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GEOTECHNICAL ACTIVITIES IN THE EXHAUST SHAFT

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GEOTECHNICAL ACTIVITIES IN THE EXHAUST SHAFT

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EXECUTIVE SUMMARY

The exhaust shaft at the Waste Isolation Pilot Plant (WIPP) site was a conventional mining-slashing enlargement of an upreamed shaft. Geotechnical activities in the exhaust shaft were designed to provide additional confirmation of the stratigraphic details that exist in the strata overlying the WIPP underground facility, provide detailed information about the geology in identified zones of interest, confirm the geology of planned instrument levels and locations, and provide a basis for field adjustment and modification of key and aquifer seal design. These activities were carried out concurrently with construction during the period from July 16, 1984 through January 18, 1985.

The exhaust shaft penetrates thin surficial deposits and five formations: the Gatuña Formation of Quaternary age, the Santa Rosa Sandstone of Triassic age, and a Permian age section consisting of the Dewey Lake Redbeds, the Rustler Formation, and the Salado Formation. The entire shaft section from the surface to the facility level was geologically mapped. Ten preselected zones of special interest were mapped in detail. Gypsum-filled fracture systems in three zones in the Dewey Lake Redbeds were mapped in detail as follows:

- The depth interval from 195.0 to 210.0 feet (Figure 6)
- The depth interval from 269.0 to 280.5 feet (Figure 7)
- The depth interval from 353.5 to 375.0 feet (Figure 8).

Seven zones were located in or adjacent to the Rustler Formation:

- The Dewey Lake/Rustler contact (546.5 feet, Figure 9)
- The Forty-Niner Member claystone (575.5 to 586.5 feet, Figure 10)
- The Magenta Dolomite Member (602.5 to 627.0 feet, Figure 10)
- The Tamarisk Member claystone (689.0 to 695.5 feet, Figure 11)
- The Culebra Dolomite Member (713.5 to 736.0 feet, Figure 11)
- The upper portion of the unnamed lower member (736.0 to 800 feet, Figure 11)
- The Rustler/Salado Formation contact and the keyway (845.0 to 912.0 feet, Figure 12).

The stratigraphy observed in the exhaust shaft correlates well with that observed in the waste handling shaft.

Minor fluid-producing zones were observed within the Magenta and Culebra Dolomite Members of the Rustler Formation. The shaft key and aquifer seals were adjusted downward between seven and nine feet as a result of the observed geology.

1.0 INTRODUCTION

The Waste Isolation Pilot Plant (WIPP) project is a Department of Energy (DOE) research-and-development facility constructed to demonstrate the safe disposal of radioactive wastes derived from the defense activities of the United States. The WIPP project's mission consists of two parts. The first is to demonstrate the safe handling and disposal of transuranic (TRU) waste in bedded salt. The second is to create a research facility for in-situ examination of the technical issues related to the emplacement of defense-related radioactive waste in bedded salt.

The WIPP facility is located approximately 26 miles east of Carlsbad, New Mexico in an area known as Los Medanos (Figure 1). The underground portion of the facility is located at a depth of approximately 2,150 feet in the bedded salt deposits of the Salado Formation (Figure 2). An extensive program of site characterization and validation has been conducted for the past nine years (1976-1985). The results of these studies are summarized in the WIPP "Geological Characterization Report" (Powers et al., 1978), the WIPP "Safety Analysis Report" (DOE, 1980), the WIPP "Preliminary Design Validation Report" (Bechtel, 1983), and the WIPP "Results of Site Validation Experiments" (Black et al., 1983). Additional site investigations are being conducted as part of an ongoing program to further refine the understanding of the site-specific geology. The geotechnical activities conducted in the exhaust shaft are part of this program.

The exhaust shaft will provide a pathway for the release of exhaust air from the facility to the surface. The shaft is an enlargement of a six-foot diameter, upreamed shaft. The finished diameter is 14 feet in the lined portion of the shaft and 15 feet minimum in the unlined portion. Geotechnical activities consisting of reconnaissance geologic mapping, detailed geologic mapping in specific zones of interest, geologic confirmation of instrument locations, and field adjustment and modification of the key and aquifer seal design were performed concurrently with construction from July 16, 1984 to January 18, 1985. This report presents and discusses the findings from the geologic mapping efforts in the exhaust shaft. Also, the construction history of the exhaust shaft is summarized, and several engineering geology characteristics are discussed.

1.1 SCOPE OF WORK

The detailed scope of work is presented in the January 12, 1984 Work Plan of Geotechnical Activities in the Waste and Exhaust Shafts (Appendix A). The objectives of the geotechnical activities are as follows:

- Provide additional confirmation and documentation of the strata overlying the WIPP facility horizon.
- Provide detailed information of the gypsum-filled fractures in the Dewey Lake Redbeds.
- Provide detailed information of the geologic conditions in the Rustler Formation in the vicinity of the Dewey Lake/Rustler Formation contact, the Forty-Niner Member claystone, the Magenta Dolomite Member, the Tamarisk Member claystone, the Culebra Dolomite Member, the upper portion of the unnamed lower member, the Rustler/Salado Formation contact, and keyway interval.
- Confirm the geology of planned geomechanical instrument levels/locations.
- Provide a basis for field adjustment and modification of key and aquifer seal design, based on the observed geology.

The geotechnical activities performed to fulfill these objectives included:

- Reconnaissance geologic mapping of the exposed shaft surface during sinking operations.
- Detailed, 360 degree geologic mapping of identified zones of interest.
- Geologic confirmation of planned instrument locations during the aforementioned activities.

Reconnaissance geologic mapping was performed throughout the entire shaft section, with the exception of the zones mapped in detail. Detailed, 360 degree geologic mapping was performed in previously identified zones of interest in the Dewey Lake Redbeds and the Rustler Formation. Three zones containing abundant gypsum filled fractures were selected in the Dewey Lake

Redbeds. Seven zones were selected in the Rustler Formation. In addition, the keyway interval was designated as a zone of interest and mapped in detail. These zones were selected because of possible dissolution origin or hydrologic significance.

1.2 METHODOLOGY

1.2.1 Reconnaissance Geologic Mapping

Reconnaissance geologic mapping was performed concurrently with construction on a non-interference basis in the lined portion of the shaft (from 0 to 907 feet). During each construction cycle, the freshly exposed strata were mapped using the galloway (Figure 3) as the work platform. The lithology observed was measured and described; the entire exposed interval was photographed, and when possible, representative samples were taken.

In the concrete-lined portion of the shaft, the construction cycle consisted of: a) excavation (drilling and blasting), and b) liner construction (pouring concrete in the curb ring and main forms). Exactly 24 feet of the concrete liner was poured during each construction cycle. After excavation, the curb ring was set prior to the pouring of the concrete. At that time, the strata in the interval between the base of the previous pour and the base of the new pour were mapped (Figure 3).

In the unlined portion of the shaft (below 907 feet), reconnaissance geologic mapping could not be performed on a non-interference basis due to the unpredictable nature of the construction cycle. The construction cycle in the unlined portion (i.e., lined only with rock-bolted wire mesh) of the shaft consisted of: a) excavation (similar to lined portion), and b) "hanging" wire mesh. The inability to maintain vertical control and the inconsistent positioning of the galloway during this phase of construction deterred mapping on a non-interference basis. As a result, dedicated shaft time was purchased from the construction contractor (Ohbayashi-Gumi Ltd.) to allow a mapping team of three to four geologists full control of the shaft. Reconnaissance mapping was done on a weekly basis in the unlined portion of the shaft. The entire unlined portion of the shaft was mapped in a total of six exercises averaging about five hours in length. Up to 250 feet of exposed section was mapped at any one time. A vertical strip, approximately five feet wide, of the entire mapping interval was cleaned and mapped.

Vertical survey control was provided by the contractor during both phases of shaft construction. As the shaft liner was constructed, the depth to the base of each successive pour was provided by the contractor and vertical control for mapping was then established from the base of the previous pour. During construction of the unlined portion of the shaft, the contractor's need to maintain vertical control decreased and vertical control was established with survey chains hung from contractor-supplied survey control points.

The procedural guide used for the reconnaissance geologic mapping is outlined by McKinney and Newton (1983) in the "Site Validation Field Program Plan". In the Salado, reconnaissance field maps were drawn on predrafted sheets of gridded mylar at a scale of one inch equals ten feet.

1.2.2 Detailed Geologic Mapping

Dedicated shaft time was purchased from the construction contractor (Ohbayashi-Gumi, Ltd.) to allow mapping teams of four to six geologists full control of the shaft during detailed mapping exercises. Field maps were drawn on blank, gridded mylar at a scale of one inch equals five feet. Vertical control was established from the base of the previous pour, and horizontal lines were spray-painted at five-foot intervals around the circumference of the shaft. Horizontal control and the southernmost point in the shaft were established using the contractor's plumb lines (side lines). A vertical line was spray-painted at the southernmost point of the shaft, and the shaft wall was marked with spray-painted vertical lines at five-foot intervals both east and west of the south line around the circumference of the shaft. This procedure established a five-foot by five-foot grid on the shaft surface.

Accurate map locations of lithologic contacts and features were established using the grid for survey control. The grid also provided a means for identifying locations of samples, features of specific interest, and photographs of the shaft wall. Photographic coverage of each mapped interval was provided for the full circumference of the shaft. All samples were marked with an azimuth and an up arrow, so they can be properly oriented. The samples are cataloged in Appendix B.

1.3 SHAFT CONDITIONS

During the geotechnical activities in the exhaust shaft, a galloway was utilized as the main work platform (Figure 3). The galloway is a steel structure 12 feet in diameter, consisting of three levels or decks. The galloway is raised and lowered by two cables operating on a system separate from the main hoist. The main hoist provides access from the surface to the galloway via a cage.

To assure the optimum observations, geologic mapping exercises were performed as soon as possible after the shaft surface was exposed. However, the shaft wall was often coated with dust from blasting and/or concrete spill-over from the shaft liner construction. In some cases, the shaft wall was covered with rock-bolted wire mesh to prevent spalling, and occasionally material caught behind the mesh totally obscured the lithology. During reconnaissance geologic mapping in the lined portion of the shaft, the walls of the shaft could not be cleaned or washed, as this would interfere with construction progress. However, the shaft surface was washed prior to each detailed mapping exercise when the mapping team had full control of the shaft.

2.0 CONSTRUCTION HISTORY

The exhaust shaft is an enlargement of a six-foot diameter upreamed (raise-bored) shaft. The initial up-reaming or raise-boring was done by two companies: Raisebor, Inc. and J.S. Redpath Co. The construction contractor (Ohbayashi-Gumi, Ltd) employed a conventional mining-slashing method to enlarge the original six-foot diameter shaft to a 14-foot diameter in the lined portion and a 15-foot minimum diameter in the unlined portion. The pilot hole was completed during the period from September 22, 1983 to December 16, 1983. The raise-boring of the exhaust shaft commenced on December 31, 1983 and was completed on February 10, 1984. Excavation for the exhaust shaft collar began on July 15, 1984. The collar liner plate was installed and the concrete backfill was poured on July 17, 1984. The shaft was lined with concrete from the top of the collar to the base of the shaft key at a depth of 907 feet. Concrete liner construction began on July 18, 1984 and was completed on November 29, 1984.

As part of the shaft design, both the Magenta and Culebra Dolomite Members of the Rustler Formation were covered with liner plate prior to the pouring of the concrete liner. The liner plate provided for a temporary void between the rock surface and the concrete lining to prevent hydrostatic pressure buildup before the concrete lining had reached its full strength. After the concrete lining had reached full strength, the area behind the liner plate was grouted to seal off possible fluid inflow. The Culebra was grouted during the period from December 2 to December 4, 1984, and the Magenta was grouted during the period from December 4 to December 5, 1984. Rock-bolted wire mesh was installed in the unlined portion of the shaft. Construction in this phase began on December 7, 1984. On January 17, 1985, excavation in the exhaust shaft was completed to the WIPP underground facility at a depth of approximately 2150 feet. A summary of the exhaust shaft construction history is given in Table 1.

3.0 EXHAUST SHAFT GEOLOGY

3.1 GEOLOGIC MAPPING RESULTS

Geologic mapping was performed using two levels of effort: reconnaissance or detailed mapping. Reconnaissance geologic mapping was performed in all shaft sections not mapped in detail. The results of the reconnaissance geologic mapping are presented in Figure 4. Twenty-five samples were taken during reconnaissance geologic mapping exercises and are cataloged in Appendix B-1.

A higher level of mapping detail was provided by detailed, 360 degree mapping of specific zones of interest. The goals for the detailed mapping in the exhaust shaft were to provide (1) an initial data base of information gathered from in-situ gypsum filled fractures in the Dewey Lake Redbeds, and (2) detailed information concerning previously identified zones of interest.

The gypsum-filled fractures in the Dewey Lake Redbeds are well exposed in both the exhaust and waste shafts. Three intervals containing representative sections of Dewey Lake fractures were selected to be mapped in detail in the exhaust shaft:

- The depth interval from 195.0 to 210.0 feet (Figure 6)
- The depth interval from 269.0 to 280.5 feet (Figure 7)
- The depth interval from 353.5 to 375.0 feet (Figure 8).

These zones were mapped in detail, and the fractures and morphology of their fillings were described. When viewing the figures, it is important to note that only mappable fractures were described, and many fractures were not mapped as they were too small to be included on a map of the entire circumference of the shaft. The lithology of these intervals was reconnaissance mapped in an effort to conserve the amount of time purchased from the construction contractor.

Detailed mapping in the remainder of the shaft section was performed in previously identified zones of interest, as follows:

- The Dewey Lake/Rustler contact (546.5 feet, Figure 9)

- The Forty-Niner Member claystone (575.5-586.5 feet, Figure 10)

- The Magenta Dolomite Member (602.5-627.0 feet, Figure 10)
- The Tamarisk Member claystone (689.0-695.5 feet, Figure 11)
- The Culebra Dolomite Member (713.5-736.0 feet, Figure 11)
- The upper portion of the unnamed lower member (736.0-800 feet, Figure 11)
- The Rustler/Salado Formation contact and the keyway (845.0-912.0 feet, Figure 12).

The data obtained from detailed mapping efforts are presented in Figures 6 through 12. A total of 255 samples were collected during the detailed mapping efforts and are cataloged in Appendix B-2.

In general, the exhaust shaft mapping results correlate well with the geology in the waste handling shaft. Minor exceptions do occur, as the geology appears to vary slightly laterally. Other minor discrepancies are the result of more complete and accurate descriptions during the exhaust shaft mapping as the amount of time available for reconnaissance geologic mapping was greater than that provided for the geologic inspections in the waste handling shaft. Unlike the geologic inspections in the waste handling shaft which confirmed previously mapped strata (Holt and Powers, 1984), the descriptions in the exhaust shaft were completely independent of previously collected data.

3.2 EXHAUST SHAFT STRATIGRAPHY

The exhaust shaft penetrates surficial deposits consisting of Quaternary dune sands and the Mescalero caliche and five formations. In descending order, they are the Gatuña Formation of Quaternary age, the Santa Rosa Sandstone of Triassic age, and the Dewey Lake Redbeds, the Rustler Formation, and the Salado Formation, all of Permian age (Figure 5).

3.2.1 Quaternary Dune Sand

The most recent wide-spread sedimentary deposit in the WIPP site area is a thin blanket of windblown sand. The sand, known locally as the Mescalero sand

(Vine, 1963), occurs as relatively inactive dunes, except in areas where local blowouts occur.

Nearly eight feet of unconsolidated sand occurs at the exhaust shaft. This sand is reddish-brown, silty, and poorly sorted. The majority of the grains are subangular. Less than ten percent of the grains are mafic.

3.2.2 Mescalero Caliche

The Mescalero caliche is an informal stratigraphic unit which derives its name from the Mescalero plain. It is an areally extensive pedogenic petrocalcic horizon that began to form 510,000 years ago (Bachman, 1985).

The Mescalero caliche is 9.5 feet thick in the area of the exhaust shaft. The upper one-foot of the caliche is very hard, and the hardness and overall degree of induration decrease with depth. It also becomes nodular with depth, and the size of the nodules increases with depth. Locally, siltstone and sandstone are engulfed by the caliche. Chert and sandstone pebbles are engulfed higher in the section, and large zones of sand are engulfed at the base.

3.2.3 Gatuña Formation

The Gatuña Formation was named by Robinson and Lang (1938). In the WIPP site area the Gatuña is represented by a thin veneer of fluvial sandstone that is locally absent (Powers et al., 1978). The upper part of the formation is middle Pleistocene in age (Bachman, 1980).

The Gatuña Formation occurs in the depth interval from 17.2 to 34.0 feet. It is a poorly sorted, fine to very fine grained, friable, calcareous sandstone. The lower 1.5 feet of the Gatuña contains angular debris from the underlying Santa Rosa Formation.

3.2.4 Santa Rosa Formation

The Late Triassic Santa Rosa Formation is part of the Dockum Group. In the WIPP site area, the Santa Rosa occurs as an erosional wedge that pinches out west of the site center (Powers et al., 1978).

The Santa Rosa occurs in the depth interval from 34.0 to 53.5 feet. It consists of calcareous reddish-brown siltstone and fine-grained sandstone and contains pebbles of chert.

3.2.5 Dewey Lake Redbeds

The Dewey Lake Redbeds were named by Page and Adams (1940). The term "Dewey Lake" is now used for Permian beds included in the "Pierce Canyon" originally proposed by Lang (1935). The term "Pierce Canyon" was used as late as 1963 by Vine in his descriptions of the Permian redbeds in Nash Draw. However, the United States Geological Survey (USGS) adopted the term "Dewey Lake", as it was more widely accepted by geologists.

The Dewey Lake Redbeds occur in the depth interval from 53.5 to 546.5 feet. The Dewey Lake is characterized by its reddish-orange to reddish-brown color and varying sedimentary structures. In the exhaust shaft, the Dewey Lake consists almost entirely of mudstone, claystone, siltstone, and interbedded sandstone. Abundant sedimentary structures are evident throughout the Dewey Lake section in the exhaust shaft. These structures include horizontal laminations, fine cross-laminations of varying size, rip-up clasts, silt-filled mud cracks, interbasinally-derived pebble conglomerates, fining-upward sequences, and soft sediment deformation features. Locally, greenish-gray reduction spots are abundant, and occasionally, entire beds may have a gray color.

With the exception of the upper portion, the Dewey Lake is characterized by locally abundant gypsum-filled fractures. The majority of the fractures are filled with fibrous gypsum, although granular gypsum fillings mark the first occurrence of gypsum fracture fillings in the Dewey Lake. The first occurrence of gypsum fracture fillings in the Dewey Lake at the exhaust shaft is at a depth of 121.5 feet. The significance of the first occurrence of gypsum-filled fractures at various localities is not clear. Preliminary comparisons of data gathered from the waste handling and exhaust shafts with data gathered from boreholes around the WIPP site indicate that the first gypsum fracture fillings do not occur in the same stratigraphic interval laterally.

The majority of all fractures in the Dewey Lake are horizontal to subhorizontal and follow bedding planes (Figures 6, 7, and 8). High angle fractures constitute the lowest percentage of fracture types in the Dewey Lake. At least three separate episodes of fracturing and subsequent filling are locally discernable in the Dewey Lake at the exhaust shaft. In general, younger horizontal to subhorizontal gypsum-filled fractures cross-cut older subvertical fractures, and, in rare cases, younger subvertical fractures cross-cut older horizontal to subhorizontal fractures.

The crystal morphology of the fibrous fracture filling is the result of the stress field which produced it (Durney and Ramsay, 1973). The majority of the gypsum fibers in the fracture fillings are perpendicular to the wall rock. This indicates that there was no displacement parallel to the fracture surface at the time of fracturing and subsequent filling. In some instances, the fibers are not at right angles to the fracture surface, indicating that a component of displacement parallel to the fracture surface occurred throughout the period of fracturing and filling. In rare cases, the fibers have a sigmoidal shape which indicates that there was a component of displacement parallel to the fracture surface not synchronous with the initial fracturing.

3.2.6 Rustler Formation

The term Rustler Formation was clarified by Lang (1935) to stratigraphically define the interval between the Pierce Canyon Redbeds (now recognized as the Dewey Lake Redbeds) and the Salado Formation. Two laterally persistent units of dolomite were recognized, described, and named by Lang (1935; in Adams, 1944). The lowermost is named the Culebra Dolomite Member, and the uppermost is named the Magenta Dolomite Member. A five-fold stratigraphic subdivision of the Rustler was introduced by Vine (1963). Vine designated the anhydrite section above the Magenta as the Forty-Niner Member, and named the interval between the Culebra and the Magenta the Tamarisk Member. The clastic-rich interval below the Culebra was not named and herein is referred to as the unnamed lower member of the Rustler Formation. The Rustler Formation occurs in the depth interval from 546.5 to 850.5 feet. Overall, the lithology of the Rustler is quite variable, containing carbonates, sulfates (gypsum, anhydrite, polyhalite), clastic materials, and halite. The lower portion of the Rustler consists of clastics with some interbedded evaporites, and the upper portion consists predominantly of anhydrite, carbonates, and clastic materials. As previously indicated, all or a portion of these members were mapped in detail. The lithology of each of the five members is summarized below.

3.2.6.1 Forty-Niner Member

In the exhaust shaft, the top of the Forty-Niner Member occurs at a depth of 546.5 feet, and the depth to the base is 602.5 feet. The Forty-Niner consists of an upper anhydrite (29.0 feet thick), a middle claystone (11.0 feet thick), and a lower anhydrite (16.0 feet thick).

The upper 29.0 feet of the Forty-Niner Member consists of gray, hard, finely crystalline anhydrite. The contact with the Dewey Lake Redbeds is sharp, and undulatory up to 1.5 feet (Figure 9). Laminae within the anhydrite are erosionally terminated at the upper contact, suggesting at least a minor disconformity between the Dewey Lake and the Rustler. The anhydrite is laminated to banded to locally nodular and contains an increasing upwards content of clay interbeds. Horizontal to subhorizontal, gypsum-filled fractures up to 1/2-inch thick with variable spacing occur throughout the anhydrite.

An 11-foot thick clastic zone underlies the upper anhydrite (Figure 10). The clastic zone, commonly called the Forty-Niner Member claystone, is divided into five lithologically distinct mapping units (Figure 10), but herein is divided into three compositionally distinct zones: an upper silty mudstone and claystone zone, a middle gypsiferous silty claystone zone, and a lower gypsiferous siltstone and argillaceous siltstone zone.

The upper zone is approximately one-foot thick and consists of gray (at the top) and reddish-brown, thinly laminated, silty mudstone and silty claystone. An erosional contact marks the base of the gypsum-free upper zone.

The middle zone is about seven feet thick and consists of reddish-brown, thinly laminated to cross-laminated, silty claystone with varying amounts of gypsum. The gypsum occurs locally as nodules and often exhibits enterolithic structures; also, gypsum may occur as cement. The overall content of gypsum in the claystone decreases with depth, and the bedding surrounding local occurrences of gypsum usually shows evidence of soft sediment deformation.

Greenish-gray reduction spots occur locally throughout the middle zone and often have a morphology similar to the gypsum nodules and enterolithic structures. The middle zone contains one major erosional surface between mapping unit 5 and mapping unit 6 (Figure 10). The lower contact of the middle zone appears to be disconformable.

The lower zone consists of siltstone at the top grading to argillaceous siltstone with depth. The lower zone is thinly laminated to very thinly bedded and rarely exhibits soft sediment deformation features. Gypsum nodules occur in the lower zone, and the frequency of their occurrence decreases with depth. The basal contact of the Forty-Niner claystone is sharp, undulatory, and erosional.

The lower anhydrite is gray to brownish-gray, hard, finely crystalline, and 16.0 feet thick. It is laminated to nodular and contains interbeds of laminated carbonate locally and near the base. Fibrous gypsum-filled fractures up to 1/2-inch thick occur throughout the lower anhydrite. The lower contact of the lower anhydrite is sharp and disconformable.

3.2.6.2 Magenta Dolomite Member

The Magenta Dolomite Member of the Rustler Formation is the uppermost of two regionally extensive dolomite units in the Rustler Formation. It is considered to be the second most productive hydrologic unit in the Los Medanos area (Mercer, 1983).

The Magenta occurs in the depth interval from 602.5 to 627.0 feet (Figure 10). The Magenta consists of light brown to dark brown arenaceous dolomite with disseminated gypsum crystals, nodules, and vugs. It contains an abundance of primary sedimentary structures. The bedding is tabular to lenticular, discontinuous, frequently convoluted, and occasionally may be erosionally truncated. Cross-bedding and cross-laminations are pervasive throughout the upper portion of the Magenta. The density of cross-laminations decreases with depth. Clay drape over ripple forms is locally abundant. The bedding often resembles flaser bedding and wavy and lenticular bedding (after Reineck and Singh, 1980).

Load structures occasionally occur at the base of individual beds, and light brown flattened pebbles occur locally. In general, the bedding and associated sedimentary structures become larger with depth.

A zone containing abundant probable algal structures occurs in the lower two feet (Magenta unit 8, Figure 10). These structures are mound-shaped and contain dark brown, probably organic-rich, claystone laminae. Also, a zone containing brownish-black claystone laminae of possible organic origin occurs near the base of the Magenta. The basal contact with the Tamarisk Member is gradational.

3.2.6.3 Tamarisk Member

In the exhaust shaft, the top of the Tamarisk occurs at a depth of 627.0 feet, and the base occurs at a depth of 713.5 feet. Like the Forty-Niner Member, the Tamarisk Member may be divided into three parts: an upper anhydrite, a middle claystone, and a lower anhydrite (Figure 11).

As observed in the exhaust shaft, the upper 62.0 feet of the Tamarisk Member consists of anhydrite. The upper one to two feet of the anhydrite is gypsiferous and exhibits a nodular chicken-wire structure. Below the gypsiferous area, the upper anhydrite becomes finely crystalline and hard. Sedimentary structures in the anhydrite are locally quite variable, and the anhydrite may be laminated to banded to nodular. Interbeds of tan, thinly laminated carbonate are quite common and may be associated with anhydrite pseudomorphs after gypsum swallowtail crystals. A one-inch to two-inch thick bed of black organic-rich (?) claystone containing fibrous gypsum-filled fractures occurs at a depth of 665.9 feet. A one-foot thick light and dark gray, thinly laminated anhydritic claystone occurs 1.5 feet from the top of the middle claystone and is underlain by argillaceous anhydrite containing enterolithic structures and nodules flattened parallel to bedding. The basal contact of the upper anhydrite with the middle claystone is sharp and occurs at a depth of 689.0 feet.

The Tamarisk Member middle claystone is silty and is subdivided on the basis of color; the upper portion of the claystone is gray, and the lower portion is reddish-brown. The contact between the two is diffuse, undulatory up to 3.5

feet, and is considered to be a reduction-oxidation contact. Both the gray and reddish-brown portions of the Tamarisk Member middle claystone contain irregularly-shaped zones of the other color, reddish-brown or gray.

The upper gray and lower reddish-brown units of the middle claystone do not appear to be consistently separable by any means other than color, and for ease of reporting, will be considered as one unit. The claystone is weakly thinly laminated. Locally, the laminae may be slickensided, and as a whole, the unit appears to have undergone ductile flow. Nodules of gypsum and subangular, irregularly shaped clasts of anhydrite occur throughout the claystone, and in general, the concentration of both increases with depth. Pyrite or marcasite occurs locally in the upper part, and stringers of orange sand occur locally in the lower part. The lower two inches to 1.5 feet is in part anhydritic. The basal contact of the claystone with the lower anhydrite occurs at an average depth of 695.5 feet, is sharp, extremely undulatory, and erosional. An erosional channel 2.5 feet into the underlying anhydrite occurs at the west side of the shaft.

This zone contains considerably less gypsum-filled fractures than the stratigraphic equivalent in the waste handling shaft. The prevalent fracture pattern is arcuate, and the gypsum filling in the fractures is fibrous and commonly exhibits a sigmoidal internal structure.

The lower 18.0 feet of the Tamarisk Member consists of light gray to gray anhydrite. The anhydrite is finely crystalline and nodular to thinly laminated to banded. The upper 0.1 to 0.2 feet contains brown gypsum stars or rosettes. In cross-section the gypsum rosettes have a radiating crystal habit. Between a depth of 702.0 and 702.5 feet, a dark gray claystone bed occurs; the claystone bed contains locally bifurcating fibrous gypsum-filled fractures. Below the clay seam, cross-cutting relationships within the anhydrite are evident. Thin beds and laminae containing thinly laminated carbonate occur with depth.

The lower two feet of the lower anhydrite is gypsiferous and displays a nodular chicken-wire structure. The basal contact of the Tamarisk Member occurs at an average depth of about 713.5 feet, is sharp, and is slightly undulatory.

3.2.6.4 Culebra Dolomite Member

The Culebra is the lowermost of two laterally persistent units of dolomite in the Rustler. The Culebra is the most productive hydrologic unit in the Los Medanos area (Mercer, 1983).

In the exhaust shaft, the Culebra occurs in the depth interval from 713.5 to about 736.0 feet (Figure 11). The Culebra consists primarily of dolomite and argillaceous dolomite containing some arenaceous material. Gypsum-filled vugs and nodules are locally abundant and may vary in diameter from less than 1/16 inch to 1-1/2 inch. The dolomite is microlaminated to medium bedded, and often, the thicker beds are microlaminated to thinly laminated to structureless, and are occasionally cross-laminated.

The lower one-half to one foot of the Culebra (mapping unit 7, Figure 11) is lithologically distinct from the rest of the section. It consists of well indurated and bedded, thinly laminated to laminated dolomite. The laminae within this bed parallel an extremely undulatory lower contact and locally dip up to 45 degrees. Deformational space problems are apparent as individual laminae are locally contorted and apparently displaced parallel to bedding. An east-west trending trough-shaped downwarp of the bedding was observed in the shaft. On the west side of the shaft, a zone of breccia clasts is associated with the downwarp. These clasts apparently originate from the basal unit in the Culebra (Culebra unit 7, Figure 11); the breccia is clast supported, consisting of roughly 80 percent angular to subangular clasts of dolomite with a dolomite matrix.

In the exhaust shaft, the bedding in the Culebra is disjointed by abundant fractures which cause a very broken overall appearance. The fracture patterns are locally consistent but vary from unit to unit. In many cases, mapping units were picked on the basis of the nature of fracture patterns. In the Culebra, the degree of induration and apparent competency of various units, as well as the nature of the fracture patterns displayed, appear to be a function of the amount of clay-rich interbeds and the clay content of the dolomite itself. A general correlation can be made between the abundance of broken, fractured beds and the overall content of clay.

In the upper portion of the Culebra, fracture surfaces are usually marked with an orange stain. In the lower portion, the orange stain occurs less frequently, and the fracture surfaces are, instead, marked by what appears to be relict gypsum fracture fillings.

3.2.6.5 Unnamed Lower Member

The unnamed lower member of the Rustler Formation occurs in the depth interval from about 736.0 to 850.5 feet. It overlies the Salado Formation and underlies the Culebra Dolomite Member. The composition of the lower member is the most variable of any member in the Rustler; it consists of clastic material with subordinate amounts of interbedded halite, anhydrite, and polyhalite (Figures 4 and 11).

The upper nine feet of the lower member consist of claystone, silty claystone, and argillaceous siltstone with minor amounts of interbedded anhydrite and gypsum. This interval is subdivided into five mapping units. The lithology of this zone from top to bottom is subdivided as follows: an upper claystone, an upper fining-upward sequence, a middle claystone, a middle fining-upward sequence, and a lower gypsiferous claystone. The contacts of the mapping units are undulatory and mimic the upper contact with the Culebra.

Along the west side of the shaft, the unnamed lower member mapping units are deformed where they underlie the breccia at the base of the Culebra. The mapping units are continuous around the circumference of the shaft, but are bent downward in the area of disturbance. The upper two mapping units are identified as the major constituents in this zone. The lowermost claystone unit thins directly below the zone and thickens in the area adjacent. Flowage type structures are abundant in the zone and are indicated by abundant slickensides. The middle claystone and the middle fining-upward sequence are bent downward in the area directly adjacent to the zone and apparently thin in that direction.

The upper claystone is gray to grayish-maroon and thinly laminated. Each of the fining-upward sequences consists of argillaceous siltstone at the base grading upward into silty claystone. The middle claystone and the argillaceous siltstone at the base of the middle fining-upward sequence are thinly laminated. Each of the fining-upward sequences contain locally broken interbeds of anhydrite. These anhydrite beds, although broken, are continuous and traceable around the shaft wall. The uppermost fining-upward sequence contains poorly preserved gypsum enterolithic structures. The lower gypsiferous zone consists of locally thinly laminated, silty claystone containing abundant nodules of gypsum up to two inches in diameter. Slickensides are locally present throughout the majority of the section, and where the units are laminated, the laminae often are slickensided. Fibrous gypsum-filled fractures occur in the lower three mapping units; they vary in thickness from 1/32 inch to one inch. The overall size and frequency of occurrence decreases with depth. The majority of the fractures are horizontal to subhorizontal. The basal contact of this unit occurs at an average depth of 745.0 feet and is sharp.

Anhydrite occurs in the depth interval from 745.0 to 755.0 feet. The upper 0.5 to 1.5 feet of the anhydrite is white, gypsiferous and contains radial gypsum structures. A one-foot thick bed of mixed reddish-pink polyhalite and anhydrite occurs below the gypsiferous zone. Within the one-foot thick bed, the polyhalite content increases with depth and then abruptly decreases at the base. This is the only polyhalite bed observed in the Rustler section in the exhaust shaft. The remainder of the anhydrite is nodular to thinly laminated to laminated. Halite pseudomorphs after gypsum swallowtail crystals become abundant with depth. The pseudomorphs vary in size up to a maximum of two inches. The basal contact of the anhydrite is sharp.

An 11-foot thick, halite-rich sequence underlies the anhydrite. In general, the halite content increases with depth, and the detrital content decreases with depth. The upper two feet of this zone consists of thinly laminated, sandy mudstone with about one to two percent halite. The remainder of the section consists of halitic mudstone and argillaceous halite. Halite occurs as clear displacive crystals (e.g., Shearman, 1978). Deeper in the section, some halite crystals contain fluid inclusions aligned in zones parallel to crystal faces. Clay occurs as interstitial material and matrix. Several small channels were observed in the middle part of the section. The basal contact of this interval is gradational. A two-foot thick, finely crystalline anhydrite underlies the halite sequence and contains five to ten percent halite in irregularly shaped, horizontal vugs or spaces. It is thinly laminated at the base. The bedding is distorted in the upper 10 to 12 inches, and beds are frequently tilted upward toward peaks in a manner similar to carbonate tepee structures.

A second halite-rich sequence occurs beneath the anhydrite in the depth interval from approximately 767.5 to 790.0 feet. The upper three feet of this sequence consists of pink to white, polyhalitic, coarsely crystalline halite interbedded with layers of anhydrite and claystone which contain displacive halite crystals. The middle part of this sequence consists of argillaceous halite containing halitic sandy mudstone locally near the base. Halite occurs as displacive crystals which have disrupted the surrounding bedding. The lower part of this sequence consists of argillaceous halite and halitic mudstone grading to sandy halitic siltstone with depth. In this lower unit, halite occurs as displacive crystals and as clear crystals with fluid inclusions. Although there are local occurrences where the halite content increases with depth, the overall halite content decreases and the amount of clastic material increases with depth.

From a depth of about 790.0 feet to a depth of about 803.8 feet, the lower member consists of siltstone and sandy siltstone interbedded with claystone and mudstone. The lithology exposed in this interval may be subdivided into units eight to twenty inches thick. The units in this interval are micro-laminated to thinly bedded and exhibit cross-cutting relationships. In general, units are down-cut to the east and the southeast. Observed sedimentary structures include: symmetrical ripples with clay drape, local fining-upward sequences, cross-laminations, and rare soft sediment deformation. The majority of the cross-laminations show current directions to the south.

The remainder of the unnamed lower member, with the exception of the basal one to two feet, consists mainly of siltstone and argillaceous siltstone interbedded with minor amounts of claystone. The majority of the section is thinly laminated and exhibits an abundance of sedimentary structures. A major portion of the remainder of the unnamed lower member contains sedimentary rock disturbed in a manner which resembles bioturbation. Clasts or nodules of anhydrite, 1/8 inch to 1-1/2 inch in diameter, occur lower in the section and may be aligned in zones parallel to bedding. A sandstone pebble conglomerate occurs near the base of the unnamed lower member. This conglomerate contains fossil bivalve hash and exhibits a petroliferous odor when broken.

Two sulfate units occur in the lower one to two feet. The uppermost sulfate unit consists of finely crystalline, locally nodular and enterolithic mix of polyhalite and anhydrite. The lower sulfate unit consists of argillaceous polyhalite and anhydrite with very small displacive halite crystals. The basal contact of the unnamed lower member of the Rustler Formation occurs at an average depth of 850.5 feet and is marked by a change in matrix from sulfate to clay.

3.2.7 Salado Formation

The term Salado was originated by Lang (1935) for the upper, salt-rich part of the Castile gypsum of Richardson (1904). An informal threefold division of the Salado Formation is herein utilized; it includes: an unnamed upper member, a middle member locally designated the McNutt potash zone, and an unnamed lower member. As each of the members contain similar amounts of halite, anhydrite, and polyhalite (Jones, 1973), the distinction between the members is made on the basis of the content of other potassium and magnesium-bearing minerals. The upper and lower members demonstrate a lack of these minerals, while the middle member (McNutt potash zone) shows a relative abundance of potassium and magnesium-bearing minerals. Due to the abundance of laterally-persistent beds, the Salado is also subdivided on a much finer scale. A system of numbering individual beds of anhydrite and polyhalite (marker beds) was introduced by geologists of the USGS (Jones et al., 1960). The marker bed system is used extensively by mining companies in the Carlsbad potash mining district.

The top of the Salado occurs at an average depth of 850.5 feet in the exhaust shaft. The Salado consists of halite, anhydrite, and polyhalite with varying amounts of other potassium-bearing minerals. About 85 to 90 percent of the Salado is halite (Jones, 1973). Beds of anhydrite and polyhalite alternate with thicker beds of halite throughout the Salado section.

Halite in the Salado is rarely pure and often contains minor amounts of clay, polyhalite, and anhydrite. The halite is generally white to clear, but it may be tinted orange, reddish-brown, and gray by varying amounts of interstitial polyhalite or clay. Halite may also occur in some beds of claystone, argillaceous halite and, occasionally, anhydrite as displacive crystals. Halite replacements of sulfate are common and most visibly occur as halite pseudomorphs after gypsum swallowtail crystals.

In the Salado, argillaceous halite is reddish-brown to gray in color. In an argillaceous halite, clay may occur as matrix material, interstitial material, and intercrystalline material. The clay content of most argillaceous halites decreases with depth. Clay frequently occurs as stringers, usually less than 1/4 inch thick, which may be horizontal to subhorizontal or randomly oriented. Thin beds of claystone frequently occur at the base of sulfate units.

The majority of the sulfate units in the Salado consist of finely crystalline polyhalite and/or anhydrite. In the exhaust shaft, various classic sulfate sedimentary structures were observed in the anhydrites and polyhalites of the Salado, including nodular structures, enterolithic structures, and swallowtail structures. Some of the anhydrite and polyhalite beds are visually structureless. The majority of the polyhalite and anhydrite beds are underlain by thin beds of gray claystone. Polyhalite and anhydrite may also occur in halite beds as disseminated, irregularly shaped blebs or as stringers.

Several sedimentary features, previously unreported at the WIPP site, were observed in the Salado at the exhaust shaft and are discussed below. In the depth interval between 1038.7 and 1040.3 feet, two beds of carbonate occur. The upper bed is thinly laminated with alternating light brown and grayish-brown laminae. The structure displayed in this interval is remarkably similar to that which occurs in an algal stromatolite. The lower bed consists of finely crystalline dolomite.

The Vaca Trista marker bed, which marks the top of the McNutt potash zone, occurs in the interval between 1353.6 and 1358.0 feet. The Vaca Trista is classified as a halitic siltstone. Abundant channel forms filled with siltstone up to three feet deep, occasionally containing cross-laminations, were observed in this unit. Halite occurs as isolated displacive crystals up to 1-1/2 inch on a side.

Erosional features are very common in the Salado at the exhaust shaft. Penecontemporaneous dissolution pits, similar to those described by Powers and Hassinger (1985), occur abundantly throughout the Salado section and may occasionally achieve depths greater than three feet. Between 2032.0 and 2036.3 feet, the exhaust shaft penetrated a 4.3-foot deep erosional channel in marker bed 136 that is filled with halite. The width of this channel could not be determined, as only the west bank of the channel was intercepted by the shaft.

3.3 ENGINEERING GEOLOGY

3.3.1 Fractures and Hardness of Rock Types

Engineering properties related to the occurrence of significant naturally occurring fractures/joints and the relative hardness of some rocks exposed are described in the lithologic descriptions in Figures 4, 6, 7, 8, 9, 10, 11, and 12.

Due to the lithostatic pressure, many unfilled fractures were naturally closed and could not be readily observed unless blasting had removed the block from one side and exposed a flat surface. Thus, unfilled fracture density and orientation could not be readily determined, as the data available was incomplete. Where observed, significant filled and unfilled fractures are described in the aforementioned figures.

3.3.2 Groundwater Inflows

Of the five formations observed during geologic mapping in the exhaust shaft, only the Rustler Formation contained obvious fluid-bearing zones. These zones are the Magenta and the Culebra Dolomite Members of the Rustler Formation. The Rustler/Salado contact, often considered a fluid-producing zone (Mercer, 1983), did not yield any observable fluid.

In the Magenta Dolomite Member, the only zone observed producing fluid occurs in the depth interval from about 609.5 to 615.0 feet (Magenta mapping unit 5, Figure 10). This zone produced very little fluid. It was moist at the onset of mapping and remained so even after the rock was washed and the rest of the section had dried. No obvious source of fluid was visible. The section was distinctly moist, but the quantity of fluid produced was too small to be measured or estimated. Fluid production in this interval is confined to a lithologically distinct unit and cannot be attributed to any macroscopically visible lithologic features. The unit is neither fractured to any great extent nor does it contain an excessive amount of vugs when compared with the rest of the Magenta section. The unit is well indurated and hard and contains an abundance of primary sedimentary structures.

Unlike the Magenta, the entire Culebra section was wet. Fluid was observed issuing from bedding planes, fracture surfaces, and small unfilled vugs. In general, the zones producing the most fluid contained more abundant natural fractures. The major fluid producing zone appeared to occur in the interval between 724.5 feet and about 735.5 feet (Culebra mapping unit 6, Figure 11). This zone is a lithologically distinct unit and is the most fractured unit mapped in the Culebra. Overall inflow into the shaft from the Culebra was visually estimated to be between three and six gallons per minute.

3.3.3 Unstable Areas

The majority of the shaft section could be considered relatively stable with respect to overall rock strength characteristics. Only a few intervals were substantially less stable. All of these zones occur in the Rustler Formation and include the Forty-Niner Member claystone (575.5 to 586.5 feet), the Tamarisk Member claystone (689.0 to 695.5 feet), and the upper nine feet of the unnamed lower member (736.0 to 745.0 feet).

3.3.4 Blast-Related Effects

The effects of smooth wall blasting were visually assessed during the geologic mapping. In particular, two blasting-induced effects were observed: over-blast and blast-induced fracturing.

As used here, the term overblast refers to the removal of material, by blasting, from outside the designed shaft wall circumference. The ideal final result of smooth wall blasting is a relatively smooth shaft wall with one-half of each of the outermost blasting drill-holes remaining. An overblast situation occurs when the explosive charge in an outer drill-hole is too large to permit the wall rock to remain in place, and thus removes more rock than originally designed, including all trace of the original drill-hole. Slight overblasts were observed in almost every interval exposed in the shaft. Due to the frequency and irregular distribution of overblasted zones, they were not included on the final lithologic descriptions. However, two general observations can be made; the frequency of overblasts in the Salado section was considerably less than elsewhere in the shaft, and the Rustler anhydrites were rarely overblasted.

The most common type of fractures induced by blasting originate from a blast-hole at the shaft wall and radiate outward into the wall rock. The rock surface in the lined portion of the shaft was rarely exposed for more than one day before it was covered with concrete. As a result, blast-induced fractures were rarely observed, and when observed, were not very prominent. In the unlined section, the rock was not covered with concrete and was observed up to a week after the initial exposure by blasting. In this case, blast-induced fractures were distinctly visible. The fractures were commonly open, and often, several fractures could be observed originating from one remnant blast-hole.

3.3.5 Shaft Design Modifications Based on Observed Geology

With the exception of the diameter, concrete thickness, and station configuration, the exhaust shaft design is similar to the waste handling shaft design. During mapping, however, it was noted that the Magenta, Culebra, and the top of the Salado Formation occurred deeper in the exhaust shaft than in the waste handling shaft. As a result, the liner plated zones and the shaft keyway were located deeper than originally designed (Table 2).

Designed geomechanical instrumentation locations (Table 3) were selected based on the observed geology and construction-related constraints.

4.0 CONCLUSION

The objectives of the geotechnical activities in the exhaust shaft were fulfilled during the period from July 16, 1984 through January 18, 1985. Geologic mapping of the shaft (including documentation from samples and photographs) from the surface to the facility level provided additional confirmation of the geologic conditions that exist above the WIPP facility level and were the basis for field modification of the key and aquifer seal design.

The exhaust shaft mapping data correlates well with the data collected in the waste handling shaft and boreholes adjacent to the WIPP. No anomalous structural or stratigraphic features were observed, although slight differences in the depth and thickness of various stratigraphic units were noted. In general, stratigraphic units occurred slightly deeper in the exhaust shaft than they do in the waste handling shaft. As a result, the key and aquifer seal depths were adjusted downward seven and nine feet respectively.

The Magenta and Culebra Dolomite Members of the Rustler Formation contained the only fluid-producing zones observed in the shaft. The fluid-producing zones within each member were identified. Each zone produced only minor amounts of fluid.

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TABLE 1

ABRIDGED CONSTRUCTION HISTORY OF THE EXHAUST SHAFT

Location:	Eddy County, New Mexico New Mexico Grid Coordinates Y 499287.23, X 667370.39
Elevation:	Shaft Collar: 3411.5 feet MSL Reference: 3409 feet MSL
Construction Contractor:	Ohbayashi-Gumi, Ltd.
Subcontractors for Raise Bore Shaft:	Raisebore, Inc. and J. S. Redpath Co.
Pilot Hole for Raise Bore Started:	September 22, 1983
Pilot Hole Completed:	December 16, 1983
Upreaming Started:	December 31, 1983
Upreaming Completed:	February 10, 1984
Collar Excavation Began:	July 15, 1984
Liner Plate and Concrete Backfill Completed:	July 17, 1984
Concrete Liner Started:	July 18, 1984
Concrete Liner Completed:	November 29, 1984
Culebra Dolomite Grouted:	December 2-4, 1984
Magenta Dolomite Grouted:	December 4-5, 1984
Construction of Unlined Portion Began:	December 7, 1984
Construction of Unlined Portion Completed:	January 17, 1985

TABLE 2

EXHAUST SHAFT DESIGN LOCATIONS MODIFIED ON THE BASIS OF THE OBSERVED GEOLOGY

	Design Location Depth (Feet)[1]	As-Built Location Depth (Feet)[1]	Net Adjustment[2] (Feet)
Top of Liner Plate			
Magenta	591	600	+9
Culebra	701	710	+9
Top of Keyway	837	844	+7
Bottom of Keyway	900	907	+7

Notes:

(1) Depths are based on reference elevation at 3409 feet msl.

(2) Positive adjustment (+) indicates that the item was adjusted downward relative to land surface.

TABLE 3
INSTRUMENT LOCATIONS IN THE EXHAUST SHAFT

Instrument Type [(1)]	Number	Depth (feet) [(2)]	Elevation (feet)
PE	3	544	2865
PE	3	615	2794
PE	3	673	2736
PE	3	721	2688
PE	3	768	2641
PE	3	850	2559
WE	4	874	2535
PE	3	887	2522
GE	3	1078	2331
GE	3	1573.5	1835.5
GE	3	2066	1343

Notes:

[(1)] Instrument Type:

GE = Extensometer
PE = Piezometer
WE = Earth pressure cell

[(2)] "Depths" are based on the reference elevation at 3409 feet MSL. From marked-up as-built drawing No. 35-J-003-030, Rev.2, p. 3.

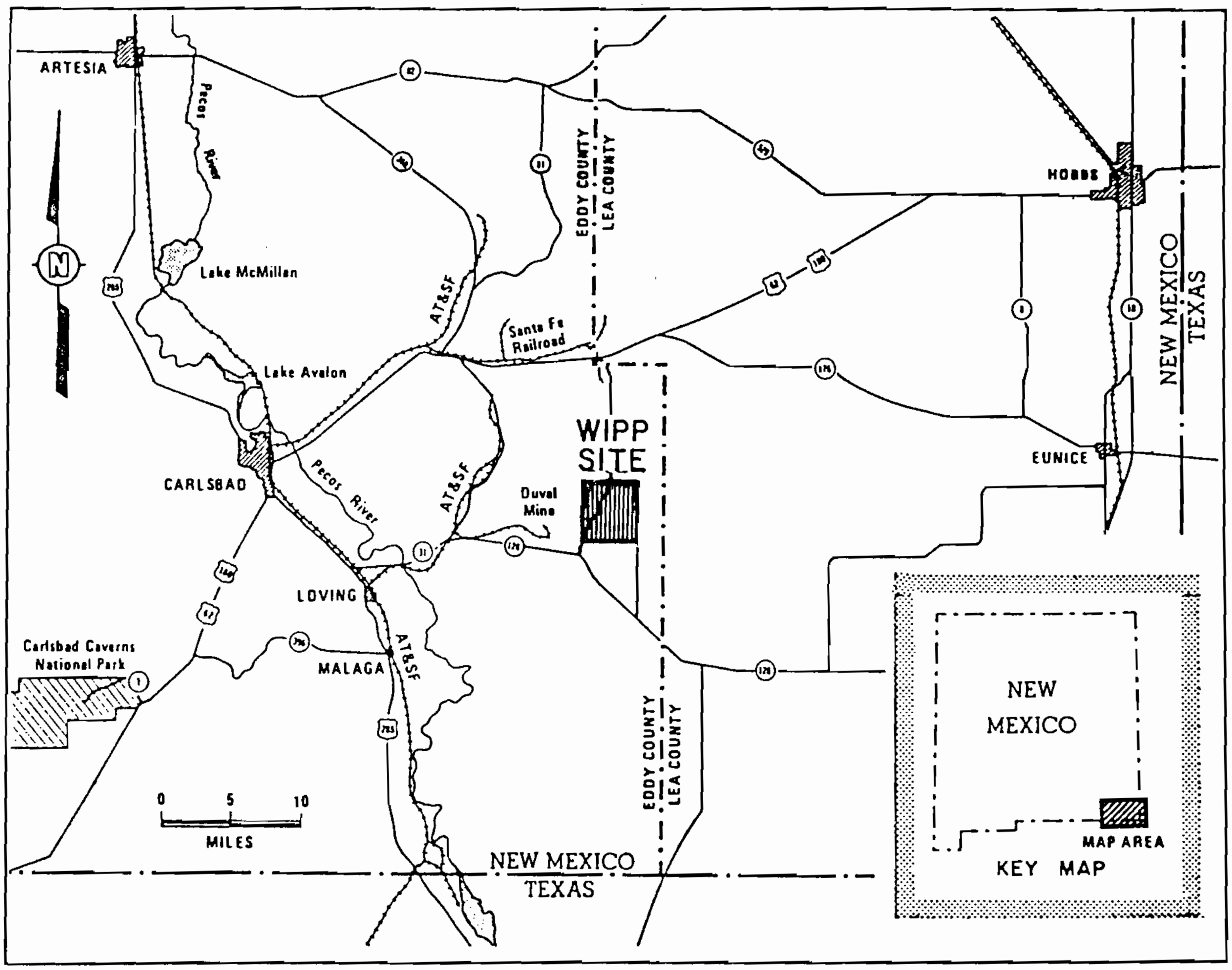


FIGURE I

GENERAL LOCATION
OF THE
WIPP SITE

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
CARLSBAD, NEW MEXICO

IT CORPORATION

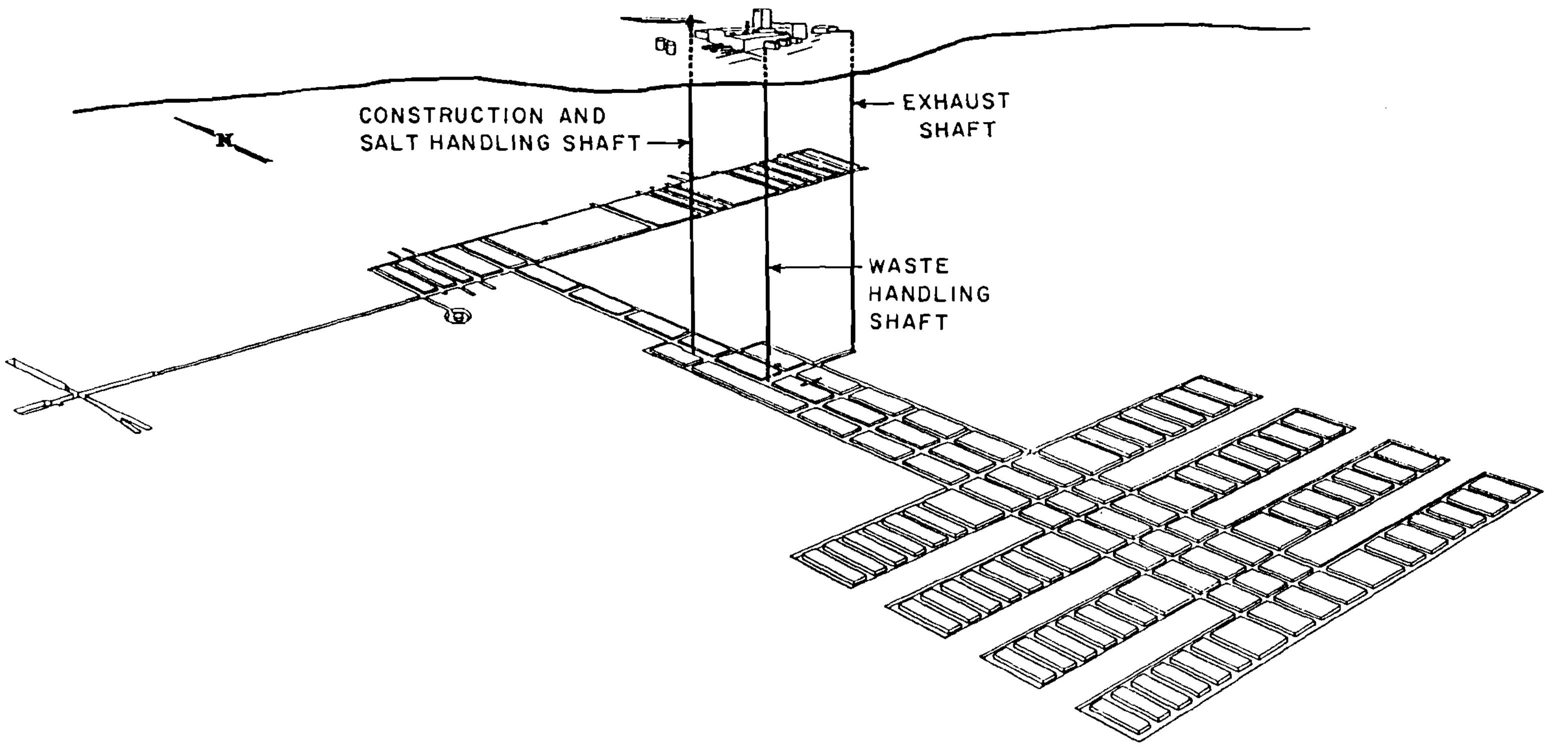


FIGURE 2

WASTE ISOLATION PILOT PROJECT PLANT
UNDERGROUND LAYOUT

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
CARLSBAD, NEW MEXICO

IT CORPORATION

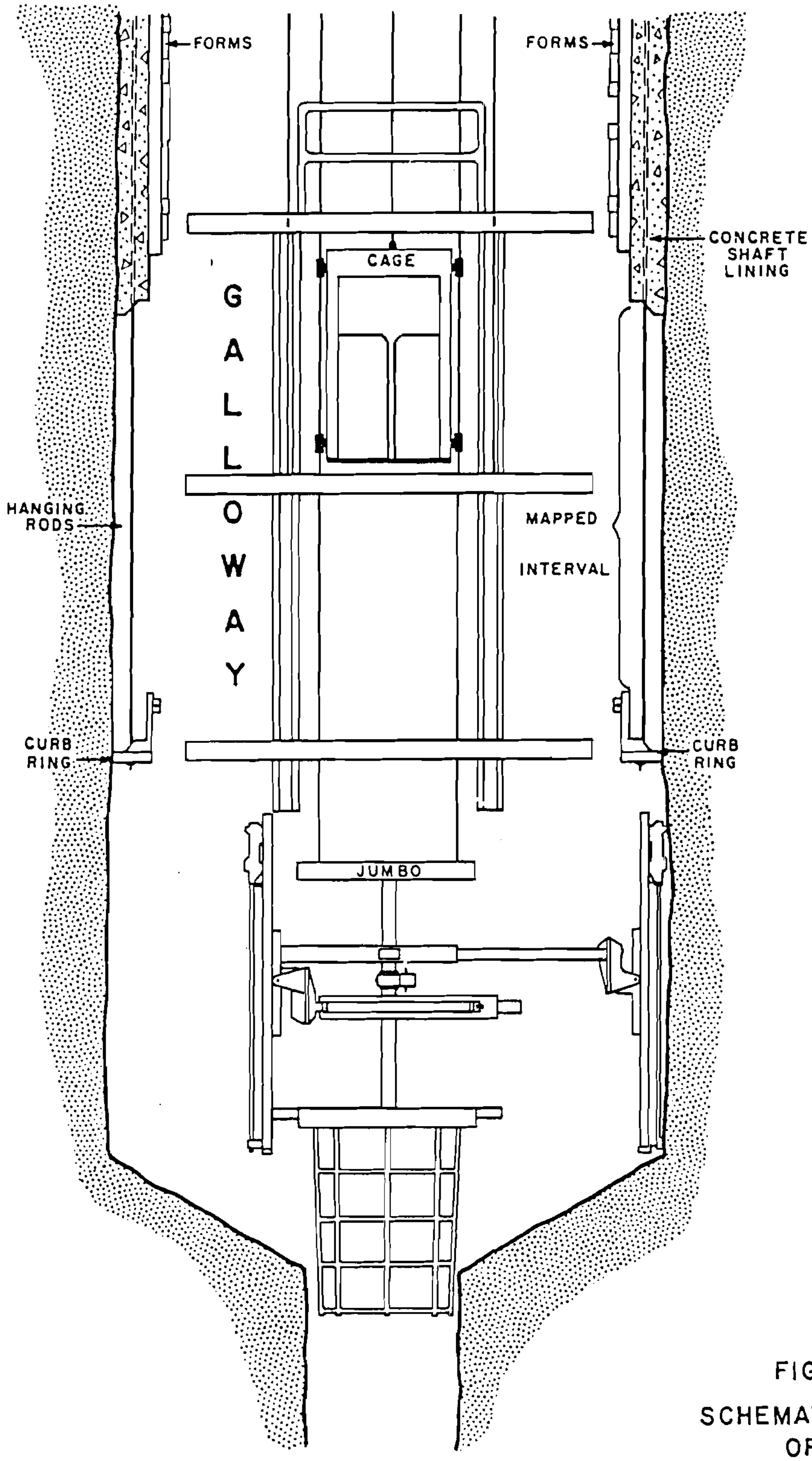


FIGURE 3

SCHEMATIC SECTION OF THE GALLOWAY

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
CARLSBAD, NEW MEXICO

IT CORPORATION

Figure 4

EXHAUST SHAFT
LITHOLOGIC
LOG

SHEET 1 OF 50

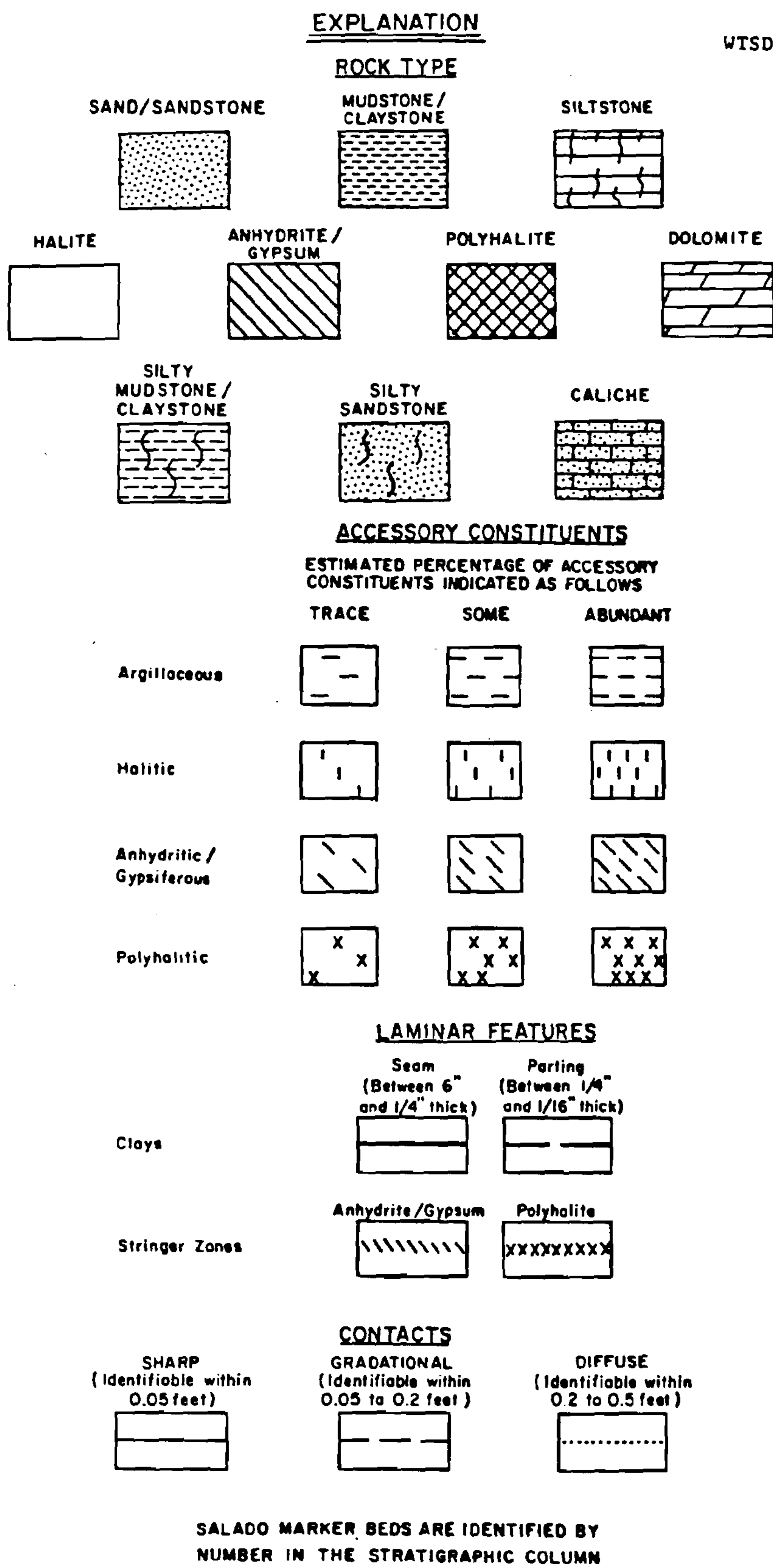


FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG
SHEET 2 OF 50

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	REMARKS
3411.5		COLLAR PAD
3410		QUATERNARY DUNE SAND. SAND, SILTY, REDDISH-BROWN, POORLY SORTED, SUBANGULAR GRAINS, A FEW MAFIC GRAINS (LESS THAN 10%); WEAKLY CONSOLIDATED.
3409	0	
3404	5	
		MESCALERO CALICHE. CALICHE, WHITE TO TAN, NODULAR, SIZE AND QUANTITY OF NODULES INCREASING WITH DEPTH; CARBONATE CONTENT HIGHEST IN LIGHT COLORED SUBHORIZONTAL STRINGERS; UPPER 1.0' HARD, HARDNESS DECREASING TOWARD BASE; MOIST; CONTAINS LOCAL CONCENTRATIONS OF SILTSTONE AND SANDSTONE; COLOR BECOMES REDDISH-BROWN TOWARD BASE; IRREGULARLY-SHAPED DISCONTINUOUS BEDS OF SILTSTONE, CHERT AND SANDSTONE PEBBLE CONGLOMERATE MIGRATE VERTICALLY AND LATERALLY; THICK DISCONTINUOUS BEDS OF ORANGISH-BROWN SAND OCCUR NEAR BASE; BASAL CONTACT DIFFUSE.
3399	10	
3394	15	
		GATUNA FORMATION. SANDSTONE, FINE TO VERY FINE GRAINED, REDDISH-BROWN, POORLY SORTED, CALCAREOUS, FRIABLE, DRY; BASAL 1.5' IS SANDSTONE, COARSE TO FINE GRAINED, POORLY SORTED, ROUNDED, CONTAINING ANGULAR DEBRIS FROM UNDERLYING REDBEDS; BASAL CONTACT SHARP, EROSIONAL, SLIGHTLY UNDULATORY.
3389	20	
3384	25	
3379	30	
		SANTA ROSA FORMATION. SILTSTONE AND VERY FINE GRAINED SANDSTONE, SILT TO VERY FINE SAND-SIZED GRAINS, REDDISH-BROWN, CALCAREOUS, POORLY SORTED, CONTAINS PEBBLES OF CHERT AND MAFIC GRAINS; UPPER 1.0' CONTAINS CALICHE IN SUBHORIZONTAL STRINGERS; BASAL CONTACT DIFFUSE.
3374	35	
3369	-40	

FIGURE 4 (CONTINUED)

EXHAUST SHAFT

LITHOLOGIC LOG

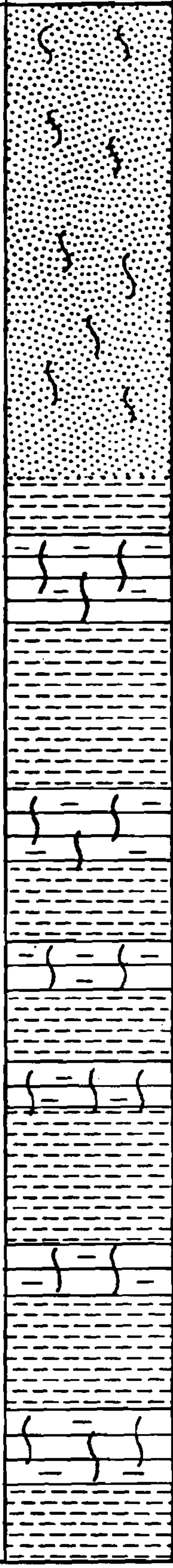
PRELIMINARY ELEV. (FT. MSL)	DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
3369	40		AS ABOVE
3364	45		
3359	50		
3354	55		**DEWEY LAKE REDBEDS** MUDSTONE INTERBEDDED WITH ARGILLACEOUS SILTSTONE, REDDISH-BROWN, THINLY LAMINATED TO THINLY BEDDED (1/8" TO 1"), BEDDING SLIGHTLY UNDULATORY, HARD; SEDIMENTARY STRUCTURES INCLUDE: SMALL TABULAR RIP-UP CLASTS (<1/4") ALIGNED IN THIN BEDS, CROSS LAMINATIONS, LOAD STRUCTURES, FILLED DESICCATION CRACKS; OCCASIONAL 1-1/2" INTERBEDS OF GRAY SILTSTONE; RARE GREENISH-GRAY REDUCTION SPOTS (<1/16" DIAMETER); BASAL CONTACT GRADATIONAL.
3349	60		
3344	65		
3339	70		
3334	75		
3329	80		
3324	85		

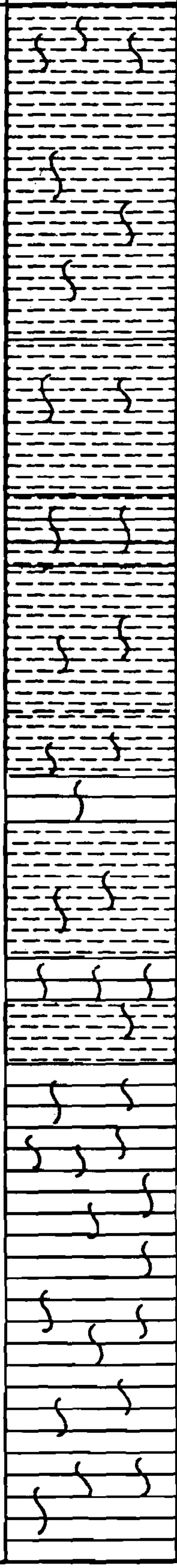
FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
3324	85		AS ABOVE
3319	90		MUDSTONE, REDDISH-BROWN, THINLY LAMINATED TO THINLY BEDDED, HARD; CONTAINS THIN BEDS (1/2" TO 1") OF GRAY SILTY MUDSTONE; FRACTURES PARALLEL TO BEDDING, SPACED 3"; OCCASIONAL GREENISH-GRAY REDUCTION SPOTS (1/4" TO 1/2" DIAMETER); CONTAINS OCCASIONAL LOAD STRUCTURES; BASAL CONTACT DIFFUSE.
3314	95		SILTY MUDSTONE INTERBEDDED WITH ARGILLACEOUS SILTSTONE, REDDISH-BROWN, THINLY LAMINATED TO THINLY BEDDED (<1/32" TO 2-1/2"); OCCASIONAL GREENISH-GRAY SILTSTONE INTERBEDS; OCCASIONAL LOAD STRUCTURES; SMALL OPEN FRACTURES PARALLEL TO BEDDING, SPACED 1" TO 2-1/2"; FEW SUBVERTICAL FRACTURES, SPACED 1' TO 2.5'; BASAL CONTACT DIFFUSE.
3309	100		
3304	105		SANDSTONE, VERY FINE GRAINED, REDDISH-BROWN, THINLY LAMINATED TO CROSS-LAMINATED, HARD TO SOFT, RARE INTERBEDS OF SILTY MUDSTONE (1/2" TO 1" THICK); THIN (<1/32") SUBHORIZONTAL FRACTURES PARALLEL TO BEDDING, SPACED 3" TO 9"; TWO 1/2" THICK PARALLEL HORIZONTAL FRACTURES FILLED WITH CARBONATE OCCUR AT 108.0' AND 108.5'; OCCASIONAL GREENISH-GRAY REDUCTION SPOTS; BASAL CONTACT DIFFUSE.
3299	110		
3294	115		SILTY MUDSTONE INTERBEDDED WITH MUDSTONE, REDDISH-BROWN, THINLY LAMINATED TO CROSS-LAMINATED, HARD; RARE GREENISH-GRAY REDUCTION SPOTS (1/16" TO 1/2" DIAMETER); OCCASIONAL 1/4" TO 2" THICK GREENISH-GRAY INTERBEDS; OCCASIONAL SOFT SEDIMENT DEFORMATION FEATURES; HORIZONTAL FRACTURES PARALLEL TO BEDDING, SPACED 1" TO 4"; BASAL CONTACT SHARP.
3289	120		SILTSTONE, REDDISH-BROWN, THINLY LAMINATED TO CROSS-LAMINATED; OCCASIONAL INTERBEDS OF SILTY MUDSTONE; LOAD STRUCTURES, MUDSTONE RIP-UP CLASTS; MODERATELY ABUNDANT GREENISH-GRAY REDUCTION SPOTS (1/16" TO 1/4" DIAMETER); OCCASIONAL GREENISH-GRAY BEDS (1/2" TO 2" THICK); THIN HORIZONTAL FRACTURES (<1/32") WITH GYPSUM FILLING BELOW 121.5', SPACED 2" TO 1.5'; BASAL CONTACT SHARP.
3284	125		
3279	130		

EXHAUST SHAFT
LITHOLOGIC LOG

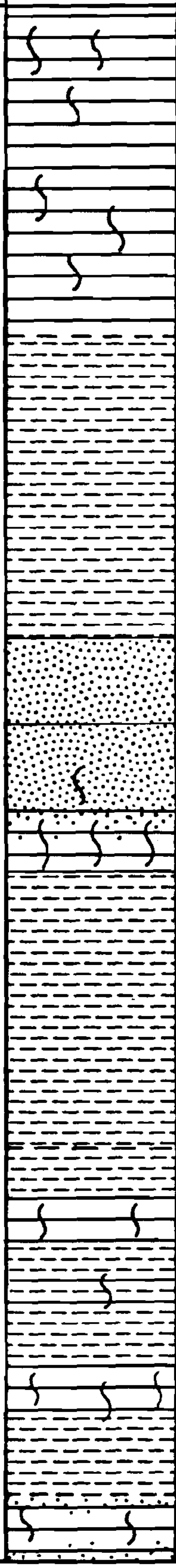
FIGURE 4 (CONTINUED)



PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
3279	130		SILTY MUDSTONE, REDDISH-BROWN, THINLY LAMINATED (<1/32"), LOCALLY INTERBEDDED WITH SILTSTONE; CONTAINS CROSS-LAMINATIONS, FILLED DESICCATION CRACKS; SUBVERTICAL CLAY-FILLED FRACTURES OCCUR NEAR TOP, SPACED 3" TO 4"; LOCALLY, BEDDING MAY BE GREENISH-GRAY IN COLOR; OCCASIONAL GREENISH-GRAY REDUCTION SPOTS (1/16" TO 1" DIAMETER); SUBHORIZONTAL GYPSUM-FILLED FRACTURES, SPACED 3" TO 6"; SUBVERTICAL FRACTURES SPACED 3" TO 12"; IN LOWER 3', 1/8" TO 3" THICK HORIZONTAL GREENISH-GRAY REDUCTION ZONES OCCUR IN GROUPS, INDIVIDUAL ZONES SPACED 1/2", GROUPS SPACED 0.8' TO 1.5'; BASAL CONTACT SHARP, MARKED BY 2" BED OF WHITISH-GRAY SILTSTONE WITH A GREENISH-GRAY REDUCTION ZONE ABOVE AND BELOW.
3274	135		
3269	140		MUDSTONE, DARK REDDISH-BROWN, INTERBEDDED WITH SILTY MUDSTONE, LIGHT REDDISH-BROWN, THINLY LAMINATED TO BEDDED (<1/32" TO 1/2"), LOCALLY FISSILE, OCCASIONALLY CROSS-LAMINATED, BEDDING MAY TERMINATE EROSIONALLY, STRUCTURES BECOMES LESS FINE BELOW 148.0'; RARE SUBVERTICAL TO HIGH ANGLE FRACTURES WITH GRANULAR GYPSUM FILLING (<1/8" THICK); FROM 132.5' TO 147.5', ABUNDANT SUBHORIZONTAL FRACTURES, SPACED 1'; ABUNDANT GREENISH-GRAY REDUCTION SPOTS (1/32" TO 2" DIAMETER); BASAL CONTACT GRADATIONAL.
3264	145		
3259	150		SILTY MUDSTONE, DARK REDDISH-BROWN, INTERBEDDED WITH SILTSTONE, REDDISH-BROWN, THINLY LAMINATED TO BEDDED (1/32" TO 1-1/2"), SOFT; OCCASIONALLY CROSS-LAMINATED, CONTAINS LOAD STRUCTURES, OVERALL SEDIMENTARY STRUCTURES ARE LESS FINE THAN OVERLYING UNIT, GRAIN SIZE COARSENS DOWNWARD; 1" TO 2" THICK HORIZONTAL GREENISH-GRAY REDUCED ZONES, SPACED 3" TO 5"; FRACTURES OCCUR BELOW 154.5', 1/8" THICK, FILLED WITH GYPSUM; SUBVERTICAL FRACTURES SPACED 2' TO 3', SUBHORIZONTAL FRACTURES SPACED 0.5' TO 1.5'; BASAL 2' CONTAINS GREENISH-GRAY AND REDDISH-BROWN INTERBEDDED MUDSTONE; ABUNDANT GREENISH-GRAY REDUCTION SPOTS (1/32" TO 1" DIAMETER); BASAL CONTACT SHARP.
3254	155		
3249	160		SILTSTONE, REDDISH-BROWN, THINLY LAMINATED TO STRUCTURELESS; BEDDING THICKENS AND THINS (1/2" TO 2"); OCCASIONAL GREENISH-GRAY BEDS 1/8" TO 1/2" THICK, SPACED 3.0'; ONLY A FEW HIGH ANGLE FRACTURES 1/8" THICK, GYPSUM-FILLED, STRIKING N60°W; AT 167.5' CHANNEL LAG CONGLOMERATE OCCURS CONTAINING SILTSTONE PEBBLES; THINLY LAMINATED SILTY MUDSTONE FROM 170.5' TO 171.3' WITH GREENISH-GRAY REDUCTION ZONES 1" TO 3" THICK, SPACED 4"; NEAR 171.3' BECOMES POORLY SORTED; THINLY LAMINATED WITH CROSS-LAMINATIONS AND EROSIONAL TERMINATIONS NEAR BASE; CONTAINS GREENISH-GRAY REDUCTION SPOTS UP TO 2" DIAMETER; BASAL CONTACT GRADATIONAL.
3244	165		
3239	170		
3234	175		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG



PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
3234	175		AS ABOVE
3229	180		
3224	185		MUDSTONE, REDDISH-BROWN, THINLY LAMINATED TO BEDDED (1/32" TO 1/2" THICK), SOFT; BEDDING INDISTINCT; RARE GREENISH-GRAY REDUCTION SPOTS TO 1" DIAMETER, REDUCTION SPOTS CONCENTRATED AROUND REDUCED, GREENISH-GRAY, 1" WIDE HORIZONTAL BAND AT 191.7', VERY FEW FRACTURES; BASAL 1.5' BECOMES SILTY; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY, OVERLYING BEDS DRAPE OVER CONTACT, EROSIONAL.
3219	190		
3214	195		SANDSTONE, VERY FINE GRAINED, GRAYISH-WHITE, HARD TO SOFT; TROUGH CROSS-BEDDING BECOMES APPARENT NEAR BASE; CONTAINS FIBROUS GYPSUM-FILLED FRACTURES WITH VARIABLE ORIENTATION, 1/4" TO 1" THICK; BASAL CONTACT SHARP.
			SANDSTONE AT TOP GRADING TO SILTSTONE, REDDISH-MAROON, LAMINATED TO BEDDED, OCCASIONALLY CROSS-LAMINATED, HARD; COLOR BECOMES WHITISH-MAROON TOWARD BASE; LOWER 1.3' IS SANDSTONE, STRUCTURELESS EXCEPT FOR OCCASIONAL INTERBEDS OF REDDISH-BROWN SILTSTONE; ABUNDANT FRACTURES, MOST HORIZONTAL TO SUBHORIZONTAL AND SLIGHTLY UNDULATORY, FILLED WITH FIBROUS GYPSUM, THICKNESS 1/16" TO 2", SPACED 1/8" TO 6"; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY.
3209	200		CLAYSTONE, REDDISH-BROWN, THINLY LAMINATED; CROSS-LAMINATED, SETS 1/2" ACROSS, BEDDING EROSIONALLY TERMINATED, CONTAINS SOFT SEDIMENT DEFORMATION FEATURES; BECOMES SILTY TOWARD BASE; OCCASIONAL GREENISH-GRAY REDUCTION SPOTS TO 1/2" DIAMETER, SPOTS OCCASIONALLY BROKEN BY GYPSUM-FILLED FRACTURES; SEE FIGURE 6 FOR FRACTURE NOTES; BASAL CONTACT GRADATIONAL.
3204	205		
3199	210		MUDSTONE WITH INTERBEDDED SILTSTONE, DARK REDDISH-BROWN, THINLY LAMINATED, ABUNDANT CROSS-LAMINATIONS, BEDDING OFTEN TERMINATED EROSIONALLY; ABUNDANT SUBHORIZONTAL GYPSUM-FILLED FRACTURES, SPACED 6", 1/8" TO 3" THICK; VERTICAL AND SUBVERTICAL FRACTURES RARE; OCCASIONAL GREENISH-GRAY REDUCTION SPOTS; BASAL CONTACT GRADATIONAL.
3194	215		
3189	220		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

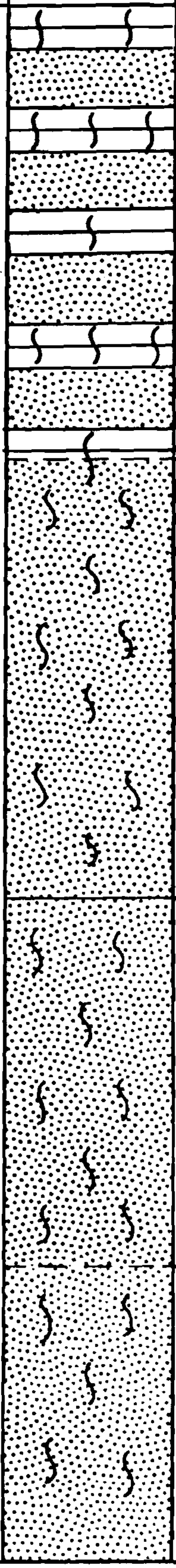
PRELIMINARY ELEV. (FT. MSL)	DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
3189	220		SILTSTONE INTERBEDDED WITH VERY FINE SANDSTONE, REDDISH-BROWN, THINLY LAMINATED TO BEDDED, CROSS-LAMINATED, BEDS OFTEN EROSIONALLY TERMINATED, HARD; CROSS-LAMINATIONS INCREASE BELOW 223.0', HORIZONTAL EROSIONAL PLANES OCCUR BELOW 223.0', SPACED 1.0' TO 2.0'; SUBHORIZONTAL GYPSUM-FILLED FRACTURES ABUNDANT, 1/16" TO 1/4" THICK; RARE SUBVERTICAL FRACTURES; BASAL CONTACT GRADATIONAL.
3184	225		
3179	230		
			SANDSTONE, REDDISH-BROWN, SILTY, THINLY LAMINATED TO BEDDED, OCCASIONALLY CROSS-LAMINATED; ABUNDANT SUBHORIZONTAL GYPSUM-FILLED FRACTURES, 1/16" TO 1" THICK, SPACED 2" TO 1.0', FRACTURES BIFURCATE LOCALLY; RARE SUBVERTICAL GYPSUM-FILLED FRACTURES; BASAL CONTACT SHARP.
3174	235		
3169	240		
3164	245		
			SANDSTONE, REDDISH-BROWN, SILTY, STRUCTURELESS EXCEPT RARE CROSS-LAMINATIONS AND HORIZONTAL LAMINATIONS; FEWER GYPSUM-FILLED FRACTURES THAN OVERLYING UNIT, FRACTURES TO 2" THICK; BASAL CONTACT GRADATIONAL.
3159	250		
3154	255		
			SANDSTONE, REDDISH-BROWN, SILTY, LOCALLY LAMINATED AND CROSS-LAMINATED; OCCASIONAL SUBHORIZONTAL GYPSUM-FILLED FRACTURES, 1/4" TO 1/2" THICK, SPACED 2.8' TO 3.4'. FRACTURES BIFURCATE LOCALLY; SUBVERTICAL FRACTURES RARE; OCCASIONAL GREENISH-GRAY REDUCTION SPOTS TO 1" DIAMETER; BASAL 1.0' CONSISTS OF REDDISH-BROWN SILTSTONE; BASAL CONTACT GRADATIONAL.
3149	260		
3144	265		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

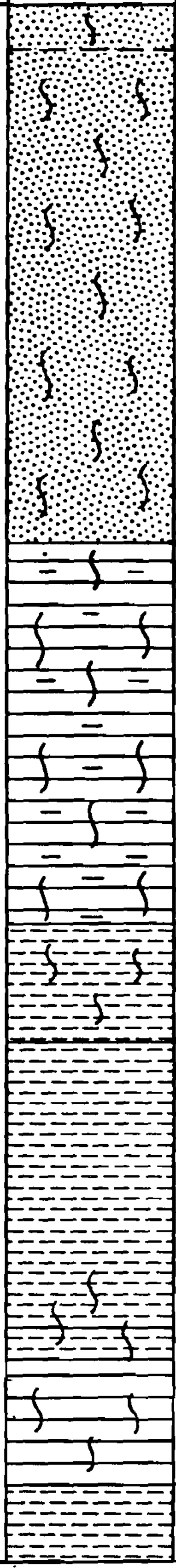
PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
3144	265		AS ABOVE
			SANDSTONE, REDDISH-BROWN, SILTY, MOSTLY MASSIVE WITH SOME LOCAL LAMINATIONS AND CROSS-BEDDING; SUBHORIZONTAL AND SUBVERTICAL GYPSUM-FILLED FRACTURES, SUBHORIZONTAL MORE ABUNDANT, SEE FIGURE 7; BASAL CONTACT GRADATIONAL.
3139	270		
3134	275		
3129	280		
			ARGILLACEOUS SILTSTONE, REDDISH-BROWN, THINLY LAMINATED TO LAMINATED (1/16" TO 1/4" THICK); ABUNDANT SEDIMENTARY STRUCTURES INCLUDING: TROUGH CROSS-LAMINATIONS, EROSIONAL SURFACES TRACEABLE AROUND CIRCUMFERENCE OF SHAFT, SOFT SEDIMENT DEFORMATION FEATURES; CROSS-LAMINATION SETS ARE 1" TO 4" ACROSS, INCREASING TO 2.0' TO 3.0' ACROSS NEAR BASE; LOWER 1.0' CONTAINS 1/4" THICK BEDS OF CLAYSTONE; HORIZONTAL AND SUBHORIZONTAL GYPSUM-FILLED FRACTURES 1/4" TO 1" THICK, SPACED 0.5' TO 2.0'; VERTICAL AND SUBVERTICAL GYPSUM-FILLED FRACTURES 1/8" TO 1/4" THICK, SPACED 3.0' TO 5.0'; OCCASIONAL GREENISH-GRAY REDUCTION SPOTS TO 1" DIAMETER; BASAL CONTACT SHARP, MARKED BY OCCURRENCE OF A MUDSTONE BED.
3124	285		
3119	290		
			MUDSTONE INTERBEDDED WITH SILTY CLAYSTONE, REDDISH-BROWN, THINLY LAMINATED TO VERY THINLY BEDDED (<1/16" TO 1/2" THICK); ABUNDANT SETS OF TROUGH CROSS-LAMINATIONS 1" TO 4" ACROSS, CLAY DRAPE OVER RIPPLE CROSS-LAMINATIONS; OCCASIONAL SOFT SEDIMENT DEFORMATION; OCCASIONAL GREENISH-GRAY REDUCTION SPOTS (1/16" TO 1/2" DIAMETER); UNIT BOUNDED BY HORIZONTAL GYPSUM-FILLED FRACTURES, 1" THICK AT TOP GRADING TO 1/2" THICK AT BASE; BASAL CONTACT SHARP.
3114	295		
			MUDSTONE AT TOP GRADING TO SILTSTONE AT BASE, REDDISH-BROWN, THINLY LAMINATED TO THINLY BEDDED (1/6" TO 1" THICK); ABUNDANT FINE STRUCTURES INCLUDING: FLASER BEDDING, CROSS-LAMINATIONS, TROUGH CROSS-LAMINATIONS, FILLED DESICCATION CRACKS, LOAD STRUCTURES, ABUNDANT EROSIONAL CONTACTS; GYPSUM-FILLED FRACTURES ARE MODERATELY ABUNDANT, 1/16" TO 1-1/2" THICK, HORIZONTAL AND SUBHORIZONTAL FRACTURES SPACED 1.0' TO 4.0', VERTICAL AND SUBVERTICAL FRACTURES SPACED 3.0' TO 5.0'; OCCASIONAL GREENISH-GRAY REDUCTION SPOTS (1/16" TO 1" DIAMETER); RARE 2" THICK, SUBHORIZONTAL, GREENISH-GRAY REDUCED ZONES; BASAL CONTACT SHARP.
3109	300		
3104	305		
			AS BELOW
3099	310		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)
3099	310
3094	315
3089	320
3084	325
3079	330
3074	335
3069	340
3064	345
3059	350
3054	355

REMARKS
MUDSTONE AT TOP, GRADING TO SILTSTONE, DARK REDDISH-BROWN TO REDDISH-BROWN, WITH MINOR INTERBEDDED MUDSTONE, THINLY LAMINATED TO LAMINATED (<1/32" TO 1/8"), HARD; CROSS-LAMINATED, BECOMING MORE ABUNDANT WITH DEPTH; OCCASIONAL GREENISH-GRAY REDUCTION SPOTS (1/16" TO 1/4" DIAMETER); FIBROUS GYPSUM-FILLED FRACTURES BECOME LESS ABUNDANT WITH DEPTH; HORIZONTAL AND SUBHORIZONTAL FRACTURES 1/16" TO 1" THICK, SPACED 2" TO 2.0'; VERTICAL AND SUBVERTICAL FRACTURES 1/16" TO 1/4" THICK, SPACED 2" TO 2.0'; BASAL CONTACT SHARP.
MUDSTONE AT TOP, GRADING TO SILTSTONE WITH DEPTH, DARK REDDISH-BROWN TO REDDISH-BROWN, UNIT SIMILAR TO ABOVE EXCEPT FOR A 3" THICK BED OF MUDSTONE WHICH OCCURS AT 316.2' AND HAS A SHARP UPPER CONTACT AND GRADES TO SILTSTONE WITH DEPTH, HARD; MUDSTONE: STRUCTURELESS; SILTSTONE: FINELY LAMINATED TO CROSS-LAMINATED; FRACTURES SIMILAR TO OVERLYING UNIT; OCCASIONAL GREENISH-GRAY REDUCTION SPOTS TO 1" DIAMETER; BASAL CONTACT MARKED BY 3" THICK SUBHORIZONTAL GREENISH-GRAY ZONE AND DARK REDDISH-BROWN MUDSTONE, SHARP.
MUDSTONE, REDDISH-BROWN, STRUCTURELESS; FRACTURES SIMILAR TO OVERLYING UNIT; BASAL CONTACT GRADATIONAL.
CLAYSTONE, DARK REDDISH-BROWN, INTERBEDDED WITH SILTSTONE, LIGHT REDDISH-BROWN, MICRO-LAMINATED TO VERY THINLY BEDDED (<1/32" TO 1/2"); SILTSTONE: CROSS-LAMINATED; CLAYSTONE: STRUCTURELESS; ABUNDANT GREENISH-GRAY REDUCTION SPOTS; GRADES TO SILTSTONE AT BASE; ALL FRACTURES FILLED WITH FIBROUS GYPSUM; HORIZONTAL AND SUBHORIZONTAL FRACTURES 1/8" TO 1" THICK, SPACED 3" TO 2.0'; VERTICAL AND SUB-VERTICAL FRACTURES 1/16" TO 1/4" THICK, SPACED 2.0' TO 3.0'; BASAL CONTACT SHARP.
CLAYSTONE, DARK REDDISH-BROWN, MICRO-LAMINATED TO THINLY LAMINATED (<1/32" TO 1/16"), STRUCTURE POORLY DEFINED DUE TO ABUNDANT FRACTURING, OCCASIONAL CROSS-LAMINATIONS, BEDDING OFTEN CONVOLUTED AND EROSIONALLY TERMINATED; ABUNDANT GREENISH-GRAY REDUCTION SPOTS (1/16" TO 1" DIAMETER); ABUNDANT GYPSUM-FILLED FRACTURES, ~90% HORIZONTAL AND SUBHORIZONTAL; TWO SCALES OF SPACING: MINOR - 1/8" TO 2", MAJOR - 2" TO 6". FRACTURE DENSITY INCREASES TOWARD BASE, THICKNESS VARIES FROM 1/16" TO 1.0'; REMAINING ~10% VERTICAL AND SUBVERTICAL FRACTURES, SPACED 2" TO 2.5', THICKNESS 1/16" TO 1/4"; BASAL CONTACT SHARP.
SILTSTONE, REDDISH-BROWN, LAMINATED TO BEDDED, CROSS-LAMINATED, SOFT SEDIMENT DEFORMATION FEATURES, HARD; ALL FRACTURES FILLED WITH FIBROUS GYPSUM; SUBHORIZONTAL AND HORIZONTAL FRACTURES 1/16" TO 1" THICK, SPACED 1" TO 1.0'; VERTICAL AND SUBVERTICAL FRACTURES 1/8" TO 1/2" THICK, SPACED 6" TO 2.0'; ABUNDANT GREENISH-GRAY REDUCTION SPOTS 1/16" TO 1" DIAMETER; BASAL CONTACT SHARP.

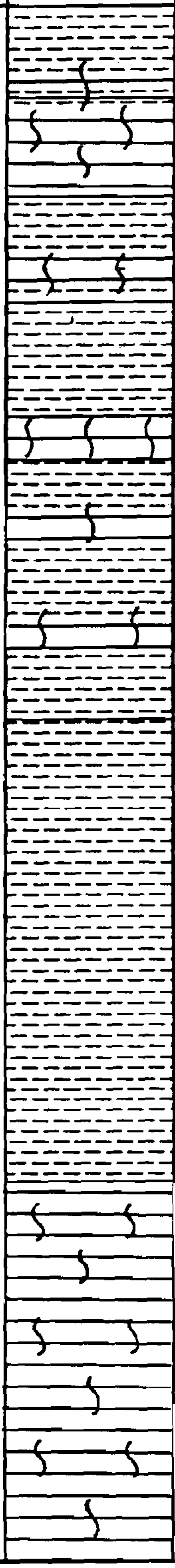


FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

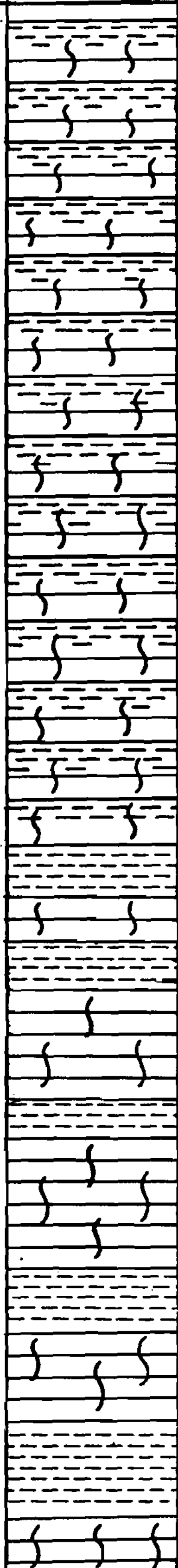
PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
3054	355		MUDSTONE GRADING TO SILTSTONE IN VERTICAL GRADATIONAL SEQUENCES 1.0' TO 3.0' THICK, REDDISH-BROWN (SILTSTONE) AND DARK REDDISH-BROWN (MUDSTONE), EACH SEQUENCE CONSISTS OF STRUCTURELESS MUDSTONE AT TOP GRADING TO THINLY LAMINATED TO BEDDED SILTSTONE AT BASE; AMOUNT OF SEDIMENTARY STRUCTURES INCREASE TO BASE OF EACH SEQUENCE, THESE STRUCTURES INCLUDE: CROSS-LAMINATIONS, TROUGH CROSS-LAMINATIONS, EROSIONAL SURFACES, OCCASIONAL SOFT SEDIMENT DEFORMATION FEATURES; UPPER CONTACT OF EACH SEQUENCE IS EROSIONAL; OCCASIONAL GREENISH-GRAY REDUCTION SPOTS (1/16" TO 1" DIAMETER); ALL FRACTURES GYPSUM-FILLED; VERTICAL AND HIGH ANGLE FRACTURES APPEAR YOUNGER THAN HORIZONTAL AND SUBHORIZONTAL FRACTURES; SUBHORIZONTAL FRACTURE FILLING OCCASIONALLY SIGMOIDAL AND/OR TILTED; FILLING IN VERTICAL AND HIGH ANGLE FRACTURES HAVE A COMPONENT OF THRUST; THREE TYPES OF HORIZONTAL AND SUBHORIZONTAL FRACTURES; THICK - 1/2" TO 1", SPACED 1.0' TO 2.0'; MODERATELY THIN - 1/8" TO 1/2:, SPACED 1" TO 1.5'; THIN - <1/8", SPACED 1/4" TO 1"; BASAL CONTACT SHARP.
3049	360		
3044	365		
3039	370		
3034	375		
3029	380		SILTSTONE, REDDISH-BROWN, WITH INTERBEDDED CLAYSTONE, DARK REDDISH-BROWN, 1" TO 4" THICK FINING UPWARD SEQUENCES, THINLY LAMINATED TO THINLY BEDDED (1/16" TO 2" THICK), HARD; SEDIMENTARY STRUCTURES INCLUDE: CROSS-LAMINATIONS, SOFT SEDIMENT LOAD STRUCTURES, EROSIONAL CONTACTS AT TOP OF EACH FINING UPWARD SEQUENCE; LOCALLY ABUNDANT GREENISH-GRAY REDUCTION SPOTS (1/16" TO 1" DIAMETER), SOME OCCUR IN ALIGNED ZONES; OVERALL GRAIN SIZE INCREASES TO BASE; ABUNDANT HORIZONTAL, FIBROUS GYPSUM-FILLED FRACTURES OCCUR IN TWO SIZE GROUPS: 0" TO 1/4" THICK, SPACED 1/4" TO 1"; 1/4" TO 1/2" THICK, SPACED 0.5' TO 2.0'; VERTICAL AND HIGH ANGLE FIBROUS GYPSUM-FILLED FRACTURES ARE MODERATELY ABUNDANT, 1/16" TO 1/2" THICK, SPACED 2.5' TO 5'; BASAL CONTACT SHARP, UNDULATORY, POSSIBLY EROSIONAL.
3024	385		
3019	390		
3014	395		
3009	400		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

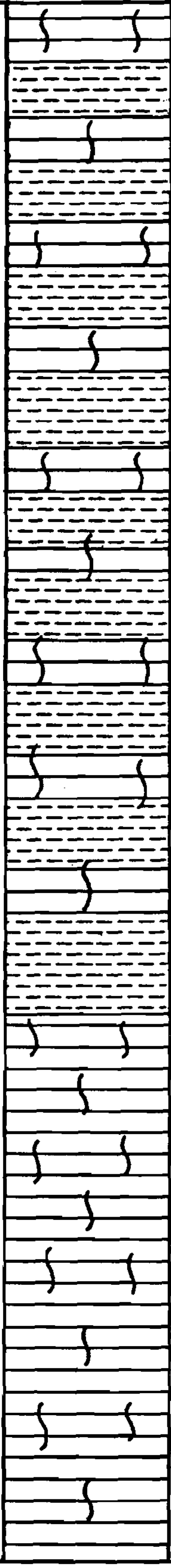
PRELIMINARY ELEV. (FT. MSL)	DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
3009	400		SILTSTONE, REDDISH-BROWN, WITH INTERBEDDED CLAYSTONE, DARK REDDISH-BROWN, 1" TO 4" THICK FINING UPWARD SEQUENCES, THINLY LAMINATED TO THINLY BEDDED (1/16" TO 2" THICK), HARD; SEDIMENTARY STRUCTURES INCLUDE: CROSS-LAMINATIONS, SOFT SEDIMENT LOAD STRUCTURES, EROSIONAL CONTACTS AT TOP OF EACH FINING UPWARD SEQUENCE; LOCALLY ABUNDANT GREENISH-GRAY REDUCTION SPOTS (1/16" TO 1" DIAMETER), SOME OCCUR IN ALIGNED ZONES; OVERALL GRAIN SIZE INCREASES TO BASE; ABUNDANT HORIZONTAL, FIBROUS GYPSUM-FILLED FRACTURES OCCUR IN TWO SIZE GROUPS: 0" TO 1/4" THICK, SPACED 1/4" TO 1"; 1/4" TO 1/2" THICK, SPACED 0.5' TO 2.0'; VERTICAL AND HIGH ANGLE FIBROUS GYPSUM-FILLED FRACTURES ARE MODERATELY ABUNDANT, 1/16" TO 1/2" THICK, SPACED 2.5' TO 5'; BASAL CONTACT SHARP, UNDULATORY, POSSIBLY EROSIONAL.
3004	405		
2999	410		
2994	415		
2989	420		
2984	425		
2979	430		SILTSTONE AT TOP, GRADING TO CLAYSTONE AT BASE, REDDISH-BROWN TO DARK REDDISH-BROWN, TRACE OF BEDDING AT TOP GRADING TO STRUCTURELESS AT BASE, HARD; CONTAINS OCCASIONAL CLAYSTONE CLASTS <1/8" DIAMETER; RARE INTERBEDS OF CLAYSTONE, 1/16" THICK; ABUNDANT GREENISH-GRAY REDUCTION SPOTS (1/16" TO 2" DIAMETER) OCCUR IN ZONES; ABUNDANT HORIZONTAL AND SUBHORIZONTAL FIBROUS GYPSUM-FILLED FRACTURES, MAJORITY 1/16" THICK, SPACED 1" TO 2"; MODERATELY ABUNDANT VERTICAL AND SUBVERTICAL FIBROUS GYPSUM-FILLED FRACTURES UP TO 1/4" THICK, SPACED 1.0' TO 3.0'; BASAL CONTACT OBSCURED.
2974	435		
2969	440		
2964	445		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG
SHEET 12 OF 50

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2964	445		AS ABOVE
2959	450		
2954	455		
		OBSCURED	SLIGHTLY SANDY SILTSTONE, REDDISH-BROWN, INTERBEDDED WITH SILTY-MUDSTONE, DARK REDDISH-BROWN, 1" THICK FINING UPWARDS SEQUENCES, THINLY BEDDED (1"); MINOR EROSIONAL CONTACTS AT TOP OF EACH FINING UPWARD SEQUENCE; HORIZONTAL AND SUBHORIZONTAL FIBROUS GYPSUM-FILLED FRACTURES <1/8" THICK, SPACED 0" TO 6"; SUBVERTICAL AND VERTICAL FIBROUS GYPSUM-FILLED FRACTURES ARE LESS ABUNDANT AND CROSS-CUT HORIZONTAL AND SUBHORIZONTAL FRACTURES; BASAL CONTACT SHARP.
2949	460		
2944	465		SILTSTONE AT TOP GRADING TO CLAYSTONE AT BASE, REDDISH-BROWN TO DARK REDDISH-BROWN, TRACE OF BEDDING AT TOP GRADING TO STRUCTURELESS AT BASE, HARD; ABUNDANT GREENISH-GRAY REDUCTION SPOTS (1/16" TO 2" DIAMETER); HORIZONTAL AND SUBHORIZONTAL FIBROUS GYPSUM-FILLED FRACTURES <1/8" THICK; SUBVERTICAL AND VERTICAL GYPSUM-FILLED FRACTURES ARE LESS ABUNDANT AND CROSS-CUT HORIZONTAL AND SUBHORIZONTAL FRACTURES; BASAL CONTACT SHARP.
2939	470		
2934	475		
2929	480		
			MUDSTONE, SILTY, DARK REDDISH-BROWN, STRUCTURELESS; NO HORIZONTAL OR SUBHORIZONTAL GYPSUM-FILLED FRACTURES; RARE SUBVERTICAL AND VERTICAL FRACTURES PRESENT, 0" TO 1/2" THICK; BASAL CONTACT GRADATIONAL.
2924	485		
2919	490		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	REMARKS
2919	490	AS ABOVE
2914	495	
2909	500	CLAYSTONE GRADING TO SILTSTONE WITH DEPTH, REDDISH-BROWN TO DARK REDDISH-BROWN, THIN 1" TO 3" THICK FINING UPWARDS SEQUENCES, THINLY BEDDED; CONTAINS MINOR EROSIONAL CONTACTS AT TOP OF EACH FINING UPWARDS SEQUENCE; ABUNDANT HORIZONTAL AND SUBHORIZONTAL FIBROUS GYPSUM-FILLED FRACTURES 0" TO 1/8" THICK, SPACED 0" TO 6"; MODERATELY ABUNDANT VERTICAL AND SUBVERTICAL FIBROUS GYPSUM-FILLED FRACTURES 1/8" TO 1/2" THICK; BASAL CONTACT SHARP.
2904	505	
2899	510	
2894	515	
2889	520	
2884	525	SILTSTONE, (FIGURE 9).
2879	530	
2874	535	

STRATIGRAPHIC COLUMN

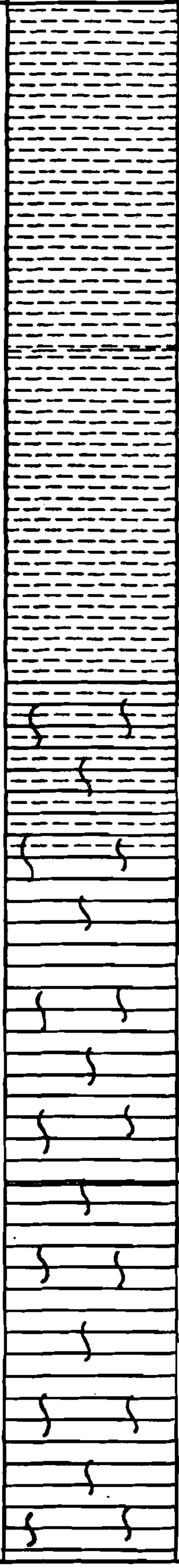


FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

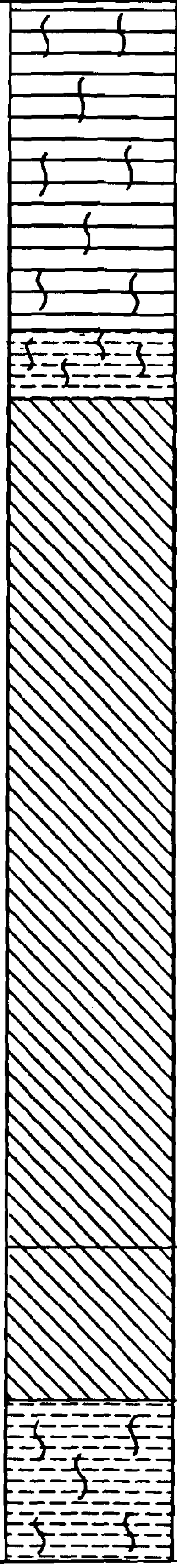
PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2874	535		
2869	540		
2864	545		SILTSTONE, (FIGURE 9).
			<u>RUSTLER FORMATION</u> <u>FORTY-NINER MEMBER</u> ANHYDRITE, FINELY CRYSTALLINE, GRAY TO GRAYISH-BROWN, WHITE AT UPPER CONTACT, BANDED TO OCCASIONALLY LAMINATED, SPACED 1/16" TO 1"; BANDS AND LAMINAE UNDULATORY UP TO 1/4" AND OCCASIONALLY TERMINATE ABRUPTLY, GRAY BANDS USUALLY THICKEST, BECOME STRUCTURELESS WITH DEPTH, LOCALLY NODULAR; UPPER 3.0' CONTAINS INTERBEDDED CLAY LAMINAE, CONTENT DECREASING WITH DEPTH; LOCALLY GYPSIFEROUS IN UPPER 6"; NEAR TOP, HORIZONTAL AND SUBHORIZONTAL GYPSUM-FILLED FRACTURES ARE ABUNDANT, 1/8" TO 1/2" THICK, SPACED 1" TO 3"; BEDDING TERMINATED EROSIONALLY AT UPPER CONTACT; HORIZONTAL AND SUBHORIZONTAL GYPSUM-FILLED FRACTURES SPACED 1" ~~TO 2.0'~~, 1/16" ~~TO 1/4" THICK; NEAR~~-VERTICAL AND SUBVERTICAL GYPSUM-FILLED FRACTURES, 1/8" TO 1/4" THICK, SPACED 2.0' TO 6.0'; BASAL CONTACT SHARP.
2859	550		
2854	555		
2849	560		
2844	565		
2839	570		
			ANHYDRITE; SEE FIGURE 10.
2834	575		
			SILTY CLAYSTONE; SEE FIGURE 10.
2829	580		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG
SHEET 15 OF 50

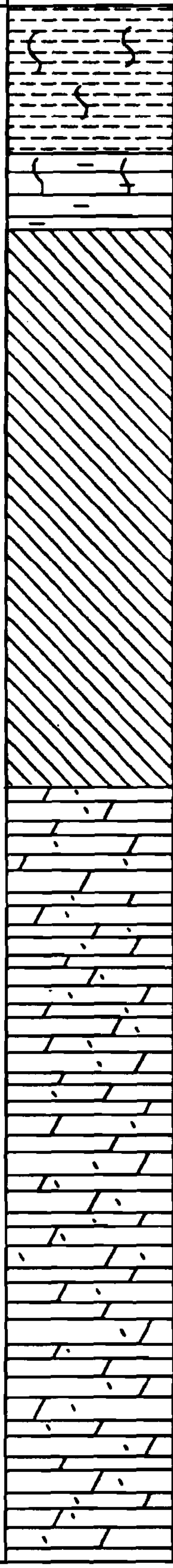
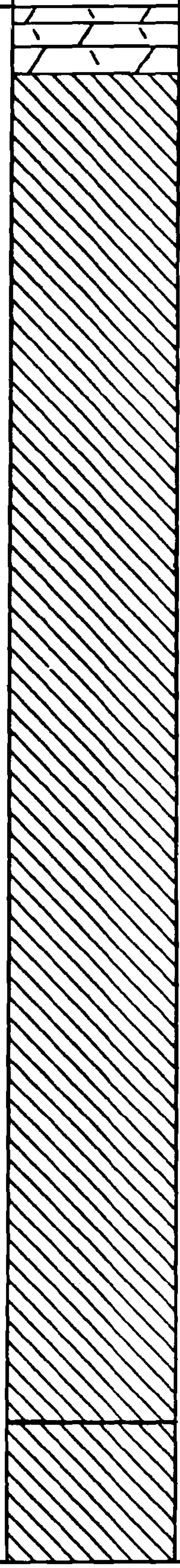
PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2829	580		
2824	585		
			ANHYDRITE; SEE FIGURE 10.
2819	590		
2814	595		
2809	600		
			<u>MAGENTA DOLOMITE MEMBER</u> DOLOMITE, GYPSIFEROUS; SEE FIGURE 10.
2804	605		
2799	610		
2794	615		
2789	620		
2784	625		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)
2784	625
2779	630
2774	635
2769	640
2764	645
2759	650
2754	655
2749	660
2744	665
2739	670

STRATIGRAPHIC COLUMN



REMARKS

TAMARISK MEMBER

ANHYDRITE, FINELY CRYSTALLINE, GRAY TO LIGHT BROWNISH-GRAY TO TAN WITH DEPTH, LAMINATED TO NODULAR, HARD; LOCALLY GYPSIFEROUS AT UPPER CONTACT; CONTAINS INTERBEDS OF LAMINATED CARBONATE LOCALLY AND NEAR BASE; LAMINAE MAY LOCALLY BE TERMINATED EROSIONALLY; 1" TO 2" THICK ORGANIC (?) BLACK CLAYSTONE AT 665.9', CONTAINS FIBROUS GYPSUM-FILLED FRACTURES, FIBERS ORIENTED VERTICALLY, 1/32" TO 1" THICK, DISCONTINUOUS, LOCALLY BIFURCATING; HORIZONTAL FIBROUS GYPSUM-FILLED FRACTURES THROUGHOUT WITH SPACING 0.5' TO 1.5', 1/32" TO 1/16" THICK; RARE SUBVERTICAL FRACTURES; BASAL CONTACT GRADATIONAL.

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

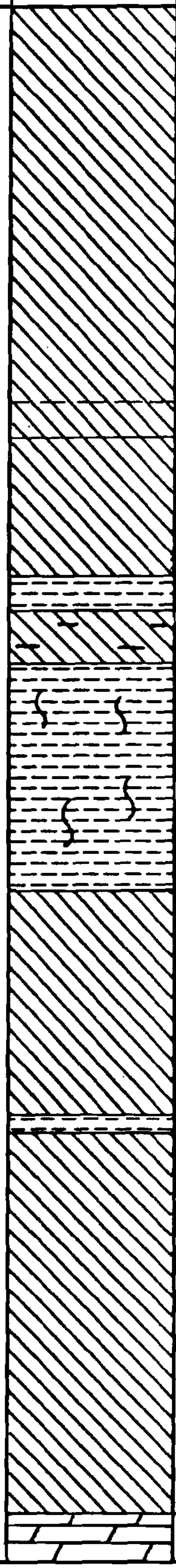
PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2739	670		AS ABOVE
2734	675		
2729	680		
			ANHYDRITE; SEE FIGURE 11.
			ANHYDRITE; SEE FIGURE 11.
2724	685		
			CLAYSTONE; SEE FIGURE 11.
			ANHYDRITE, ARGILLACEOUS; SEE FIGURE 11.
			SILTY CLAYSTONE; SEE FIGURE 11.
2719	690		
2714	695		
			ANHYDRITE; SEE FIGURE 11.
2709	700		
			CLAYSTONE; SEE FIGURE 11.
			ANHYDRITE; SEE FIGURE 11.
2704	705		
2699	710		
			CULEBRA DOLOMITE MEMBER
2694	715		DOLOMITE, GYPSIFEROUS; SEE FIGURE 11.

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG
SHEET 18 OF 50

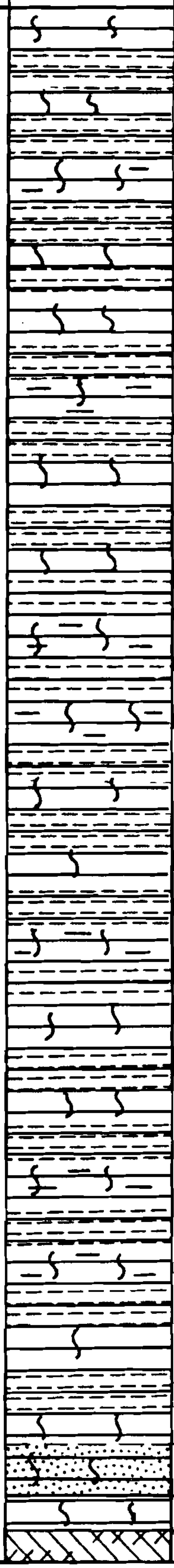
PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2694	715		AS ABOVE
2689	720		
2684	725		
2679	730		
2674	735		
			UNNAMED LOWER MEMBER SILTY CLAYSTONE; SEE FIGURE 11.
2669	740		
2664	745		ANHYDRITE; SEE FIGURE 11.
2659	750		
2654	755		SANDY MUDSTONE; SEE FIGURE 11.
			HALITIC MUDSTONE OR ARGILLACEOUS HALITE; SEE FIGURE 11.
2649	760		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2649	760		AS ABOVE
			HALITE; SEE FIGURE 11.
2644	765		
			ANHYDRITE; SEE FIGURE 11.
			HALITE, ARGILLACEOUS HALITE; SEE FIGURE 11.
2639	770		
			ARGILLACEOUS HALITE AND HALITIC MUDSTONE; SEE FIGURE 11.
2634	775		
			ARGILLACEOUS HALITE AND HALITIC MUDSTONE; SEE FIGURE 11.
2629	780		
2624	785		
			SANDY HALITIC SILTSTONE; SEE FIGURE 11.
2619	790		
			SILTSTONE AND SANDY SILTSTONE, LIGHT BROWN TO REDDISH-BROWN WITH THIN LAYERS OF MEDIUM GRAY CLAYSTONE AND MUDSTONE, THINLY BEDDED TO LAMINATED, DIVISIBLE INTO UNITS 8" TO 20" THICK; BEDDING AND LAMINATIONS GENERALLY HORIZONTAL TO SUBHORIZONTAL, SOME WAVY BEDDING, SOME MICRO CROSS-LAMINATIONS; FROM 792.0' TO 795.0' LARGER CROSS-CUTTING RELATIONSHIPS WITH SOME UNITS PARTIALLY TO WHOLLY EROSIONALLY REMOVED, UNITS GENERALLY DOWN-CUT TO EAST AND SOUTHEAST; SMALL-SCALE CROSS-BEDDING HAS VARIABLE CURRENT DIRECTIONS WITH DEPTH, MOST SOUTH; AT 794.0' SYMMETRICAL RIPPLES WITH CLAY DRAPE; RIPPLE SETS 1/4" TO 1/2" THICK; MINOR SOFT SEDIMENT DEFORMATION, LOCAL FINING UPWARDS SEQUENCES; BASAL CONTACT GRADATIONAL.
2614	795		
2609	800		
2604	805		

FIGURE 4 (CONTINUED)

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2604	805		SILTSTONE AND ARGILLACEOUS SILTSTONE INTERBEDDED WITH CLAYSTONE, GRAY AND DARK GRAY, THINLY LAMINATED (1/32" TO 1/8"); ABUNDANT FINE STRUCTURES INCLUDING HORIZONTAL LAMINATIONS, LOW-ANGLE CROSS-LAMINATION SETS OF VARYING SIZE (2" TO 3.0'); CURRENT DIRECTIONS IN SMALLER SETS VARY, CURRENT DIRECTIONS IN LARGER SETS MOSTLY NORTHEAST; RARE LOAD STRUCTURES, EROSIONAL SCOUR AND FILL; RARE HIGH-ANGLE HALITE-FILLED FRACTURES; FRACTURE OCCURRENCE INCREASES WITH DEPTH, NEAR BASE RARE HORIZONTAL AND SUBVERTICAL HALITE-FILLED FRACTURES 1/8" TO 3" THICK, SPACED 3.0' TO 8.0'; SOME LARGER SUBHORIZONTAL FRACTURES EXHIBIT AN EAST (TOP) WEST (BOTTOM) SHEAR; CONTAINS DARK GRAY SPOTS AND BLEBS (BIOTURBATION), CONTENT INCREASING WITH DEPTH; BECOMES ARGILLACEOUS SILTSTONE WITH DEPTH; GRAY WITH LOCAL REDDISH-BROWN AREAS, THINLY LAMINATED AND CONTAINS BROWNISH CLASTS OF ANHYDRITE (1/8" TO 1-1/2" DIAMETER) ROUNDED AND OCCASIONALLY FLATTENED PARALLEL TO BEDDING; CLASTS RANDOMLY SCATTERED THROUGHOUT; RARE LOW-ANGLE CROSS-LAMINATION SETS; BASAL CONTACT GRADATIONAL OVER 1/2", IRREGULAR, MAPPED AS DIFFUSE DUE TO EXTREME CONTACT UNDULATIONS.
2599	810		
2594	815		
2589	820		
2584	825		
2579	830		
2574	835		
2569	840		
2564	845		
			SANDY SILTSTONE; SEE FIGURE 12.
			SILTSTONE; SEE FIGURE 12.
2559	850		POLYHALITE, ANHYDRITE, AND ARGILLACEOUS ANHYDRITE; SEE FIGURE 12.

EXHAUST SHAFT
LITHOLOGIC LOG

FIGURE 4 (CONTINUED)

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2559	850		SALADO FORMATION HALITIC MUDSTONE; SEE FIGURE 12.
			HALITE; SEE FIGURE 12.
2554	855		
2549	860		HALITE; SEE FIGURE 12.
2544	865		
			HALITIC CLAYSTONE; SEE FIGURE 12.
			HALITE; SEE FIGURE 12.
2539	870		
2534	875		
			HALITIC CLAYSTONE; SEE FIGURE 12.
			HALITE; SEE FIGURE 12.
2529	880		
			HALITIC CLAYSTONE; SEE FIGURE 12.
			ARGILLACEOUS HALITE; SEE FIGURE 12.
2524	885		
			CLAYSTONE, SLIGHTLY HALITIC; SEE FIGURE 12.
2519	890		
			HALITE, ARGILLACEOUS; SEE FIGURE 12.
2514	895		

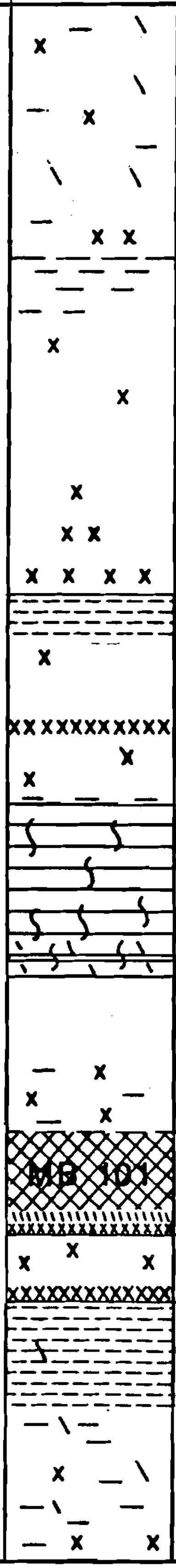
FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

<table>
<tr><th colspan="2">PRELIMINARY</th><th rowspan="2">STRATIGRAPHIC COLUMN</th><th rowspan="2">REMARKS</th></tr>
<tr><th>ELEV. (FT. MSL)</th><th>DEPTH (FT.)</th></tr>
<tr><td>2514</td><td>895</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>ARGILLACEOUS HALITE; SEE FIGURE 12.</td></tr>
<tr><td></td><td></td><td></td><td>HALITE; SEE FIGURE 12.</td></tr>
<tr><td>2509</td><td>900</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>ARGILLACEOUS HALITE; SEE FIGURE 12.</td></tr>
<tr><td>2504</td><td>905</td><td></td><td>HALITE, SLIGHTLY ARGILLACEOUS; SEE FIGURE 12.</td></tr>
<tr><td>2499</td><td>910</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>HALITE, COARSELY CRYSTALLINE, WHITE TO TINTED ORANGE, THINLY BEDDED WITH THIN SUBHORIZONTAL STRINGERS OF ANHYDRITE AND POLYHALITE; SLIGHTLY ARGILLACEOUS IN UPPER 0.5'; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY.</td></tr>
<tr><td>2494</td><td>915</td><td></td><td>SILTY CLAYSTONE, BROWNISH-RED, VERY SOFT; HALITIC, HALITE OCCURS AS 1/4" TO 1" DISPLACIVE CRYSTALS; CONTAINS LOCALLY REDUCED CLAYSTONE; BASAL CONTACT DIFFUSE, GENETICALLY GRADATIONAL.</td></tr>
<tr><td>2489</td><td>920</td><td></td><td>HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; CONTAINS INTERSTITIAL RED CLAY IN UPPER 3.0', CONTENT DECREASES WITH DEPTH; TRACE RANDOMLY ORIENTED STRINGERS OF POLYHALITE IN REMAINDER OF UNIT; BASAL CONTACT DIFFUSE.</td></tr>
<tr><td>2484</td><td>925</td><td></td><td>HALITE MIXED WITH POLYHALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO CLEAR; POLYHALITE CONTENT DECREASES WITH DEPTH, CONTENT GREATEST IN UPPER 0.5', OCCURS AS GROUPS OF SUBHORIZONTAL STRINGERS, BECOMING LESS ABUNDANT WITH DEPTH; SUBHORIZONTAL STRINGERS OF ANHYDRITE OCCUR WITH DEPTH, STRINGERS OF POLYHALITE AND ANHYDRITE BECOME RANDOMLY ORIENTED WITH DEPTH; BASAL CONTACT GRADATIONAL.</td></tr>
<tr><td>2479</td><td>930</td><td></td><td>HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO ORANGE TO CLEAR; ABUNDANT POLYHALITE IN UPPER 3" TINTS HALITE ORANGE; SUBHORIZONTAL STRINGERS OF POLYHALITE AND ANHYDRITE SPACED 1" TO 3"; BED OF VERY POLYHALITIC HALITE OCCURS BETWEEN 729.4' AND 730.0', UNIDENTIFIED GAS ORIGINATES FROM THIS AREA ALONG FRACTURES; BASAL CONTACT DIFFUSE.</td></tr>
<tr><td>2474</td><td>935</td><td></td><td>ARGILLACEOUS HALITE, ARGILLACEOUS MATERIAL REDDISH-BROWN, HALITE WHITISH-GRAY TO CLEAR; HALITE OCCURS AS DISPLACIVE CRYSTALS AND AGGREGATES OF CRYSTALS; UNIT CONTAINS LOCAL GREENISH-GRAY REDUCTION ZONES; CLAY CONTENT DECREASES WITH DEPTH, DECREASES ABRUPTLY BELOW 937.0'; ROCK BELOW 937.0' CLASSIFIED AS: HALITE, WHITE, MEDIUM TO COARSELY CRYSTALLINE, SLIGHTLY ARGILLACEOUS, CLAY CONTENT DECREASING WITH DEPTH, TRACE POLYHALITE AND ANHYDRITE STRINGERS CONTENT INCREASING WITH DEPTH, STRINGERS RANDOMLY ORIENTED AT TOP, BECOMING SUBHORIZONTAL WITH DEPTH, SPACED 1" TO 3"; BASAL CONTACT GRADATIONAL, MARKED BY 1" THICK ZONE OF GRAYISH-WHITE HALITE.</td></tr>
<tr><td>2469</td><td>940</td><td></td><td></td></tr>
</table>

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG



PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	REMARKS
2469	940	AS ABOVE
2464	945	
		ARGILLACEOUS HALITE, FINELY TO COARSELY CRYSTALLINE, WHITISH-GRAY TO CLEAR, MASSIVE; HALITE OCCURS AS CRYSTAL AGGREGATES IN ZONES OR PODS; CLAY CONTENT DECREASES ABRUPTLY BELOW 949.0'; TRACE DISSEMINATED POLYHALITE BLEBS, CONTENT INCREASES WITH DEPTH; BECOMES BEDDED IN LOWER 2.0' WITH ALTERNATING POLYHALITIC HALITE AND CLEAR HALITE BEDS 2" TO 3" THICK; BASAL CONTACT SHARP, DISCONFORMABLE.
2459	950	
2454	955	
		ARGILLACEOUS HALITE IN UPPER 2.0', REDDISH-BROWN, CLAY CONTENT DECREASES WITH DEPTH, GRADES INTO POLYHALITIC HALITE; HALITE IS WHITE TO TINTED ORANGE TO CLEAR, MEDIUM TO COARSELY CRYSTALLINE; POLYHALITE OCCURS AS BLEBS AND STRINGERS, POLYHALITE BED AT 961.5'; CONTAINS LOCAL GREENISH-GRAY REDUCTION SPOTS IN ARGILLACEOUS MATERIAL NEAR THE BASE; BASAL CONTACT SHARP, MARKED BY 3" THICK HORIZONTAL FIBROUS HALITE-FILLED FRACTURE.
2449	960	
		SILTSTONE, REDDISH-BROWN, TRACE OF BEDDING; CONTAINS SMALL 1/4" IMBAYED DISPLACIVE HALITE CRYSTALS NEAR TOP; CONTAINS RARE SUBVERTICAL HALITE-FILLED FRACTURES; BECOMES ANHYDRITIC (GRAY) IN LOWER 2.0'; CONTAINS DISPLACIVE HALITE CRYSTALS <1/8"; BASAL CONTACT SHARP.
2444	965	
		ARGILLACEOUS HALITE, ARGILLACEOUS MATERIAL REDDISH-BROWN, HALITE CLEAR; BELOW 969.0' CLAY CONTENT DECREASES ABRUPTLY, UNIT BECOMES SLIGHTLY ARGILLACEOUS AND POLYHALITIC, CLAY AND POLYHALITE OCCUR AS RANDOMLY ORIENTED STRINGERS; OVERALL CLAY CONTENT DECREASES WITH DEPTH; POLYHALITE CONTENT INCREASES WITH DEPTH; BASAL CONTACT GRADATIONAL.
2439	970	
		POLYHALITE, ANHYDRITIC, FINELY CRYSTALLINE, ORANGE, HARD; HALITIC, HALITE WHITE; ANHYDRITE GRAY; DISCONTINUOUS BEDS OF WHITE FINELY CRYSTALLINE HALITE NEAR TOP; AT 975.0', 1" THICK BED OF THINLY LAMINATED ANHYDRITE OCCURS; UNIT CONTAINS CLEAR DISPLACIVE HALITE CRYSTALS NEAR BASE; BASAL CONTACT SHARP.
2434	975	
		HALITE, POLYHALITIC, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO TINTED ORANGE, THIN TO MEDIUM BEDDED BY SUBHORIZONTAL STRINGERS OF POLYHALITE; BASAL CONTACT SHARP, MARKED BY A 2" THICK BED OF POLYHALITE.
		ARGILLACEOUS HALITE, REDDISH-BROWN, SLIGHTLY ANHYDRITIC, CLAY CONTENT DECREASES WITH DEPTH; NEAR TOP, HALITE OCCURS AS DISPLACIVE CRYSTALS; BECOMES THE DOMINANT MINERAL TYPE WITH DEPTH, BECOMES MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR, THINLY BEDDED IN LOWER 2.0' WITH STRINGERS OF POLYHALITE SEPARATING BEDS; ARGILLACEOUS MATERIAL OCCURS AS MATRIX IN UPPER PART, STRINGERS IN LOWER PART; SOME GREENISH-GRAY REDUCTION SPOTS OCCUR NEAR TOP; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH; BASAL CONTACT SHARP, DISCONFORMABLE.
2429	980	
2424	985	

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

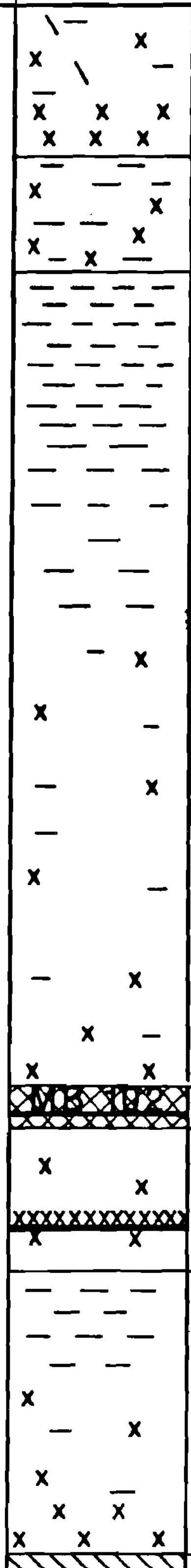
PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2424	985		AS ABOVE
2419	990		ARGILLACEOUS HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO TINTED ORANGE; REDDISH-BROWN CLAY MATRIX IN UPPER 4"; POLYHALITIC; CLAY AND POLYHALITE OCCUR AS SUBHORIZONTAL STRINGERS SPACED 1" TO 4"; BASAL CONTACT SHARP.
2414	995		ARGILLACEOUS HALITE GRADING TO HALITE WITH DEPTH; CLAY OCCURS AS REDDISH-BROWN MATRIX AT TOP, HALITE OCCURS AS DISPLACIVE CRYSTALS AND CRYSTAL AGGREGATES ALIGNED IN ZONES, CLAY IN UPPER 1" GREENISH GRAY; CLAY CONTENT DECREASES WITH DEPTH, OCCURS AS SUBHORIZONTAL STRINGERS; HALITE BECOMES DOMINANT ROCK TYPE WITH DEPTH, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; TRACE POLYHALITE BLEBS AND RANDOMLY ORIENTED TO SUBHORIZONTAL STRINGERS; RARE ANHYDRITE STRINGERS; LOWER 3.0' TINTED ORANGE; BASAL CONTACT SHARP.
2409	1000		
2404	1005		
2399	1010		
2394	1015		POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE; 1" THICK GRAY CLAYSTONE BEDS 3" ABOVE AND AT BASAL CONTACT; BASAL CONTACT SHARP. HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR TO ORANGE; TRACE POLYHALITE STRINGERS AND DISSEMINATED BLEBS; AT 1017.8', 1" THICK BED OF POLYHALITE OCCURS UNDERLAIN BY A 1/4" THICK BED OF GRAY CLAYSTONE; BASAL CONTACT SHARP, MARKED BY DISSOLUTION TROUGHS.
2389	1020		ARGILLACEOUS HALITE, WHITE TO CLEAR, MEDIUM TO COARSELY CRYSTALLINE; CLAY OCCURS AS BROWN SUBHORIZONTAL STRINGERS, SPACED 1" TO 2"; STRINGERS ARE TERMINATED EROSIONALLY AT UPPER CONTACT, CLAY CONTENT DECREASES WITH DEPTH; TRACE POLYHALITE STRINGERS AND DISSEMINATED BLEBS, CONTENT INCREASES IN LOWER 3.0'; BASAL CONTACT SHARP, EROSIONAL, UNDULATORY UP TO 1.0'.
2384	1025		
2379	1030		AS BELOW

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2379	1030	MB 103	ANHYDRITE, FINELY CRYSTALLINE, ALTERNATING LIGHT AND DARK GRAY, LAMINATED TO VERY THINLY BEDDED; BEDDING UNDULATES SLIGHTLY, BEDS OFTEN CONTAIN ENTROLITHIC STRUCTURES; LOCAL <1/4" CRYSTALS OF HALITE; LIGHT BROWN CARBONATE (?) INTERBEDS; BASAL CONTACT GRADATIONAL.
2374	1035		
			CARBONATE (DOLOMITE?), FINELY CRYSTALLINE OR GRAINED, LIGHT BROWN WITH GRAYISH-BROWN LAMINAE, THINLY LAMINATED, LAMINAE OCCUR AS CONCAVE DOWNWARD SETS AVERAGING 4" TO 7" ACROSS; PROBABLE ALGAL STROMATOLITES; DARKER LAMINAE ORGANIC (?); BASAL CONTACT MARKED BY SUBHORIZONTAL GRAYISH-BROWN LAMINAE, GRADATIONAL.
2369	1040		DOLOMITE, FINELY CRYSTALLINE, LIGHT BROWN, HINT OF BEDDING; BASAL CONTACT SHARP, EROSIONAL.
		MB 103	ANHYDRITE, CARBONATE-RICH, FINELY CRYSTALLINE, ALTERNATING LIGHT GRAY AND GRAY, THINLY LAMINATED IN UPPER 0.9', REMAINDER STRUCTURELESS; BASAL CONTACT SHARP, EROSIONAL.
			SILTY CLAYSTONE, GRAY, LOCALLY THINLY LAMINATED; CONTAINS DISPLACIVE HALITE CRYSTALS; BASAL CONTACT SHARP.
2364	1045		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO ORANGE; CLAY MATRIX IN UPPER 1.0', HALITE OCCURS AS DISPLACIVE CRYSTALS, CLAY CONTENT DECREASES WITH DEPTH; CLAY MORPHOLOGY CHANGES FROM MATRIX TO SUBHORIZONTAL STRINGERS SPACED 1" TO 2", BELOW 1047.0' ARGILLACEOUS STRINGERS BECOME DISCONTINUOUS AND ORIENTED RANDOMLY; TRACE DISCONTINUOUS SUBHORIZONTAL STRINGERS AND PODS OF POLYHALITE, CONTENT INCREASES WITH DEPTH; AT 1050.0' A 0.3' THICK LAMINATED BED OF ANHYDRITE OCCURS, BELOW THIS BED CLAY CONTENT DECREASES MARKEDLY AND TRACE AMOUNTS OF POLYHALITE AND ANHYDRITE OCCUR IN DISCONTINUOUS STRINGERS; 2" THICK BED OF ANHYDRITE OCCURS AT 1055.0'; LOWER 1.0' IS VERY POLYHALITIC; BASAL CONTACT SHARP.
2359	1050	MB 104	
2354	1055		
2349	1060		ARGILLACEOUS HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR, CLAY OCCURS IN RANDOMLY-ORIENTED STRINGERS; STRINGERS AND BLEBS OF POLYHALITE; BASAL CONTACT SHARP, UNDULATORY UP TO 1.0'.
2344	1065		
		MB 105	POLYHALITE, FINELY CRYSTALLINE, ORANGE, STRUCTURELESS EXCEPT NEAR BASE; LOCALLY HALITIC; THIN GRAY ANHYDRITE BED OCCURS AT BASE; BASAL CONTACT SHARP, MARKED BY A THIN BED OF GRAY CLAYSTONE.
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; ARGILLACEOUS AT TOP, REDDISH-BROWN, CONTENT DECREASES WITH DEPTH, CLAY OCCURS IN STRINGERS; TRACE POLYHALITE AS RANDOMLY-ORIENTED STRINGERS WHICH GRADE TO SUBHORIZONTAL WITH DEPTH, CONTENT INCREASES WITH DEPTH; AT 1071.6, 1" THICK BED OF POLYHALITE OCCURS UNDERLAIN BY 1" THICK GRAY CLAYSTONE BED; CLAY CONTENT INCREASES SLIGHTLY BELOW 1071.6', COLOR REDDISH-BROWN TO GRAY; BECOMES VERY POLYHALITIC IN LOWER 1.0'; BASAL CONTACT SHARP.
2339	1070		
2334	1075		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

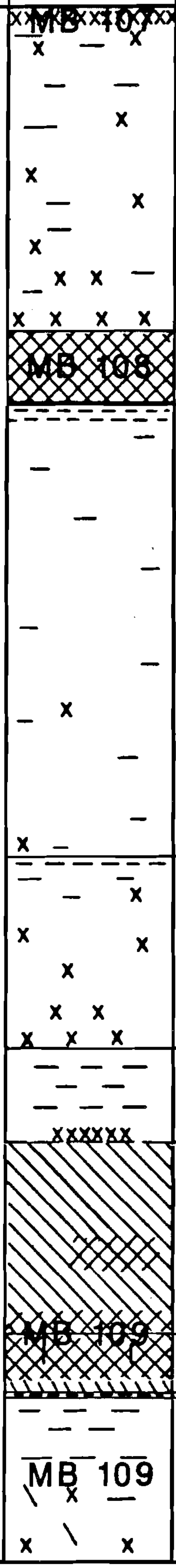
PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2334	1075		AS ABOVE
2329	1080		
			POLYHALITE, FINELY CRYSTALLINE, ORANGE; UNDERLAIN BY 1/2" THICK GRAY CLAYSTONE BED; BASAL CONTACT SHARP.
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, CLEAR TO WHITE; UPPER 1.0' ARGILLACEOUS STRINGERS, CONTENT DECREASES WITH DEPTH; POLYHALITE STRINGERS, CONTENT INCREASES WITH DEPTH; BASAL CONTACT SHARP.
2324	1085		
		MB-106	POLYHALITE, FINELY CRYSTALLINE, ORANGE, STRUCTURELESS; UNDERLAIN BY 1" THICK GRAY CLAYSTONE BED; BASAL CONTACT SHARP.
			HALITE, MODERATELY ARGILLACEOUS AND POLYHALITIC, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; LOCAL REDDISH-BROWN CLAY MATRIX, HALITE OCCURS AS DISPLACIVE CRYSTALS, LOCAL GREENISH-GRAY REDUCTION ZONES; ARGILLACEOUS STRINGERS ABUNDANT IN UPPER 3.0', CONTENT DECREASES WITH DEPTH, ABSENT BELOW 1103.0'; POLYHALITE OCCURS AS DISSEMINATED BLEBS AND STRINGERS, CONTENT INCREASING WITH DEPTH, 1" THICK POLYHALITE BED AT 1105.2'; BASAL CONTACT SHARP.
2319	1090		
2314	1095		
2309	1100		
2304	1105		
2299	1110		
			HALITE, ARGILLACEOUS AND POLYHALITIC, COARSELY CRYSTALLINE, WHITE TO CLEAR; CLAY OCCURS AS STRINGERS; POLYHALITE OCCURS AS DISSEMINATED BLEBS AND STRINGERS, 6" THICK IRREGULAR BED OF POLYHALITE AT 1120.5', LOWER 6" VERY POLYHALITIC; BASAL CONTACT SHARP.
2294	1115		
2289	1120		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)
2289	1120
2284	1125
2279	1130
2274	1135
2269	1140
2264	1145
2259	1150
2254	1155
2249	1160
2244	1165

STRATIGRAPHIC COLUMN



REMARKS

AS ABOVE

POLYHALITE, FINELY CRYSTALLINE, ORANGE, STRUCTURELESS; UNDERLAIN BY 2" THICK GRAY CLAYSTONE BED; BASAL CONTACT SHARP.

HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; UPPER 4" VERY ARGILLACEOUS, CLAY OCCURS AS REDDISH-BROWN DISCONTINUOUS RANDOMLY-ORIENTED STRINGERS; REMAINDER CONTAINS TRACE CLAY STRINGERS, LOCALLY STRINGERS BECOME SUBHORIZONTAL AND DENSITY MAY INCREASE; CONTAINS TRACE POLYHALITE WITH DEPTH; BASAL CONTACT SHARP, DISCONFORMABLE.

HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR TO ORANGE; UPPER 1" VERY ARGILLACEOUS, SLIGHTLY ARGILLACEOUS TO 1146.0'; MODERATELY ABUNDANT RANDOMLY-ORIENTED STRINGERS AND LARGE BLEBS OF POLYHALITE, CONTENT INCREASING WITH DEPTH, LOWER 1.5' VERY POLYHALITIC; BASAL CONTACT SHARP, DISCONFORMABLE.

ARGILLACEOUS HALITE, FINELY TO COARSELY CRYSTALLINE; LOCALLY INTERBEDDED WITH HALITIC MUDSTONE CONTAINING DISPLACIVE HALITE CRYSTALS; REDDISH-BROWN CLAY DISSEMINATED THROUGHOUT AS MATRIX, CONTENT INCREASES WITH DEPTH; IRREGULARLY SHAPED ZONES (1.0' x 2.0') OF PURE HALITE RANDOMLY SCATTERED THROUGHOUT UNIT; LOCAL SMALL ZONES OF REDUCED GREENISH-GRAY CLAY; DISSOLUTION PITS THROUGH UNIT FILLED WITH ARGILLACEOUS HALITE; POLYHALITIC, CONTENT INCREASES WITH DEPTH, DISCONTINUOUS 1" THICK POLYHALITE BED AT BASAL CONTACT; BASAL CONTACT GRADATIONAL, IRREGULAR WITH UP TO 1.0' OF RELIEF, LOCALLY SHARP, EROSIONAL.

ANHYDRITE, FINELY CRYSTALLINE, LIGHT GRAY TO LIGHT TANNISH-GRAY, THINLY LAMINATED TO THINLY BEDDED, BEDS SEPARATED BY DARK GRAY THIN LAMINAE; HALITE PSEUDOMORPHS AFTER GYPSUM SWALLOWTAIL CRYSTALS BECOME ABUNDANT BELOW 1155.0', 1/16" TO 2" HIGH, BECOME MORE ABUNDANT AND LARGER WITH DEPTH, MOST OCCUR ALONG SUBHORIZONTAL BEDDING PLANES, OCCASIONALLY PSEUDOMORPHS LIE PARALLEL TO BEDDING; AT UPPER CONTACT DISSOLUTION PITS INTO ANHYDRITE OCCUR, FILLED WITH GRAY ARGILLACEOUS HALITE AND HALITIC MUDSTONE, 0.5' TO 2.0' DEEP INTO ANHYDRITE, BEDDING TERMINATED EROSIONALLY AT SIDES OF DISSOLUTION PITS; LOCALLY, POLYHALITE IS INCLUDED IN HALITE FILLING OF HALITE PSEUDOMORPHS AFTER GYPSUM SWALLOWTAIL CRYSTALS, POLYHALITE ALSO OCCURS IN IRREGULARLY-SHAPED ZONES (2" x 3") AS REPLACEMENT OF ANHYDRITE; HALITE OCCURS ALONG BEDDING PLANES BELOW 1157.0'; LOWER 1" CONTAINS INTERBEDS OF POLYHALITE; BASAL CONTACT SHARP.

POLYHALITE, SLIGHTLY HALITIC, FINELY CRYSTALLINE, REDDISH-ORANGE, HINT OF BEDDING IN UPPER 4", REMAINDER STRUCTURELESS EXCEPT FOR RARE HALITE PSEUDOMORPHS AFTER SWALLOWTAIL GYPSUM CRYSTALS; CONTAINS ABUNDANT IRREGULARLY-SHAPED CRYSTALS OF HALITE (1/32" TO 1/2"); LOWER 3" IS ANHYDRITIC OR CARBONATE-RICH, COLOR GRADES TO BROWN AT BASE; BASAL CONTACT SHARP, UNDULATORY ON TWO SCALES: MINOR - UP TO 3", MAJOR - UP TO 2.5', EXHIBITS SOFT SEDIMENT DEFORMATION DUE TO LOADING.

CLAYSTONE, LIGHT GRAY AT TOP TO GRAY AT BASE, STRUCTURELESS EXCEPT FOR FLOWAGE STRUCTURES; THICKNESS RANGES FROM 0.2' TO 1.0'; LOCALLY BROKEN BY 0" TO 2" THICK FRACTURES FILLED WITH CLEAR TO ORANGE HALITE; BASAL CONTACT SHARP, UNDULATORY UP TO 2.0', DISCONFORMABLE.

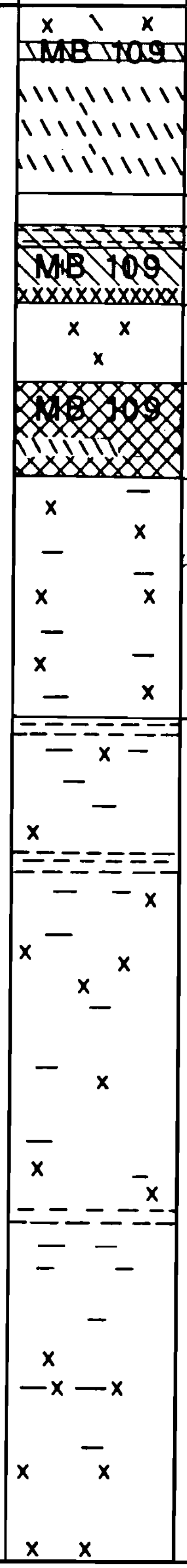
HALITE, COARSELY CRYSTALLINE, CLEAR TO WHITE; CONTAINS GRAY CLAY STRINGERS IN UPPER 2.0', CONTENT DECREASES WITH DEPTH; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH, OCCURS AS BLEBS, RANDOMLY-ORIENTED STRINGERS, AND AS THICK SUBHORIZONTAL STRINGERS 1/4" THICK; ANHYDRITE OCCURS WITH POLYHALITE STRINGERS, CONTENT INCREASES WITH DEPTH; BASAL CONTACT SHARP, UNDULATORY UP TO 1.0'.

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)
2244	1165
2239	1170
2234	1175
2229	1180
2224	1185
2219	1190
2214	1195
2209	1200
2204	1205
2199	1210

STRATIGRAPHIC COLUMN



REMARKS

ANHYDRITE, FINELY CRYSTALLINE, GRAY TO LIGHT GRAY, HINT OF THIN LAMINATIONS; CONTAINS 1" THICK ANHYDRITE LOCAL ZONES OF MIXED HALITE AND FINELY CRYSTALLINE; BASAL CONTACT SHARP.

HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR; CONTAINS HORIZONTAL STRINGERS OF ANHYDRITE, 1" TO 3" THICK BEDS OF FINELY CRYSTALLINE ANHYDRITE WITH HALITE PSEUDOMORPHS AFTER GYPSUM SWALLOWTAIL CRYSTALS AT 1167.3', 1168.4', 1169.4'; BASAL CONTACT SHARP.

ANHYDRITE, FINELY CRYSTALLINE, LIGHT GRAY TO GRAY, FINELY LAMINATED; CONTAINS HALITE PSEUDOMORPHS AFTER GYPSUM SWALLOWTAIL CRYSTALS, 1/4" TO 1-1/2" HIGH, OCCURRING PARALLEL TO BEDDING PLANES; BASAL CONTACT UNDULATORY DUE TO INFILLING OF SHALLOW CHANNEL FORMS IN UNDERLYING UNIT, SHARP, DISCONFORMABLE.

ANHYDRITE AND CLAYSTONE; ANHYDRITE OCCURS AS ISOLATED GRAY NODULES IN A POORLY INDURATED GRAY CLAYSTONE MATRIX; SIZE OF NODULES INCREASES WITH DEPTH; TEXTURE OF BASAL 1.8' DEFINED AS NODULAR; BASAL CONTACT SHARP, DISCONFORMABLE.

ANHYDRITE, HALITIC, FINELY CRYSTALLINE, GRAY TO BROWNISH-GRAY, MICRO TO THINLY LAMINATED, LAMINAE ALTERNATE LIGHT TO DARK; CONTAINS LOCAL HALITE PSEUDOMORPHS AFTER GYPSUM SWALLOWTAIL CRYSTALS, < 1/8" HIGH; BASAL CONTACT SHARP, UNDULATORY, LOCALLY DISCONFORMABLE, MARKED BY DISCONTINUOUS 1" THICK POLYHALITE BED.

HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; POLYHALITIC AT TOP, CONTENT DECREASES WITH DEPTH; BASAL CONTACT SHARP, DISCONFORMABLE.

POLYHALITE, FINELY CRYSTALLINE, PALE ORANGISH-BROWN, LOCALLY MICROLAMINATED TO BANDED (< 1/32" TO 1" THICK); LOCALLY 1/2" TO 1" THICK UNALTERED ANHYDRITE BEDS, NEAR TOP BEDS CONTAIN HALITE PSEUDOMORPHS AFTER GYPSUM SWALLOWTAIL CRYSTALS 1/4" TO 1/2" HIGH; BASAL CONTACT SHARP, UNDULATORY UP TO 0.5', DISCONFORMABLE, MARKED BY THE OCCURRENCE OF 1" TO 2" THICK BED OF GRAY CLAYSTONE.

HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; BLEBS AND SUBHORIZONTAL STRINGERS OF POLYHALITE TO 1/2" THICK; LOCAL GRAY SUBHORIZONTAL STRINGERS OF CLAY TERMINATED AT PENECONTEMPORANEOUS DISSOLUTION PITS; BASAL CONTACT SHARP, DISCONFORMABLE, UNDULATORY UP TO 0.4'.

HALITE AND ARGILLACEOUS HALITE; HALITE: WHITE TO CLEAR TO TINTED ORANGE; CLAY: REDDISH-BROWN; UPPER 0.5' VERY ARGILLACEOUS, CONTAINS DISPLACIVE HALITE CRYSTALS (< 1/4") IN MUDSTONE MATRIX, UPPER 3" GREENISH-GRAY IN COLOR, CLAY CONTENT DECREASES WITH DEPTH TO 1189.0', 0.5' THICK REDDISH-BROWN ARGILLACEOUS HALITE BED OCCURS BELOW 1189.0', CLAY CONTENT INCREASES ABRUPTLY, THEN DECREASES WITH DEPTH, CLAY MATERIAL OCCURS AS MATRIX MATERIAL OR AS RANDOMLY-ORIENTED STRINGERS, CLAY CONTENT LOCALLY INCREASES BELOW 1200.0'; TRACE POLYHALITE AT TOP, CONTENT INCREASING WITH DEPTH, AS DISSEMINATED BLEBS AND RANDOMLY-ORIENTED DISCONTINUOUS STRINGERS; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY, DISCONFORMABLE.

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2199	1210		
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO ORANGISH-WHITE; UPPER 2.0' REDDISH-BROWN HALITIC MUDTONE CONTAINING DISPLACIVE HALITE CRYSTALS, GRADES INTO SLIGHTLY ARGILLACEOUS HALITE; REMAINDER CONTAINS GRAY CLAY DISSEMINATED THROUGHOUT AS INTER-CRYSTALLINE MATERIAL; POLYHALITE OCCURS AS RANDOMLY-ORIENTED STRINGERS AND DISSEMINATED BLEBS, BETWEEN 1217.0' AND 1219.0', 2" THICK POLYHALITE BEDS SPACED 0.5' TO 1.0' OCCUR, 3" THICK DISCONTINUOUS BED OF POLYHALITE UNDERLAIN BY A THIN BED OF GRAY CLAYSTONE OCCURS AT 1219.0', BED OF FINELY CRYSTALLINE ORANGISH-WHITE POLYHALITE OCCURS BETWEEN 1227.1' TO 1227.5'; 1/8" TO 1/4" THICK SUBHORIZONTAL STRINGERS OF POLYHALITE OCCUR IN THE INTERVALS FROM 1225.1' TO 1227.1' AND 1227.5' TO 1229.5'; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY, DISCONFORMABLE.
2194	1215		
		MB 110	
2189	1220		
2184	1225		
		MB 111	
2179	1230		
			HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR; CLAY AND POLYHALITE OCCUR AS RANDOMLY-ORIENTED DISCONTINUOUS STRINGERS; UPPER 2.0' ARGILLACEOUS HALITE, HALITE OCCURS IN DISCONTINUOUS ZONES AND PODS OF CRYSTALS IN CLAY AND HALITE MATRIX, CLAY CONTENT DECREASES WITH DEPTH; BASAL CONTACT SHARP, UNDULATORY.
2174	1235		
			HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR; POLYHALITIC AND ARGILLACEOUS; ARGILLACEOUS HALITE OCCURS IN UPPER 0.5', CONTENT DECREASES WITH DEPTH; POLYHALITE OCCURS AS DISCONTINUOUS STRINGERS, BELOW 1243.0' POLYHALITE BECOMES ABUNDANT; BASAL CONTACT SHARP, UNDULATORY UP TO 1.0'.
2169	1240		
2164	1245	MB 112	POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE, CONTAINS ZONES OF LIGHT ORANGE; APPEARS TO HAVE MOUND FORMS AT UPPER CONTACT; CONTAINS IRREGULARLY-SHAPED CRYSTALS OF HALITE (1/16" TO 3/4") DISSEMINATED THROUGHOUT; BASAL CONTACT SHARP, MARKED BY 1" TO 2-1/2" THICK GRAY CLAYSTONE CONTAINING HALITE.
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; TRACE GRAY CLAY, CONTENT DECREASES WITH DEPTH, BETWEEN 1255.8' AND 1257.0' SUBHORIZONTAL STRINGERS OF REDDISH-BROWN CLAY ARE CONTINUOUS AROUND THE CIRCUMFERENCE OF THE SHAFT; DISSEMINATED POLYHALITE BLEBS, CONTENT INCREASES WITH DEPTH; BASAL CONTACT SHARP.
2159	1250		
2154	1255		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2154	1255		AS ABOVE
2149	1260		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; UPPER 0.5' ARGILLACEOUS, CLAY OCCURS WITH HALITE AS MATRIX, BELOW 1260.7' CLAY OCCURS AS STRINGERS, CONTENT DECREASES WITH DEPTH; DISSEMINATED POLYHALITE BLEBS; BASAL CONTACT SHARP.
			POLYHALITE, FINELY CRYSTALLINE, ORANGISH-RED, STRUCTURELESS; UNDERLAIN BY 1" THICK GRAY CLAYSTONE BED; BASAL CONTACT SHARP.
2144	1265		HALITE, WHITE TO CLEAR, COARSELY CRYSTALLINE, SLIGHTLY ARGILLACEOUS; CLAY OCCURS IN STRINGERS, CONTENT DECREASES WITH DEPTH, ABSENT BELOW 1268.0'; TRACE POLYHALITE BLEBS; BASAL CONTACT SHARP.
2139	1270		
		MB 113	POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE, STRUCTURELESS; UNIT SPLIT BY 4" THICK CLEAR HALITE BED, OCCURS 3" BELOW UPPER CONTACT; BASAL CONTACT SHARP, MARKED BY 2" THICK GRAY CLAYSTONE BED.
2134	1275		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO ORANGE TO CLEAR; TRACE POLYHALITE, OCCURS AS DISCONTINOUS RANDOMLY-ORIENTED STRINGERS AND AS DISSEMINATED BLEBS; SLIGHTLY ARGILLACEOUS, GRAY CLAY STRINGERS TO 1276.0', ABSENT BETWEEN 1276.0' AND 1280.0', CLAY STRINGERS IN 1.0' THICK BAND BELOW 1280.0', BELOW 1284.0' CLAY CONTENT INCREASES AS SUBHORIZONTAL STRINGERS; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY.
2129	1280		
2124	1285		
2119	1290		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; ARGILLACEOUS, UPPER 1.5' TO 2.0' ARGILLACEOUS HALITE WITH CLAY AND HALITE MATRIX, HALITE OCCURS AS ZONES AND PODS OF CRYSTALS AND DISPLACIVE CRYSTALS TO 1/2" ACROSS, CLAY CONTENT DECREASES WITH DEPTH; POLYHALITE OCCURS AS SUBHORIZONTAL STRINGERS AND DISSEMINATED BLEBS, CONTENT INCREASES WITH DEPTH; BASAL CONTACT SHARP, UNDULATORY.
		MB 114	POLYHALITE, FINELY CRYSTALLINE, ORANGISH-RED, STRUCTURELESS EXCEPT FOR 1" THICK INTERBEDS OF HALITE; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY.
2114	1295		HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR; CONTAINS SUBHORIZONTAL CONTINUOUS STRINGERS OF POLYHALITE IN UPPER 0.5', IN THE REMAINDER OF THE UNIT POLYHALITE OCCURS AS RARE DISSEMINATED BLEBS; BASAL CONTACT SHARP.
2109	1300		HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR; ARGILLACEOUS AT TOP, CLAY OCCURS AS RANDOMLY-ORIENTED STRINGERS, CONTENT DECREASES WITH DEPTH; BASAL CONTACT GRADATIONAL.

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2109	1300		AS ABOVE
2104	1305		POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE; CONTAINS IRREGULAR CRYSTALS AND BEDS OF HALITE; BASAL CONTACT SHARP, EXTREMELY IRREGULAR.
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; POLYHALITE OCCURS AS IRREGULAR RANDOMLY-ORIENTED AND SUBHORIZONTAL STRINGERS AND AS DISSEMINATED BLEBS, CONTENT INCREASES WITH DEPTH; BETWEEN 1307.0' AND 1308.0' HORIZONTAL AND SUBHORIZONTAL STRINGERS OF CLAY OCCUR; BASAL CONTACT DIFFUSE.
2099	1310		
2094	1315		ARGILLACEOUS HALITE, REDDISH-BROWN CLAY, HALITE WHITE TO CLEAR; HALITE OCCURS IN PODS AND IRREGULARLY-SHAPED ZONES AND AS GROUPS OF CRYSTALS DISPERSED THROUGHOUT, BOTH CLAY AND HALITE OCCUR AS MATRIX; BASAL CONTACT GRADATIONAL.
			HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR; SLIGHTLY ARGILLACEOUS, REDDISH-BROWN, CLAY CONTENT DECREASES WITH DEPTH; TRACE DISSEMINATED POLYHALITE BLEBS, CONTENT INCREASES WITH DEPTH, FROM 1320.4' TO 1320.9' A REDDISH-ORANGE, FINELY CRYSTALLINE POLYHALITE BED OCCURS; BASAL CONTACT SHARP.
2089	1320		HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR; UPPER 4" ARGILLACEOUS, CLAY OCCURS AS FINE DISCONTINUOUS STRINGERS, CONTENT DECREASES WITH DEPTH, ABSENT BELOW 1326.0'; BECOMES POLYHALITIC BELOW 1326.0', CONTENT INCREASES WITH DEPTH; BASAL CONTACT GRADATIONAL.
2084	1325		
			ANHYDRITE, FINELY CRYSTALLINE, LIGHT AND MEDIUM GRAY; INTERBEDS OF HALITE IN UPPER PART, CONTENT DECREASES WITH DEPTH; LOWER 1" CONTAINS NO INTERBEDS OF HALITE; BASAL CONTACT SHARP.
2079	1330	MB 115	POLYHALITE, HALITIC, FINELY CRYSTALLINE, REDDISH-ORANGE; CONTAINS IRREGULAR DISCONTINUOUS BEDS OF CLEAR HALITE AND IRREGULARLY-SHAPED CRYSTALS OF HALITE 1/32" TO 1/8" ACROSS; OCCASIONAL HALITE PSEUDOMORPHS AFTER GYPSUM SWALLOWTAIL CRYSTALS IN UPPER 1"; FROM 1331.5' TO 1331.8' OF GRAY FINELY CRYSTALLINE ANHYDRITE BED OCCURS; BASAL CONTACT SHARP, MARKED BY 1" THICK BED OF GRAY CLAYSTONE.
2074	1335		HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR; VERY SLIGHTLY ARGILLACEOUS; TRACE POLYHALITE AND ANHYDRITE, IRREGULAR BLEBS OF POLYHALITE OCCURS ABOVE 1335.0', ANHYDRITE OCCURS AS CONTINUOUS AND DISCONTINUOUS STRINGERS BELOW 1335.0', BASAL 2.0' CONTAINS 1/4" THICK SUBHORIZONTAL STRINGERS OF ANHYDRITE; BASAL CONTACT SHARP.
2069	1340		
		MB 116	POLYHALITE INTERBEDDED WITH ANHYDRITE, FINELY CRYSTALLINE, LIGHT GRAY TO LIGHT GRAYISH-ORANGE, THINLY LAMINATED TO STRUCTURELESS; HALITE BED BETWEEN 1343.1' AND 1343.4'; BASAL CONTACT SHARP, MARKED BY 1" THICK GRAY CLAYSTONE BED.
2064	1345		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2064	1345		HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR; POLYHALITE OCCURS AS CONTINUOUS HORIZONTAL AND SUBHORIZONTAL STRINGERS AND AS IRREGULARLY-SHAPED BLEBS, CONTENT INCREASES WITH DEPTH; BASAL CONTACT SHARP.
2059	1350		ARGILLACEOUS HALITE, FINELY TO COARSELY CRYSTALLINE, REDDISH-BROWN HALITIC CLAYSTONE MATRIX, HALITE CLEAR TO WHITE; HALITE OCCURS AS IRREGULARLY-SHAPED AGGREGATES OF CRYSTALS; CONTAINS 1/4" TO 2" THICK SUBHORIZONTAL HALITE-FILLED FRACTURES; BASAL CONTACT UNDULATORY UP TO 2.0', GRADATIONAL TO SHARP, DISCONFORMABLE.
2054	1355		McNUTT POTASH ZONE VACA TRISTA MARKER BED HALITIC SILTSTONE, REDDISH-BROWN, THINLY LAMINATED TO STRUCTURELESS; HALITE OCCURS AS ISOLATED DISPLACIVE CRYSTALS UP TO 1-1/2" ACROSS; LOCAL CHANNEL FILL STRUCTURES PRESENT; CONTAINS BOTH SUBVERTICAL AND SUBHORIZONTAL HALITE-FILLED FRACTURES 1/8" TO 2" THICK; CHANNEL INTO UNDERLYING UNIT 3.0' DEEP (EAST SIDE OF SHAFT); NUMEROUS FILLED CHANNELS THROUGHOUT UNIT; OCCASIONAL CROSS-LAMINATIONS; BASAL CONTACT GRADATIONAL TO LOCALLY SHARP, UNDULATORY UP TO 3.0'.
2049	1360		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; ARGILLACEOUS TO 1363.0', CLAY OCCURS AS REDDISH-BROWN MATRIX, CONTENT DECREASES WITH DEPTH, HALITE OCCURS AS IRREGULARLY-SHAPED CRYSTAL MASSES; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH AS SUBHORIZONTAL CONTINUOUS AND DISCONTINUOUS STRINGERS AND THIN BEDS, ALSO AS DISSEMINATED BLEBS; BELOW 1363.0' ARGILLACEOUS MATERIAL OCCURS AS LOCAL SUBHORIZONTAL STRINGERS; 1" THICK BED OF POLYHALITE OCCURS AT 1365.6'; FROM 1373.4' TO 1373.9' ARGILLACEOUS HALITE OCCURS; BASAL CONTACT SHARP, DISCONFORMABLE.
2044	1365		
2039	1370		
2034	1375		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE, CRUDELY THIN TO MEDIUM BEDDED; POLYHALITE OCCURS AS SUBHORIZONTAL PARALLEL STRINGERS GROUPED IN UPPER 2.0', RANDOMLY-ORIENTED STRINGERS BELOW 1380.4', DISSEMINATED BLEBS, CONTENT DECREASES WITH DEPTH; LOCALLY SLIGHTLY ARGILLACEOUS, COLOR WHITISH-GRAY, SUBHORIZONTAL STRINGERS AND LOCAL IRREGULARLY-SHAPED ZONES OF CLAY, CONTENT DECREASES WITH DEPTH; 1/4" TO 1/2" THICK CLAYSTONE BED AT 1383.8'; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY, DISCONFORMABLE.
2029	1380		HALITIC CLAYSTONE AND ARGILLACEOUS HALITE, CLAY REDDISH-BROWN, HALITE WHITE TO CLEAR AND FINELY CRYSTALLINE; HALITE CONTENT INCREASES WITH DEPTH, OCCURS AS DISPLACIVE CRYSTALS (1/8" TO 1/2" ACROSS) AND PODS OF RELATIVELY PURE HALITE; LOCAL PODS OF POLYHALITE; BASAL CONTACT GRADATIONAL.
2024	1385		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; LOCALLY ARGILLACEOUS, REDDISH-BROWN CLAY OCCURS AS RANDOMLY-ORIENTED STRINGERS IN SUBHORIZONTAL ZONES, CONTENT DECREASES WITH DEPTH, DECREASES ABRUPTLY BELOW 1390.1'; TRACE POLYHALITE AS RARE DISSEMINATED RANDOMLY-ORIENTED STRINGERS AND BLEBS, CONTENT INCREASES WITH DEPTH, POLYHALITE BED OCCURS BETWEEN 1390.9' AND 1391.1', CONTENT INCREASES ABRUPTLY NEAR BASE; LOCAL ZONES AND STRINGERS OF ARGILLACEOUS HALITE CONTAINING GRAY CLAY; BASAL CONTACT SHARP, DISCONFORMABLE.
2019	1390		

EXHAUST SHAFT
LITHOLOGIC LOG

FIGURE 4 (CONTINUED)

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
2019	1390		AS ABOVE
2014	1395		HALITIC CLAYSTONE, UPPER 2" GRAY, REMAINDER REDDISH-BROWN, STRUCTURELESS EXCEPT FOR DISPLACIVE CRYSTALS (1/8" TO 1/2"); LOCAL GREENISH-GRAY REDUCTION SPOTS; HINT OF RELICT BEDDING; BASAL CONTACT GRADATIONAL, UNDULATORY.
2009	1400		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; VERY POLYHALITIC TO 1400.0', OCCURRING AS ABUNDANT RANDOMLY-ORIENTED TO SUBHORIZONTAL STRINGERS AND ZONES; BELOW 1400.0' RARE POLYHALITE AND SUBHORIZONTAL GRAY STRINGERS OF CLAY; BASAL CONTACT SHARP, DISCONFORMABLE.
2004	1405		ARGILLACEOUS HALITE; GRAY CLAY IN UPPER 1.0', REMAINDER REDDISH-BROWN; HALITE OCCURS AS WELL-ROUNDED PODS OR COBBLES (?) 1" TO 4" DIAMETER, FINE GRAINED OR CRYSTALLINE COARSENING TOWARD CENTER, WHITE TO CLEAR WITH RARE ORANGE TINT, PODS BREAK IN SPHERICAL PATTERN; LOCALLY HALITE OCCURS AS CLEAR TO WHITE IRREGULARLY SHAPED ZONES, HALITE ALSO OCCURS AS SMALL DISPLACIVE CRYSTALS <1/32" TO 1/8" ACROSS; LOCAL 1/8" TO 1/4" DISCONTINUOUS HALITE-FILLED (FIBROUS) FRACTURES; CONTAINS LOCAL POLYHALITE ZONES; BASAL CONTACT SHARP.
1999	1410		
1994	1415		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; ARGILLACEOUS AT TOP, CONTENT DECREASES WITH DEPTH, LOCAL DISCONTINUOUS IRREGULARLY-SHAPED ZONES OF CLAYSTONE, CLAY ALSO OCCURS AS RANDOMLY-ORIENTED AND SUBHORIZONTAL STRINGERS; MODERATELY ABUNDANT POLYHALITE, OCCURS AS DISSEMINATED BLEBS AND SUBHORIZONTAL DISCONTINUOUS STRINGERS; CLAY ABSENT BELOW 1415.0'; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY UP TO 4".
1989	1420	MB 117	POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE; THIN SUBHORIZONTAL HALITE-FILLED FRACTURES <1/16" THICK; CONTAINS RARE CRYSTALS OF HALITE 1/16" TO 1/4" ACROSS; LOWER 4" CONTAINS BLACK LAMINAE PARALLEL TO LOWER CONTACT; BASAL CONTACT SHARP, UNDULATORY ON TWO SCALES: MAJOR - 0.8', MINOR - 0.1', MARKED BY 1" THICK GREENISH-GRAY CLAYSTONE BED.
1984	1425		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; RARE IRREGULAR DISCONTINUOUS STRINGERS AND BLEBS OF POLYHALITE; LOCAL TRACE AMOUNTS OF GRAY SUBHORIZONTAL STRINGERS OF CLAY; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY, DISCONFORMABLE.
1979	1430		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; MODERATELY ARGILLACEOUS, CLAY REDDISH-BROWN TO GRAY WITH DEPTH, OCCURS AS INTER-CRYSTALLINE MATERIAL AND SUBHORIZONTAL TO RANDOMLY-ORIENTED STRINGERS, CONTENT DECREASES WITH DEPTH; TRACE POLYHALITE BLEBS, CONTENT INCREASES WITH DEPTH, AT 1437.5' A 0.1' THICK BED OF REDDISH-ORANGE POLYHALITE OCCURS; BELOW POLYHALITE BED CLAY CONTENT INCREASES SLIGHTLY THEN DECREASES WITH DEPTH; BASAL CONTACT DIFFUSE, CONFORMABLE.
1974	1435		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
1974	1435		AS ABOVE
1969	1440		
1964	1445	MB 118	POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE, STRUCTURELESS; HALITIC IN UPPER 1.5', HALITE OCCURS AS DISCONTINUOUS THIN BEDS AND IRREGULARLY-SHAPED ZONES, WHITE TO CLEAR; REMAINDER HALITE-FREE; BASAL CONTACT SHARP, MARKED BY 1" TO 2" THICK GREENISH-GRAY CLAYSTONE BED, DISCONFORMABLE.
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH, OCCURS AS RARE DISSEMINATED BLEBS AND SUBHORIZONTAL STRINGERS; TWO 3/4" THICK BEDS OF POLYHALITE NEAR 1450'; BASAL CONTACT SHARP.
1959	1450		POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE, STRUCTURELESS EXCEPT FOR RARE SUBHORIZONTAL AND SUBVERTICAL HALITE-FILLED FRACTURES < 1/8" THICK; BASAL CONTACT SHARP.
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE; TRACE SUBHORIZONTAL GRAY CLAY STRINGERS; RARE DISSEMINATED BLEBS AND SUBHORIZONTAL STRINGERS OF POLYHALITE, CONTENT INCREASES WITH DEPTH, INCREASES ABRUPTLY IN LOWER 4"; BASAL CONTACT SHARP.
1954	1455		ARGILLACEOUS HALITE AND HALITIC CLAYSTONE; UPPER 0.5' TO 1.0' GRAY, REMAINDER REDDISH-BROWN; HALITE OCCURS AS IRREGULARLY-SHAPED ZONES, DISCONTINUOUS BEDS, DISPLACIVE CRYSTALS < 1/8" ACROSS; BASAL CONTACT DIFFUSE.
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; VERY ARGILLACEOUS TO 1459.0', CLAY CONTENT DECREASES WITH DEPTH, OCCURS AS IRREGULARLY-SHAPED ZONES OF HALITIC CLAYSTONE WITH DISPLACIVE HALITE CRYSTALS AND AS MATRIX AND RANDOMLY-ORIENTED STRINGERS OF CLAY IN ARGILLACEOUS HALITE, BELOW 1459.0' CLAY CONTENT DECREASES ABRUPTLY; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND RANDOMLY-ORIENTED TO SUBHORIZONTAL STRINGERS, STRINGERS BECOME HORIZONTAL AND 1/4" THICK SPACED 2" TO 4" IN LOWER 5.0', 0.5' THICK BED OF POLYHALITE OCCURS AT 1469.0'; BASAL CONTACT GRADATIONAL.
1949	1460		
1944	1465		POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE TO ORANGISH-RED; UPPER 0.5' CONTAINS DISCONTINUOUS BEDS OF IRREGULARLY-SHAPED PODS OF HALITE; BECOMES LAMINATED WITH CLAY PARTINGS BELOW 1470.0'; BASAL CONTACT SHARP, MARKED BY 1" TO 4" THICK BED OF GRAY CLAYSTONE SPLIT BY BIFURCATING HALITE-FILLED SUBHORIZONTAL FRACTURE, UNDULATORY UP TO 0.5'.
1939	1470	MB 119	HALITE, COARSELY CRYSTALLINE, WHITE, BEDDED WITH SUBHORIZONTAL CONTINUOUS STRINGERS AND BEDS OF POLYHALITE 1/4" TO 3/4" THICK; POLYHALITE CONTENT DECREASES WITH DEPTH, ABSENT BELOW 1475.0'; BEDDED WITH SUBHORIZONTAL STRINGERS OF GRAY CLAY BELOW 1475.0'; BASAL CONTACT SHARP.
			HALITE, FINELY TO MEDIUM CRYSTALLINE, WHITE TO CLEAR; GRAYISH-BLACK CLAY OCCURS AS INTERSTITIAL FILLING AND AS DISCONTINUOUS SUBHORIZONTAL STRINGERS; BASAL CONTACT SHARP.
1934	1475		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE, BANDED BY ORANGE-TINTED HALITE SPACED 1" TO 2"; 1" THICK BED OF GREENISH-GRAY CLAYSTONE OCCURS 2" ABOVE LOWER CONTACT; BASAL CONTACT SHARP, IRREGULAR, SLIGHTLY UNDULATORY.
			HALITIC CLAYSTONE AND ARGILLACEOUS HALITE, REDDISH-BROWN; HALITE OCCURS AS DISPLACIVE CRYSTALS AND SUBHORIZONTAL FRACTURE FILLINGS 1/4" THICK; UPPER 4" GREENISH-GRAY; BASAL CONTACT DIFFUSE.
1929	1480		

FIGURE 4 (CONTINUED)

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
1929	1480		AS ABOVE
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; SLIGHTLY ARGILLACEOUS IN UPPER 2.0' AS DISCONTINUOUS RANDOMLY-ORIENTED STRINGERS; TRACE POLYHALITE AT TOP, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND STRINGERS; BASAL CONTACT SHARP.
1924	1485		
1919	1490	MB 120	POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE, STRUCTURELESS; BASAL CONTACT SHARP, MARKED BY 1/2" TO 1" THICK GRAY CLAYSTONE BED.
			HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO CLEAR; CONTAINS SUBHORIZONTAL STRINGERS OF BLACKISH-GRAY CLAY SPACED 2" TO 4"; BASAL CONTACT SHARP.
			HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE, BANDED WHITE AND ORANGE, SPACED 1" TO 2", TRACE POLYHALITE; BASAL CONTACT GRADATIONAL.
1914	1495		
			ARGILLACEOUS HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO CLEAR; HALITE OCCURS AS PODS AND IRREGULARLY-SHAPED ZONES OF CRYSTALS SURROUNDED BY REDDISH-BROWN CLAY MATRIX; CLAY CONTENT DECREASES WITH DEPTH; UPPER 4" CONTAINS SUBHORIZONTAL STRINGERS OF BLACKISH-GRAY CLAY SPACED 1"; BASAL CONTACT DIFFUSE.
1909	1500		HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR TO ORANGE; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND RANDOMLY-ORIENTED STRINGERS; BASAL CONTACT SHARP, IRREGULAR, UNDULATORY UP TO 1", DISCONFORMABLE.
1904	1505	MB 121	POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE; HALITIC, CONTAINS IRREGULARLY-SHAPED PODS OF HALITE TO 4" ACROSS; CONTAINS LOCAL ZONES RICH IN ANHYDRITE OR LANGBEINITE (?); BASAL CONTACT SHARP, UNDULATORY, SLIGHTLY IRREGULAR.
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND RANDOMLY-ORIENTED STRINGERS; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY.
1899	1510		
		MB 122	POLYHALITE, FINELY CRYSTALLINE, BROWN TO TAN, STRUCTURELESS; BASAL CONTACT SHARP.
			HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO CLEAR; CONTAINS STRINGERS OF POLYHALITE AND GRAY CLAY SPACED 1" TO 2"; BASAL CONTACT SHARP.
1894	1515		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO TINTED ORANGE; UPPER 0.5' ARGILLACEOUS, REDDISH-BROWN, CONTENT DECREASES WITH DEPTH; TWO 3" THICK BEDS OF REDDISH-BROWN ARGILLACEOUS HALITE OCCUR AT 1519.8' AND 1520.2'; BASAL 0.5' CONTAINS SUBHORIZONTAL GRAY CLAY STRINGERS, SPACED 1" TO 3"; TRACE POLYHALITE, OCCURS AS DISSEMINATED BLEBS AND RANDOMLY-ORIENTED TO SUBHORIZONTAL STRINGERS; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY, DISCONFORMABLE.
1889	1520		
1884	1525		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
1884	1525		AS ABOVE
1879	1530		ARGILLACEOUS HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; CLAY REDDISH-BROWN, UPPER 1.0' TO 3.0' GRAY ARGILLACEOUS HALITE WITH RARE SMALL DISPLACIVE HALITE CRYSTALS < 1/16" ACROSS; HALITE OCCURS AS AGGREGATES OF CRYSTALS IN PODS OR ZONES; CLAY OCCURS AS MATRIX IN UPPER PART, OCCURS AS DISSEMINATED IRREGULARLY-SHAPED ZONES AND RANDOMLY-ORIENTED STRINGERS WITH DEPTH, CONTENT DECREASES WITH DEPTH; BASAL CONTACT SHARP.
1874	1535		UNION ANHYDRITE ANHYDRITE, ALTERNATES WHITISH-GRAY TO DARK GRAY, FINELY CRYSTALLINE, THINLY LAMINATED TO THINLY BEDDED; HALITIC, CONTAINS RARE 1/16" CRYSTALS OF HALITE; UPPER 2" TO 5" POLYHALITIC, DISCONTINUOUS POLYHALITE LENS OCCURS ON NORTHWEST SIDE OF SHAFT BETWEEN 1539.5' AND 1541.6'; LOWER 1.0' TO 2.0' CONTAINS WHITE LAMINAE INTERBEDDED WITH ANHYDRITE, POSSIBLY CARBONATE; BASAL CONTACT GRADATIONAL, ALTERNATION CONTACT, CONFORMABLE.
1869	1540		POLYHALITE, FINELY CRYSTALLINE, ORANGISH-RED TO REDDISH-ORANGE, THINLY LAMINATED TO THINLY BEDDED, LOCALLY STRUCTURELESS, LAMINAE OFTEN SLIGHTLY CONTORTED; LOCALLY ANHYDRITIC, OCCURS AS UNALTERED LAMINAE AND ZONES; BASAL CONTACT SHARP, MARKED BY LOAD CASTS INTO UNDERLYING UNIT (2" DEEP BY 1" TO 3" ACROSS) AND FLAME STRUCTURES.
			ANHYDRITIC CLAYSTONE, FINELY LAMINATED, GRAY TO WHITISH-GRAY; CONTAINS LOCAL, SMALL ENTROLITHIC STRUCTURES; BASAL CONTACT GRADATIONAL TO DIFFUSE.
1864	1545		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE, SLIGHTLY BEDDED BY DISCONTINUOUS SUBHORIZONTAL STRINGERS OF POLYHALITE AND BANDS OF POLYHALITIC HALITE; BASAL CONTACT SHARP, DISCONFORMABLE.
1859	1550		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO TINTED ORANGE, STRUCTURELESS; SLIGHTLY ARGILLACEOUS, MODERATELY ABUNDANT IN UPPER 1.0', CONTENT DECREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND RANDOMLY-ORIENTED STRINGERS; BASAL CONTACT GRADATIONAL.
1854	1555		
1849	1560		HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO CLEAR; ARGILLACEOUS IN UPPER 1.5', GRAY, AS SUBHORIZONTAL STRINGERS AND BEDS, CONTENT DECREASES WITH DEPTH, 1.0' TO 2.0' THICK BED OF GRAY ARGILLACEOUS HALITE AT 1560.2'; BELOW 1560.2' CLAY CONTENT INCREASES AND BECOMES REDDISH-BROWN, OCCURS AS STRINGERS AND DISCONTINUOUS BEDS OF ARGILLACEOUS HALITE, CONTENT DECREASES WITH DEPTH, LOCALLY GRAY, CONTENT DROPS TO TRACE NEAR BASE; SOME POLYHALITE, CONTENT INCREASES TO 1560.2', BELOW WHICH IT DECREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND RANDOMLY-ORIENTED TO SUBHORIZONTAL STRINGERS; BASAL CONTACT SHARP, DISCONFORMABLE.
1844	1565		
1839	1570		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
1839	1570		AS ABOVE
1834	1575		
1829	1580		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO TINTED ORANGE, STRUCTURELESS; UPPER 0.5' SLIGHTLY ARGILLACEOUS, REDDISH-BROWN, CONTENT DECREASES WITH DEPTH, ABSENT BELOW 1582.0', OCCURS AS DISCONTINUOUS STRINGERS AND AS INTERCRYSTALLINE MATRIX; TRACE DISSEMINATED POLYHALITE BLEBS; BASAL CONTACT GRADATIONAL, HIGHLY IRREGULAR, MARKED BY THE OCCURRENCE OF ARGILLACEOUS HALITE.
1824	1585		
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; UPPER 0.5' HAS REDDISH-BROWN CLAY MATRIX, CONTENT DECREASES SLIGHTLY WITH DEPTH, CLAY BECOMES BOTH GRAY AND REDDISH-BROWN, OCCURS AS RANDOMLY-ORIENTED STRINGERS; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND AS STRINGERS WITH DEPTH; BASAL CONTACT GRADATIONAL, DISCONFORMABLE.
1819	1590		
1814	1595		
1809	1600	XXXXXXXX	
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; SLIGHTLY ARGILLACEOUS, CONTENT DECREASES WITH DEPTH, REDDISH-BROWN, OCCURS AS INTERCRYSTALLINE MATERIAL AND RANDOMLY-ORIENTED STRINGERS, LOCALLY OCCURS IN GREATER CONCENTRATIONS; TRACE POLYHALITE, CONTENT INCREASES SLIGHTLY WITH DEPTH, OCCURS AS DISSEMINATED BLEBS, BLEBS BECOME LARGER WITH DEPTH (UP TO 2" x 1"); BASAL CONTACT SHARP.
1804	1605		
1799	1610		
1794	1615		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
1794	1615		
1789	1620	MB 123	ANHYDRITE, FINELY CRYSTALLINE, BROWNISH-GRAY TO ORANGISH-TAN, THINLY LAMINATED; LOCALLY ALTERED TO POLYHALITE; LAMINAE OFTEN CONTORTED AND SLIGHTLY HALITIC, LOCALLY NODULAR, STRUCTURE OFTEN ENTROLITHIC; BASAL CONTACT GRADATIONAL.
1784	1625		HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO TINTED ORANGE; 3" THICK BED OF ORANGISH-RED POLYHALITE AT 1624.2'; TRACE POLYHALITE, OCCURS AS RANDOMLY-ORIENTED TO SUBHORIZONTAL STRINGERS AND AS DISSEMINATED BLEBS; THIN 1" THICK IRREGULAR BED OF ANHYDRITE AT 1628.3'; BASAL CONTACT SHARP, DISCONFORMABLE (?).
1779	1630	MB 124	ANHYDRITE, FINELY CRYSTALLINE, BROWNISH-GRAY TO TANNISH-GRAY, ENTROLITHIC TO NODULAR TO 1633.0', BELOW 1633.0', BECOMES LAMINATED TO THINLY BEDDED, LOCALLY CONTAINS ANHYDRITE PSEUDOMORPHS AFTER GYPSUM SWALLOWTAIL CRYSTALS; LOCALLY POLYHALITIC; BASAL CONTACT SHARP, MARKED BY 2.0" TO 4.0" THICK GRAY THINLY LAMINATED CLAYSTONE BED CONTAINING SEVERAL SUBHORIZONTAL FIBROUS HALITE-FILLED FRACTURES 1/8" TO 1/4" THICK, SPACED 1" TO 2"; BASAL CONTACT GRADATIONAL.
1774	1635	MB 124	ARGILLACEOUS POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE; POLYHALITE OCCURS AS REPLACEMENT OF ANHYDRITE OR GYPSUM NODULES IN GRAY CLAYSTONE MATRIX; NODULE CONCENTRATION INCREASES WITH DEPTH UNTIL MATRIX IS POLYHALITE; NODULE DIAMETER 1/8" TO 1/2"; UNDERLAIN BY 1" TO 2" GRAY CLAYSTONE BED; BASAL CONTACT SHARP, UNDULATORY, IRREGULAR.
1769	1640		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO TINTED ORANGE; POLYHALITIC, OCCURS AS DISSEMINATED BLEBS AND AS RANDOMLY-ORIENTED TO SUBHORIZONTAL STRINGERS; GRAY CLAYSTONE BED OCCURS AT 1644.0'; POLYHALITE CONTENT TRACE BELOW 1644.0'; LOWER 1.5' CONTAINS TRACE AMOUNT OF CLAY STRINGERS; BASAL CONTACT SHARP, IRREGULAR WITH DISSOLUTION PITS 0.3' DEEP, MARKED BY 2" TO 3" THICK GRAY CLAYSTONE BED.
1764	1645		
1759	1650		
1754	1655		HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO ORANGE; POLYHALITIC, OCCURS AS DISSEMINATED BLEBS AND RANDOMLY-ORIENTED TO SUBHORIZONTAL STRINGERS; TRACE DISSEMINATED GRAY CLAY; BASAL CONTACT SHARP.
1749	1660		AS BELOW

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
1749	1660		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; TRACE REDDISH-BROWN AND GRAY CLAY, OCCURRING AS STRINGERS AND AS LOCALLY DISSEMINATED MATRIX, CLAY CONTENT INCREASES ABRUPTLY BELOW 1662.0' AS REDDISH-BROWN STRINGERS, CONTENT DECREASES WITH DEPTH, ARGILLACEOUS HALITE BED OCCURS WITH CLAY AS STRINGERS AND MATRIX BETWEEN 1673.0' AND 1673.8', LOWER 2.5' CONTAINS DISCONTINUOUS HORIZONTAL AND SUBHORIZONTAL STRINGERS OF GRAY CLAY; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS WITH SIZE INCREASING WITH DEPTH (1" DIAMETER); BASAL CONTACT SHARP, IRREGULAR, UNDULATORY TO 0.5'.
1744	1665		
1739	1670		
1734	1675		
1729	1680		
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; ARGILLACEOUS HALITE OCCURS BETWEEN 1681.4' AND 1682.6', GRAY CLAY; REDDISH-BROWN ARGILLACEOUS HALITE OCCURS BETWEEN 1682.6' AND 1684.1', CLAY OCCURS AS RANDOMLY-ORIENTED STRINGERS AND AS MATRIX; CLAY CONTENT DECREASES ABRUPTLY BELOW 1684.1'; TRACE POLYHALITE BELOW 1686.4', CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND AS RANDOMLY-ORIENTED TO SUBHORIZONTAL STRINGERS; BASAL CONTACT SHARP.
1724	1685		
1719	1690		
1714	1695		ARGILLACEOUS HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; VERY ARGILLACEOUS IN UPPER 0.5', CLAY REDDISH-BROWN, CONTENT DECREASES WITH DEPTH, OCCURS AS INTERCRYSTALLINE MATRIX AND RARE STRINGERS, CONTENT DECREASES ABRUPTLY BELOW 1704.0'; TRACE POLYHALITE, OCCURS AS DISSEMINATED BLEBS; BASAL CONTACT SHARP, IRREGULAR, DISCONFORMABLE.
1709	1700		
1704	1705		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
1704	1705		AS ABOVE
1699	1710		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; UPPER 0.3' TO 0.4' AND LOWER 0.7' PURE HALITE, REMAINDER SLIGHTLY ARGILLACEOUS, CLAY REDDISH-BROWN, BECOMING GRAY WITH DEPTH; BASAL CONTACT SHARP, IRREGULAR, DISCONFORMABLE.
1694	1715		
1689	1720		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; UPPER 1.0' ARGILLACEOUS, CONTENT DECREASES WITH DEPTH; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND RANDOMLY-ORIENTED STRINGERS, LOWER 1.0' VERY POLYHALITIC; BASAL CONTACT SHARP, IRREGULAR, UNDULATORY.
1684	1725		
		MB 126	POLYHALITE, FINELY CRYSTALLINE, ORANGISH-RED, STRUCTURELESS; UNIT VERY UNDULATORY; BASAL 0.4' CONSISTS OF GREENISH-GRAY CLAYSTONE; BASAL CONTACT SHARP, UNDULATORY, DISCONFORMABLE.
1679	1730		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; LOCALLY ARGILLACEOUS, CLAY REDDISH-BROWN, CONTENT DECREASES WITH DEPTH; TRACE POLYHALITE, OCCURS AS DISSEMINATED BLEBS; BASAL CONTACT SHARP, IRREGULAR WITH DISSOLUTION PITS 1.0' DEEP INTO UNDERLYING UNIT.
1674	1735		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; UPPER 2.0' SLIGHTLY ARGILLACEOUS, CLAY REDDISH-BROWN, OCCURS AS RANDOMLY-ORIENTED TO SUBHORIZONTAL STRINGERS AND DISSEMINATED INTERCRYSTALLINE MATERIAL; TRACE POLYHALITE AT TOP, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND RANDOMLY-ORIENTED STRINGERS; BASAL CONTACT GRADATIONAL.
1669	1740		
1664	1745		
1659	1750		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
1659	1750	X	AS ABOVE
		MB 127	POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE, TRACE THIN LAMINATIONS; LOCALLY ANHYDRITIC; BASAL CONTACT SHARP.
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE OCCASIONALLY TINTED ORANGE; SUBHORIZONTAL POLYHALITE STRINGERS, 1/8" THICK; BASAL CONTACT SHARP, IRREGULAR.
		MB 127	POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE; BASAL CONTACT SHARP, MARKED BY 1" THICK GRAY CLAYSTONE BED.
1654	1755	X	HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; POLYHALITIC, CONTENT DECREASES WITH DEPTH, OCCURS AS STRINGERS AND BLEBS; 0.1' TO 0.4' THICK ANHYDRITE BED OCCURS AT 1761.9'; BASAL CONTACT SHARP.
1649	1760	X	
		MB 128	POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE, THINLY LAMINATED; 0.3' THICK HALITE BED AT 1763.9', LOWER 0.1' TO 0.2' HALITIC GRAY CLAYSTONE; BASAL CONTACT SHARP.
1644	1765	— — —	HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE OCCASIONALLY TINTED ORANGE, HINT OF BEDDING FROM SUBHORIZONTAL STRINGERS OF POLYHALITE SPACED 0.2'; 0.1' THICK BED OF ARGILLACEOUS HALITE OCCURS AT 1767.3'; POLYHALITE CONTENT INCREASES ABRUPTLY NEAR BASE; BASAL CONTACT SHARP, DISCONFORMABLE.
1639	1770	X X	
		— — — X X X	ARGILLACEOUS HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; GRAY CLAY OCCURS AS MATRIX AND INTERCRYSTALLINE MATERIAL,CLAY BECOMES REDDISH-BROWN BELOW 1773.8', CLAY CONTENT DECREASES WITH DEPTH; CLAY-FREE POLYHALITIC HALITE OCCURS BETWEEN 1773.3' AND 1773.8'; POLYHALITE CONTENT INCREASES WITH DEPTH; BASAL CONTACT SHARP, IRREGULAR.
1634	1775	— —	
1629	1780	—	
		— —	HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; ARGILLACEOUS TO 1782.4', CONTENT DECREASES ABRUPTLY BELOW, CLAY OCCURS AS MATRIX; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND RANDOMLY-ORIENTED STRINGERS; BASAL CONTACT GRADATIONAL.
1624	1785	X	
		MB 129	POLYHALITE, FINELY CRYSTALLINE, DARK REDDISH-ORANGE, HINT OF THIN LAMINATIONS; TRACE HALITE; BASAL CONTACT SHARP, MARKED BY 1" THICK GRAY CLAYSTONE BED, SLIGHTLY UNDULATORY, DISCONFORMABLE.
1619	1790	— — — X —	ARGILLACEOUS HALITE, FINELY TO COARSELY CRYSTALLINE, CLEAR; GRAY CLAY AT TOP, GRADING TO REDDISH-BROWN WITH DEPTH, CONTENT DECREASES WITH DEPTH UNTIL ABSENT AT 1792.3'; CLAY CONTENT INCREASES AS INTERCRYSTALLINE MATERIAL AND STRINGERS BELOW 1792.3', CONTENT DECREASES WITH DEPTH, ABSENT BELOW 1794.0'; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND RANDOMLY-ORIENTED TO SUBHORIZONTAL STRINGERS; BASAL CONTACT SHARP, MARKED BY 0.1' THICK BED OF POLYHALITE UNDERLAIN BY 1/4" THICK GRAY CLAYSTONE BED.
1614	1795		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
1614	1795		AS ABOVE
1609	1800	MB 130	HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; CONTAINS SUBHORIZONTAL GRAY CLAY STRINGERS TO 1804.3', ABSENT BELOW 1804.3'; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND SUBHORIZONTAL STRINGERS; BASAL CONTACT SHARP, MARKED BY 3" ZONE OF GRAYISH HALITE UNDERLAIN BY 1" THICK GRAY CLAYSTONE.
1604	1805		
1599	1810		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; UPPER 1.8' ARGILLACEOUS, REDDISH-BROWN, CONTENT DECREASES WITH DEPTH; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS, BLEBS ALIGNED IN ZONES AND STRINGERS OCCUR BELOW 1817.6'; CONTAINS GRAY CLAY AS STRINGERS AND DISSEMINATED INTER-CRYSTALLINE MATERIAL BETWEEN 1819.2' AND 1819.9'; BASAL CONTACT SHARP, IRREGULAR, DISCONFORMABLE.
1594	1815		
1589	1820		HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; ARGILLA-CEOUS, REDDISH-BROWN, CLAY OCCURS AS INTERCRYSTALLINE MATRIX AND STRINGERS, CONTENT DECREASES WITH DEPTH, CONTENT DECREASES ABRUPTLY BELOW 1823.0'; TRACE POLYHALITE, OCCURS AS DISSEMINATED BLEBS; BASAL CONTACT GRADATIONAL.
1584	1825		
1579	1830		HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; SLIGHTLY ARGILLACEOUS IN UPPER 4.0', CONTENT DECREASES WITH DEPTH, CLAY OCCURS AS STRINGERS AND INTERCRYSTALLINE MATRIX, CONTAINS RARE SMALL (<1/16") DISPLACIVE HALITE CRYSTALS; TRACE POLYHALITE, OCCURS AS DISSEMINATED BLEBS; BASAL CONTACT SHARP, MARKED BY DISSOLUTION PITS 6" TO 8" DEEP INTO UNDERLYING UNIT, IRREGULAR, UNDU-LATORY.
1574	1835		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; ARGILLACEOUS TO 1839.8', OCCURS AS GRAY STRINGERS; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH, OCCURS AS BLEBS AND RANDOMLY-ORIENTED TO SUBHORIZONTAL STRINGERS; BASAL CONTACT GRADATIONAL, HIGHLY IRREGULAR, SLIGHTLY UNDULATORY.
1569	1840		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT

LITHOLOGIC LOG

PRELIMINARY ELEV. (FT. MSL)	PRELIMINARY DEPTH (FT.)
1569	1840
1564	1845
1559	1850
1554	1855
1549	1860
1544	1865
1539	1870
1534	1875
1529	1880
1524	1885

STRATIGRAPHIC COLUMN: MB 131

REMARKS

AS ABOVE

POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE; HALITIC; BASAL CONTACT GRADATIONAL, VERY IRREGULAR, UNDULATORY.

HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; ARGILLACEOUS, GRAY AT TOP GRADING TO REDDISH-BROWN WITH DEPTH, CONTENT DECREASES WITH DEPTH, CLAY OCCURS AS SUBHORIZONTAL STRINGERS AND AS MATRIX MATERIAL IN IRREGULARLY-SHAPED ZONES OF ARGILLACEOUS HALITE; POLYHALITIC, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND RANDOMLY-ORIENTED DISCONTINUOUS STRINGERS; CONTAINS LARGE IRREGULAR ZONES (SEVERAL SQUARE FOOT AREA) OF PURE WHITE HALITE WHICH ARE CONTINUOUS INTO UNDERLYING UNIT (DISSOLUTION PITS ?); BASAL CONTACT SHARP, IRREGULAR, DISCONFORMABLE.

HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; ARGILLACEOUS AT TOP, CONTENT DECREASES WITH DEPTH, OCCURS AS RANDOMLY-ORIENTED STRINGERS; TRACE POLYHALITE, OCCURS AS DISSEMINATED BLEBS; CONTAINS DISSOLUTION PITS 2.0' TO 3.0' DEEP, FILLED WITH WHITE COARSELY CRYSTALLINE HALITE; BASAL CONTACT SHARP TO ABSENT, MARKED BY 1" THICK GRAY CLAYSTONE BED.

HALITE, COARSELY CRYSTALLINE, WHITE TO TINTED ORANGE; POLYHALITIC, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND SUBHORIZONTAL 1/4" THICK STRINGERS; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY.

POLYHALITE, FINELY CRYSTALLINE, DARK REDDISH-ORANGE, STRUCTURELESS; HALITIC; UNDERLAIN BY 4" THICK BED OF GRAY HALITIC CLAYSTONE; BASAL CONTACT GRADATIONAL.

HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; SLIGHTLY ARGILLACEOUS, CONTENT DECREASES WITH DEPTH, OCCURS AS SUBHORIZONTAL STRINGERS; POLYHALITIC, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND SUBHORIZONTAL STRINGERS, POLYHALITE BED 0.1' THICK AT 1875.7'; BASAL CONTACT SHARP, IRREGULAR, SLIGHTLY UNDULATORY.

ARGILLACEOUS HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO CLEAR; CLAY REDDISH-BROWN TO GRAY, OCCURS AS IRREGULAR SUBHORIZONTAL STRINGERS; HALITE OCCURS IN PODS OR ZONES OF CRYSTALS; TRACE POLYHALITE; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY.

HALITE, COARSELY CRYSTALLINE, WHITE; BECOMES SLIGHTLY ARGILLACEOUS WITH DEPTH; POLYHALITIC, OCCURS AS BLEBS AND SUBHORIZONTAL STRINGERS; BASAL CONTACT SHARP, IRREGULAR, SLIGHTLY UNDULATORY.

ARGILLACEOUS HALITE, REDDISH-BROWN WITH TRACE OF GRAY; HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO CLEAR, OCCURS AS IRREGULARLY-SHAPED BEDS AND PODS, LOCALLY POLYHALITIC AND FREE OF CLAY; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND IRREGULAR RANDOMLY-ORIENTED STRINGERS; 1/4" THICK BED OF POLYHALITE UNDERLAIN BY 1/4" THICK DISCONTINUOUS BED OF GRAY CLAYSTONE OCCURS AT 1898.2'; BASAL CONTACT SHARP, IRREGULAR, SLIGHTLY UNDULATORY.

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
1524	1885		AS ABOVE
1519	1890		
1514	1895		
		MB 132	POLYHALITE, FINELY CRYSTALLINE, DARK REDDISH-ORANGE, STRUCTURELESS; UNDERLAIN BY 1" THICK GREENISH-GRAY CLAYSTONE; BASAL CONTACT SHARP.
1509	1900		HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE; TRACE ARGILLACEOUS MATERIAL BELOW 1901.0', CONTENT DECREASES WITH DEPTH, TOTALLY ABSENT BELOW 1904.8', OCCURS AS RANDOMLY-ORIENTED TO SUBHORIZONTAL STRINGERS BECOMING BLEBS WITH DEPTH; 1/4" THICK SUBHORIZONTAL STRINGERS OF ANHYDRITE OCCUR BELOW 1914.0'; AT 1916.5', A 0.2' THICK PINKISH-RED POLYHALITE BED OCCURS; BASAL CONTACT SHARP, SLIGHTLY IRREGULAR AND UNDULATORY.
1504	1905		
1499	1910		
1494	1915		
		MB 133	POLYHALITE, FINELY CRYSTALLINE, DARK RED, STRUCTURELESS AT TOP GRADING TO LAMINATED AT BASE; HALITIC, BASAL CONTACT SHARP TO GRADATIONAL, MARKED BY 0.1' TO 0.2' THICK GRAY CLAYSTONE BED.
1489	1920		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR, SLIGHTLY ARGILLACEOUS, OCCURS AS RANDOMLY-ORIENTED STRINGERS; ABUNDANT POLYHALITE, OCCURS AS DISSEMINATED BLEBS; CONTAINS LOCAL ZONES OF PURE HALITE; BASAL CONTACT GRADATIONAL, IRREGULAR.
1484	1925		HALITE, MEDIUM TO COARSELY CRYSTALLINE, CLEAR TO WHITE; RANDOMLY-ORIENTED TO SUBHORIZONTAL STRINGERS OF BLACK CLAY OCCUR BETWEEN 1923.5' AND 1926.4'; POLYHALITIC, CONTENT INCREASES ABRUPTLY BELOW 1926.8', THEN DECREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS; BASAL CONTACT DIFFUSE.
1479	1930		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT MSL)	PRELIMINARY DEPTH (FT.)
1479	1930
1474	1935
1469	1940
1464	1945
1459	1950
1454	1955
1449	1960
1444	1965
1439	1970
1434	1975

STRATIGRAPHIC COLUMN	REMARKS
	HALITE, FINELY TO COARSELY CRYSTALLINE, CLEAR TO WHITE; MODERATELY ARGILLACEOUS, CONTENT DECREASES WITH DEPTH, OCCURS AS BLACK BLEBS AND STRINGERS; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH, OCCURS AS DISCONTINUOUS IRREGULAR RANDOMLY-ORIENTED TO SUBHORIZONTAL STRINGERS AND DISSEMINATED BLEBS; CONTAINS LOCAL BEDS AND ZONES OF CLAY-FREE HALITE; POLYHALITE CONTENT INCREASES ABRUPTLY NEAR BASE; BASAL CONTACT SHARP.
	ANHYDRITE, FINELY CRYSTALLINE, LIGHT TO DARK GRAY, THINLY LAMINATED TO LAMINATED; UPPER 0 TO 0.5' POLYHALITIC; LOCALLY HALITIC, OCCURS AS DISCONTINUOUS BEDS AND PODS; SOME LAMINAE ORGANIC-RICH (?); LAMINAE UNDULATE SLIGHTLY; UNDERLAIN BY 0.1' TO 0.3' THICK GRAY HALITIC CLAYSTONE; BASAL CONTACT SHARP, IRREGULAR, SLIGHTLY UNDULATORY.
	HALITE, COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE, STRUCTURELESS; SLIGHTLY ARGILLACEOUS IN UPPER 5.0', OCCURS AS GRAY DISCONTINUOUS SUBHORIZONTAL STRINGERS, BELOW 1952.3' CONTENT INCREASES SHARPLY, THEN DECREASES WITH DEPTH, DISCONTINUOUS 1" TO 2" THICK IRREGULAR GRAY CLAYSTONE BED OCCURS AT 1952.3'; TRACE POLYHALITE, OCCURS AS LIGHT ORANGISH-WHITE DISSEMINATED BLEBS; IN BASAL 1.0' POLYHALITE AND ANHYDRITE OCCUR AS DISCONTINUOUS SUBHORIZONTAL STRINGERS; BASAL CONTACT SHARP, IRREGULAR.
MB 134	ANHYDRITE, FINELY CRYSTALLINE, GRAY ALTERNATING WITH DARK GRAY, THINLY LAMINATED; LOCALLY CONTAINS PODS OF HALITE AND HALITE-RICH LAMINAE; BASAL CONTACT SHARP, CONFORMABLE.
MB 134	ANHYDRITE, FINELY CRYSTALLINE, GRAY; HALITIC, OCCURS AS ABUNDANT HALITE PSEUDOMORPHS AFTER GYPSUM SWALLOWTAIL CRYSTALS ALIGNED PARALLEL TO BEDDING, 1/8" TO 2" HIGH, MAJORITY ORIENTED VERTICALLY; LOCALLY, ANHYDRITE IS FREE OF PSEUDOMORPHS AND THINLY LAMINATED, LAMINAE ALTERNATE FROM LIGHT TO DARK GRAY; HALITE PSEUDOMORPHS ABSENT BETWEEN 1966.6' AND 1967.5'; BASAL CONTACT GRADATIONAL TO DIFFUSE.
MB 134	ANHYDRITE, FINELY CRYSTALLINE, ALTERNATING LIGHT AND DARK GRAY, THINLY LAMINATED TO LAMINATED; LAMINAE OFTEN CONTAIN INSIPIENT ENTEROLITHIC STRUCTURES AND ANHYDRITE PSEUDOMORPHS AFTER GYPSUM SWALLOWTAIL CRYSTALS; UNDERLAIN BY 0.4' TO 0.5' THICK BED OF MICROLAMINATED TO THINLY LAMINATED GRAY CLAYSTONE CONTAINING SUBHORIZONTAL BIFURCATING 0 TO 1" THICK HALITE-FILLED FRACTURES; BASAL CONTACT SHARP, IRREGULAR, UNDULATORY, DISCONFORMABLE.

FIGURE 4 (CONTINUED)

EXHAUST SHAFT

LITHOLOGIC LOG

PRELIMINARY ELEV. (FT MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
1434	1975		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR, STRUCTURELESS; MODERATELY ARGILLACEOUS, GRAY, CONTENT DECREASES WITH DEPTH, OCCURS AS DISSEMINATED RANDOMLY-ORIENTED DISCONTINUOUS STRINGERS AND BLEBS; TRACE POLYHALITE BLEBS; CONTAINS INTER-UNIT DISSOLUTION PITS FILLED WITH RELATIVELY PURE HALITE; FREE OF GRAY CLAY FROM 1985.0' TO 1989.0'; THIN (<1/8") SUBHORIZONTAL STRINGERS OF ANHYDRITE OCCUR BELOW 1986.0'; IRREGULAR BED OF HALITIC ANHYDRITE IN LOWER 1" TO 3" OVERLIES HIGHLY UNDULATORY BASAL CONTACT, CONTACT MARKED BY GRAY CLAYSTONE IN CHANNEL TROUGHS, CONTACT EROSIONALLY TERMINATES UNDERLYING UNIT AT THE WEST SIDE OF SHAFT; BASAL CONTACT SHARP.
1429	1980		
1424	1985		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE; CONTAINS DISCONTINUOUS SUBHORIZONTAL STRINGERS OF ANHYDRITE, <1/4" THICK; UNIT THICKNESS VARIES FROM 0 TO 1.5' AS IT IS EROSIONALLY TERMINATED AT UPPER CONTACT; SHAPE LENTICULAR (0 TO 1.5' X 6'); BASAL CONTACT SHARP.
1419	1990	MB 135	ANHYDRITE, FINELY CRYSTALLINE, LIGHT GRAY, LOCALLY THINLY LAMINATED; CONTAINS ABUNDANT HALITE PSEUDOMORPHS AFTER GYPSUM SWALLOWTAIL CRYSTALS; BASAL CONTACT SHARP, MARKED BY 1/4" TO 1/2" THICK GRAY CLAYSTONE BED. HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED GRAY, BANDED, SPACED 1/2" TO 4", TRACE GRAY CLAY; CONTAINS CONTINUOUS IRREGULAR SUBHORIZONTAL STRINGERS OF GRAY CLAY; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY UP TO 4".
1414	1995		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED GRAY, BANDED ON 1/2" TO 2" SCALE, SLIGHTLY ARGILLACEOUS, OCCURS AS SUBHORIZONTAL STRINGERS AND LOCAL RANDOMLY-ORIENTED STRINGERS; TRACE POLYHALITE, OCCURS AS DISSEMINATED BLEBS, CONTENT INCREASES WITH DEPTH; BASAL CONTACT SHARP. HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR, STRUCTURELESS; SLIGHTLY ARGILLACEOUS IN UPPER PART, CONTENT DECREASES WITH DEPTH, OCCURS AS REDDISH-BROWN RANDOMLY-ORIENTED STRINGERS; TRACE POLYHALITE, CONTENT INCREASES WITH DEPTH; BASAL CONTACT SHARP, SLIGHTLY IRREGULAR, SLIGHTLY UNDULATORY (3").
1409	2000		ARGILLACEOUS HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO TINTED ORANGE; CLAY REDDISH-BROWN, CONTENT DECREASES WITH DEPTH, OCCURS AS INTERCRYSTALLINE MATRIX, GRADES TO SUBHORIZONTAL STRINGERS WITH DEPTH; HALITE OCCURS AS DISCONTINUOUS BEDS AND ALIGNED PODS; BASAL CONTACT SHARP, IRREGULAR, UNDULATORY.
1404	2005		
1399	2010		
1394	2015		
1389	2020		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
1389	2020		AS ABOVE
			HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO TINTED ORANGE, OCCURS AS IRREGULAR DISCONTINUOUS BEDS 1/2" TO 2" THICK AT TOP, BECOMES MASSIVE WITH DEPTH; VERY ARGILLACEOUS AT TOP, CONTENT DECREASES WITH DEPTH, OCCURS AS INTERCRYSTALLINE MATRIX; ABUNDANT POLYHALITE AT TOP, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS AND RARE SUBHORIZONTAL STRINGERS; CONTAINS ABUNDANT VERTICALLY-ORIENTED ELONGATE ZONES OF PURE AND POLYHALITIC HALITE WITH IRREGULAR EDGES, 1.0' TO 2.0' ACROSS, UP TO 3.0' DEEP; BASAL CONTACT EXHIBITS CHANNEL FORM, WITH HIGH SIDE OCCURRING ON WEST SIDE OF SHAFT AT 2032.0' AND LOW POINT OCCURRING ON EAST SIDE OF SHAFT AT 2036.3'; CHANNEL FILL CONSISTS OF HALITE AND POLYHALITIC HALITE BELOW 2032.0', A 0.5' THICK BED OF FINELY CRYSTALLINE ANHYDRITE OCCURS AT 2032.3' AND TERMINATES AGAINST UNDERLYING UNIT AT WEST SIDE OF SHAFT, FILL CONTAINS ABUNDANT SUBHORIZONTAL STRINGERS OF ANHYDRITE THAT TERMINATE AGAINST UNDERLYING UNIT AT WEST SIDE OF SHAFT; BASAL CONTACT SHARP.
1384	2025		
1379	2030		
1374	2035		
		MB 136	POLYHALITE, FINELY CRYSTALLINE, REDDISH-ORANGE, STRUCTURELESS EXCEPT FOR LOCAL ZONES CONTAINING HALITE PSEUDOMORPHS AFTER GYPSUM SWALLOWTAIL CRYSTALS AND LOCAL ZONES WITH NODULAR STRUCTURE, LOCALLY THINLY LAMINATED NEAR BASE; UPPER 2.0' ON WEST SIDE OF SHAFT CONSISTS OF THINLY LAMINATED ANHYDRITE; BASAL CONTACT GRADATIONAL, UNDULATORY.
1369	2040		
1364	2045	MB 136	ANHYDRITE, FINELY CRYSTALLINE, ALTERNATING LIGHT AND DARK GRAY, THINLY LAMINATED, LAMINAE UNDULATE SLIGHTLY; 0.3' ABOVE LOWER CONTACT, 0 TO 1" THICK DISCONTINUOUS PURE HALITE BED OCCURS, CONTAINS ONE DISCONTINUOUS STRINGER OF POLYHALITE; BASAL CONTACT SHARP.
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; SLIGHTLY ARGILLACEOUS, CONTENT DECREASES WITH DEPTH, OCCURS AS REDDISH-BROWN TO GRAY RANDOMLY-ORIENTED TO SUBHORIZONTAL STRINGERS WHICH BECOME SUBHORIZONTAL WITH DEPTH; TRACE POLYHALITE, OCCURS AS DISSEMINATED BLEBS AND SUBHORIZONTAL STRINGERS NEAR BASE; 1" TO 2" THICK BED OF ANHYDRITE (NORTHWEST SIDE OF SHAFT) AND POLYHALITE (SOUTHEAST SIDE OF SHAFT) AT 2059.3'; SUBHORIZONTAL STRINGERS OF ANHYDRITE IN LOWER 5.0'; NO CLAY OCCURS BELOW 2059.3'; BASAL CONTACT SHARP, UNDULATORY TO 0.4', DISCONFORMABLE.
1359	2050		
1354	2055		
		MB 137	
1349	2060		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR TO TINTED ORANGE AND GRAY, THINLY BEDDED TO GRAY ARGILLACEOUS HALITE WITH CLAY-FREE HALITE, BEDDING TERMINATED AT UPPER CONTACT; TRACE POLYHALITE AT TOP, CONTENT INCREASES WITH DEPTH, OCCURS AS DISSEMINATED BLEBS; ARGILLACEOUS, CONTENT DECREASES WITH DEPTH, GRAY AT TOP GRADING TO GRAYISH-BROWN WITH DEPTH, OCCURS AS DISCONTINUOUS RANDOMLY-ORIENTED STRINGERS AND LOCAL ZONES OF INTERCRYSTALLINE MATERIAL, BECOMES REDDISH-BROWN BELOW 2070.2', CONTENT DECREASES ABRUPTLY BELOW 2079.0', BASAL 2.0' SLIGHTLY ARGILLACEOUS; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY, IRREGULAR, MARKED BY DISCONTINUOUS IRREGULAR 2" THICK BED OF HALITIC ANHYDRITE.
1344	2065		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT

LITHOLOGIC LOG

PRELIMINARY ELEV. (FT MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
1344	2065		AS ABOVE
1339	2070		
1334	2075		
1329	2080		
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; TRACE POLYHALITE, OCCURS AS DISSEMINATED BLEBS; ARGILLACEOUS IN UPPER 1.2', OCCURS AS REDDISH-BROWN DISCONTINUOUS SUBHORIZONTAL STRINGERS AND MASSES OF HALITIC MUDSTONE, CONTENT DECREASES WITH DEPTH; BASAL CONTACT SHARP.
1324	2085		
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; TRACE DISSEMINATED BLEBS AND RANDOMLY-ORIENTED STRINGERS OF POLYHALITE; ARGILLACEOUS IN UPPER 1.0', CONTENT DECREASES WITH DEPTH; LOCAL ANHYDRITE STRINGERS OCCUR NEAR BASAL CONTACT; BASAL CONTACT SHARP, SLIGHTLY IRREGULAR AND UNDULATORY.
1319	2090		
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; RARE DISSEMINATED POLYHALITE BLEBS; ARGILLACEOUS AT TOP, CONTENT DECREASES WITH DEPTH EXCEPT FOR LOCAL INCREASES, CONTENT DECREASES ABRUPTLY BELOW 2101.5', OCCURS AS DISCONTINUOUS SUBHORIZONTAL STRINGERS; THIN DISCONTINUOUS STRINGERS OF ANHYDRITE AND POLYHALITE OCCUR IN LOWER 2.0'; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY.
1314	2095		
1309	2100		
			ANHYDRITE, FINELY CRYSTALLINE, ALTERNATING LIGHT AND DARK GRAY, THINLY LAMINATED; UNDERLAIN BY 1/2" THICK GRAYISH-BROWN CLAYSTONE BED; BASAL CONTACT SHARP.
1304	2105	MB 138	
			HALITE, FINELY TO COARSELY CRYSTALLINE, WHITE TO TINTED ORANGE, BEDDED AT TOP WITH REDDISH-BROWN ARGILLACEOUS HALITE, SPACED 1" TO 2"; ARGILLACEOUS, CONTENT DECREASES WITH DEPTH, OCCURS AS INTERCRYSTALLINE MATRIX IN ARGILLACEOUS HALITE BANDS AT TOP AND RANDOMLY-ORIENTED STRINGERS WITH DEPTH, CONTENT DECREASES ABRUPTLY BELOW 2111.3'; RARE DISSEMINATED BLEBS OF POLYHALITE; BASAL CONTACT DIFFUSE.
1299	2110		

FIGURE 4 (CONTINUED)

EXHAUST SHAFT
LITHOLOGIC LOG

PRELIMINARY ELEV. (FT MSL)	PRELIMINARY DEPTH (FT.)	STRATIGRAPHIC COLUMN	REMARKS
1299	2110		AS ABOVE
1294	2115		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; RARE STRINGERS OF CLAY IN UPPER 1.7'; TRACE SUBHORIZONTAL TO HORIZONTAL CONTINUOUS STRINGERS OF ANHYDRITE BELOW 2117.0'; BASAL CONTACT SHARP.
1289	2120		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO TINTED ORANGE, RARE RANDOMLY-ORIENTED CLAY STRINGERS TO 2125.2'; UPPER CONTACT MARKED BY ANHYDRITIC CLAYSTONE CONTAINING DISPLACIVE HALITE CRYSTALS (<1/4"); TRACE POLYHALITE BLEBS; ANHYDRITE STRINGERS OCCUR BETWEEN 2128.1' AND 2128.5'; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY, IRREGULAR.
1284	2125		
			ANHYDRITE (A), FINELY CRYSTALLINE, LIGHT GRAY, THINLY LAMINATED, LAMINAE SLIGHTLY CONTORTED; LOCALLY CONTAINS SMALL HALITE CRYSTALS (<1/16"); BASAL CONTACT SHARP, SLIGHTLY UNDULATORY.
1279	2130		HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; RARE CLAY STRINGERS TO 2131.5'; SUBHORIZONTAL STRINGERS OF ANHYDRITE SPACED 2" TO 4" OCCUR BELOW 2134.0'; BASAL CONTACT SHARP.
1274	2135		
			ANHYDRITE (B), FINELY CRYSTALLINE, LIGHT GRAY, HINT OF THIN LAMINATIONS; HALITIC, BASAL CONTACT SHARP, IRREGULAR, SLIGHTLY UNDULATORY.
			HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO CLEAR; RARE SUBHORIZONTAL CLAY STRINGERS AT TOP, CONTENT DECREASES WITH DEPTH; VERY RARE BLEBS OF POLYHALITE; BASAL CONTACT NOT OBSERVED.
1269	2140		
1264	2145		
	2146.4	FACILITY LEVEL	

FIGURE 4 (CONTINUED)

EXHAUST SHAFT

LITHOLOGIC LOG

SHEET 50 OF 50

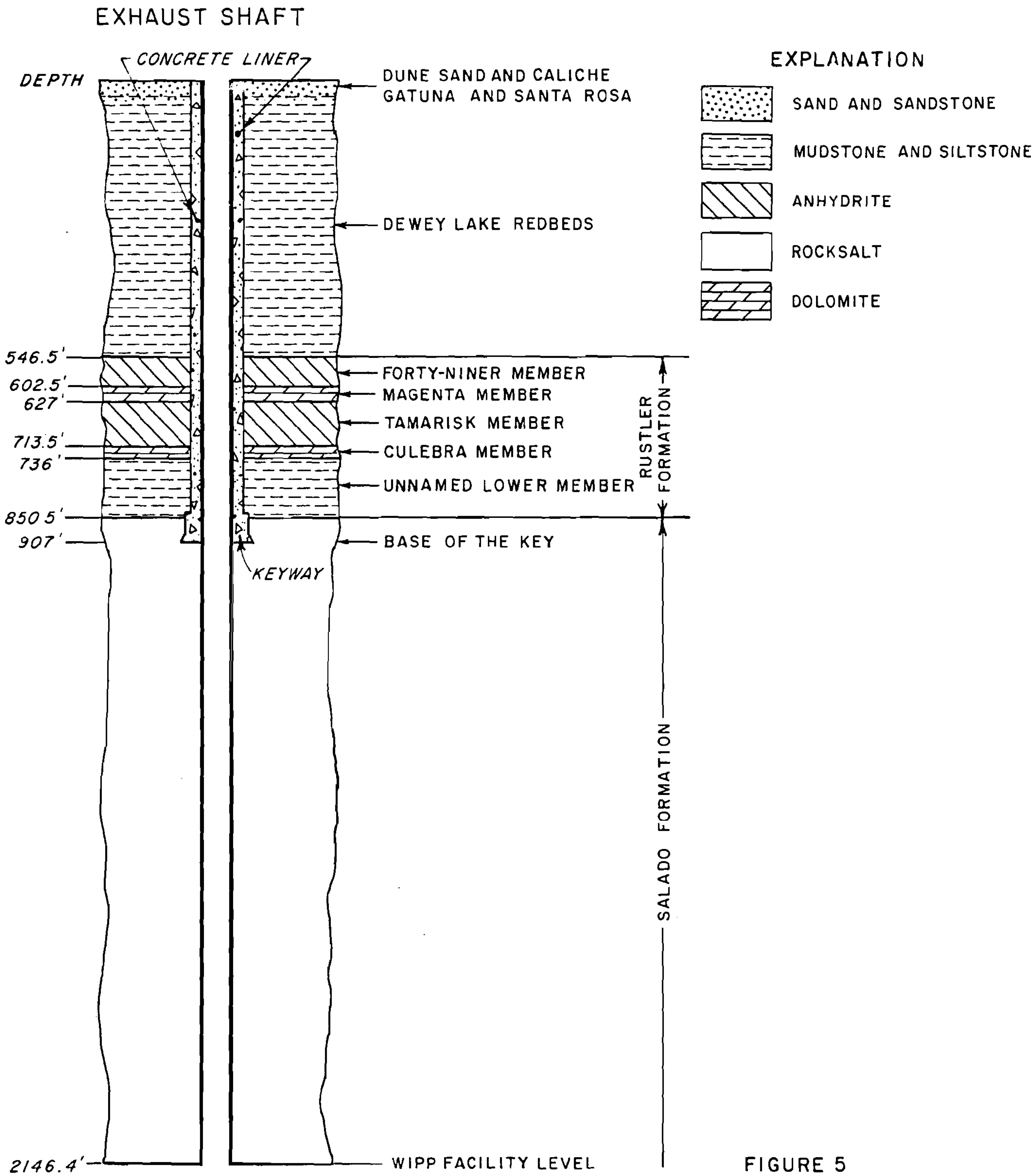


FIGURE 5

GENERALIZED
EXHAUST SHAFT
STRATIGRAPHY

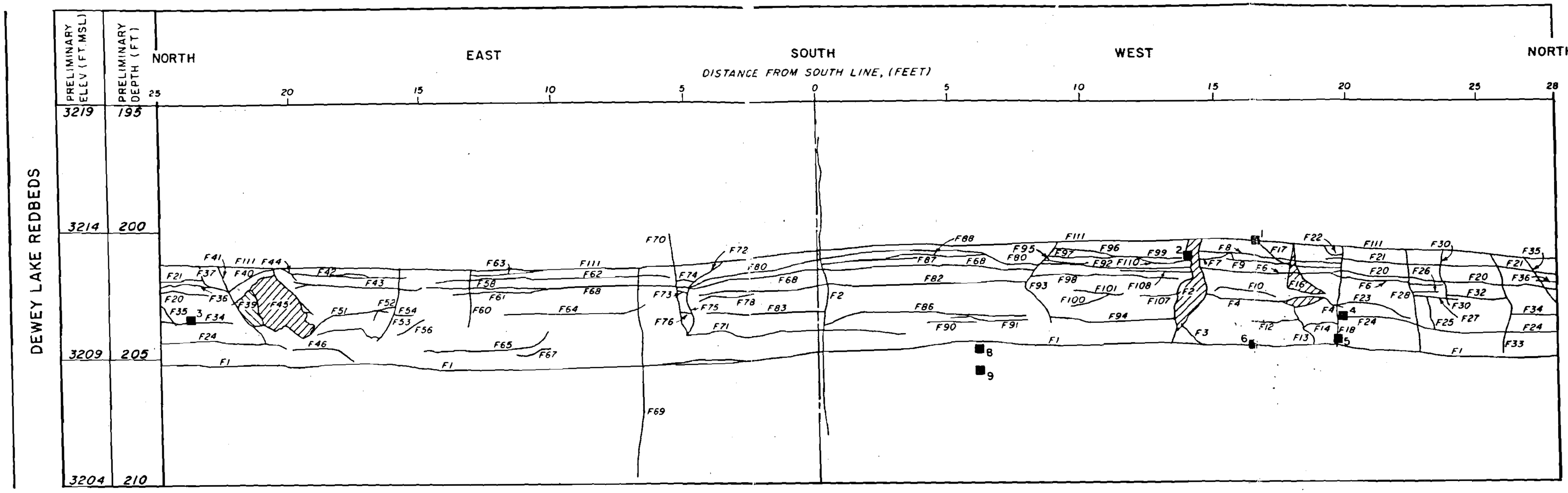
PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
CARLSBAD, NEW MEXICO

IT CORPORATION

NOTES:

1. *ALL ROCKS BELOW SANTA ROSA ARE PERMIAN IN AGE.*
2. *ALL DEPTHS ARE MEASURED FROM A REFERENCE ELEVATION AT 3409' MSL.*



NOTES

1) THIS INTERVAL WAS MAPPED ON 10-3-84.
2) THE LITHOLOGY OF THIS INTERVAL IS DESCRIBED IN FIGURE 4.
3) DEPTHS AND EVALUATIONS ARE RELATED TO THE REFERENCE ELEVATION OF 3409 FEET ABOVE MSL.
4) ONLY FRACTURES THAT WERE DEEMED "MAPABLE" AT A SCALE OF ONE INCH EQUALS FIVE FEET ARE INCLUDED ON THE MAP.
5) MAPPING EFFORTS WERE CONCENTRATED IN THE DEPTH INTERVAL FROM 195.0 FEET TO 200.0 FEET.

EXPLANATION

F20 MAPPED FRACTURE #20, SEE FRACTURE NOTES FOR DESCRIPTION

■24 SAMPLE LOCATION, EXHAUST SHAFT DETAILED MAPPING SAMPLE #24

F29 MAPPED FRACTURE #29, FRACTURE SURFACE EXPOSED

FIGURE 6 - SHEET 1 OF 11

FRACTURE LOG IN
THE DEWEY LAKE REDBEDS
DEPTH 190.0 THROUGH 205.0 FEET
EXHAUST SHAFT

WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR
WESTINGHOUSE ELECTRIC CORPORATION
CARLSBAD, NEW MEXICO

IT CORPORATION

WIPP EXHAUST SHAFT
FIGURE 6 - SHEET 2 OF 11
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth** of Pole	Fracture Thickness	Fill* Material	Structure Within Vein	Cross-Cutting Relationships
F1	horizontal		1/4-1/2"	fg	Fibers perpendicular to fractured surface, second growth 1/4 inch from base	No terminations
F2	70-85°	230	1/4-3/4"	fg	Sigmoidal growth of fibers suggesting slight left lateral movement	
F3	56°	000	1/4"	fg	Fibers are straight, but at angle of 30° to the fractured surface	F2 and F1 terminate F3
F4	15°	330	0-1/4"	fg	Fibers oriented vertically with slight inclination to the fracture plane; contains small siltstone inclusions in center of vein	F4 cut by F2
F5***	44°	055	<1/16"	fg	Fibers oriented vertically	
F6	subhorizontal		0-1/4"	fg	Fibers oriented vertically with small siltstone inclusions in middle to lower 1/2	F6 intersects F16, F18, F28 relationships not determined
F7	20°	270	1/4"	fg	Fibers oriented vertically	F7 intersects F8, F2
F8	horizontal		1/8-1/4"	fg	Fibers oriented vertically	F8 terminated at F2, F18

*fg = fibrous gypsum
**Azimuth of pole describes the direction of dip; quadrant notation describes the strike of the plane.
***Fracture not mapped

WIPP EXHAUST SHAFT
FIGURE 6 - SHEET 4 OF 11
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F19***	26°	350	1/4"	fg	Fibers oriented vertically with suture line	F19 terminates at F8 & F18
F20	horizontal		0-1/4"	fg	Consistent vertical sigmoidal fibers	F20 cut by F28, F18 F20 intersects F30, F35, and F33
F21	horizontal		0-1/2"	fg	Fibers oriented vertically, suture contains frequent thin lenticular siltstone inclusions	F21 intersects F18, F28, F30, F33 and F35 F21 terminates at F37
F22	38°	100	1/4"	fg	Fibers oriented vertically	F22 terminates at F111 and F18
F23	subhorizontal		1/4"	fg	Fibers oriented vertically	F23 terminates at F18
F24	subhorizontal undulatory		1/4-2"	fg	Fibers oriented vertically, fibers are straight to sigmoidal, bifurcates with inclusions of siltstone up to one inch thick	F24 terminates at F18 F24 intersects F33
F25	75°	080	1/16"	fg		F25 terminates at F24, F27
F26	22°	350	0-1/8"	fg	Fibers oriented vertically	F26 terminates at F28
F27	horizontal		1/16"	fg	Fibers oriented subvertically	F27 terminates at F28 F27 intersects F30
F28	70°	090	0-1/16"			F28 terminates at F111 and F1 F28 intersects F20, F21, F6, and F24

WIPP EXHAUST SHAFT
FIGURE 6 - SHEET 5 OF 11
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F29***	horizontal		1/16"	fg	Fibers oriented subvertically	F29 terminates at F28 and F30
F30	subvertical	N70E	<1/16"	fg		F30 terminates at F111 F27, F21 and F20 intersect F30
F31***	subvertical	N10W	0-1/16"	fg		
F32	23°	350	0-1/8"	fg	Fibers perpendicular to fracture plane	F32 terminates at F33 and F30
F33	65°	080	0-1/8"	fg	Fibers oriented subvertically	F33 cut by F21 and F20 F33 intersects F24 F33 terminates at F111
F34	subhorizontal		1/8"	fg	Fibers oriented vertically	F34 terminated by F33 F34 cut by F35
F35	56°	090	1/8"	fg	Fibers oriented subvertically	F35 terminates at F111
F36	subhorizontal		1/8"	fg	Fibers oriented subvertically	F36 terminates at F37 F36 cut by F35
F37	55°	060	1/4"	fg	Fibers oriented subvertically	F37 terminates at F111 F37 joins F41
F38 - not described						
F39	subvertical	EW to S30E	1/8-1/4"	fg	Fibers oriented horizontally	Indeterminable

FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F40	35°	300	1/8"	fg	Fibers oriented vertically	F40 terminated at F111 and F41
F41	65°	070	1/8-1/4"	fg	Fibers oriented subvertically	F24 and F111 terminate F41
F42	subhorizontal undulatory		1/8-1/2"	fg	Fibers oriented vertically	F42 cut by F53
F43	subhorizontal		1/8-1/4"	fg	Fibers oriented vertically, includes siltstone clasts	F43 cut by F53
F44 - not described						
F45	65°	160	1/16-1/8"	fg	Fibers oriented subhorizontally	F45 terminates at F111 and F51
F46	80°	010	1/8"	fg	Fibers perpendicular to fracture plane	
F47***	subhorizontal		1/2"	fg	Fibers oriented vertically	
F48***	subhorizontal		1/8"	fg	Fibers oriented vertically	
F49***	subvertical	N70E		none		
F50***	30°	000	1/16-1/8"	fg	Fibers oriented subvertically	F50 terminates at F52
F51	subhorizontal		1/8-1/4"	fg	Fibers oriented vertically	F51 cut by F52

WIPP EXHAUST SHAFT
FIGURE 6 - SHEET 7 OF 11
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F52	subvertical	N30E	1/8-1/4"	fg	Fibers oriented subhorizontally	F52 terminates at F53
F53	vertical	N35E	1/4-1/2"	fg	Fibers oriented subhorizontally with suture line	F53 terminates at F111 F53 intersects F42
F54	subhorizontal		1/4"	fg	Fibers oriented vertically	F54 terminates at F53
F55***	subhorizontal		1/8"	fg	fibers oriented vertically	F53 and F56 terminate F55
F56	subvertical	S60E	0-1/4"	fg	Gypsum filling is discontinuous, fibers oriented subvertically	
F57***	subhorizontal		1/8"	fg	Fibers oriented subvertically	F53 and F56 terminate F57
F58	subhorizontal		1/8"	fg	Fibers oriented vertically	F58 intersects F60
F59***	subhorizontal		1/8-1/4"	fg	Fibers oriented vertically	F56 and F60 terminate F59
F60	85°	040	0-1/8"			F111 terminates F60
F61	subhorizontal		0-1/8"	fg	Fibers oriented vertically	
F62	subhorizontal		0-1/2"	fg	Fibers oriented vertically	F62 intersects F60 and F69

WIPP EXHAUST SHAFT
FIGURE 6 - SHEET 8 OF 11
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F63	subhorizontal		0-1/8"	fg	Fibers oriented vertically	
F64	subhorizontal		0-1/4"	fg	Fibers oriented vertically	F69 terminates F64
F65	subhorizontal		0-1/4"	fg	Fibers oriented subvertically	
F66***	65°	190	1/8"			F1 and F65 terminate F66
F67	subhorizontal		0-1/8"	fg	Fibers oriented subvertically	
F68	subhorizontal		1/4-1/2"	fg	Fibers oriented subvertically, is a continuation of F58 and F61	F68 terminates at F93 F68 intersects F69, F70 and F2
F69	subvertical	110	1/4-1/2"	fg	Fibers oriented horizontally	F69 cut by F62, F68, F64, and F1; F111 cut by F69
F70	subvertical	110				F70 cut by F68
F71	subhorizontal		1/4-1/2"	fg	Fibers oriented vertically	F70 cut by F71
F72	25°	060	1/4-1/2"			F72 terminates at F111 and F68
F73	subhorizontal		1/8-1/2"	fg	Fibers oriented vertically	F72 and F70 terminate F73
F74	subhorizontal		1/4"	fg	Fibers oriented vertically	F70 and F72 terminate F74

WIPP EXHAUST SHAFT
FIGURE 6 - SHEET 9 OF 11
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F75	subvertical	110	1/8-1/4"	fg		F75 joins F70 and F72
F76	subhorizontal		1/8"			F75 and F70 terminate F76
F77***	subhorizontal		1/8"	fg	Fibers oriented vertically	Joins with F78 and F79
F78 - not described						
F79*** - not described						
F80	subhorizontal		1/4"	fg	Fibers oriented vertically	F80 joins F72 F93 terminates F80
F81***	subhorizontal		0-1/8"	fg	Fibers oriented vertically	F81 joins F68
F82	subhorizontal		0-1/2"	fg	Fibers oriented vertically	F82 terminates at F93
F83	subhorizontal		1/8"	fg	Fibers oriented vertically	F83 terminates at F2
F84***	37°	000	1/16"	fg	Fibers oriented subvertically	
F85***	subhorizontal		1/4"	fg	Fibers oriented vertically	
F86	subhorizontal		1/16-1/4"	fg	Fibers oriented vertically	F2 terminates F86
F87	subhorizontal		1/16-1/4"	fg	Fibers oriented vertically	F80 terminates F84
F88	subhorizontal		1/8-1/4"	fg	Fibers oriented subvertically	F80 terminates F88 F88 joins F87

WIPP EXHAUST SHAFT
FIGURE 6 - SHEET 10 OF 11
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F89***	subhorizontal		1/16-1/4"	fg	Fibers oriented vertically	F89 joins F68 and F80
F90	subhorizontal		1/8"	fg	Fibers oriented vertically	
F91	subhorizontal		0-1/8"	fg	Fibers oriented vertically	Discontinuous
F92	subhorizontal		0-1/8"	fg	Fibers oriented vertically	F68 terminates F92
F93	68°	090	1/8"	fg	Fibers oriented subvertically	F111 terminates F93
F94	subhorizontal		1/8-1/4"	fg	Fibers oriented vertically	F94 terminates at F93
F95	subhorizontal		1/8-1/4"	fg	Fibers oriented vertically	F95 terminates at F93
F96	subhorizontal		1/8"	fg	Fibers oriented vertically	F96 terminates at F93 F96 joins F97
F97	subhorizontal		1/8"	fg	Fibers oriented vertically	F97 terminates at F93 F97 joins F96
F98	subhorizontal		1/4-1/8"	fg	Fibers oriented vertically	F93 terminates F98
F99	subhorizontal		0-1/8"	fg		F2 terminates F99
F100	subhorizontal		1/8"	fg	Fibers oriented vertically	F100 joins F101
F101	subhorizontal		1/8"			
F102***	subhorizontal		1/16"	fg	Fibers oriented vertically	F102 terminates at F93

WIPP EXHAUST SHAFT
FIGURE 6 - SHEET 11 OF 11
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F103***	subvertical		1/16"	fg	Fibers oriented subhorizontally	F98 terminates F102
F104***	subvertical	N20E	1/16"	fg		F104 terminates at F111 and F101
F105***	subhorizontal		0-1/8"	fg	Fibers oriented vertically	F105 cut by F104 F105 terminates at F2
F106***	subhorizontal		0-1/6"	fg	Fibers oriented vertically	F106 terminates at F104
F107	subhorizontal		0-1/8"	fg	Fibers oriented vertically	F107 terminates at F2
F108	subhorizontal		1/8-1/4"	fg	Fibers oriented vertically	F108 terminates at F2
F109*** - not described						
F110	subhorizontal		0-1/8"	fg	Fibers oriented vertically	F110 terminates at F2 F110 joins F99
F111	subhorizontal		1-2"	fg	Fibers oriented vertically, frequent siltstone clasts along suture, suture closer to top	F111 terminates most vertical fractures except F2, F69, and F70

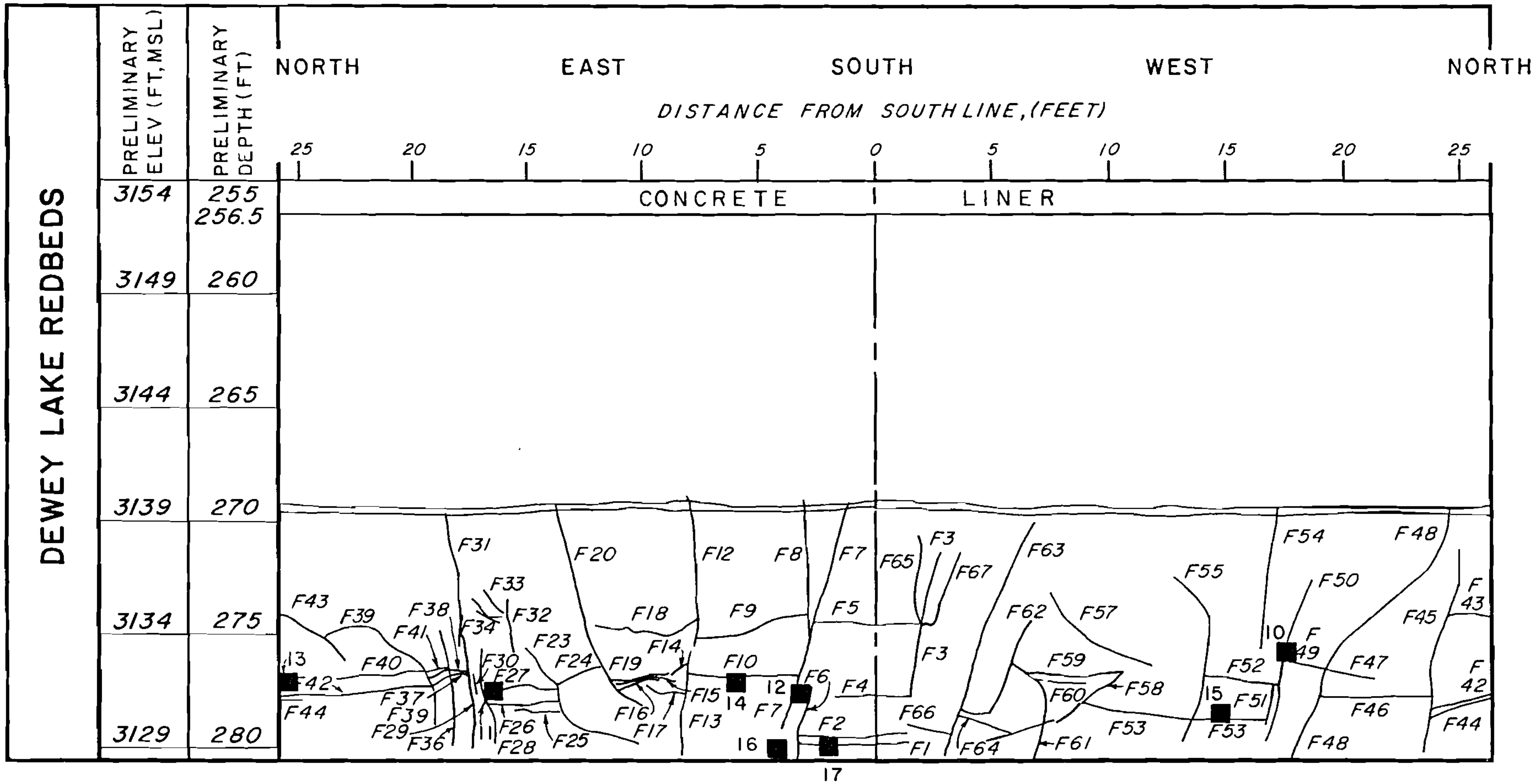


FIGURE 7 - SHEET 1 OF 9

FRACTURE LOG IN THE DEWEY LAKE REDBEDS
DEPTH 256.5 TO 280.5 FEET, EXHAUST SHAFT

WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR
WESTINGHOUSE ELECTRIC CORPORATION
CARLSBAD, NEW MEXICO

IT CORPORATION

WIPP EXHAUST SHAFT
FIGURE 7 - SHEET 2 OF 9

EXPLANATION

F20 MAPPED FRACTURE #20, SEE FRACTURE NOTES FOR DESCRIPTION.

24 SAMPLE LOCATION, EXHAUST SHAFT DETAILED MAPPING SAMPLE #24.

NOTES

1) THIS INTERVAL WAS MAPPED ON 10-3-84.
2) THE LITHOLOGY OF THIS INTERVAL IS DESCRIBED IN FIGURE 4.
3) DEPTHS AND ELEVATIONS ARE RELATED TO THE REFERENCE ELEVATION OF 3409 FEET ABOVE MSL.
4) ONLY FRACTURES THAT WERE DEEMED "MAPABLE" AT A SCALE OF ONE INCH EQUALS FIVE FEET ARE INCLUDED ON THE MAP.
5) MAPPING EFFORTS WERE CONCENTRATED IN THE DEPTH INTERVAL FROM 269.0 FEET TO 280.5 FEET.

WIPP EXHAUST SHAFT
FIGURE 7 - SHEET 3 OF 9
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth[1] of Pole	Fracture Thickness	Fill[2] Material	Structure Within Vein	Cross-Cutting Relationships
F1	not described					
F2	not described					
F3	subvertical	280	1/4"	wfg	Fibers perpendicular to fractured surface, with suture	F4 & F5 terminate at F3
F4	subhorizontal		1/8"	wfg	Fibers perpendicular to fractured surface	F4 terminates at F3
F5	subhorizontal		1 - 1-1/2"	wfg	Suture closer to upper fractured surface (1/3 distance), contains small fragment of wall rock material at suture	F5 terminates at F3 & F7
F6	89°	100	1/16"	wfg	Fibers perpendicular to fractured surface	No terminations
F7	79°	100	1/4"	wfg	Fibers perpendicular to fractured surface	F5, F8, F10 terminate at F7
F8	subvertical	90	1/4"	wfg	Fibers perpendicular to fractured surface	F9 terminates at F8 F8 terminates at F7
F9	subhorizontal		1/4"	wfg	Fibers perpendicular to fractured surface	F9 terminates at F8 & F12

(1) Azimuth of pole describes the direction of dip; quadrant notation describes the strike of the plane.
(2) wfg - white fiberous gypsum

WIPP EXHAUST SHAFT
FIGURE 7 - SHEET 4 OF 9
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F10	horizontal		1"	wfg	Fibers perpendicular to fractured surface, suture closer to top	F10 terminates at F7 & F13
F11(3)	subhorizontal		1/4"	wfg	Fibers dip W 80°	not mapped
F12	subvertical	80	1/4"	wfg	Fibers dip SE	
F13	subvertical	70	1/4"	wfg	Fibers perpendicular to fractured surface	F10, F14 & F17 terminate at F13
F14	32°(apparent)	undetermined	5/8"	wfg	Fibers perpendicular to fractured surface	F14 terminates at F13
F15	subhorizontal		5/8"	wfg	Fibers dip W of perpendicular	No termination
F16	subhorizontal		0-1/4"	wfg	Fibers dip W of perpendicular	F16 terminates at F20
F17	subhorizontal		1/2"	wfg	Fibers perpendicular to fractured surface	F17 terminates at F13
F18	horizontal		1/16-3/8"	wfg	Fibers perpendicular to fractured surface	F18 terminates at F12
F19	subhorizontal		0-1/4"	wfg	Fibers perpendicular to fractured surface	F19 terminates at F20
F20	49°	45	1/8-3/8"	wfg	Fibers dip SW of perpendicular	F16, F19, & F24 terminate at F20

(3) Not mapped

WIPP EXHAUST SHAFT
FIGURE 7 - SHEET 5 OF 9
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F21(3)	horizontal		1/8-1/4"	wfg	Fibers perpendicular to fractured surface	F21 terminates at F20
F22(3)	36°	45	1/16"	wfg	Indeterminable	
F23	75°	110	1/4"	wfg	Perpendicular to fracture surface	F24, F25, F26, F27 terminate at F23
F24	17°(apparent)	undetermined	1/4"	wfg	Fibers oriented vertically	F24 terminates at F20 & F23
F25	subhorizontal		0-5/8"	wfg	Fibers perpendicular to fractured surface	F25 terminates at F23
F26	subhorizontal		3/8-3/4"	wfg	Fibers perpendicular to fractured surface	F26 terminates at F23 & F28
F27	subhorizontal		1/2"	wfg	Fibers vertical to sub-vertical, dip N	F27 terminates at F23 & F28
F28	subvertical	130	3/16"	wfg	Indeterminable	F26 & F27 terminate at F28
F29	83°	130	<1/16-1/8"	wfg	Fibers perpendicular to fractured surface	F37 & F38 terminate at F29
F30	74°	30	1/16-1/8"	wfg	Fibers perpendicular to fractured surface	no terminations
F31	84°	120	0-3/8"	wfg	Fibers perpendicular to fractured surface	no terminations
F32	76°	135	undetermined	wfg	Indeterminable	no terminations

(3) Not mapped

WIPP EXHAUST SHAFT
FIGURE 7 - SHEET 6 OF 9
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F33	65°	90	1/8"	wfg	Fibers oriented vertically	F33 terminates at F34
F34	70°	150	1/8"	wfg	Fibers perpendicular to fractured surface	F33 terminates at F34 F34 intersects F21 (relationship indeterminable)
F35(3)	not described					
F36	76°	43	1/16-1/4"	wfg	Fibers perpendicular to fractured surface	F41, F38 & F37 terminate at F36
F37	subhorizontal		1/2"	wfg	Fibers perpendicular to fractured surface	F37 terminates at F39 & F36
F38	horizontal		7/16"	wfg	Fibers perpendicular to fractured surface	F38 terminates at F39 & F36
F39	0 to 60°	170	1/4"	wfg	Fibers perpendicular to fractured surface	F39 terminates at F43 F40 & 42 terminate at F39
F40	horizontal		0-1/2"	wfg	Fibers perpendicular to fractured surface	F40 terminates at F39
F41	subhorizontal		1/4-3/8"	wfg	Fibers perpendicular to fractured surface	F41 terminates at F39, F36
F42	subhorizontal		1"	wfg	Fibers oriented vertically, suture closer to top	F42 terminates at F39 & F45

(3) Not mapped

WIPP EXHAUST SHAFT
FIGURE 7 - SHEET 7 OF 9
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F43	66°	190	1/4"	wfg	Fibers perpendicular to fractured surface	F39 terminates at F43 F43 terminates at F45
F44	subhorizontal		0-1"	wfg	Fibers perpendicular to fractured surface	F44 terminates at F45
F45	71°	80	0-1/4"	wfg	Fibers perpendicular to fractured surface	F46, F44, F43, F42 terminate at F45
F46	horizontal		0-1"	wfg	Fibers perpendicular to fractured surface	F46 terminates at & F48
F47	horizontal		0-1"	wfg	Fibers perpendicular to fractured surface	F47 terminates at F48
F48	61°	50	1/4"	wfg	Fibers oriented horizon-tally	F46, F47 & F49 terminate at F48
F49	32°	25	not measured	clear fg	Fibers perpendicular to fractured surface	F49 terminates at F48 & F50
F50	82°	60	1/4"	wfg	Fibers oriented horizon-tally	F52 & F49 terminate F50
F51	75°	75	3/16"	wfg	Fibers perpendicular to fractured surface	F51 terminates at F52 F53 terminates at F51

WIPP EXHAUST SHAFT
FIGURE 7 - SHEET 8 OF 9
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F52	subhorizontal		3/4"	wfg	Fibers oriented vertically	F52 terminates at F50 & F55
F53	subhorizontal		3/4"	wfg	Fibers oriented vertically	F53 terminates at F51 & F58
F54	80°	45	1/4"	wfg	Fibers perpendicular to fractured surface	No terminations
F55	88°	20	1/8-1/4"	wfg	Fibers perpendicular to fractured surface	F52 terminates at F55 F53 intersects F55 (relationship indeterminable)
F56 = F53						
F57	65°(variable) (20° apparent in lower part)	70	1/4-3/8"	wfg	Fibers perpendicular to fractured surface	No terminations
F58	58°	45	1/4"	wfg	Fibers perpendicular to fractured surface	F64, F59 & F53 terminate at F58; F61 intersects F58 (relationship indeterminable)
F59	subhorizontal		1/4"	wfg	Fibers oriented vertically	F59 terminates at F58 & F61
F60	subhorizontal		1/4"	wfg	Fibers oriented vwetically	F60 terminates at F61
F61	89° (25° at top)	120	1/8"	wfg	Fibers perpendicular to fractured surface	F59 & F60 terminate at F61; F61 intersects F58 (relationship indeterminable)

WIPP EXHAUST SHAFT
FIGURE 7 - SHEET 9 OF 9
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F62	65°	45	1/4"	wfg	Fibers dip S	F62 terminates at F63; F61 terminates at F62
F63	70°	90	1/8-1/4"	wfg	Fibers dip W	F64, F62, F66 terminate at F63
F64	subhorizontal		3/4"	wfg	Fibers oriented vertically	F64 terminates at F63 & F58
F65	89°	0	1/4"	wfg	Fibers perpendicular to fractured surface	Terminations indetermin-able
F66	subhorizontal		3/8"	wfg	Fibers perpendicular to fractured surface	F66 terminates at F63
F67	80°	35	1/4"	wfg	Fibers oriented horizon-tally	Termination indetermin-able

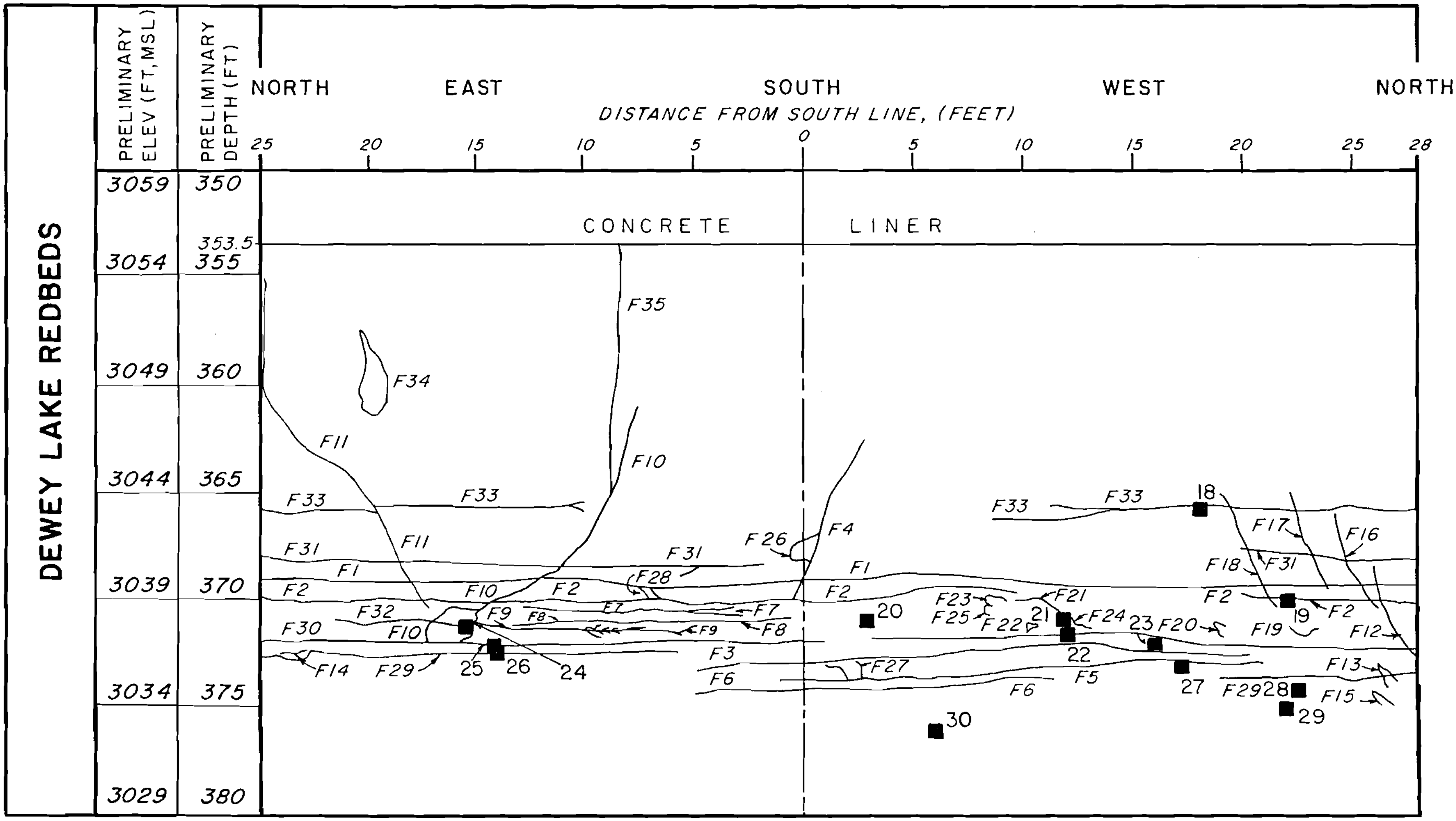


FIGURE 8 - SHEET 1 OF 6

FRACTURE LOG IN THE DEWEY LAKE REDBEDS
DEPTH 353.5 TO 380.0 FEET, EXHAUST SHAFT

WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR
WESTINGHOUSE ELECTRIC CORPORATION
CARLSBAD, NEW MEXICO

IT CORPORATION

WIPP EXHAUST SHAFT
FIGURE 8 - SHEET 2 OF 6

EXPLANATION

F20 MAPPED FRACTURE #20, SEE FRACTURE NOTES FOR DESCRIPTION.

■ 24 SAMPLE LOCATION, EXHAUST SHAFT DETAILED MAPPING SAMPLE #24.

NOTES

1) THIS INTERVAL WAS MAPPED ON 10-8-84.
2) THE LITHOLOGY OF THIS INTERVAL IS DESCRIBED IN FIGURE 4.
3) DEPTHS AND ELEVATIONS ARE RELATED TO REFERENCE ELEVATION OF 3409 FEET ABOVE MSL.
4) ONLY FRACTURES THAT WERE DEEMED "MAPPABLE", AT A SCALE OF ONE INCH EQUALS FIVE FEET ARE INLUDED ON THE MAP.
5) MAPPING EFFORTS WERE CONCENTRATED IN THE DEPTH INTERVAL FROM 365.0 FEET TO 375.0 FEET.

WIPP EXHAUST SHAFT
FIGURE 8 - SHEET 3 OF 6
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth[2] of Pole	Fracture Thickness	Fill[1] Material	Structure Within Vein	Cross-Cutting Relationships
F1	subhorizontal		1/8-1/4"	wfg	Fibers perpendicular to fracture surface,(fracture at top of mudstone bed)	F18, F17, F16, F12, F11, F10 & F4 cuts F1
F2	subhorizontal		1/4-1/2"	wfg	Fibers perpendicular to fracture surface (fracture at top of mudstone bed)	F18, F16, F12, F11, F10, & F4 cuts F2 1/4" downward displacement of F2 E. of F16
F3	subhorizontal		0-1/2"	wfg	Fibers perpendicular to fracture surface	not cut
F4	62°E	80		wfg	Fibers perpendicular to fracture surface (thrust components of movement 1/4-inch)	F4 cuts F1 & F2
F5	subhorizontal		0-3/8"	wfg	Fibers perpendicular to fracture surface	not cut
F6	subhorizontal		1/8-1/4"	wfg	Fibers perpendicular to fracture surface	not cut
F7	subhorizontal		0-1/4"	wfg	Bifurcates, sigmoidal fibers indicating W/E	Cross-cut by several minor subvertical fractures dipping East with thrust com-component of movement, displacement 1/8-inch

(1) wfg = white fiberous gypsum
(2) Azimuth of pole describes the direction of dip; quadrant notation describes the strike of the plane.

WIPP EXHAUST SHAFT
FIGURE 8 - SHEET 4 OF 6
FRACTURE NOTES

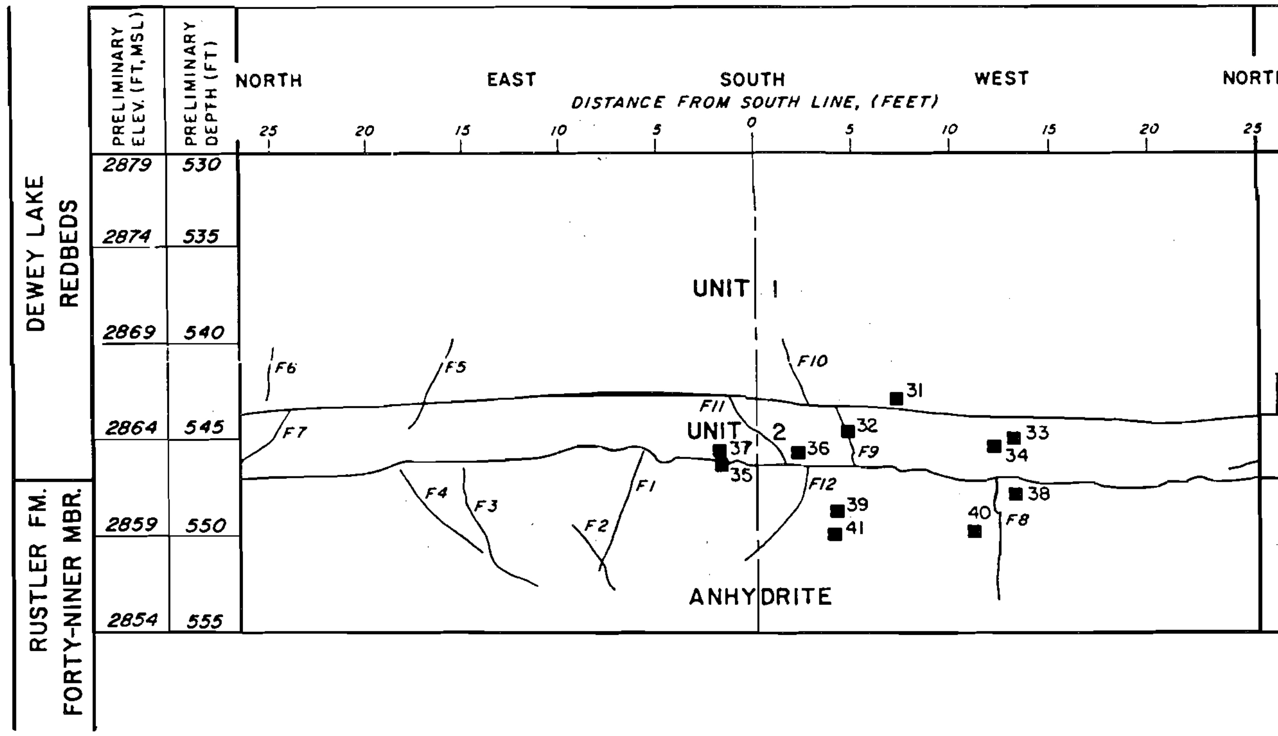
Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F8	subhorizontal		1/4"	wfg	Fibers perpendicular to fracture surface	Cross-cut by several minor subvertical fractures dipping East with thrust component of movement 1/8-in.
F9	subhorizontal		0-1/4"	wfg	Fibers perpendicular to fracture surface, fracture bifurcates	F9 terminates at F10
F10	69°E	80	1/4"	wfg	Indeterminable	F10 cross-cuts many horizontal fractures
F11	70°E	45	1/2"	wfg		Cross-cuts many horizontal fractures, may have a component of thrust
F12	74°NE	40	1/8"	wfg	Indeterminable	No terminations obvious
F13	82°NE	25	1/4"	wfg	Indeterminable	No terminations obvious
F14	vertical	N	1/8"	wfg	Indeterminable	Indeterminable
F15	74°NE	25	1/4"	wfg	Indeterminable	No terminations obvious
F16	62°E	60	0-1/4"	wfg	Fibers perpendicular to fracture surface	F16 cuts F31, F1 & F2
F17	67°SE	135	0-1/8"	wfg	Fiber are not perpendicular, indicate thrust displacement	F17 cuts F33,F31 & F1

WIPP EXHAUST SHAFT
FIGURE 8 - SHEET 5 OF 6
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F18	62°E	135	1/8-1/4"	wfg	Fibers perpendicular to fracture surface	Cross-cuts many horizontal fractures
F19	62°E	135	Indeterminable		Indeterminable	No terminations
F20	61°SE	135	Indeterminable		Indeterminable	No terminations
F21	30°NW	340	1/16-1/8"	wfg	Fibers perpendicular to fracture surface	No terminations
F22	67°SW	110	1/8"		Fibers perpendicular to fracture surface	No terminations
F23	61°NE	45	Indeterminable		Indeterminable	Indeterminable
F24	68°E	80	1/8"		Fibers perpendicular to fracture surface	Indeterminable
F25	85°E	80	Indeterminable		Indeterminable	Indeterminable
F26	75°N	345	Indeterminable		Indeterminable	Indeterminable
F27	71°N	340	Indeterminable		Indeterminable	Indeterminable
F28	58°W	280	Indeterminable		Indeterminable	Indeterminable
F29	subhorizontal		1"		Fibers are not perpendicular to fracture surface, but inclined out to the South at edges and to the North at the suture	F13 cuts F29

WIPP EXHAUST SHAFT
FIGURE 8 - SHEET 6 OF 6
FRACTURE NOTES

Fracture Number	Dip of Fracture	Azimuth of Pole	Fracture Thickness	Fill Material	Structure Within Vein	Cross-Cutting Relationships
F30	subhorizontal		1/16-3/8"		Fibers similar to F29	No terminations or cross-cuts discernible
F31	subhorizontal		1/4-3/4"		Suture near base	F11 & F10 cut F31
F32	subhorizontal		1/8-1/2"		Sigmoidal fibers with S/N displacement, bifurcates	F10 cuts F32
F33	not described					
F34	not described					
F35	not described					



LITHOLOGIC DESCRIPTION

DEWEY LAKE REDBEDS

UNIT 1. SILTSTONE, REDDISH-BROWN, STRUCTURELESS; CONTAINS ABUNDANT GREENISH-GRAY REDUCTION SPOTS 1/16" to 1/2" DIAMETER; EXTENSIVELY FRACTURED, THIN 1/16" TO 1/8" THICK FIBROUS GYPSUM-FILLED FRACTURES, ORIENTATIONS VARIABLE BUT MAJORITY ARE HORIZONTAL TO SUBHORIZONTAL, SPACED 1" to 2"; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY.

UNIT 2. ARGILLACEOUS SILTSTONE, REDDISH-BROWN, STRUCTURELESS; CONTAINS FRACTURES SIMILAR TO UNIT 1; ABUNDANT GREENISH-GRAY REDUCTION SPOTS; GRADES TO SILTY CLAYSTONE IN UPPER 1/4" TO 3/4"; LOWER 1/4" TO 1/2" CONSISTS OF GREENISH-GRAY ARGILLACEOUS SILTSTONE; FRACTURES IN UNIT DO NOT EXTEND INTO UNDERLYING ANHYDRITE; BASAL CONTACT SHARP, UNDULATORY UP TO 1.5', EROSIONALLY TERMINATES LAMINAE IN UNDERLYING ANHYDRITE.

RUSTLER FORMATION

UNIT 1. ANHYDRITE, FINELY CRYSTALLINE, ALTERNATING MEDIUM GRAY TO GRAYISH-BROWN, WHITE AT UPPER CONTACT, BANDED TO OCCASIONALLY LAMINATED, BANDS SPACED 1/16" to 1", BANDS AND LAMINAE UNDULATE UP TO 1/4" AND OCCASIONALLY TERMINATE ABRUPTLY, GRAY BANDS ARE USUALLY THICKER; UPPER 3.0' CONTAINS AN INCREASING ABUNDANCE UPWARD OF CLAY INTERBEDS; FROM 0 TO 6" OF GYPSUM OCCURS AT UPPER CONTACT; CONTAINS ABUNDANT HORIZONTAL TO SUBHORIZONTAL FIBROUS GYPSUM-FILLED FRACTURES, 1/8" TO 1/2" THICK, SPACED 1" TO 3"; BASAL CONTACT NOT OBSERVED.

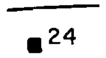
FRACTURE NOTES

ONLY FRACTURES WITH OBTAINABLE ATTITUDES WERE MAPPED AS THERE WERE TOO MANY SMALL FRACTURES TO BE INCLUDED ON THE MAP.

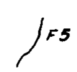
	DIP	AZIMUTH OF THE POLE	THICKNESS
F1	75°	90°	1/8"
F2	78°	170°	1/8"
F3	NOT MEASURABLE		1/8"
F4	64°	80°	1/4"
F5	58°	280°	1/8"-1/2"
F6	78°	315°	1/8"
F7	69°	280°	1/8"
F8	90°	45°	1/8"
F9	72°	340°	1/8"-1/4"
F10	80°	315°	1/8"
F11	54°	280°	1/8"
F12	82°	165°	1/4"

EXPLANATION

SHARP CONTACT



SAMPLE LOCATION, EXHAUST SHAFT DETAILED MAPPING SAMPLE #24



MAPPED FRACTURE

NOTES

1) THIS INTERVAL WAS MAPPED ON 10-15-84.
2) THE DEPTHS ARE RELATED TO THE SHAFT REFERENCE LOCATION AT 3409.0 FEET ABOVE MSL.
3) STANDARD GEOLOGIC SYMBOLS ARE NOT USED IN ORDER TO ENHANCE THE CLARITY OF THE LOG COLUMN.

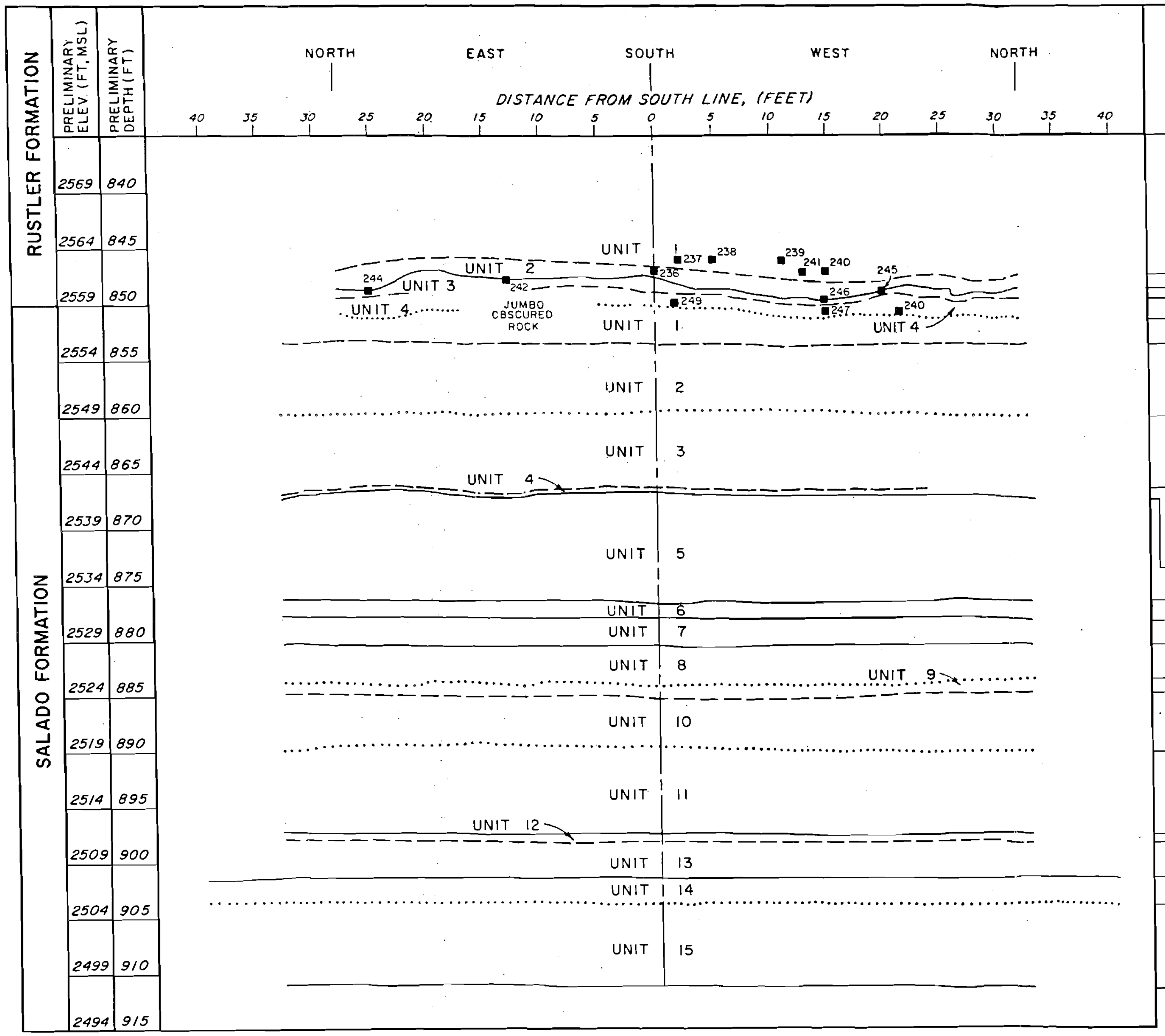
FIGURE 9

GEOLOGIC LOG OF DEWEY LAKE REDBEDS - RUSTLER FORMATION CONTACT DEPTH 530 THROUGH 555 FEET EXHAUST SHAFT

WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR
WESTINGHOUSE ELECTRIC CORPORATION
CARLSBAD, NEW MEXICO

IT CORPORATION



LITHOLOGIC DESCRIPTION

RUSTLER FORMATION - UNNAMED LOWER MEMBER

UNIT 1. ARGILLACEOUS SILTSTONE, GRAY WITH LOCAL REDDISH-BROWN AREAS, THINLY LAMINATED, RARE LOW-ANGLE CROSS-LAMINATIONS; CONTAINS BROWN CLASTS OF ANHYDRITE RANDOMLY SCATTERED THROUGHOUT UNIT, 1/8" TO 1-1/2" DIAMETER, ROUNDED AND FLATTENED PARALLEL TO BEDDING; BASAL CONTACT GRADATIONAL OVER 1/2", IRREGULAR, UNDULATORY, REDUCTION-OXIDATION CONTACT, MAPPED AS DIFFUSE DUE TO EXTREME CONTACT UNDULATIONS.

UNIT 2. SANDY SILTSTONE WITH ARGILLACEOUS SILTSTONE AT TOP, REDDISH-BROWN WITH LOCAL GRAY AREAS, FINELY LAMINATED, LOW ANGLE CROSS-LAMINATIONS MODERATELY ABUNDANT; BROWN CLASTS OF ANHYDRITE OCCUR THROUGHOUT BUT CONCENTRATED IN UPPER PART, SMALLER CLASTS ARE LOCALLY ALIGNED IN ZONES PARALLEL TO BEDDING; LOWER 1" TO 2" DEFINED AS SANDSTONE PEBBLE CONGLOMERATE: WHITE TO LIGHT GRAY TO BLACK, MATRIX SILTSTONE, POORLY SORTED; FINE SANDSTONE PEBBLES ROUNDED TO SUBANGULAR, GRAY AND REDUCED, TO 1" HIGH AND 3" LONG, FLATTENED PARALLEL TO BEDDING; CONTAINS FOSSIL BIVALVE HASH; THIN BLACK LAMINATIONS OCCUR THROUGHOUT; EXHIBITS PETROLIFEROUS ODOR WHEN BROKEN; ROCK AND MATRIX ABOVE PEBBLES REDUCED; LOWER 1/32" CONTAINS SAND-SIZED CLASTS; BASAL CONTACT SHARP, EXHIBITS SOFT SEDIMENT LOADING INTO UNDERLYING UNITS, LOCALLY BEDDING AND CONGLOMERATE BED ARE BENT AND SQUEEZED DOWNWARD INTO UNDERLYING UNIT, LAMINAE OF UNIT AT BASE PARALLEL LOWER CONTACT AND COMMONLY EXHIBIT ROOM PROBLEMS HIGHER IN SECTION DUE TO LOADING DEFORMATION, LOCAL CLAY DRAPE OVER BASAL CONTACT INDICATES THAT IT IS EROSIONAL, CONTACT UNDULATORY.

UNIT 3. SILTSTONE, REDDISH-BROWN, THINLY LAMINATED, CROSS-LAMINATED, FINES UPWARD; SOFT SEDIMENT LOADING OF OVERLYING UNIT AT TOP; BASAL CONTACT GRADATIONAL.

UNIT 4. SUBDIVIDED INTO TWO LITHOLOGICALLY DISTINCT SUBUNITS:
- 4A. ANHYDRITE AND POLYHALITE, FINELY CRYSTALLINE, REDDISH-BROWN TO WHITISH-GRAY, POORLY BEDDED TO STRUCTURELESS, LOCALLY NODULAR TO ENTROLITHIC; 3" TO 1.0' THICK; BASAL CONTACT SHARP, MARKED BY FIRST OCCURRENCE OF DISPLACIVE HALITE.
- 4B. ARGILLACEOUS POLYHALITE AND ANHYDRITE, REDDISH-BROWN TO WHITE, LAMINATED; UPPER CONTACT MARKED BY 1/2" TO 1" THICK BED OF GREENISH-GRAY ARGILLACEOUS ANHYDRITE CONTAINING SMALL DISPLACIVE HALITE CRYSTALS, OCCURS AROUND 70% OF CIRCUMFERENCE OF SHAFT; SMALL, <1/3" ACROSS, DISPLACIVE HALITE CRYSTALS OCCUR THROUGHOUT; BASAL CONTACT DIFFUSE, MARKED BY CHANGE IN MATRIX FROM ANHYDRITE TO CLAY.

SALADO FORMATION

UNIT 1. HALITIC MUDSTONE, REDDISH-BROWN, CONTAINS CLEAR DISPLACIVE HALITE CRYSTALS 1/32" TO 1/16" ACROSS AND 1/4" TO 3" PODS OF WHITE TO ORANGE HALITE; LARGE GREENISH-GRAY SPOTS UP TO 2" DIAMETER; BASAL CONTACT GRADATIONAL.

UNIT 2. HALITE, FINELY TO COARSELY CRYSTALLINE, SLIGHTLY ARGILLACEOUS AND POLYHALITIC, PINK TO WHITE TO CLEAR, MASSIVE EXCEPT FOR DISCONTINUOUS CLAY STRINGERS; CLAY CONTENT INCREASES WITH DEPTH, CLASSIFIED AS ARGILLACEOUS HALITE AT BASE; BASAL CONTACT DIFFUSE.

UNIT 3. HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO PINK, LOCALLY REDDISH-ORANGE AND REDDISH-BROWN; TRACE POLYHALITE BLEBS; LOCALLY ARGILLACEOUS NEAR TOP, CONTENT DECREASES WITH DEPTH, CLAY OCCURS IN STRINGERS NEAR BASE; BASAL CONTACT GRADATIONAL.

UNIT 4. HALITIC CLAYSTONE WITH POLYHALITE AND ANHYDRITE; UPPER 0.2' TO 0.3' CONSISTS OF STRUCTURELESS PINK POLYHALITE; THIN DISCONTINUOUS BED OF ANHYDRITE UNDERLIES POLYHALITE; LOWER 0.1' TO 0.2' CONSISTS OF STRUCTURELESS HALITIC CLAYSTONE; BASAL CONTACT SHARP.

UNIT 5. HALITE, COARSELY CRYSTALLINE, WHITE, COARSELY BEDDED WITH CONTINUOUS TO DISCONTINUOUS SUBHORIZONTAL STRINGERS OF POLYHALITE AND CLAY IN UPPER 1.0', STRINGERS SPACED 0.3' TO 0.6'; BASAL CONTACT SHARP.

UNIT 6. HALITIC CLAYSTONE, REDDISH-BROWN TO GREENISH-GRAY IN UPPER 1.0', STRUCTURELESS, CONTAINS DISPLACIVE HALITE CRYSTALS; MODERATELY ABUNDANT GREENISH-GRAY STRINGERS DISSEMINATED THROUGHOUT; RARE RANDOMLY-ORIENTED HALITE-FILLED FRACTURES; BASAL CONTACT SHARP.

UNIT 7. HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO PINK; COARSELY BEDDED WITH HORIZONTAL TO SUBHORIZONTAL STRINGERS OF POLYHALITE AND ANHYDRITE, SPACED 1" TO 3"; BASAL CONTACT SHARP.

UNIT 8. HALITIC CLAYSTONE, REDDISH-BROWN, STRUCTURELESS, CONTAINS DISPLACIVE HALITE; MODERATELY ABUNDANT SUBHORIZONTAL REDUCED GREENISH-GRAY ZONES 1/2" THICK; 1/4" TO 1" THICK RANDOMLY-ORIENTED HALITE-FILLED FRACTURES; BASAL CONTACT DIFFUSE.

UNIT 9. ARGILLACEOUS HALITE, MEDIUM TO COARSELY CRYSTALLINE, MATRIX REDDISH-BROWN, HALITE PINK TO WHITE TO CLEAR, COARSELY BEDDED; TRACE POLYHALITE; TRACE SUBHORIZONTAL ANHYDRITE STRINGERS; OCCASIONAL GREENISH-GRAY ZONES; BASAL CONTACT GRADATIONAL.

UNIT 10. CLAYSTONE, SLIGHTLY HALITIC, REDDISH-BROWN, UPPER 1.5' STRUCTURELESS AND CONTAINS DISPLACIVE HALITE CRYSTALS, REMAINDER THINLY LAMINATED; HALITE CONTENT INCREASES WITH DEPTH; SUBVERTICAL HALITE-FILLED FRACTURES SPACED 1.0' TO 4.0', 1/2" TO 1" THICK; BASAL CONTACT DIFFUSE.

UNIT 11. HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO PINK TO REDDISH-BROWN; ARGILLACEOUS, 5% TO 10% CLAY, CLAY OCCURS AS INTERSTITIAL MATERIAL AND AS LENTICULAR CLAYSTONE PODS, CONTENT DECREASES WITH DEPTH; SUBHORIZONTAL DISCONTINUOUS STRINGERS OF CLAY AND ANHYDRITE SPACED 2" TO 4"; BASAL CONTACT SHARP.

UNIT 12. ARGILLACEOUS HALITE, REDDISH-BROWN, FAINTLY LAMINATED; HALITE OCCURS AS DISPLACIVE CRYSTALS; BASAL CONTACT SHARP, MAPPED AS GRADATIONAL AS IT WAS OBSCURED.

UNIT 13. HALITE, MEDIUM TO COARSELY CRYSTALLINE, WHITE TO SLIGHTLY ORANGE, THICKLY BEDDED; TRACE SUBHORIZONTAL STRINGERS AND BEDS OF POLYHALITE, SPACED 2" TO 5", CONTENT DECREASES WITH DEPTH, RARE STRINGERS OF CLAY NEAR BASE; BASAL CONTACT SHARP.

UNIT 14. ARGILLACEOUS HALITE, REDDISH-BROWN; HALITE OCCURS AS DISPLACIVE CRYSTALS TO 3/4" ACROSS; 1" THICK BAND OF HALITE OCCURS 2" BELOW UPPER CONTACT; BASAL CONTACT DIFFUSE.

UNIT 15. HALITE, COARSELY CRYSTALLINE, WHITE TO TINTED ORANGE, COARSELY BEDDED BY HALITE, CONTAINING HORIZONTALLY ALIGNED PODS OF ARGILLACEOUS HALITE, SEPARATED BY BEDS OF WHITE HALITE; LOWER 2.0' CONTAINS STRINGERS OF CLAY, POLYHALITE, AND ANHYDRITE SPACED 1" TO 2"; BASAL CONTACT SHARP.

NOTES

1) THIS INTERVAL WAS MAPPED ON 11/11/84 AND 11/16/84.
2) THE DEPTHS ARE RELATED TO THE SHAFT REFERENCE ELEVATION AT 3409.0 FEET ABOVE MSL.
3) STANDARD GEOLOGIC SYMBOLS ARE NOT USED IN ORDER TO ENHANCE THE CLARITY OF THE LOG COLUMN.
4) THE INTERVAL FROM 835-855 FEET WAS MAPPED FROM THE BENCH.
5) A PORTION OF THE ROCK WAS OBSCURED BY THE DRILLING JUMBO.
6) THE MAPPING INTERVAL VISIBLY PRODUCED NO WATER. HOWEVER, MAPPING CONDITIONS WERE WET FROM CULEBRA DISCHARGE.

EXPLANATION

- ——— SHARP CONTACT
- — — — GRADATIONAL CONTACT (DEFINED WITHIN 2 IN.)
- ········ DIFFUSE CONTACT (DEFINED WITHIN 6 IN.)
- ■ 24 SAMPLE LOCATION, EXHAUST SHAFT DETAILED MAPPING SAMPLE #24

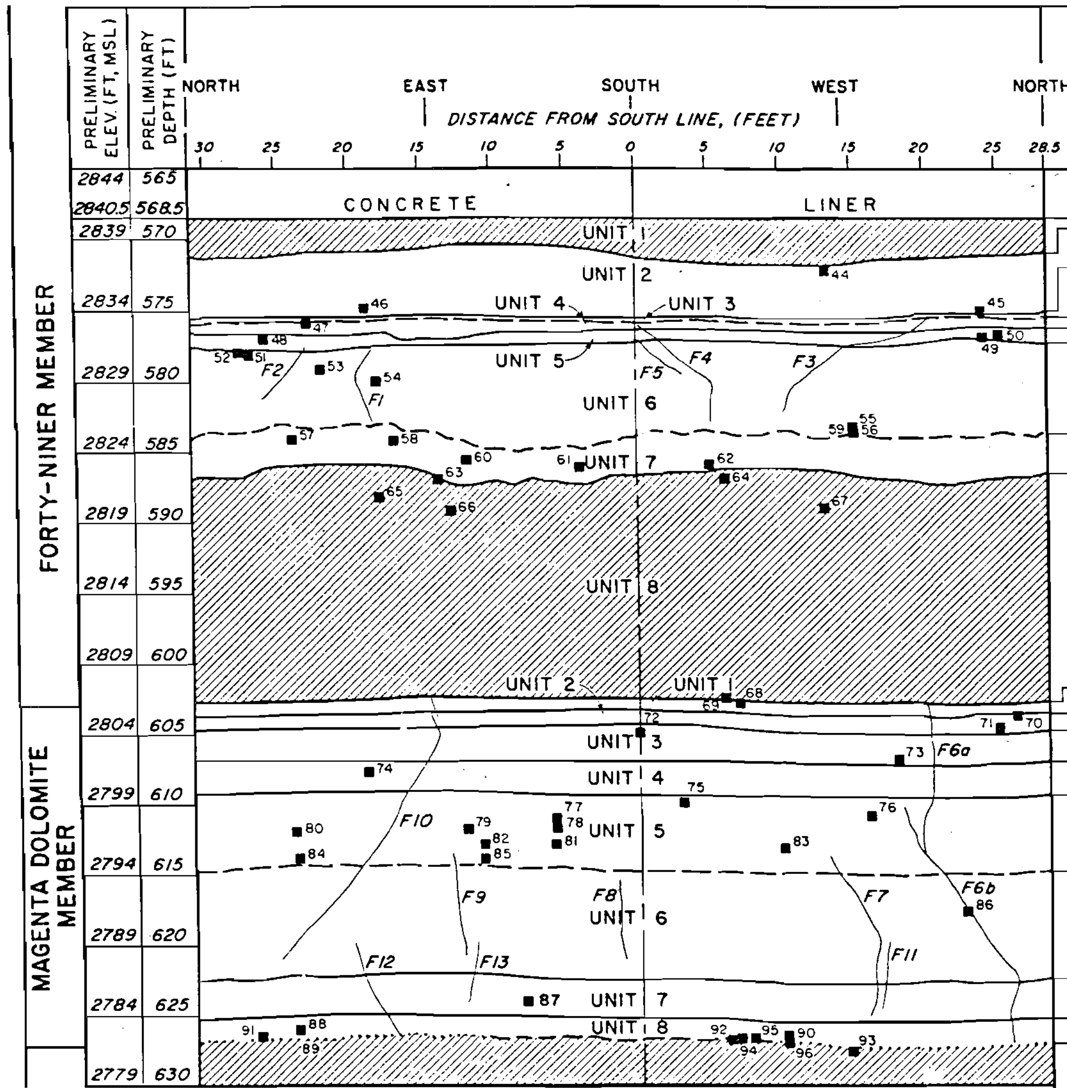
FIGURE 12

GEOLOGIC LOG OF
RUSTLER-SALADO FORMATION CONTACT
AND THE KEYWAY AREA
DEPTH 835 THROUGH 915 FEET
EXHAUST SHAFT

WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR
WESTINGHOUSE ELECTRIC CORPORATION
CARLSBAD, NEW MEXICO

IT CORPORATION



LITHOLOGIC DESCRIPTION

FORTY-NINER MEMBER

UNIT 1. ANHYDRITE, FINELY CRYSTALLINE, MEDIUM TO DARK GRAY, POSSIBLE NODULAR STRUCTURE, HARD; UPPER CONTACT NOT OBSERVED; BASAL CONTACT SHARP.

UNIT 2. ANHYDRITE, FINELY TO MEDIUM CRYSTALLINE, ALTERNATING LIGHT TO DARK GRAY, STRUCTURELESS AT TOP BECOMING BANDED WITH DEPTH, HARD; GYPSIFEROUS NEAR BASE; BASAL CONTACT SHARP.

UNIT 3. SILTY MUDSTONE, GRAY (REDUCED), THINLY LAMINATED, SOFT; FRACTURES FROM UNDERLYING UNIT CONTINUOUS INTO UNIT 3; BASAL CONTACT GRADATIONAL.

UNIT 4. SILTY CLAYSTONE, REDDISH-BROWN, THINLY LAMINATED, CONTAINS 1/16" TO 1/8" THICK SUBHORIZONTAL GYPSUM-FILLED FRACTURES SPACED 1" TO 3"; BASAL CONTACT SHARP, UNDULATORY, DISCONFORMABLE, MARKED BY THE OCCURRENCE OF A FINELY LAMINATED SLIGHTLY FISSILE DARK REDDISH-BROWN SILTY MUDSTONE.

UNIT 5. SILTY CLAYSTONE, REDDISH-BROWN, LOCALLY THINLY LAMINATED; CONTAINS LOCAL ZONES OF GYPSUM NODULES AND CRYSTALS, BEDDING LOCALLY DISRUPTED IN GYPSUM-RICH ZONES; LOCAL POORLY-DEFINED WHITE ZONES (GYPSIFEROUS CLAYSTONE ?); BASAL CONTACT SHARP, UNDULATORY, DISCONFORMABLE, MARKED BY FIRST OCCURRENCE OF GYPSUM.

UNIT 6. SILTY CLAYSTONE, REDDISH-BROWN, LARGE GREENISH-GRAY AREAS IN LOWER 1.0' TO 1.5', THINLY LAMINATED, LAMINAE OFTEN SLIGHTLY UNDULATORY AND TERMINATED EROSIONALLY, TRACE CROSS-LAMINATIONS, SOFT; UPPER 0 TO 5" DEFINED AS GYPSIFEROUS CLAYSTONE; GYPSUM NODULES (<1/2") AND FINE ENTROLITHIC STRUCTURES OCCUR THROUGHOUT, CONTENT DECREASES TOWARD THE BASE, CLAYSTONE LAMINAE SURROUNDING GYPSUM NODULES AND ENTROLITHIC STRUCTURES EXHIBIT SOFT-SEDIMENT DEFORMATION, LAMINAE ARE CONTORTED, CONVOLUTED, AND DISRUPTED BY GYPSUM STRUCTURES; GREENISH-GRAY REDUCTION SPOTS LOCALLY ABUNDANT, OFTEN HAVE MORPHOLOGY SIMILAR TO GYPSUM, SEVERAL 1" THICK HORIZONTAL TO SUBHORIZONTAL ZONES CONTAINING ABUNDANT GREENISH-GRAY SPOTS OCCUR IN UPPER 2.0'; BASAL CONTACT SHARP TO GRADATIONAL, DISCONFORMABLE.

UNIT 7. SILTSTONE GRADING TO ARGILLACEOUS SILTSTONE WITH DEPTH, LIGHT GRAY WITH RARE DARK GRAY (ORGANIC-RICH ?) LAMINAE, THINLY LAMINATED TO VERY THINLY BEDDED, LAMINAE UNDULATE SLIGHTLY PARALLELING LOWER CONTACT, RARE SOFT-SEDIMENT DEFORMATION; UPPER 0.2' TO 0.5' STRUCTURELESS WITH FAINT HINTS OF THIN LAMINATIONS, STRUCTURELESS ZONE BOUNDED AT BASE BY MINOR EROSIONAL SURFACE WHICH TERMINATES UNDERLYING BEDDING, CONTAINS NODULES OF WHITE GYPSUM (<1/2" DIAMETER), CONTENT DECREASES WITH DEPTH; HORIZONTAL AND SUBHORIZONTAL GYPSUM-FILLED FRACTURES 1/16" TO 1/4" THICK, UNDULATORY, FOLLOWS BEDDING PLANES, AVERAGE SPACING 3" TO 5"; VERTICAL AND SUBVERTICAL GYPSUM-FILLED FRACTURES 1/16" TO 1/4" THICK, SPACED 0.25' TO 1.5', ABSENT IN UPPER 0.2' TO 0.5'; BASAL CONTACT SHARP, UNDULATORY, EROSIONAL.

UNIT 8. ANHYDRITE, FINELY CRYSTALLINE, GRAY TO GRAYISH-BROWN, THINLY LAMINATED IN UPPER 1.0' TO 2.0' GRADING TO NODULAR WITH DEPTH; LOCAL GYPSIFEROUS AREAS NEAR TOP AND BASE ARE MEDIUM CRYSTALLINE; MAJORITY OF FRACTURES HORIZONTAL TO SUBHORIZONTAL, FILLED WITH FIBROUS GYPSUM, 1/16" TO 1/2" THICK, SPACED 1" TO 1.0'; BASAL CONTACT SHARP, DISCONFORMABLE.

MAGENTA DOLOMITE MEMBER

UNIT 1. DOLOMITE, GYPSIFEROUS, SOME ARENACEOUS MATERIAL, FINELY CRYSTALLINE AND FINE-GRAINED, BROWN AND LIGHT BROWN, THIN TO MEDIUM BEDDED, BEDS INTERNALLY STRUCTURELESS EXCEPT FOR RARE THIN LAMINATIONS AND RARE CROSS-LAMINATIONS, LOWER 3" CONTAIN EROSIONALLY TERMINATED TABULAR BEDS; CONTAINS GYPSUM-FILLED VUGS UP TO 1/4" DIAMETER; BASAL CONTACT SHARP, TERMINATES UNDERLYING BEDDING, DISCONFORMABLE.

UNIT 2. DOLOMITE, GYPSIFEROUS, ABUNDANT ARENACEOUS MATERIAL, MEDIUM-GRAINED SAND, MAJORITY OF GRAINS APPEAR TO BE DOLOMITE, LESS ABUNDANT DARK GRAINS, ALTERNATING LIGHT AND MEDIUM BROWN, MICROLAMINATED TO VERY THINLY BEDDED, ABUNDANT CROSS-LAMINATIONS AND RIPPLE FORMS, CROSS-LAMINATION SETS BROAD, VARY FROM 2" TO 6" ACROSS, BEDDING TABULAR TO LENTICULAR OFTEN TERMINATED EROSIONALLY, LOAD STRUCTURES; OVERALL, STRUCTURE MORE BROAD AND LESS VARIABLE AND GRAIN SIZE LARGER THAN UNDERLYING UNITS; 2" THICK STRUCTURELESS BED WITH LOAD CASTS AT BASE OCCURS BELOW UPPER CONTACT; GYPSUM-FILLED VUGS UP TO 1/2" DIAMETER; DENSITY OF SEDIMENTARY STRUCTURES INCREASES MARKEDLY IN LOWER 2" TO 3"; THIN CLAY BED AT UPPER CONTACT; BASAL CONTACT SHARP, MARKED BY THIN CLAY LAMINAE, EROSIONALLY TERMINATES BEDDING OF UNDERLYING UNIT.

UNIT 3. DOLOMITE, GYPSIFEROUS, SOME ARENACEOUS MATERIAL, FINE-GRAINED AND FINELY CRYSTALLINE, ALTERNATING LIGHT AND DARK BROWN, MICROLAMINATED TO THINLY BEDDED, CROSS-LAMINATED, OCCASIONAL TROUGH CROSS-LAMINATIONS WITH VARIABLE CURRENT DIRECTIONS, CROSS-LAMINATION SETS VARY FROM 2" TO 4" ACROSS, OCCASIONAL RIPPLE FORMS, LARGER BEDS USUALLY CONTINUOUS AROUND CIRCUMFERENCE OF SHAFT, BUT ARE OCCASIONALLY TABULAR; OVERALL, BEDDING MORE CONTINUOUS THAN UNDERLYING UNITS; MODERATELY ABUNDANT GYPSUM-FILLED VUGS UP TO 1/4" DIAMETER; BASAL CONTACT SHARP, MARKED BY 4" THICK STRUCTURELESS LIGHT-COLORED BED OVERLYING CLAY LAMINAE, TERMINATES BEDDING OF UNDERLYING UNIT.

UNIT 4. DOLOMITE, GYPSIFEROUS, ABUNDANT ARENACEOUS MATERIAL, FINE-GRAINED, LIGHT BROWN WITH RARE DARK BROWN INTERBEDS, MICROLAMINATED TO THINLY BEDDED; STRUCTURE IN UPPER 4" VERY FINE, INCLUDING FINE CROSS-LAMINATIONS, FINE STRUCTURE LOCALLY DISRUPTED AROUND ABUNDANT GYPSUM-FILLED VUGS 1/16" TO 1/2" DIAMETER; BETWEEN 4" AND 8" BELOW UPPER CONTACT, DOLOMITE IS THINLY BEDDED WITH FEW CLAYSTONE LAMINAE AS INTERBEDS; MAJORITY OF UNIT IS THINLY LAMINATED WITH CROSS-LAMINATIONS AND TROUGH CROSS-LAMINATIONS, CROSS-LAMINATION SETS 1/4" TO 2" ACROSS, PREVALENT CURRENT DIRECTION SOUTH, EXTREMELY FINE SEDIMENTARY STRUCTURES, RIPPLE FORMS OCCUR WITH WAVELENGTHS OF 1" TO 2" AND AMPLITUDES OF 1/4"; LOWER 0.5' LIGHTER COLORED, MORE COARSELY GRAINED, CONTAINS DARK-COLORED SAND-SIZED GRAINS <1/32", ROUNDED BY LOAD STRUCTURES, THINLY BEDDED EXCEPT FOR THINLY LAMINATED INTERBEDS OF DARK MATERIAL, BEDS THICKEN AND THIN DUE TO LOADING STRUCTURES, CONTAINS ABUNDANT GYPSUM-FILLED VUGS; BASAL CONTACT SHARP, MARKED BY LOAD CASTS INTO UNDERLYING UNIT, EROSIONALLY TERMINATES BEDDING OF UNDERLYING UNIT.

UNIT 5. DOLOMITE, GYPSIFEROUS, SOME ARENACEOUS MATERIAL, FINE-GRAINED AND FINELY CRYSTALLINE, ALTERNATING DARK AND LIGHT BROWN, MICROLAMINATED (USUALLY DARK BROWN) TO THINLY BEDDED; UPPER 1.0' DARK BROWN WITH MINOR AMOUNTS OF LIGHT BROWN INTERBEDS, FINELY LAMINATED, CROSS-LAMINATED, TROUGH CROSS-LAMINATIONS, CURRENT DIRECTIONS VARIABLE, CONTAINS CONCAVE UPWARD BEDS OF LIGHT-COLORED MATERIAL EROSIONALLY PLANED OFF, RIPPLE FORMS MODERATELY ABUNDANT, ALL CROSS-LAMINAE CONTAIN LIGHT BROWN PEBBLES FLATTENED PARALLEL TO BEDDING; REMAINDER LIGHT BROWN COLOR DOMINATES, MICROLAMINATED TO THINLY BEDDED, THICKER BEDS LENTICULAR TO TABULAR, OFTEN CONTAINS CROSS-LAMINATIONS; CROSS-LAMINATIONS AND TROUGH CROSS-LAMINATIONS WITH VARIABLE CURRENT DIRECTIONS VERY ABUNDANT, CROSS-LAMINATION SETS VARY FROM 1/4" TO 2" ACROSS; BEDDING BECOMES MORE SUBHORIZONTAL AND WAVY WITH DEPTH, DENSITY OF CROSS-LAMINATIONS DECREASES WITH DEPTH, FEW BEDS ARE CONTINUOUS AROUND THE CIRCUMFERENCE OF THE SHAFT MARKING MINOR EROSIONAL CONTACTS; UNIT 5 IS MAJOR FLUID-PRODUCING ZONE IN MAGENTA, WET AT OUTSET OF MAPPING, REMAINED WET AFTER OTHER ZONES WERE WASHED AND HAD DRIED, NO OBVIOUS SOURCE OF FLUID WAS OBSERVED; BASAL CONTACT GRADATIONAL.

UNIT 6. DOLOMITE, GYPSIFEROUS, SOME ARENACEOUS MATERIAL, FINE-GRAINED AND FINELY CRYSTALLINE, ALTERNATING LIGHT AND DARK BROWN, MICROLAMINATED TO THINLY BEDDED, LIGHT BROWN COLOR DOMINATES, STRUCTURE SIMILAR TO UNIT 5 EXCEPT FEWER CROSS-LAMINATIONS, BEDDING IS COARSER, MORE HORIZONTAL, WAVY AND CONTINUOUS; BASAL CONTACT SHARP, MARKED BY 1" TO 2" THICK BED OF FINE-GRAINED DOLOMITE WITH NO INTERNAL STRUCTURE EXHIBITING RIPPLE FORMS ALONG UPPER SURFACE.

UNIT 7. DOLOMITE, GYPSIFEROUS, ABUNDANT ARENACEOUS MATERIAL, FINE-GRAINED, ALTERNATING LIGHT AND DARK BROWN, THINLY LAMINATED TO VERY THINLY BEDDED, BEDDING TABULAR TO LENTICULAR, THIN LAMINAE OF DARK-COLORED MATERIAL DRAPE OVER RIPPLE FORMS AT THE UPPER SURFACE OF THICKER BEDS, BEDDING CONTINUOUS FOR UP TO 2.0' AND EROSIONALLY TERMINATED, FEW BEDS HAVE INTERNAL STRUCTURE, BEDS THICKEN AND THIN WITH BOTH UPPER AND LOWER SURFACES EXHIBITING UNDULATIONS, ABUNDANT DRAPE OF DARKER LAMINAE OVER UNDULATORY SURFACES; CONTAINS 1/16" TO 1/4" THICK FIBROUS GYPSUM-FILLED FRACTURES PARALLEL TO BEDDING; OCCASIONAL GYPSUM-FILLED VUGS UP TO 1/4" DIAMETER; BASAL CONTACT SHARP, MARKED BY BLACK CLAY LAMINAE, EROSIONALLY TERMINATES BEDDING OF UNDERLYING UNIT.

UNIT 8. DOLOMITE, GYPSIFEROUS, ORGANIC OR CLAY-RICH, SOME ARENACEOUS MATERIAL, VERY FINE-GRAINED AND FINELY CRYSTALLINE ALTERNATING BROWN AND DARK BROWN, THINLY LAMINATED, DARK BROWN LAMINAE POSSIBLY ORGANIC-RICH, LAMINAE ARE MOUNDED, LAMINAE OFTEN CONTINUOUS FROM MOUND TO MOUND, LAMINAE DIP FROM 30° TO 70° ON SIDES OF MOUNDS, FILL BETWEEN MOUNDS IS WEDGE FORM TO LENTICULAR-SHAPED FILL, OFTEN OCCURS AS ALTERNATING SEQUENCES OF CONVEX AND CONCAVE LENS FORMS WITH CLAY-RICH LAMINAE DRAPED OVER EROSIONAL MARGINS OF LENTICALS, HIGHEST DIPS OF LAMINAE IN CENTER OF MOUNDS, WAVELENGTH BETWEEN TROUGHS 4" TO 8"; NEAR THE BASE LAMINAE BECOME SUBHORIZONTAL AND WAVY, NO MOUND FORMS; UPPER 1" TO 4" VERY THINLY BEDDED; FIBROUS GYPSUM-FILLED FRACTURES 1/16" TO 1/8" THICK OCCUR PARALLEL TO BEDDING SPACED 1/4" TO 3", GYPSUM-FILLED VUGS TO 1/4" DIAMETER OCCUR, LOCAL ZONES CONTAIN GYPSUM; BROWNISH-BLACK ORGANIC-RICH ZONE OCCURS NEAR BASE; BASAL CONTACT GRADATIONAL TO DIFFUSE, DOLOMITE LAMINAE OCCUR LOCALLY, SURROUNDED BY GYPSUM OF UNDERLYING UNIT, IN RARE CASES ZONES OF GYPSUM ARE INCORPORATED INTO DOLOMITE.

TAMARISK MEMBER

UNIT 1. ANHYDRITE, GYPSIFEROUS AT TOP, CONTENT DECREASES WITH DEPTH, FINELY CRYSTALLINE TO MEDIUM CRYSTALLINE (GYPSUM), DARK GRAY TO WHITE, NODULAR; BASAL CONTACT NOT OBSERVED.

EXPLANATION

- SHARP CONTACT (solid line)
- GRADATIONAL CONTACT (DEFINED WITHIN 2 IN.) (dashed line)
- DIFFUSE CONTACT (DEFINED WITHIN 6 IN.) (dotted line)
- ■24 SAMPLE LOCATION EXHAUST SHAFT DETAILED MAPPING SAMPLE #24
- F3 MAPPED FRACTURE #3

NOTES

1) THIS INTERVAL WAS MAPPED ON 10/17/84.
2) DEPTHS ARE RELATED TO THE REFERENCE ELEVATION AT 3409.0 FEET ABOVE MSL.
3) STANDARD GEOLOGIC SYMBOLS ARE NOT USED IN ORDER TO ENHANCE THE CLARITY OF THE LOG COLUMN.

FRACTURE NOTES

ALL FRACTURES ARE FILLED WITH FIBROUS GYPSUM.
F1 - 1/8"-1/4" THICK, HORIZONTAL FIBER ORIENTATION.
F2 - 1/16"-1/4" THICK, HORIZONTAL FIBER ORIENTATION.
F3 - 1/16"-1/8" THICK, HORIZONTAL FIBER ORIENTATION.
F4 - 1/8"-1/4" THICK, HORIZONTAL FIBER ORIENTATION.
F5 - 1/16"-1/8" THICK, HORIZONTAL FIBER ORIENTATION.
F6A - 1/2" THICK, SIGMOIDAL FILLING INDICATING SOUTH SIDE UPTHROWN RELATIVE TO NORTH SIDE, DIP 61°N, STRIKE N80°W.
F6B - 1/2" THICK, FIBERS ORIENTED 30° FROM FRACTURE PLANE, WEST SIDE UPTHROWN RELATIVE TO EAST SIDE.
F7 - 1/4" THICK, STRIKE N45°W, DIP 80°S.
F8 - 1/8" THICK, FIBERS ORIENTED PERPENDICULAR TO FRACTURE PLANE, STRIKE N30°W.
F9 - 1/8"-1/4" THICK, FIBERS ORIENTED PERPENDICULAR TO FRACTURE PLANE, STRIKE N70°W.
F10 - 1/2" THICK, FIBERS ORIENTED 60° FROM FRACTURE PLANE AND LOCALLY SIGMOIDAL, SOUTH SIDE UPTHROWN RELATIVE TO NORTH SIDE, STRIKE N80°W, DIP 62°N.
F11 - 1/4" THICK, STRIKE N45°W, DIP 80°S.
F12 - 1/8"-1/4" THICK, FIBERS ORIENTED PERPENDICULAR TO FRACTURE PLANE, STRIKE N50°E, DIP 66°S.
F13 - 1/4"-1/2" THICK, FIBERS ORIENTED PERPENDICULAR TO FRACTURE PLANE, STRIKE S30°E.

FIGURE 10

GEOLOGIC LOG OF THE FORTY-NINER MEMBER CLAYSTONE AND THE MAGENTA DOLOMITE MEMBER, RUSTLER FORMATION DEPTH 568.5 THROUGH 630 FEET EXHAUST SHAFT

WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR
WESTINGHOUSE ELECTRIC CORPORATION
CARLSBAD, NEW MEXICO

IT CORPORATION

APPENDIX A

WORK PLAN OF GEOTECHNICAL ACTIVITIES IN THE WASTE AND EXHAUST SHAFTS [1]
WASTE ISOLATION PILOT PLANT (WIPP)
CARLSBAD, NEW MEXICO

[1] This plan is a working document to provide overall guidance for the field geotechnical activities. Its recommendations are subject to modification according to the actual field conditions and further analysis of the technical issues.

WORK PLAN OF GEOTECHNICAL ACTIVITIES IN THE WASTE AND EXHAUST SHAFTS WIPP FACILITY, CARLSBAD, NEW MEXICO

1.0 INTRODUCTION

The purpose of this work plan is to describe the upcoming geotechnical activities during enlargement of the waste shaft (previously referred to as the ventilation shaft) and sinking of the exhaust shaft and to provide background information for the planning of field activities. The previous results of the geologic mapping of the 6-foot diameter vent shaft will be confirmed by additional geologic mapping in zones of interest (e.g., Magenta and Culebra dolomites, Rustler/Salado Formation contact) and by observations of the geology exposed during the enlargement of the shaft to a 19-foot finished diameter. In the new exhaust shaft, a geologic strip log to total depth will be produced, along with more detailed geologic mapping in zones of interest. Because the strata above the Salado Formation will be covered by a concrete liner in both shafts, emphasis will be directed to gathering geologic information on the overlying strata during shaft sinking.

Information from the geologic mapping will be used to:

- o Provide additional confirmation and documentation of the strata overlying the WIPP facility horizon.
- o Provide detailed information of the geologic conditions in the vicinity of the Magenta dolomite, Culebra dolomite, washout zones and the Rustler/ Salado Formation contact.
- o Confirm geomechanical instrument levels/locations.
- o Provide basis for field adjustment and modification of key and aquifer seal design, based on the observed geology

For the purposes of geologic mapping, the field procedures given in Appendix A of the Site Validation Field Program Plan (McKinney and Newton, 1983) will be followed; a copy of Appendix A is included as Attachment A to this work plan. Certain references in Attachment A are specific to the exploratory shaft mapping, but the principles and methods are appropriate to the waste and exhaust shaft mapping effort as well.

2.0 SCOPE OF WORK

Prior to performing the geotechnical activities in the waste and exhaust shafts, the following work items will be addressed:

- o Hazard training for shaft work for all personnel who will perform shaft mapping. Training will be performed at the WIPP Site.
- o Familiarization with the geology overlying the facility horizon as necessary by review of appropriate literature and selected core in the WIPP core library.
- o Preparation of inspection and geologic mapping forms for use in the shafts.
- o Coordinate with OSM personnel to establish horizontal survey control (by use of tightlines or laser) and vertical survey control (relative to known construction features to be surveyed in later).
- o Coordinate with OSM personnel for shaft access, timing of mapping activities relative to on-going shaft sinking operations, galloway lighting, ventilation, etc.
- o Check, clean, and procure supplies and equipment needed to support the mapping activity.

The specific activities to be performed in the two shafts are described below.

2.1 WASTE SHAFT

Geologic mapping, both detailed and reconnaissance level, has been performed in the existing 6-foot diameter ventilation shaft (to become the new waste shaft) from a depth of 97 to 2168 feet, as described in "Geotechnical Field Data Report No. 4." The geotechnical activities planned for the new waste shaft will concentrate on confirming the previous mapping results and noting any change of conditions from that previously observed. The activities will include geologic inspection and observation of the exposed shaft surface during sinking operations and detailed mapping in specific zones of interest. Identified zones of interest include:

- o Magenta dolomite - Approximate map depths 590-625 feet
- o Culebra dolomite - Approximate map depths 700-735 feet

- Keyway and the Rustler/Salado Formation contact - Approximate map depths 840-900 feet

- Washout zones observed during the vent shaft mapping - Approximate map depths: 565-580 feet
675-695 feet
725-735 feet
745-785 feet

- Any anomalous areas in the Rustler Formation indicative of dissolution, brecciation, etc.

In addition, a strip log near the major instrumentation levels not already covered by the above activities will be provided in the following areas:

Piezometers - Approximate depths: 530 feet
610 feet (Covered by mapping of Magenta dolomite)
665 feet
720 feet (Covered by mapping of Culebra dolomite)

Extensometers - Approximate depths: 1073 feet
1568 feet
2058 feet

The detailed geologic mapping in the zones of interest will consist of map coverage at a map scale of 1 in. equals 5 ft., horizontally and vertically, supplemented by continuous 360° photo coverage. Geologic observations and photographs will be made prior to placement of each segment of concrete liner. The shaft inspection form is included in Figure 1. Of particular concern during the inspection will be areas producing observable amounts of water, vuggy areas, zones of possible dissolution, or any change of conditions from previous observations.

2.2 EXHAUST SHAFT

Reconnaissance mapping, resulting in a strip log at a scale of 1 in. equals 10 ft., will be performed in the exhaust shaft from the first available exposed bedrock down to the facility level. The mapping will be performed following upreaming of the exhaust shaft to a six-foot diameter. Should the exhaust shaft be unavailable due to safety considerations or access limitations after up-reaming, the mapping activities will be performed concurrent with shaft enlargement activities. In addition to the reconnaissance geologic log, detailed 360° geologic mapping at a scale of 1 in. equals 5 ft., both horizontally and vertically, and a photo log will be made in zones of interest. Known zones of interest are similar to those previously described in the waste shaft.

2.3 PRESENTATION OF MAPPING RESULTS

The results of the geologic mapping effort will be summarized in a memo after the shaft mapping and inspection has been completed. Photo coverage and other information will be presented as the project needs dictate.

3.0 PERSONNEL

The reconnaisance geologic mapping and photo log effort will be typically performed on a non-interference basis, concurrent with the Contractor's construction activities by a geologist dedicated to the activity. Detailed geologic mapping of zones of interest will also be performed concurrent with the Contractor's construction activities, using a second geologist to supplement the dedicated full-time geologist. However, shaft time limitations for performing the detailed mapping may require four or more geologists working simultaneously in teams of two in order to expedite the data collection, or it may become necessary to negotiate a dedicated block of shaft time from the Contractor. The actual field conditions will dictate how the mapping personnel will be scheduled. Support for the mapping effort will be provided by either on-site personnel or home office support, depending on availability and other project commitments.

4.0 SCHEDULE

According to the latest available Contractor's schedule, geologic mapping activity will begin immediately in the waste shaft and will continue through May 1984. Subsequent activity in the exhaust shaft will begin in July 1984 and will be completed in January 1985. It is expected that the mapping within the concrete-lined portions of the shafts (above the Salado Formation) will primarily be limited to a several hour block of time following blasting and slashing operations, but before the concrete liner is placed. Due to the 24-hour construction activities, the geologist assigned to the shaft activities would be available on-call to cover the construction activities. Following completion of the field activities, a final report describing the geologic conditions will be produced.

5.0 ADDITIONAL ITEMS

5.1 SURVEY CONTROL

In order to perform the geologic mapping of the shafts, it is necessary to establish survey control in the shaft for both depth and orientation. Since the working conditions are a typical shaft sinking operation, the survey control methods must be quick and reliable. Horizontal survey control can be established by using Contractor installed tightlines and marking an orientation (compass direction) on the exposed rock below the concrete and on the finished concrete surface of the lift above the zone to be mapped. Depth control for geologic mapping control can be tied into two systems. General approximate depths can be obtained from the Contractor by using the concrete curb ring for a particular concrete placement as a reference level during mapping. In addition, a reference point (such as a ramset nail with an identifying tag) can be installed in the concrete liner lift immediately above the zone to be mapped. Placing the reference point at a predetermined orientation (compass direction) would provide both a horizontal and vertical reference for the zone being mapped. The identified reference points would be later surveyed using an EDM device to establish elevations. The actual method that will be used will depend on the field conditions.

5.2 QUALITY ASSURANCE

Quality assurance will be performed by R. A. Lundstrom (D'Appolonia) in accordance with the Quality Assurance Plan which was presented in the Site Validation Field Program Plan (McKinney and Newton, 1983). The following exception is noted: there will be no field audit of the shaft activities. However, field records will be audited as a part of a project and report audit of the presentation memo. Also, references in the QA plan to subcontractors or equipment calibration are not applicable to the shaft activities.

5.3 ADMINISTRATION

All geotechnical work described in this plan will be performed under the technical and administrative direction of Roy McKinney. It will be Mr.

McKinney's responsibility to coordinate activities of all permanent, temporary, and consultant-type personnel utilized during the performance of these tasks and to insure that the tasks performed are coordinated with the schedules of the project participants or interested individuals/organizations.

REFERENCES

Geotechnical Field Data Report No. 4, 1983, "Geologic Mapping and Water Inflow Testing in the SPDV Ventilation Shaft, Waste Isolation Pilot Plant," compiled for U.S. Department of Energy by TSC/D'Appolonia, January 8, 1983.

McKinney, R. F., and R. S. Newton, 1983, "Site Validation Field Program Plan," in Results of Site Validation Experiments, S. R. Black, R. S. Newton, D. K. Shukla, editors, Supporting Document 3, TME 3177, March 1983.

APPENDIX B
EXHAUST SHAFT SAMPLE CATALOG

APPENDIX B
EXHAUST SHAFT SAMPLE CATALOG

All samples taken during the geotechnical activities in the exhaust shaft are permanently stored in the WIPP core storage library at the WIPP site for future reference. They are cataloged in two parts: a catalog of samples taken during reconnaissance geologic mapping (Appendix B-1) and a catalog of samples taken during detailed geologic mapping exercises (Appendix B-2). In each case, the notation used for sample identification also describes the depth and, in the case of detailed mapping samples, the location of the sample with respect to the shaft wall. The notations are described below.

RECONNAISSANCE GEOLOGIC MAPPING SAMPLES

The method of identification used for samples taken during geologic inspections is as follows:

ES24-466

The notation ES24 indicates that the sample is exhaust shaft reconnaissance geologic mapping sample number 24. The number 466 indicates that the sample was taken at the depth of 466 below the reference elevation.

DETAILED GEOLOGIC MAPPING SAMPLES

Samples taken during detailed geologic mapping exercises are identified using the following notation:

ESM49-715/10' W. of S.

As above, the ESM49 indicates that the sample is the exhaust shaft sample number 49, and the number 715 corresponds with the depth. In addition, 10' W. of S. indicates the location of the sample along the circumference of the shaft. This notation means that the sample location is ten feet west of the south line along the circumference of the shaft.

APPENDIX B-1

CATALOG OF SAMPLES TAKEN DURING RECONNAISSANCE GEOLOGIC MAPPING

Sample No.	Formation
ES1-196	Dewey Lake
ES2-197	Dewey Lake
ES3-199	Dewey Lake
ES4-212	Dewey Lake
ES5-225	Dewey Lake
ES6-324	Dewey Lake
ES7-344	Dewey Lake
ES8-350	Dewey Lake
ES9-393.5	Dewey Lake
ES10-421	Dewey Lake
ES11-435	Dewey Lake
ES12-645	Rustler
ES13-665.9	Rustler
ES14-667	Rustler
ES15-812	Rustler
ES16-814.5	Rustler
ES17-822	Rustler
ES18-822	Rustler
ES19-823	Rustler
ES20-828	Rustler
ES21-828	Rustler
ES22-833	Rustler
ES23-835	Rustler
ES24-835	Rustler
ES25-836	Rustler

APPENDIX B-1

CATALOG OF SAMPLES TAKEN DURING RECONNAISSANCE GEOLOGIC MAPPING

Sample No.	Formation
ES1-196	Dewey Lake
ES2-197	Dewey Lake
ES3-199	Dewey Lake
ES4-212	Dewey Lake
ES5-225	Dewey Lake
ES6-324	Dewey Lake
ES7-344	Dewey Lake
ES8-350	Dewey Lake
ES9-393.5	Dewey Lake
ES10-421	Dewey Lake
ES11-435	Dewey Lake
ES12-645	Rustler
ES13-665.9	Rustler
ES14-667	Rustler
ES15-812	Rustler
ES16-814.5	Rustler
ES17-822	Rustler
ES18-822	Rustler
ES19-823	Rustler
ES20-828	Rustler
ES21-828	Rustler
ES22-833	Rustler
ES23-835	Rustler
ES24-835	Rustler
ES25-836	Rustler

APPENDIX B-2

CATALOG OF SAMPLES TAKEN DURING DETAILED GEOLOGIC MAPPING EXERCISES

Mapping Exercise	Date Collected	Sample No.
Dewey Lake	9/29/84	ESM1-200/17'W. of S.
		ESM2-201/14' W. of S.
		ESM3-203/24' E. of S.
		ESM4-203.5/20' W. of S.
		ESM5-204/19' W. of S.
		ESM6-204/16' W. of S.
		ESM7-204/19' W. of S.
		ESM8-205/6' W. of S.
		ESM9-206/6' W. of S.
	10/3/84	ESM10-276/18' W. of S.
		ESM11-277/16' E. of S.
		ESM12-277/3' E. of S.
		ESM13-277/26' E. of S.
		ESM14-277/6' E. of S.
		ESM15-278/15' W. of S.
		ESM16-280/4' E. of S.
		ESM17-280/3' E. of S.
	10/8/84	ESM18-366/18' W. of S.
		ESM19-370/22' W. of S.
		ESM20-371/3' W. of S.
		ESM21-371/12' W. of S.
		ESM22-372/12' W. of S.
		ESM23-372/16' W. of S.
		ESM24-372/16' E. of S.
		ESM25-372.5/14' E. of S.
		ESM26-373/14' E. of S.
		ESM27-373/17' W. of S.
		ESM28-374/22.5' W. of S.
		ESM29-375/22' W. of S.
		ESM30-376/6' W. of S.
Dewey Lake/ Rustler Contact	10/15/84	ESM31-543/7' W. of S.
		ESM32-544/4.5' W. of S.
		ESM33-545/13' W. of S.
		ESM34-545.5/12' W. of S.
		ESM35-546/2' E. of S.
		ESM36-546/2' W. of S.
		ESM37-546/2' E. of S.
		ESM38-548/13' E. of S.
		ESM39-549/4' W. of S.

APPENDIX B-2
(Continued)

Mapping Exercise	Date Collected	Sample No.
Dewey Lake/ Rustler Contact	10/15/84	ESM40-550/11' W. of S. ESM41-550/4' W. of S. ESM42/No location above D/R contact ESM43/No location below D/R contact
Forty-Niner Member Claystone	10/17/84	ESM44-573/13' W. of S. ESM45-575/24' W. of S. ESM46-575/19' E. of S. ESM47-576/23' E. of S. ESM48-577/26' E. of S. ESM49-577/24' W. of S. ESM50-577/25' W. of S. ESM51-578/27' E. of S. ESM52-578/28' E. of S. ESM53-579/22' E. of S. ESM54-580/18' E. of S. ESM55-583.5/15' W. of S. ESM56-584/15' W. of S. ESM57-584/24' E. of S. ESM58-584/17' E. of S. ESM59-584/15' W. of S. ESM60-585.5/12' E. of S. ESM61-586/4' E. of S. ESM62-586/5' W. of S. ESM63-587/14' E. of S. ESM64-587/6' W. of S. ESM65-588/18' E. of S. ESM66-589/13' E. of S. ESM67-589/13' W. of S.
Magenta Dolomite Member	10/19/84	ESM68-603/7' W. of S. ESM69-603/6' W. of S. ESM70-604/26' W. of S. ESM71-605/25' W. of S. ESM72-605/S. Line ESM73-607/18' W. of S. ESM74-608/19' E. of S. ESM75-610/3' W. of S. ESM76-611/16' W. of S. ESM77-611/6' E. of S. ESM78-612/6' E. of S. ESM79-612/12' E. of S. ESM80-612/24' E. of S. ESM81-613/6' E. of S. ESM82-613/11' E. of S.

APPENDIX B-2
(Continued)

Mapping Exercise	Date Collected	Sample No.
Magenta Dolomite Member	10/19/84	ESM83-613/10' W. of S.
		ESM84-614/24' E. of S.
		ESM85-614/11' E. of S.
		ESM86-618/23' W. of S.
		ESM87-624/8' E. of S.
		ESM88-626/24' E. of S.
		ESM89-626/24' E. of S.
		ESM90-626/10' W. of S.
		ESM91-626/27' E. of S.
		ESM92-627/6' W. of S.
		ESM93-627/14' W. of S.
		ESM94-627/7' W. of S.
		ESM95-627/8' W. of S.
		ESM96-627/10' W. of S.
		ESM97-629/10' W. of S.
Tamarisk Member Claystone	10/29/84	ESM98-678/16' W. of S.
		ESM99-680/16' W. of S.
		ESM100-685/No location
		ESM101-688/17' E. of S.
		ESM102-689/20' W. of S.
		ESM103-689/12.5' W. of S.
		ESM104-687/6' W. of S.
		ESM105-690/20' W. of S.
		ESM106-690/3' W. of S.
		ESM107-690/14' E. of S.
		ESM108-691/3' W. of S.
		ESM109-692/16' W. of S.
		ESM110-693/17' W. of S.
		ESM111-693/25' E. of S.
		ESM112-694/10' W. of S.
		ESM113-695/6' E. of S.
		ESM114-695/23' E. of S.
		ESM115-695/21' W. of S.
		ESM116-695/21' W. of S.
		ESM117-696/22' W. of S.
		ESM118-697/17' W. of S.
		ESM119-697/17' W. of S.
		ESM120-698/20' W. of S.
		ESM121-698/No location
		ESM122-Unoriented sample Unit 4
Culebra Dolomite Member	11/1/84	ESM123-No location
		ESM124-702/8' E. of S.
		ESM125-702/3' W. of S.
		ESM126-703/4' E. of S.

APPENDIX B-2
(Continued)

Mapping Exercise	Date Collected	Sample No.
Culebra Dolomite Member	11/1/84	ESM127-707/5' W. of S.
		ESM128-708/No location
		ESM129-710/N. line
		ESM130-710/30' W. of S.
		ESM131-711/7' E. of S.
		ESM132-712/28.5' E. of S.
		ESM133-714/10' W. of S.
		ESM134-714.25/10' W. of S.
		ESM135-714/1' W. of S.
		ESM136-713.5/5' E. of S.
		ESM137-715/13' W. of S.
		ESM138-715.5/5' W. of S.
		ESM139-716/17.5' W. of S.
		ESM140-716/17.5' W. of S.
		ESM141-717.5/0.5' E. of S.
		ESM142-720/28' W. of S.
		ESM143-720/28' W. of S.
		ESM144-720/12.5' W. of S.
		ESM145-720/28' W. of S.
		ESM146-720.5/10' E. of S.
		ESM147-721/2.5' E. of S.
		ESM148-722/16' E. of S.
		ESM149-722/19' W. of S.
		ESM150-723/3' E. of S.
		ESM151-723/3' W. of S.
		ESM152-724/21' W. of S.
		ESM153-725/12.5' E. of S.
		ESM154-725/8' W. of S.
		ESM155-727/8.5' E. of S.
		ESM156-728/9' E. of S.
		ESM157-728/N. Line
		ESM158-730/14' W. of S.
		ESM159-732/9' W. of S.
	11/3/84	ESM160-738/17.5' W. of S.
		ESM161-736.5/19' W. of S.
		ESM162-736/24' W. of S.
Unnamed Lower Member	11/3/84	ESM163-737/12' W. of S.
		ESM164-739/17.5' W. of S.
		ESM165-739/5' W. of S.
		ESM166-739/21' W. of S.
		ESM167-740/5' W. of S.
		ESM168-741/5' E. of S.
		ESM169-741/19' W. of S.
		ESM170-741/22' E. of S.
		ESM171-742/3' W. of S.

APPENDIX B-2
(Continued)

Mapping Exercise	Date Collected	Sample No.
Unnamed Lower Member	11/3/84	ESM172-743/4' E. of S.
		ESM173-743/1.5' E. of S.
		ESM174-745.5/4' W. of S.
		ESM175-744/S. Line
		ESM176-745/S. Line
		ESM177-747/S. Line
		ESM178-747/10' E. of S.
		ESM179/No location
	11/6/84	ESM180-750/4' W. of S.
		ESM181-750/No location
		ESM182-751/6' W. of S.
		ESM183-751/1' W. of S.
		ESM184-751/7' E. of S.
		ESM185-752/15' W. of S.
		ESM186-755/12' E. of S.
		ESM187-756/6' E. of S.
		ESM188-756/10' E. of S.
		ESM189-760/21' W. of S.
		ESM190-761/29' W. of S.
		ESM191-762.5/5' E. of S.
		ESM192-763/14' W. of S.
		ESM193-763/13' E. of S.
		ESM194-763.5/9' E. of S.
		ESM195-767/6' E. of S.
		ESM196-767/22' E. of S.
		ESM197-767/27' E. of S.
		ESM198-767/27' W. of S.
		ESM199-767/2' W. of S.
		ESM200-768/6' E. of S.
		ESM201-769/18' W. of S.
		ESM202-769/25' E. of S.
		ESM203-770/11' E. of S.
		ESM204-770/21' E. of S.
		ESM205-771/4' E. of S.
		ESM206-771/29' E. of S.
		ESM207-771/3' W. of S.
		ESM208-771/25' E. of S.
		ESM209-775/12' W. of S.
	11/8/84	ESM210-775/1' W. of S.
		ESM211-776/6' W. of S.
		ESM212-777/2' E. of S.
		ESM213-777/9' E. of S.
		ESM214-778/11' W. of S.
		ESM215-778/17' W. of S.

APPENDIX B-2
(Continued)

Mapping Exercise	Date Collected	Sample No.
Unnamed Lower Member	11/8/84	ESM216-779/9' W. of S.
		ESM217-782/17' W. of S.
		ESM218-782/21' W. of S.
		ESM219-782.5/16' E. of S.
		ESM220-786/2' E. of S.
		ESM221-787/15' W. of S.
		ESM222-787/6' W. of S.
		ESM223-788/4' W. of S.
		ESM224-788/11' W. of S.
		ESM225-789/14' W. of S.
		ESM226-790/14' W. of S.
		ESM227-790/14' W. of S.
		ESM228-790.5/4.5' W. of S.
		ESM229-792.5/No location
		ESM230-792.5/21' W. of S.
		ESM231-792/18' E. of S.
		ESM232-794/16' W. of S.
		ESM233-794.5/16' W. of S.
		ESM234-797/7' W. of S.
Rustler/Salado Contact	11/11/84	ESM235-846/2' W. of S.
		ESM236-846/S. Line
		ESM237-846/2' W. of S.
		ESM238-846/5' W. of S.
		ESM239-846/11' W. of S.
		ESM240-847/15' W. of S.
		ESM241-847/13' E. of S.
		ESM242-847/18' E. of S.
		ESM243-848/14' E. of S.
		ESM244-848/25' E. of S.
		ESM245-849/20' W. of S.
		ESM246-849.8/14.7' W. of S.
		ESM247-850.5/15' W. of S.
		ESM248-850.5/22' W. of S.
		ESM249-851/2' W. of S.
Assorted Samples Near Basal Conglomerate		ESM250
		ESM251
		ESM252
		ESM253
		ESM254
		ESM255

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LITHOLOGICAL DESCRIPTION

.LINE, LIGHT GRAYISH-BROWN TO TAN, THINLY LAMINATED TO BEDDED, BEDDING MAY TERMINATE EROSIONALLY, CARBONATE
:CREASES AND COLOR BECOMES GRAY TO DARK GRAY WITH DEPTH; BASAL CONTACT GRADATIONAL.

LLINE, BROWNISH-GRAY, MICRO TO THINLY LAMINATED, LAMINAE UNDULATE WITH CRESTS ABOUT 1.0' APART AND TROUGHS 1/2"
Y, MARKED BY 1/2" BED OF BLACKISH-GRAY ORGANIC (?) CLAYSTONE.

AY TO BROWNISH-GRAY, THINLY LAMINATED TO THINLY BEDDED, LOCALLY CONTAINS ANHYDRITE PSEUDOMORPHS AFTER GYPSUM
ZONTAL TO SUBHORIZONTAL FIBROUS GYPSUM-FILLED FRACTURES WHICH FOLLOW BEDDING PLANES, LOCALLY BIFURCATE AND
TO 1/2"; BASAL CONTACT LOCALLY SHARP, MAPPED AS GRADATIONAL, UNDULATORY UP TO 1".

HINLY LAMINATED, LAMINAE CONTORTED AND DIP AT HIGH ANGLES IN UPPER PART; CONTAINS ABUNDANT FIBROUS GYPSUM-FILLED
BIFURCATE AND TERMINATE, UP TO 2" THICK, LOCALLY DISTORTS BEDDING; LOWER 0 TO 4" CONSISTS OF SOFT CLAYSTONE WHICH
RP.

REENISH-GRAY TO GRAY, THINLY LAMINATED TO THINLY BEDDED, LOCALLY ENTROLITHIC, CONTAINS NODULES OF ANHYDRITE
TO 4" LONG; 1/2" TO 1" THICK BEDS OF ANHYDRITE OCCUR NEAR TOP; LOCAL NODULAR GYPSUM, VERY SMALL CRYSTALS OF PYRITE
LANES IN LOWER PART; BASAL CONTACT UNDULATORY, SHARP, MARKED BY FIRST OCCURRENCE OF GRAY CLAY.

SHAPED ZONES OF REDDISH-BROWN, LOCAL WHITISH-GRAY ZONES, CONTAINS FAINT HINTS OF THIN LAMINATIONS, LOCALLY THINLY
JLES OF GYPSUM AND IRREGULARLY-DEFINED CLASTS OF ANHYDRITE, 1/8" TO 3" DIAMETER, GYPSUM NODULE CONCENTRATION
IRS LOCALLY; LAMINAE SLICKENSIDED IN MIDDLE AND LOWER PORTION OF UNIT, OVERALL UNIT APPEARS TO HAVE UNDERGONE
N/OXIDATION CONTACT, HIGHLY IRREGULAR, UNDULATORY.

EGULARLY-SHAPED ZONES OF GREENISH-GRAY, COLOR GRADES TO DARK BROWNISH-GRAY IN LOWER 2" TO 1.5', ALL COLOR CONTACTS
THIN LAMINATIONS, LOCAL STRINGERS OF VERY FINE-GRAINED ORANGE SAND; ABUNDANT GYPSUM NODULES TO 3" DIAMETER AND
ONCENTRATION INCREASES WITH DEPTH; GRAY ZONE AT BASE LOCALLY ANHYDRITIC; STRUCTURE SIMILAR TO OVERLYING UNIT; BASAL
ON WEST SIDE OF SHAFT.

GRAY, NODULAR; UPPER 0.1' TO 0.2' CONTAINS BROWN GYPSUM STARS OR ROSETTES; LOWER 1.0' ARGILLACEOUS AND LAMINATED;

ED, CONTAINS LAMINAE OF SILT AND SAND NEAR BASE; EXHIBITS CLAY DRAPE OVER UNDULATORY BASAL CONTACT; LAMINAE OFTEN
"; CONTAINS SUBHORIZONTAL FIBROUS GYPSUM-FILLED FRACTURES WITH VERTICAL FIBERS, LOCALLY TERMINATE AND BIFURCATE;
OF GYPSUM UP TO 1/4" ACROSS; BASAL CONTACT SHARP, EROSIONAL.

MINATED TO BANDED, UNDULATORY BEDDING SHOWS CROSS-CUTTING RELATIONSHIPS; UPPER 3.0' CONTAINS GYPSUM CRYSTALS TO
UPPER CONTACT; BEDS THICKEN TO 3/4" WITH DEPTH; CARBONATE LAMINAE OCCUR WITH DEPTH; LOWER 2.0' GYPSIFEROUS,
ZONTAL FIBROUS GYPSUM-FILLED FRACTURES OCCUR NEAR BASE, SPACED 1" TO 3", 1/32" TO 1/4" THICK, FIBERS SIGMOIDAL,
ENT; BASAL CONTACT SHARP, UNDULATORY, POSSIBLY EROSIONAL.

AMINATED, CROSS-LAMINATED, STRUCTURE BECOMES LESS OBVIOUS WITH DEPTH; UPPER 4" CONTAINS COARSE SAND-SIZED GRAINS OF
ERAL LAMINAE OF DARK BLACKISH-BROWN ORGANIC (?) CLAYSTONE NEAR MIDDLE AND BASE OF UNIT; CONTAINS WHITE TO CLEAR
IAMETER; FRACTURE SURFACES LOCALLY STAINED RED; LOWER 1" CONTAINS A FINING UPWARDS SEQUENCE OF SMALL GYPSUM GRAINS
D FRACTURE SURFACES; BASAL CONTACT SHARP, UNDULATORY, MARKED BY CLAY LAMINAE, EROSIONAL.

CEOUS MATERIAL, FINELY CRYSTALLINE AND FINE-GRAINED, LIGHT AND DARK BROWN, THINLY TO MEDIUM BEDDED WITH THINLY
EOUS DOLOMITE POORLY TO MODERATELY INDURATED, DOLOMITE WELL INDURATED; SMALL GYPSUM-FILLED VUGS IN ARGILLACEOUS
L CONTACT SHARP TO GRADATIONAL.

L, FINELY CRYSTALLINE AND FINE-GRAINED, MEDIUM BROWN, THINLY LAMINATED TO STRUCTURELESS, MODERATELY WELL INDURATED;
ABUNDANT SMALL <1/16" DIAMETER GYPSUM-FILLED AND UNFILLED VUGS, LARGER FILLED VUGS UP TO 1" DIAMETER MODERATELY
TERN, INDIVIDUAL BLOCKS AVERAGE 4" HIGH BY 4" LONG, MOST FRACTURE SURFACES COLORED WITH ORANGE STAIN; BASAL CONTACT
IRE.

STALLINE AND FINE-GRAINED, MEDIUM BROWN, VERY THINLY BEDDED TO THINLY BEDDED WITH LAMINATED TO CROSS-LAMINATED
SUM-FILLED AND UNFILLED VUGS TO 1/4" DIAMETER, VERY RARE LARGE GYPSUM-FILLED VUGS TO 1-1/2" DIAMETER; CHARACTERIZED
TURED THAN OVERLYING UNIT, ORANGE STAIN APPARENT ON MOST FRACTURE SURFACES; BASAL CONTACT SHARP, MARKED BY GRAY

CEOUS MATERIAL, FINELY CRYSTALLINE AND FINE-GRAINED, BROWN, THINLY TO MEDIUM BEDDED WITH FINELY LAMINATED INTERNAL
TED, LOCAL ZONES OF MODERATELY INDURATED DOLOMITE; RARE LARGE 1" DIAMETER GYPSUM-FILLED AND UNFILLED VUGS; FRACTURE
N ON FRACTURE SURFACES; BASAL CONTACT DIFFUSE TO GRADATIONAL.

EDS OF ARGILLACEOUS DOLOMITE, SOME ARENACEOUS MATERIAL, FINELY CRYSTALLINE AND FINE-GRAINED, LIGHT BROWN, VERY
ATED TO MICRO CROSS-LAMINATED INTERNAL STRUCTURE, VERY POORLY INDURATED; VERY WET, FLUID OBSERVED ORIGINATING FROM
ANT SMALL <1/32" DIAMETER UNFILLED VUGS, MODERATELY ABUNDANT LARGE GYPSUM-FILLED VUGS TO 1-1/2" DIAMETER; FRACTURE
ORANGE STAIN ON FRACTURE SURFACES OCCURS LESS OFTEN, MAJORITY OF FRACTURE SURFACES MARKED BY RELICT GYPSUM FRACTURE
AL; BASAL CONTACT SHARP, POSSIBLY EROSIONAL.

STALLINE AND FINE-GRAINED, ALTERNATING THICK BROWN AND THIN DARK BROWN LAMINAE, THINLY LAMINATED TO LAMINATED,
RGANIC-RICH (?) LAMINAE, LAMINAE CONTORTED PARALLEL TO BASAL CONTACT, BEDS LOCALLY DIP UP TO 45° AND ARE

EXPLANATION

———	SHARP CONTACT
– – –	GRADATIONAL CONTACT (DEFINED WITHIN 2 IN.)
········	DIFFUSE CONTACT (DEFINED WITHIN 6 IN.)
■24	SAMPLE LOCATION, EXHAUST SHAFT DETAILED MAPPING SAMPLE #24
F4 /	MAPPED FRACTURE #4, SEE FRACTURE NOTES
/	HALITE FILLED FRACTURE

NOTES

1) THIS INTERVAL WAS MAPPED IN FIVE PARTS: INTERVAL 675.0-698.5 FEET ON 10-29-84, INTERVAL 698.5-730.0 FEET ON 10-31-84; INTERVAL 730.0-748.0 FEET ON 11-3-84; INTERVAL 748.0-775.0 FEET ON 11-6-84; INTERVAL 775.0-800.0 FEET ON 11-8-84.
2) THE MAJOR FLUID PRODUCING ZONE IN THE CULEBRA OCCURS IN THE INTERVAL FROM 724.5 FEET TO ABOUT 735.5 FEET (CULEBRA MAPPING UNIT 6).
3) THE SHAFT CIRCUMFERENCE WAS MEASURED DURING EACH MAPPING EXERCISE. AS A RESULT, VARIATIONS IN THE SHAFT CIRCUMFERENCE ARE RECORDED ON THE MAP.
4) **DEPTHS AND ELEVATIONS ARE RELATED TO THE REFERENCE ELEVATION AT 3409.0 FEET ABOVE MSL.**
5) STANDARD GEOLOGIC SYMBOLS ARE NOT USED IN ORDER TO ENHANCE THE CLARITY OF THE LOG COLUMN.

ARP, UNDULATORY.

T TOP THICKENS WHEN LOWER CONTACT DROPS LOWER, REMAINDER GRAYISH-MAROON WITH THIN <1/8" INTERBEDS COLORED RED AND
LEL UPPER CONTACT, NEARLY FISSILE, POORLY INDURATED, SOFT, SLICKENSIDES OCCUR PARALLEL TO BEDDING; BASAL CONTACT

STONE AT TOP, REDDISH-BROWN TO MAROON, CONTAINS LOCAL RED AND GRAY INTERBEDS, LOWER 1.0' WELL INDURATED, POORLY
LE; CONTAINS LOCALLY BROKEN INTERBEDS OF GRAY, FINELY TO MEDIUM CRYSTALLINE ANHYDRITE; LOCAL 1/4" THICK GYPSIFEROUS
TRUCTURES; VERY FEW GYPSUM-FILLED FRACTURES; BASAL CONTACT DIFFUSE, VERY UNDULATORY.

LLY THINLY LAMINATED, LAMINAE SLICKENSIDED, POORLY TO MODERATELY POORLY INDURATED, UNIT DEFINED ON BASIS OF COLOR
<1/4" FIBROUS GYPSUM-FILLED FRACTURES CONTINUOUS THROUGH UNIT INTO UNDERLYING AND OVERLYING UNITS; UPPER AND LOWER
UT MAPPED AS DIFFUSE DUE TO EXAGGERATED UNDULATIONS.

Y CLAYSTONE AT TOP, REDDISH-BROWN, SILTSTONE THINLY LAMINATED, CLAYSTONE STRUCTURELESS WITH HINTS OF THIN
Y INDURATED; LOWER 1.0' TO 1.5' CONSISTS OF ARGILLACEOUS SILTSTONE, WHERE UNIT THINS DRAMATICALLY ARGILLACEOUS
ILLACEOUS SILTSTONE CONTAINS 1" TO 2" THICK LOCALLY BROKEN BED OF ARGILLACEOUS ANHYDRITE; ABUNDANT 1/2" TO 1" THICK
IONS, MAJORITY OF FRACTURES HORIZONTAL TO SUBHORIZONTAL; BASAL CONTACT GRADATIONAL, UNDULATORY.

GREENISH-GRAY, LOCALLY THINLY LAMINATED, MODERATELY POORLY INDURATED IN LOWER 1.5', REMAINDER VERY POORLY
DIAMETER OF GYPSUM IN LOWER 1.5'; FIBROUS GYPSUM-FILLED FRACTURES WITH VARIABLE ORIENTATION, 1/32" TO 1/4" THICK,
; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY.

INATED TO NODULAR; UPPER 0.5' TO 1.5' WHITE, GYPSIFEROUS, CONTAINS RADIAL GYPSUM STRUCTURES; 1.0' THICK ZONE OF
PSIFEROUS ZONE, POLYHALITE REDDISH-PINK, CONTENT INCREASES WITH DEPTH, THEN ABRUPTLY DECREASES; 1/2" TO 2" HIGH
RYSTALS OCCUR 10" TO 13" ABOVE LOWER CONTACT; BASAL CONTENT GRADATIONAL, MARKED BY ZONE WITH PROMINENT HORIZONTAL

GRAY, THINLY LAMINATED TO LAMINATED, BEDDING FLAT TO SLIGHTLY UNDULATORY; LOWER THIRD HAS ABUNDANT SMALL <1/2" HIGH
RYSTALS; MIDDLE THIRD HAS UP TO 2" HIGH HALITE PSEUDOMORPHS AFTER GYPSUM SWALLOWTAIL CRYSTALS SEPARATING LAMINAR
ED; UPPER THIRD LESS WELL BEDDED, GRAYER, CONTAINS FEWER PSEUDOMORPHS; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY.

-GRAY IN UPPER 6" TO 8", THINLY LAMINATED TO THINLY BEDDED; CONTAINS 1 TO 2% HALITE; BASAL CONTACT SHARP, POSSIBLY

ISH-BROWN, THINLY LAMINATED NEAR BASE; HALITE OCCURS AS CLEAR DISPLACIVE CRYSTALS, CRYSTAL SIZE IS LARGE, >1" NEAR
/2") GREENISH-GRAY SPOTS ARE SCATTERED THROUGH LOWER HALF OF UNIT; SMALL CHANNELS AT 5E OF S AND 25E OF S; BASAL
E.

ITE LIGHT PINK TO WHITE, SOME HALITE CRYSTALS CONTAIN FLUID INCLUSIONS ALIGNED IN PARALLEL AND PERPENDICULAR ZONES;
TRIX ALIGNED IN CRUDE BEDDING, CLAY CONTENT 10 TO 15%, CONTENT INCREASES WITH DEPTH; BASAL CONTACT GRADATIONAL.

TO THINLY BEDDED IN LOWER 4" TO 6", BEDDING NOT DISPLAYED OR DEVELOPED WELL IN MIDDLE 8" TO 12"; UPPER 10" TO 12"
ALITE IN IRREGULARLY-SHAPED HORIZONTAL VUGS OR SPACES, HALITE OCCURS IN SLIGHTLY DISTORTED ANHYDRITE BEDS, BEDDING
(SIMILAR TO CARBONATE TEPEE STRUCTURES); UPPER CONTACT SLIGHTLY UNDULATORY AND REFLECTS STRUCTURE IMMEDIATELY

E; LOWER 1" CONSISTS OF GRAY ANHYDRITE WITH SMALL DISPLACIVE HALITE CRYSTALS; ARGILLACEOUS HALITE WITH INCREASING
HALITE WHITE TO PINK, MOSTLY CLEAR, SOME CRYSTALS CONTAIN FLUID INCLUSIONS, GRADES TO REDDISH-BROWN MUDSTONE IN
THICK LAMINATED GRAY ANHYDRITE OVERLIES REDDISH-BROWN MUDSTONE, INTERBEDDED WITH THIN LAMINAE OF MUDSTONE, CONTAINS
LS; HALITE, COARSELY CRYSTALLINE, CLEAR TO WHITE TO TINTED PINK, 10 TO 20% CONTAIN FLUID INCLUSIONS ALIGNED
32" TO 1/16" THICK LAMINAE OF ANHYDRITE, LAMINAE EROSIONALLY TERMINATED AT TOP, INTERVAL 2.0' THICK; DARK REDDISH-
SHARP.

JDSTONE NEAR BASE, REDDISH-BROWN MATRIX, MODERATELY DISTINCT THIN LAMINATIONS TO VERY THIN BEDS; LOWER 3.3' MORE
ALITE CRYSTALS, 1/32" TO 1" ACROSS; REMAINDER CONTAINS ABUNDANT SMALL (<1/4" ACROSS) DISPLACIVE HALITE CRYSTALS,
) DISRUPTED WHERE LARGER DISPLACIVE HALITE CRYSTALS OCCUR; POSSIBLE CROSS-LAMINATIONS IN SLIGHT TROUGH 22E TO 25E
, POSSIBLY DISCONFORMABLE.

REDDISH-BROWN, CRUDELY BEDDED NEAR BASE, COARSE TO THINLY BEDDED AT TOP; UPPER 1.0' AND LOWER 1.3' CONSIST OF
OF ARGILLACEOUS HALITE, HALITE CONTENT DECREASES WITH DEPTH, HALITE OCCURS AS DISPLACIVE CRYSTALS AND AS CLEAR
ITE SIZE DECREASES FROM 1" ACROSS AT TOP TO 1/32" ACROSS AT BASE; 1/4" TO 1/2" THICK BED OF GRAY ANHYDRITIC (?)
, SLIGHTLY UNDULATORY, POSSIBLY DISCONFORMABLE.

ROWN AND GRAY, THINLY BEDDED TO THINLY LAMINATED, BEDDING HORIZONTAL TO WAVEY TO CROSS-LAMINATED, CROSS-LAMINATION
DIRECTIONS, BUT SOUTHEAST PREVALENT; CONTAINS SCATTERED SMALL (<1/32" ACROSS) DISPLACIVE HALITE CRYSTALS; BASAL
OF GRAY COLOR.

REDDISH-BROWN, INTERBEDDED WITH THIN LAYERS OF MEDIUM GRAY CLAYSTONE AND MUDSTONE, THINLY BEDDED TO MICROLAMINATED,
HORIZONTAL TO SUBHORIZONTAL WITH SOME WAVY BEDDING AND CROSS-LAMINATIONS; LARGE CROSS-CUTTING RELATIONSHIPS WITH
DOWNCUTTING TREND TO EAST AND SOUTHEAST; SMALL-SCALE CROSS-LAMINATIONS SHOW VARIABLE CURRENT DIRECTION, BUT SOUTH
CAL RIPPLES WITH CLAY DRAPE OCCUR; RIPPLE SETS AVERAGE 1/4" TO 1/2" THICK; CONTAINS OCCASIONAL ANHYDRITE CLASTS
MENT DEFORMATION DUE TO FLUID SHEAR; BASAL CONTACT NOT OBSERVED.

FRACTURE NOTES

ALL FRACTURES IDENTIFIED WITH AN F AND FOLLOWED BY A NUMBER ARE FILLED WITH FIBROUS GYPSUM. ALL OTHER MAPPED FRACTURES ARE HALITE FILLED.

F1A - 1/2"-1" THICK
F1B - 1/2"-1" THICK
F2 - 2" THICK, SIGMOIDAL FILLING, TOP HAS MOVED NORTH RELATIVE TO BOTTOM.
F3 1/2"-3/4" THICK
F4 1" THICK, SIGMOIDAL FILLING, TOP HAS MOVED NORTH WEST RELATIVE TO BOTTOM
F5 1/4"-1/2" THICK, SIGMOIDAL FILLING, TOP HAS MOVED EAST RELATIVE TO BOTTOM.
F6 0-1" THICK, SIGMOIDAL FILLING, TOP HAS MOVED EAST RELATIVE TO BOTTOM.
F7 0-1/2" THICK.
F8 1/2" - 1-1/4" THICK, SIGMOIDAL FILLING, TOP HAS MOVED WEST RELATIVE TO BOTTOM.
F9 1" THICK, SIGMOIDAL FILLING, TOP HAS MOVED NORTH RELATIVE TO BOTTOM
F10 1/2" THICK
F11 3/4" THICK
F12 1" THICK

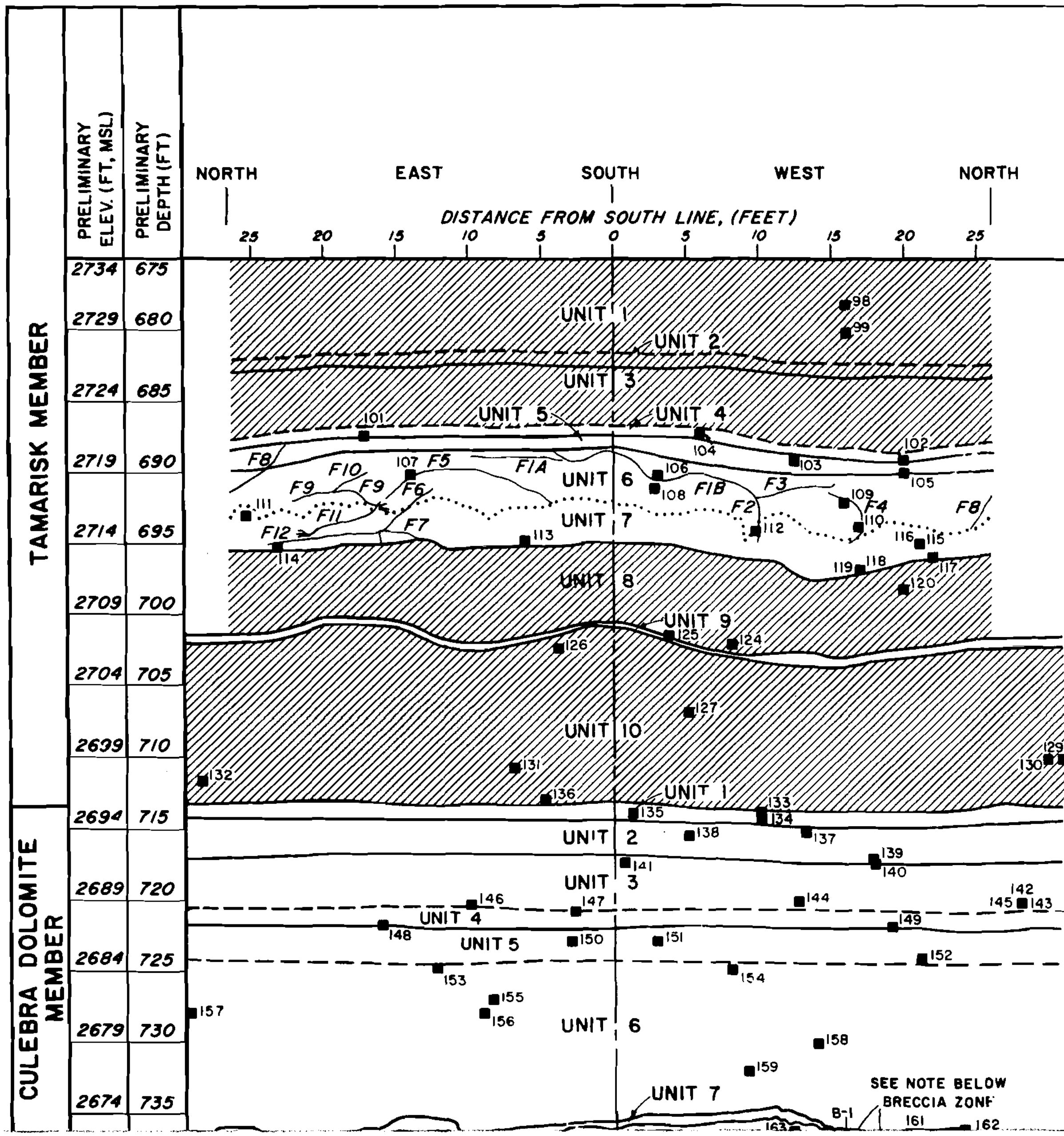
FIGURE 11

GEOLOGIC LOG OF
THE TAMARISK MEMBER CLAYSTONE,
THE CULEBRA DOLOMITE MEMBER, AND THE UPPER PORTION
OR THE UNNAMED LOWER MEMBER, RUSTLER FORMATION
DEPTH 675.0 FEET TO 800.0 FEET
EXHAUST SHAFT

WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR
WESTINGHOUSE ELECTRIC CORPORATION
CARLSBAD, NEW MEXICO

IT CORPORATION



UNIT 1. ANHYDRITE WITH MINOR CARBONATE, FINELY CRYSTAL
INTERBEDS MICROLAMINATED; CARBONATE CONTENT DE

UNIT 2. ANHYDRITE WITH MINOR CARBONATE, FINELY CRYSTAL
DEEP; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY

UNIT 3. ANHYDRITE, FINELY CRYSTALLINE, ALTERNATING GR
SWALLOWTAIL CRYSTALS 1/4" HIGH; ABUNDANT HORI
TERMINATE, SPACED 1/2" TO 3", THICKNESS 1/4"

UNIT 4. CLAYSTONE, ALTERNATING LIGHT AND DARK GRAY, T
FRACTURES, MOST PARALLEL TO BEDDING, LOCALLY
THICKENS AND THINS LOCALLY; BASAL CONTACT SHA

UNIT 5. ARGILLACEOUS ANHYDRITE, FINELY CRYSTALLINE, G
FLATTENED PARALLEL TO BEDDING, 1/4" HIGH, 2"
OR MARCASITE OCCUR, SCATTERED ALONG BEDDING P

UNIT 6. SILTY CLAYSTONE, GRAY WITH LOCAL IRREGULARLY-
LAMINATED IN UPPER 1.0' TO 2.0'; CONTAINS NOD
INCREASES WITH DEPTH; PYRITE OR MARCASITE OCC
DUCTILE FLOW; BASAL CONTACT DIFFUSE, REDUCTIO

UNIT 7. SILTY CLAYSTONE, REDDISH-BROWN WITH LOCAL IRR
IRREGULAR AND DIFFUSE OVER 1" TO 6", HINTS OF
SUBANGULAR ANHYDRITE CLASTS TO 3" DIAMETER, C
CONTACT SHARP, UNDULATORY, EROSIONAL CHANNEL

UNIT 8. ANHYDRITE, FINELY CRYSTALLINE, LIGHT GRAY TO
BASAL CONTACT SHARP.

UNIT 9. CLAYSTONE, DARK GREENISH-GRAY, THINLY LAMINAT
DISTORTED; CONTAINS SMALL REDDISH SPOTS <1/32
LOWER PORTION GYPSIFEROUS, CONTAINS CRYSTALS

UNIT 10. ANHYDRITE, FINELY CRYSTALLINE, GRAY, THINLY L
1/4" DIAMETER; LAMINAE IN UPPER 1.0' PARALLEL
EXHIBITS NODULAR CHICKEN WIRE STRUCTURE; HORI
INDICATING WEST (TOP)/EAST (BOTTOM) DISPLACEM

CULEBRA DOLOMITE MEMBER

UNIT 1. DOLOMITIC MUDSTONE, BROWN, MICROLAMINATED TO
UNKNOWN CLEAR MINERAL (GYPSUM ?); CONTAINS SEV
DISPLACIVE NODULES OF GYPSUM, <1/16" TO 1/4" D
OR CRYSTALS; FLUID ORIGINATES ALONG BEDDING A

UNIT 2. DOLOMITE AND ARGILLACEOUS DOLOMITE, SOME AREN
LAMINATED TO STRUCTURELESS INTERIORS; ARGILLAC
DOLOMITE; RED STAIN ON FRACTURE SURFACES; BAS

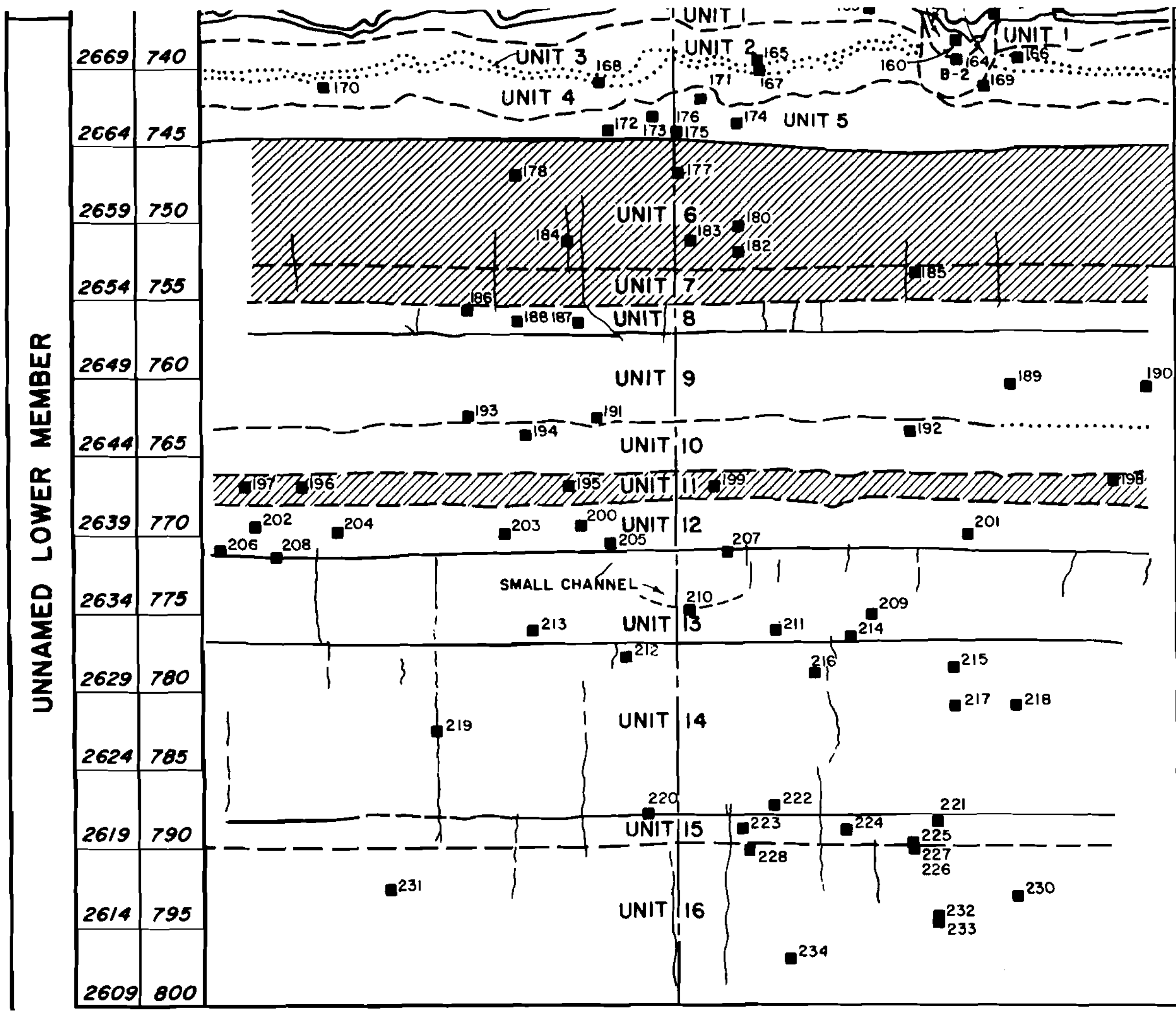
UNIT 3. DOLOMITE, GYPSIFEROUS, SOME ARENACEOUS MATERI
CONTAINS LOCAL BEDS OF ARGILLACEOUS DOLOMITE;
ABUNDANT; CHARACTERIZED BY BLOCKY FRACTURE PA
GRADATIONAL, MARKED BY ABSENCE OF BLOCKY TEXT

UNIT 4. DOLOMITE, SOME ARENACEOUS MATERIAL, FINELY CR
INTERIORS, MODERATELY WELL INDURATED; RARE GY
BY TABULAR FRACTURE PATTERN, OVERALL MORE FRA
CLAYSTONE BED 1/8" THICK.

UNIT 5. DOLOMITE AND ARGILLACEOUS DOLOMITE, SOME AREN
STRUCTURE, ARGILLACEOUS DOLOMITE POORLY INDUR
PATTERN BLOCKY TO RANDOMLY SHAPED, ORANGE STA

UNIT 6. DOLOMITE INTERBEDDED WITH 1/4" TO 1/2" THICK B
THINLY BEDDED TO THINLY BEDDED WITH MICROLAMIN
SMALL UNFILLED VUGS AND FRACTURE PLANES; ABUND
PATTERN BLOCKY TO TABULAR TO RANDOMLY-SHAPED,
FILLING; LOCAL ZONES WITH ABUNDANT CLAY MATERI

UNIT 7. DOLOMITE, SOME ARENACEOUS MATERIAL, FINELY CRY
DOLOMITE LAMINAE OVERLAIN BY THIN DARK BROWN G



OCCASIONALLY BENT AND BROKEN; BASAL CONTACT S

UNNAMED LOWER MEMBER

UNIT 1. CLAYSTONE, GRAY AT TOP AND BOTTOM, GRAY ZONE
BROWNISH-GRAY, THINLY LAMINATED, LAMINAE PARAL
GRADATIONAL.

UNIT 2. ARGILLACEOUS SILTSTONE AT BASE WITH SILTY CLAY
INDURATED NEAR TOP, UPPER PORTION NEARLY FISSI
BEDS CONTAINING POORLY PRESERVED ENTROLITHIC S

UNIT 3. CLAYSTONE, SLIGHTLY SILTY, GREENISH-GRAY, LOC
ONLY; CONTAINS LOCAL REDDISH-BROWN AREAS; THI
CONTACTS SHARP TO GRADATIONAL ON FINE LEVEL,

UNIT 4. ARGILLACEOUS SILTSTONE AT BASE GRADING TO SIL
LAMINATIONS AND FREQUENTLY SLICKENSIDED, POOR
SILTSTONE IS ONLY LITHOLOGY PRESENT; LOWER ARG
GYPSUM-FILLED FRACTURES WITH VARIABLE ORIENTA

UNIT 5. SILTY CLAYSTONE, REDDISH-BROWN, LOCAL ZONES OF
INDURATED; CONTAINS ABUNDANT NODULES UP TO 2"
RARE NEAR BASE BUT ARE ABUNDANT HIGHER IN UNIT

UNIT 6. ANHYDRITE, FINELY CRYSTALLINE, LIGHT GRAY, LAM
MIXED POLYHALITE AND ANHYDRITE OCCURS BELOW GY
HALITE PSEUDOMORPHS AFTER GYPSUM SWALLOWTAIL C
VUGS FILLED WITH ANHYDRITE.

UNIT 7. ANHYDRITE, FINELY CRYSTALLINE, LIGHT BROWN TO
HALITE PSEUDOMORPHS AFTER GYPSUM SWALLOWTAIL C
ZONES, SOME PSEUDOMORPHS MAY BE SLIGHTLY CRUSH

UNIT 8. SANDY MUDSTONE, DARK REDDISH-BROWN TO GREENISH
EROSIONAL.

UNIT 9. HALITIC MUDSTONE AND ARGILLACEOUS HALITE, REDD
BASE, AND DECREASES UPWARD TO <1/2"; SMALL (<1
CONTACT GRADATIONAL, GENETICALLY DISCONFORMABL

UNIT 10. ARGILLACEOUS HALITE, REDDISH-BROWN MATRIX, HAL
CLAY OCCURS AS INTERSTITIAL MATERIAL AND AS MA

UNIT 11. ANHYDRITE, FINELY CRYSTALLINE, GRAY, LAMINATED
LIGHTER IN COLOR AND CONTAINS 5 to 10% CLEAR H
FREQUENTLY TILTED SLIGHTLY UPWARD TOWARD PEAKS
OVERLYING; BASAL CONTACT SHARP TO GRADATIONAL.

UNIT 12. HALITE WITH INTERBEDDED ANHYDRITE AND CLAYSTON
CLAY CONTENT UPWARD OVERLIES ANHYDRITE LAYER,
UPPER 1"; ABOUT 1.0' ABOVE LOWER CONTACT A 2"
SMALL (<1/32" ACROSS) DISPLACIVE HALITE CRYSTA
PARALLEL TO CRYSTAL FACES, INTERBEDDED WITH 1/
BROWN MUDSTONE OVERLIES HALITE; BASAL CONTACT

UNIT 13. ARGILLACEOUS HALITE WITH LOCAL HALITIC SANDY M
HALITIC THAN UPPER PART, CONTAINS DISPLACIVE H
LESS HALITE (50% OF ROCK); BEDDING DEFORMED AN
OF S; BASAL CONTACT SHARP, SLIGHTLY UNDULATORY,

UNIT 14. ARGILLACEOUS HALITE AND HALITIC MUDSTONE, DARK
SLIGHTLY HALITIC MUDSTONE; REMAINDER CONSISTS
CRYSTALS WITH FLUID INCLUSIONS, DISPLACIVE HAL
MUDSTONE OCCURS AT 782.5'; BASAL CONTACT SHARP

UNIT 15. SANDY HALITIC SILTSTONE, ALTERNATING REDDISH-B
SETS 1/4" TO 1/2" THICK WITH VARIABLE CURRENT
CONTACT GRADATIONAL, MARKED BY LAST OCCURRENCE

UNIT 16. SILTSTONE AND SANDY SILTSTONE, LIGHT BROWN TO
DIVISIBLE INTO UNITS 8" TO 20" THICK, BEDDING
SOME UNITS PARTIALLY TO WHOLLY REMOVED, SHOWS
IS PREVALENT NEAR 794.0'; NEAR 794.0' SYMMETRI
1/2" TO 1" DIAMETER AT 792.3'; MINOR SOFT SED

BRECCIA ZONE

B-1. **ARGILLACEOUS DOLOMITE**, BROWN, 80% ANGULAR TO SUBANGULAR CLASTS OF DOLOMITE, APPARENT SOURCE OF DOLOMITE IS UNIT 7 OF CULEBRA, DOLOMITE MATRIX WITH NO MIXING OF UNDERLYING CLAY, OVERLYING BEDS FRACTURED AND TREND DOWNWARD; UPPER AND LOWER CONTACTS GRADATIONAL.

B-2. CLAYSTONE, EQUIVALENT TO UNIT 1 AND POSSIBLY UNIT 2 OF UNNAMED LOWER MEMBER, SLICKENSIDED; SURROUNDING BEDS THIN TOWARD ZONE; BASAL CONTACT DIFFUSE.