Waste Isolation Pilot Plant

Compliance Certification Application

Reference 335

Jarolimek, L., M.J. Timmer, and R.F. McKinney, 1983.
Geotechnical Activities in the Exploratory Shaft - Selection of the Facility Interval Waste Isolation Pilot Plant (WIPP) Project Southeastern New Mexico, TME 3178, Albuquerque, NM, U.S. DOE.

Submitted in accordance with 40 CFR §194.13, Submission of Reference Materials.

DUPLICATE

GEOTECHNICAL ACTIVITIES IN THE EXPLORATORY SHAFT — SELECTION OF THE FACILITY INTERVAL

waste isolation

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.

TECHNICAL SUPPORT CONTRACT

DE-AC04-78AL05346

WESTINGHOUSE ELECTRIC CORP.

D'APPOLONIA CONSULTING ENGRS.

DRAVO MINING

GIBBS & HILL INC.

TME 3178

GEOTECHNICAL ACTIVITIES IN THE EXPLORATORY SHAFT-- SELECTION OF THE FACILITY INTERVAL WASTE ISOLATION PILOT PLANT (WIPP) PROJECT SOUTHEASTERN NEW MEXICO

March 1983

U.S. DEPARTMENT OF ENERGY
WASTE ISOLATION PILOT PLANT
ALBUQUERQUE, NEW MEXICO

TME 3178

This report also serves as Supporting Document No. 4a for TME 3177, entitled "Results of Site Validation Experiments," prepared for the U.S. Department of Energy by TSC-D'Appolonia (S. R. Black, R. S. Newton, D. K. Shukla, editors) in March 1983.

TME 3178

GEOTECHNICAL ACTIVITIES IN THE EXPLORATORY SHAFT-- SELECTION OF THE FACILITY INTERVAL WASTE ISOLATION PILOT PLANT (WIPP) PROJECT SOUTHEASTERN NEW MEXICO

AUTHORS:

3/18/83

L. Jarolimek — Date
D'Appolonia Consulting Engineers, Inc.

M. J. Timmer 3/18/83

M. J. Timmer — Date
D'Appolonia Consulting Engineers, Inc.

Roy F. McKinney 3/18/83

R. F. McKinney — Date
D'Appolonia Consulting Engineers, Inc.

COGNIZANT MANAGER:

D.K. Shukla 3/21/83

D. K. Shukla, Manager--Geotechnical, WIPP-TSC — Date
D'Appolonia Consulting Engineers, Inc.

APPROVED BY:

3/21/83

G. L. Hohmann, Technical Director, WIPP-TSC — Date
Westinghouse Electric Corporation

TABLE OF CONTENTS

	PAGE
LIST OF TABLES/FIGURES	iii
LIST OF PLATES WITH SELECTED PHOTOGRAPHS	iv
LIST OF APPENDICES	v
1.0 ABSTRACT	1-1
2.0 INTRODUCTION AND SUMMARY	2-1
3.0 BACKGROUND INFORMATION, SCOPE OF WORK, AND METHODOLOGY	3-1
3.1 BACKGROUND INFORMATION	3-1
3.2 SCOPE OF WORK AND METHODOLOGY	3-2
3.2.1 Key Zone	3-3
3.2.2 Shaft Interval Between the Key and Station Zones	3-4
3.2.3 Station Zone	3-6
3.2.4 Surveying Control in the Shaft	3-7
4.0 MAPPING RESULTS	4-1
4.1 SHAFT GEOLOGY	4-1
4.2 KEY ZONE GEOLOGY	4-4
4.3 STATION ZONE GEOLOGY	4-5
5.0 SHAFT KEY DESIGN ADJUSTMENT AND INSTRUMENT LOCATIONS IN THE KEY BASED ON OBSERVED GEOLOGIC CONDITIONS	5-1
5.1 SHAFT KEY COMPONENTS	5-1
5.2 DESIGN ADJUSTMENT AND MODIFICATION	5-2
5.3 INSTRUMENT LOCATION IN THE SHAFT KEY	5-2
6.0 FACILITY INTERVAL SELECTION	6-1
6.1 SELECTION CRITERIA	6-1
6.2 SELECTION PROCESS	6-2
6.3 CONFORMANCE OF SELECTED INTERVAL TO CRITERIA	6-5
7.0 SELECTION OF THE INSTRUMENT LOCATIONS IN THE SHAFT BETWEEN THE KEY AND STATION ZONES	7-1
7.1 DESIGN REQUIREMENTS	7-1
7.2 SELECTION PROCESS	7-2

TABLE OF CONTENTS
(Continued)

	PAGE
7.3 CONFORMANCE OF THE SELECTED LOCATIONS WITH THE DESIGN REQUIREMENTS	7-2
7.3.1 Extensometer Locations	7-3
7.3.2 Radial Convergence Point Locations	7-3
REFERENCES	R-1
TABLES	
FIGURES	
PLATES	
APPENDICES	

LIST OF TABLES

TABLE NO.	TITLE	PAGE
1	Abridged History of the Exploratory Shaft Drilling and Construction	T-1
2	List of Participants in Various Phases of the Geological/Geotechnical Activities in the Exploratory Shaft	T-3
3	Summary of Relation Between Preliminary and Corrected Depths in the Exploratory Shaft	T-5
4	Summary of Selected Stratigraphic Intervals	T-6
5	Instrument Locations in the Exploratory Shaft	T-7

LIST OF FIGURES

FIGURE NO.	TITLE
1	Location Map
2	Schematic Geologic Section
3	Geophysical Logs (Six Sheets)
4	Lithologic Log, Sample, and Instrument Locations (Three Sheets)
5	Geology of the Key Zone
6	Geology of the Station Zone
7	Original Shaft Key Design and Revised Location of Shaft Key Components

LIST OF PLATES WITH SELECTED PHOTOGRAPHS[1]

PLATE NO.	DEPTH (FT)[2] FROM-TO	ELEVATION (FT. MSL)[3] FROM-TO	DESCRIPTION (ABBREVIATED)
1	842-853	2568 - 2557	Key Zone--Bottom of Casing to Rustler/ Salado Contact
2	884-892	2526 - 2518	Key Zone--Massive Sandy Siltstone
3	2118-2125	1289 - 1283	Anhydrite "a"
4	2125-2132	1283 - 1276	Anhydrite "b"
5	2132-2138	1276 - 1269	Halite
6	2138-2145	1269 - 1263	Halite
7	2145-2152	1263 - 1256	Halite
8	2152-2159	1256 - 1249	MB 139
9	2159-2166	1249 - 1241	Halite
10	2155±	1252±	Detail of MB 139
11A	2118-2127	1289 - 1280	Anhydrite "b" at the brow and anhydrite "a" above; looking approximately south and up 45 ±° into the exploratory shaft from the station floor
11B	2127-2149	1280 - 1258	Banded halite within the facility interval and anhydrite "b" at approximately north-northeast

(1) Photographs by F. Hensley, Sandia National Laboratories; for more data and complete list of photographs from mapping activities, see Appendix D.

(2) Depths refer to "Preliminary Depths" corresponding to depths shown on the photographs themselves.

(3) Elevations have been corrected according to Table 3.

LIST OF APPENDICES

APPENDIX	TITLE
A	MAPPING PROCEDURES
	A-1 Procedure for Geologic Mapping - (Appendix A of the Site Validation Field Program Plan)
	A-2 Geologic Investigation of Shaft Key Area/Zone - (Appendix D of the Site Validation Field Program Plan)
	A-3 Galloway
B	STRATIGRAPHIC SUMMARY OF THE EXPLORATORY SHAFT
C	DESCRIPTION OF ROCK SAMPLES
D	DESCRIPTIONS OF PHOTOGRAPHS FROM KEY AND STATION ZONES
	D-1 Photographs of the Key Zone (Photography on March 30, 1982)
	D-2 Photographs of the Station Zone (Photography on May 2, 1982)
E	SURVEYING NOTES
F	BACKGROUND - FACILITY INTERVAL SELECTION PROCESS AND CRITERIA

1.0 ABSTRACT

This report on geotechnical activities in the exploratory shaft was prepared as part of the Site Validation Field Program for the U.S. Department of Energy's Waste Isolation Pilot Plant near Carlsbad, New Mexico. The report (1) summarizes basic data on shaft drilling and construction, (2) presents the geologic mapping results which essentially correspond to the conditions predicted from previous investigations, and (3) discusses the optimization process based on the geologic conditions encountered and its results for the (a) adjustment and modification of the shaft key design, (b) selection of the facility interval, and (c) selection of the geotechnical instrument locations.

2.0 INTRODUCTION AND SUMMARY

This Technical Memorandum External (TME) has been prepared in response to Task 2.1 (Geologic Mapping of the Underground Excavations/Shafts) of the Site Validation Field Program Plan for the Waste Isolation Pilot Plant (WIPP) in Southeastern New Mexico (McKinney and Newton, 1983)[1] and assumes that the reader is familiar with the basic WIPP concept and site geology.

Most of the subject work was performed and this report prepared by D'Appolonia Consulting Engineers, Inc. (D'Appolonia), under Subcontract S9-CJR-45451 with Westinghouse Electric Corporation, Waste Technology Services Division, under Contract DE-AC04-78-ET095346 with the U.S. Department of Energy (DOE). The Westinghouse team is serving as the Technical Support Contractor (TSC) to the DOE for the WIPP project.

The report summarizes basic data on the shaft drilling and construction, presents the geologic mapping of the exploratory shaft, and discusses decisions based on the mapping results.

The objectives of the geologic mapping were:

- Confirmation of suitable facility interval stratigraphy/lithology and structure;
- Confirmation of absence of disqualifying geologic features;
- Evaluation of interbeds which could have a potentially unacceptable influence on excavation stability and containment capability of the rock;

[1] The planning and performance of the field activities in the exploratory shaft were based on the draft of the plan completed in March 1982 but which was first issued on April 28, 1982. Only minor changes referring to the exploratory shaft were made in the referenced document.

- Establishment of baseline data on geologic conditions; and
- To support field decisions reflecting the geologic conditions encountered in an optimization process that led to:
  - Field adjustment and modification of the shaft key design;
  - Selection of the facility horizon/interval; and
  - Selection of the geotechnical[1] instrument locations.

The information contained in this report provides a documentation of the subject activities and a portion of the data included in the WIPP report entitled "Results of Site Validation Experiments," (Black, et al., 1983) in particular to address WIPP Site Qualification Criterion No. 3.0 - Thickness of Host Rock (U.S. DOE, 1982).

In summary, this report documents that:

- The geologic conditions encountered in the exploratory shaft within the accessible and mapped interval (from the elevations of 1207.4 to 2567.7 feet MSL) correspond to the conditions expected from previous investigations (Powers, et al., 1978). Drillhole ERDA-9 (Jones, 1981), in particular,[2] showed conditions similar to the exploratory shaft.
- The components of the shaft key structure (Bechtel, 1981) were (1) adjusted vertically to allow placement of critical elements, such as chemical seals and drains, next to appropriate lithologies and (2) modified by (a) increasing the key length by about five feet so that its base could be

(1) The terms "geotechnical and "geomechanical" instrumentation are used in different reports but refer to the same type of instruments.

(2) Corresponding beds were encountered in the exploratory shaft at slightly shallower depths than in ERDA-9 due to a gentle regional dip.

located on top of massive layers of sandy siltstone and (b) replacing the key skirt by a six-foot-high rock-bolted wire mesh below the base of the key.

- The station/facility interval was selected within the host rock interval between Marker Beds (MB) 136 and 140 according to the criteria presented in Section 6.1 and Appendix F. The facility interval selected was a 27±-foot-thick salt bed (without any interbeds) below anhydrite "b" and above MB 139. The station floor was located at a preliminary depth of 2,149 feet corresponding to an elevation of approximately 1258.4 feet MSL,[1] i.e., about 4.7 feet above the top of MB 139.

- The geotechnical instrument levels (Bechtel, 1980 and 1981) were adjusted in both the shaft key and the unlined portion of the shaft between the key and the station according to the criteria for instrument locations as presented in Chapter 7.0, while the number and type of instruments were maintained as shown in the design drawings.

[1] The relation between preliminary depths and elevations is discussed in Section 3.2.4 and in Appendix E.

3.0 BACKGROUND INFORMATION, SCOPE OF WORK, AND METHODOLOGY

3.1 BACKGROUND INFORMATION

The exploratory shaft is a part of the WIPP-SPDV facility and represents the first directly accessible underground working at the WIPP site. The exploratory shaft serves: (1) as the main access to the underground portion of the facility, (2) as a ventilation intake, and (3) as a means for the removal of salt from the underground excavations. The locations of the exploratory shaft, the nearest drillholes, and the ventilation shaft are shown in Figure 1. The schematic geologic section penetrated by the exploratory shaft is shown in Figure 2. An abridged history of the shaft drilling, logging, construction, and mapping is presented in Table 1.

The shaft was "blind" drilled to a depth of about 2,300 feet (12-foot diameter) with subsequent installation of a 10-foot-diameter steel liner from the surface to an approximate depth of 842 feet to stabilize the overburden and minimize inflow of water from the aquifers above the bedded salt. A series of geophysical logs (gamma ray, epithermal neutron, density, and average caliper) was obtained as indicated in Table 1. The four logs and a schematic lithologic log are presented in Figure 3.

A shaft key was installed with appurtenant components, such as chemical seals, drains, water ring, built-in instrumentation, etc. During the shaft outfitting performed from the galloway, the conveyance support members (buntons made from tubular steel for attaching wooden guides for the skip and man-cage), utility lines, and depth measurement hooks were installed.

The shaft mapping was performed in several phases, as discussed in Section 3.2, concurrently with shaft outfitting. To allow access to areas below the potential facility level, fluid (mainly a mixture of

drilling mud, water, and small quantities of brine that had seeped from behind the liner) was removed from the shaft bottom (below an elevation of about 1252 feet MSL) by pumping the fluid into a bucket and hoisting the bucket to the surface.

3.2 SCOPE OF WORK AND METHODOLOGY

The detailed scope of work and methodology for the geotechnical activities were presented in the Site Validation Field Program Plan (McKinney and Newton, 1983), in particular in its Appendices A, C, and D which are included as Appendices/Attachments A-1, F/3, and A-2, respectively.

A phased sequence of the geotechnical activities in the exploratory shaft was planned in three individual shaft zones as follows:

- Key Zone:
  - Mapping of the key zone (below the liner).
  - Subsequent field adjustment and modification of the key design, including the key instrumentation, to accommodate the observed geology.
- Shaft Between the Key and Station Zones:
  - Reconnaissance mapping of the shaft walls.
  - Selection of the instrument levels/locations after the evaluation of the mapping of the entire shaft.
- Station Zone:
  - Mapping of the station zone.
  - Subsequent selection of the station horizon/facility interval to accommodate the observed geology.

Detailed mapping of the entire circumference was planned in the key and station zones, while only reconnaissance/strip mapping was planned in the remaining accessible portion of the shaft.

The geotechnical activities in the individual zones were performed as follows.

3.2.1 Key Zone (Elevations 2490.2 to 2567.7 feet MSL)

The objectives of the geotechnical activities were:

- Confirmation of geologic conditions as identified in previous reports on geological characterization.
- Confirmation of the absence of adverse features (for example, dissolution zones).
- Finalization of design details for the shaft key; in particular, adjusting the key components to accommodate the encountered geologic conditions prior to key construction.
- Selection of locations for installation of geotechnical instrumentation.

The preparation for the mapping consisted of the following items:

- Detailed review of the Field Program Plan by the mapping team, including a review of the Quality Assurance needs and procedures.
- Review of geological log (Bechtel, 1979) and core samples from Borehole B-25, the nearest cored hole to the exploratory shaft.
- Development of a coded legend (shown in Figure 5) based on the core and log review. The purpose of this legend was to assure consistency among mapping personnel and decrease mapping time in the shaft.
- Review of earlier Sandia National Laboratories (SNL) video tapes of the shaft geology.
- Reconnaissance of the key zone by the personnel listed in Table 2, Section A, on March 30, 1982, which consisted of:

  - Visual inspection,
  - Video taping, and
  - Photographing of selected features.

Video tapes are stored in SNL and WIPP-TSC files. Selected photographs are presented on Plates 1 and 2. Descriptions and locations of all photographs are included in Appendix D-1.

The reconnaissance provided data on the geologic conditions prior to mapping and allowed mapping procedures to be finalized.

- Review of the new video tape of the key zone.

Mapping of a 77.5-foot-long section, from the base of the steel liner at the elevations of 2567.7 to 2490.2 feet MSL, was performed from the galloway (Appendix A-3) on March 31, 1982 by the personnel listed in Table 2, Section B. The mapped interval consisted of the lower 8.2 feet of the Rustler Formation, its contact with the Salado Formation, and 69.3 feet of the uppermost portion of the Salado Formation.

The geology was recorded on prepared log sheets at a scale of 1 inch = 5 feet with a 0.5-foot grid and the south line (180 degrees) at the center--similar to the survey controls as discussed in Appendix E. The field logs were transcribed into a combined log (Figure 5). Fourteen grab samples (Nos. EXS-1 through EXS-14) were collected and later examined under a binocular microscope and described by one of the team geologists. Their descriptions are presented in Appendix C. No samples of the formation fluids encountered during the mapping were obtained due to the minute quantities of the fluids. The mapping results are discussed in Sections 4.1 and 4.2 and the key adjustment and modification process is discussed in Chapter 5.0.

3.2.2 Shaft Interval Between the Key and Station Zones[1] (Elevations 1327.4 to 2490.2 feet MSL)

The objectives of the geotechnical activities were:

[1] An additional eight feet below the station zone (Elevations 1207.4 to 1215.4 feet MSL) was also mapped on May 2, 1982 using the reconnaissance mapping procedures.

- Characterization of the geologic conditions.
- Confirmation of the absence of disqualifying features.
- Selection of locations for installation of geotechnical instrumentation.

Prior to the reconnaissance mapping of this shaft interval, the core log from ERDA-9 (Jones, 1981) and selected sections of ERDA-9 core from the depths of interest were reviewed by key members of the mapping team. The review prompted additions to the unit descriptions prepared during the key zone mapping. Further modifications to these descriptions were made in the shaft in response to the shaft geology.

The reconnaissance geologic mapping of this 1,163-foot-long interval was performed from the base of the key zone at an elevation of 2490.2 feet MSL to the top of the shaft station zone at an elevation of 1327.4 feet MSL on a continuous basis (three shifts per day) from April 26 to 30 and on May 2, 1982 by the personnel listed in Table 2, Section C.

The mapping was performed by one geologist working from the lower deck of the galloway (Appendix A-3) in conjunction with the construction work on the upper two decks. The map coverage at a scale of 1 inch = 10 feet consisted of a strip log prepared from examination of an about 1- to 5-foot-wide vertical band of the south side of the shaft. A 60-foot interval between Elevations 1518 to 1578 feet MSL (approximately 200 feet above the station zone) was not mapped due to interference with construction.

Forty-one grab samples (Nos. EXS-15 through EXS-55) were collected and examined under a binocular microscope; the resulting descriptions are presented in Appendix C. No formation fluid was encountered within this interval. Conditions for photography were unfavorable (dust, space, and distance).

A comparison of selected geophysical logs from the entire shaft with a schematic geologic log from the mapping is presented in Figure 3. The more detailed results of the reconnaissance mapping (together with summarization of the stratigraphy and sample locations in the key and shaft station zones, which resulted in lithology descriptions and a stratigraphic column covering a 1,360-foot-long interval from the elevations of 1207.4 to 2567.7 feet MSL in Figure 4) are discussed in Section 4.1.

Recommendations for instrumentation locations in this shaft zone are discussed in Chapter 7.0 of this report; instrument locations are indicated in Figure 4.

3.2.3 Station Zone (Elevations 1217.4 to 1327.4 feet MSL)

The objectives of the geotechnical activities were:

- Confirmation of adequate thickness of facility interval (horizon) beds, i.e., geologic strata above and below the facility.
- Confirmation of absence of disqualifying features.
- Confirmation of suitable facility horizon stratigraphy/lithology and structure.
- Evaluation of interbeds which could influence excavation or stability of underground openings.
- Demonstration of lateral continuity of facility strata (by comparison with the ventilation shaft and drillholes penetrating the host rock interval within the facility area).[1]

The geologic mapping was performed on a continuous basis during the period from April 30 to May 2, 1982. Personnel involved in this mapping effort are listed in Table 2, Section D. The investigation included inspection and detailed mapping of the full circumference of the shaft at

[1] A more detailed response to this objective is presented in Jarolimek, L., et al. (1983).

a scale of 1 inch = 5 feet in the vicinity of the proposed shaft station (between Elevations 1217.4 and 1327.4 feet MSL). The results of this mapping effort are discussed in Section 4.3. Four selected grab samples of the wall rock (Nos. EXS-56 through EXS-59) were also collected; their descriptions are presented in Appendix C.

Video tapes, continuous strips of still photographs of the south shaft wall, and detailed still photographs of selected features, such as anhydrites "a" and "b" and MB 139, were obtained. Selected photographs are presented on Plates 3 through 10. Descriptions and locations of all photographs are included in Appendix D-2. Plate 11 contains two additional photographs taken later from the shaft station illustrating the geology of the facility interval.

Preliminary evaluation of the suitability of the geologic conditions for the proposed facility interval (discussed in Chapter 6.0) was made simultaneously with the mapping activities. A preliminary location for the facility interval between Elevations 1258.4 and 1275.4 feet MSL (preliminary depths 2,149 and 2,132 feet) was selected during the shaft inspection on May 1 and 2, 1982 through discussion and concurrence of the personnel listed in Table 2, Section E. The preliminary location recommendation was finalized by further technical discussions during a meeting held on May 2, 1982.

3.2.4 Surveying Control in the Shaft

The vertical and horizontal survey controls in the shaft and establishment of correction factors after final precise surveying performed in December 1982 and after correlating the geological features with the established elevations on January 22, 1983 are discussed in Appendix E.

In this report, it was necessary to use both the preliminary and corrected values. However, the following guidelines were applied:

- Elevations are always expressed in corrected values referenced to the CWI[1] bench marks.

- Use of depth values is minimized (except on drawings and photographs showing geology) and preference is given to corrected depth values with the exception of cases where (1) the preliminary value is essential, such as on photographs with recorded preliminary depths, or (2) the preliminary depth value has been used extensively. When the type of depth value is not indicated, preliminary depth has been used.

[1] CWI stands for Cementation West, Inc., the WIPP-SPDV construction contractor to the DOE.

4.0 MAPPING RESULTS

4.1 SHAFT GEOLOGY

The geologic conditions encountered in the shaft correspond well with those described in reports on previous investigations, e.g., the "Geological Characterization Report" by Powers, et al. (1978).

Figure 3 (Sheets 1 through 6) presents a compilation of the four principal geophysical logs (gamma ray, epithermal neutron, density, and average caliper) obtained before the liner was installed and compares the logs to the geologic column (below the liner) adapted from Figure 4. Major geologic features within the lined section were adapted from Drillholes B-25 (Bechtel, 1979) and/or ERDA-9 (Jones, 1981).

The log signatures of individual strata in the exploratory shaft are generally similar to other borings, especially ERDA-9 and B-25. However, the caliper log indicates that a few larger washouts resulted from drilling in the Rustler Formation, predominantly in the siltstones/mudstones directly above and below the Magenta and Culebra dolomites. These washouts reached a radial distance beyond the nominal shaft wall up to 19 inches and 22 inches in the vicinity of the Magenta and Culebra dolomites, respectively, while the washout near the Rustler/Salado contact was only 4 inches.

The results of the shaft mapping are presented in Figure 4 (Sheets 1 through 3) as a columnar log of the shaft stratigraphy with lithologic descriptions and grab sample locations. The figures present the 1,360.3-foot-long mapped interval below the bottom of the liner at the elevations of 2567.7 to 1207.4 feet MSL (about 51 feet below the facility level). A summary of selected stratigraphic intervals is presented in Table 4, while a complete stratigraphic summary including elevations, depths, and thicknesses of individual beds is assembled as a table in Appendix B.

Selected photographs from the key and station zones are presented on Plates 1 through 11. A complete list of photographs with their detailed locations is provided in Appendix D.

Descriptions of 59 grab samples obtained during the mapping are presented in Appendix C. These descriptions are based on hand specimens as well as binocular microscope identifications.

The wall of the shaft below the steel liner was generally smooth and showed little evidence of post-excavation deformation such as spalling or rock falls. The only irregularities occurred at some of the thicker clay seams which tended to wash out during drilling. The maximum washout was approximately one foot into the wall. The wall of the shaft showed no evidence of water seepage below an elevation of 2509 feet MSL (within the key zone).

Base of the Rustler Formation

The bottom of the steel liner was located about eight feet above the Rustler/Salado contact, allowing only the base of the Rustler Formation to be mapped. The Rustler Formation consists primarily of siltstone with several vertical or nearly vertical fractures 1/8- to 1/2-inch wide (Figure 5 and Plate 1). Very minor seepage was observed from some of these fractures and from behind the liner.

The Salado Formation

The Rustler/Salado contact was encountered at an elevation of 2559.4 feet MSL and is described in Section 4.2. The Salado Formation to the bottom of the mapped portion of the shaft consists principally of halite, polyhalitic halite, and argillaceous halite. Interbedded at irregular intervals are beds of anhydrite, polyhalite, and siltstone. Thin clay seams and partings commonly occur throughout the shaft below the key underlying many of the polyhalite and anhydrite beds and overlying many of the argillaceous halite beds.

The polyhalite typically occurs as distinct clusters of orange crystals disseminated within the halite; however, locally, the polyhalite occurs as stringers and layers up to several inches thick. The argillaceous material generally occurs interstitially and imparts a reddish brown color to the salt, although locally the argillaceous material occurs as blebs, stringers, and discontinuous thin partings.

The interbeds in the halite range from several inches thick up to approximately 14 feet thick with an average thickness on the order of 1 to 2 feet. Siltstone is most common in the key zone near the contact with the Rustler Formation. Interbeds of polyhalite are most common in the interval of the shaft from the bottom of the key to an elevation of about 1510 feet MSL. All marker beds were positively identified at the expected elevations. All have minor undulations, except the top of MB 139 which has an undulation amplitude of about 1.6 feet along the shaft perimeter. Below Elevation 1510 feet MSL, the interbeds are generally composed of anhydrite.

No evidence of halite dissolution or significant squeezing of clay seams was observed. Fractures were observed at only four locations in the shaft: two of them are in the siltstone beds in the key zone between elevations of (1) 2568 and 2563, and (2) 2525 and 2520 feet MSL, as described in Section 4.2. The other two locations are in a siltstone bed at the elevations of 2449 to 2444 feet MSL and in an anhydrite bed at the elevations of 2386 to 2373 feet MSL. Fractures in the lower two beds are nearly vertical and halite-filled, with apertures typically less than one inch with the exception of the fracture in the anhydrite which is up to three inches wide.

Exploratory Shaft Water/Brine Inflow

The water inflow tests were planned and performed in the ventilation shaft and are documented in Geotechnical Field Data Report (GFDR) No. 4, 1983a. These data, combined with the observations in the exploratory shaft, indicate that total inflow from all Rustler Formation aquifers

into the exploratory shaft before the liner installation was less than 1.5 gallons per minute and, after the liner installation, less than 0.1 gallon per minute; hence, the shaft construction has not had a deleterious effect on site aquifers.

4.2 KEY ZONE GEOLOGY

The results of the mapping of the 77.5-foot-long key zone from the bottom of the steel liner at the elevations of 2567.7 to 2490.2 feet MSL are presented in Figure 5 as a detailed circumferential elevation log showing individual lithological units, their contacts and thicknesses, fractures, grab sample locations, etc. Descriptions of 14 grab samples based on macro- and microscopic (binocular) examination are presented in Appendix C. Selected photographs are shown on Plates 1 and 2. A complete list of photographs with their locations is provided in Appendix D-1.

Base of the Rustler Formation

The interval between the elevations of 2567.7 to 2559.4 feet MSL, as shown in Figure 5, consists of siltstone with several vertical or nearly vertical fractures (between the elevations of 2567.7 and 2562.0 feet MSL) with apertures ranging from 1/8 to 1/2 inch. Their attitude was difficult to determine; however, at one location a preliminary trend striking N 20±°E was estimated. Minute seepage which stained the shaft wall was observed from some of the fractures as shown on Plate 1.

The Rustler-Salado Contact

The zone in the vicinity of the Rustler/Salado contact at an elevation of 2559.4 feet MSL is represented by an anhydrite layer with clayey silt stringers, a 4±-inch-thick clay seam, siltstone with halite, and halitic siltstone grading into massive argillaceous halite. Contacts exhibit undulation up to about 0.75 foot in amplitude over the shaft circumference. The zone of halitic siltstone between elevations of 2560 and 2556 feet MSL had been washed out during drilling of the shaft to a maximum radial depth of about one foot beyond the nominal shaft wall as can be seen on Plate 1.

Top of the Salado Formation

The top of the Salado Formation between elevations of 2559.4 and 2490.2 feet MSL is represented by massive halite that is locally argillaceous and intercalated with siltstone layers (0.5 to 8 feet thick) and clay seams (up to 0.5± foot thick). One anhydrite layer 6 inches thick with an underlying clay seam was encountered at an elevation of 2545 feet MSL. The contacts are quite regular with minor undulation.

Siltstone and halitic siltstone are the predominant rock types in the approximately 14-foot interval below an elevation of 2530 feet MSL. A layer of massive sandy siltstone was observed between Elevations 2525 and 2520 feet MSL. It contained vertical, halite-filled fractures with apertures ranging up to one inch as seen on Plate 2. It was difficult to positively match individual fractures because of their verticality. However, two apparent fracture sets could be identified with the following strikes: (1) E-W and (2) N10° to 30°E. There was no indication of seepage occurring along any of these fractures. The siltstone grades downward into halitic siltstone which averages about 2± feet in thickness.

The halite layer below this siltstone is very coarsely crystalline and contains irregular lenses of siltstone up to 18 inches in diameter. Below an elevation of about 2513 feet MSL, the Salado Formation consists of massive halite with three interbedded siltstone layers (0.5 to 4 feet thick) and two clay seams (3 to 6 inches thick).

4.3 STATION ZONE GEOLOGY

The results of the mapping of the 112-foot-long station zone between elevations of 1327.4 and 1215.4 feet MSL are presented in Figure 6 as a detailed circumferential log at a scale of 1 inch = 5 feet showing individual lithological units, their contacts and thicknesses, grab sample locations, etc.

Descriptions of four grab samples are presented in Appendix C. Additional rock samples were obtained and tested at a later time. The descriptions of these later samples will be presented in the report entitled "Results of Site Validation Experiments" (Black, et al., 1983).

Selected photographs are presented on Plates 3 through 11. Plates 3 through 9 depict a continuous strip along the south wall of the shaft between elevations of 1289 and 1241 feet MSL (about 48 feet of the host rock interval; about 31 feet above and 17 feet below the recommended facility floor at an elevation of 1258.4 feet MSL).

The rock in the station zone consists of halite with varying amounts of polyhalite and argillaceous material (Figure 6). No structural discontinuities, dissolution features, or squeezing of clay seams were visible in the mapped interval.

Of particular interest during the mapping was the location and nature of MB 139 and the presence of any clay seams or partings. As shown in Figure 6 and Plates 8 and 10, MB 139 is approximately 2 to 3.4 feet thick and is principally composed of anhydrite with minor amounts of polyhalite that occur in stringers and thin beds, particularly in the upper portion of the bed. The upper contact of MB 139 is undulatory and occurs between the elevations of 1251.7 and 1253.9 feet MSL. This undulatory contact (with an amplitude of 1.6 feet around the shaft) is believed to be the result of syndepositional processes, such as differential compaction of soft sediments and/or growth of "swallow-tail" gypsum crystals (Plate 10). The absence of displaced stratigraphic contacts implies a nontectonic origin to the undulatory top of MB 139. More detailed discussion on MB 139 is presented in TME 3179 (Jarolimek, et al., 1983).

Clay seams and/or partings were mapped at approximate elevations of 1326, 1317 (discontinuous parting), 1311, 1310 (discontinuous parting),

1303, 1297, 1287, 1280, 1251, 1242, and 1223 feet MSL. Within the station zone, the greatest thickness free of clay seams or partings and anhydrite occurs between the elevations of 1280 and 1255 feet MSL.

The stratigraphy in the recommended shaft station between the preliminary depths of 2,132 and 2,149 feet (corresponding to elevations of 1275.4 and 1258.4 feet MSL, respectively) consists of halite containing varying amounts of dispersed polyhalite and argillaceous material (Figure 6 and Plate 11B). Below the recommended floor of the facility is a polyhalitic halite that contains stringers and thin beds of pure polyhalite near its base. The recommended floor was approximately 3.6 to 5.0 feet above MB 139 and was located in argillaceous halite that decreases in argillaceous content towards the top of the bed. The argillaceous halite extends for approximately 6-1/2 to 7 feet above the recommended floor to an elevation of 1265 feet MSL. The argillaceous halite is overlain by a 2-1/2-foot-thick bed of clear halite having trace amounts of polyhalite and argillaceous material to an elevation of 1267 feet MSL, approximately 9 feet above the recommended floor. This, in turn, grades upwards to a 3-1/2-foot-thick bed of halite containing more argillaceous material than the underlying bed. The upper part of the station from an elevation of about 1271 feet MSL to the recommended roof elevation at 1275 feet MSL contains clear halite with trace amounts of polyhalite and argillaceous material. This unit extends to an elevation of 1277 feet MSL, approximately 2 feet above the roof where there is a gradational contact with argillaceous halite. The upper limit of the argillaceous halite is a 1/8±-inch-thick clay parting at the base of anhydrite "b"[1] at an elevation of about 1280.8 feet MSL. Anhydrite "b" is 3± inches thick and is separated by about a 7-foot-thick layer of clear halite (mottled with 1/8±-inch-thick anhydrite partings) from

[1] Anhydrite "b" was not identified during the logging of the core from ERDA-9 and therefore was not included in the "reference stratigraphy" for the WIPP facility design. It was identified there later (after exploratory shaft mapping) according to its signature on geophysical logs.

anhydrite "a." Anhydrite "a" is 9± inches thick and has a bottom elevation of about 1287.7 feet MSL. Anhydrite "a" is also underlain by a 1/8±-inch-thick clay parting. Both anhydrites are clearly visible on Plate 11A. Another very thin, indistinct, and apparently discontinuous clay parting was observed along the south wall about one foot below anhydrite "a."

The first significantly thick layer of anhydrite/polyhalite above the station roof is MB 136 with its base at an elevation of about 1374 feet MSL, about 99 feet above the recommended station roof. The thickness of MB 136 as encountered in the exploratory shaft is about 8.5 feet.

5.0 SHAFT KEY DESIGN ADJUSTMENT AND INSTRUMENT LOCATIONS IN THE KEY BASED ON OBSERVED GEOLOGIC CONDITIONS

The data obtained during the geologic mapping of the key zone, as discussed in Section 4.2, were used in a review and evaluation of the original key design (Bechtel, 1981) as shown in Figure 7A. The review was accomplished on April 2, 1982 via discussion among the appropriate project participants and resulted in an adjustment/modification of the shaft key design and location of instrumentation in the key zone to match the geologic conditions encountered (schematically shown in Figure 7B). The revised location of the shaft key components and key modification are shown in Figure 7C.

5.1 SHAFT KEY COMPONENTS

The original design of the shaft key was based on conditions encountered in Drillholes B-25 and ERDA-9 and contained the following principal components (from top to bottom):

- Steel ring (four feet in height) connecting the existing shaft liner with the key, with grouting behind.
- Upper chemical seal.
- Drain trench.
- Lower chemical seal.
- Water ring.
- Skirt.

The total height of the original design of the key structure was 55.75 feet (key, 32.75 feet and skirt, 23 feet).

The geotechnical instrumentation to be installed, as indicated on the original design (Bechtel, 1980), consisted of:

- 2 levels of strain gages.
- 1 level of pressure cells.
- 1 level of piezometers.

5.2 DESIGN ADJUSTMENT AND MODIFICATION

In the final vertical design adjustment, the shaft key components are compatible with the encountered/observed geologic conditions. The upper chemical seal was placed next to the area where some minor washout had occurred at the Rustler/Salado contact. Its purpose is to prevent seeping water from coming into contact with the salt. The drain trench was set next to the lowest observable potential seepage at the clay seam at an elevation of 2552 feet MSL. The lower chemical seal was placed next to the lowest anhydrite/clay seam at an elevation of 2544 feet MSL. The water ring with a base widened to three feet, two inches was set at the halite/siltstone contact at an elevation of 2530 feet MSL, extending the total key height to 37.55 feet. The 23-foot-long key skirt was eliminated because of the observed sound rock condition of the strata below the base of the key. This zone consists of 24 feet of siltstone with only two beds of argillaceous halite (1.6 and 4.0 feet thick). A 6-foot-high rock-bolted wire mesh section below the base of the key was recommended as an alternative to the skirt.

5.3 INSTRUMENT LOCATION IN THE SHAFT KEY

Based on the results of the geologic mapping and the field adjustments and modification to the key, preliminary instrumentation locations in the shaft key were established. Final instrumentation locations were determined in the field just prior to the installation based upon a detailed observation and evaluation of the rock at each particular location after the excavation. In the preliminary selection of the instrument locations, the original minimum setbacks from irregular concrete sections and separation of instruments (three feet, three inches and two feet, zero inches, respectively) could not be maintained due to the design adjustment. A section of uniform concrete with a length (height) of 11 feet, 9 inches as in the original design was no longer available. After considering various alternatives, the decision was made that

preliminary locations of the instruments (one set of strain gages and the pressure cells) would be possible in the available seven-foot uniform section (height) between the drain trench and lower chemical seal. The second set of strain gages was located above the drain trench. The instrument locations shown in Figure 7C represent the as-built conditions. A summary of the basic data on the instruments is provided in Table 5.

6.0 FACILITY INTERVAL SELECTION

Facility interval selection following the station zone mapping represented the culmination of a several-year-long process in the development of various facility concepts (single or multiple level), alternatives, and criteria for optimization of the facility level.

Preliminary evaluation of the suitability of the proposed facility interval relative to the geologic conditions encountered in the exploratory shaft was made concurrently with the geologic mapping conducted in April and May 1982.

The final selection was made after several meetings of the appropriate project participants at the site and in Carlsbad during which the characteristics of the proposed interval were evaluated in terms of their ability to satisfy the selection criteria. A description of the selection criteria, the selection process, and the conformance of the selected facility interval to the selection criteria follows.

6.1 SELECTION CRITERIA

The criteria for selection of the facility interval were first defined in 1979 (Appendix F, Attachment F/1).[1] The following is a list of the criteria used for the final selection of the facility interval (Appendix F, Attachment F/3), with differences from the original criteria indicated where appropriate. The criteria were:

1. The rock comprising the facility interval must contain no significant dissolution features, faults, and fractures. If any such features are noted, a detailed investigation of those features must be conducted. (This criterion was not explicitly stated in the set of criteria defined in 1979.)

[1] The first criteria were based on the two-level facility design concept (CH and RH levels) and different room sizes being considered at that time. The initial criteria have been later modified to suit the changed WIPP facility concept.

2. There should be a minimum four-foot thickness of halite between the top of MB 139 and the facility floor. The undulatory upper contact of MB 139 shall be considered in selection of the facility floor level. (The 1979 criteria required a five-foot thickness between the facility floor and the next lower clay seam or parting.)

3. There should be a minimum 14-1/2-foot section of halite for construction of nominally 13-foot-high rooms. Minor impurities, such as argillaceous halite and polyhalite, may be acceptable. (The facility design as of 1979 called for 12-foot-high rooms.)

4. There should be a minimum of five feet of halite between the facility roof and the next higher clay seam (defined as 1/4-inch-thick or greater) for purposes of roof stability. (This criterion was adjusted at the site to a five- to ten-foot thickness at the verbal request of SNL personnel.)

5. Horizons containing substantial amounts of polyhalite should be avoided. The minimum thickness of halite defined in the third criterion listed above was increased from 14-1/2 feet to 17 feet or more to accommodate the 17-foot-high exploratory shaft station.

Inconsistency with any of the above criteria would not have necessarily implied that the horizon was unacceptable, rather that such a condition and its impact would require further detailed investigation and adequate engineered mitigating measures.

6.2 SELECTION PROCESS

The selection of the WIPP facility interval received careful consideration in the early design stages, in particular in 1979 as indicated in Appendix F. Thorough reviews and evaluations of available data, mainly core and core photographs from Drillhole ERDA-9, led to the identification of seven potential alternatives for the facility level as documented in Appendix F, Attachment F/2, the base of which is a portion of the ERDA-9 log. This attachment also indicates the "rank of acceptability

preference by Sandia" for individual alternatives. The options were ranked according to their suitability in terms of waste containment, cost to construct, potential mining problems, etc., as follows:

- Ranks 1 and 2 were given to intervals above MB 139,
- Ranks 3 through 5 to intervals between MB 139 and MB 140, and
- Rank 6 to an interval below MB 140.

An additional potential interval was identified below the Cowden anhydrite. This ranking was developed and accepted by all participants (representatives of DOE, TSC, SNL, USGS, and Bechtel) in the discussions on the facility interval selection.

The exploratory shaft was constructed to a depth of approximately 2,300 feet (about 68 feet below MB 140), thereby maintaining viability of all six ranked alternatives. The interval selection process and criteria and the ERDA-9 core were reviewed prior to and in conjunction with the geologic mapping of the exploratory shaft. The location of the facility within the stratigraphy which best satisfied the selection criteria was chosen after tabulation of the geologic data and preparation of a log showing the detailed stratigraphy in the preferred interval. Conformance of the selected interval to the selection criteria is discussed in Section 6.3.

A tentative level for the facility floor at a preliminary depth of 2,149 feet (elevation of 1258.4 feet MSL) was selected during a shaft inspection conducted on May 1 and 2, 1982 following the evaluation of the geologic mapping results (the personnel involved are listed in Table 2, Section E). The floor and roof levels of the station were marked on the shaft wall, and the geology of the facility interval was documented further with color video tapes and still photographs (Section 3.2.3). Selected photographs are presented on Plates 5 through 7.

The preliminary recommendation for the proposed facility interval depth was confirmed through further technical discussions among the project participants (DOE, TSC, Bechtel, and SNL) in a meeting held at the WIPP office in Carlsbad on May 2, 1982. At the conclusion of the meeting, a final recommendation for the facility interval was made by the geotechnical task manager to DOE. The recommendation was accepted. The meeting and inspection participants are listed in Table 2, Section F.

The discussion during the meeting concentrated on:

- Mapped/observed geologic features as summarized in Figure 6.

- Other potential facility intervals within the limits of the shaft depth. The conclusion was made that the recommended interval represents the best location between MB 136 and the lower limit of detailed mapping (Elevation 1215 feet MSL, i.e., about 37 feet below MB 139).

- Presence of argillaceous halite material and its potential impact. Argillaceous content may increase the rate of mining but may also result in more rapid creep closure and/or sloughing. However, the argillaceous halite is present near the floor and does not occur in the roof. In an overall sense, the conclusion was made that the argillaceous content does not represent a significant concern.

- Geotechnical significance of MB 139 and overlying anhydrite "b"/clay seam. It appears that the strata separating these two rock units are sufficiently thick (about 27 feet) and free of any adverse geologic features to locate the 13-foot-high facility interval in it and keep the facility adequately separated from both boundary layers. Concerns were expressed with regard to the proximity of the 17-foot station roof to the anhydrite "b"/clay seam which may require ground control measures.

- Other technical/mining aspects, such as location of MB 139 and presence of polyhalite. Polyhalitic halite, which occurs immediately above MB 139 and below the recommended floor level, may result in a more stable floor than that of purer halite.

Before the conclusion of the meeting, each participant was asked individually to express his/her technical opinion on the suitability of the recommended facility depth. This resulted in a unanimous confirmation of the facility floor selection at the prelimimary shaft depth of 2,149 feet (elevation of 1258.4 feet MSL). This placed the floor approximately 3.6 to 5.0 feet above the undulatory upper contact of MB 139 (Figure 6) and the roof of the 17-foot-high station opening approximately 5 feet below the nearest clay parting (at the base of anhydrite "b") at the shaft location.

The New Mexico Environmental Evaluation Group (EEG) was invited to review the decision of the facility horizon selection and the technical data forming its basis. The EEG representative joined the technical meeting in Carlsbad on Sunday morning (May 2, 1982) and reviewed the recommendation for the facility horizon selection and the technical data. The data included the geologic mapping results, shaft conditions, and the video tape of the shaft station zone. In addition, he also visited the WIPP site and examined the shaft geology from elevations of 1279 to 1237 feet MSL where further discussions were held with the personnel listed in Table 2, Section G, concerning the recommended facility interval and the geologic conditions. Following the site visit and technical discussions, all participants expressed their satisfaction with the findings and conclusions.

6.3 CONFORMANCE OF SELECTED INTERVAL TO CRITERIA

Subsequent to the geologic mapping and ensuing discussions, the following observations were made and conclusions reached regarding conformance of the selected facility interval to the selection criteria, as listed in Section 6.1:

Criterion No. 1:

Faults and fractures were not observed in the facility interval and no features known to be due to dissolution were observed.

Criterion Nos. 2, 3, and 4:

There is a 14-1/2-foot-thick section of halite, containing minor amounts of argillaceous material and polyhalite, separated from MB 139 by at least a 4-foot interval and from the nearest overlying clay seam by at least a 5-foot interval. The selected halite section is adequate for construction of the 13-foot-high test rooms and the 8- to 12-foot-high access drifts. The 17-foot-high exploratory shaft station can also be constructed approximately 3-1/2 to 5 feet above MB 139 and with approximately 5 feet of halite between the roof and the nearest clay seam. Uncertainty in the thickness of the section below the floor is due to the undulation of the upper surface of MB 139.

Criterion No. 5:

The entire halite section selected as the facility interval has very little polyhalite (less than five percent).

7.0 SELECTION OF THE INSTRUMENT LOCATIONS IN THE SHAFT BETWEEN THE KEY AND STATION ZONES

Instrumentation in the unlined portion of the exploratory shaft (Bechtel, 1980) consists of three levels of multi-position extensometers (total of nine extensometers; three at each level) and six radial convergence points. Following the review of the actual geologic conditions in the shaft, the recommendation was made to modify the depth of the instruments from those shown in the contract drawings to correspond more closely to the design requirements established for instrument location. The design requirements, location selection process, and conformance of the selected locations with the design requirements are discussed in the following sections.

7.1 DESIGN REQUIREMENTS

The design requirements established for instrument location were developed through the interaction of personnel from DOE, SNL, Bechtel, and TSC. The following considerations were identified for the selection of instrument locations:

- All instruments except one set of radial convergence pins should be located in competent halite.
- No interbeds such as clay or anhydrite seams or partings should be located nearby; if possible, the location should be a minimum of two shaft radii (12 feet) from any interbed.
- The instruments should be in close proximity to the actual excavation for LTC's and preliminary instrumentation depths as shown on the contract drawings.
- Optimum spacing of the instruments should be obtained in the unlined portion of the shaft to evaluate changes in the deformation of the shaft with depth. If possible, the instruments should be located near the upper, middle, and lower portion of the salt section overlying the facility interval.

7.2 SELECTION PROCESS

The process of selecting the instrument locations relied upon: (1) the criteria (design requirements) for establishing instrumentation levels, (2) the instrumentation depths as shown on the contract drawings and specifications (Bechtel, 1980), and (3) the preliminary stratigraphic column of the exploratory shaft from elevations of 2567.7 to 1207.4 feet MSL. The final version of the stratigraphic column is provided in Figure 4, discussion of the geology of this zone is provided in Section 4.1, and a summary of data on instrumentation is presented in Table 5. The depths from the design drawings were used as a guide for general spacing of the instruments. The stratigraphic column was examined for several alternative locations in the vicinity of those depths and the locations which best fit the design requirements were recommended for instrument installation. After an agreement on these recommended depths was reached by discussion among participating organizations (DOE, TSC, Bechtel, SNL), the depths were used to identify each selected strata in the shaft. The midpoints between the top and bottom contacts of the strata were determined and marked in the shaft. The instruments were installed near these midpoints with only small changes to avoid minor variations within the strata.

7.3 CONFORMANCE OF THE SELECTED LOCATIONS WITH THE DESIGN REQUIREMENTS

Table 5 provides the preliminary depths from the design drawings and the actual installed depths (GFDR No. 6, 1983) for the three extensometer locations and the six radial convergence points.[1] Figure 4 provides the locations of the instruments within the stratigraphic column. The following sections discuss the geologic location of these instruments and the conformance of the installed locations with the design requirements.

[1] For completeness, Table 5 lists data on all geotechnical instruments in the exploratory shaft.

7.3.1 Extensometer Locations

In order to avoid any potential geomechanical influences from interbeds such as clay, anhydrite, and polyhalite, the recommendation was made that the three main instrument levels be lowered to 1,073 feet (from 915 feet), to 1,564 feet (from 1,491 feet), and to 2,057 feet (from 2,043 feet). As stated in the design requirements, the instruments were, if possible, to be a minimum of two shaft radii (12 feet) from any significant interbed; however, the intercalated nature of the geology precluded finding a continuous 24-foot section of clean halite. This was particularly true in the upper portion of the salt section where there was a relatively significant amount of variation in the lithology of the beds.

The locations of the extensometers after installation in the shaft are shown on the stratigraphic column provided in Figure 4 and the final depths and elevations are provided in Table 5. The upper extensometer was installed at an elevation of 2336.6 feet MSL in the center of a 14.5-foot-thick bed of halite containing trace amounts of polyhalite. Immediately above and below the halite bed are thin beds (four and eight inches, respectively) of polyhalite. This instrument location was moved down 158 vertical feet from the design preliminary depth of 915 feet to the installed depth of 1,073 feet. This large move was required to position the extensometer in a thick, competent halite which does not exist in the upper portion of the shaft. The middle extensometer was installed at an elevation of 1843.9 feet MSL in a 14-foot-thick halite bed. Directly overlying the halite bed is a bed of argillaceous halite. Underlying the halite bed is a 1/2-inch clay seam which is again underlain by halite. The lower extensometer was installed at an elevation of 1351.4 feet MSL in a 9-foot-thick halite bed that grades above and below into argillaceous halite.

7.3.2 Radial Convergence Point Locations

Three of the radial convergence points were recommended to be at the main instrument levels at elevations of 2336.6, 1843.9, and 1351.4 feet MSL. Two of the remaining three were to be situated in halite at two

intermediate levels--1,275 and 1,815 feet. The last was to be located in argillaceous halite containing trace amounts of polyhalite at 940 feet. The depths of the instruments after installation (Table 5) are slightly different from the recommended depths because changes were made during installation to provide a better fit to the design requirements, i.e., a location was adjusted to center the instruments more accurately within the halite beds.

REFERENCES

Bechtel, 1979, "Geologic Data and Hole History for Borehole B-25," prepared for U.S. Department of Energy, Document No. 22-V-510-02.

Bechtel, 1980, "Exploratory Shaft and Station, Instrument Location," Drawing No. 37-X-005, Rev. 5, dated October 3, 1980, prepared for U.S. Department of Energy, Waste Isolation Pilot Plant.

Bechtel, 1981, "Exploratory Shaft Key, Sections and Details," Drawing No. 37-R-012, Rev. 6, dated January 6, 1981, prepared for U.S. Department of Energy, Waste Isolation Pilot Plant.

Black, S. R., Newton, R. S., and D. K. Shukla, editors, 1983, "Results of Site Validation Experiments," Volumes I and II, TME 3177, prepared for U.S. Department of Energy by TSC-D'Appolonia, March 1983.

GFDR (Geotechnical Field Data Report) No. 4, 1983a, "Geologic Mapping and Water Inflow Testing in the SPDV Ventilation Shaft," prepared for U.S Department of Energy by TSC-D'Appolonia, dated January 8, 1983.

GFDR (Geotechnical Field Data Report) No. 6, 1983b, "Underground Excavation Field Instrumentation Data,"compiled for U.S. Department of Energy by TSC-D'Appolonia, dated January 17, 1983.

Jones, C. L., 1981, "Geologic Data for Borehole ERDA-9, Eddy County, New Mexico," USGS Open-File Report 81-469.

Jarolimek, L., M. J. Timmer, and D. W. Powers, 1983, "Correlation of Drillhole and Shaft Logs," TME 3179, prepared for U.S. Department of Energy by TSC-D'Appolonia, March 1983.

McKinney, R. F. and R. S. Newton, 1983, "Site Validation Field Program Plan," Revision 1.2, January 3, 1983, prepared for the U.S. Department of Energy by the WIPP Technical Support Contractor.

Powers, D. W., S. J. Lambert, S. Shaffer, L. R. Hill, and W. D. Weart, editors, 1978, "Geological Characterization Report, Waste Isolation Pilot Plant (WIPP) Site, Southeastern New Mexico," SAND78-1596, issued by Sandia National Laboratories for U.S. Department of Energy, Albuquerue, New Mexico.

U.S. Department of Energy, 1982, "Site Validation Program," WIPP-DOE-116, Revision 1, Waste Isolation Pilot Plant Project Office.

TABLE 1

ABRIDGED CONSTRUCTION HISTORY OF THE EXPLORATORY SHAFT

Location:	Eddy County, New Mexico T22S, R31E, Sec. 20 New Mexico Grid Coordinates: N499687.23 E666894.89
Elevation:	Ground Surface 3410.5 ft MSL

"BLIND" SHAFT DRILLING[1]

Drilling Contractors-Rig Types:	Meredith Drilling Company - Auger (11.0-93.4 ft) Challenger Drilling Company - National 125 Jacknife Rotary (93.4-2298 ft)
Site Preparation:	May 14, 1981
Spudded:	July 4, 1981
Drilling Completed:	December 20, 1981
Casing:	180-inch, corrugated metal pipe, ground surface to 11 feet 144-inch, 1" steel pipe, ground surface to 93.4 feet 120-inch, 5/8" to 1 1/2" steel pipe, ground surface to 844 feet
Drill Hole:	142-inch uncased borehole from 844 feet to total depth of 2298 feet
Directional Survey Contractor:	Sperry-Sun (Gyroscopic Multishot Surveys)
Horizontal Displacement at 2276 feet:	1.59 ft., S 65° 02' W

(Continued on page T-2)

[1] All depths measured from ground surface.

TABLE 1
(Continued)

GEOPHYSICAL LOGGING

Geophysical Logging Contractor: Birdwell/Dresser Atlas

Log Type:	Logging Depth:[1]	Contractor:	Date:
Fluid Density	1200' to 550'	Dresser Atlas	10/16/81
Fluid Density	750' to 20'	Birdwell	10/24/81
Density	2294' to 50'	Birdwell	10/26/81
Caliper (3-diameter/Aver.)	2294' to 50'	Birdwell	10/26/81
Epithermal Neutron	2294' to 50'	Birdwell	10/27/81
Gamma Ray	2300' to 0'	Birdwell	10/27/81
Nuclear Cement Top Locator (NCTL)	827' to 0'	Birdwell	12/03/81
Nuclear Annulus Investigation Log (NAIL)	839' to 0'	Birdwell	12/03/81
Fluid Density	2250' to 2003'	Dresser Atlas	12/17/81

SHAFT OUTFITTING

Outfitting Contractor:	Cementation West, Inc.
Headframe Completed:	March 9, 1982
Hoist and Winches Completed:	March 24, 1982
Installation of Key Zone Instrumentation Completed:	April 16, 1982
Key Construction Completed:	April 20, 1982
Station Excavation Completed:	June 2, 1982
Installation of Station Zone Instrumentation Completed:	July 3, 1982
Installation of Shaft Instrumentation Completed:	July 9, 1982

GEOLOGIC MAPPING

Lead Organization for Geologic Mapping:	TSC/D'Appolonia
Other Participants in Geologic Mapping:	Bechtel, SNL, TSC/Dravo, TSC/Gibbs and Hill
Detailed Geologic Mapping of the Key Zone Completed:	March 31, 1982
Reconnaissance Geologic Mapping of the Shaft Completed:	May 2, 1982
Detailed Geologic Mapping of the Station Zone Completed:	May 2, 1982

[1] All depths measured from ground surface.

TABLE 2

LIST OF PARTICIPANTS IN VARIOUS PHASES OF THE GEOLOGICAL/GEOTECHNICAL ACTIVITIES IN THE EXPLORATORY SHAFT

A. Individuals involved in reconnaissance of exploratory shaft key zone on March 30, 1982:

F. Hensley, Photographer, SNL
L. Jarolimek, Task Leader, D'Appolonia
A. L. Moss, TSC-D'Appolonia

B. Individuals involved in exploratory shaft key zone mapping on March 31, 1982:

S. R. Black, D'Appolonia
C. Buffkin, Gibbs and Hill
T. Dillon, Shift Engineer, Dravo
L. Jarolimek, Task Leader, D'Appolonia
R. F. McKinney, D'Appolonia
A. L. Moss, TSC-D'Appolonia
D. Roberts, Bechtel

C. Individuals involved in reconnaissance geologic mapping from April 26 to 30 and on May 2, 1982:

S. R. Alcorn, TSC-D'Appolonia
S. R. Black, D'Appolonia
L. Jarolimek, Task Leader, D'Appolonia
L. Matthews, Bechtel
R. F. McKinney, D'Appolonia
A. L. Moss, TSC-D'Appolonia

D. Individuals involved in mapping of the station zone between April 30 and May 2, 1982:

S. R. Alcorn, TSC-D'Appolonia
S. R. Black, D'Appolonia
T. Dillon, Shift Engineer, Dravo
L. Jarolimek, Task Leader, D'Appolonia
A. K. Kuhn, D'Appolonia
L. Matthews, Bechtel
R. F. McKinney, D'Appolonia
A. L. Moss, TSC-D'Appolonia
D. W. Powers, SNL
J. K. Register, TSC-D'Appolonia
D. K. Shukla, TSC Task Manager, D'Appolonia

Continued on page T-4)

TABLE 2
(Continued)

E. Individuals involved in the shaft inspection and facility interval selection between 11:00 pm Saturday, May 1 and 2:00 am Sunday, May 2, 1982:

F. Hensley, Photographer, SNL
G. L. Hohmann, TSC Technical Director, Westinghouse
L. Jarolimek, Task Leader, D'Appolonia
A. K. Kuhn, D'Appolonia
L. Matthews, Bechtel
D. K. Shukla, TSC Task Manager, D'Appolonia
J. S. Treadwell, DOE Engineering Manager
R. Newton, Shift Engineer, Dravo

F. Individuals participating in the review meeting of the facility interval selection, in Carlsbad at 8:00 am Sunday, May 2, 1982:

S. R. Alcorn, TSC-D'Appolonia
S. R. Black, D'Appolonia
F. J. Gurney, TSC Site Manager, Westinghouse
F. Hensley, Photographer, SNL
G. L. Hohmann, TSC Technical Director, Westinghouse
L. Jarolimek, Task Leader, D'Appolonia
W. F. Jebb, DOE Site Manager
A. K. Kuhn, D'Appolonia
L. Matthews, Bechtel
A. L. Moss, TSC-D'Appolonia
D. W. Powers, SNL
J. K. Register, TSC-D'Appolonia
D. K. Shukla, TSC Task Manager, D'Appolonia
J. S. Treadwell, DOE Engineering Manager

G. Individuals involved in further review of the technical data, the facility interval selection decision, and the shaft geology by EEG representative at 12:00 p.m., Sunday, May 2, 1982:

L. Chaturvedi, EEG Representative
L. Jarolimek, Task Leader, D'Appolonia
D. W. Powers, SNL
D. K. Shukla, TSC Task Manager, D'Appolonia
R. Newton, Shift Engineer, Dravo

TABLE 3

SUMMARY OF RELATION BETWEEN PRELIMINARY AND CORRECTED DEPTHS IN THE EXPLORATORY SHAFT

PRELIMINARY DEPTHS[1][2] (ft)	CORRECTION FACTOR[3] (ft)	CORRECTED DEPTHS[2][4] (ft)	ELEVATIONS[5] (ft MSL)
0.0	0.0	0.0	3410.0
840.0	-0.2	839.8	2570.2
920.0	-0.2	919.8	2490.2
954.0	+0.8	954.8	2455.2
1465.0	+1.8	1466.8	1943.2
1925.0	+1.8	1926.8	1483.2
2055.0	+2.6	2057.6	1352.4
2229.0	+2.6	2231.6	1178.4

(1) Preliminary depths correspond to the CWI approximate surveying performed during the period March - May, 1982. The results of this survey were used during geological mapping.

(2) Depths are based on zero datum point (top of first bunton) at elevation of 3410.0 ft. MSL.

(3) Correction factors at these depths were determined by comparison of CWI electronic surveying of December 2, 1982 and TSC surveying of January 22, 1983 with the preliminary depths of geologic logs.

(4) The depths within each interval between the indicated preliminary depths have been corrected by interpolation of the correction factor between the endpoints of the interval.

(5) Elevations are based on the survey conducted by CWI on December 2, 1982 (using electronic distance meter Lietz RED-2) and referenced to CWI bench mark No. CW-1 (brass cap outside the exploratory shaft) at elevation 3410.080 which was tied to the existing "North Base Line" to the north of the site.

TABLE 4
SUMMARY OF SELECTED STRATIGRAPHIC INTERVALS

STRATA/CONTACT	PRELIMINARY DEPTH (FEET)	CORRECTED DEPTH (FEET)	ELEVATION[1] (FEET MSL)
Ground Surface	-0.5	-0.5	3410.5
Top of First Bunton	0	0	3410.0
Rustler/Salado	850.8	850.6	2559.4
Upper Salado/McNutt	1344.0	1345.6	2064.4
Vaca Triste Sandstone Member (Top)	1347.1	1348.7	2061.3
Vaca Triste Sandstone Member (Bottom)	1348.8	1350.4	2059.6
Union Anhydrite (Top)	1534.0	1535.8	1874.2
Union Anhydrite (Bottom)	1538.0	1539.8	1870.2
Marker Bed 136 (Top)	2025.0	2027.4	1382.6
Marker Bed 136 (Bottom)	2033.4	2035.9	1374.1
Marker Bed 137 (Top)	2049.0	2051.6	1358.4
Marker Bed 137 (Bottom)	2049.7	2052.3	1357.7
Marker Bed 138 (Top)	2095.8	2098.4	1311.6
Marker Bed 138 (Bottom)	2096.1	2098.7	1311.3
Anhydrite "a" (Top)	2119.0	2121.6	1288.4
Anhydrite "a" (Bottom)	2119.7	2122.3	1287.7
Anhydrite "b" (Top)	2126.3	2128.9	1281.1
Anhydrite "b" (Bottom)	2126.6	2129.2	1280.8
Marker Bed 139 (Top)	2153.7	2156.3	1253.7
Marker Bed 139 (Center)	2155.1	2157.7	1252.3
Marker Bed 139 (Bottom)	2156.5	2159.1	1250.9
Marker Bed 140 (Top)	2220.0	2222.6	1187.4
Marker Bed 140 (Bottom)	2229.0	2231.6	1178.4

[1] Elevations are based on the survey conducted by CWI on December 2, 1982 (using electronic distance meter Lietz RED-2) and referenced to CWI bench mark No. CW-1 (brass cap outside the exploratory shaft) at elevation 3410.080 which was tied to the existing "North Base Line" to the north of the site.

TABLE 5

INSTRUMENT LOCATIONS IN THE EXPLORATORY SHAFT

INSTRUMENT TYPE[1]	NUMBER	LEVEL[2] ON DESIGN DRAWINGS[3] (feet)		INSTALLED LEVEL[2][4] (feet)	INSTALLED DEPTH[5] (feet)	INSTALLED ELEVATION[6] (feet MSL)
RC	1 set	300		296	295.6	3114.4
RC	1 set	450		454	453.7	2956.3
PE	2	550		580	579.5	2830.5
RC	1 set	580		584	584.5	2825.5
PE	2	610	SHAFT	620	619.3	2790.7
PE	2	665	LINER	691	690.3	2719.7
PE	2	720		726	726.5	2683.5
RC	1 set	730		730	730.3	2679.7
PE	2	780		802	802.4	2607.6
RC	1 set	810		814	814.0	2596.0
PE	2	842		850	850.0	2560.0
ZE	20	852	SHAFT	857	857.5[7]	2552.5[7]
ZE	20	857	KEY	862.4	862.5[7]	2547.5[7]
WE	4	855		862.4	861.5[7]	2548.5[7]
RC	1 set	915		940	940.2	2469.8
RC	1 set	2100		1073	1073.4	2336.6
GE	3	915		1073	1073.4	2336.6
RC	1 set	1250		1275	1276.5	2133.5
RC	1 set	1600	UNLINED	1564	1566.1	1843.9
GE	3	1491	SHAFT	1564	1566.1	1843.9
RC	1 set	1800		1815	1616.0	1594.0
RC	1 set	2043		2057	2058.6	1351.4
GE	3	2043		2057	2058.6	1351.4

(1) Instrument Type:
GE = Extensometer
PE = Piezometer
RC = Radial convergence points (each set consists of 4 RC points)
WE = Earth pressure cell
ZE = Strain gage.

(2) "Level" refers to approximate depth below zero datum point (top of first bunton).

(3) Bechtel Drawing No. 37-X-005, Rev. 5, dated October 3, 1980.

(4) Geotechnical Field Data Report No. 6, Sheets 5 and 6 of 287, dated January 17, 1983.

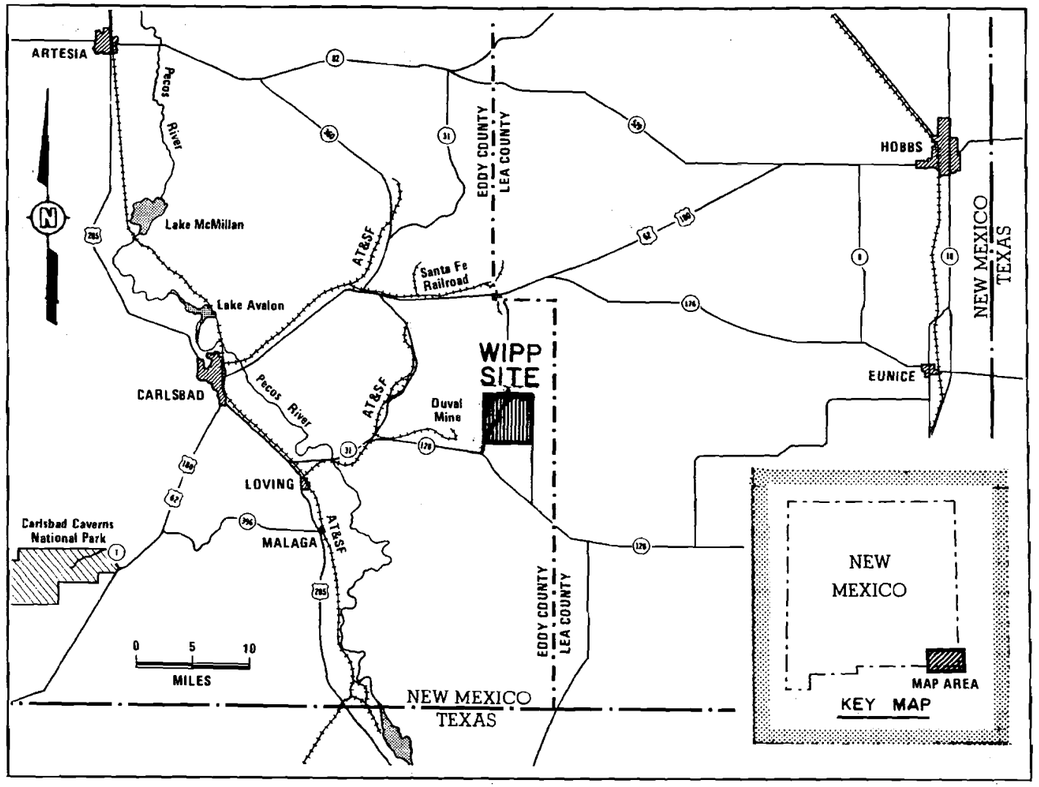
(5) "Depths" are based on zero datum point (top of first bunton) at elevation of 3410.0 feet MSL and correspond to the "corrected" depths.

(6) "Elevations" are based on the survey conducted by CWI on December 2, 1982 (using electronic distance meter Lietz RED-2) and referenced to CWI bench mark No. CW-1 (brass cap outside the exploratory shaft) at elevation 3410.080 which was tied to the existing "North Base Line" to the north of the site.

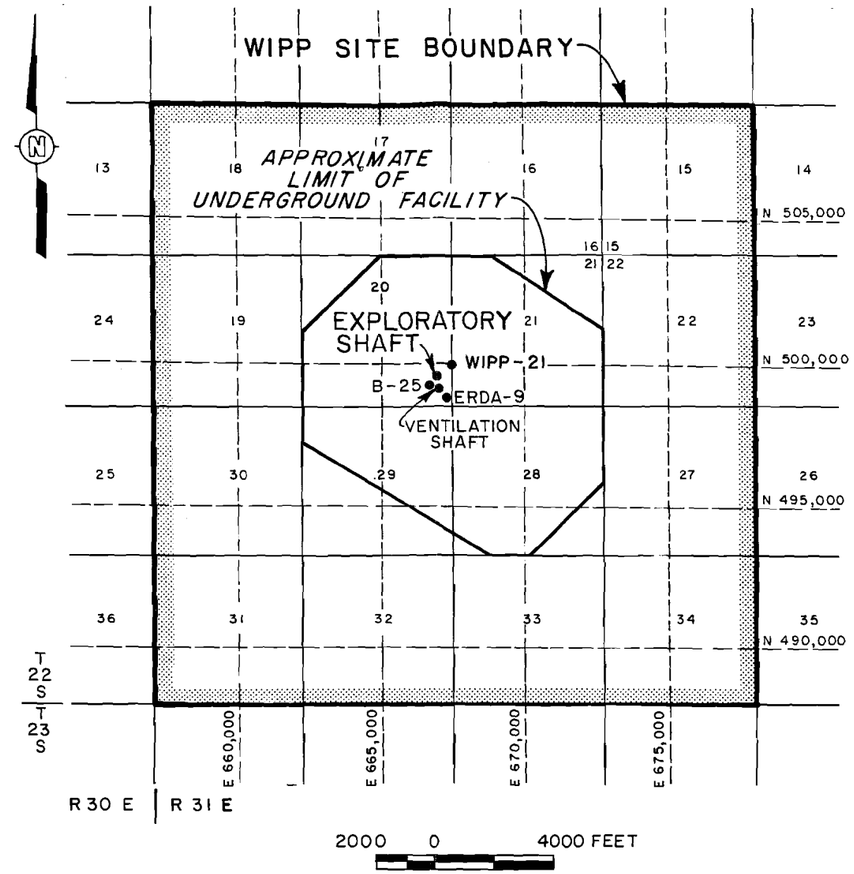
(7) Approximate depth and elevation; instruments covered by concrete, hence, their position could not be surveyed by EDM.

090

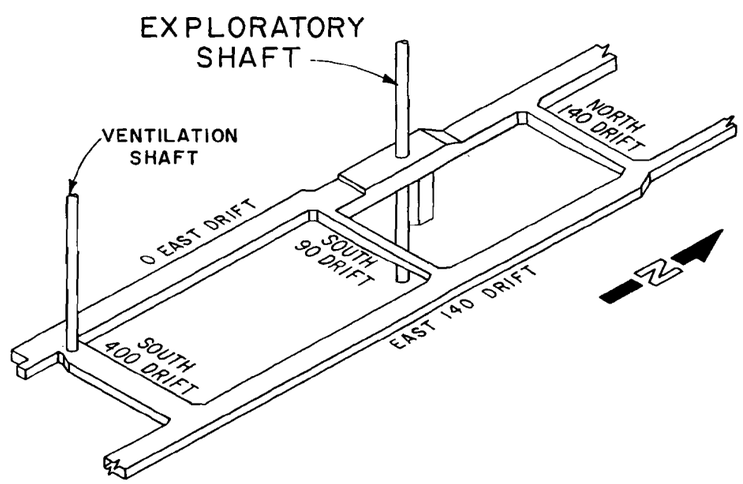
DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
EF 1/21/83	MT 3-18-83	LT 3/18/83	NM78-648-B68



A. LOCATION MAP



B. PLAN VIEW



C. SCHEMATIC ISOMETRIC VIEW

FIGURE 1

LOCATION MAP

EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO
PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

19 1253 HERCULENE, A&B SMITH CO., PGH., PA LT1530-1079

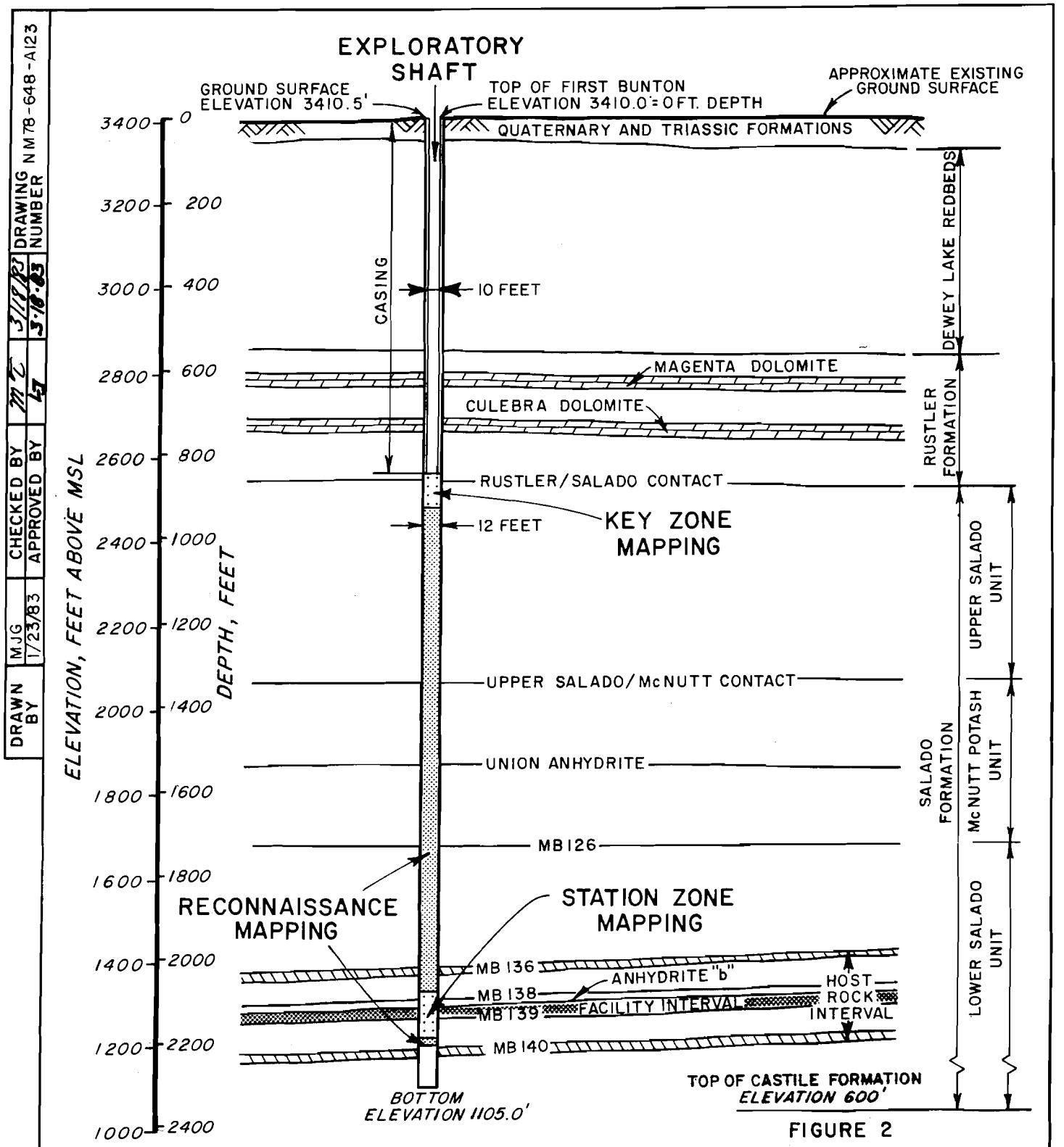


FIGURE 2
SCHEMATIC GEOLOGIC SECTION
EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO
PREPARED FOR
WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

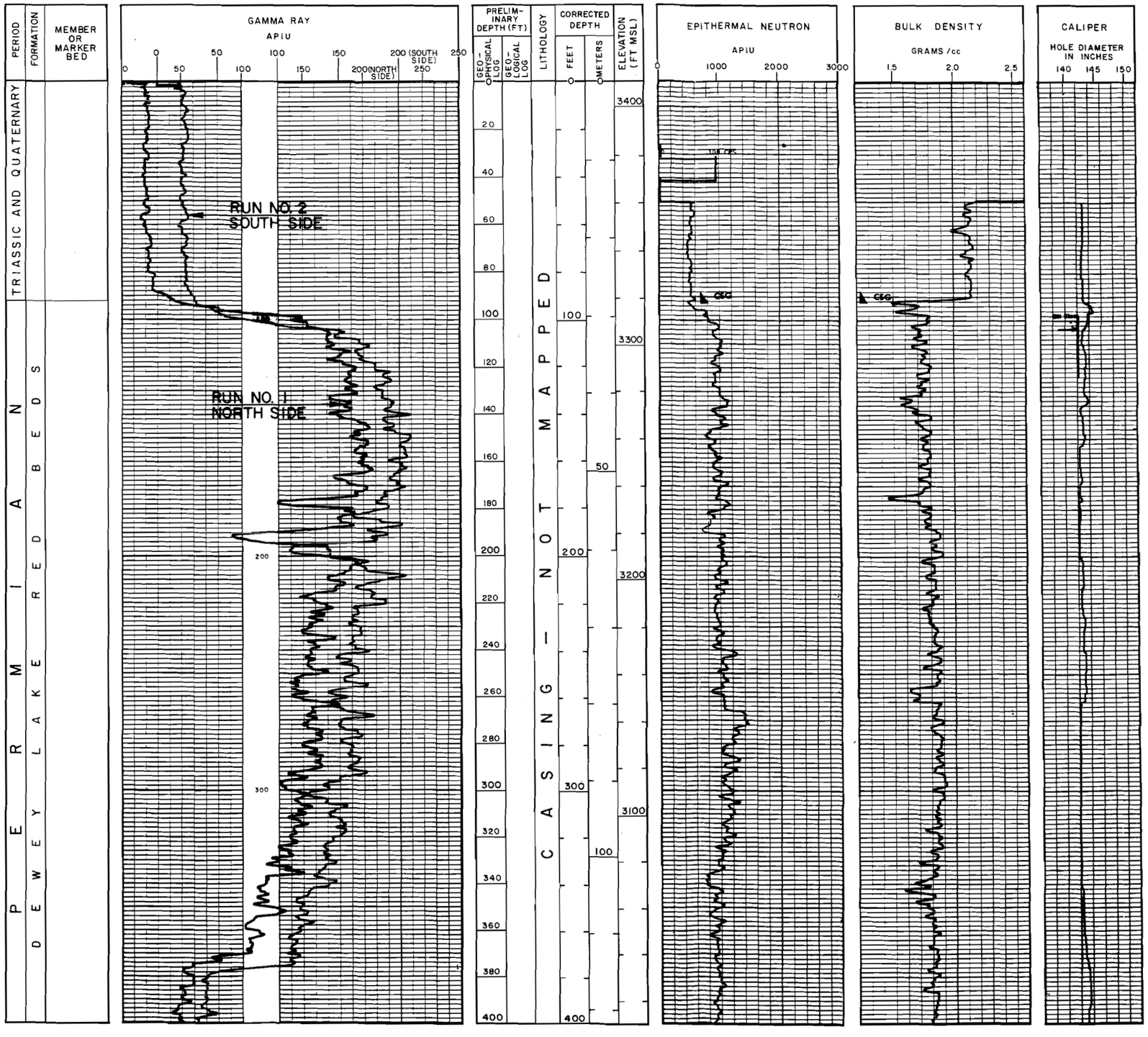
D'APPOLONIA

DRAWN BY	MJG 1/23/83	CHECKED BY	MC 3/17/83	DRAWING NUMBER	NM78-648-A123
		APPROVED BY	LT 3-18-83		

19 1253 HERCULENE. A&B SMITH CO., PGH., PA LT1530-1079

090B

DRAWN BY	CHECKED BY	DRAWING NUMBER
gb/sbe 02-27-83	APPROVED BY	NM 78-648-E14



NOTES:

1. GEOPHYSICAL LOGS IN THIS FIGURE ARE DIRECT COPIES OF ORIGINAL LOGS PRODUCED BY BIRDWELL ON OCTOBER 26 AND 27, 1981.
2. PRELIMINARY DEPTHS FOR THE GEOPHYSICAL LOGS CORRESPOND TO THE DEPTHS RECORDED ON THE LOGS AND REFER TO THE GROUND SURFACE AT ELEVATION 3410.5 FEET MSL AS THE DATUM POINT.
3. FOR MORE DETAILED LITHOLOGY AND EXPLANATION OF GEOLOGIC SYMBOLS, SEE FIGURE 4.
4. THE GEOLOGICAL LOG HAS BEEN ADJUSTED TO CORRESPOND AS CLOSELY AS POSSIBLE TO THE GEOPHYSICAL LOGS.
5. PRELIMINARY DEPTHS FOR THE GEOLOGICAL LOG CORRESPOND TO THE CWI APPROXIMATE SURVEYING PERFORMED FROM MARCH TO MAY 1982 AND REFER TO THE TOP OF FIRST BUNTON AT ELEVATION 3410.0 FEET MSL AS THE ZERO DATUM POINT.
6. CORRECTED DEPTHS WERE DETERMINED BY THE ADDITION OF A CORRECTION FACTOR TO THE PRELIMINARY DEPTHS OF THE GEOLOGICAL LOG IN ACCORDANCE WITH TABLE 3 AND ALSO REFER TO THE TOP OF FIRST BUNTON AT ELEVATION 3410.0 FEET MSL AS THE ZERO DATUM POINT.
7. ELEVATIONS REFER TO THE BOTTOM OF CONCRETE (SHAFT KEY) AT ELEVATION 2530.38 FEET MSL AND TO CWI BENCHMARK NO. 82-D (BRASS CAP ON NORTHWEST CORNER OF UNDERGROUND POWER CENTER FOUNDATION) AT ELEVATION 1259.59 FEET MSL. BOTH POINTS WERE TIED TO CWI BENCHMARK NO. CW-1 (BRASS CAP OUTSIDE THE EXPLORATORY SHAFT) AT ELEVATION 3410.080 FEET MSL. SEE APPENDIX C FOR FURTHER INFORMATION CONCERNING SURVEYING IN THE EXPLORATORY SHAFT.

FIGURE 3
SHEET 1 OF 6
GEOPHYSICAL LOGS

EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

090B

DRAWN BY	cjb/sbe 02-27-83	CHECKED BY	MTE	S/12/83	DRAWING NUMBER	NM 78-648-E15
		APPROVED BY		3-18-83		

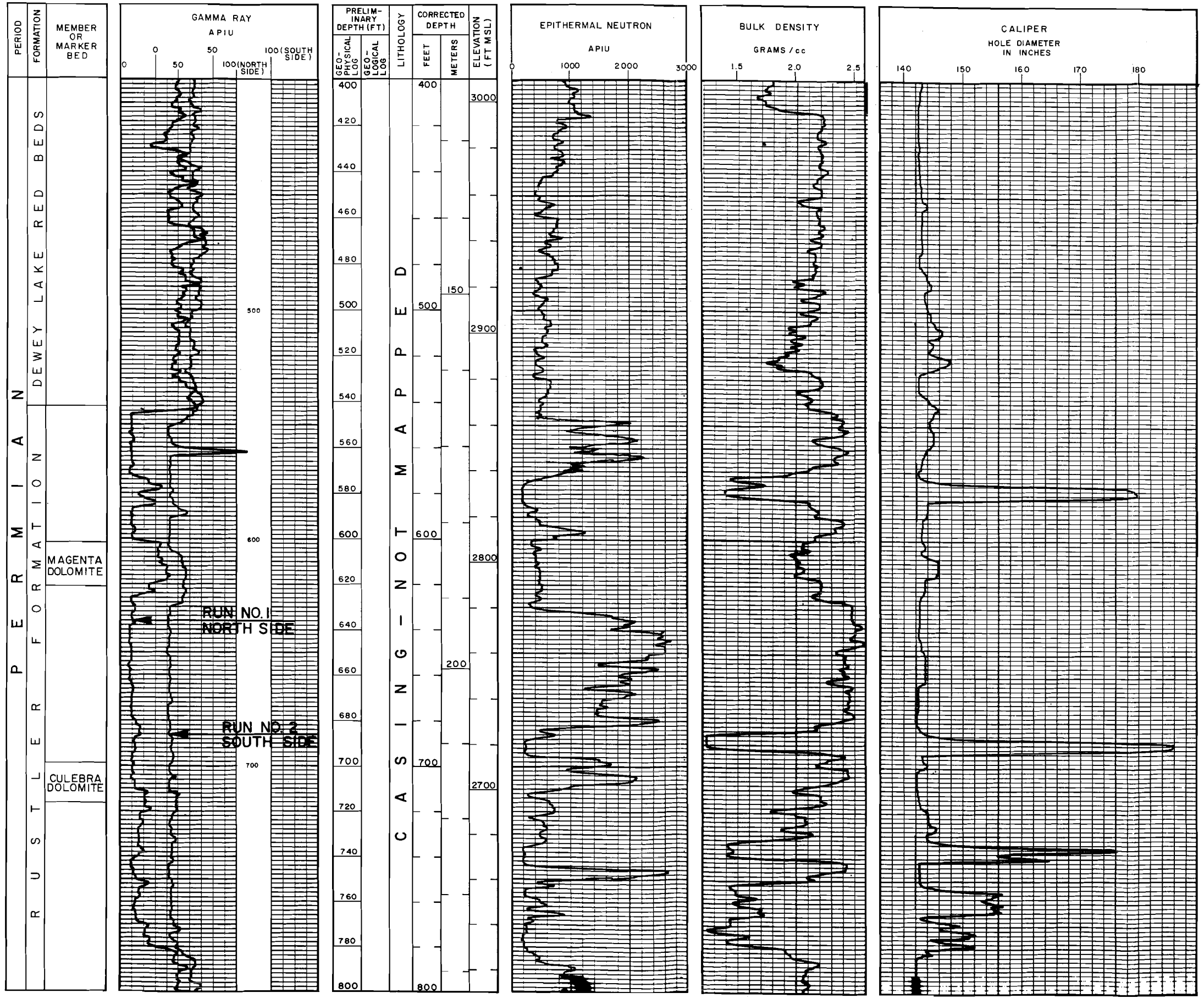


FIGURE 3
SHEET 2 OF 6
GEOPHYSICAL LOGS

EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

090B

DRAWN BY	cjb/sbe 02-27-83	CHECKED BY	MT	3/18/83	DRAWING NUMBER	NM 78-648-E16
		APPROVED BY	LJ	3-18-83		

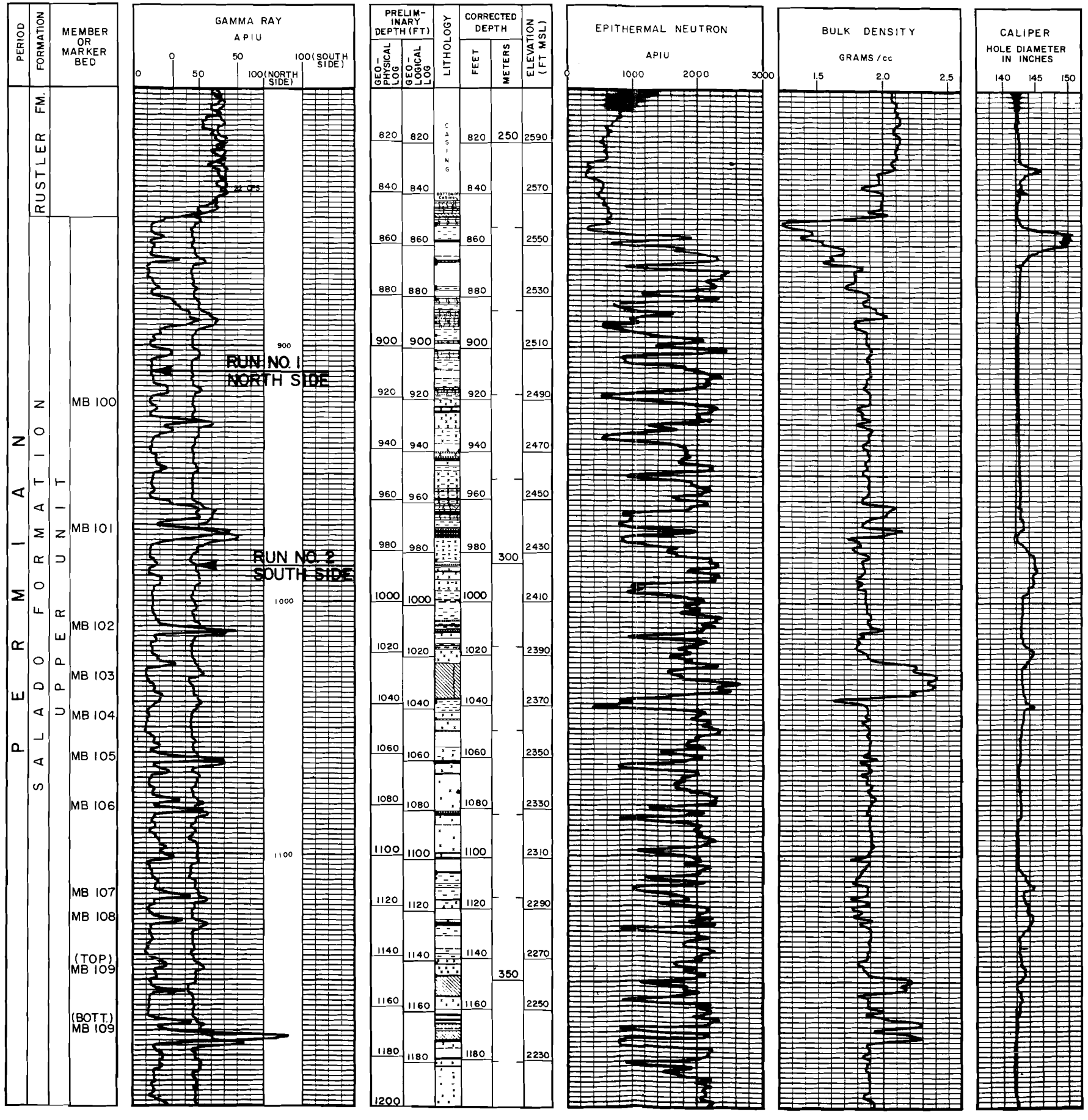


FIGURE 3
SHEET 3 OF 6
GEOPHYSICAL LOGS

EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

090 B

DRAWN BY	cjb/sbe	CHECKED BY	MC	Sup/Sci	DRAWING NUMBER NM 78-648-E17
	02-27-83	APPROVED BY	LJ	3.18.83	

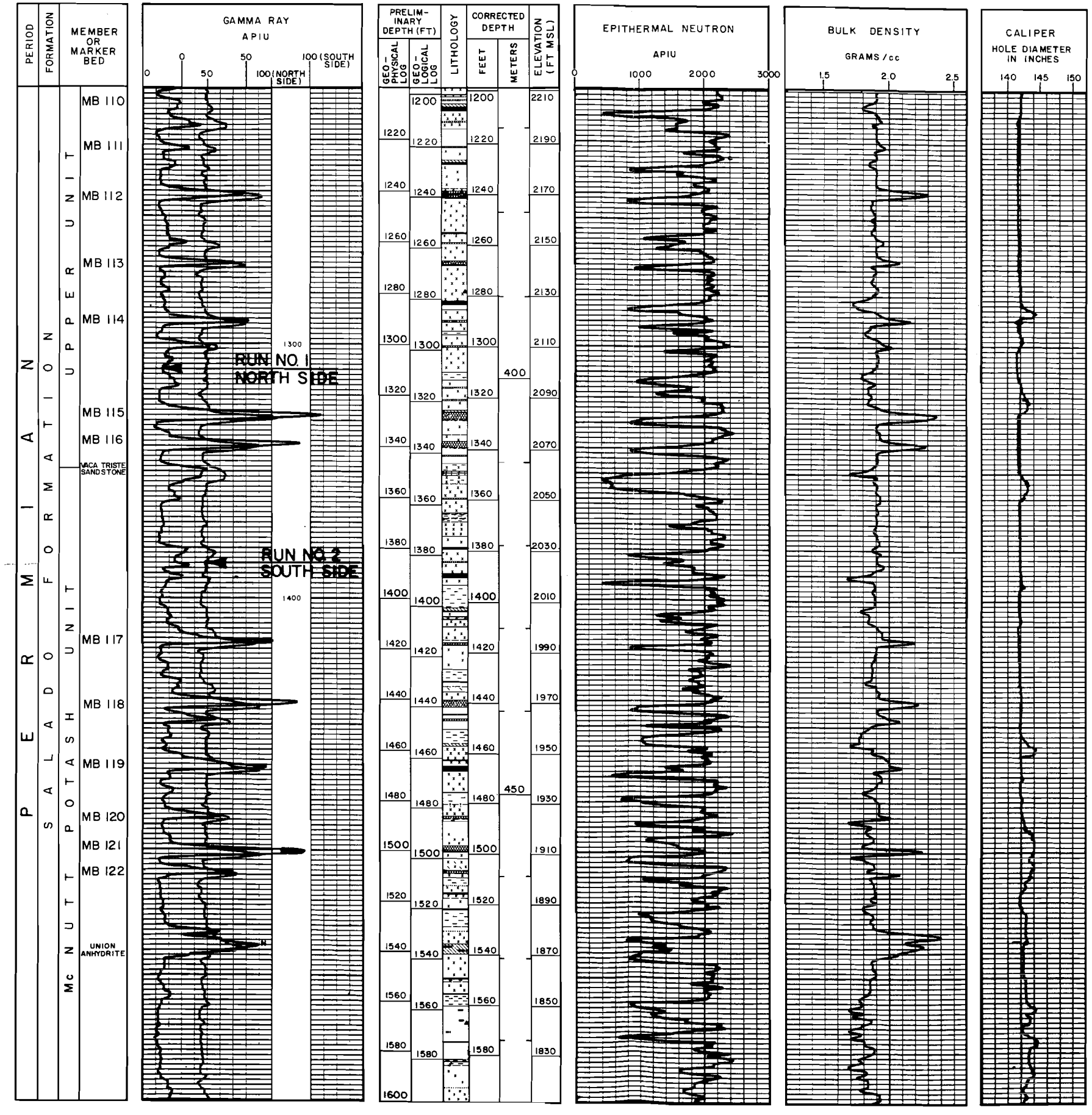


FIGURE 3
SHEET 4 OF 6
GEOPHYSICAL LOGS

EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

090 B

DRAWN BY	cjb/sbe	CHECKED BY	MT	3/18/83	DRAWING NUMBER NM 78-648-E18
	02-27-83	APPROVED BY	LJ	3/18/83	

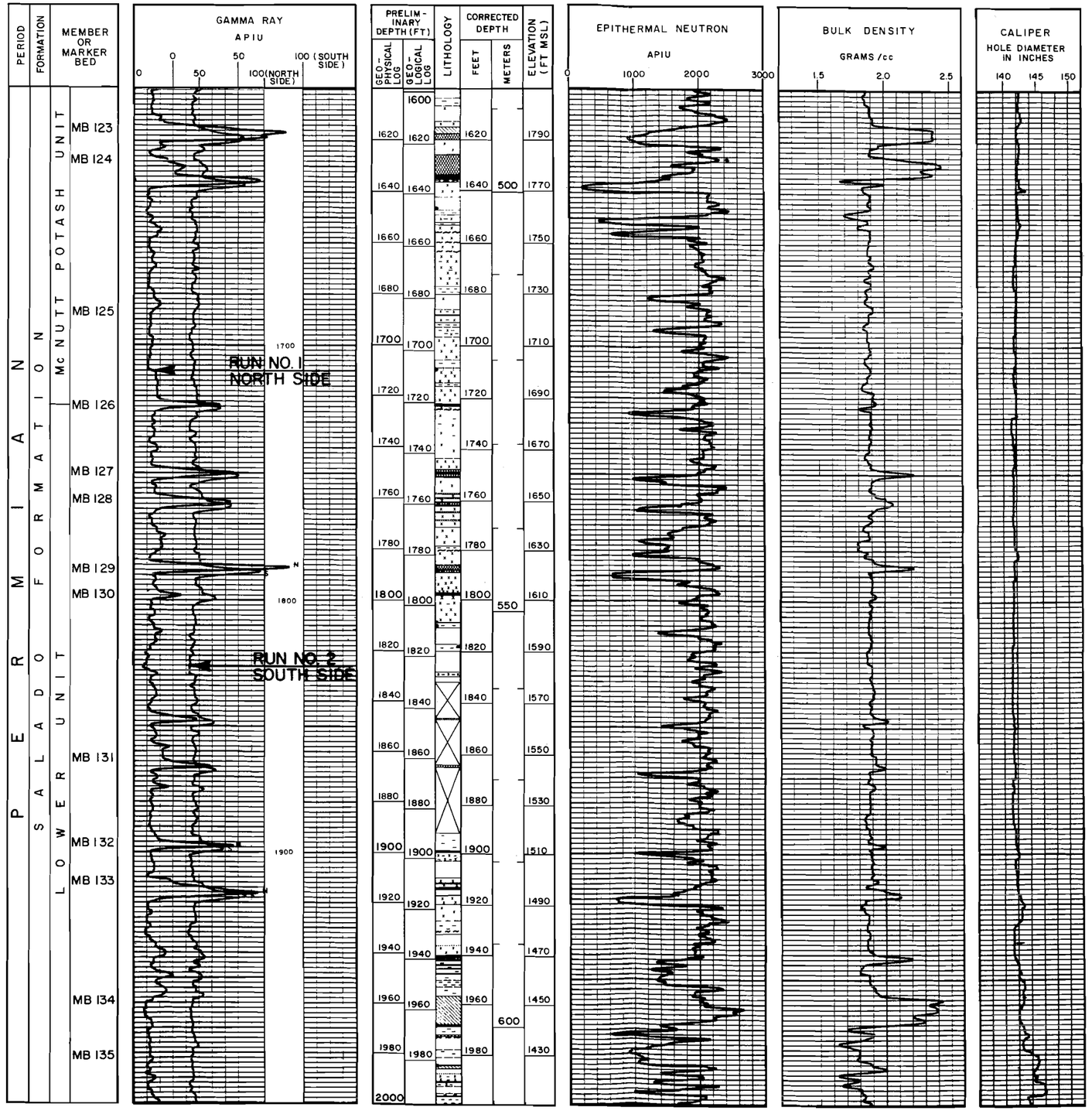


FIGURE 3
SHEET 5 OF 6
GEOPHYSICAL LOGS

EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

090B

DRAWN BY	CHECKED BY	DRAWING NUMBER
djb/sbe 02-27-83	APPROVED BY	NM 78-648-E19

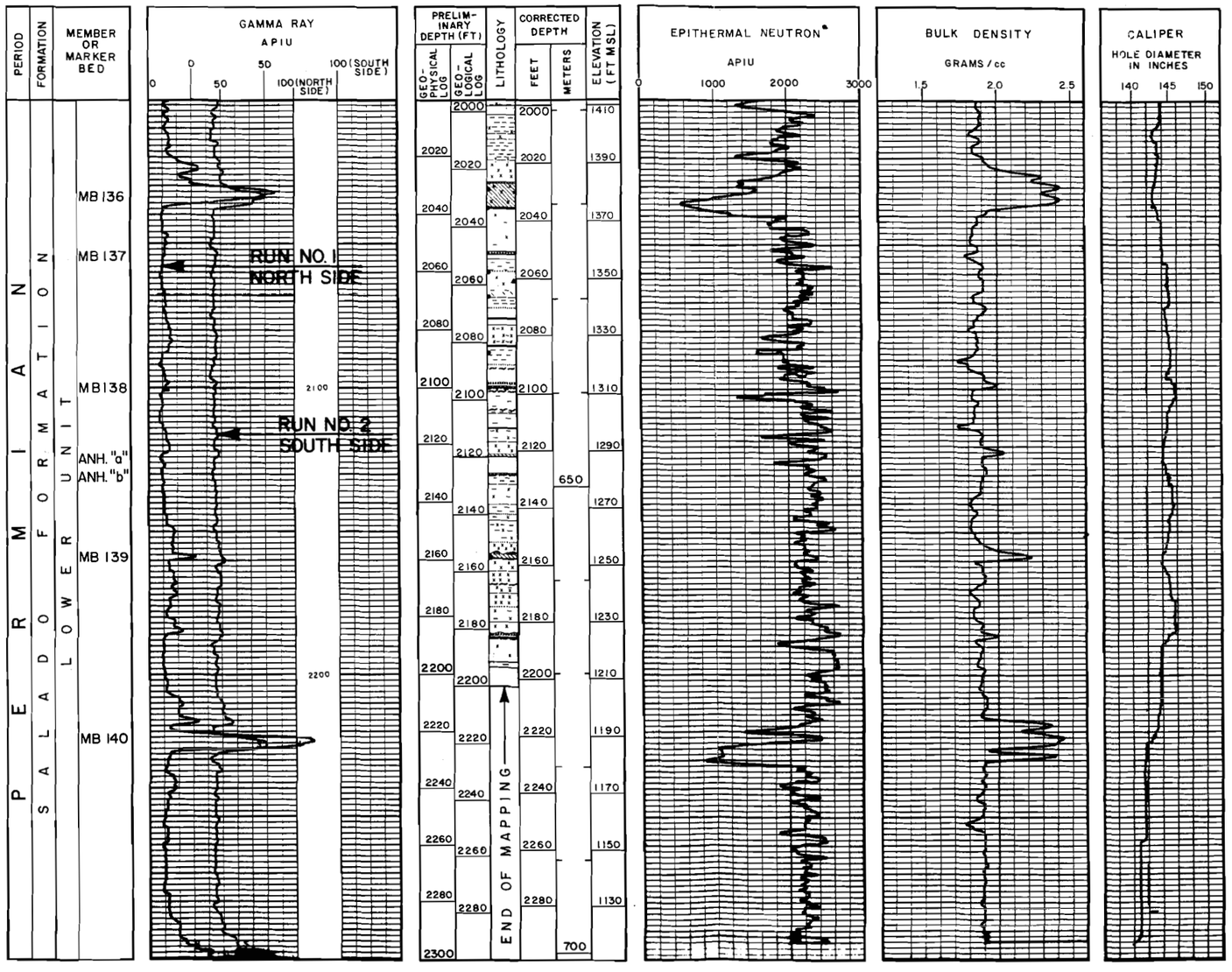


FIGURE 3
SHEET 6 OF 6
GEOPHYSICAL LOGS

EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

090B

DRAWN BY	MJG 1/10/83	CHECKED BY	APPROVED BY	DRAWING NUMBER NM78-648-E9
		MT	L7	2/12/83 3-18-83

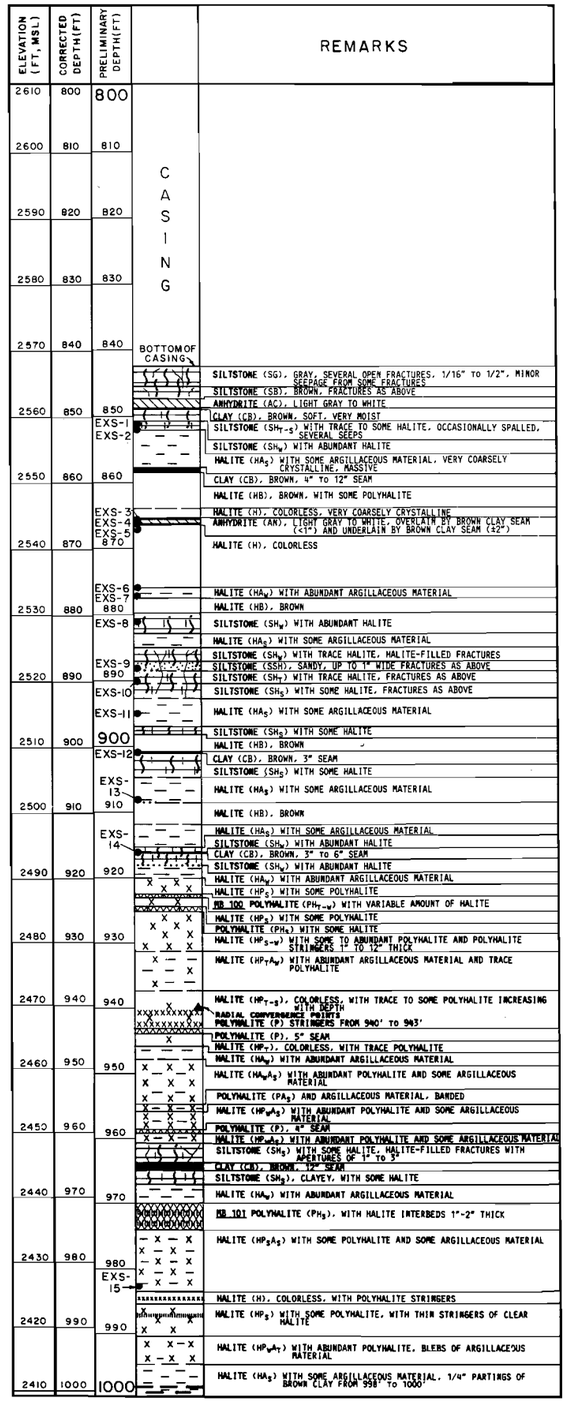
NOTES

1) ELEVATIONS REFER TO BOTTOM OF CONCRETE AT ELEVATION OF 2530.38 WHICH WAS TIED TO CWI BENCHMARK NO. CW-1 (BRASS CAP OUTSIDE THE EXPLORATORY SHAFT) AT ELEVATION 3410.080 ON DECEMBER 2, 1982.

2) DEPTHS ARE RELATED TO THE TOP OF FIRST BUNTON AT ELEVATION 3410.0 FT. MSL.

3) PRELIMINARY DEPTHS WERE CORRECTED BY THE ADDITION OF A CORRECTION FACTOR IN ACCORDANCE WITH TABLE 3.

4) STANDARD GEOLOGIC SYMBOL IS NOT USED IN ORDER TO ENHANCE THE CLARITY OF THE LOG COLUMN.



GEOLOGIC UNIT SYMBOLS AND DESCRIPTIONS*

A — **ARGILLACEOUS** MATERIAL, GENERALLY FOUND AS AN INTERGRANULAR ACCESSORY CONSTITUENT, LIGHT GRAY (N7) TO MODERATE REDDISH-BROWN (10R 4/6), SLIGHTLY MOIST TO MOIST, TRACE TO SOME SILT.

AC — **ANHYDRITE**, LIGHT GRAY (N7) TO WHITE (N9) TO GRAYISH-ORANGE (10YR 7/4), FINELY CRYSTALLINE TO MICROCRYSTALLINE, SEVERAL SOFT 1/2- TO 1 1/2-INCH CLAY STRINGERS WITH TRACE SILT.

AN — **ANHYDRITE**, MEDIUM DARK GRAY (N4) TO LIGHT GRAY (N7) TO WHITE (N9), MODERATE ORANGE-PINK (10R 7/4) TO PALE REDDISH-BROWN (10R 5/4), FINELY CRYSTALLINE TO MICROCRYSTALLINE.

CB — **CLAY**, DARK REDDISH-BROWN (10R 3/4), TRACE TO SOME SILT, TRACE TO SOME HALITE.

CG — **CLAY**, MEDIUM LIGHT GRAY (N6) TO MEDIUM DARK GRAY (N4) TO LIGHT OLIVE-GRAY (5Y 6/1), TRACE TO SOME SILT, TRACE TO SOME HALITE.

H — **HALITE**, COLORLESS (TRANSPARENT TO TRANSLUCENT) TO GRAYISH-ORANGE-PINK (5YR 7/2), MEDIUM TO COARSELY CRYSTALLINE, MAY BE BANDED.

HA** — **HALITE**, DARK REDDISH-BROWN (10R 3/4) TO MODERATE REDDISH-BROWN (10R 4/6), MEDIUM TO COARSELY CRYSTALLINE, ARGILLACEOUS.

HB — **HALITE**, DARK REDDISH-BROWN (10R 3/4) TO MOODERATE REDDISH-BROWN (10R 4/6), SLIGHTLY TRANSLUCENT.

HP** — **HALITE**, TRANSLUCENT TO MODERATE REDDISH-ORANGE (10R 6/6) TO MODERATE REDDISH-BROWN (10R 4/6), POLYHALITIC.

HPA** — **HALITE**, MODERATE REDISH-ORANGE (10R 6/6) TO MODERATE REDDISH-BROWN (10R 4/6), POLYHALITIC AND ARGILLACEOUS.

P — **POLYHALITE**, MODERATE REDDISH-BROWN (10R 4/6) TO MODERATE REDDISH-ORANGE (10R 6/6), FINELY CRYSTALLINE TO MICROCRYSTALLINE.

PA** — **POLYHALITE**, MODERATE REDDISH-BROWN (10R 4/6), FINELY CRYSTALLINE TO MICROCRYSTALLINE, ARGILLACEOUS.

PH** — **POLYHALITE**, MODERATE REDDISH-BROWN (10R 4/6) TO MOODERATE REDDISH-ORANGE (10R 6/6), FINELY CRYSTALLINE TO MICROCRYSTALLINE, HALITIC.

SB — **SILTSTONE**, DARK REDDISH-BROWN (10R 3/4), TRACE HALITE, TRACE FINE SAND.

SG — **SILTSTONE**, LIGHT OLIVE-GRAY (5Y 6/1), TRACE HALITE, TRACE FINE-GRAINED SAND.

SH** — **SILTSTONE**, DARK REDDISH-BROWN (10R 3/4) TO MODERATE REDDISH-BROWN (10R 4/6), HALITIC, TRACE TO SOME CLAY, LOCALLY CONTAINS VERY FINE-GRAINED SAND.

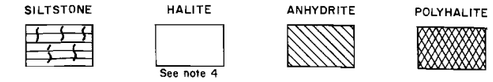
SSH — **SILTSTONE**, MODERATE REDDISH-ORANGE (10R 6/6), WITH VERY FINE-GRAINED SAND, TRACE HALITE; LOCALLY GRADES TO VERY FINE TO FINE-GRAINED SANDSTONE, MODERATE REDDISH-BROWN (10R 4/6) TO MEDIUM LIGHT GRAY (N6), TRACE TO SOME SILT.

* SLIGHT VARIATIONS FROM THESE GENERAL DESCRIPTIONS MAY EXIST. THE EXCEPTIONS ARE NOTED IN THE REMARKS COLUMN.

**ESTIMATED CONTENT OF ACCESSORY CONSTITUENTS IS INDICATED BY A MODIFIER:
T = TRACE
S - SOME
W = WITH OR ABUNDANT

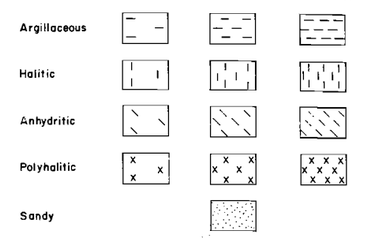
EXPLANATION

ROCK TYPE

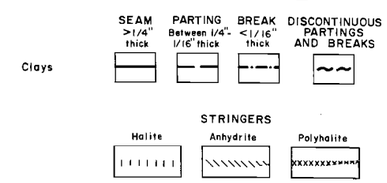


ACCESSORY CONSTITUENTS

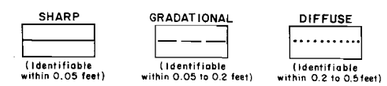
ESTIMATED PERCENTAGE OF ACCESSORY CONSTITUENTS INDICATED AS FOLLOWS:



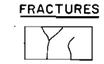
LAMINAR FEATURES



CONTACTS



FRACTURES



EXS-6 ● ROCK SAMPLE LOCATION AND NUMBER

▲ INSTRUMENT LOCATION

FIGURE 4
SHEET 1 OF 3

LITHOLOGIC LOG,
SAMPLE AND INSTRUMENT LOCATIONS

EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR
WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

090 B

DRAWN BY	E F 1/10/83	CHECKED BY	APPROVED BY	DRAWING NUMBER NM78-648-E7
		JM C	L.J.	3/18/83

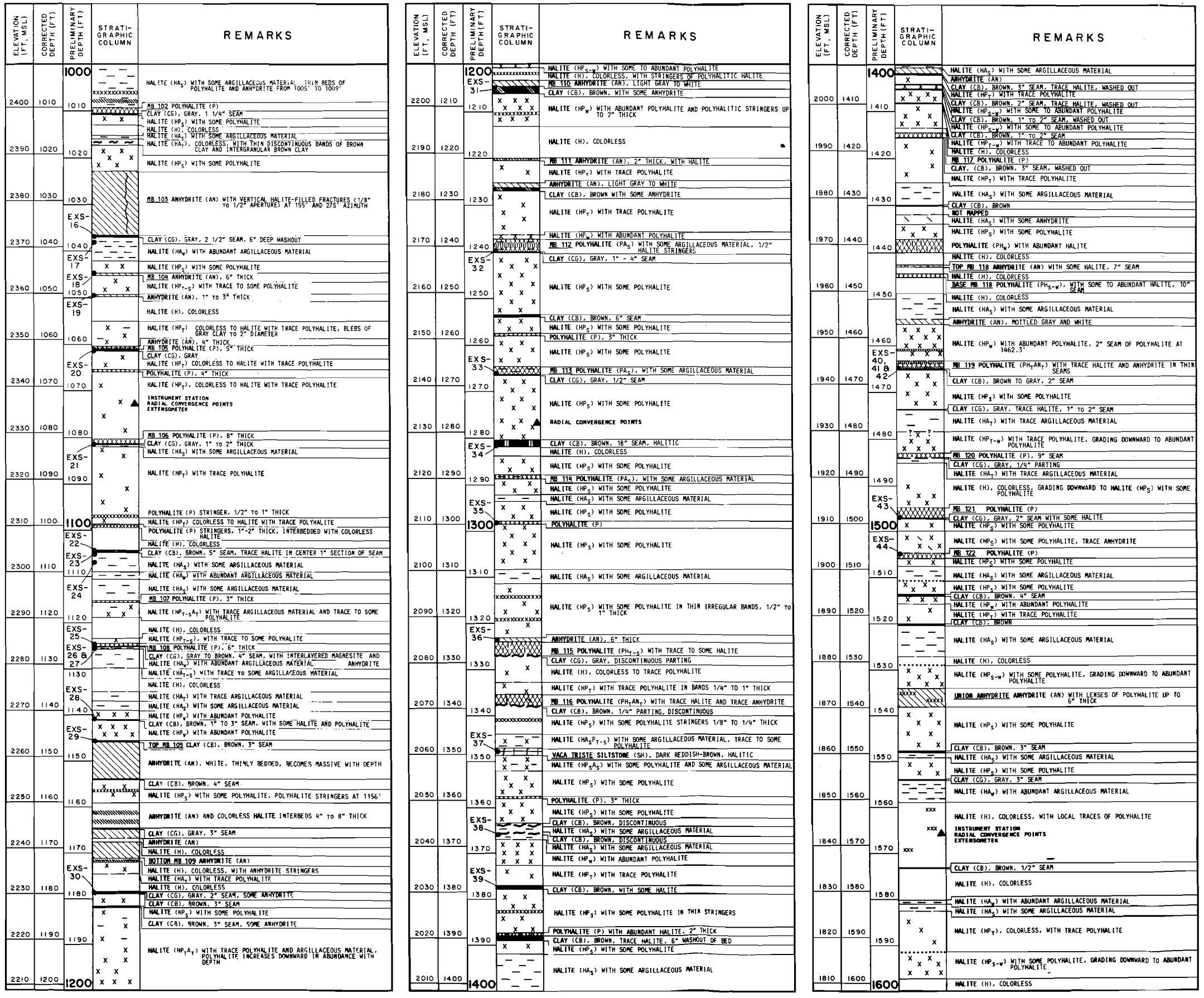


FIGURE 4
SHEET 2 OF 3

LITHOLOGIC LOG,
SAMPLE AND INSTRUMENT LOCATIONS

EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

090 B

DRAWN BY	EF	1/10/83	CHECKED BY	MC	3/18/83	DRAWING NUMBER	NM78-648-E8
			APPROVED BY	LJ	3-18-83		

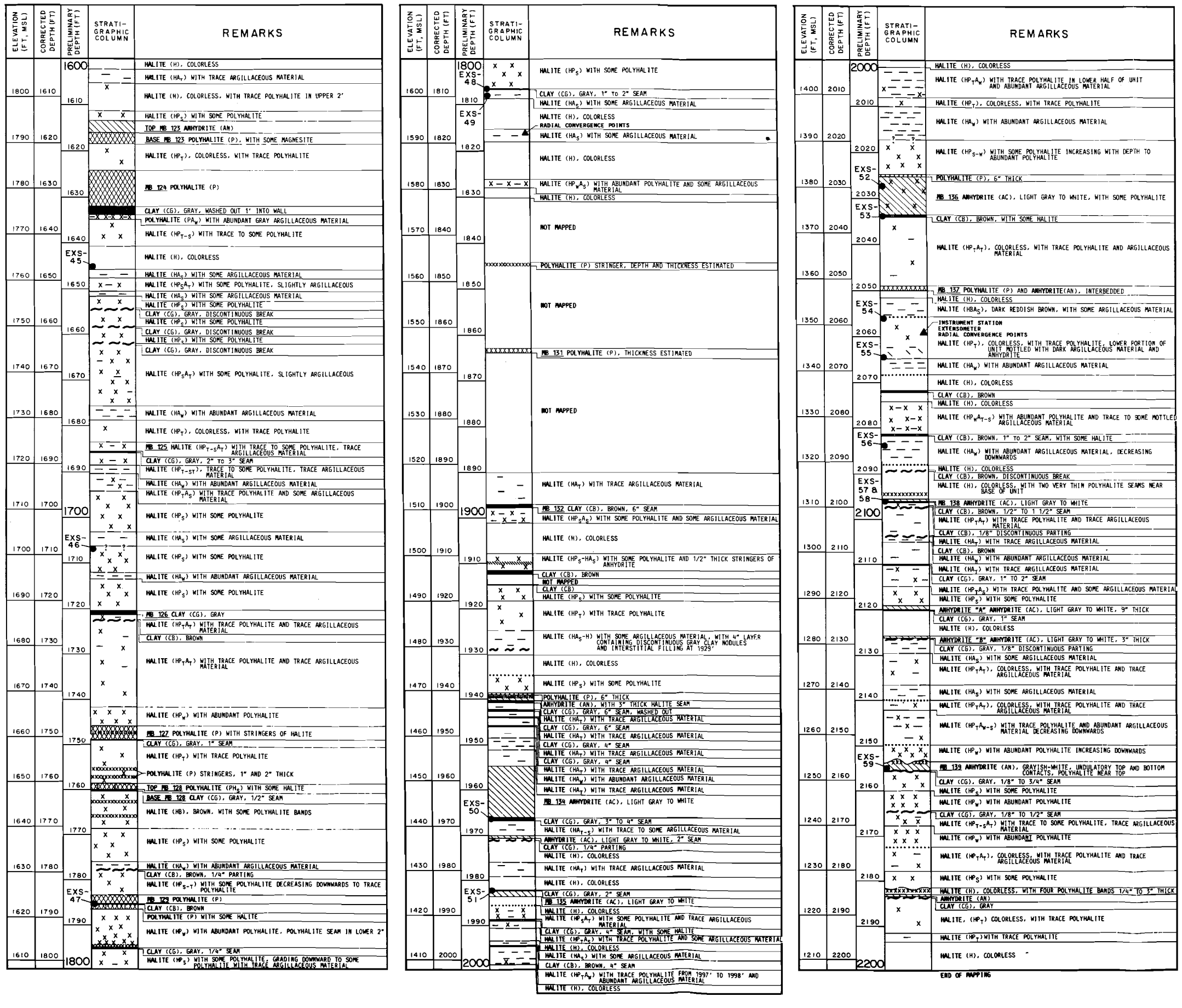


FIGURE 4

SHEET 3 OF 3

LITHOLOGIC LOG,
SAMPLE AND INSTRUMENT LOCATIONS

EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

090B

DRAWN BY	CHECKED BY	DRAWING NUMBER
DJ Rodriguez 1-8-83	APPROVED BY	NM78-648-E10

3-18-83

NOTES:

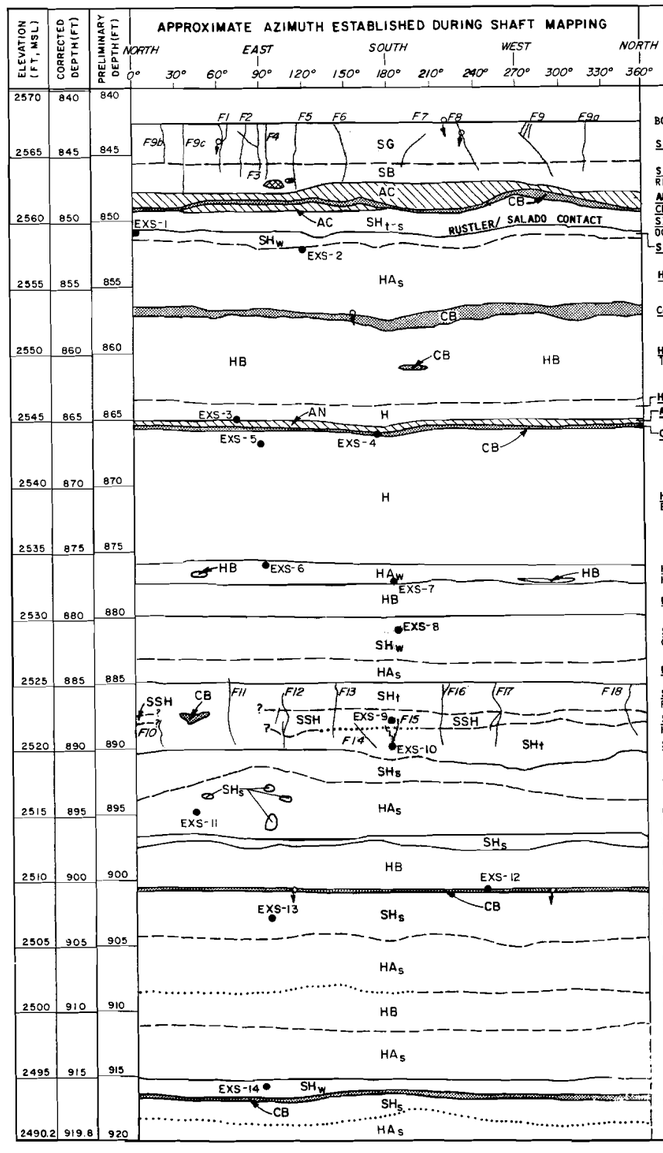
1) ELEVATIONS REFER TO BOTTOM OF CONCRETE AT ELEVATION OF 2530.38 WHICH WAS TIED TO CWI BENCHMARK NO. CW-1 (BRASS CAP OUTSIDE THE EXPLORATORY SHAFT) AT ELEVATION 3410.080 ON DECEMBER 2, 1982.

2) DEPTHS ARE RELATED TO THE TOP OF FIRST BUNTON AT ELEVATION 3410.0 FT. MSL.

3) PRELIMINARY DEPTHS WERE CORRECTED BY THE ADDITION OF A -0.2 FT. CORRECTION FACTOR.

4) NO CHANGES IN THE RELATIVE POSITIONS OF THE ROCK UNITS HAVE BEEN MADE FROM THOSE SHOWN IN THE SEPTEMBER 28, 1982, MEMO DESCRIBING THE GEOLOGIC MAPPING OF THE KEY ZONE.

5) STANDARD GEOLOGIC SYMBOL IS NOT USED IN ORDER TO ENHANCE THE CLARITY OF THE LOG COLUMN.



REMARKS

BOTTOM OF CASING

SILTSTONE, GRAY, NUMEROUS FRACTURES, SOME FRACTURES SEEPING

SILTSTONE, BROWN, NO HALITE, SEVERAL SPALLED AREAS; SPALLS SHALLOW (0.1' DEEP), WITH REDDISH-BROWN TO BLACK OXIDIZED FRACTURE SURFACE

ANHYDRITE, LIGHT GRAY TO WHITE, UNDULATORY LOWER CONTACT

CLAY, BROWN, 1/2" TO 1 1/2" THICK, SOFT, VERY MOIST

SILTSTONE, BROWN, TRACE TO SOME HALITE, LOCALLY MOTTLED WITH LIGHT OLIVE-GRAY, OCCASIONALLY SPALLED, SEVERAL SEEPS

SILTSTONE, BROWN, WITH ABUNDANT HALITE, WASHED OUT APPROXIMATELY 1' INTO SHAFT WALL

HALITE WITH SOME ARGILLACEOUS MATERIAL, VERY COARSELY CRYSTALLINE, MASSIVE

CLAY, BROWN, WITH TRACE HALITE, MINOR SEEPS ALONG LOWER CONTACT

HALITE, BROWN, WITH SOME POLYHALITE, VERY COARSELY CRYSTALLINE, CONTAINS BROWN CLAY LENS 1-2" THICK AND 1 1/2' LONG

HALITE, COLORLESS, VERY COARSELY CRYSTALLINE

ANHYDRITE, LIGHT GRAY TO WHITE, FINE-GRAINED, POROUS, MASSIVE AT TOP, UPPER CONTACT OVERLAIN BY THIN (<1") SEAM OF SOFT, SATURATED CLAY

CLAY, BROWN, 2" SEAM SATURATED, VERY SOFT

HALITE, COLORLESS, CONTAINS BANDS (2 1/2"-7" THICK) OF COLORLESS HALITE ALTERNATING WITH BANDS (UP TO 1 1/2" THICK) OF DARK REDDISH-BROWN HALITE; BANDS ARE SLIGHTLY UNDULATORY.

HALITE WITH ABUNDANT ARGILLACEOUS MATERIAL, HALITE CONTENT VARIES FROM BLEBS OF PURE HALITE TO PREDOMINANTLY SILTSTONE, LOCALLY 50% DARK REDDISH-BROWN CLAYEY SILT.

HALITE, BROWN, OCCASIONAL IRREGULAR BLEBS AND LAYERS OF ANHYDRITE

SILTSTONE WITH ABUNDANT HALITE, SILTSTONE CLAYEY, DARK RED, COMPETENT; HALITE MEDIUM CRYSTALLINE (IN BOREHOLE B-25 THIS BED IS AN ARGILLACEOUS HALITE)

HALITE WITH SOME ARGILLACEOUS MATERIAL AS SILTY CLAY

SILTSTONE WITH TRACE HALITE, LIGHT PINKISH-GRAY, NUMEROUS FRACTURES, MOST FRACTURES HALITE FILLED

SILTSTONE, SANDY, MEDIUM REDDISH-ORANGE, VERY FINE-GRAINED, GRADES ABOVE AND BELOW TO HALITIC SILTSTONE, NUMEROUS FRACTURES CONTINUING FROM ABOVE UNIT

SILTSTONE WITH TRACE HALITE, NUMEROUS FRACTURES CONTINUING FROM ABOVE UNIT

SILTSTONE WITH SOME HALITE, HALITE IN LARGE (1/2"-1") CUBES AND BLEBS

HALITE WITH SOME ARGILLACEOUS MATERIAL, HALITE IS VERY COARSELY CRYSTALLINE (1" TO 2" CRYSTALS), CONTAINS IRREGULAR FRAGMENTS OF SILTSTONE UP TO 1.5' LONG

SILTSTONE WITH SOME HALITE, HALITE FINELY TO MEDIUM CRYSTALLINE

HALITE, BROWN, CONTAINS 1/4" THICK DISCONTINUOUS LAYERS OF CLAYEY SILTSTONE, COLOR OF BED BECOMES LIGHTER TOWARD BASE

CLAY, BROWN, 1" TO 3" SEAM, SILTY, CONTAINS THIN LAMINAE OF CRYSTALLINE HALITE, MINOR SEEPS

SILTSTONE WITH SOME HALITE, SOME CLAY, HALITE CONTENT INCREASES DOWNWARD TO TRANSITIONAL CONTACT WITH UNDERLYING HALITE

HALITE, WITH SOME ARGILLACEOUS MATERIAL, IRREGULAR BLEBS (1" TO 2" DIAMETER) OF CLAYEY SILTSTONE

HALITE, BROWN, CONTAINS LESS ARGILLACEOUS MATERIAL THAN ABOVE HALITE, MORE MASSIVE AND LIGHTER IN COLOR THAN ABOVE

HALITE WITH SOME ARGILLACEOUS MATERIAL SIMILAR TO ARGILLACEOUS HALITE AT 904' TO 908.5', HOWEVER 5" CONTAINS ARGILLACEOUS MATERIAL IN THIN DISCONTINUOUS BANDS

SILTSTONE WITH ABUNDANT HALITE

CLAY, BROWN, 3"-6" SEAM, SOFT

SILTSTONE WITH SOME HALITE, CONTAINS COARSELY CRYSTALLINE HALITE (UP TO 1 1/2" CRYSTALS)

HALITE WITH SOME ARGILLACEOUS MATERIAL, VERY COARSELY CRYSTALLINE

EXPLANATION

ROCK TYPE

SILTSTONE (See note 5) — HALITE (See note 5) — ANHYDRITE

CONTACTS

SHARP (Identifiable within 0.05 feet) — GRADATIONAL (Identifiable within 0.05 to 0.2 feet) — DIFFUSE (Identifiable within 0.2 to 0.5 feet)

F1 FRACTURE — EXS-5 ROCK SAMPLE LOCATION AND NUMBER

SEEP — CLAY LAYER (See note 5)

SPALLED AREA

GEOLOGIC UNIT SYMBOLS AND DESCRIPTIONS *

A — **ARGILLACEOUS** MATERIAL, GENERALLY FOUND AS AN INTERGRANULAR ACCESSORY CONSTITUENT, LIGHT GRAY (N7) TO MODERATE REDDISH-BROWN (10R 4/6), SLIGHTLY MOIST TO MOIST, TRACE TO SOME SILT.

AN — **ANHYDRITE**, LIGHT GRAY (N7) TO WHITE (N9), MODERATE ORANGE-PINK (10R 7/4) TO PALE REDDISH-BROWN (10R 5/4), FINELY CRYSTALLINE.

AC — **ANHYDRITE**, LIGHT GRAY (N7) TO GRAYISH-ORANGE (10YR 7/4) TO WHITE (N9), WITH SEVERAL SOFT 1/2- TO 1 1/2-INCH CLAY STRINGERS WITH TRACE OF SILT.

CB — **CLAY**, DARK REDDISH-BROWN (10R 3/4) TO MODERATE REDDISH-BROWN (10R 4/6) WITH TRACE TO SOME SILT, TRACE TO SOME HALITE.

HA** — **HALITE**, DARK REDDISH-BROWN (10R 3/4) TO MODERATE REDDISH-BROWN (10R 4/6) TO MODERATE REDDISH-ORANGE (10R 6/6), LOCALLY MEDIUM LIGHT GRAY (N7), MEDIUM TO COARSELY CRYSTALLINE, ARGILLACEOUS.

HB — **HALITE**, DARK REDDISH-BROWN (10R 3/4) TO MODERATE REDDISH-BROWN (10R 4/6), SLIGHTLY TRANSLUCENT, MEDIUM TO COARSELY CRYSTALLINE.

H — **HALITE**, COLORLESS (TRANSPARENT TO TRANSLUCENT) TO GRAYISH-ORANGE-PINK (5YR 7/2), MEDIUM TO COARSELY CRYSTALLINE, MAY BE BANDED.

SB — **SILTSTONE**, DARK REDDISH-BROWN (10R 3/4), TRACE TO NO HALITE, TRACE FINE-GRAINED SAND.

SG — **SILTSTONE**, LIGHT OLIVE-GRAY (5Y 6/1), TRACE FINE-GRAINED SAND, TRACE TO NO HALITE.

SH** — **SILTSTONE**, DARK REDDISH-BROWN (10R 3/4) TO MODERATE REDDISH-BROWN (10R 4/6), HALITIC, TRACE TO SOME CLAY, LOCALLY CONTAINS VERY FINE TO FINE-GRAINED SAND.

SSH — **SILTSTONE**, MODERATE REDDISH-ORANGE (10R 6/6), WITH VERY FINE-GRAINED SAND, TRACE HALITE; LOCALLY GRADES TO A VERY FINE TO FINE-GRAINED SANDSTONE, MODERATE REDDISH-BROWN (10R 4/6) TO MEDIUM LIGHT GRAY (N7), TRACE TO SOME SILT.

* SLIGHT VARIATIONS FROM THESE GENERAL DESCRIPTIONS MAY EXIST. THE EXCEPTIONS ARE NOTED IN THE REMARKS COLUMN.

** ESTIMATED CONTENT OF ACCESSORY CONSTITUENTS IS INDICATED BY A MODIFIER: T = TRACE
S = SOME
W = WITH OR ABUNDANT

SCALE
5 0 5 10 FT.

FRACTURE NOTES:

FRACTURES DESIGNATED F1 TO F9C REFER TO THOSE IN A SILTSTONE BED AT DEPTHS 842.5 TO 847 FEET. FRACTURES F10 TO F18 ARE IN A SILTSTONE BED AT DEPTHS 875 TO 880 FEET.

F1 OPEN TO 1/4-INCH WIDE ABOVE CONTACT, CLOSED BELOW CONTACT; VERY MINOR SEEPAGE.

F2 FILLED WITH WHITE PRECIPITATE (SALT?); 1/8-INCH WIDE IN UPPER EXTENT, CLOSED IN LOWER EXTENT.

F3 BIFURCATION FORMS POTENTIAL SPALL AREA.

F4 VERY MINOR SEEPAGE; OPEN.

F5 OXIDIZED MATERIAL IN FRACTURE BELOW CONTACT; 1/8-INCH MAXIMUM WIDTH.

F6 TRENDS N20°E; 1/4-INCH WIDE; OPEN.

F7 CLOSED ABOVE CONTACT, OPEN TO 1/4-INCH WIDE BELOW CONTACT.

F8 OPEN 1/16- TO 1/2-INCH WIDE ABOVE CONTACT, CLOSED BELOW CONTACT; PARTIALLY FILLED WITH SILT; MINOR SEEPAGE.

F9 1/8- TO 1/4-INCH WIDE.

F9a ESTIMATED STRIKE N60°W.

F9b OPEN 1/4-INCH WIDE.

F9c CLOSED TO OPEN 1/4-INCH WIDE.

F10 HALITE FILLED, STRIKE E-W.

F11 VERTICAL FRACTURE WITH MAXIMUM WIDTH OF 1 INCH; HALITE FILLED; MODERATE REDDISH-BROWN COLOR; ESTIMATED STRIKE N30°E; MATCHES WITH F15.

F12 FRACTURE PARTIALLY FILLED WITH HALITE; STRIKE N88°E; MATCHES WITH F17.

F13 NO SPECIFIC DATA.

F14 ESTIMATED STRIKE N60°W, DIPPING ±40°SW.

F15 POSSIBLY MATCHES F11?; STRIKE N30°E.

F16 VERTICAL FRACTURE 3/4-INCH WIDE; HALITE FILLED; PROBABLY MATCHES F18; STRIKE N11°E.

F17 VERTICAL FRACTURE 1/2-INCH WIDE; HALITE FILLED; MATCHES F12; STRIKE N88°E.

F18 ESTIMATED STRIKE N10 TO 20°E; FRACTURE F18 MATCHES F16; HALITE FILLED.

FIGURE 5
GEOLOGY OF THE KEY ZONE

EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

090B

DRAWN BY	MJG 1/7/83	CHECKED BY	MT 2/11/83	DRAWING NUMBER	NM78-648-EII
		APPROVED BY	L.J. 2-11-83		

NOTES:

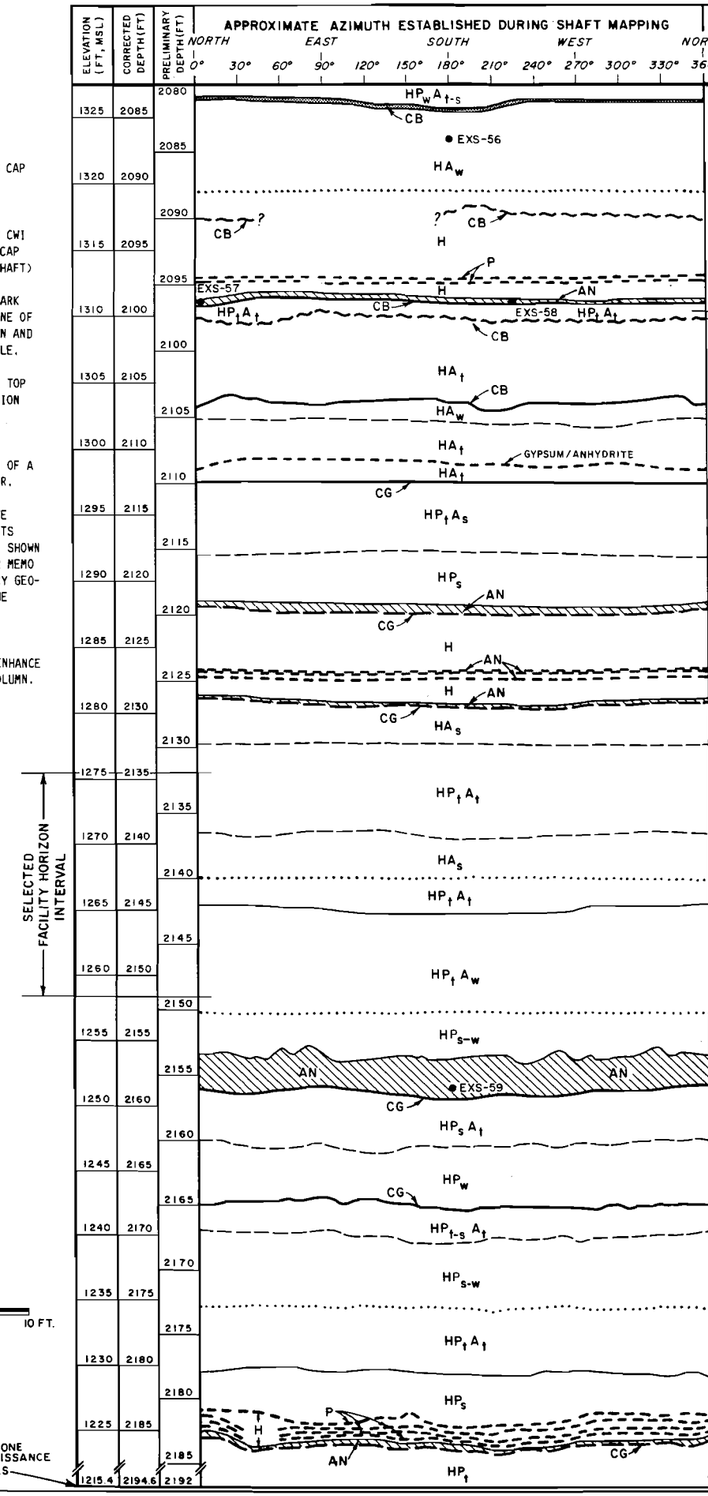
1) ELEVATIONS REFER TO CWI BENCHMARK NO. 82-D (BRASS CAP ON N.W. CORNER OF THE UNDERGROUND POWER CENTER FOUNDATION) AT ELEVATION 1259.59 WHICH WAS TIED TO CWI BENCHMARK NO. CW1 (BRASS CAP OUTSIDE THE EXPLORATORY SHAFT) AT ELEVATION 3410.080 ON DECEMBER 2, 1982. BENCHMARK NO. 82-D IS WITHIN THE ZONE OF DEFORMATION OF THE STATION AND CANNOT BE CONSIDERED STABLE.

2) DEPTHS ARE RELATED TO THE TOP OF FIRST BUNTON AT ELEVATION 3410.0 FT. MSL.

3) PRELIMINARY DEPTHS WERE CORRECTED BY THE ADDITION OF A +2.6 FT. CORRECTION FACTOR.

4) NO CHANGES IN THE RELATIVE POSITIONS OF THE ROCK UNITS HAVE BEEN MADE FROM THOSE SHOWN IN THE SEPTEMBER 21, 1982 MEMO DESCRIBING THE PRELIMINARY GEOLOGIC INVESTIGATION OF THE STATION ZONE.

5) STANDARD GEOLOGIC SYMBOL IS NOT USED IN ORDER TO ENHANCE THE CLARITY OF THE LOG COLUMN.



REMARKS

HALITE WITH ABUNDANT POLYHALITE, TRACE TO SOME ARGILLACEOUS MATERIAL
CLAY, BROWN, 1" TO 2" SEAM, WITH SOME HALITE

HALITE WITH ABUNDANT ARGILLACEOUS MATERIAL, CLAY CONTENT DECREASING TOWARDS BASE

HALITE, COLORLESS
CLAY, DISCONTINUOUS BREAK *

HALITE, COLORLESS

POLYHALITE, TWO THIN SEAMS APPROXIMATELY 6" APART
HALITE, COLORLESS
MB 138 ANHYDRITE, MEDIUM DARK GRAY, MICROCRYSTALLINE, FAINTLY BANDED, WITH 1/8 TO 1/4" THICK SEAMS OF CRYSTALLINE HALITE; BROWN CLAY SEAM, 1/2" TO 1 1/2" THICK, AT BASE
HALITE WITH TRACE POLYHALITE AND ARGILLACEOUS MATERIAL
CLAY, DARK REDDISH-BROWN, DISCONTINUOUS PARTING, 1/8" THICK

HALITE WITH TRACE ARGILLACEOUS MATERIAL; LOCALLY ABUNDANT IN DISCONTINUOUS PARTINGS

CLAY, REDDISH-BROWN, 1/8" TO 1/2" THICK
HALITE WITH ABUNDANT ARGILLACEOUS MATERIAL IN NUMEROUS GRAY CLAY BLEBS

HALITE WITH TRACE ARGILLACEOUS MATERIAL AND A THIN DISCONTINUOUS GYPSUM/ANHYDRITE SEAM,

CLAY, GRAY TO GRAYISH-RED TO LIGHT BROWN, 1" TO 2 1/2" THICK, WITH IRREGULAR LENSES OF ANHYDRITE AND HALITE ALONG UPPER SURFACE

HALITE WITH TRACE POLYHALITE, SOME ARGILLACEOUS MATERIAL

HALITE WITH SOME INTERGRANULAR POLYHALITE IN IRREGULAR ELONGATED BLEBS, 1/4" TO 1 1/2" LONG AND 1/16 TO 1/8" THICK
ANHYDRITE "A"
ANHYDRITE, WHITE TO VERY LIGHT GRAY, 9±" THICK; WITH 1/8±" THICK SOFT GRAY CLAY PARTING AT BASE

HALITE, COLORLESS, MOTTLED WITH 1/8±" THICK, GENERALLY DISCONTINUOUS ANHYDRITE PARTINGS; PERSISTENT PARTINGS SHOWN

ANHYDRITE "B"
ANHYDRITE, WHITE TO VERY LIGHT GRAY, 3±" THICK, CONTAINS IRREGULAR BLEBS OF HALITE; WITH 1/8±" (LOCALLY THICKENS TO 1") SOFT TO MEDIUM GRAY CLAY PARTING AT BASE
HALITE, MOTTLED WITH SOME ARGILLACEOUS MATERIAL, OCCASIONALLY WITH REDDISH-BROWN CLAY STRINGERS

HALITE WITH TRACE POLYHALITE, TRACE ARGILLACEOUS MATERIAL AS REDDISH-BROWN CLAY; ARGILLACEOUS CONTENT (BLEBS) INCREASES IN LOWER TWO FEET

HALITE, SLIGHTLY BANDED, WITH SOME ARGILLACEOUS MATERIAL

HALITE, COLORLESS, TRACE POLYHALITE AND TRACE ARGILLACEOUS MATERIAL

HALITE WITH TRACE POLYHALITE, ABUNDANT ARGILLACEOUS MATERIAL AS GRAY CLAY BLEBS, DECREASING ARGILLACEOUS MATERIAL TOWARDS BASE

HALITE WITH SOME POLYHALITE, POLYHALITE CONTENT INCREASING TOWARDS BASE

MB 139 ANHYDRITE, LIGHT GRAY, MICROCRYSTALLINE; WITH DISCONTINUOUS 1/4 TO 1/2" THICK POLYHALITE SEAM AT TOP; ANHYDRITE CONTAINS FLOW STRUCTURES WITH HALITE PSEUDOMORPH CRYSTALS AND BLEBS OF POLYHALITE NEAR TOP, LOCALLY MASSIVE TO LAYERED POLYHALITE BELOW FLOW STRUCTURES; CONTINUOUS 1/8±" (LOCALLY THICKENS TO 1/2" AND 3/4") SOFT GRAY CLAY SEAM AT BASE

HALITE WITH SOME POLYHALITE IN DISCONTINUOUS 1/4" TO 1" THICK BANDS AND IN IRREGULAR BLEBS; TRACE OF GRAY CLAY IN THIN IRREGULAR PARTING

HALITE WITH ABUNDANT POLYHALITE; 3" TO 6" THICK LAYER OF CLEAR HALITE AT THE TOP; INCREASING POLYHALITE CONTENT WITH DEPTH

CLAY, LIGHT GRAY, 1/8" TO 1/2" THICK SEAM, SOFT
HALITE WITH TRACE TO SOME POLYHALITE, TRACE ARGILLACEOUS MATERIAL

HALITE WITH SOME TO ABUNDANT INTERGRANULAR POLYHALITE

HALITE, COLORLESS, WITH TRACE POLYHALITE; TRACE OF ARGILLACEOUS MATERIAL IN 1/8" TO 1/2" THICK IRREGULAR DISCONTINUOUS PARTINGS

HALITE, COARSELY CRYSTALLINE, WITH POLYHALITE STRINGERS DISPERSED THROUGHOUT

HALITE, COLORLESS, WITH FOUR POLYHALITE BANDS 1/4" TO 3" THICK SPACED AT 2" TO 3" INTERVALS
ANHYDRITE, LIGHT GRAY, FINELY CRYSTALLINE, WITH GRAY CLAY PARTING AT BASE

HALITE WITH TRACE POLYHALITE

EXPLANATION

ROCK TYPE

HALITE — See note 5
ANHYDRITE

LAMINAR FEATURES

MISCELLANEOUS (AS LABELED)
CLAY: SEAM >1/4" thick; PARTING Between 1/4" 1/16" thick; BREAK <1/16" thick; DISCONTINUOUS PARTINGS AND BREAKS

CONTACTS

SHARP (Identifiable within 0.05 feet)
GRADATIONAL (Identifiable within 0.05 to 0.2 feet)
DIFFUSE (Identifiable within 0.2 to 0.5 feet)

EXS-56 ROCK SAMPLE LOCATION AND NUMBER
CLAY LAYER — See note 5

GEOLOGIC UNIT SYMBOLS AND DESCRIPTIONS*

A** **ARGILLACEOUS** MATERIAL, GENERALLY FOUND AS AN INTERGRANULAR ACCESSORY CONSTITUENT, LIGHT GRAY (N7) TO MODERATE REDDISH-BROWN (10R 4/6), SLIGHTLY MOIST TO MOIST, TRACE TO SOME SILT.

AN **ANHYDRITE**, MEDIUM DARK GRAY (N4) TO LIGHT GRAY (N7) TO WHITE (N9), MODERATE ORANGE-PINK (10R 7/4) TO PALE REDDISH-BROWN (10R 5/4), FINELY CRYSTALLINE TO MICROCRYSTALLINE.

CB **CLAY**, DARK REDDISH-BROWN (10R 3/4), TRACE TO SOME SILT, TRACE TO SOME HALITE.

CG **CLAY**, MEDIUM LIGHT GRAY (N6) TO MEDIUM DARK GRAY (N4) TO LIGHT OLIVE-GRAY (5Y 6/1), TRACE TO SOME SILT, TRACE TO SOME HALITE.

HA** **HALITE**, DARK REDDISH-BROWN (10R 3/4) TO MODERATE REDDISH-BROWN (10R 4/6), MEDIUM TO COARSELY CRYSTALLINE, ARGILLACEOUS.

H **HALITE**, COLORLESS (TRANSPARENT TO TRANSLUCENT) TO GRAYISH-ORANGE-PINK (5YR 7/2), MEDIUM TO COARSELY CRYSTALLINE, MAY BE BANDED.

HP** **HALITE**, TRANSLUCENT TO MODERATE REDDISH-ORANGE (10R 6/6) TO MODERATE REDDISH-BROWN (10R 4/6), POLYHALITIC.

HPA** **HALITE**, MODERATE REDDISH-ORANGE (10R 6/6) TO MODERATE REDDISH-BROWN (10R 4/6), POLYHALITIC AND ARGILLACEOUS.

P **POLYHALITE**, MODERATE REDDISH-BROWN (10R 4/6) TO MODERATE REDDISH-ORANGE (10R 6/6), FINELY CRYSTALLINE TO MICROCRYSTALLINE.

* SLIGHT VARIATIONS FROM THESE GENERAL DESCRIPTIONS MAY EXIST. THE EXCEPTIONS ARE NOTED IN THE REMARKS COLUMN.

** ESTIMATED CONTENT OF ACCESSORY CONSTITUENTS IS INDICATED BY A MODIFIER: T = TRACE; S = SOME; W = WITH OR ABUNDANT

FIGURE 6

GEOLOGY OF THE STATION ZONE

EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

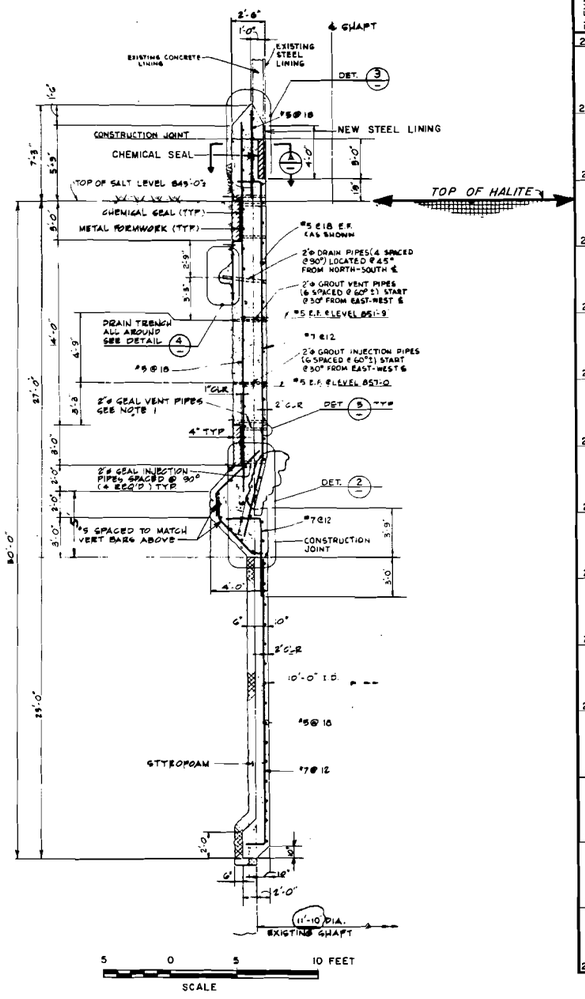
WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

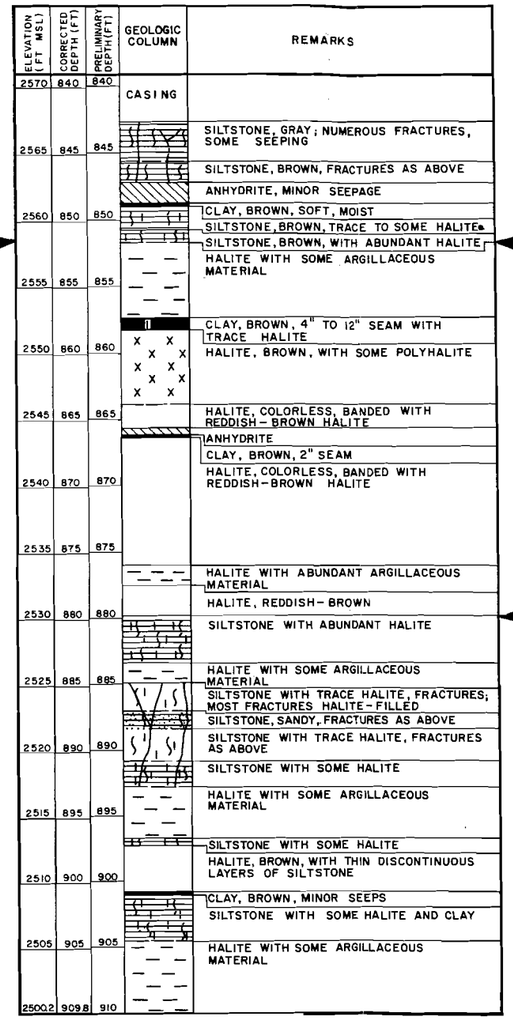
090B

DRAWN BY	EF	2/16/82	CHECKED BY	MC	3/12/82
			APPROVED BY	LJ	3-18-83

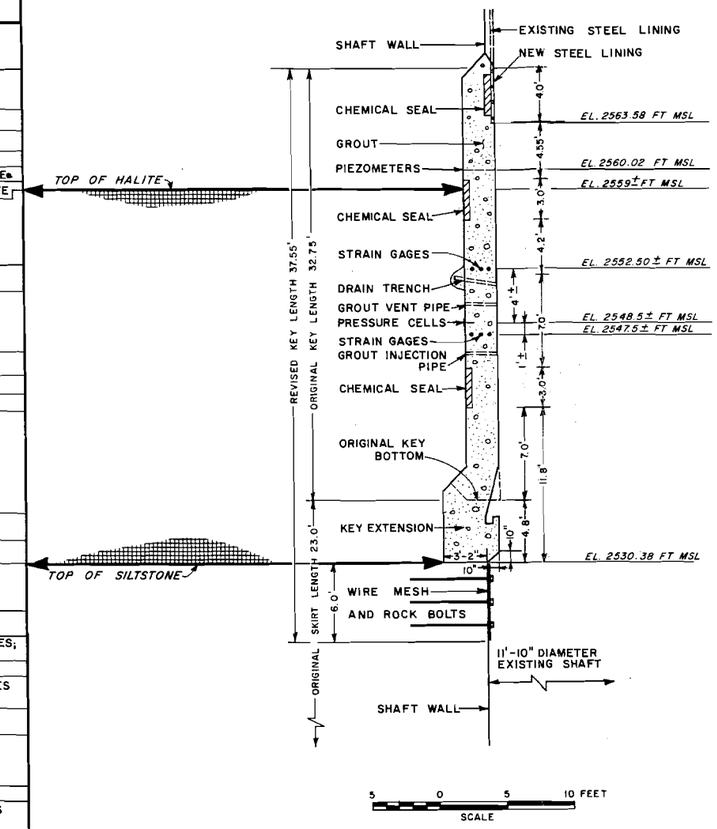
DRAWING NUMBER NM78-648-E12



A. ORIGINAL SHAFT KEY DESIGN
(AS PER BECHTEL DRAWING NO. 37-R-012/REV. 6)



B. GEOLOGIC COLUMN
(AS PER FIGURE 4-1)



C. REVISED LOCATION OF SHAFT KEY COMPONENTS
(TO ACCOMMODATE GEOLOGICAL CONDITIONS ENCOUNTERED)

NOTES:

1) ESTIMATE OF "TOP OF SALT LEVEL" IN THE ORIGINAL DESIGN WAS BASED ON THE GEOLOGY OF ERDA-9.

2) DEPTHS IN THE GEOLOGIC COLUMN REFER TO ZERO DATUM POINT (TOP OF FIRST BUNTON) AT ELEVATION OF 3410.00 FT MSL.

3) ELEVATIONS ARE BASED ON EDM SURVEYING BY CWI ON DECEMBER 2, 1982, WHICH ESTABLISHED THE ELEVATION OF THE BOTTOM OF THE CONCRETE OF THE KEY AT 2530.38 FT MSL AND WAS TIED TO CWI BENCHMARK NO. CW-1 AT ELEVATION 3410.080 FT MSL.

4) FOR EXPLANATION OF GEOLOGIC SYMBOLS, SEE FIGURE 4-1.

5) SEE FIGURE 5 FOR DETAILED CIRCUMFERENTIAL GEOLOGIC LOG OF THE KEY ZONE.

FIGURE 7

ORIGINAL SHAFT KEY DESIGN AND REVISED LOCATION OF SHAFT KEY COMPONENTS

EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

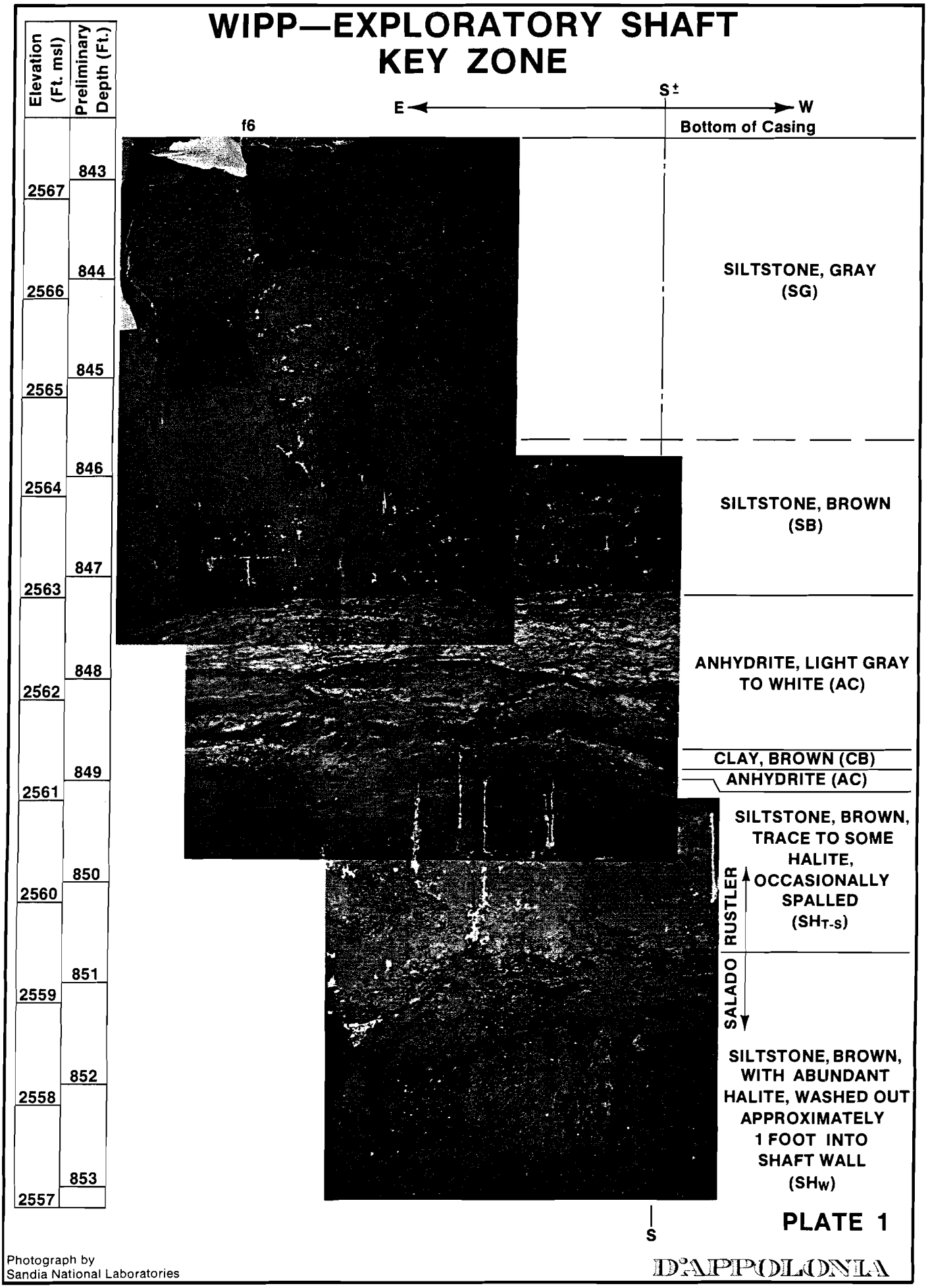
D'APPOLONIA

LIST OF PLATES WITH SELECTED PHOTOGRAPHS[1]

PLATE NO.	DEPTH (FT)[2] FROM-TO	ELEVATION (FT MSL)[3] FROM-TO	DESCRIPTION (ABBREVIATED)	PHOTO NOS.[4]	DATE 1982
1	842-853	2568-2557	Key Zone--Bottom of Casing to Rustler/ Salado Contact	11,12,29	3-30
2	884-892	2526-2518	Key Zone--Massive Sandy Siltstone	1,2	3-30
3	2118-2125	1289-1283	Anhydrite "a"	B-7 to 9	5-02
4	2125-2132	1283-1276	Anhydrite "b"	B-10 to 12	5-02
5	2132-2138	1276-1269	Halite	B-13 to 15	5-02
6	2138-2145	1269-1263	Halite	A-1 to 3	5-02
7	2145-2152	1263-1256	Halite	A-4 to 7	5-02
8	2152-2159	1256-1249	MB 139	A-7 to 11	5-02
9	2159-2166	1249-1241	Halite	A-11 to 14	5-02
10	2155±	1252±	Detail of MB 139	F-4	5-02
11A	2118-2127	1289-1280	Anhydrite "b" at the brow and anhydrite "a" above; looking approximately south and up 45±° into the exploratory shaft from the station floor	LJ-F2/6	5-25
11B	2127-2149	1280-1258	Banded halite within the facility interval and anhydrite "b" at the shaft brow; looking approximately north-northeast	LJ-F2/0	5-25

(1) Photographs by F. Hensley, Sandia National Laboratories; for more data and complete list of photographs from mapping activities, see Appendix D.
(2) Depths refer to "Preliminary Depths" corresponding to depths shown on the photographs themselves.
(3) Elevations have been corrected according to Table 3.
(4) Photo numbers refer to those used in Appendix D, except on Plate 11 which refers to photo numbers used in TSC files.

WIPP—EXPLORATORY SHAFT KEY ZONE



Photograph by
Sandia National Laboratories

WIPP—EXPLORATORY SHAFT KEY ZONE

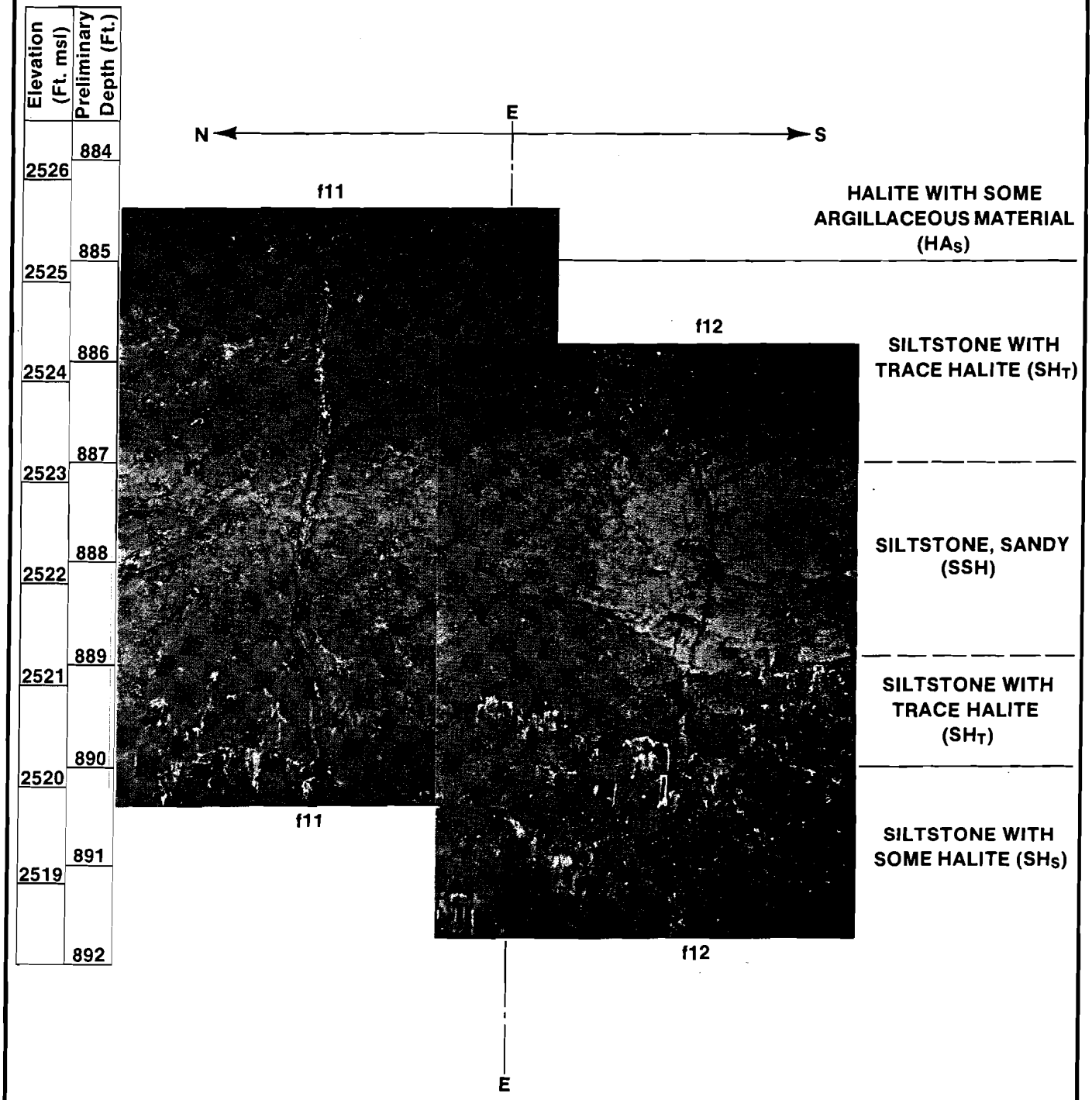


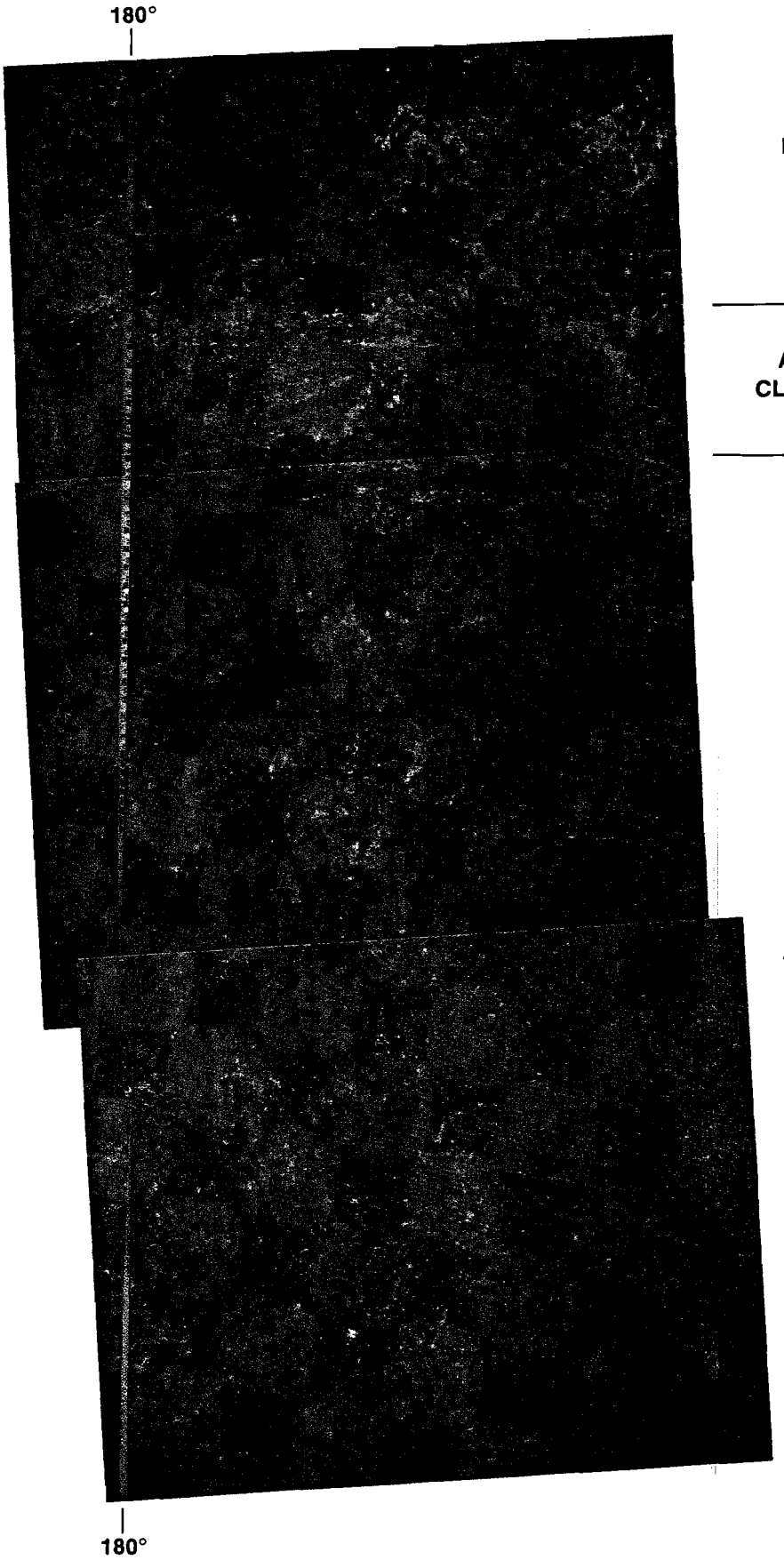
PLATE 2

Photograph by
Sandia National Laboratories

D'APPOLONIA

WIPP—EXPLORATORY SHAFT STATION ZONE

Elevation (Ft. msl)	Preliminary Depth (Ft.)
	2118
1289	
	2119
1288	
	2120
1287	
	2121
1286	
	2122
1285	
	2123
1284	
	2124
1283	
	2125



HALITE WITH SOME POLYHALITE (HP_S)

ANHYDRITE "a" (AC) CLAY PARTING AT BASE

HALITE, COLORLESS, MOTTLED WITH THIN ANHYDRITE PARTINGS (H)

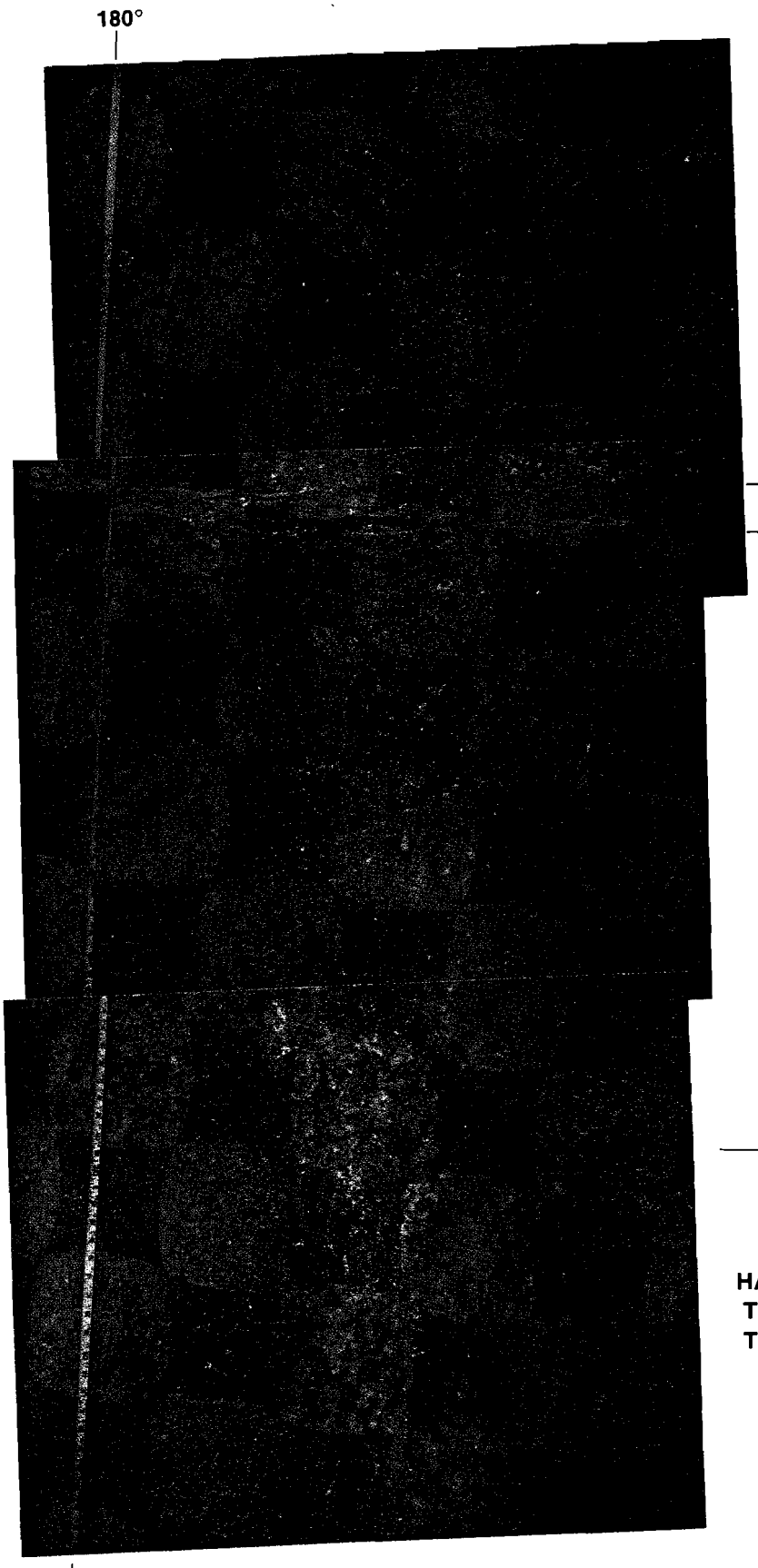
Photograph by Sandia National Laboratories

PLATE 3

D'APPOLONIA

WIPP—EXPLORATORY SHAFT STATION ZONE

Elevation (Ft. msl)	Preliminary Depth (Ft.)
	2125
1282	
	2126
1281	
	2127
1280	
	2128
1279	
	2129
1278	
	2130
1277	
	2131
1276	
	2132



HALITE, COLORLESS, MOTTLED WITH THIN ANHYDRITE PARTINGS (H)

ANHYDRITE "b" (AC) CLAY PARTING AT BASE

HALITE WITH SOME ARGILLACEOUS MATERIAL, RED-BROWN CLAY STRINGERS (HA_S)

HALITE, COLORLESS, WITH TRACE POLYHALITE AND TRACE REDDISH-BROWN CLAY (HP_TA_T)

Photograph by Sandia National Laboratories

PLATE 4

D'APPOLONIA

WIPP—EXPLORATORY SHAFT STATION ZONE

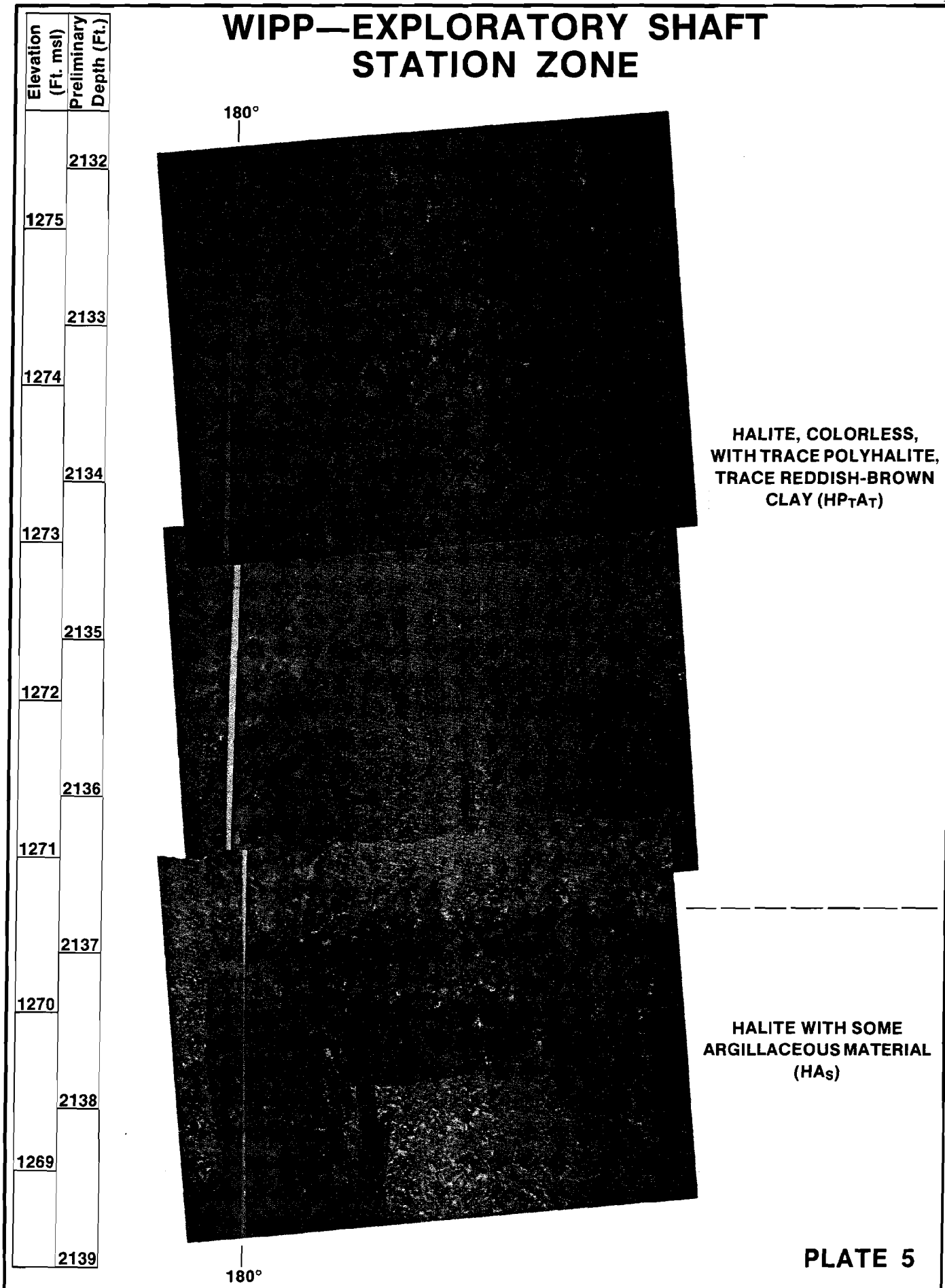


PLATE 5

Photograph by
Sandia National Laboratories

D'APPOLONIA

WIPP—EXPLORATORY SHAFT STATION ZONE

Elevation (Ft. msl)	Preliminary Depth (Ft.)
	2138
1269	
	2139
1268	
	2140
1267	
	2141
1266	
	2142
1265	
	2143
1264	
	2144
1263	
	2145

HALITE WITH SOME ARGILLACEOUS MATERIAL (HA_S)

HALITE, COLORLESS, WITH TRACE POLYHALITE AND ARGILLACEOUS MATERIAL (HP_TA_T)

HALITE WITH ABUNDANT ARGILLACEOUS MATERIAL, TRACE POLYHALITE, LOCAL CLAY BLEBS AND STRINGERS (HP_TA_W)

PLATE 6

Photograph by Sandia National Laboratories

D'APPOLONIA

WIPP—EXPLORATORY SHAFT STATION ZONE

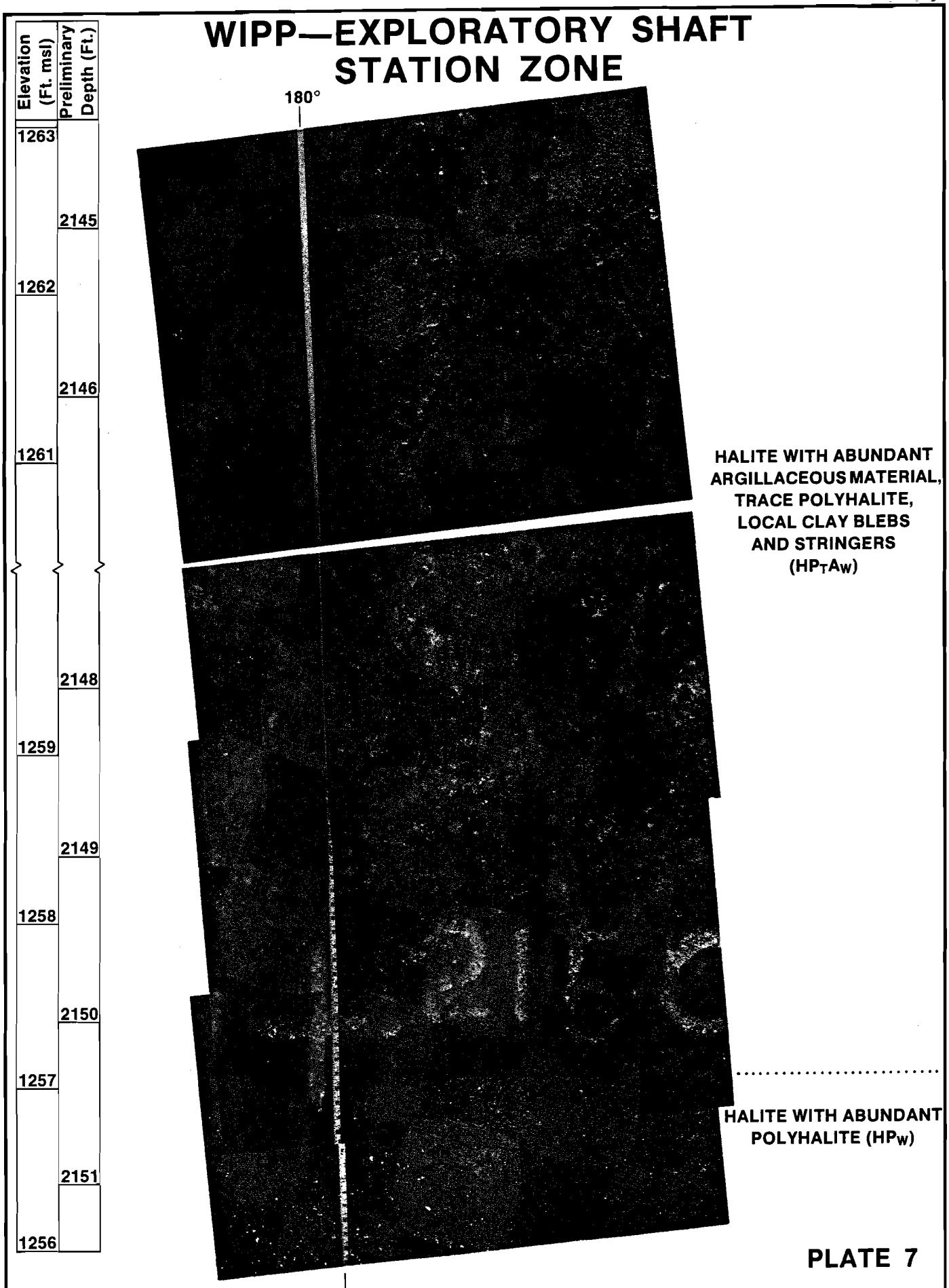


PLATE 7

Photograph by Sandia National Laboratories

D'APPOLONIA

WIPP—EXPLORATORY SHAFT STATION ZONE

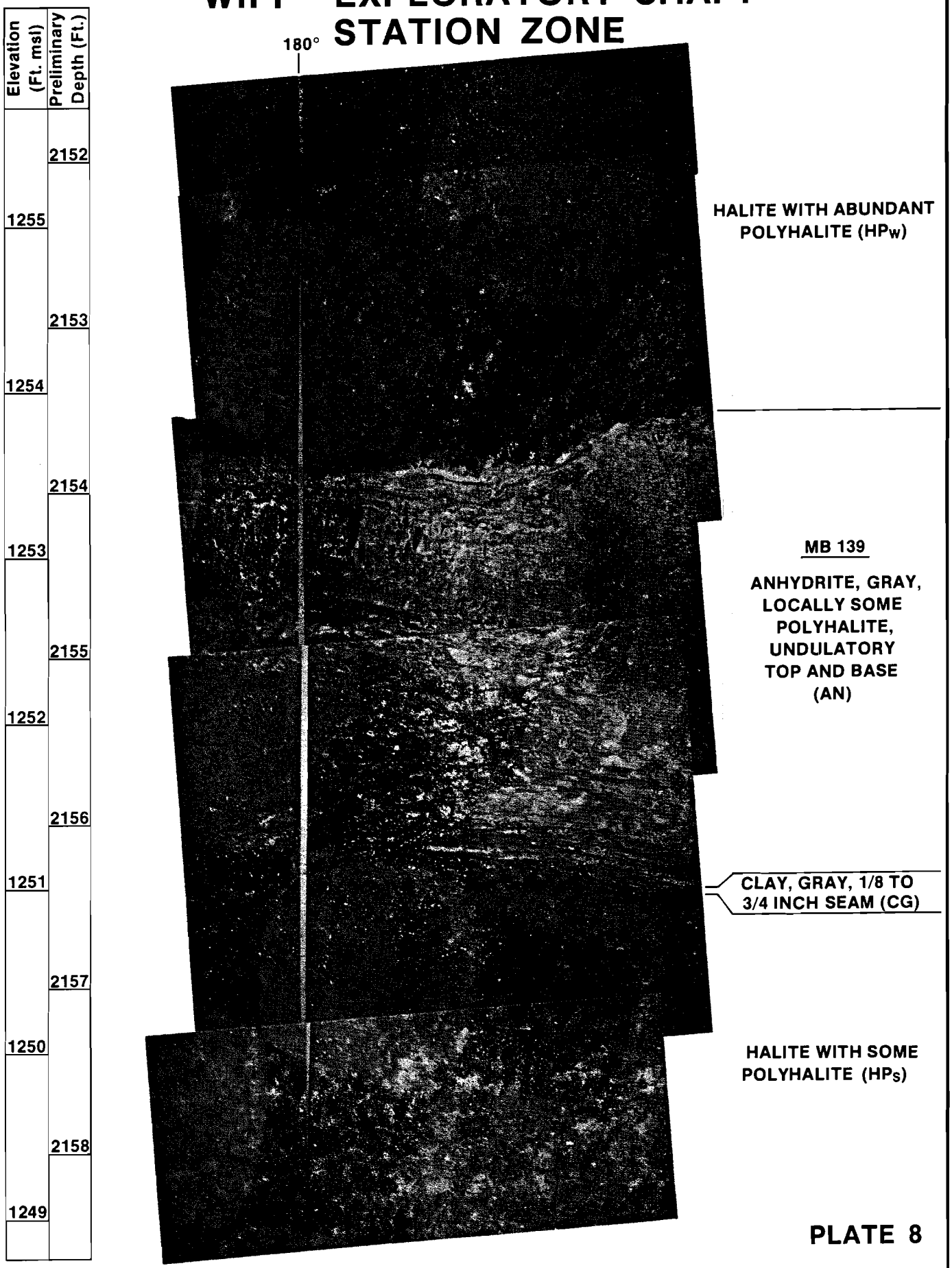
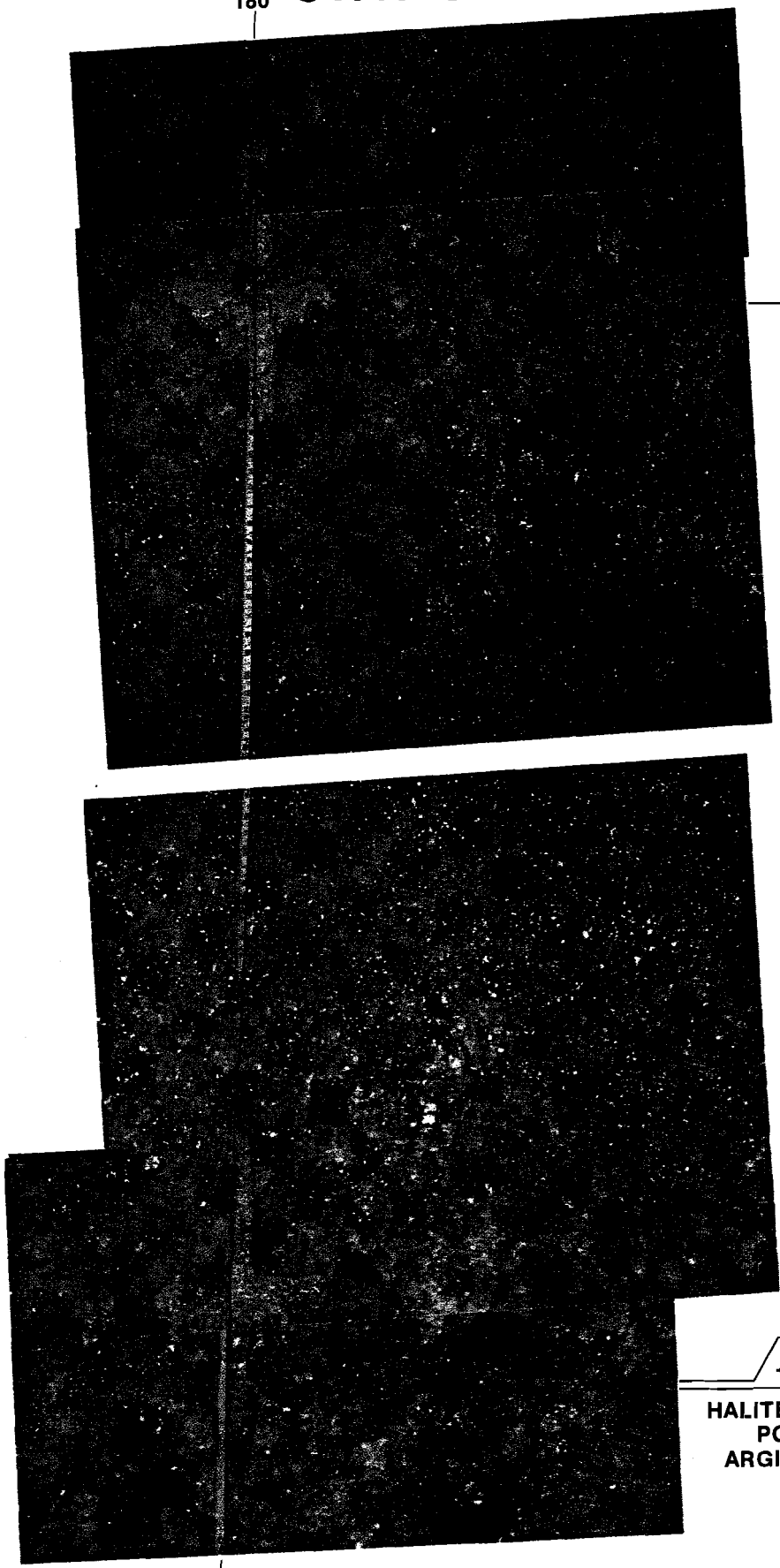


PLATE 8

Photograph by
Sandia National Laboratories

WIPP—EXPLORATORY SHAFT STATION ZONE

Elevation (Ft. msl)	Preliminary Depth (Ft.)
	2159
1248	
	2160
1247	
	2161
1246	
	2162
	2163
1244	
	2164
1243	
	2165
1242	
	2166
1241	



HALITE WITH SOME POLYHALITE (HP_S)

HALITE WITH ABUNDANT POLYHALITE (HP_W)

CLAY, GRAY, 1/8 TO 1/2 INCH PARTING (CG)

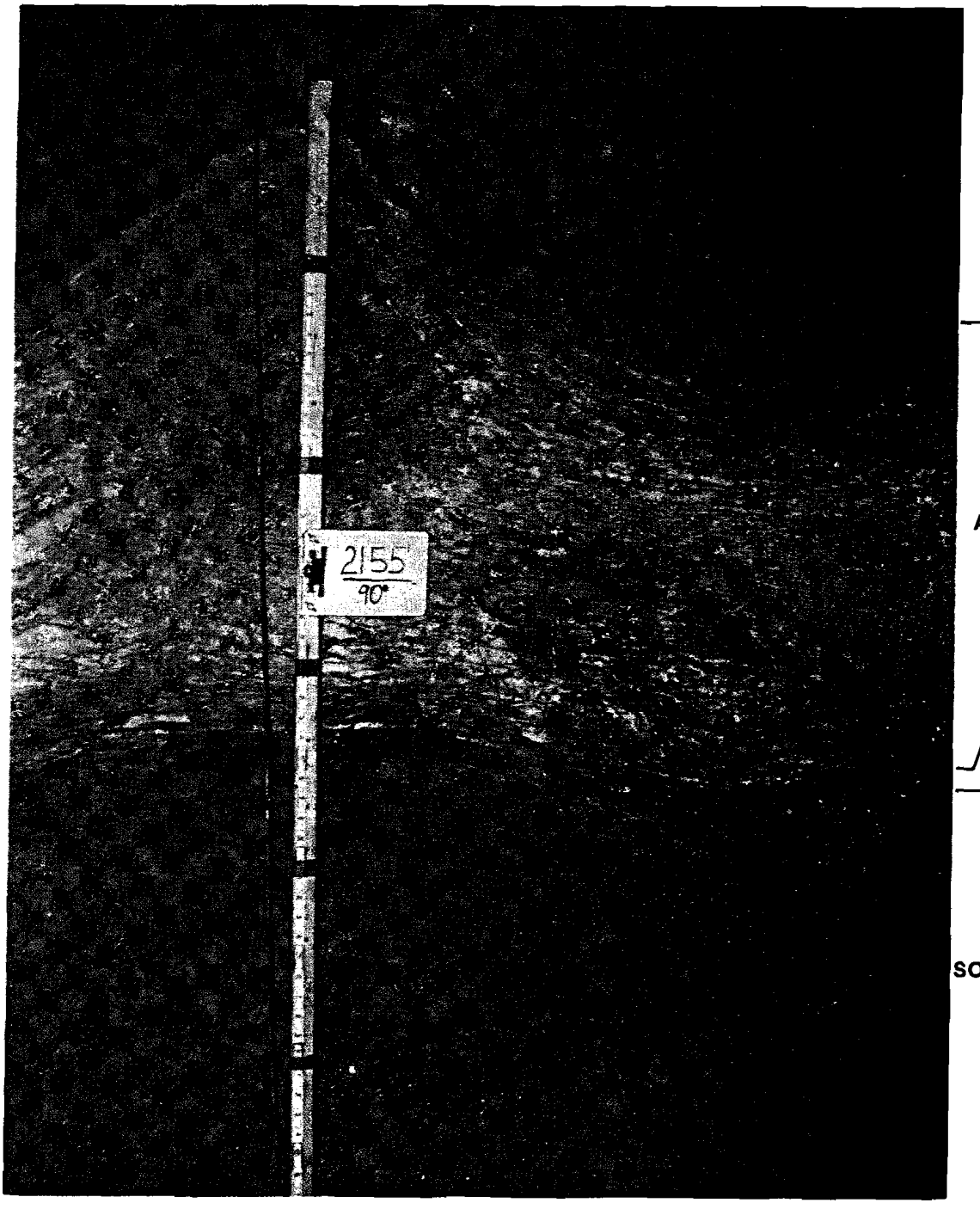
HALITE WITH TRACE TO SOME POLYHALITE, TRACE ARGILLACEOUS MATERIAL ($HP_{T\text{-}S}A_T$)

Photograph by Sandia National Laboratories

PLATE 9

D'APPOLONIA

WIPP—EXPLORATORY SHAFT STATION ZONE



HALITE WITH ABUNDANT POLYHALITE (HP_W)

MB 139

ANHYDRITE (AN)

CLAY, GRAY, 1/8 TO 3/4 INCH SEAM (CG)

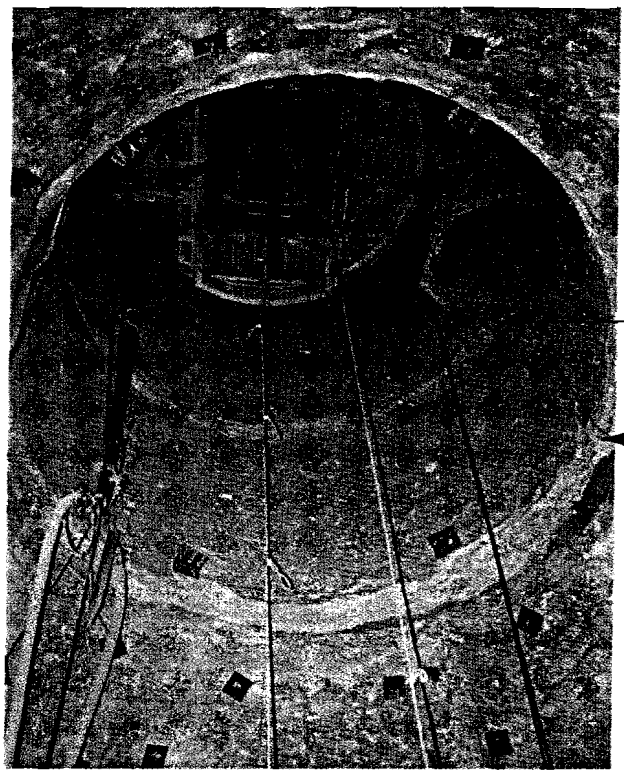
HALITE WITH SOME POLYHALITE (HP_S)

PLATE 10

Photograph by Sandia National Laboratories

D'APPOLONIA

WIPP—EXPLORATORY SHAFT STATION ZONE



ANHYDRITE "a" WITHIN THE SHAFT

ANHYDRITE "b" AT THE BROW OF THE SHAFT

PLATE 11A
(LOOKING SOUTH)

PLATE 11B
(LOOKING NORTH-NORTHEAST)

ANHYDRITE "b" AT THE BROW OF THE SHAFT

BANDED HALITE WITH TRACE POLYHALITE AND TRACE CLAY WITHIN THE FACILITY INTERVAL

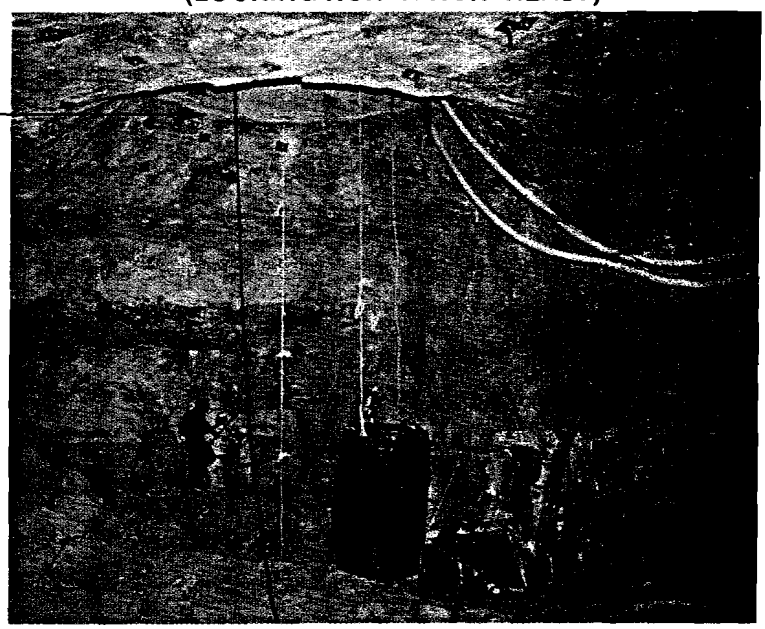


PLATE 11

Photograph by
Sandia National Laboratories

D'APPOLONIA

APPENDIX A

MAPPING PROCEDURES
AND
GEOLOGIC INVESTIGATION OF SHAFT KEY AREA/ZONE

APPENDIX A

MAPPING PROCEDURES AND GEOLOGIC INVESTIGATION OF SHAFT KEY AREA/ZONE

TABLE OF CONTENTS

APPENDIX NO.	TITLE
A-1	Procedure for Geologic Mapping - (Appendix A of the Site Validation Field Program Plan)
A-2	Geologic Investigation of Shaft Key Area/Zone - (Appendix D of the Site Validation Field Program Plan)
A-3	Galloway

APPENDIX A-1
PROCEDURE FOR GEOLOGIC MAPPING

EXCERPT (APPENDIX A)[1] FROM THE
SITE VALIDATION FIELD PROGRAM PLAN
Waste Isolation Pilot Plant (WIPP) Project
Southeastern New Mexico

Revision 1.2
January 3, 1983

(1) Only minor changes were made in revision 1.2 in comparison with the original which was dated April 28, 1982

APPENDIX A
PROCEDURE FOR GEOLOGIC MAPPING

A.1.0 PURPOSE

The following procedure is designed to provide for consistency and accuracy during geologic mapping of the underground excavations at WIPP. The geologic logs or maps will provide a detailed record of geologic conditions in the underground excavations and will eventually become part of the official WIPP files. The logs will also be important in evaluation of the subsurface geology for use in selecting final geomechanical instrument locations, making modifications in the preliminary design of the shaft key, and for selecting the final facility horizon depth. The type and form of any final geologic map to be developed from this activity will be established by the requirements of the project.

A.2.0 MAPPING OF THE EXCAVATIONS

The following guidelines shall be used in conjunction with the geologic mapping activities.

Wall Preparation

The walls of the openings should be relatively clean and free of debris that may interfere with visual observations of the wall rock. If the geology is obscured by debris, the wall shall be appropriately cleaned with brushes, brooms, scrapers, air hose, or other appropriate means.

Personnel

The logging will be accomplished by two engineering geologists or geologists, familiar with underground mapping, working together as a team. Two individuals are needed for maximum mapping efficiency and as a check on one another to ensure that all pertinent geologic features are recognized. It would be the responsibility of one individual to measure the geologic features with respect to a specific reference datum and the other to record the information on the appropriate log sheet. Upon

completion of a set of logs for a section of the underground excavation, the logs will be reviewed by the TSC field supervisor.

Geologic Logs

The completed logs will graphically represent the wall rock geology. The geology will be recorded on standardized, preprinted log sheets by sketching to scale all the visible traces formed by geologic features exposed at the excavation surfaces and by describing the lithology of the rock and any pertinent geologic features. The location of any samples together with an identification key or sample number shall be appropriately noted on the logs. Two basic log sheets will be used depending on the opening configuration as described below.

- Shafts - The entire circumference of the wall shall be represented on the log sheet as a cylinder rolled out to planar form. However, in the area of the exploratory shaft from the bottom of the shaft key to the shaft station, the map coverage may consist of a strip log or a vertical profile of the exposed stratigraphy depending on the amount of time available for mapping and the complexity of the geology. The vertical component of the log is referenced to survey stations established along the length of the shaft, while the horizontal component corresponds to the circumference of the shaft and is referenced to azimuthal coordinates as well as circumferential length. Sample logs are shown in Figures A-1 and A-2.

- Drifts and Test Panels - The standardized log sheet for the underground drifts and storage test panels will represent the surface of one wall. At roughly 300 foot intervals along each drift, an approximately 3 to 5 foot wide band depicting both ribs and the back will be mapped and represented on the log in a "folded out" planar view. An example of the log to be used in these sections is shown in Figure A-3. A detailed geologic section at an established elevation will be prepared.

Logging Scale and Accuracy

The geologic mapping will be performed at a scale of 1 inch equals 5 feet horizontally and vertically in areas requiring detailed coverage. The scale of mapping will be selected based on the complexity of the geology and at the discretion of the TSC field supervisor. In less critical areas, 1 inch equals 10 feet (or more) may be used. Detailed mapping is required in the following areas:

- shaft key - bottom of liner (± 840 ft) to 900-foot depth
- exploratory shaft - approximately 2100- to 2200-foot depth
- underground drifts and storage test panels

Portions of the exploratory shaft not included above and the ventilation shaft (above the salt) may be mapped at a scale of 1 inch equals 10 feet.

Geologic features, such as bedding planes, joints, fractures, and other measurable features, should be measured to the nearest 0.1 foot in areas where desirable and feasible. Otherwise features could be measured to the nearest 0.5 foot (or more).

Mapping Symbols and Notations

Symbols and notations to be used during mapping of the underground excavations are given in Figure A-4.

Lithologic Descriptions

The physical and lithological descriptions of each major rock type shall be described on the logs. The lithologic descriptions should include, as appropriate, the following in the order shown:

> Rock type, color, grain/crystal size, minor constituents, bedding, hardness, cement/matrix, friability, structural features, weathering.

The length and content of the description will vary depending on the rock type being described. In clastic sediments, it may be appropriate to note all of the characteristics listed above. For chemical precipitate rocks such as halite, the description may be somewhat shorter and may only include rock type, color, grain size, and minor constituents.

The physical condition of the walls shall also be recorded on the logs. This includes such items as the location and character of vugs, washout areas, and spalling of the wall rock.

For uniformity, the lithologic descriptions are to be based on:

- Color

  Wet color of the wall rock shall be based on the Geological Society of America color chart.

- Grain Size

  The rock types in the Salado Formation will consist primarily of halite with lesser amounts of anhydrite and polyhalite. In order to provide for a uniform classification of crystallinity, the following convention will be used:

coarse-crystalline	-	greater than 5 mm
medium-crystalline	-	1-5 mm
fine-crystalline	-	less than 1 mm

(continued on next page)

Grain size descriptions for clastic sediments, primarily those overlying the salt beds, shall be in terms of the Wentworth Scale which follows:

Particle Diameter(mm)	Individual Particles	Consolidated Rock
256 or more	Boulder	Boulder conglomerate
64-256	Cobble	Cobble conglomerate
4-64	Pebble	Pebble conglomerate
2-4	Granule	Granule conglomerate
1-2	Very coarse sand	Very coarse sandstone
.5-1	Coarse sand	Coarse sandstone
.25-.5	Medium sand	Medium sandstone
.125-.25	Fine sand	Fine sandstone
.0625-.125	Very fine sand	Very fine sandstone
.004-.0625	Silt	Siltstone
.004 or less	Clay	Claystone or shale

- Bedding

Scale		Classification
		Very thick bedded or massive
3.3 ft.	1 m	----------
		Thick bedded
1 ft.	30 cm	----------
		Medium bedded
4 in.	10 cm	----------
		Thin bedded
1 in.	3 cm	----------
		Very thin bedded
2/5 in.	1 cm	----------
		Laminated
1/8 in.	3 mm	----------
		Thinly laminated
1/32 in.	1 mm	----------
		Micro laminated

- **Hardness**

Descriptive Terms	Defining Characteristics
Very soft	Crushes under pressure of fingers and/or thumb.
Soft	Crushes under pressure of pressed hammer.
Medium Hard	Breaks easily under single hammer blow, but with crumbly edges.
Hard	Breaks under one or two strong hammer blows, but with resistant sharp edges.
Very hard	Breaks under several strong hammer blows, but with very resistant sharp edges and possibly conchoidal fractures.

- **Fractures**

In addition to the fracture and joint spacing defined below, the openness, filling material, and surface roughness should be indicated, as appropriate.

Descriptive Terms	Fracture Spacing
Very broken	Less than 1 in.
Broken	1 in. to 3 in.
Slightly broken	3 in. to 6 in.
Massive/Unbroken	6 in. and greater

- **Rock Weathering**

Fresh	- Rock fresh, crystals bright, few joints, may show slight staining. Rock rings under hammer if crystalline.
Very Slight	- Rock generally fresh, joints stained, some joints may show clay if open, crystals in broken face show bright.

Slight	- Rock generally fresh, joints stained and discoloration extends into rock up to 1 in. Open joints contain clay.
Moderate	- Significant portions of rock show discoloration and weathering effects. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately Severe	- All rock except quartz discolored or stained. Rock shows severe loss of strength and can be excavated with geologist's pick. Rock has a dull sound when struck.
Severe	- All rock except quartz discolored or stained. Rock "fabric" clear and evident but reduced in strength to strong soil. Some fragments of strong rock usually left.
Very Severe	- All rock except quartz discolored or stained. Rock "fabric" discernible but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	- Rock reduced to "soil." Rock "fabric" not discernible or discernible only in small scattered locations. Quartz may be present as dikes or stringers.

Steps in Logging

1. Clean section of wall to be mapped.

2. Establish vertical and horizontal datum in wall of excavation.

3. Plot datum and reference stations on log. Measure and plot surface area of opening on the log.

4. Inspect geology and establish geologic features to be measured and described.

5. Measure and plot position of geologic features with respect to datum.

6. Describe lithology, physical condition, and attitude of the geologic units on the log. Record the condition of the surface of the wall.

7. Show sample locations on the geologic log where appropriate.

Photography

In conjunction with geologic logging of the excavations, sufficient photographs shall be taken to document the typical mapped units as well as any significant anomalies. Photograph coverage, to the extent feasible, should include geologic features potentially significant to the design, important portions of the facility (i.e., shaft station, shaft key), and representative geologic conditions.

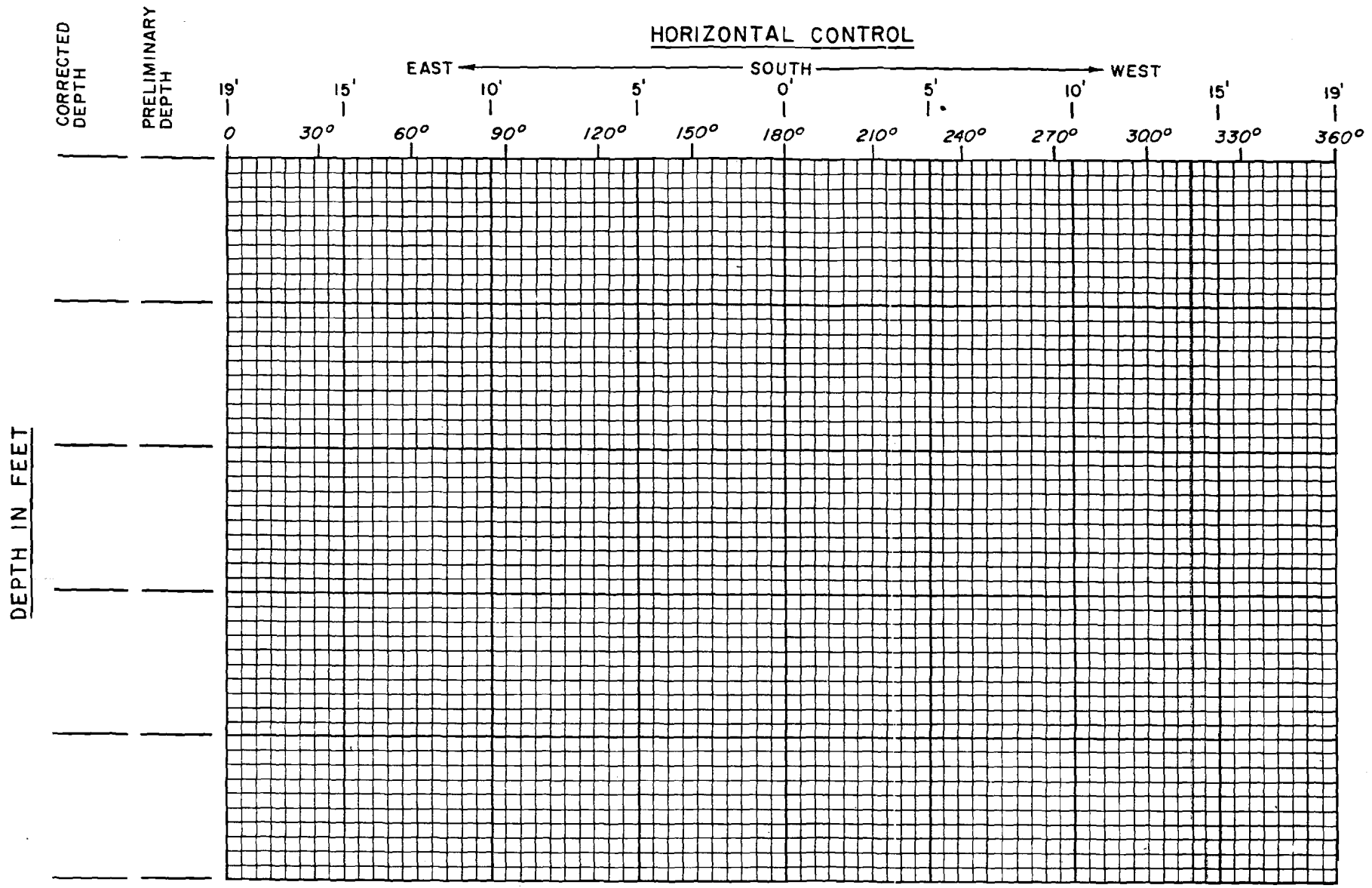
Photographs shall be in color and shall show or be located with reference to an established datum. A visual scale should be located in each photograph. Photographic coverage of the excavations will be performed jointly by the TSC and SNL.

Sampling

If appropriate, grab samples of the rock will be collected during mapping of the underground excavations. The location and sample number shall be shown on the geologic log and recorded on the sample summary sheet shown in Figure A-5. Samples in the exploratory shaft shall be numbered consecutively beginning with WIPP-EXS-1. For the facility horizon, the samples shall be designated by consecutive numbers beginning with WIPP-FH-1 and for the vent shaft with WIPP-VS-1. Sample containers shall be clearly identified with the following information:

- WIPP-SPDV
- sample number
- sample location (vertical and horizontal)
- date collected
- collector's initials

DRAWN BY
CHECKED BY
APPROVED BY
DRAWING NUMBER NM78-648-B68



1 INCH = 5 FEET
(HORIZONTAL AND VERTICAL SCALE)

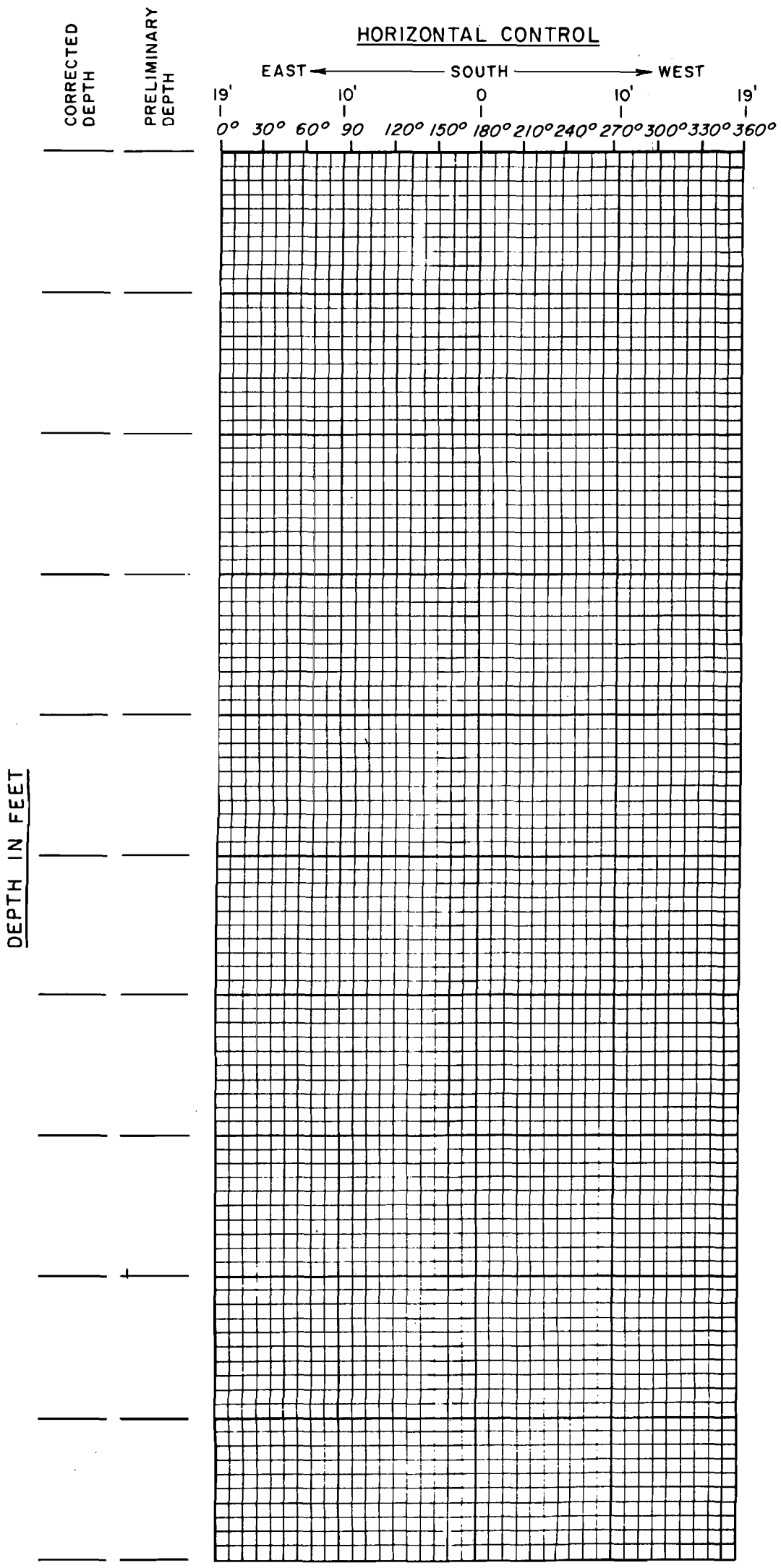
EXPLANATION

WASTE ISOLATION PILOT PLANT
DETAILED GEOLOGIC LOG
SPDV EXPLORATORY SHAFT

Depth _____ to _____ feet
By _____
Date _____
Reviewed by _____ Date _____
Project no. _____ Sheet no. _____ of _____

FIGURE A-1

DRAWN BY		CHECKED BY			DRAWING NUMBER NM78-648-B69
		APPROVED BY			



1 INCH = 10 FEET
(HORIZONTAL AND VERTICAL SCALE)

EXPLANATION

WASTE ISOLATION PILOT PLANT
RECONNAISSANCE GEOLOGIC LOG
SPDV EXPLORATORY SHAFT

Depth _____ to _____ feet

By _____

Date _____

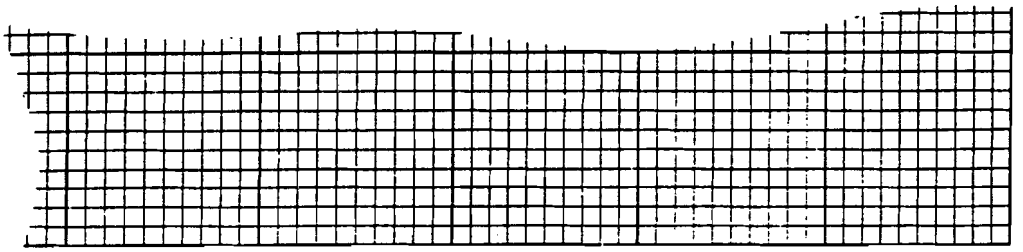
Reviewed by _____ Date _____

Project no _____ Sheet no. _____ of _____

FIGURE A-2

TME 3178

NOT APPLICABLE TO THE SHAFT MAPPING



WIPP-SPDV WASTE ISOLATION PILOT PLANT	UNDERGROUND GEOLOGIC LOG
LOCATION STA._____ TO_____	
HORIZONTAL AND VERTICAL SCALE:	
PREPARED BY_____ DATE_____ CHECKED BY_____ DATE_____	SHEET ___OF___

FIGURE A-3

MAPPING SYMBOLS AND ABBREVIATIONS

The following symbols and abbreviations may be used as appropriate:

- Contacts between different rock types will be symbolized by:

  sharp contact identifiable within 0.05 feet or less:

  gradational contact within 0.05 feet to 0.2 feet:

  diffuse contact within 0.2 feet to 0.5 feet:

- Clay features will be noted by:

  seams greater than 1/4 inch thick:

  partings between 1/4 inch to 1/16 inch thick:

  breaks less than 1/16 inch thick:

  discontinuous partings and breaks

- Spalling area:

- Seep or seep line:

- Joint or fracture trace showing attitude:

- Bedding showing attitude:

- Fault trace showing attitude and/or relative separation:

- Sample location:

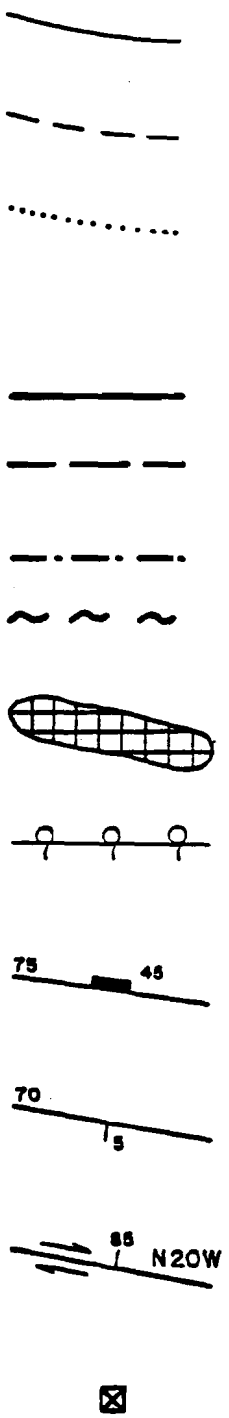


FIGURE A-4

Figure A-4
(Continued)

o **Abbreviations:**

C	Coarse	V	Very	Gr	Gray	Tr	Trace*
Med	Medium	Lt	Light	Rd	Red	Sm	Some*
F	Fine	Dk	Dark	Tn	Tan	Wh	White
VF	Very Fine	Br	Brown	Bk	Black	Yl	Yellow
Xln	Crystalline	Jnt	Joint	Gn	Green		

Symbols and abbreviations used other than those indicated above should be fully explained on the logs.

*During the mapping, the following abbreviations were used:
t - trace
s - some
w - abundant.
The field judgment is often very subjective and is affected by shape, size, color (transparency), etc., of the accessory constituents and matrix.

TME 3178

WIPP-SPDV

WASTE ISOLATION PILOT PLANT

SAMPLE SUMMARY SHEET

SAMPLE NO. _____

LOCATION:

DRIFT _____

STATION _____

FACE _____

_____

COLLECTION DATE: _____

_____

COLLECTED BY: _____

_____

PURPOSE: _____

_____

SAMPLE TYPE: _____

APPROXIMATE SIZE: _____

_____

Sketch of Sample Location (as appropriate)

SAMPLE DESCRIPTION AND PACKAGING _____

_____

_____

_____

DISPOSITION _____

_____

_____

_____

REMARKS _____

_____

_____

_____

SAMPLE NO. _____

FIGURE A-5

APPENDIX A-2

GEOLOGIC INVESTIGATION OF SHAFT KEY AREA/ZONE

EXCERPT (APPENDIX D)[1] FROM THE
SITE VALIDATION FIELD PROGRAM PLAN
Waste Isolation Pilot Plant (WIPP) Project
Southeastern New Mexico

Revision 1.2
January 3, 1983

[1] Only minor changes were made in Revision 1.2 in comparison with the original which was dated April 28, 1982.

APPENDIX D
GEOLOGIC INVESTIGATION OF SHAFT KEY AREA

D.1.0 PURPOSE

Construction of a shaft key at the bottom of the liner and extending into competent salt has been planned. The purpose of geologic mapping of the shaft key is to:

- Document geologic conditions that will be covered by construction of the shaft key
- Provide geologic input to the final design and construction of the shaft key

The key will consist of a circular reinforced concrete structure having two water seals and a water collection ring to collect any seepage, if present, below the liner. The key will begin at the bottom of the liner at about 840 feet and will extend approximately 60 feet to a depth of 900 feet.

The final design details for construction of the shaft key will be based on the actual subsurface conditions at the Rustler/Salado Formation contact as by direct visual inspection of the rock conditions of the shaft wall and any water inflow below the liner.

D.2.0 INVESTIGATIVE PLAN

After the shaft has been made ready for safe access to the shaft key area, TSC field personnel familiar with underground construction will be lowered into the shaft to inspect directly the subsurface conditions just below the liner. At this point, the TSC and other WIPP participants will assess the adequacy of the planned key design to perform under the actual shaft conditions observed. In addition to visual inspection of the shaft condition, detailed geologic mapping of the wall rock will be conducted from a depth of 840 feet (bottom of the liner) to about 900 feet. This information will be used to document the subsurface conditions for the WIPP files and for background information in helping to assess the performance of the shaft key. The mapping will be

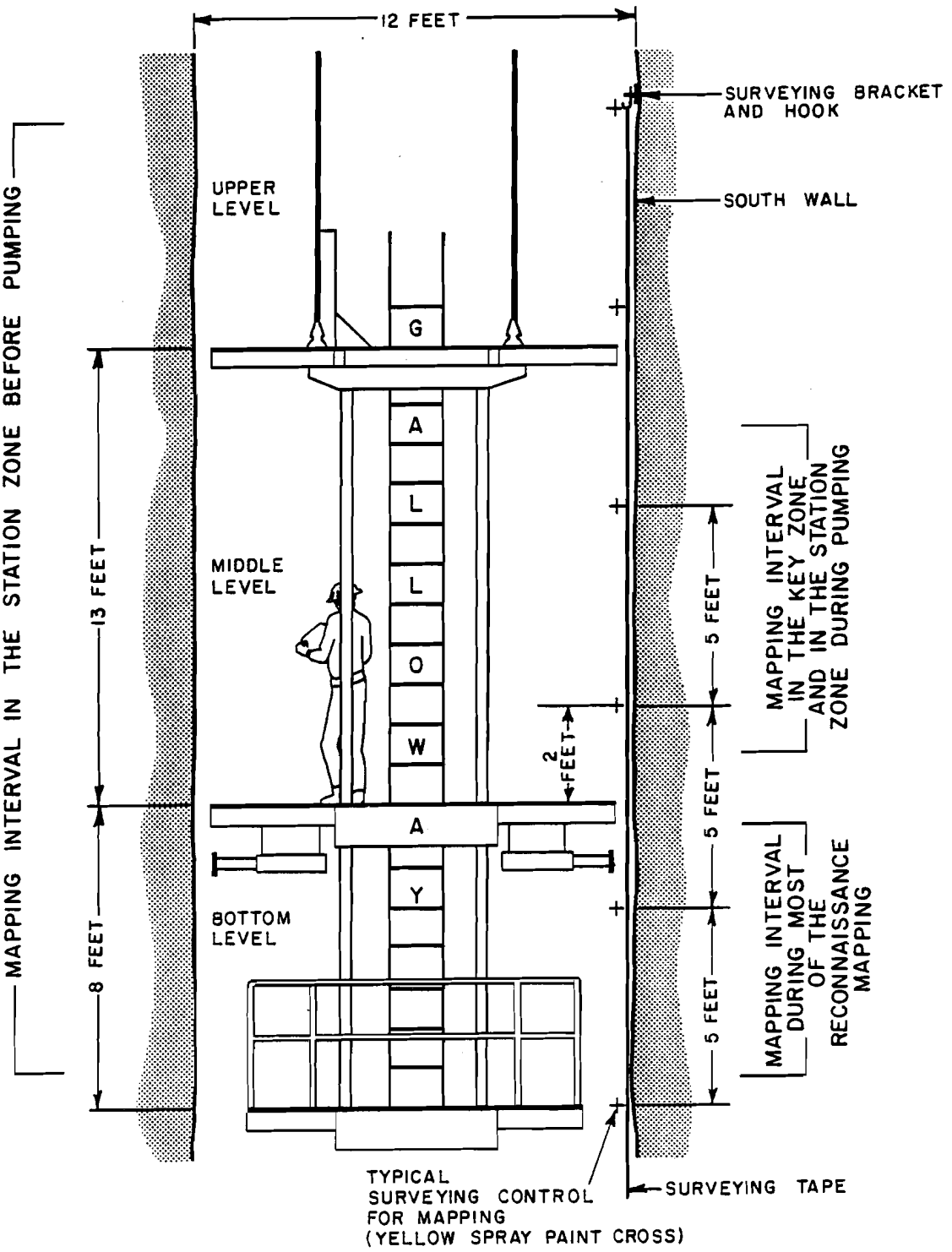
performed in accordance with the geologic mapping procedures given in Appendix A.

The product of the mapping will be a geologic log that will be an accurate two-dimensional representation of the entire circumference of the wall rock in the shaft key area. The logs will record the attitude and character of the stratigraphy, physical condition (washout areas, spalling rock, etc.) of the wall, and water inflow below the liner. Careful attention will be given to describing the stratigraphy, joints, fractures, vugs, argillaceous zones, and any other geologic features that may adversely impact the short- and long-term stability of the shaft.

APPENDIX A-3
GALLOWAY

APPENDIX A-3
GALLOWAY

All mapping in the exploratory shaft was performed from the galloway which is shown in schematic sections on Page A-3/3. The galloway is a steel structure 11 feet in diameter consisting of three levels. It is raised and lowered by two cables operated by a system separate from the main hoist. The main hoist provided access to or slightly below the galloway in buckets (either a 6-man, 48-inch diameter or a 4-man, 40-inch diameter, respectively). The bottom level has a diameter of 9 feet.



SCHEMATIC SECTION OF GALLOWAY

EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

APPENDIX B

STRATIGRAPHIC SUMMARY OF THE EXPLORATORY SHAFT

APPENDIX B

STRATIGRAPHIC SUMMARY OF THE EXPLORATORY SHAFT

LISTING OF CODES

General

MB - Marker bed

SEAM - Clay layer greater than 1/4" thick

PART - Clay parting between 1/16" and 1/4" thick

-T - Top of layer/bed

-C - Center of layer/bed

-B - Bottom of layer/bed

/ - Contacts between strata

Formations/Members/Units (in descending stratigraphic order)

RUS - Rustler Formation

SAL - Salado Formation

UP. SAL - Upper Salado Member

MCN - McNutt Potash Member

V.T. SAND - Vaca Triste Sandstone Member

UN. ANH - Union Anhydrite

Lithological Facies

H - Halite, colorless

HB - Halite, reddish brown

HAS - Halite, some argillaceous material (HA_s)

HAW - Halite, with abundant argillaceous material (HA_w)

CB - Clay, brown

CG - Clay, gray

POLYH. S. - Polyhalite seams

AN. A - Anhydrite "a"

AN. B - Anhydrite "b"

HPTAW - Halite with trace of polyhalite and abundant argillaceous material (HPA_{tw})

HPW - Halite with abundant polyhalite (HP_w)

H + 4P - Halite with four polyhalite bands or seams

AN-CG - Anhydrite and gray clay layer

STRATIGRAPHIC SUMMARY OF THE EXPLORATORY SHAFT

Depths refer to zero datum point (top of first bunton).

Preliminary depths correspond to the CWI approximate surveying performed March to May, 1982.

Correction factors were determined by comparison of CWI electronic surveying of December 2, 1982, and TSC surveying of January 22, 1983, with the preliminary depths of geological logs.

Elevations are referenced to:

(1) Zero datum point for depth measurements (top of first bunton) at elevation of 3410.00 ft. MSL, based on CWI bench mark No. CW-1 at elevation of 3410.080 ft. MSL (brass cap outside the exploratory shaft) and tied to the existing north baseline to the north of the site.

(2) Bottom of concrete (shaft key) at elevation of 2530.38 ft. MSL; and

(3) Steel deck (center of south edge) at elevation of 1259.03 ft. MSL based on CWI bench mark No. 82-D (brass cap at NW corner of the underground power center foundation) at elevation of 1259.59 ft. MSL.

LITHOLOGICAL CONTACT	PRELIMINARY DEPTH (FT)	CORRECTION FACTOR (FT)	CORRECTED DEPTH (FT)	ELEVATION (FT MSL)	INTERVAL THICKNESS(FT) [FROM PRECEDING CONTACT]
GR. SURFACE	-0.5	0.0	-0.5	3,410.5	-0.5
RUS/SAL	850.8	-0.2	850.6	2,559.4	851.1
MB100-T	922.1	-0.1	922.0	2,488.0	71.4
MB100-B	922.9	-0.1	922.8	2,487.2	0.8
MB101-T	970.0	0.8	970.8	2,439.2	48.0
MB101-B	974.2	0.8	975.0	2,435.0	4.2
MB102-T	1008.8	0.9	1009.7	2,400.3	34.7
MB102-B	1010.2	0.9	1011.1	2,398.9	1.4
MB103-T	1022.5	0.9	1023.4	2,386.6	12.3
MB103-B	1036.5	1.0	1037.5	2,372.5	14.1
MB104-T	1044.6	1.0	1045.6	2,364.4	8.1
MB104-B	1045.1	1.0	1046.1	2,363.9	0.5
MB105-T	1060.4	1.0	1061.4	2,348.6	15.3
MB105-B	1060.8	1.0	1061.8	2,348.2	0.4
MB106-T	1080.3	1.0	1081.3	2,328.7	19.5
MB106-B	1081.3	1.0	1082.3	2,327.7	1.0
MB107-T	1115.2	1.1	1116.3	2,293.7	34.0
MB107-B	1115.5	1.1	1116.6	2,293.4	0.3
MB108-T	1124.7	1.1	1125.8	2,284.2	9.2
MB108-B	1125.2	1.1	1126.3	2,283.7	0.5
MB109-T	1146.0	1.2	1147.2	2,262.8	20.9
MB109-B	1171.5	1.2	1172.7	2,237.3	25.5
MB110-T	1203.0	1.3	1204.3	2,205.7	31.6
MB110-B	1204.2	1.3	1205.5	2,204.5	1.2

LITHOLOGICAL CONTACT	PRELIMINARY DEPTH (FT)	CORRECTION FACTOR (FT)	CORRECTED DEPTH (FT)	ELEVATION (FT MSL)	INTERVAL THICKNESS(FT) [FROM PRECEDING CONTACT]
MB111-T	1220.0	1.3	1221.3	2,188.7	15.8
MB111-B	1220.2	1.3	1221.5	2,188.5	0.2
MB112-T	1237.0	1.4	1238.4	2,171.6	16.9
MB112-B	1239.9	1.4	1241.3	2,168.7	2.9
MB113-T	1264.7	1.4	1266.1	2,143.9	24.8
MB113-B	1266.3	1.4	1267.7	2,142.3	1.6
MB114-T	1287.7	1.5	1289.2	2,120.8	21.5
MB114-B	1289.0	1.5	1290.5	2,119.5	1.3
MB115-T	1324.0	1.5	1325.5	2,084.5	35.0
MB115-B	1327.0	1.5	1328.5	2,081.5	3.0
MB116-T	1335.5	1.5	1337.0	2,073.0	8.5
MB116-B	1338.0	1.6	1339.6	2,070.4	2.6
UP. SAL/MCN	1344.0	1.6	1345.6	2,064.4	6.0
V. T. SAND-T	1347.1	1.6	1348.7	2,061.3	3.1
V. T. SAND-B	1348.8	1.6	1350.4	2,059.6	1.7
MB117-T	1414.2	1.7	1415.9	1,994.1	65.5
MB117-B	1415.3	1.7	1417.0	1,993.0	1.1
MB118-T	1442.7	1.8	1444.5	1,965.5	27.5
MB118-B	1445.4	1.8	1447.2	1,962.8	2.7
MB119-T	1463.3	1.8	1465.1	1,944.9	17.9
MB119-B	1465.1	1.8	1466.9	1,943.1	1.8
MB120-T	1483.2	1.8	1485.0	1,925.0	18.1
MB120-B	1484.1	1.8	1485.9	1,924.1	0.9
MB121-T	1495.0	1.8	1496.8	1,913.2	10.9
MB121-B	1497.3	1.8	1499.1	1,910.9	2.3
MB122-T	1504.3	1.8	1506.1	1,903.9	7.0
MB122-B	1505.6	1.8	1507.4	1,902.6	1.3
UN. ANH-T	1534.0	1.8	1535.8	1,874.2	28.4
UN. ANH-B	1538.0	1.8	1539.8	1,870.2	4.0
MB123-T	1613.1	1.8	1614.9	1,795.1	75.1
MB123-B	1618.2	1.8	1620.0	1,790.0	5.1
MB124-T	1623.8	1.8	1625.6	1,784.4	5.6
MB124-B	1631.8	1.8	1633.6	1,776.4	8.0
MB125-T	1683.3	1.8	1685.1	1,724.9	51.5
MB125-B	1685.4	1.8	1687.2	1,722.8	2.1
MB126-T	1721.5	1.8	1723.3	1,686.7	36.1
MB126-B	1723.0	1.8	1724.8	1,685.2	1.5
MB127-T	1745.9	1.8	1747.7	1,662.3	22.9
MB127-B	1748.9	1.8	1750.7	1,659.3	3.0
MB128-T	1757.1	1.8	1758.9	1,651.1	8.2
MB128-B	1760.0	1.8	1761.8	1,648.2	2.9
MB129-T	1783.5	1.8	1785.3	1,624.7	23.5
MB129-B	1785.4	1.8	1787.2	1,622.8	1.9
MB130-T	1795.4	1.8	1797.2	1,612.8	10.0
MB130-B	1795.5	1.8	1797.3	1,612.7	0.1
MB131-T	1862.8	1.8	1864.6	1,545.4	67.3
MB131-B	1864.1	1.8	1865.9	1,544.1	1.3
MB132-T	1897.3	1.8	1899.1	1,510.9	33.2
MB132-B	1897.9	1.8	1899.7	1,510.3	0.6
MB133-T	1911.7	1.8	1913.5	1,496.5	13.8
MB133-B	1912.6	1.8	1914.4	1,495.6	0.9
MB134-T	1954.9	2.0	1956.9	1,453.1	42.5
MB134-B	1966.5	2.1	1968.6	1,441.4	11.7
MB135-T	1982.7	2.2	1984.9	1,425.1	16.3
MB135-B	1983.8	2.2	1986.0	1,424.0	1.1
MB136-T	2025.0	2.4	2027.4	1,382.6	41.4
MB136-B	2033.4	2.5	2035.9	1,374.1	8.5
MB137-T	2049.0	2.6	2051.6	1,358.4	15.7
MB137-B	2049.7	2.6	2052.3	1,357.7	0.7

LITHOLOGICAL CONTACT	PRELIMINARY DEPTH (FT)	CORRECTION FACTOR (FT)	CORRECTED DEPTH (FT)	ELEVATION (FT MSL)	INTERVAL THICKNESS(FT) [FROM PRECEDING CONTACT]
H/HB	2050.3	2.6	2052.9	1,357.1	0.6
HB/HAS	2051.7	2.6	2054.3	1,355.7	1.4
HAS/H	2056.0	2.6	2058.6	1,351.4	4.3
H/HAW	2065.0	2.6	2067.6	1,342.4	9.0
CB-SEAM-B	2072.4	2.6	2075.0	1,335.0	7.4
CB-HAL-B	2081.9	2.6	2084.5	1,325.5	9.5
CB-BRK-C	2089.9	2.6	2092.5	1,317.5	8.0
POLYH. S. -C	2094.9	2.6	2097.5	1,312.5	5.0
MB138-T	2095.8	2.6	2098.4	1,311.6	0.9
MB138-B	2096.1	2.6	2098.7	1,311.3	0.3
CB-PART-C	2097.6	2.6	2100.2	1,309.8	1.5
CB-SEAM-B	2104.0	2.6	2106.6	1,303.4	6.4
AN-SEAM-B	2108.5	2.6	2111.1	1,298.9	4.5
CG-SEAM-B	2110.0	2.6	2112.6	1,297.4	1.5
AN. A-T	2119.0	2.6	2121.6	1,288.4	9.0
AN. A-B	2119.7	2.6	2122.3	1,287.7	0.7
CB-PART-C	2119.8	2.6	2122.4	1,287.6	0.1
AN. B-T	2126.3	2.6	2128.9	1,281.1	6.5
AN. B-B	2126.6	2.6	2129.2	1,280.8	0.3
HAS/HPTAT	2129.7	2.6	2132.3	1,277.7	3.1
HPTAT/HAS	2136.7	2.6	2139.3	1,270.7	7.0
HAS/HPTAT	2139.9	2.6	2142.5	1,267.5	3.2
HPTAT/HPTA	2142.6	2.6	2145.2	1,264.8	2.7
HPTAW/HPSW	2150.1	2.6	2152.7	1,257.3	7.5
MB139-T	2153.7	2.6	2156.3	1,253.7	3.6
MB139-C	2155.1	2.6	2157.7	1,252.3	1.4
MB139-B	2156.5	2.6	2159.1	1,250.9	1.4
CG-PART-C	2165.1	2.6	2167.7	1,242.3	8.6
HPSW/HPTAT	2172.7	2.6	2175.3	1,234.7	7.6
HPTAT/HPS	2177.9	2.6	2180.5	1,229.5	5.2
H+4P-T	2182.0	2.6	2184.6	1,225.4	4.1
H+4P-B	2183.7	2.6	2186.3	1,223.7	1.7
AN-CG-B	2183.9	2.6	2186.5	1,223.5	0.2
CG-PART-C	2184.0	2.6	2186.6	1,223.4	0.1
MB140-T	2220.0	2.6	2222.6	1,187.4	36.0
MB140-B	2229.0	2.6	2231.6	1,178.4	9.0

APPENDIX C
DESCRIPTION OF ROCK SAMPLES

APPENDIX C
DESCRIPTION OF THE ROCK SAMPLES

Grab samples taken from the shaft were examined by Sara Black and/or Mike Freeland (D'Appolonia) to determine general lithologic and mineralogic composition and to verify the identification of rock and mineral types encountered during shaft mapping. Samples were examined using a 10-power hand lens and a 40-power binocular microscope. Descriptions were prepared following examination, supplemented if necessary by simple diagnostic tests (such as solubility in acid). Rock and mineral colors were identified using a modified Munsell color chart distributed by the Geological Society of America. Letter symbols (in parenthesis) following each sample description correspond to the legend developed and used for the mapping.

SAMPLE NO.	DEPTH (FT) AZIMUTH	COLLECTED WHEN/WHO	DESCRIPTION
EXS-1	851.0 0°	3/31/81 ALM	Siltstone, dark reddish-brown (10R 3/4), trace to some clay, trace to some microhalite cubic crystals. (SH)
EXS-2	852.0 120°	3/31/82 RFM	Halite, clear, transparent to translucent, pale reddish-brown (10R 3/4), massive, macrocrystalline; large irregular intergrown crystals, some crystals striated. (HC in HA)
EXS-3	865.0 70°	3/31/82 RFM	Anhydrite and gypsum, white (N9) to pale reddish-brown (10R 5/4). Predominantly anhydrite but with abundant gypsum crystals on outer surfaces; some polyhalite in layers, moderate red (5R 4/6). (A)
EXS-4	866.4 170°	3/31/82 RFM	Anhydrite (?), white (N9) soft; contains intergranular argillaceous material in some places, moderate reddish-brown (10R 4/6) (small sample, difficult to identify). (A and CB)

SAMPLE NO.	DEPTH (FT) AZIMUTH	COLLECTED WHEN/WHO	DESCRIPTION
EXS-5	867.0 90°	3/31/82 RFM	Halite, clear, transparent to tinged with moderate reddish-orange (10R 6/6), massive, macrocrystalline. (HC)
EXS-6	876.0 90°	3/31/82 RFM	Halite, clear, micro- to macro-crystalline; with intergranular argillaceous material, dark reddish-brown (10R 3/4). Some apparent "hopper" halite crystals. (HA)
EXS-7	877.0 185°	3/31/82 LJ	Halite, argillaceous, as above. (HA)
EXS-8	881.0 180°	3/31/82 LJ	Siltstone, dark reddish-brown (10R 3/4), trace to some clay with halite, clear, micro- to macrocrystalline, cubic crystals. (SH)
EXS-9	888.0 180°	3/31/82 RFM	Sample contains 2 rock types: (1) Sandstone, moderate reddish-brown (10R 4/6) to medium light gray (N6), very fine to fine grained, subangular grains, trace to some silt, occasional grains of halite and gypsum, moderately cemented. (SSH) (2) Siltstone, moderate reddish-orange (10R 6/6) with very fine sand, trace to some halite. (SSH)
EXS-10	890.0 180°	3/31/82 RFM	Siltstone, moderate reddish brown (10R 4/6), contains some very fine sand. Trace grayish-green (5G 5/2) halite, surfaces coated with very fine needle-like gypsum crystals. (SH)
EXS-11	895.0 45°	3/31/82 RFM	Halite, clear to medium light gray (N6), argillaceous with as much as 40% moderate reddish-brown (10R 4/6) silt and very fine sand, coarsely crystalline halite. (HA)

SAMPLE NO.	DEPTH (FT) AZIMUTH	COLLECTED WHEN/WHO	DESCRIPTION
EXS-12	901.0 250°	3/31/82 LJ	Clay, moderate reddish-brown (10R 4/6), contains 20 to 30% halite, halite is clear to medium light gray (N6) and finely to coarsely crystalline. (CB)
EXS-13	908.0 90°	3/31/82 RFM	Halite, moderate reddish-brown (10R 4/6), medium to coarsely crystalline, argillaceous; surface coated with fine, needle-like gypsum crystals. (HA)
EXS-14	917.0 90°	3/31/82 LJ	Clay, moderate reddish-brown (10R 4/6), hard, halitic, halite is clear to medium dark gray (N4) and coarsely crystalline. Contains traces of white gypsum. (CB)
EXS-15	983.0 180°	4/26/82 ALM	Gypsum, white (N9), microcrystalline, translucent under microscope. (Gypsum in HPA)
EXS-16	1036.6-1036.8 180°	4/26/82 ALM	Sample contains two rock types: (1) Clay, medium dark gray (N4) to grayish-red (5R 4/2), halitic, medium hard, euhedral halite crystals $\leq$ 1 mm in diameter. Sample is slickensided on surface. (CG) (2) Halite, pale reddish-brown (10R 5/4) to moderate reddish-brown (10R 4/6), fracture filling.
EXS-17	1036.6-1037.0 180°	4/26/82 ALM	Clay, medium dark gray (N4), halitic euhedral halite crystals < 1 mm in diameter. (CG)
EXS-18	1044.7 180°	4/26/82 ALM	Anhydrite, very light gray (N8) to light olive gray (5Y 6/1), finely crystalline. (A)
EXS-19	1049.5 185°	4/26/82 LJ	Anhydrite, very light gray (N8) to light olive gray (5Y 6/1), finely crystalline (very small chip sample). (A)

TME 3178

SAMPLE NO.	DEPTH (FT) AZIMUTH	COLLECTED WHEN/WHO	DESCRIPTION
EXS-20	1061.2 165°	4/26/82 LJ	Clay, medium gray (N5) to medium greenish-gray (5G 5/1). (CG)
EXS-21	1081.3 190°	4/26/82 LJ	Clay, medium greenish-gray (5G 5/1) to pale reddish-brown (10R 5/4), silty. (CG)
EXS-22	1104.7 175°	4/26/82 LJ	Clay, dark reddish-brown (10R 3/4) silty, trace finely crystalline halite. (CB)
EXS-23	1104.9 175°	4/26/82 LJ	Halite, dark reddish-brown (10R 3/4), coarsely crystalline, very argillaceous. (mixed HC and CB)
EXS-24	1107.0 185°	4/26/82 LJ	Clay, dark reddish-brown (10R 3/4), silty; trace of white (N9), finely crystalline halite. (Bleb of CB in HA)
EXS-25	1125.0 190°	4/26/82 LJ	Magnesite, medium light gray (N6), massive, interlayered with anhydrite 1/16- to 1/4-inch thick.
EXS-26	1125.0 190°	4/26/82 LJ	Halite, moderate reddish-brown (10R 4/6), coarsely crystalline, polyhalitic. (HP)
EXS-27	1125.3 190°	4/26/82 LJ	Clay, dark reddish-brown (10R 3/4); with 20 to 40% interbeds of halite 1/16- to 1-inch thick, coarsely crystalline. (CB)
EXS-28	1141.5 220°	4/26/82 SRA	Polyhalite, halitic; polyhalite is moderate orange-pink (10R 7/4) and microcrystalline; halite is clear and medium crystalline. (Polyhalite-rich portion of HP)
EXS-29	1146.0 215°	4/26/82 SRA	Clay, grayish-red (5R 4/2); trace of white (N9), finely crystalline halite. (CB)
EXS-30	1179.0 230°	4/26/82 SRA	Clay, dark reddish-brown (10R 3/4) to medium light gray (N6). (CG/CB)

SAMPLE NO.	DEPTH (FT) AZIMUTH	COLLECTED WHEN/WHO	DESCRIPTION
EXS-31	1205.0 230°	4/26/82 SRA	Clay, dark reddish-brown (10R 3/4), slightly silty, halitic, with coarsely crystalline halite. (CB)
EXS-32	1240.0 230°	4/26/82 SRA	Polyhalite, moderate reddish-brown (10R 4/6), microcrystalline, dense, and clayey silt, medium light gray (N6), halitic. (P and CG)
EXS-33	1266.2 180°	4/27/82 ALM	Polyhalite, moderate reddish-brown (10R 4/6), halitic. (P)
EXS-34	1281.5 180°	4/27/82 ALM	Clay, dark reddish-brown (10R 3/4), trace of silt, some medium to coarsely crystalline halite. (CB)
EXS-35	1298.0-1298.5 180°	4/27/82 ALM	Polyhalite, moderate reddish-orange (10R 6/6). (P)
EXS-36	1324.0 180°	4/27/82 ALM	Anhydrite, white (N9), finely crystalline. (A)
EXS-37	1348.0 180°	4/27/82 SRB	Clayey silt to siltstone, dark reddish-brown (10R 3/4), containing some very fine sand, halitic; contains approximately 30% clear, fine to medium crystalline halite, gypsiferous (?). (SH-Vaca Triste)
EXS-38	1366.0 180°	4/27/82 SRB	Clay, dark reddish-brown (10R 3/4), slightly silty, trace halite. (CB)
EXS-39	1377.0 230°	4/28/82 SRA	Halite, dark reddish-brown (10R 3/4), very argillaceous (silty clay); halite is clear to translucent, coarsely crystalline. (Halite-rich sample of CB)
EXS-40	1465.0 180°	4/28/82 ALM	Polyhalite, moderate reddish-brown (10R 4/6), surfaces coated with sugary, finely crystalline halite. (P)
EXS-41	1465.0 180°	4/28/82 ALM	Polyhalite, moderate reddish-brown (10R 4/6). (P)

SAMPLE NO.	DEPTH (FT) AZIMUTH	COLLECTED WHEN/WHO	DESCRIPTION
EXS-42	1465.0 180°	4/28/82 ALM	Polyhalite, moderate reddish-brown (10R 4/6), and silty clay, light olive gray (5Y 6/1), halitic. (P, CG)
EXS-43	1497.5 180°	4/28/82 ALM	Halite, translucent to moderate reddish-orange (10R 6/6), coarsely crystalline, slightly polyhalitic, surface coated with medium light gray (N6) clay. (HP, CG)
EXS-44	1505.0 180°	4/28/82 ALM	Polyhalite, moderate reddish-brown (10R 4/6). (P)
EXS-45	1645.5 180°	4/29/82 SRB	Halite, clear to medium light gray (N6), argillaceous with approximately 20% medium light gray (N6) to moderate reddish-orange (10R 6/6) clay; halite is euhedral and medium crystalline, disaggregated. (HA)
EXS-46	1706.5 180°	4/29/82 ALM	Halite, medium light gray (N6) to pale red (10R 6/2), medium to coarsely crystalline, argillaceous, trace to some gray clay, trace polyhalite. (HA)
EXS-47	1785.5 180°	4/29/82 ALM	Halite, clear to moderate reddish-brown (10R 4/6), polyhalitic, coarsely crystalline; with 5 to 10% clay, medium light gray (N6), halitic, trace silt. (HP and CG)
EXS-48	1807.5 180°	4/29/82 ALM	Silty clay, medium light gray (N6), halitic with approximately 35% halite; halite is medium light gray (N6), medium to coarsely crystalline. (CG)
EXS-49	1808.0 180°	4/29/82 ALM	Halite, translucent to moderate reddish-orange (10R 6/6), medium to coarsely crystalline, slightly argillaceous. (HA)
EXS-50	1966.5 90°	4/30/82 RFM	Clay, medium dark gray (N4), halitic, contains approximately 5% finely crystalline halite (visible under microscope). (CG)

SAMPLE NO.	DEPTH (FT) AZIMUTH	COLLECTED WHEN/WHO	DESCRIPTION
EXS-51	1982.5 90°	4/30/82 RFM	Clay, medium gray (N5), silty, halitic, contains approximately 10% finely crystalline halite. (CG)
EXS-52	2027.0 270°	4/30/82 ALM	Polyhalite, moderate reddish-orange (10R 6/6), microcrystalline, translucent. Sample contains a thin (1 mm) lamina of anhydrite. (P in AC)
EXS-53	2034.0 180°	4/30/82 ALM	Clay? but is crystalline with micrograins of halite (?), anhydrite (?), magnesite (?). (CG)
EXS-54	2056.3 0°	4/30/82 ALM	Clay, medium light gray (N6), contains grains of halite (?), polyhalite (?), and other unidentified evaporite minerals, crystalline appearance. (CG bleb in HC)
EXS-55	2064.5 240°	4/30/82 ALM	Anhydrite, white (N9) to moderate reddish-brown (10R 4/6), massive, granular, microcrystalline. (A in HC)
EXS-56	2084.0 180°	4/30/82 ALM	Halite, clear, transparent, argillaceous; argillaceous material is moderate reddish-brown (10R 4/6) and microscopically intergranular; halite crystals range from microscopic, cubic to 1 inch long, some elongated, columnar. (HA)
EXS-57	2096.5 0°	4/30/82 LJ	Clay, grayish-red (10R 4/2), few visible crystals of halite. (CB)
EXS-58	2096.5 225°	4/30/82 LJ	Anhydrite, medium dark gray (N4), microcrystalline, faintly banded; contains veins 1/8- to 1/4-inch thick of crystalline halite, clear to moderate reddish-orange (10R 6/6); halite in veins appears cubic to striated. (A)
EXS-59	2156.0 180°	4/30/82 ALM	Anhydrite, medium dark gray (N4), microcrystalline, faintly banded. As above, with included bands of halite. Trace grayish- ed (10R 4/2) clay from underlying clay seam. (A-MB 139)

APPENDIX D
DESCRIPTIONS OF PHOTOGRAPHS FROM KEY AND STATION ZONES

APPENDIX D

DESCRIPTIONS OF PHOTOGRAPHS FROM KEY AND STATION ZONES

TABLE OF CONTENTS

APPENDIX NO.	TITLE/SUBJECT
D-1	Photographs of the Key Zone (Photography on March 30, 1982)
D-2	Photographs of the Station Zone (Photography on May 2, 1982)

APPENDIX D-1

PHOTOGRAPHS OF THE KEY ZONE IN THE EXPLORATORY SHAFT, WIPP FACILITY SOUTHEASTERN NEW MEXICO

TME 3178

PHOTOGRAPHS OF THE KEY ZONE IN THE EXPLORATORY SHAFT, WIPP FACILITY SOUTHEASTERN NEW MEXICO

TABLE OF CONTENTS

	PAGE
NOTES	D-1/3
SUBJECT INDEX	D-1/5
INDEX TO PHOTOGRAPHS	D-1/6
PHOTOGRAPH DESCRIPTIONS	D-1/8

PHOTOGRAPHS OF THE KEY ZONE IN THE EXPLORATORY SHAFT, WIPP FACILITY SOUTHEASTERN NEW MEXICO

NOTES

Color photographs (8- by 10-inch) were taken by Frank Hensley of Sandia National Laboratories. Photographs 1 through 29 were taken during a reconnaissance of the key zone on March 30, 1982. Accompanying F. Hensley on the reconnaissance were Lubor Jarolimek (D'Appolonia) and Art Moss (TSC-D'Appolonia). The additional two photographs (D-4 and D-5) were taken during a trip out of the shaft on May 2, 1982.

Negatives (marked "Key Zone") of the photographs are retained in the Sandia central files for the WIPP project. The photograph numbers correspond to the negative numbers which indicate a frame sequence and do not refer to the numbers imprinted on the margin of the negative (corresponding to different negative format).

This set of photographs was taken from the 40-inch-diameter bucket prior to establishing survey control in the key zone and prior to geologic mapping. As a result, the locations (depth and azimuth) of the photographs are approximate and were established by a review of a narrated video tape of the key zone and comparison of distinctive features as shown on the geological log.

All depths indicated refer to the preliminary depths on the geological log. Preliminary depths correspond to the CWI approximate surveying performed during the period March to May 1982. The results of this survey were used during geological mapping. A correction factor of -0.2 foot was determined by comparison of CWI electronic surveying of December 2, 1982 and TSC surveying of January 22, 1983 with the preliminary depths of geologic logs. All depths are based on zero datum point (top of first bunton) at an elevation of 3410.0 feet MSL. Correct depths and elevations can be calculated as follows:

- Corrected depth = Preliminary depth - 0.2 foot
- Elevation = 3410.0 feet - Corrected depth.

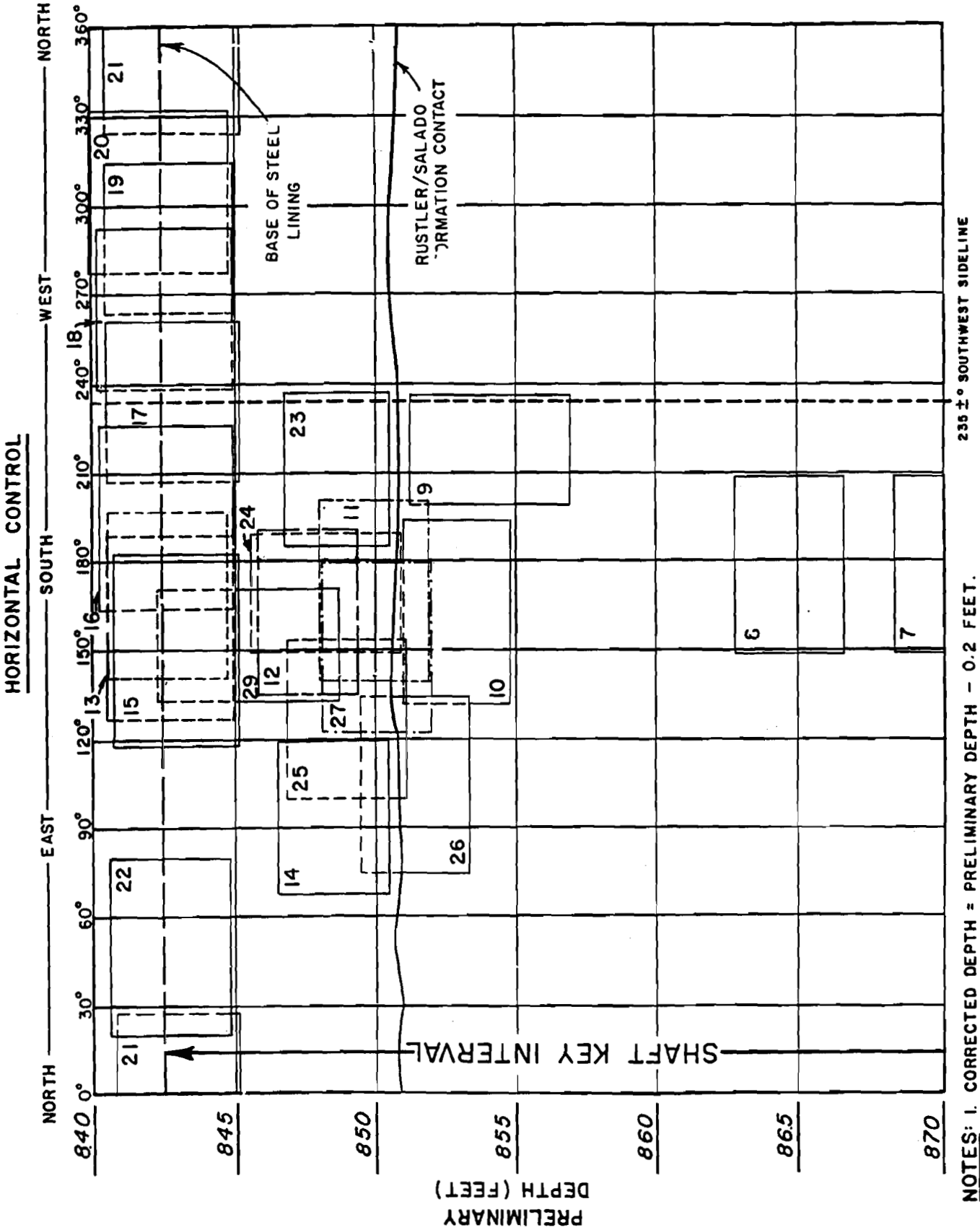
Although there is no scale shown in the photographs, an approximate scale of 1 inch equals 10 inches was estimated by using several of the more distinctive beds whose dimensions were measured during the mapping. However, this scale varies considerably depending on the distance of the camera to the wall and the angle the camera makes with the wall.

A subject index, photo index, and description of each photo are provided for reference.

SUBJECT INDEX
WIPP EXPLORATORY SHAFT KEY ZONE PHOTOGRAPHS

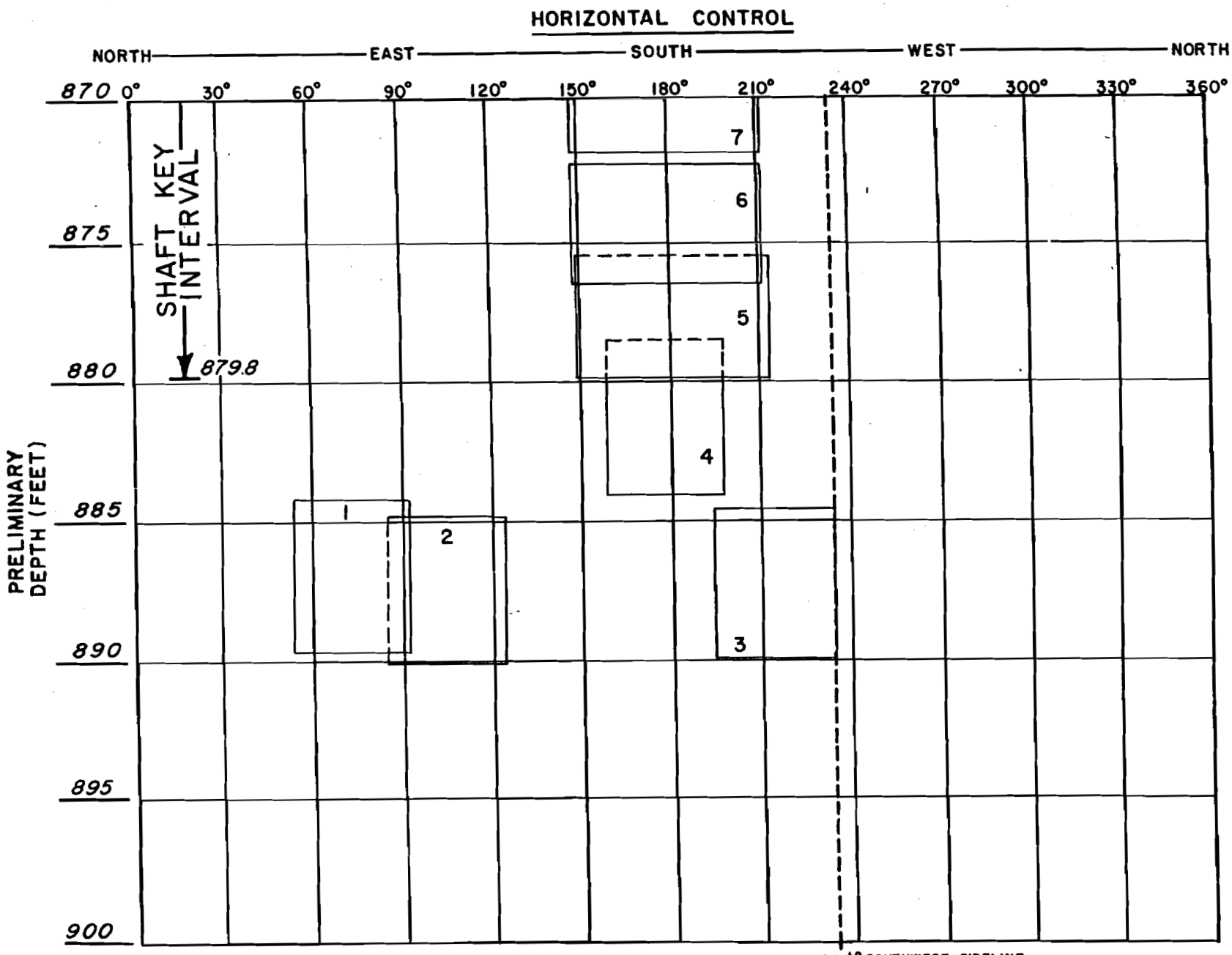
SUBJECT	PHOTOGRAPH NUMBER
Base of steel lining at a depth of 842.5 feet[1]	13, 15, 16, 17, 18, 19, 20, 21, 22, 28, 29
Rustler Formation at depths from 842.5 to 851 feet	12, 14, 23, 24, 25
Rustler-Salado Formation contact at a depth of 851 feet	11, 14, 26, 27
Salado Formation at depths from 852 to 885 feet	4, 5, 6, 7, 8, 9, 10
Fracture in Salado Formation at a depth of 885 to 890 feet	1, 2, 3
Key zone following construction	D-4, D-5

[1] All depths indicated refer to the preliminary depths on the geological log.



NOTES: 1. CORRECTED DEPTH = PRELIMINARY DEPTH - 0.2 FEET.
2. THE LOCATIONS SHOWN IN THIS FIGURE ARE APPROXIMATE AND MAY VARY SOMEWHAT FROM THE ACTUAL PHOTOGRAPH LOCATIONS.

INDEX TO PHOTOGRAPHS OF THE WIPP EXPLORATORY SHAFT - KEY ZONE



NOTES: 1. CORRECTED DEPTH = PRELIMINARY DEPTH − 0.2 FEET.

2. THE LOCATIONS SHOWN IN THIS FIGURE ARE APPROXIMATE AND MAY VARY SOMEWHAT FROM THE ACTUAL PHOTOGRAPH LOCATIONS.

INDEX TO PHOTOGRAPHS OF THE WIPP EXPLORATORY SHAFT - KEY ZONE (CONTINUED)

PHOTOGRAPH DESCRIPTIONS

The following section provides the location and a brief description of each photograph. All depths indicated refer to the preliminary depths on the geological log.

Photograph 1
Location: WIPP Exploratory Shaft - depth of 887± feet and an azimuth of 70±° (center of photo).
Comments: Vertical, halite-filled fracture (f11, as shown on the geologic map of the key zone) in fine sandy siltstone (lighter colored unit) and siltstone (dark reddish-brown siltstone beds above and below sandy siltstone).

Photograph 2
Location: WIPP Exploratory Shaft - depth of 888± feet and an azimuth of 105° (center of photo).
Comments: Open, vertical fracture (f12, as shown on the geologic map of the key zone) in fine sandy siltstone (lighter colored unit) and siltstone (dark reddish-brown siltstone beds above and below sandy siltstone).

Photograph 3
Location: WIPP Exploratory Shaft - depth of 887.5± feet and an azimuth of 215±° (center of photo).
Comments: Vertical, halite-filled fracture, f16 (as shown on the geologic map of the key zone), in siltstone and sandstone bed.

Photograph 4
Location: WIPP Exploratory Shaft - depth of 881± feet and an azimuth of 185±° (center of photo).
Comments: Bed of clear to reddish-brown halite in the upper part of the photo (above 879.8 feet, as noted). Argillaceous halite occurs below, but is mostly covered by fine, gray drilling debris.

Photograph 5
Location: WIPP Exploratory Shaft - depth of 878.5± feet and an azimuth of 185±° (center of photo).
Comments: Bed of clear to reddish-brown halite across the middle of the photo (877.5 to 879.8 feet, as noted). Argillaceous halite occurs above; argillaceous halite to halitic siltstone below. White streaks are a surficial salt precipitate on the wall.

Photograph 6
Location: WIPP Exploratory Shaft - depth of 876± feet and an azimuth of 185±° (center of photo).
Comments: Banded halite from the top of the photo to 876 feet, as noted; argillaceous halite from 876 to 877.5 feet; clear halite from 877.5 feet to the bottom of the photo.

Photograph 7
Location: WIPP Exploratory Shaft - depth of 870± feet and an azimuth of 185±° (center of photo).
Comments: Wall rock is banded, clear and reddish-brown halite of the Salado Formation. Vertical streaks in the middle of the photo are due to minor seepage along the wall of the shaft causing staining and dissolution of the salt.

Photograph 8
Location: WIPP Exploratory Shaft - depth of 865.5± feet and an azimuth of 185±° (center of photo).
Comments: Anhydrite bed (average 6 inches thick) directly underlain by a clay seam across the middle of the photo. The light-colored bed above the anhydrite is relatively clear halite. Relatively clear to reddish-brown halite underlies the anhydrite, although mostly covered by fine drilling debris.

Photograph 9
Location: WIPP Exploratory Shaft - depth of 854± feet and an azimuth of 210±° (center of photo).
Comments: Wall rock of reddish-brown argillaceous halite located just below the Rustler/Salado contact. Mostly covered by fine drilling debris except in the middle of the photo where the debris has been removed due to water seepage down the face. Vertical fluting caused by dissolution from minor seepage.

Photograph 10
Location: WIPP Exploratory Shaft - depth of 853± feet and an azimuth of 165±° (center of photo).
Comments: Wall rock of reddish-brown argillaceous halite located just below the Rustler/Salado contact. Mostly covered by fine drilling debris. Vertical fluting in the middle of the photo caused by dissolution from minor seepage.

Photograph 11
Location: WIPP Exploratory Shaft - Rustler/Salado contact at a depth of 851± feet and an azimuth of 165±°.
Comments: Rustler/Salado contact visible across the middle of the photo. Washout of up to one foot into the wall just below the contact. Reddish-brown argillaceous halite of the Salado below the contact (visible in lower middle of photo); siltstone above the contact. In this photo, the halite is generally covered by fine drilling debris.

Photograph 12
Location: WIPP Exploratory Shaft - depth of 848± feet and an azimuth of 160±° (center of photo).
Comments: White unit is an anhydrite bed containing clayey stringers and partings near the base of the Rustler Formation. Beds of siltstone (Rustler Formation) occur above and below. Lower extent of fracture, f6 (as shown on the geologic map of the key zone), is visible in upper siltstone bed at 150±°.

Photograph 13
Location: WIPP Exploratory Shaft - bottom of steel lining at a depth of 842.5 feet and an azimuth of 150±°.
Comments: Remnant of the grout plug and plastic sheeting in the upper left corner of the photo; base of steel lining to the right of the grout plug. Wall rock is siltstone of the Rustler Formation. Fracture, f6 (as shown on the geologic map of the key zone), is visible in the lower middle of the photo.

Photograph 14
Location: WIPP Exploratory Shaft - depth of 848.5± feet and an azimuth of 90±° (center of photo).
Comments: White unit is the lowermost anhydrite bed in the Rustler Formation. Rustler/Salado contact is visible in the bottom of the photo.

Photograph 15
Location: WIPP Exploratory Shaft - bottom of steel lining at a depth of 842.5 feet and an azimuth of 150±°.
Comments: Remnant of the grout plug and plastic sheeting in the upper left corner of the photo; base of steel lining to the right of the grout plug. Wall rock is siltstone of the Rustler Formation. Fracture, f6 (as shown on the geologic map of the key zone), is visible in the lower middle of the photo.

Photograph 16
Location: WIPP Exploratory Shaft - bottom of steel lining at a depth of 842.5 feet and an azimuth of 190±°.
Comments: Remnant of the grout plug at the bottom of the lining on the right side of the photo. Wall rock is siltstone of the Rustler Formation. Upper extent of fracture, f7 (as shown on the geologic map of the key zone), is visible just to the right of the water stain trending approximately 60° down to the left.

Photograph 17
Location: WIPP Exploratory Shaft - bottom of steel lining at a depth of 842.5 feet and an azimuth of 235±°.
Comments: Remnant of the grout plug and plastic sheeting at the bottom of the lining in the upper half of the photo. Wall rock is siltstone of the Rustler Formation. Fracture, f8 (as shown on the geologic map of the key zone), is visible just to the right of the sideline. Dark iron oxide/water staining on the wall due to seepage from behind the liner (215±°).

Photograph 18
Location: WIPP Exploratory Shaft - bottom of steel lining at a depth of 842.5 feet and an azimuth of 265±°.
Comments: Remnant of the grout plug and plastic sheeting at the bottom of the lining shown in the upper half of the photo. Wall rock is siltstone of the Rustler Formation. Fracture, f9 (as

shown on the geologic map of the key zone), is visible in the lower right corner of the photo. Silvery reflection in lower middle is due to moisture on the wall.

Photograph 19
Location: WIPP Exploratory Shaft - bottom of steel lining at a depth of 842.5 feet and an azimuth of 285±°.
Comments: Remnant of the grout plug and plastic sheeting at the bottom of the lining. Wall rock is siltstone of the Rustler Formation. Fracture, f9 (as shown on the geologic map of the key zone), is visible in the lower middle part of the photo.

Photograph 20
Location: WIPP Exploratory Shaft - bottom of steel lining at a depth of 842.5 feet and an azimuth of 305±°.
Comments: Remnant of the grout plug and plastic sheeting at the bottom of the lining in the upper half of the photo. Wall rock is siltstone of the Rustler Formation. Fracture, f9 (as shown on the geologic map of the key zone), is visible in the lower left corner of the photo. Several iron oxide/water stains due to seepage from behind the lining.

Photograph 21
Location: WIPP Exploratory Shaft - bottom of steel lining at a depth of 842.5 feet and an azimuth of 0±°.
Comments: Remnant of grout plug at the bottom of the lining in the upper half of the photo. Wall rock is siltstone of the Rustler Formation. White staining in the lower right corner is salt precipitate due to seepage from behind the lining.

Photograph 22
Location: WIPP Exploratory Shaft - bottom of steel lining at a depth of 842.5 feet and an azimuth of 65±°.
Comments: Remnant of the grout plug with plastic sheeting at the bottom of the lining. Wall rock is siltstone of the Rustler Formation. Prominent fracture, f9B (as shown on the geologic map of the key zone), with minor seepage visible just to the left of the middle of the photo. Vertical fracture, f9C (as shown on the geologic map of the key zone), is visible just to the right of the middle of the photo.

Photograph 23
Location: WIPP Exploratory Shaft - depth of 848± feet and an azimuth of 215±° (center of photo).
Comments: White unit in the middle of the photo is an anhydrite bed containing clayey stringers and partings near the base of the Rustler Formation. Beds of siltstone (Rustler Formation) occur above and below. Water stain at 215±° due to seepage from behind the liner. Southwest sideline along right margin at 235±°.

Photograph 24
Location: WIPP Exploratory Shaft - depth of 848± feet and an azimuth of 170±° (center of photo).
Comments: White unit is an anhydrite bed containing clayey stringers and partings near the base of the Rustler Formation. Beds of siltstone (Rustler Formation) occur above and below.

Photograph 25
Location: WIPP Exploratory Shaft - depth of 849± feet and an azimuth of 130±° (center of photo).
Comments: White unit is the lowermost anhydrite bed in the Rustler Formation. Siltstone beds of the Rustler Formation occur above and below the anhydrite.

Photograph 26
Location: WIPP Exploratory Shaft - Rustler/Salado contact at a depth of 851± feet and an azimuth of 100±°.
Comments: Rustler/Salado contact visible across the upper part of the photo. Washout of up to one foot into the wall just below the contact. Siltstone above the contact; argillaceous halite below. Reddish-brown argillaceous halite visible in the middle of the photo; remainder of the halite is covered by fine drilling debris.

Photograph 27
Location: WIPP Exploratory Shaft - Rustler/Salado contact at a depth of 851± feet and an azimuth of 160±°.
Comments: Rustler/Salado contact visible across the middle of the photo. Washout of up to one foot into the wall just below the contact. Siltstone above the contact; argillaceous halite below. Reddish-brown argillaceous halite visible in the lower right corner; remainder of the halite is covered by fine drilling debris.

Photograph 28
Location: WIPP Exploratory Shaft - bottom of steel lining at a depth of 842.5 feet and an azimuth of 160±°.
Comments: Wall rock is siltstone of the Rustler Formation.

Photograph 29
Location: WIPP Exploratory Shaft - depth of 845± feet and an azimuth of 150±° (center of photo).
Comments: Wall rock is siltstone and anhydrite (bottom of photo only) of the Rustler Formation. Prominent fracture in middle of the photo is f6 (as shown on the geologic map of the key zone). Fracture, f5, is visible along the left margin of the photo.

Photograph D-4
Location: WIPP Exploratory Shaft - depth of 885± feet.[1]
Comments: Bottom of wire mesh and rock bolts installed at the base of the key from a depth of 880 to 886 feet.

Photograph D-5
Location: WIPP Exploratory Shaft - depth of 847± feet.[1]
Comments: Connection between the steel lining above and the concrete portion of the key.

[1] No azimuth recorded - photograph was taken without horizontal control from a fast moving bucket.

APPENDIX D-2

PHOTOGRAPHS OF THE STATION ZONE IN THE EXPLORATORY SHAFT, WIPP FACILITY SOUTHEASTERN NEW MEXICO

PHOTOGRAPHS OF THE STATION ZONE IN THE EXPLORATORY SHAFT, WIPP FACILITY SOUTHEASTERN NEW MEXICO

TABLE OF CONTENTS

	PAGE
NOTES	D-2/3
SUBJECT INDEX	D-2/5
INDEX TO PHOTOGRAPHS	D-2/6
PHOTOGRAPH DESCRIPTIONS	D-2/10

PHOTOGRAPHS OF THE STATION ZONE IN THE EXPLORATORY SHAFT, WIPP FACILITY SOUTHEASTERN NEW MEXICO

NOTES

Color photographs (8 by 10-inch) of the station zone in the exploratory shaft were taken by Frank Hensley of Sandia National Laboratories on May 2, 1982. Accompanying F. Hensley was Lubor Jarolimek (D'Appolonia). The 56 photographs were taken from the galloway and from the 48-inch-diameter bucket following geologic mapping of the shaft station area.

Negatives (1.6 by 2.2 inches) of these photographs are retained in the Sandia central files for the WIPP project. The photograph numbers correspond to the negative numbers which indicate a frame sequence and do not refer to the numbers imprinted on the margin of the negative (corresponding to different negative format).

Coverage of the photographs includes:

- A-1 to A-15 - A strip along the south wall from a preliminary depth of 2,140 to 2,165 feet
- B-1 to B-15 - A strip along the south wall from a preliminary depth of 2,105 to 2,138 feet
- C-1 to C-15 - A strip along the south wall from a preliminary depth of 2,070 to 2,105 feet
- D-1 to D-3 - Anhydrite "a" at a preliminary depth of 2,121 feet[1]
- E-1 to E-4 - Anhydrite "b" at a preliminary depth of 2,126.5 feet (E-1 to E-3) and anhydrite "a" at a preliminary depth of 2,121 feet (E-4)
- F-1 to F-4 - MB 139 at a preliminary depth of 2,155± feet

[1] This roll also contains two photographs (D-4 and D-5) of the shaft key zone obtained during the trip out of the shaft. These photographs are included in the "Key Zone" volume of photographs.

In addition to the photographs, a subject index, photo index, and descriptions of the photographs are provided for reference.

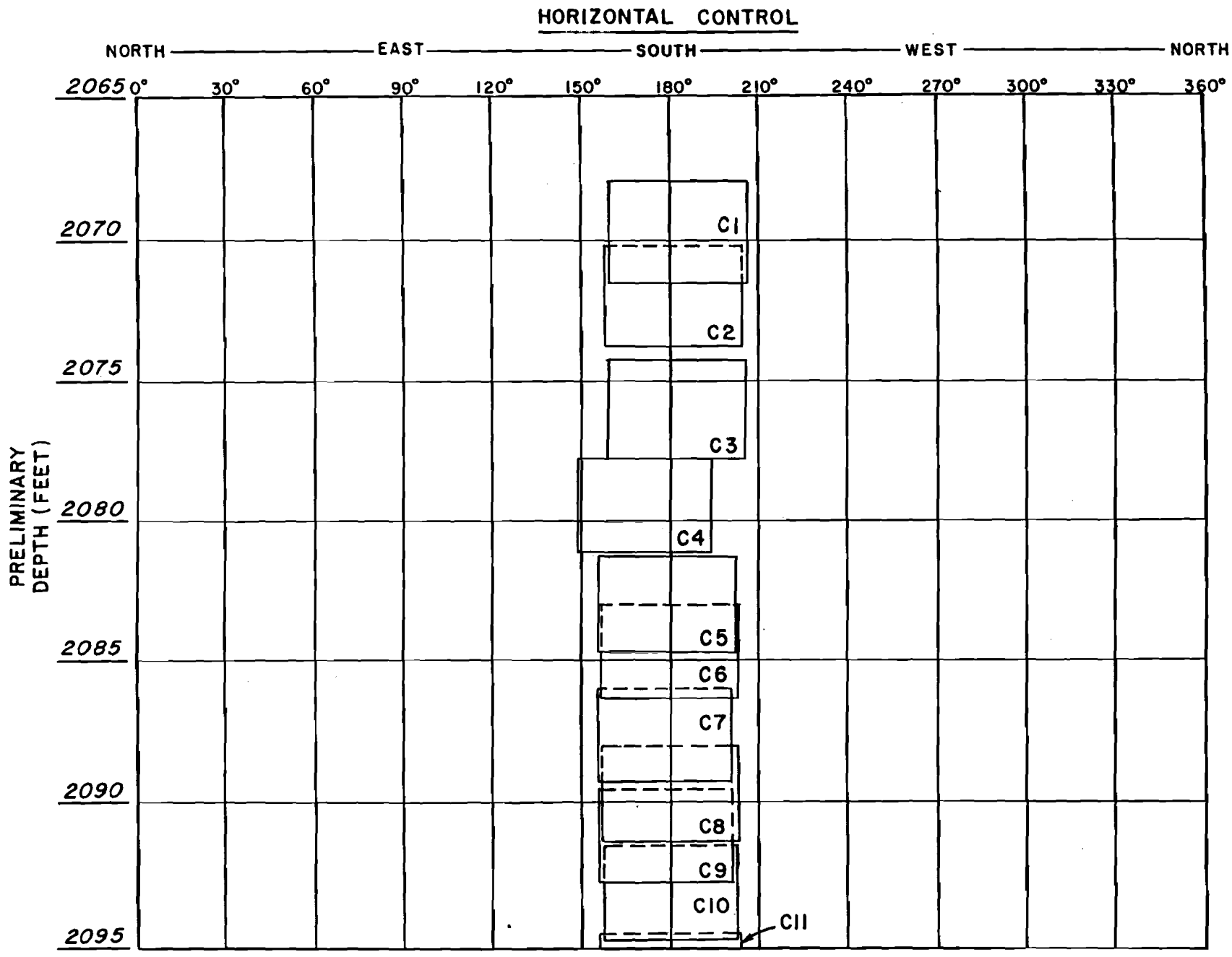
In most of the photographs from Rolls A, B, and C, survey control is provided by a yellow cross painted along the south side of the shaft wall at five-foot intervals and/or a yellow tape that was hung from the 2,100-foot hook for depth (preliminary depth) control. The approximate scale of these photographs is 1 inch equals 4 inches. For the photographs from Rolls D, E, and F, survey control is given by a note (indicating preliminary depth and azimuth of the photograph) attached to a wooden measuring scale. The scale of these photographs is approximately 1 inch equals 8 inches. The white tape appearing on some photographs was hung from near the base of MB 136 at Azimuth 270 degree (west). The zero point of the white tape is at a preliminary depth of 2,033.8± feet on the yellow tape. All depths refer to the preliminary depths indicated on the geologic log. Preliminary depths correspond to the CWI approximate surveying performed during the period March to May 1982. The results of this survey were used during geological mapping. A correction factor of +2.6 feet was determined by comparison of CWI electronic surveying of December 2, 1982 and TSC surveying of January 22, 1983 with the preliminary depths of geologic logs. All depths are based on zero datum point (top of first bunton) at an elevation of 3410.0 feet MSL. Corrected depths and elevations can be calculated as follows:

- Corrected depth = Preliminary depth + 2.6 feet
- Elevation = 3410.0 feet - Corrected depth.

SUBJECT INDEX
WIPP EXPLORATORY SHAFT STATION ZONE PHOTOGRAPHS

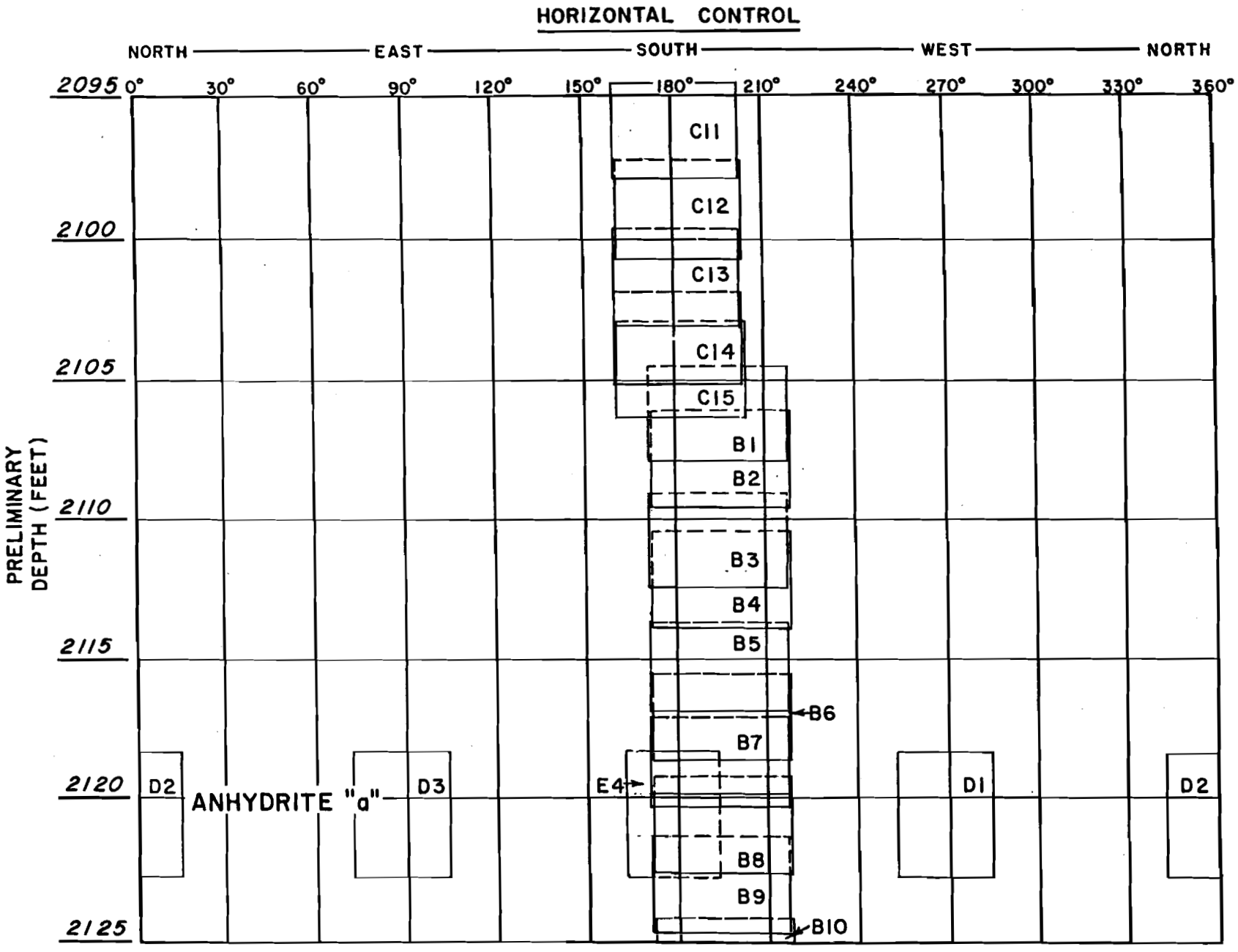
SUBJECT	PHOTOGRAPH NUMBER
Salado Formation at depths from 2070 to 2105 feet[1]	C-1 to C-15
Salado Formation at depths from 2105 to 2137 feet	B-1 to B-15
Salado Formation at depths from 2140 to 2165 feet	A-1 to A-15
Anhydrite "a" at a depth of 2121 feet	D-1 to D-3, E-4
Anhydrite "b" at a depth of 2126.5 feet	E-1 to E-3
Marker Bed 139 at a depth of 2155.0 feet	F-1 to F-4

[1] All depths indicated refer to the preliminary depths on the geologic log.



NOTES: 1. CORRECTED DEPTH = PRELIMINARY DEPTH + 2.6 FT.

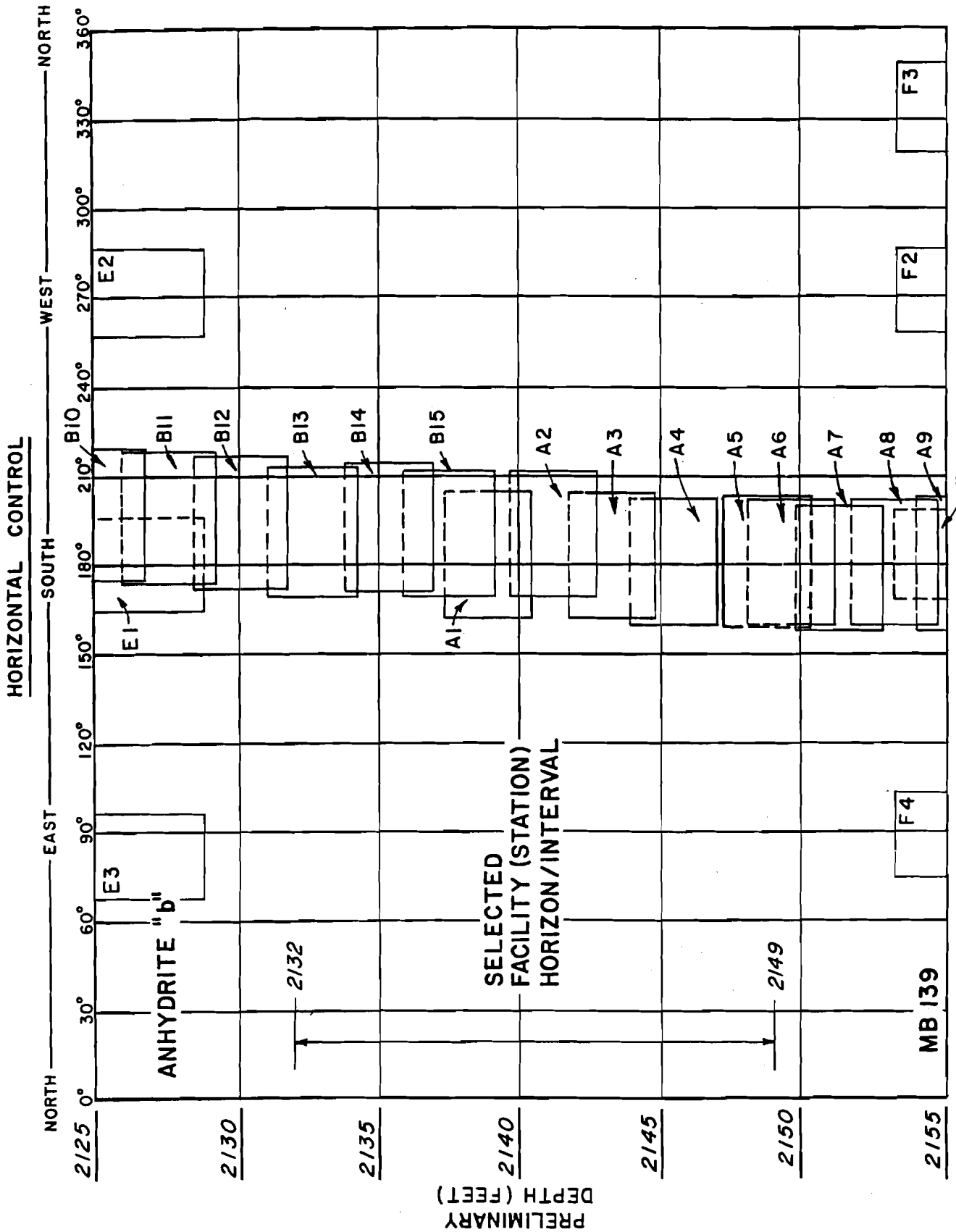
2. THE LOCATIONS SHOWN IN THIS FIGURE ARE APPROXIMATE AND MAY VARY SOMEWHAT FROM THE ACTUAL PHOTOGRAPH LOCATIONS.



NOTES: 1. CORRECTED DEPTH = PRELIMINARY DEPTH + 2.6 FT.

2. THE LOCATIONS SHOWN IN THIS FIGURE ARE APPROXIMATE AND

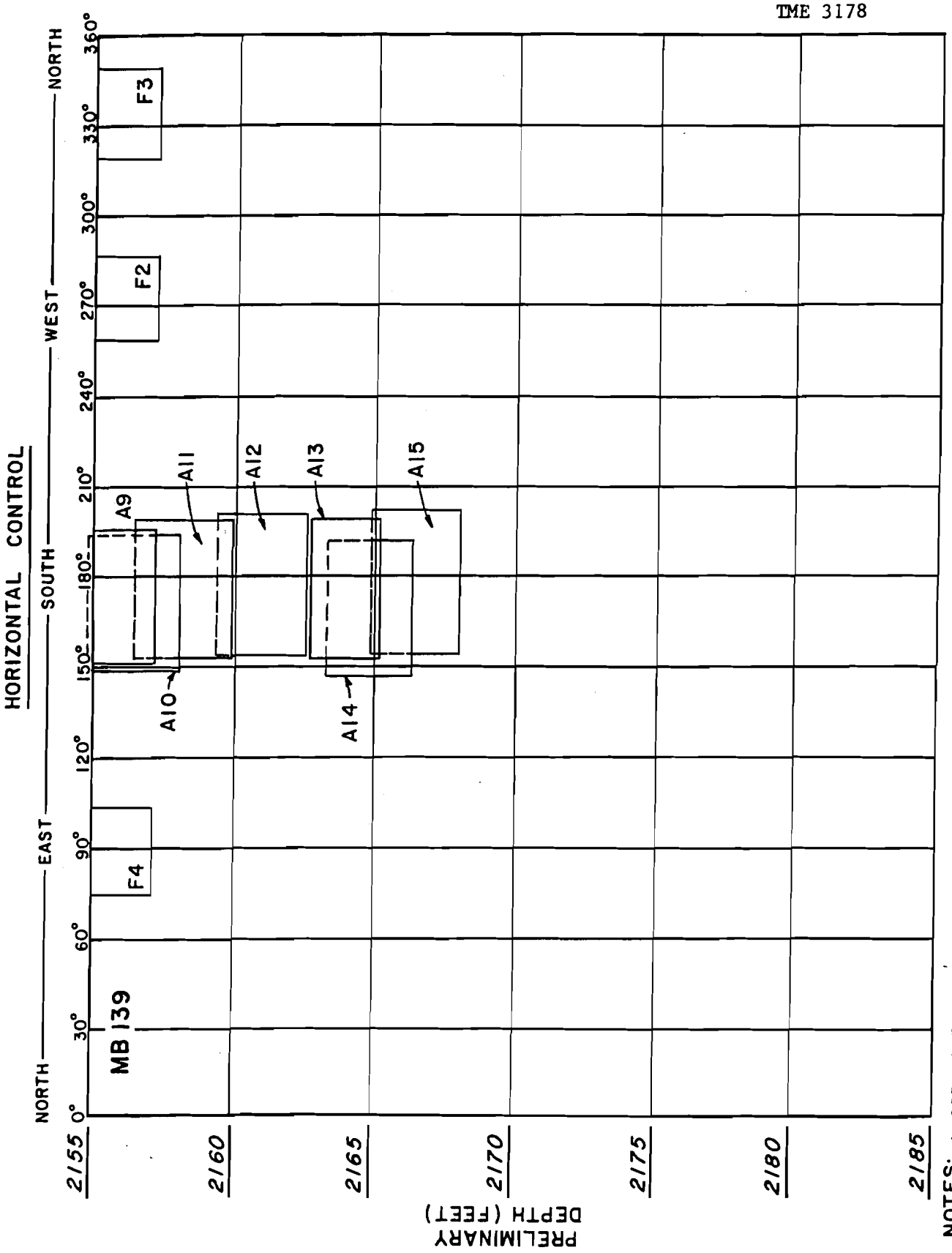
INDEX TO PHOTOGRAPHS OF THE WIPP EXPLORATORY SHAFT-STATION ZONE (CONTINUED)



NOTES: 1. CORRECTED DEPTH = PRELIMINARY DEPTH + 2.6 FT.

2. THE LOCATIONS SHOWN IN THIS FIGURE ARE APPROXIMATE AND MAY VARY SOMEWHAT FROM THE ACTUAL PHOTOGRAPH LOCATIONS.

INDEX TO PHOTOGRAPHS OF THE WIPP EXPLORATORY SHAFT - STATION ZONE



NOTES: 1. CORRECTED DEPTH = PRELIMINARY DEPTH + 2.6 FT.

2. THE LOCATIONS SHOWN IN THIS FIGURE ARE APPROXIMATE AND MAY VARY SOMEWHAT FROM THE ACTUAL PHOTOGRAPH LOCATIONS.

INDEX TO PHOTOGRAPHS OF THE WIPP EXPLORATORY SHAFT - STATION ZONE (CONTINUED)

PHOTOGRAPH DESCRIPTIONS

The following section provides the location and a brief description of each photograph. All depths indicated refer to the preliminary depths on the geologic log.

Photograph A-1
Location: WIPP Exploratory Shaft - depth of 2140 feet at the yellow cross and an azimuth of 180° at the tape.
Comments: Diffuse contact at 2140 feet having halite containing some argillaceous material above and halite containing trace polyhalite and argillaceous material below. Whiter-looking areas caused by a dusty-sandy coating on the wall from the construction activities.

Photograph A-2
Location: WIPP Exploratory Shaft - depth of 2140 feet at the cross near top of photo and an azimuth of 180° at the tape.
Comments: Wall rock of clear halite containing trace disseminated polyhalite and argillaceous material.

Photograph A-3
Location: WIPP Exploratory Shaft - depth of 2143± feet (centerline) and an azimuth of 180° at the tape.
Comments: Wall rock of halite, with argillaceous material, locally contains clay blebs and stringers, trace polyhalite.

Photograph A-4
Location: WIPP Exploratory Shaft - depth of 2145 feet at the cross and an azimuth of 180° at the tape.
Comments: Wall rock of halite, with argillaceous material, locally contains clay blebs and stringers, trace polyhalite.

Photograph A-5
Location: WIPP Exploratory Shaft - depth of 2148.5± feet (centerline) and an azimuth of 180° at the tape.
Comments: Wall rock of halite, with argillaceous material, locally contains clay blebs and stringers, trace polyhalite.

Photograph A-6
Location: WIPP Exploratory Shaft - depth of 2150 feet at the cross and an azimuth of 180° at the tape.
Comments: Wall rock of halite, with argillaceous material, locally contains clay blebs and stringers, trace polyhalite.

Photograph A-7
Location: WIPP Exploratory Shaft - depth of 2150 feet at the yellow cross and an azimuth of 180° at the tape.
Comments: Wall rock of halite with polyhalite (not visible due to debris on the wall) below 2150 feet.

Photograph A-8
Location: WIPP Exploratory Shaft - depth of 2153.8 feet at the top of Marker Bed 139 and an azimuth of 180° at tape.
Comments: Wall rock of halite with polyhalite overlying anhydrite of Marker Bed 139. Note the undulatory upper contact of Marker Bed 139.

Photograph A-9
Location: WIPP Exploratory Shaft - depth of 2155 feet at the yellow cross and an azimuth of 180° at the tape.
Comments: Halite with polyhalite in the top of the photo; remainder of photo is anhydrite (Marker Bed 139).

Photograph A-10
Location: WIPP Exploratory Shaft - depth of 2155 feet at the yellow cross (top of photo) and an azimuth of 180° at the tape.
Comments: Anhydrite (Marker Bed 139) in the upper part of the photo; halite containing some polyhalite in the lower part. White specks on the wall are pieces of styrofoam debris from construction of the key.

Photograph A-11
Location: WIPP Exploratory Shaft - depth of 2160 feet at the yellow cross (bottom of photo) and an azimuth of 180° at the tape.
Comments: Wall rock of halite containing some polyhalite.

Photograph A-12
Location: WIPP Exploratory Shaft - depth of 2160 feet at the yellow cross and an azimuth of 180° at the tape.
Comments: Gradational contact at 2160 feet from halite containing some polyhalite above 2160 feet to halite with polyhalite below (an increase in polyhalite with depth). Black lines are debris left on the wall from former water levels in the shaft.

Photograph A-13
Location: WIPP Exploratory Shaft - depth of 2165 feet at the yellow cross and an azimuth of 180° at the tape.
Comments: Wall rock of halite with polyhalite. White specks on the wall are pieces of styrofoam debris from construction of the key.

Photograph A-14
Location: WIPP Exploratory Shaft - depth of 2165 feet at the yellow cross and an azimuth of 180° at the tape.
Comments: Wall rock of halite with polyhalite from the top of the photo to just below the yellow cross at 2165.5 feet. Irregular and wavy gray clay parting 1/8 to 1/2-inch thick at 2165.5 feet. Clay parting underlain by clear halite containing trace to some argillaceous material and trace polyhalite.

Photograph A-15
Location: WIPP Exploratory Shaft - depth of 2165 feet at the yellow cross and an azimuth of 180° at the tape.
Comments: Wall rock of halite with polyhalite from the top of the photo to just below the yellow cross at 2165.5 feet. Irregular and wavy gray clay parting 1/8 to 1/2-inch thick at 2165.5 feet. Clay parting underlain by clear halite containing trace to some argillaceous material and trace polyhalite.

Photograph B-1
Location: WIPP Exploratory Shaft - depth of 2105 feet and an azimuth of 180° at the yellow cross.
Comments: Wall rock of halite containing trace argillaceous material. Increase in argillaceous content above 2105.3 feet.

Photograph B-2
Location: WIPP Exploratory Shaft - depth of 2108.5± feet (center of photo) and an azimuth 180° at the tape.
Comments: Wall rock of halite containing trace argillaceous material. Thin (up to 1/2 inch thick) discontinuous gypsum/anhydrite seam at 2108.6 feet (middle of the photo).

Photograph B-3
Location: WIPP Exploratory Shaft - depth of 2110 feet and an azimuth of 180° at the yellow cross.
Comments: Wall rock of halite containing some argillaceous material and trace polyhalite. Clay seam with anhydrite (1/4 to 1 1/2-inch thick) at 2110 feet.

Photograph B-4
Location: WIPP Exploratory Shaft - depth of 2112.5± feet (center of photo) and an azimuth of 180° at the tape.
Comments: Wall rock of halite containing some argillaceous material and trace polyhalite.

Photograph B-5
Location: WIPP Exploratory Shaft - depth at 2115 feet and an azimuth of 180° at the yellow cross.
Comments: Gradational contact at 2115.2 feet with halite containing some polyhalite below and halite containing some clay and trace polyhalite above.

Photograph B-6
Location: WIPP Exploratory Shaft - depth of 2115 feet at the yellow mark (top of photo) and an azimuth of 180° at the tape.
Comments: Wall rock of halite containing some polyhalite.

Photograph B-7
Location: WIPP Exploratory Shaft - depth of 2120 feet and an azimuth of 180° at the yellow cross.

Comments: Wall rock of anhydrite from 2119 to 2119.9 feet (see yellow tape) overlain by clear halite containing some polyhalite and underlain by clear halite.

Photograph B-8
Location: WIPP Exploratory Shaft - depth of 2120 feet and an azimuth of 180° at the yellow cross.
Comments: Wall rock of clear halite.

Photograph B-9
Location: WIPP Exploratory Shaft - depth of 2122.5± feet (center of photo) and an azimuth of 180° at the tape.
Comments: Wall rock of clear halite.

Photograph B-10
Location: WIPP Exploratory Shaft - depth of 2125 feet and an azimuth of 180° at the yellow cross.
Comments: Wall rock of anhydrite (anhydrite "b") from 2126.6 to 2126.9 feet (bottom of the photo). Overlain by clear halite.

Photograph B-11
Location: WIPP Exploratory Shaft - depth of 2128 feet (center of photo) and an azimuth of 180° at the tape.
Comments: Wall rock of argillaceous halite and an interbed (top of the photo) of anhydrite (anhydrite "b") from 2126.6 to 2126.9 feet.

Photograph B-12
Location: WIPP Exploratory Shaft - depth of 2130 feet (at the yellow mark) and an azimuth of 180° at the tape.
Comments: Wall rock of halite containing trace argillaceous material and trace polyhalite.

Photograph B-13
Location: WIPP Exploratory Shaft - depth of 2133± feet (center of photo) and an azimuth of 180° at the tape.
Comments: Wall rock of clear halite containing trace argillaceous material and trace polyhalite.

Photograph B-14
Location: WIPP Exploratory Shaft - depth of 2135 feet at the yellow cross and an azimuth of 180° at the tape.
Comments: Wall rock of clear halite containing trace argillaceous material and trace polyhalite.

Photograph B-15
Location: WIPP Exploratory Shaft - depth of 2137.5± feet and an azimuth of 180° at the tape.
Comments: Wall rock of clear halite containing trace argillaceous material and polyhalite in upper part of photo and dark reddish-brown halite with argillaceous material below. below.

Photograph C-1
Location: WIPP Exploratory Shaft - depth of 2070± feet and an azimuth of 180±° (center of photo).
Comments: Wall rock of halite containing trace polyhalite and some argillaceous material.

Photograph C-2
Location: WIPP Exploratory Shaft - depth of 2073± feet and an azimuth of 180±° (center of photo).
Comments: Wall rock of halite, argillaceous in the lower half of the photo. Sample EXS-55 taken from dark brown circular area at the top of the photo. Sample consists of an anhydrite bleb in the halite.

Photograph C-3
Location: WIPP Exploratory Shaft - depth of 2076± feet and an azimuth of 180±° (center of photo).
Comments: Wall rock of argillaceous halite.

Photograph C-4
Location: WIPP Exploratory Shaft - depth of 2080 feet and an azimuth of 180° at the yellow cross.
Comments: Wall rock of halite containing polyhalite and trace to some argillaceous material.

Photograph C-5
Location: WIPP Exploratory Shaft - depth of 2082.5± feet and an azimuth of 180° (center of photo).
Comments: Wall rock of halite with argillaceous material and clay seam (1 to 5 inches thick) across the upper part of the photo.

Photograph C-6
Location: WIPP Exploratory Shaft - depth of 2085± feet and an azimuth of 180±° (center of photo).
Comments: Wall rock of halite with argillaceous material.

Photograph C-7
Location: WIPP Exploratory Shaft - depth of 2087.5± feet and an azimuth of 180±° (center of photo).
Comments: Wall rock of halite with argillaceous material.

Photograph C-8
Location: WIPP Exploratory Shaft - depth of 2090 feet and an azimuth of 180° at the yellow cross.
Comments: Wall rock of halite with argillaceous material.

Photograph C-9
Location: WIPP Exploratory Shaft - depth of 2090 feet and an azimuth of 180° at the yellow cross.
Comments: Wall rock of clear halite becoming argillaceous towards the top of the photo.

Photograph C-10
Location: WIPP Exploratory Shaft - depth of 2093± feet (center of photo) and an azimuth of 180° at yellow cross.
Comments: Wall rock of clear halite.

Photograph C-11
Location: WIPP Exploratory Shaft - depth of 2095 feet and an azimuth of 180° at yellow cross.
Comments: Gray anhydrite bed across the middle of the photo from 2026.0 to 2096.4 feet. Overlain by clear halite; underlain by a thin clay seam at 2096.4 feet and halite containing trace amounts of polyhalite and argillaceous material.

Photograph C-12
Location: WIPP Exploratory Shaft - depth of 2100 feet at the hook and an azimuth of 180° at the tape.
Comments: Wall rock of halite with abundant argillaceous material (increase in argillaceous content from halite in Photograph C-13).

Photograph C-13
Location: WIPP Exploratory Shaft - depth of 2100 feet at the hook and an azimuth of 180° at the tape.
Comments: Wall rock of halite containing argillaceous material.

Photograph C-14
Location: WIPP Exploratory Shaft - depth of 2103.5± feet (centerline) and an azimuth of 180° at the tape.
Comments: Contact at 2104 feet (lower part of the photo) between argillaceous halite below and halite containing some argillaceous material above.

Photograph C-15
Location: WIPP Exploratory Shaft - depth of 2105 feet at the yellow cross and an azimuth of 180° at the tape.
Comments: Contact at 2105.3 feet (immediately below the yellow cross) between argillaceous halite above and halite containing trace argillaceous material below.

Photograph D-1
Location: WIPP Exploratory Shaft - depth of 2121 feet and an azimuth of 270°, as noted on the photo.
Comments: Anhydrite bed (anhydrite "a") approximately 0.7 feet thick, across upper part of photo with a gray clay parting at the base. Underlain by clear halite; overlain by halite containing some polyhalite.

Photograph D-2
Location: WIPP Exploratory Shaft - depth of 2121 feet and an azimuth of 0°, as noted on the photo.
Comments: Anhydrite bed (anhydrite "a"), approximately 0.7 feet thick, across the upper part of the photo with a gray clay parting

at its base. Underlain by clear halite; overlain by halite containing some polyhalite.

Photograph D-3
Location: WIPP Exploratory Shaft - depth of 2121 feet and an azimuth of 90°, as noted on the photo.
Comments: Anhydrite bed (anhydrite "a"), approximately 0.7 feet thick, across the upper part of the photo with a gray clay parting at its base. Underlain by clear halite; overlain by halite containing some polyhalite.

Photograph D-4[1]
Location: WIPP Exploratory Shaft - depth of 885± feet.[2]
Comments: Bottom of wire mesh and rock bolts installed at the base of the key from a depth of 880 to 886 feet.

Photograph D-5[1]
Location: WIPP Exploratory Shaft - depth of 847± feet.[2]
Comments: Connection between the steel lining above and the concrete portion of the key.

Photograph E-1
Location: WIPP Exploratory Shaft - depth of 2126.5 feet and an azimuth of 180°, as noted on the photo.
Comments: Anhydrite bed (anhydrite "b") across the middle of the photo with a gray clay parting at its base. Underlain by clear halite containing trace argillaceous material and trace polyhalite; overlain by halite.

Photograph E-2
Location: WIPP Exploratory Shaft - depth of 2126.5 feet and an azimuth of 270°, as noted on the photo.
Comments: Anhydrite bed (anhydrite "b") across the middle of the photo with a gray clay parting at its base. Underlain by clear halite containing trace argillaceous material and trace polyhalite; overlain by halite.

Photograph E-3
Location: WIPP Exploratory Shaft - depth of 2126.5 feet and an azimuth of 80°, as noted on the photo.
Comments: Anhydrite bed (anhydrite "b") across the middle of the photo with a gray clay parting at its base. Underlain by clear halite containing trace argillaceous material and trace polyhalite; overlain by halite.

Photograph E-4
Location: WIPP Exploratory Shaft - depth of 2121 feet and an azimuth of 180°, as noted on the photo.

---

(1) Photograph is included in the "Key Zone" volume of photographs.
(2) No azimuth recorded - photograph was taken without horizontal control from a fast moving bucket.

Comments: Anhydrite bed (anhydrite "a"), approximately 0.7 feet thick, across the upper part of the photo with a gray clay parting at its base. Underlain by clear halite; overlain by halite containing some polyhalite.

Photograph F-1
Location: WIPP Exploratory Shaft - depth of 2155 feet and an azimuth of 180°, as noted on the photo.
Comments: Marker Bed 139 consisting of banded anhydrite, locally polyhalitic, across the middle of the photo. Underlain and overlain by polyhalitic halite.

Photograph F-2
Location: WIPP Exploratory Shaft - depth of 2155 feet and an azimuth of 270°, as noted on the photo.
Comments: Marker Bed 139 consisting of banded anhydrite, locally polyhalitic, across the middle of the photo. Underlain and overlain by polyhalitic halite.

Photograph F-3
Location: WIPP Exploratory Shaft - depth of 2155 feet and an azimuth of 340°, as noted on the photo.
Comments: Marker Bed 139 consisting of banded anhydrite, locally polyhalitic, across the middle of the photo. Underlain and overlain by polyhalitic halite.

Photograph F-4
Location: WIPP Exploratory Shaft - depth of 2155 feet and an azimuth of 90°, as noted on the photo.
Comments: Marker Bed 139 consisting of banded anhydrite, locally polyhalitic, across the middle of the photo. Underlain and overlain by polyhalitic halite.

APPENDIX E
SURVEYING NOTES

APPENDIX E
SURVEYING NOTES

1. All present surveying at the WIPP plant site is tied to stabilized baselines, the data for which are shown on Bechtel Drawing No. 21-C-011, Rev. 7, submitted on August 13, 1982.

2. A precision depth survey, performed by CWI on December 2, 1982 using an advanced electronic distance measurement (EDM) instrument (Lietz Model RED-2), established definitive elevations in the shaft and station area. Also, a loop through the ventilation shaft was closed with satisfactory results. This survey was based on CWI Bench Mark No. CW-1 at an elevation of 3410.080 feet MSL (brass cap outside the exploratory shaft collar) which was tied to the existing "North Base Line" north of the site.

3. To correlate the geological features with the established elevations, an additional survey was performed by TSC-D'Appolonia geologists on January 22, 1983. A 200-foot fiberglass tape was hung in seven intervals starting at RC Instrument Level 814, and relative depths of selected recognizable geological features together with instrument levels and other significant features (such as shaft key features, surveying hooks from the preliminary CWI survey, etc.) were recorded. This survey showed very good correlation with the EDM data for the zone between the bottom of the shaft key concrete and the steel deck in the station. The elevation of the steel deck was tied to CWI Bench Mark No. 82-D (brass cap at the northwest corner of the underground power center foundation) at an elevation of 1259.59 feet MSL. The tape survey was 0.65 foot longer than the EDM survey over a total distance of 1,272 feet, a difference of only 0.05 percent.

4. Geological mapping (logging) of the exploratory shaft, performed from March through May 1982, was based on CWI preliminary depths (a

100-foot tape hung from hooks installed at about 100-foot intervals along the south wall of the shaft). The zero datum point was the top of the first bunton at an elevation of 3410.00 feet MSL. A survey mark (yellow cross) was spray painted on the south wall of the shaft below the steel liner every five feet in the vertical direction.

5. The horizontal control during the geologic mapping of the key and station zones was based on surveying hooks set along the south side of the shaft. Three yellow crosses were spray painted every 5 feet on the 12-foot circumference (with adjustment for variable shaft diameter) on both sides from the south line. The remaining length was split in half to obtain north. A hand level was used for vertical control on these crosses. Many of the crosses are visible on the photographs (or plates where they represent the preliminary depths. The sidelines (4 plumb lines hanging from the shaft collar) could not be used for horizontal control because they were they were catching on the galloway and not hanging freely.

6. To identify the depth corrections, the geological data and available records on the preliminary CWI depths were analyzed and compared to the new surveys. This resulted in the establishment of the "best fit" correction factors as summarized in Table 3 of this report. The depths within each interval between the depths indicated in Table 3 have been corrected by interpolation. Although there is evidence that interpolating in this manner creates minor errors, the method was used for its clarity and simplicity; the potential errors have been minimized as much as possible. Depths or elevations for a given point are believed to be generally accurate to within ±0.25 foot (±3 inches). This level of accuracy reflects the undulations and other irregularities of geological features, deformation due to

stress relief,[1] and the conditions under which the geological and surveying data were obtained. Thicknesses of thin layers or individual beds can be reported with greater accuracy since thicknesses are determined as the differences between geologic contacts and are not related to artificial control points.

[1] From the time geotechnical instrumentation was installed in the vicinity of the station zone to February 1983, the maximum measured deformation was approximately 0.2 foot (2-1/2 inches).

APPENDIX F

BACKGROUND - FACILITY INTERVAL SELECTION PROCESS AND CRITERIA

APPENDIX F

BACKGROUND - FACILITY INTERVAL SELECTION PROCESS AND CRITERIA

LIST OF ATTACHMENTS

ATTACHMENT NO.	TITLE/SUBJECT	PAGE
F/1	SNL Memo on "Horizon Selection Criteria," July 25, 1979	F-4
F/2	Attachment B to Conference Notes No. BSCN-132 on "ERDA-9 Core Examination and Horizon Selection Alternatives," July 31, 1979	F-6
F/3	Selection of Final Station Depth (Appendix C of the Site Validation Field Program Plan)	F-7

APPENDIX F

BACKGROUND - FACILITY INTERVAL SELECTION PROCESS AND CRITERIA

The preliminary WIPP facility interval selection process and criteria were developed in 1979 by representatives of the project participants including: Bechtel, WIPP-TSC/Westinghouse and D'Appolonia, Sandia National Laboratories, U.S. Geological Survey, and U.S. DOE-WIPP project office.

The bases for facility interval selection are summarized in graphic form as Attachment F/1.[1] The criteria are represented by distances between the openings (rooms) and the nearest overlying or underlying clay seams or partings.

The interval selection was based on (1) correlation of available drillholes from the WIPP site, specifically on a review of core, geologic, and geophysical logs from Drillhole ERDA-9, and (2) consideration of the selection criteria. Seven potential locations/levels were identified and ranked based on evaluation of their suitability in terms of waste containment, cost to construct, potential mining problems, etc. Options are shown in Attachment F/2.

OPTION NO.	LOCATION
1 and 2	Above MB 139
3, 4, and 5	Between MB 139 and 140
6	Between MB 140 and 141
-[2]	Below Cowden anhydrite

[1] The 1979 WIPP concept considered a two-level underground facility: (1) for the contact handled (CH) material; and (2) for the remote handled (RH) material.

[2] This option is shown without any designation.

The design of the facility is based on Alternative No. 1, i.e., above MB 139. At the time of preparation of the Site Validation Field Program Plan in 1982, the WIPP concept was for only a single-level facility; thus, the criteria were modified as shown in Attachment F/3.

TME 3178

ATTACHMENT F/1

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date: July 25, 1979

to: R. L. Rudolph, WPO, DOE/ALO

Leo W Scully

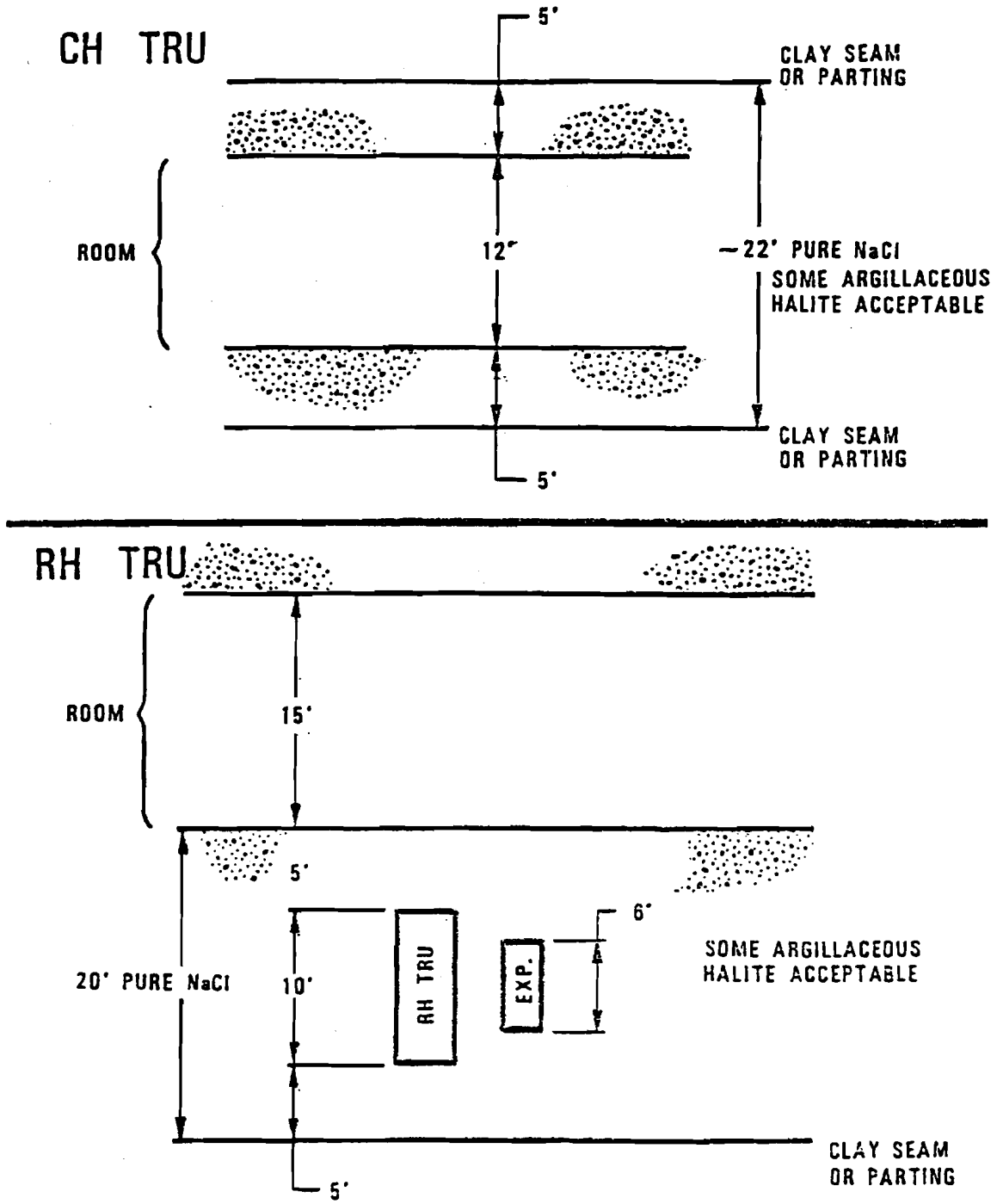
from: L. W. Scully, 4541

subject: Horizon Selection Criteria

Attached is a cleaned-up version of the pencil sketch of horizon selection criteria generated during the meeting on July 20 with WPO, Bechtel, Westinghouse and SLA. The notes that have been added are intended to represent only waste containment needs and not mine design. Any additional mine design criteria necessary for back support, floor heave or stability, will have to be applied over and above those listed.

LWS:4541:gc

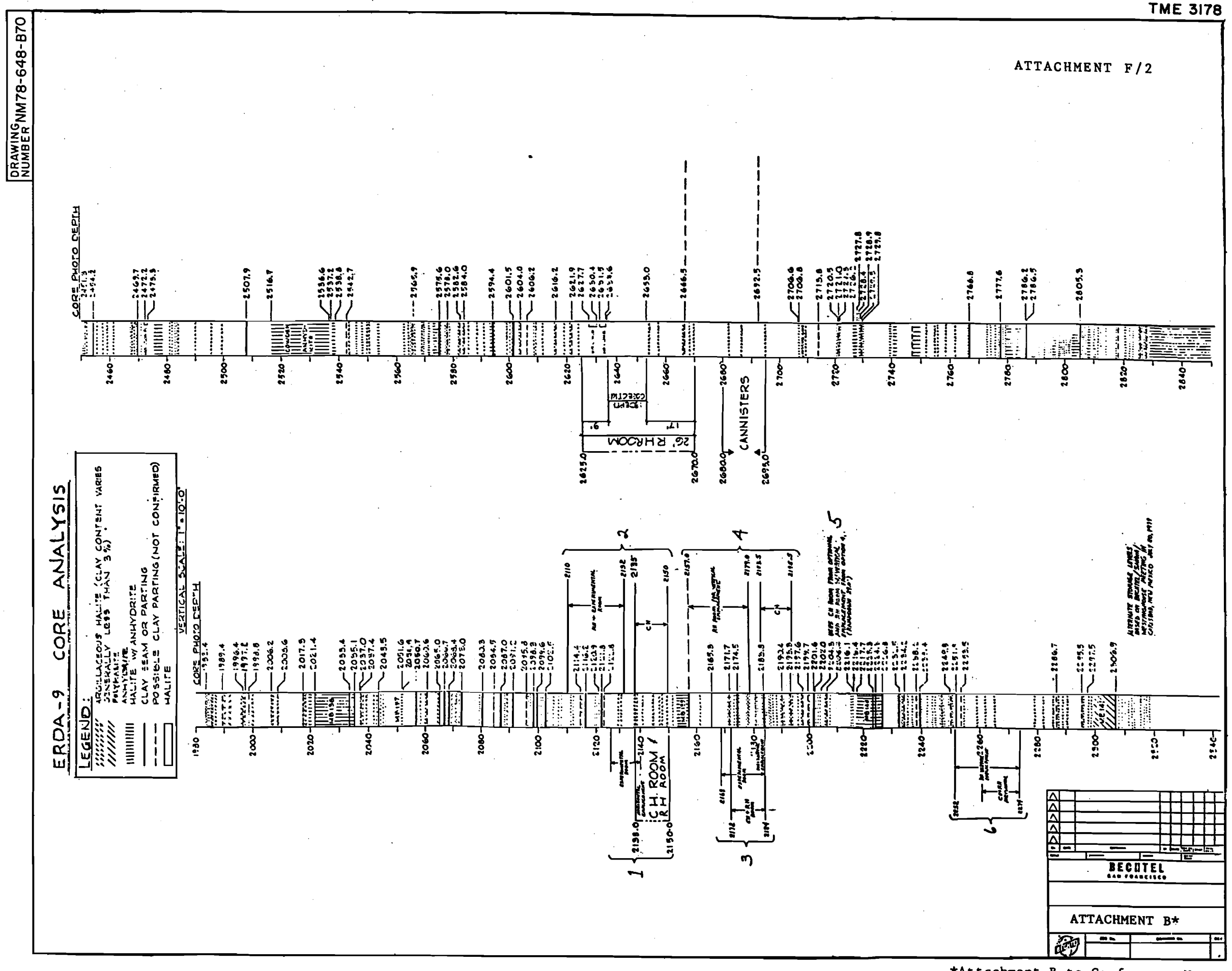
Copy to:
D. L. Hulbert, Westinghouse
R. A. Langley, Bechtel
4510 W. D. Weart
4511 D. W. Powers
4541 M. D. DeWitte
4541 L. W. Scully



ROUGH DRAFT
HORIZON SELECTION CRITERIA

Sandia Laboratories
7/20/79

ATTACHMENT F/2



*Attachment B to Conference Notes No. BSCN-132 on July 20, 1979

ATTACHMENT F/3

APPENDIX C
SELECTION OF FINAL SHAFT STATION DEPTH

C.1.0 PURPOSE

The preliminary depth for the floor of the shaft station was originally selected as 2162 feet based on the stratigraphy encountered in the nearest deep borehole (ERDA 9) to the exploratory shaft (Drawing No. 37-X-002; DOE/Bechtel, 1981). However, due to regional dip and local stratigraphic variations in the subsurface geology between ERDA 9 and the exploratory shaft, the final shaft station depth will differ from this preliminary depth somewhat. Preliminary information based on the geophysical logs and the video tape of the exploratory shaft indicate that the preliminary depth may need to be adjusted to an approximate depth of 2150 (Figure C-1). Consequently, selection of the final shaft station depth will be based on the actual subsurface stratigraphy observed in the exploratory shaft and within the framework of the criteria described below.

C.2.0 CRITERIA USED IN FINAL SHAFT STATION HORIZON SELECTION

Based on the subsurface geology encountered in the exploratory shaft, the following criteria shall guide the selection of the final shaft station depth:

- Rock containing no significant dissolution features, faults, and fractures. Presence of such features would require further detailed investigation.
- Minimum of 4 feet between top of MB 139 and the facility floor (modified from Sandia, 1979). The undulatory upper contact of MB 139 shall be considered in selection of the facility floor level.
- A 14 1/2-foot section of halite for construction of nominally 13-foot high rooms (modified from Sandia, 1979). Minor impurities, such as argillaceous halite and polyhalite, may be acceptable.
- Minimum of 5 feet between roof of facility and nearest clay seam (1/4 inch thick) for the purposes of roof stability (Sandia, 1979).

Rev. 1.2

- Avoidance of horizons containing substantial amounts of polyhalite.

Inconsistancy with any of the above criteria does not necessarily imply that the horizon is unacceptable, rather that such a condition and its impact require further detailed investigation.

C.3.0 INVESTIGATIVE PLAN

Detailed geologic mapping of the exploratory shaft from approximately 2100-foot to 2200-foot depth will be performed to provide a basis for final horizon depth selection. The geologic mapping will be conducted in accordance with the mapping procedures described in Appendix A.

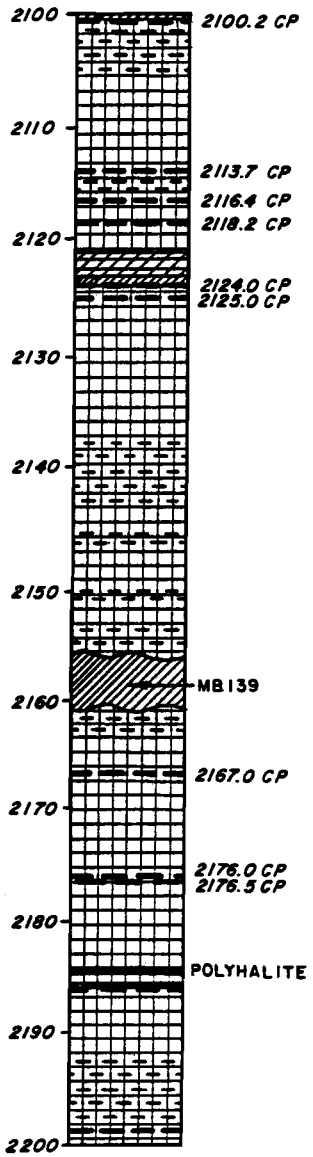
The main steps leading to selection of final shaft station depth include:

1. Inspection and detailed mapping at a scale of 1 inch equals 5 feet, or equivalent detail, of the exploratory shaft between approximately 2100- and 2200-foot depth. The mapping will focus on the location and character of MB 139, the stratigraphy, any clay partings and seams, vugs or cavities, and any structural discontinuities.

2. Comparison of actual subsurface conditions in the shaft and of the predicted geologic conditions. The predicted geology is shown in Figure C-1 and is derived from the rock encountered in ERDA 9 and the geophysical logs from the exploratory shaft.

3. Modification of the proposed depth as needed by application of the depth criteria (Section 2.0, Appendix C) and engineering judgment to the actual subsurface geology.

4. TSC personnel, in conjunction with Bechtel and SNL, shall make a recommendation to the DOE as to the final depth selection for the shaft station.



EXPLANATION

- HALITE
- HALITE, ARGILLACEOUS
- ANHYDRITE
- HALITE, ANHYDRITIC
- CLAY PARTING (C P)

NOTES

1. *DEPTH OF MB139 ESTIMATED FROM GEOPHYSICAL LOGS OF EXPLORATORY SHAFT.*
2. *STRATIGRAPHY BASED ON ERDA 9 BOREHOLE, BUT SHIFTED AS PER GEOPHYSICAL LOGS OF EXPLORATORY SHAFT.*

FIGURE C-1

PREDICTED GEOLOGY
IN THE SHAFT
FROM 2100-TO 2200-FOOT DEPTH