate, as directed by the Engineer, from the surface.

### E. Bentonite Seals

1. The annular space shall be sealed by placement of a sand pad on the cement basket. After placement of the pad, as directed by the Engineer, bentonite balls shall be placed and compacted with a tamper in lifts no greater than 6 inches.

### F. Grout Seals

1. All grout seals shall be neat cement with a weight of 15.5 pounds per gallon. The grout shall be placed by pumping through a tremmie tube, as approved by the Engineer.

G. Protective Pipe

1. The protective pipe shall be installed over the end of the well casing PVC and cemented into the surface seal. The pipe shall be fitted with a locking cap.

3.03 WELL DEVELOPMENT

A. General

1. The deep monitoring wells shall be air lifted, pumped or bailed until the water is clear, as approved by the Engineer.

3.04 SEALING OF EXISTING WELLS

A. General

1. Wells existing (Numbers 6-1, 6-2, 7-1, 7-2, 8-1, 8-2) located on Sheet 2, in the Cell 3 area shall be sealed prior to construction. Other wells to be sealed may be specified by the Engineer.

B. Method

1. The wells shall be sealed by backfilling the casing with a grout slurry placed by the tremie method.

2. A grout slurry pipe shall be placed down the well to the bottom. This pipe shall be about one inch diameter plastic pipe or equivalent.

3. The grout slurry shall be a cement water mix with mix proportions approved by the Engineer. The slurry shall be thin enough to flow easily down the pipe.

4. Placement of the slurry shall be by the tremie method. Grout slurry shall be pumped into the pipe while it is located at the bottom of the well. Placement shall continue until the level of slurry in the well is at the top of the casing. At this time the pipe may begin to be slowly removed. Placement of grout shall continue to maintain the grout level at the top of the casing. Placement shall continue until the pipe is withdrawn from the well.

5. The grout level shall be monitored for at least 2 hours after pipe removal. The grout level shall be maintained at the top of the casing during this period by placement of additional grout by pouring into the casing.

6. The total volume of grout slurry placed in the well shall be recorded along with other pertinent data.

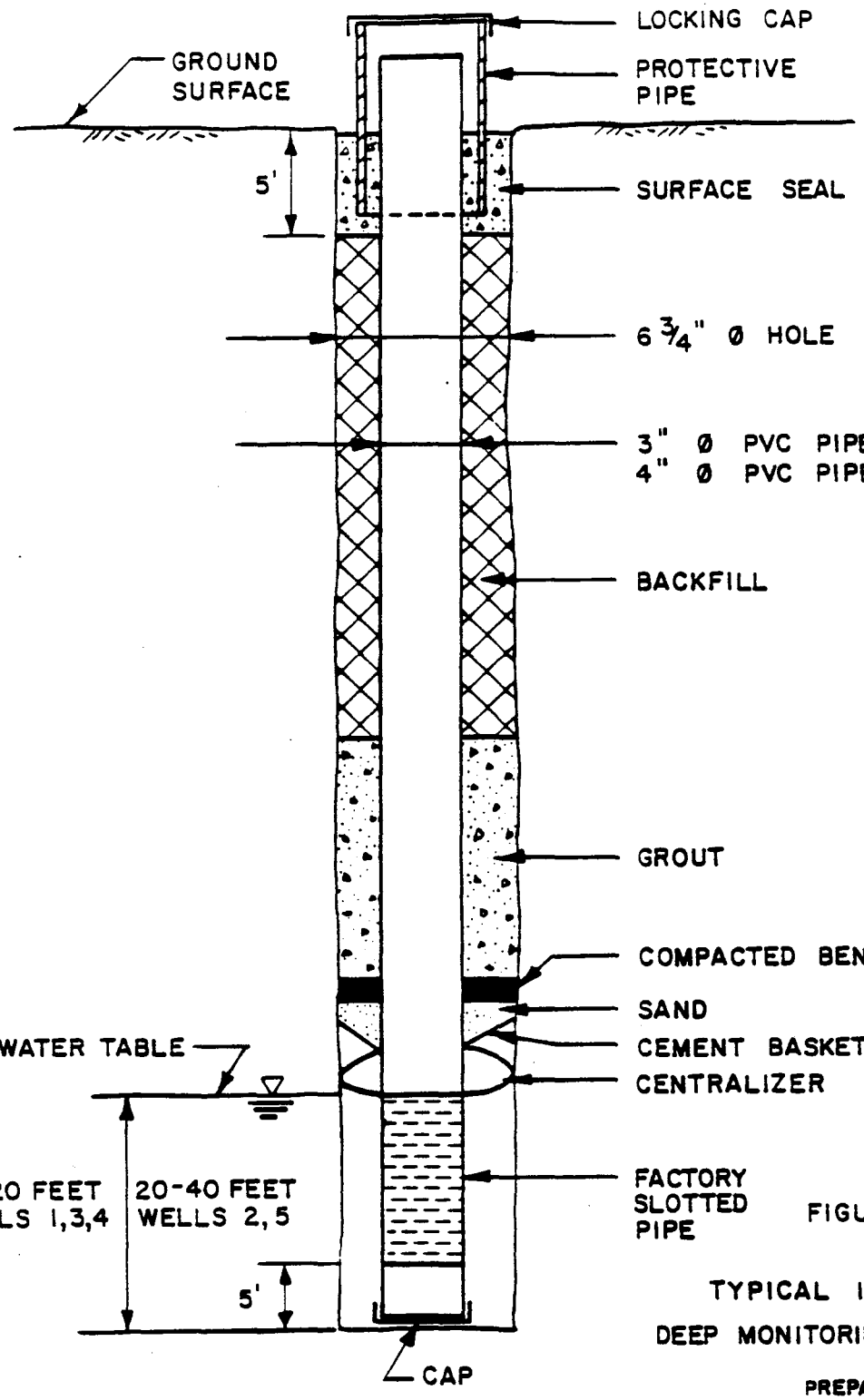



FIGURE B1

TYPICAL INSTALLATION

DEEP MONITORING/SAMPLING WELL

PREPARED FOR

ENERGY FUELS NUCLEAR, INC.

DENVER, COLORADO

"NOT TO SCALE"

D'APPOLONIA

DRA NUMBER RM70 382-A1

| DRA BY | D.J. 4-19-79 | CHE BY | APPROVED BY | DATE |
|---|---|---|---|---|
| | | | | 5/31/79 |

| DRAWN BY | B.K.H. 4-19-79 | CHECKED BY | CEQ 5/23/79 | DRAWING NUMBER | RM78-682-A3 |
|---|---|---|---|---|---|
| | | APPROVED BY | MJT 5/30/79 | | |

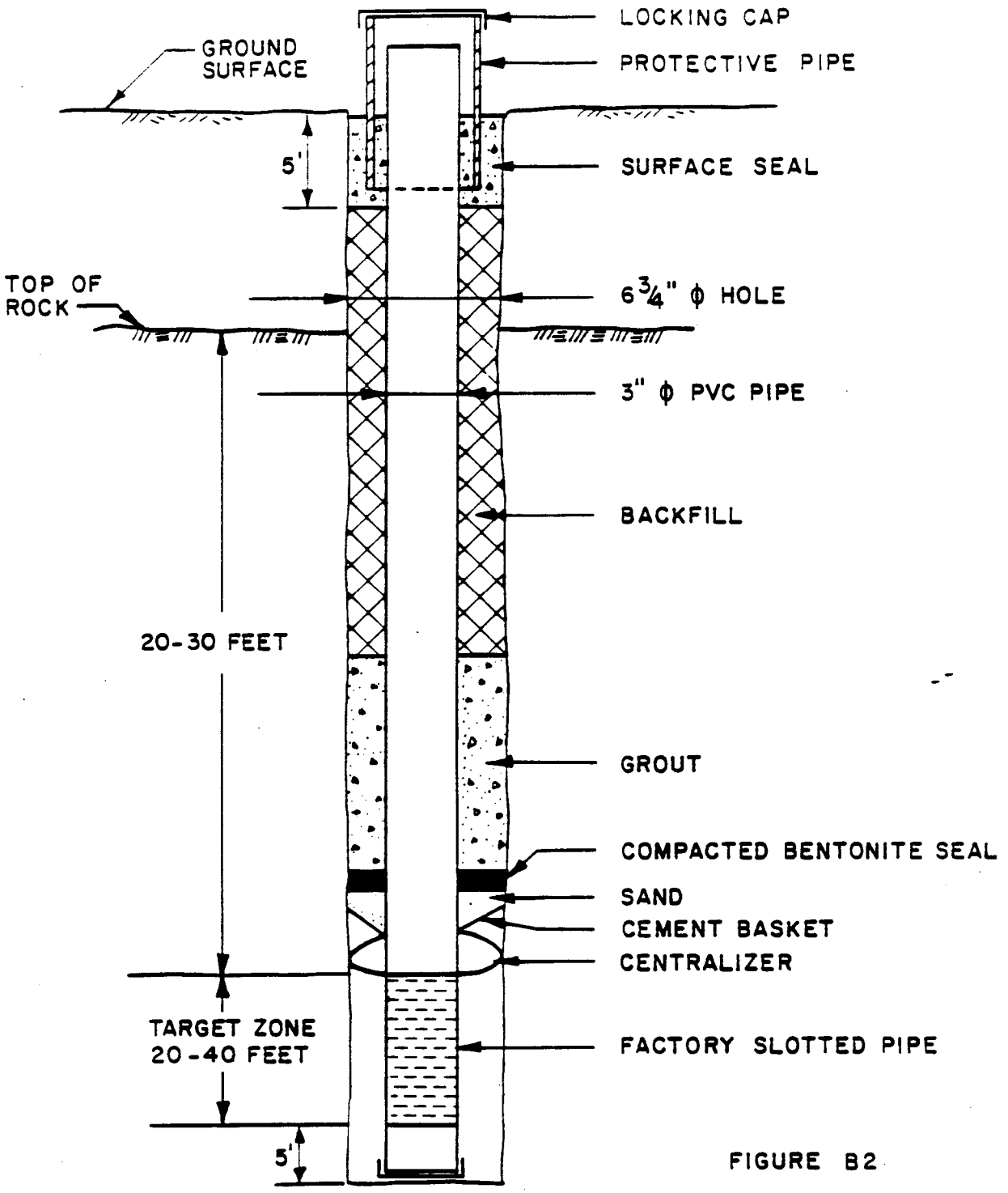



FIGURE B2

TYPICAL INSTALLATION
INTERMEDIATE DEPTH
MONITORING WELL

PREPARED FOR

ENERGY FUELS NUCLEAR, INC.
DENVER, COLORADO

D'APPOLONIA

"NOT TO SCALE"

| DRAWN BY | D. J. R. | 4-19-79 |
|---|---|---|
| CHECKED BY | | |
| APPROVED BY | MST | 5/31/79 |
| DRAWING NUMBER | RM78-682-A2 | |

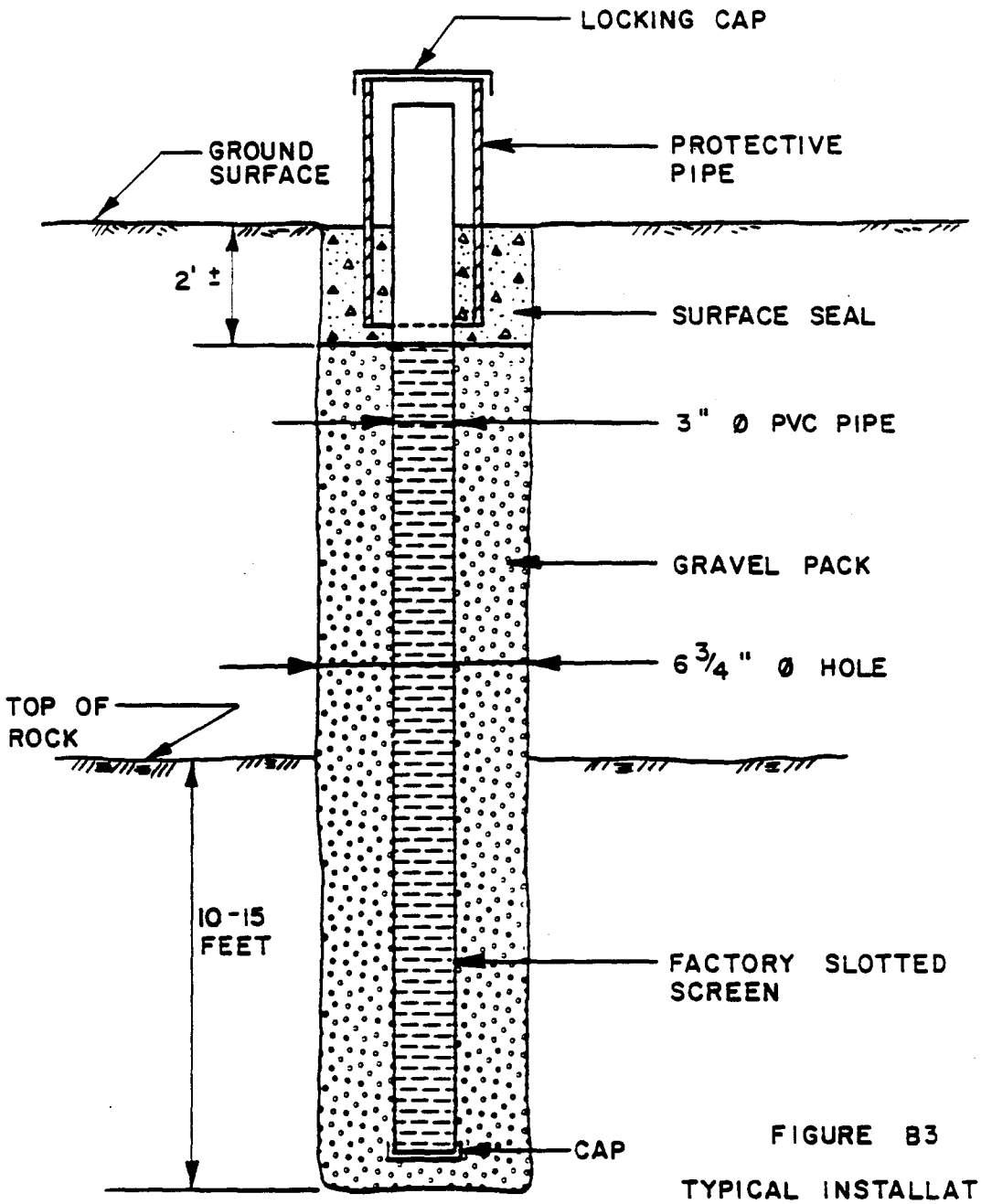



FIGURE B3

TYPICAL INSTALLATION
SHALLOW MONITORING WELL

PREPARED FOR

ENERGY FUELS NUCLEAR, INC.

DENVER, COLORADO

"NOT TO SCALE"

D'APPOLONIA

# TEST PIT LOGS
# SECOND PHASE TAILINGS MANAGEMENT SYSTEM

WHITE MESA URANIUM PROJECT
BLANDING, UTAH

DATE BEGAN: 1/14/81
DATE FINISHED: 1/14/81
GROUND SURFACE EL.: ~5594'

# TEST PIT NO. 4-1

N ~319,690' E~2,578,206'

FIELD ENGINEER: R. Greenwood
CHECKED BY: R. Greenwood

| ELEV (FEET) | DEPTH (FEET) | PROFILE | DESCRIPTION | REMARKS |
|---|---|---|---|---|
| | | | Medium stiff red sandy silt. Dry. Roots to depth | SAMPLE NO. 1 DEPTH 10"-12" TYPE JAR |
| | 1.0 | | | |
| | | | 1.5' | |
| | 2.0 | | Very stiff red-white sandy silt. Dry. Very calcareous | 2 22"-24" JAR |
| | | | 2.8' | |
| | 3.0 | | Soft-medium stiff red sandy silt. Moist, w/streaks of white. Slightly calcereous | |
| 5590 | 4.0 | | | |
| | | | | 3 4'6" JAR |
| | 5.0 | | | |
| | | | | A 5'-5'6" BAG 3.8% $CaCO_3$ |
| | 6.0 | | | |
| | 7.0 | | | |
| 5586 | 8.0 | | | |
| | | | | 4 8'4" JAR |
| | 9.0 | | | |
| | | | 9.0' | |
| | 10.0 | | Very soft greenish gray claystone. Moist, weathered | 5 10'4" JAR |
| | 11.0 | | | Consistency of soil but with intact layering |
| | | | | B 10'-10'6" BAG 9.55% $CaCO_3$ |
| 5582 | 12.0 | | | |

DATE BEGAN: 1/14/81
DATE FINISHED: 1/14/81
GROUND SURFACE EL.: ~5594'

# TEST PIT NO. 4-1

N ~319,690' E~2,578,206'

FIELD ENGINEER: R. Greenwood
CHECKED BY R. Greenwood

| ELEV (FEET) | DEPTH (FEET) | PROFILE | DESCRIPTION | REMARKS |
|---|---|---|---|---|
| | 13.0 | | "Same as above" | |
| | | | 13.5' | |
| | 14.0 | | Soft yellowish brown sandstone. Weathered | Intact, Easy rippable |
| | 15.0 | | | |
| | | | | Ripping becomes difficult |
| 5578 | 16.0 | | 16.0' | |
| | | | Bottom of test pit 16.0' | |

DATE BEGAN: 1/14/81
DATE FINISHED: 1/14/81
GROUND SURFACE EL.: ~5583 '

# TEST PIT NO. 4-2

N ~319,950' E ~2,577,955'

FIELD ENGINEER: R. Greenwood
CHECKED BY R. Greenwood

| ELEV (FEET) | DEPTH (FEET) | PROFILE | DESCRIPTION | REMARKS |
|---|---|---|---|---|
| | 1.0 | | Red sandy silt. Dry w/ roots to depth | SAMPLE NO. DEPTH TYPE |
| | 2.0 | | 2.0' | |
| 5580 | 3.0 | | Medium dense red silty sand. Moist. | A 2'-5' BAG<br>2.3% $CaCO_3$ |
| | 4.0 | | | 1 3' JAR |
| | 5.0 | | | |
| | 6.0 | | 5.7' | 2 5'8" JAR |
| 5576 | 7.0 | | Soft yellowish brown sandstone<br>7.0' | |
| | | | Bottom of test pit 7.0' | |

DATE BEGAN: 1/14/81
DATE FINISHED: 1/14/81
GROUND SURFACE EL.: ~5582'

# TEST PIT NO. 4-3

N ~319,552' E ~2,577,950'

FIELD ENGINEER: R. Greenwood
CHECKED BY: R. Greenwood

| ELEV (FEET) | DEPTH (FEET) | PROFILE | DESCRIPTION | REMARKS |
|---|---|---|---|---|
| | 1.0 | | Medium dense red sandy silt. Dry. Roots to depth 1.3' | SAMPLE NO. DEPTH TYPE |
| 5580 | 2.0 | | Medium dense red-white silty sand. Very calcereous | 1 1'8" JAR |
| | 3.0 | | | A 2'-3'4" BAG<br>21.6% $CaCO_3$ |
| 5578 | 4.0 | | Soft greenish gray to yellowish brown claystone-sandstone. Weathered 5.0' | 2 3'9" JAR |
| | 5.0 | | Bottom of test pit 5.0' | |

DATE BEGAN: 1/14/81
DATE FINISHED: 1/14/81
GROUND SURFACE EL.: ~5581'

# TEST PIT NO. 4-4

N ~319,740' E ~2,577,530'

FIELD ENGINEER: R. Greenwood
CHECKED BY R. Greenwood

| ELEV (FEET) | DEPTH (FEET) | PROFILE | DESCRIPTION | REMARKS | | |
|---|---|---|---|---|---|---|
| | | | | SAMPLE NO. | DEPTH | TYPE |
| 5580 | 1.0 | | Medium dense red sandy silt. Dry. Roots to depth | | | |
| | | | 1.5' | | | |
| | 2.0 | | Dense red-white silty sand. Slightly calcareous. Dry | 1 | 2'1" | JAR |
| | | | 2.7' | | | |
| | 3.0 | | Medium dense red silty sand. Moist | A 1.7% $CaCO_3$ | 3' | BAG |
| | 4.0 | | | | | |
| 5576 | 5.0 | | | | | |
| | 6.0 | | | 2 | 6' | JAR |
| | 7.0 | | | | | |
| | 8.0 | | | | | |
| | | | 8.0' | | | |
| 5572 | 9.0 | | Soft yellowish brown sandstone. Weathered | | | |
| | 10.0 | | | | | |
| | 11.0 | | | | | |
| | 12.0 | | | | | |
| | | | 12.0' | | | |
| | | | Bottom of test pit 12.0' | | | |

DATE BEGAN: 1/14/81
DATE FINISHED: 1/14/81
GROUND SURFACE EL.: ~5578'

# TEST PIT NO. 4-5

N ~319,760' E ~2,576,743'

FIELD ENGINEER: R. Greenwood
CHECKED BY R. Greenwood

| ELEV (FEET) | DEPTH (FEET) | PROFILE | DESCRIPTION | REMARKS | | |
|---|---|---|---|---|---|---|
| | | | | SAMPLE NO. | DEPTH | TYPE |
| | 1.0 | | Medium stiff red sandy silt. Dry. Roots to depth | | | |
| | | | 1.5' | | | |
| 5576 | 2.0 | | Dense red silty sand. Dry. Slightly calcareous | 1 | 2' | JAR |
| | 3.0 | | | | | |
| | | | | A | 3'-5' | BAG |
| | 4.0 | | 3.8' | 2.9% $CaCO_3$ | | |
| | | | Medium dense red silty sand. Moist | 2 | 4' | JAR |
| | 5.0 | | 5.0' | | | |
| 5572 | 6.0 | | Soft yellowish brown sandstone | | | |
| | 7.0 | | 7.0' | | | |
| | | | Bottom of test pit 7.0' | | | |

DATE BEGAN: 1/14/81
DATE FINISHED: 1/14/81
GROUND SURFACE EL.: ~5579'

# TEST PIT NO. 4-6

N ~319,942' E ~2,577,078'

FIELD ENGINEER: R. Greenwood
CHECKED BY R. Greenwood

| ELEV (FEET) | DEPTH (FEET) | PROFILE | DESCRIPTION | REMARKS |
|---|---|---|---|---|
| | | | Medium stiff red sandy silt | SAMPLE NO. DEPTH TYPE |
| 5578 | 1.0 | | | |
| | 2.0 | | 2.0' | |
| | 3.0 | | Dense red-white silty sand. Dry. Very calcareous | 1 3' JAR |
| | | | 3.7' | |
| | 4.0 | | Medium dense red silty sand. Moist | A 4' BAG<br>3% $CaCO_3$ |
| 5574 | 5.0 | | | 2 4.5' JAR |
| | 6.0 | | | |
| | 7.0 | | | |
| | 8.0 | | 8.0' | |
| | | | Soft yellowish brown sandstone 8.5' | |
| | | | Bottom of test pit 8.5' | |

DATE BEGAN: 1/15/81
DATE FINISHED: 1/15/81
GROUND SURFACE EL.: ~5589 '

# TEST PIT NO. 4-8

N ~319,918' E ~2,576,056'

FIELD ENGINEER: R. Greenwood
CHECKED BY R. Greenwood

| ELEV (FEET) | DEPTH (FEET) | PROFILE | DESCRIPTION | REMARKS | | |
|---|---|---|---|---|---|---|
| | | | | SAMPLE NO. | DEPTH | TYPE |
| 5588 | 1.0 | | Medium stiff red sandy silt. Dry. Roots to depth 1.7' | | | |
| | 2.0 | | Dense red silty sand. Dry. Some with white streaks 2.7' | 1 | 2' | JAR |
| | 3.0 | | Loose red silty sand. Moist. Some white streaks | A 7.2% $CaCO_3$ | 3'-6' | BAG |
| | 4.0 | | | | | |
| 5584 | 5.0 | | 5.0' | 2 | 4'5" | JAR |
| | 6.0 | | Dense whitish red silty sand. Moderately calcareous | 3 | 6' | JAR |
| | 7.0 | | | | | |
| | 8.0 | | | | | |
| 5580 | 9.0 | | 9.0' | | | |
| | 10.0 | | Soft yellowish brown sandstone 10.0' | | | |
| | | | Bottom of test pit 10.0' | | | |

DATE BEGAN: 1/15/81
DATE FINISHED: 1/15/81
GROUND SURFACE EL.: ~5589'

# TEST PIT NO. 4-8

N ~319,918' E ~2,576,056'

FIELD ENGINEER: R. Greenwood
CHECKED BY R. Greenwood

| ELEV (FEET) | DEPTH (FEET) | PROFILE | DESCRIPTION | REMARKS | | |
|---|---|---|---|---|---|---|
| | | | | SAMPLE NO. | DEPTH | TYPE |
| 5588 | 1.0 | | Medium stiff red sandy silt. Dry. Roots to depth | | | |
| | | | 1.7' | | | |
| | 2.0 | | Dense red silty sand. Dry. Some with white streaks | 1 | 2' | JAR |
| | | | 2.7' | | | |
| | 3.0 | | Loose red silty sand. Moist. Some white streaks | A 7.2% $CaCO_3$ | 3'-6' | BAG |
| | 4.0 | | | | | |
| | | | | 2 | 4'5" | JAR |
| 5584 | 5.0 | | 5.0' | | | |
| | | | Dense whitish red silty sand. Moderately calcareous | | | |
| | 6.0 | | | 3 | 6' | JAR |
| | 7.0 | | | | | |
| | 8.0 | | | | | |
| 5580 | 9.0 | | 9.0' | | | |
| | | | Soft yellowish brown sandstone | | | |
| | 10.0 | | 10.0' | | | |
| | | | Bottom of test pit 10.0' | | | |

DATE BEGAN: 1/15/81
DATE FINISHED: 1/15/81
GROUND SURFACE EL.: ~5594'

# TEST PIT NO. 4-9

N ~319,705' E ~2,575,660'

FIELD ENGINEER: R. Greenwood
CHECKED BY R. Greenwood

| ELEV (FEET) | DEPTH (FEET) | PROFILE | DESCRIPTION | REMARKS | | |
|---|---|---|---|---|---|---|
| | | | | SAMPLE NO. | DEPTH | TYPE |
| | 1.0 | | Medium stiff red sandy silt. Dry. Roots to depth | | | |
| | | | 1.7' | | | |
| | 2.0 | | Dense red silty sand. Dry. White streaks. Slightly calcareous | 1 | 2' | JAR |
| | 3.0 | | 3.0' | | | |
| 5590 | 4.0 | | Stiff redish white sandy silt. Dry. Very calcareous | 2 | 4' | JAR |
| | | | 4.3' | | | - |
| | 5.0 | | Medium dense red silty sand. Moist. Some white streaks. Slightly calcareous | A 24% $CaCO_3$ | 4'-8' | BAG |
| | 6.0 | | 6.0' | | | |
| | 7.0 | | Dense redish white silty sand. Chalky. Very calcareous. Dry | 3 | 7' | JAR |
| 5586 | 8.0 | | 8.0' | | | |
| | 9.0 | | Very soft yellowish brown sandstone. Weathered | | | |
| | 10.0 | | Medium hard yellowish brown sandstone | | | |
| | 11.0 | | 11.0' | | | |
| | | | Bottom of test pit 11.0' | | | |

DATE BEGAN: 1/14/81
DATE FINISHED: 1/14/81
GROUND SURFACE EL.: ~ 5577'

# TEST PIT NO. D4-1

N ~319,390 ' E~2,577,830 '

FIELD ENGINEER: R. Greenwood
CHECKED BY R. Greenwood

| ELEV (FEET) | DEPTH (FEET) | PROFILE | DESCRIPTION | REMARKS | | |
|---|---|---|---|---|---|---|
| | | | | SAMPLE NO. | DEPTH | TYPE |
| | 1.0 | | Stiff red sandy silt. Dry. Roots to depth | | | |
| | | | 1.3' | | | |
| | 2.0 | | Dense red silty sand. Dry. | | | |
| | | | 1.9' | | | |
| | | | Medium dense red silty sand. Moist | 1 | 2'4" | JAR |
| 5574 | 3.0 | | | | | |
| | | | | ST-1 | 3'-5' | 3" Shelby |
| | 4.0 | | | | | |
| | | | 4.3' | 2 | 4'2" | JAR |
| | | | Very soft greenish gray claystone. Moist | | | |
| | 5.0 | | | | | |
| | 6.0 | | | | | |
| 5570 | 7.0 | | 7.0' | | | |
| | | | Soft yellowish brown sandstone | 3 | 7'2" | JAR |
| | 8.0 | | 8.0' | | | |
| | | | Bottom of test pit 8.0' | | | |

DATE BEGAN: 1/14/81
DATE FINISHED: 1/14/81
GROUND SURFACE EL.: ~ 5572'

# TEST PIT NO. D4-2

N ~ 319,435' E ~ 2,577,155'

FIELD ENGINEER: R. Greenwood
CHECKED BY R. Greenwood

| ELEV (FEET) | DEPTH (FEET) | PROFILE | DESCRIPTION | REMARKS | | |
|---|---|---|---|---|---|---|
| | | | | SAMPLE NO. | DEPTH | TYPE |
| | 1.0 | | Medium stiff red sandy silt. Dry. Roots to depth | | | |
| 5570 | 2.0 | | 2.0' | | | |
| | 3.0 | | Dense red silty sand. Dry. Streaks of white 3.0' | 1 | 3' | JAR |
| | 4.0 | | Medium dense red silty sand. Moist. Streaks of white | | | |
| | 5.0 | | | | | |
| 5566 | 6.0 | | | ST-1 | 5'-7' | 3" Shelby |
| | | | | 2 | 6' | JAR |
| | 7.0 | | 7.0' | ST-2 | 6'-8' | 3" Shelby |
| | 8.0 | | Dense red silty sand. Dry | 3 | 8' | JAR |
| | 9.0 | | | | | |
| 5562 | 10.0 | | 9.75' Soft yellowish brown sandstone | | | |
| | 11.0 | | | | | |
| | | | 11.5' Bottom of test pit 11.5' | | | |

DATE BEGAN: 1/15/81
DATE FINISHED: 1/15/81
GROUND SURFACE EL.: ~5578'

# TEST PIT NO. D4-3

N ~319,430' E~2,576,315'

FIELD ENGINEER: R. Greenwood
CHECKED BY R. Greenwood

| ELEV (FEET) | DEPTH (FEET) | PROFILE | DESCRIPTION | REMARKS | | |
|---|---|---|---|---|---|---|
| | | | | SAMPLE NO. | DEPTH | TYPE |
| | 1.0 | | Medium stiff red sandy silt. Dry. Roots to depth 1.0' | | | |
| | | | Dense red silty sand. Dry. Some roots 1.7' | | | |
| | 2.0 | | Dense red silty sand. Dry. Streaks of white. Slightly calcareous | 1 | 2' | JAR |
| | 3.0 | | 3.3' | | | |
| 5574 | 4.0 | | Medium dense red silty sand. Moist | ST-1 | 3'6"-5'6" | 3"Shelby |
| | 5.0 | | | 2 | 5' | JAR |
| | 6.0 | | 6.0' | | | |
| | 7.0 | | Soft yellowish brown sandstone 7.0' | | | |
| | | | Bottom of test pit 7.0' | | | |