CHAPTER 15.0

COAL PREPARATION PLANT

EMERY MINE

CONSOLIDATION COAL COMPANY

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15.0 COAL PREPARATION PLANT

15.1 Introduction and Summary

Chapter 15.0 discusses the coal preparation plant proposed to be constructed at the Emery Mine. The plant will consist of raw coal washing and crushing facilities and a waste (refuse) disposal system. Coal for the plant will be supplied by the existing Emery Mine operations. The plant is designed to process 700 tons of coal per hour which will accomodate mine expansion; the improved coal quality will allow Consol to meet existing contractual requirements and expand its markets.

The existing Emery Mine facilities are located in a canyon formed at the confluence of Quitchupah Creek and Christiansen Wash. The mine office is located approximately 2 miles east of Highway 10 and 6 miles north of U. S. Interstate 70. The primary mine portal enters the coal seam at the bottom of the canyon and angles down-dip toward the northwest. Coal is hauled away from the mine mine via 40-ton highway trucks.

The proposed preparation plant will be located above the canyon wall north of the existing facilities. The mine electrical substation and water tank are presently located near the proposed site. Two roads will access the plant: the coal haulage road will be the primary route for exporting coal from the plant; a smaller road will provide employee access. Best available control technology will be used to control fugitive dust emissions from the plant and associated facilities.

Coal processing wastes (refuse) will be deposited at a site located outside of the canyon, west of the existing facilities. The site, which is located south of Quitchupah Creek, will be accessed by the refuse haulage road. Coarse refuse will be hauled to the disposal site by pan-type scrapers where it will be compacted in the fill area. The slurry refuse will be delivered to the impoundment site by a pipeline. Clean water will be recovered from the slurry pond and the existing mine discharge sediment pond and returned to the plant for reuse.

It is assumed that the preparation plant will remain operating throughout the life of the Emery Mine which is projected to continue until 2010. When the plant is no longer needed, the facilities will be dismantled and removed. The affected areas will then be reclaimed to provide the same land uses that existed before disturbance. The refuse disposal area will be reclaimed by replacing approximately 4 feet of fill material and topsoil over the site. A permanent vegetative cover will be established to prevent erosion and restore the land use.

The remainder of this Chapter discusses in detail the plant facility designs and environmental protection that will be implemented. References are made to previous chapters in the permit application when applicable.

15.2 Land Ownership and Related Information

Land ownership for the permit area and proposed coal preparation plant is discussed in chapter 4.0. Plate 4-1 shows land surface ownership in the permit area. The coal preparation plant, refuse disposal area, and associated facilities are located on land controlled by Consolidation Coal Company.

15.3 Operation and Reclamation Plan

15.3.1 Site Description

The proposed coal preparation plant and its facilities are located on lands adjacent to the existing Emery Mine facilities. The coal washing facilities, coal stockpiles, and coal loadout facilities are located north of the existing mine facilities on the upland area above Quitchupah Creek. Sedimentation control for the plant site will consist of a pond located adjacent to the mine access road, down drainage and west of the plant. The surficial geology consists of Bluegate shale outcrop overlain in places by thin Pediment deposits.

The coal refuse disposal site is located west of the existing mine facilities on the south side of Quitchupah Creek. The existing mine water discharge sedimentation pond is also located in the area. At this site, surficial alluvial deposits overlay Bluegate shale. Plates 15-1A and 15-1B show the layout and location of the proposed preparation plant facilities.

15.3.2 Description of Proposed Facilities

15.3.2.1 Proposed Buildings and Structures

The following section provides a general description of the type of construction and usage of the proposed structures for the Emery preparation plant (see Plates 15-1A and 15-1B).

Run-of-Mine (ROM) Belt

The run-of-mine (ROM) belt will be an extension of the existing ROM stacker (see section 3.2.3.1). The ROM belt will transport ROM coal from the existing portal to a transfer building located on top of the canyon wall at a average rate of 700 tons per hour (TPH). The belt will be a stationary 48 inch conveyor, fully hooded. This conveyor will be equipped with all safety devices required by MSHA.

Transfer Building

The transfer building will house a two-stage raw coal (RC) sampling system in addition to the chutework required to divert the coal flow to one of two raw coal (RC) storage belts. The transfer building will be totally enclosed and equipped with dust suppression (water sprays) at the transfer points. The transfer building and equipment will meet all MSHA requirements.

2 - Raw Coal (RC) Storage Belts

Two raw coal (RC) storage belts will deliver raw coal to two 10,000 ton RC storage piles. The belts will be stationary 42 inch conveyor, fully hooded, and equipped with water sprays at the head section for wetting the stockpiles. This conveyor will be equipped with all safety devices required by MSHA.

2 - Raw Coal (RC) Storage Piles

Two raw coal (RC) storage piles will be of 10,000 ton capacity each. Concrete stacking tubes will be used for each pile to drop coal from RC storage belts to piles. Water is to be applied to storage piles as needed to control dust.

Raw Coal (RC) Reclaim System

The raw coal (RC) reclaim system will consist of eight reclaim feeders (four under each storage pile) in a ventilated, reinforced concrete reclaim tunnel and a reclaim belt to deliver raw coal from the storage piles to the plant feed belt at a maximum rate of 700 TPH. The reclaim belt will be a stationary 42 inch conveyor, fully hooded after it exist the tunnel. The reclaim system will be equipped with dust suppression at all loading zones and transfer points. The reclaim system and equipment will meet all MSHA requirements.

Transfer Building

The transfer building will be located at the tail of the plant feed belt and will house the chutework required to divert raw coal to the plant feed belt. The transfer building will be totally enclosed and equipped with dust suppression at the transfer points. The transfer building and equipment will meet all MSHA requirements.

Plant Feed Belt

The plant feed belt will deliver raw coal to the preparation plant at the rate of 700 TPH. The belt will be a stationary 42 inch conveyor, fully hooded. This conveyor will be equipped with all safety devices required by MSHA.

Preparation Plant

The preparation plant will be a heavy media plant for coarse coal washing (+3/8") only (see Plate 15-2 and section 15.3.3.1) with most processes being wet. The preparation plant will be totally enclosed. The plant and equipment will meet all MSHA requirements.

120 Ft. Static Thickener

A 120 foot static thickener will be located outside of the plant and will settle out the 3 TPH of minus 100 mesh material from the "fine coal dewatering circuit" (see section 15.3.3.1). The 3 TPH of solids will be pumped with 130 GPM of water through a 3 inch line to the slurry pond (see section 15.3.3.2). The overflow (clarified water) from the thickener will be recirculated back to the plant. The static thickener will be equipped with all safety devices required by MSHA.

Refuse Facilities

The refuse facilities will consist of a 200 ton bin being fed by a refuse belt. Refuse will be loaded from the bin into scrapers which will haul the refuse to the refuse disposal area (see section 15.3.3.2). The refuse belt will be a stationary 36 inch conveyor, fully hooded. The transfer point to the refuse bin will be totally enclosed. The refuse facilities and equipment will meet all MSHA requirements.

Clean Coal (CC) Transfer Belt

The clean coal (CC) transfer belt will deliver the 1-1/4" x 0 product from the plant to the sample building. The belt will be a stationary 42 inch conveyor, fully hooded. This conveyor will be equipped with all safety devices required by MSHA.

Sample Building

The sample building will house a two-stage sampling system for the 1-1/4" x 0 clean coal. The sample building will be totally enclosed with dust suppression at the loading zone of the clean coal storage belt. The sample building and equipment will meet all MSHA requirements.

Clean Coal (CC) Storage Belt

The clean coal (CC) storage belt will deliver the 1-1/4" x 0 product to a 20,000 ton clean coal storage pile. The belt will be a stationary 42 inch conveyor, fully hooded, and equipped with water sprays at the head section for wetting the stockpile. The conveyor will be equipped with all safety devices required by MSHA.

Clean Coal (CC) Storage Pile

The clean coal (CC) storage pile will be of 20,000 ton capacity. A concrete stacking tube will be used to drop coal from the CC storage belt to the pile. Water is to be applied to storage piles as needed to control dust.

Stoker Belt

The stoker belt will deliver coal from the plant to the stoker bins. The belt will be a stationary 36 inch conveyor, fully hooded. This conveyor will be equipped with all safety devices required by MSHA.

Stoker Bins

The stoker bins will consist of one 200 ton bin (1-1/4" x 3/8") and one 50 ton bin (3/8" x 0). A two-stage sampling system will be located above the bins. The sampling system and transfer points into the bins will be totally enclosed. The stoker bins, enclosure, and equipment will meet all MSHA requirements.

Truck Loadout Belt

The truck loadout belt will feed the stoker and modified stoker coal from the bins and load it directly in trucks. An oil spray system will be installed to spray oil on the stoker as it travels up the belt. The belt will be a stationary 36 inch conveyor and will be equipped to meet all MSHA requirements.

Stoker Oil Building

The stoker oil building will house the oil tank and pumps to be used for the oiled stoker coal. The stoker oil building and equipment will meet all MSHA requirements.

Truck Scale

The truck scale will be located on the main haulage road to the plant. The scale weighs the trucks before and after loading to determine to tonnage of coal being sold. The scale will consist of a standard highway scale unit of a size and capacity suitable for weighing the highway coal trucks. Associated with the scale will be a small scale house where the controls and read-out will be located.

Make-up Water Sump

The make-up water sump will be located between the slurry pond and the existing mine discharge sedimentation pond. This make-up water sump will be used to pump make-up water (300 GPM) back to the plant. Clarified water to the make-up water sump will be pumped from both the slurry pond and mine discharge sedimentation pond. The make-up water sump will consist of an above ground 20,000 gallon sump with a small pump house adjacent to the sump. The make-up water sump, building, and equipment will meet all MSHA requirements.

Facilities for Future Surface Mine

The following structures will be required for a future surface mining operation. These facilities are being submitted at this time so that future modifications to the preparation plant permit can be minimized. Only those facilities tying directly into the plant facilities are included. Information regarding the future operation will be submitted to the regulatory authority when final designs are available.

Truck Dump-Hopper

The truck dump-hopper will receive ROM coal from a future surface mining operation. The 400 ton reinforced concrete truck dump-hopper will accomodate bottom dump off-road haulage trucks. Dust suppression will be provided for at the dump. Below the hopper will be a feeder breaker to feed ROM coal from the hopper, crush the coal to 4" x 0, and feed raw coal to the RC storage belt. Dust suppression will be used at the feeder breaker and at the loading zone of the RC storage belt. The feeder breaker area and tunnel below the hopper will be ventilated. This installation will meet all MSHA requirements.

Raw Coal (RC) Storage Belt

The raw coal (RC) storage belt will deliver raw coal to the 10,000 ton storage pile. The belt will be stationary 42 inch conveyor, fully hooded, and equipped with water sprays at the head section for wetting the stockpile. This conveyor will be equipped with all safety devices required by MSHA.

Raw Coal (RC) Storage Pile

The raw coal (RC) storage pile will be of 10,000 ton capacity. A concrete stacking tube will be used to drop coal from the RC storage belt to the pile. Water will be applied to the pile as needed to control dust.

Raw Coal (RC) Reclaim System

The raw coal (RC) reclaim system will consist of four reclaim feeders in a ventilated, reinforced concrete reclaim tunnel and a reclaim belt to deliver raw coal to a transfer building at a maximum rate of 700 TPH. The reclaim belt will be a stationary 42 inch conveyor, fully hooded after it exits the tunnel. The reclaim system will be equipped with dust suppression at all loading zones and transfer points. The reclaim system and equipment will meet all MSHA requirements.

Transfer Building

The transfer building will house a two-stage sampling system and chutework to direct raw coal to a raw coal transfer belt. The building will be totally enclosed with dust suppression at the loading zone of the transfer belt. The transfer building and equipment will meet all MSHA requirements.

Raw Coal (RC) Transfer Belt

The raw coal (RC) transfer belt will deliver coal from the transfer building to the tail of the plant feed belt where this system for the future surface mining operation will tie into the plant. The belt will be a stationary 42 inch conveyor, fully hooded. This conveyor will be equipped to meet all MSHA requirements.

Existing Buildings and Structures

As soon as the preparation plant and its associated facilities are operational several existing facilities will become inactive or be eliminated. These facilities are listed below along with the section in which they are discussed in the permit application.

Section 3.2.3.1 Stacker-Reclaim System. The stationary 48-inch conveyor will be extended and become part of the proposed ROM belt. The remaining facilities will be eliminated.

Section 3.2.3.2 Tipple. Eliminate.

Section 3.2.3.3 Tipple Control Station. Eliminate.

Section 3.2.3.9 Coal Haulage Portal. The existing coal haulage portal will remain. Coal leaving the portal will not be dumped onto the existing reclaim system, but will be transported out of the canyon by the proposed ROM belt. It will then be processed by the preparation plant.

Section 3.2.3.29 Stoker Oil Storage. Eliminate.

Section 3.2.3.33 Truck Scales. The existing scales will not be used, however they will be maintained as a reserve unit.

Section 3.2.3.36 Coal Stockpile Areas. Eliminate.

15.3.2.2 Roads and Parking Area

The proposed main entrance road will be used to access the preparation plant facilities area. This structure has been designed to handle two way traffic beginning at the preparation plant yard area and terminating at the existing county road which runs from State Highway 10 to the mine gate. The main entrance road will be used by coal haulage trucks as well as coarse refuse haulage trucks as access to and from the plant yard. It is equipped with a weigh station.

A gravel bed has been designed for the entire yard area around the preparation plant facilities area. Parking for vehicles at the preparation plant will be available outside of the main building.

The existing pond road will be upgraded to be used as access to the waste disposal area. The existing road, located about ½ mile north of the mine, west of the county road described above, was used as access to the mine discharge sedimentation pond. The proposed upgrade design provides for the crossing of Quitchupah Creek. The road is then extended beyond the creek crossing to the disposal area, where the coarse coal refuse will be hauled.

The existing substation road will be upgraded to be used as access to the preparation plant for light traffic. The structure, located on the canyon top north of the mine, begins at the county road and ends at the facilities yard area. A tank access extension has been provided beyond the yard.

Refer to section 15.6.1 for the detailed design plans and drawings of the roads.

15.3.2.3 Plant Electrical Power Supply System

Please refer to previous sections 3.2.5 and 3.2.5.1 for descriptions of the existing Power System and Surface Distribution respectively. Electrical power will be supplied to the preparation plant from the mine's existing main substation. An 8KV, 3 phase power line will tap into existing surface facilities circuit. The secondary voltage of the substation transformer is presently connected for 4160 VAC phase-to-phase, but is reconnectable to produce 7200 VAC phase-to-phase. At the time the preparation plant nears operation, 7200 VAC will be supplied to the plant. As stated above, the 8KV power line will originate from the existing mine substation and will run directly over to the preparation plant main building. There will be proper electrical protection at each end of the line as required by law. At the end of the line beside the plant, the 7200 VAC power will be brought into the building to feed 7200 to 480 VAC dry-type transformers in the plant.

15.3.2.4 Water Supply

Recently, the Utah State Engineer approved an application to appropriate up to 5 cfs of groundwater produced in the mine (application number 44305). Consol intends to use this water in the coal preparation process and as a fresh water supply (Section 3.2.6). Mine discharge water will be pumped to the sedimentation pond as before. However, rather than discharging the entire quantity to the unnamed tributary of Quitchupah Creek, a major portion of the mine discharge water will be mixed with the slurry impoundment return water at a sump (Section 15.3.3.2) to supplement the anticipated requirement of 300 gpm of makeup water for the preparation plant (see Plate 3-4).

15.3.2.5 Sedimentation Control

One sedimentation pond and two diversions are proposed for sediment control and water management, as illustrated on Plate 15-8. The proposed preparation plant sedimentation pond, Emery Pond #5, is located west of the facilities area. The impoundment serves to control disturbed area surface water runoff from a 115 acre drainage area and has a design storage volume of 3.6 acre-feet. The pond is designed to contain the runoff volume from a 10 year - 24 hour storm plus sediment. The structure is equipped with a decant system and one emergency spillway designed to pass a 25 year - 24 hour storm. The pond discharges into the natural drainage channel, flowing west.

A diversion ditch has been designed to channel undisturbed area runoff away from the plant area. This diversion controls a 75.1 acre drainage area and discharges into the proposed plant main entrance road northern ditchline where it ultimately flows into the natural drainage channel.

A second diversion has been designed to channel undisturbed area runoff away from the refuse disposal area. This diversion controls a 72.3 acre drainage area and discharges directly into the main channel of Quitchupah Creek.

Refer to Section 15.6.2 for the detailed design calculations and drawings of the sediment control structures and surface water management plan.

15.3.2.6 Refuse Disposal

A five year plan has been developed to dispose of preparation plant waste material at the mine site. The plan consists of a slurry pond for fine waste material disposal and a refuse pile for coarse waste material disposal. The site is located north of the existing mine sediment discharge pond, as shown on Plate 15-1B. The proposed refuse haul road serves as access to the disposal site.

Slurry from the plant will be pumped to the proposed impoundment, where the fines will settle. Clarified water will be returned to the plant for reuse. The slurry impoundment has been designed to ultimately facilitate 33.0 acre-feet of submerged fines.

Coarse refuse material will be hauled to the refuse pile located upstream from the slurry embankment. The proposed coarse refuse area has been designed to facilitiate approximately 700,000 cubic yards of material.

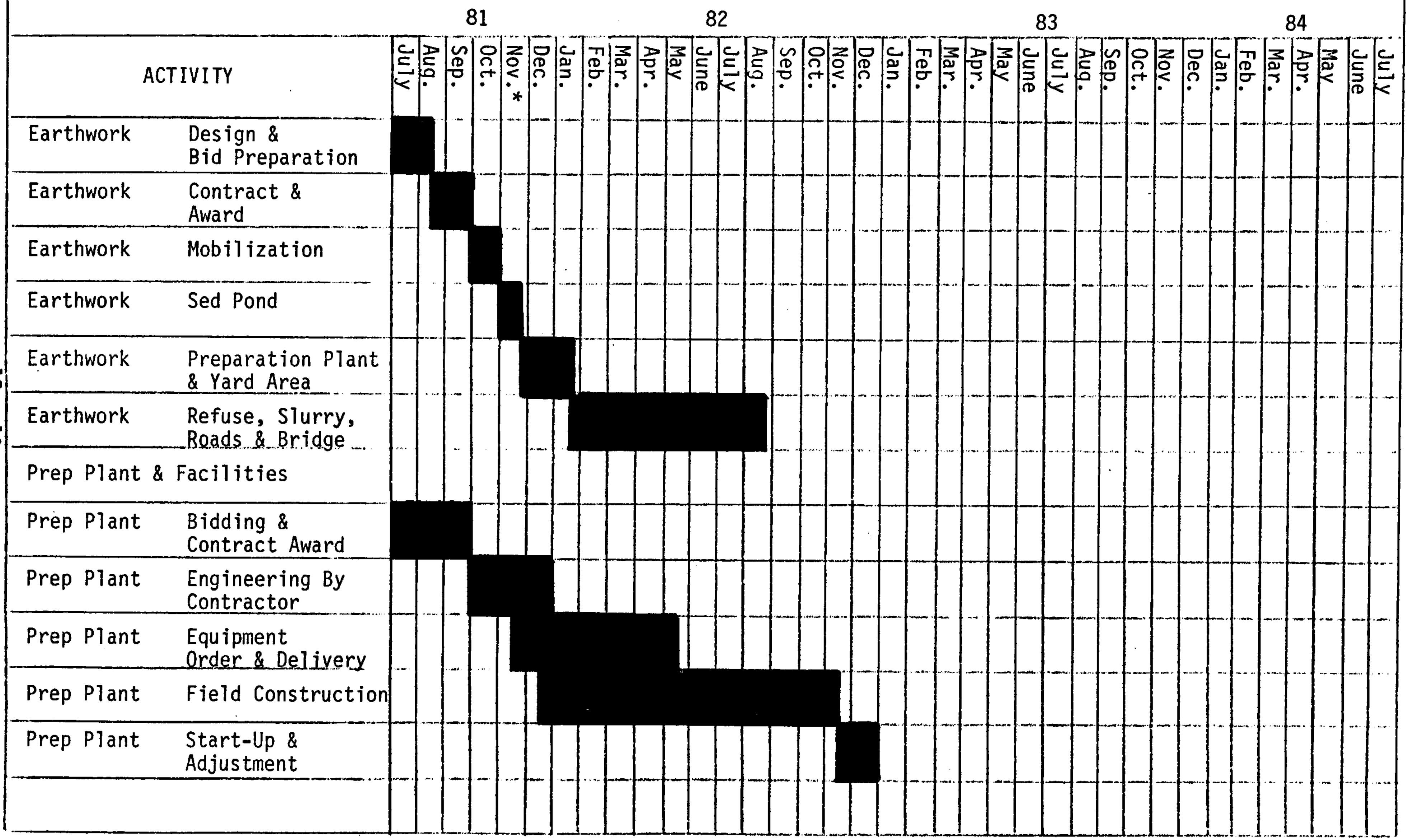
The facility is described in section 15.3.3.2. Refer to section 15.6.3 for the design calculations and drawings.

15.3.2.7 Detailed Construction Schedule

Figure 15-1 shows the proposed construction schedule for the preparation plant. The plant is scheduled to be on line and operational by January 1, 1983. This date is critical because the Emery raw coal quality is projected to fall below contract specifications during the first quarter of that year. In order to meet this completion date, construction is scheduled to begin November 1, 1981.

CONSOLIDATION COAL COMPANY EMERY MINE

PREPARATION PLANT PRELIMINARY CONSTRUCTION SCHEDULE



*Construction Scheduled to Begin 11/1/81

FIGURE 15-1

15.3.3 Operation Phase

15.3.3.1 Description of Proposed Plant Operation

The existing 42" belt from the mine will feed the 8" x 0 run-of-mine (ROM) coal to the existing ROM 48" stacker belt. The existing ROM belt will be extended to deliver the ROM coal, at an average rate of 700 tons per hour (TPH), to the transfer building located at the top of the canyon wall. Two-stage sampling of the raw coal will also be located in the transfer building.

This transfer building will divert the ROM coal to one of two 42" raw coal storage belts that will deliver the ROM coal via concrete stacking tubes to one of the two storage piles. Two storage piles are provided so that raw coal of different quality can be stockpiled separately. This will allow for a more controlled quality feed to the plant.

Each storage pile will be furnished with four reclaim feeders. The feeders will be used to control the feed from the piles to the 42" reclaim belt at a maximum rate of 700 TPH. The feeders and the reclaim belt will be located in a reinforced concrete tunnel under the piles.

The reclaim belt will then deliver the raw coal to the transfer building to be located at the tail of the 42" plant feed belt. Raw coal will be delivered to the plant at the rate of 700 TPH by the plant feed belt.

The 8" x 0 raw coal being delivered to the plant will be screened at 3/8". The 3/8" x 0 sized coal will be delivered to the clean coal conveyor or the stoker belt, as required, at the rate of 237 TPH. The 8" x 3/8" will report to the prewet screens where the remaining minus 3/8" coal will be removed from the 8" x 3/8".

The 3/8" x 0 coal from the pre-wet screens will be delivered to the "fine coal dewatering circuit" at the rate of 52 TPH. This circuit consists of a series of sieve bends, desliming screen, cyclones, and centrifuges (see Plate 15-2). The desliming screen will be used to scalp out the 28 mesh x 0 material. The 3/8" x 28 mesh material will be fed to the centribuge for drying. The minus 28 mesh will then be pumped to cyclones for a 100 mesh separation. The 28 mesh x 100 mesh from the cyclone underflow will report to another centrifuge for drying. The minus 100 mesh from the cyclones will be delivered to the static thickener. Underflow from the thickener will be pumped to the slurry pond at the rate of 3 TPH, 130 GPM (see section 15.3.3.2). The total 3/8" x 100 M product from this circuit will be delivered to the clean coal belt at the rate of 49 TPH.

The 8" x 3/8" coal from the pre-wet screens will report to the "coarse coal wash circuit" at the rate of 413 TPH. This circuit consists of a heavy media vessel, drain and rinse screens, centrifuge, clean coal crusher, and magnetic separators for recovery of the magnetite (see Plate 15-2). Magnetite is the media used in the wash. The 8" x 3/8" size fraction will be processed in the heavy media vessel. The 8" x 1 1/4" heavy media product will be crushed to 1 1/4" x 0 and then will report to the clean coal belt at the rate of 128 TPH. The 1-1/4" x 3/8" portion of the heavy media product will be centrifuged and then delivered to the clean coal belt or the stoker belt, as required, at the rate of 216 TPH.

The 8" x 3/8" coarse refuse from the heavy media vessel will be dewatered on a drain and rinse screen before being sent to the 200 ton refuse bin at the rate of 67 TPH. Coarse refuse will be hauled by scraper to the refuse disposal area (see section 15.3.3.2).

A 42" clean coal transfer belt will deliver the 1-1/4" x 0 clean product from the plant to a sample building where a two-stage sampling system will be located. A 42" clean coal storage belt will take the coal from the sample building to a 20,000 ton stockpile. A concrete stacking tube will be used to drop the coal into the pile. Clean coal will be loaded from the pile into highway haulage trucks by front-end loaders.

As mentioned earlier, the 3/8" x 0 size raw coal fraction and the 1-1/4" x 3/8" clean coal size fraction can be diverted to a 36" stoker belt. This system will be incorporated into the facilities to allow for the projected sales of 40,000 tons per year (TPY) of stoker coal (1-1/4" x 3/8") and modified stoker coal (1-1/4" x 3/8" plus 10-20% of 3/8" x 0).

The stoker belt will deliver at any given time either the 1-1/4" x 3/8" to a 200 ton bin or the 3/8" x 0 to a 50 ton bin. The proper size fraction will be diverted to the proper bin when the bin needs to be refilled. A two-stage sampling system is located above the bins.

Stoker coal and modified stoker coal will be loaded out of the bins to trucks by a 36" truck loadout belt. This belt is used so that the amount of 3/8" x 0 in the modified stoker can be monitored. The belt loadout also allows the coal to be sprayed with oil before being loaded into the trucks.

In addition to the above mentioned facilities, separate raw coal facilities for handling coal from a future surface mining operation will be provided. Information regarding this future operation will be submitted to the regulatory authority when final designs are available.

The additional raw coal facilities include a 400 ton truck dump-hopper for use with bottom dump off road haulage trucks. Raw coal will be fed from the hopper to a 42" raw coal storage belt by a feeder breaker. The feeder breaker will be located directly below the hopper and will also crush the run-of-mine (ROM) coal to a 4" x 0 size.

The raw coal storage belt will deliver the 4" x 0 raw coal from below grade to a 10,000 ton storage pile. At the average rate of 700 TPH. Coal will be dropped from the belt into the pile through a concrete stacking tube.

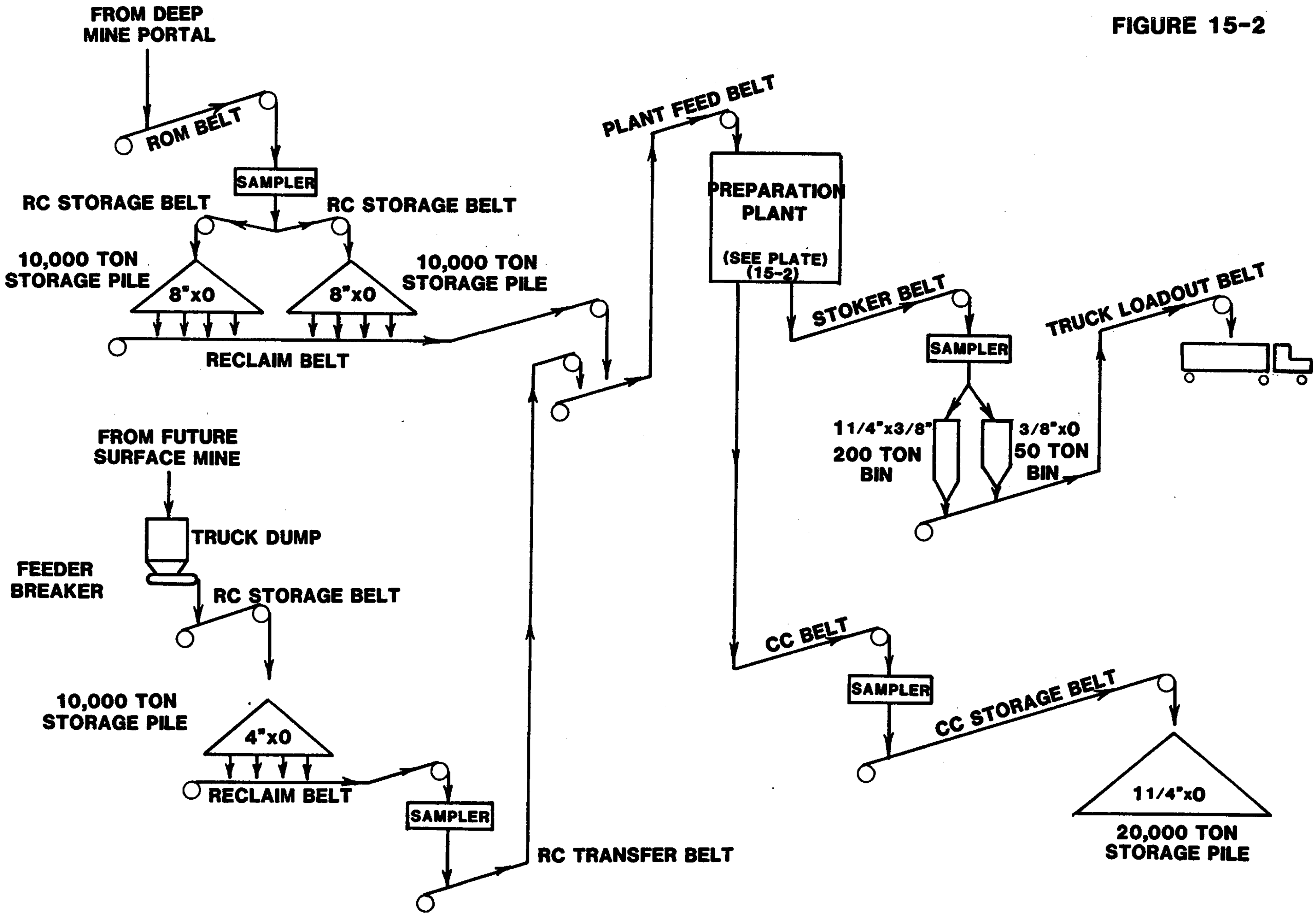
Raw coal will be drawn from the storage pile by four reclaim feeders located in a reinforced concrete tunnel under the pile. The feeders will deliver the coal to a 42" reclaim belt at a maximum rate of 700 TPH.

The reclaim belt will deliver the coal to a transfer building where two-stage sampling will be located. A 42" raw coal transfer belt will transport the raw coal from the transfer building to the transfer building located at the tail of the plant feed belt where this additional raw coal facility ties into the remaining system.

Refer to Figure 15-2 for schematic of the coal handling facilities.

COAL HANDLING FACILITIES

FIGURE 15-2



15.3.3.2 Description of Refuse Disposal Plan

The proposed disposal area has been designed to facilitate approximately 700,000 cubic yards of coarse coal refuse material and 33.0 acre-feet of submerged fines (slurry) from the proposed Emery preparation plant. The life of the plan is five years. Refer to Plate 15-1-B for the Plan View Illustration.

The site has been chosen to allow for future expansion of the disposal facility. The plan will be extended in stages as necessary for future project development. Only the five year plan is presented.

Existing Conditions

A subsurface field investigation was conducted by Rollins, Brown and Gunnell, Inc. A complete description of the work performed and laboratory test results are included in section 15.5.1. Based on the results of the analyses, investigative program, and project recommendations the following plan was developed.

Design Plan Description

Slurry Impoundment: The waste disposal site for both the slurry impoundment and the coarse refuse will first be cleared and four feet of material removed and stockpiled until the reclamation phase of the project. The topsoil will be segregated from the total depth of material removed as described in section 15.4.5. The stockpile area is located north of the disposal area and is indicated on Plate 15-1-B. Material will then be excavated from cells #1 and #2 at a 3:1 slope to elevation 5931.0 for cell #1 and 5934.0 for cell #2.

This earthen material classified largely as silty sand will be used to construct the embankment of the proposed slurry impoundment to crest elevation 5953 feet. Such material will be placed on a 3 (horizontal)-to-1 (vertical) slope upstream and a 4:1 slope downstream, with a crest width of 20 feet. All work will be done in accordance with the construction specifications detailed in section 15.6.5.

After the cells are excavated, a clay liner will be constructed to provide a protective surface against seepage. The Mancos shale in the area will be watered and rolled on the cell bottoms and compacted to a minimum of 2 feet thick. A 6-inch protective cover will then be compacted over the clay. The design bottom elevation of cell #1 is 5933.5 and cell #2, will be gently sloped from elevation 5936.75 to 5936.25 to provide drainage.

The clay liner will continue from the pond bottom into the upstream face of the embankment to elevation 5949.5. This clay zone will have a minimum thickness of two feet. A protective cover will then be placed over the clay layer at a minimum thickness of two feet.

During all phases of construction the upper surface of the embankment will be gently sloped (¼:1) toward the pond so that runoff will be channelled into the impoundment.

In accordance with MSHA, a stability analyses has been conducted for the structure. Refer to section 15.6.4.

Two 40 foot wide dikes will be constructed in the impoundment to form cell #1. The zoned dikes will be composed of an earth core zone placed at 3:1 to design elevation 5943 with a crest width of 12 feet. A two foot clay layer will be compacted over the earth zone to form a liner. Coarse refuse material will then be placed on the dike and allowed to settle at the angle of repose, approximately 1.7:1. At design elevation 5951 the dike will have a 40 foot wide crest. Three polyethelene pipes will be placed through the refuse dike between cell #1 and #2, at a 1.13% slope. The 3" perforated well pipe riser has a top elevation of 5941.6. After five years, the maximum slurry design level is 5938.5.

Is this center dike only?

The purpose of this cellular arrangement is to assure that the fines are properly settled and clarified water is available to return to the plant. Slurry will be pumped from the preparation plant to cell #2 at a rate of 130 gpm where the fines will settle out. The refuse dikes will serve to filter out the small particles in cell #2. The water in cell #1 will be clarified to enable use in the plant. The water will be pumped from cell #1 to the make-up water sump located between the existing mine discharge sediment pond and the proposed slurry pond. From this sump the clarified water from both the slurry pond and sediment pond (as necessary) will be pumped back to the preparation plant for reuse.

It is intended that the maximum amount of water be returned for reuse other than that required to keep the system working efficiently. During startup, cell #1 will be filled with 14 acre-feet of water (from the mine discharge sediment pond). The amount of available clarified water will of course depend on the hydrologic inflow parameters during the five years. Several design cases have been considered to develop an adequate maximum storage capacity of the impoundment and the minimum constant return rate of clarified water to the plant. The maximum storage capacity of the slurry impoundment is 198.2 acre-feet, at elevation 5949.5. Refer to the design calculations in section 15.6.3 for a description of the design procedure. ?

Slurry will be pumped from the plant to the pond at a rate of 130 gpm through a 3" line. Clarified water from the slurry pond varies, though the minimum constant return is expected to be 50 gpm. The pump will be staged as necessary. A concrete encasement will be provided around the pump in cell #1. Access to the pump is provided by means of a 3' wide footbridge. The clarified water is pumped to the make-up water sump.

This will consist of an above ground 20,000 gallon sump with an adjacent small pump house. From here the water is pumped to the plant through a 6" line with additional water from the mine discharge sediment pond used as required. The plant is capable of using an estimated 300 gpm return water. The pipeline location is shown on Plate 15-1-B. It will be placed approximately two feet below the original terrain.

The emergency spillway has been designed in accordance with MSHA standards. Both the PMP and PMTS were considered. The 12 foot wide trapezoidal channel is capable of passing the design storm, with 100% of the design storm inflow evacuated in one day. The impoundment has been designed to store the runoff above the maximum pool level prior to discharge while maintaining the 3 foot freeboard. The channel will be cut into the original ground, composed largely of Mancos shale, at 3:1 side slopes. The design discharge capacity of 15 cfs will have a maximum velocity of 5.5 fps. The emergency spillway will discharge directly into an unnamed tributary of Quitchupah Creek. An emergency NPDES permit will be obtained for the discharge point.

Refuse Area: The process of constructing the refuse dikes will dispose of approximately two months of coarse material. Once the dikes are completed, coarse refuse will be hauled directly to the waste disposal site by use of a scraper, with truck haulage available as standby. The refuse, comprised largely of 4" x 3/8 material (with some 8" x 3/8), will be placed on a 2.5 (horizontal)-to-1 (vertical) slope with 25-foot wide benches for every 25 feet rise in elevation or less. Each bench will be constructed with a slight reverse slope, both transverse to the face to prevent the flow of surface water runoff down the major refuse slopes, and longitudinally to the sides of the pile, where the runoff will be channelled away from the pile and directed into the slurry impoundment. This detailed drainage plan is described in design section 15.6.3 and should be referred to. A diversion ditch has been included in the design of this facility to channel the upstream undisturbed area runoff away from the disposal site. The diversion discharges directly into Quitchupah Creek.

The refuse bank will be constructed by placing material in small horizontal lifts of 2 feet maximum thickness, and compacted to attain 90 percent of the maximum dry density. The refuse bank will facilitate approximately 447 acre-feet of coarse material at maximum design elevation 6015. The completed slopes will be covered with the stockpiled material and revegetated in accordance with the reclamation plan.

What material?

Coal Refuse Production Quantities

The coal refuse production quantities for the five year design life of the facility, upon which this design was based, follow:

Plant Feed (raw)	700 TPH
Yield (clean coal)	90%
Coarse Refuse	67 TPH @ 7% S.M.
Fines (slurry)	3 TPH @ 8.5% solids (130 gpm)
Days of Operation	230 per year

Year	Annual Raw Coal Production (million tons)	Annual Waste Production (tons)	Coarse Refuse Volume (assuming 115pcf) (acre-feet)	Fine Refuse Volume (IN) (assuming 65pcf) (acre-feet	Submerged Fine Volume (acre-feet)
1982	---	---	---	---	---
1983	2.11	211,000	87.	76.	6.72
1984	2.56	256,000	106.	92.	8.04
1985	2.89	289,000	119.	104.	9.12
1986	2.89	289,000	119.	104.	9.12
TOTAL			431.	376.	33.00

Refer to section 15.6.3 for all design calculations and drawings showing the details of this plan.

15.3.4 Environmental Protection

15.3.4.1 Land Use Preservation and Impacts

The land to be affected by the proposed preparation plant is presently native rangeland, with livestock grazing as its primary land use. 85 acres of this rangeland will be disturbed but will be restored to grazing land once again after the termination of the project.

15.3.4.2 Cultural Resource Preservation

Cultural resource surveys have been conducted on all surface areas where the surface effects of underground mining have occurred or are proposed to occur. The reports for these surveys are contained in Chapter 5.0. Plate 5-1 shows the locations of the sites that were identified.

The existing and proposed operations, including the coal preparation plant and associated refuse disposal area, will not disrupt any known cultural resource sites (see Chapter 3.0, Section 3.4.2). If, during the course of the preparation plant construction activities, any unknown cultural resources are encountered Consol will halt all work in the vicinity of the resource and contact the Division to determine what mitigative measures should be taken.

15.3.4.3 Protection of Hydrologic Balance

The proposed refuse disposal area lies between Quitchupah Creek and an unnamed tributary which enters from the west, approximately 2,000 feet above their confluence (Plate 15-1C). Within this area, two processes are presently taking place which affect the local hydrologic balance. One of these, the addition of mine discharge water and its attendant salt load to Quitchupah Creek has been previously discussed (section 7.2). The other, the infiltration of excess irrigation water to form a groundwater ~~mound in~~ the vicinity of the proposed refuse disposal area was identified as a part of this investigation.

Consol intends to mitigate the addition of salt to Quitchupah Creek and dissipate the ~~artificial~~ mound as a consequence of placing the refuse disposal area in the proposed location. Both of these are viewed as beneficial effects.

Currently, the average daily discharge to the tributary of Quitchupah Creek is 0.56 cfs which carries an average daily salt load of approximately 6.5 tons. At full operation of the preparation plant, Consol intends to use 70% of the discharged water which will reduce the average daily salt load by 4.5 tons.

Calculated seepage volumes from the slurry cells approximate 500 $ft.^3$/day, at considerable points in time after their operation begins. The equilibrium TDS content of the slurry water is expected to be within the range 5,000 - 10,000 mg/l. This would add just 0.15 tons per day to the alluvial groundwater system and in turn to Quitchupah Creek, either at point or diffuse locations, ~~depending upon the development of~~ groundwater mounds beneath the slurry cells. Therefore, the total salt load addition to Quitchupah Creek is expected to be reduced to approximately 2 tons/day.

Consol intends to monitor the alluvial groundwater system with six strategically placed wells to verify the minimization of seepage losses from the proposed slurry cells and to validate the nature and quality of the anticipated seepage water.

from where? how?

With regard to the artificial groundwater mound, Consol intends to divert the excess irrigation runoff to the main reach of Quitchupah Creek and thereby remove the recharge source. This will result in the dissipation of the groundwater mound and the creation of a thicker unsaturated zone in the vicinity of the proposed impoundments. This waste disposal diversion ditch will also serve to isolate surface waters which originate above the refuse disposal area and preserve their existing quality.

Coarse refuse piles will also be protected by this diversion ditch and will be so sited that drainage from them, as a result of precipitation, will divert to the slurry cells. They will be managed to retard oxidation of the small amount of pyritic materials which have been identified, by reducing pore space within the pile by packing. Vegetation will be introduced as soon as possible to reduce erosion.

15.3.4.4 Preservation of Soil Resources

A total of 85.3 acres of soils will be affected during the construction and operating process. There are 13 different types of soils that will be affected. These soils vary in depth and quality. All of the suitable topsoil material will be removed, stockpiled, and stabilized to ensure protection until respreading begins. Stockpiles will be stabilized with an effective vegetative cover. See Table 15-1.

15.3.4.5 Protection of Vegetation

Consol will cooperate with all state and federal agencies in the protection of vegetative resources on the mine permit area. This will include adequate restoration of habitat already disturbed and protection of undisturbed habitat from operational effects. Off-road vehicle travel on unaffected lands will be prevented.

15.3.4.6 Preservation of Fish and Wildlife

Please refer to section 3.4.6.2 of the Emery Mine permit application for methods to be employed for the purpose of preserving and protecting wildlife.

PRE-DISTURBANCE TOPSOILS DATA TABLE 15-1

Disturbance Site

Soils	Prep. Plant Yard	Refuse Pile Area	Sediment Pond	Refuse Haul Road	Slurry Pond	Diversion Ditch
(49) Alluvial Land	---	---	---	4,640 yd^3 .7 acres	---	---
(12) Chipeta - Badlands	6,292 yd^3 3.9 acres	---	---	---	1,452 yd^3 .9 acres	---
(10) Hunting Clay Loam	---	---	---	---	---	268 yd^3 .2 acres
(0) Badlands	0 yd^3 2.4 acres	---	---	---	---	---
(9) Ildefonso Loam	2,057 yd^3 1.7 acres	---	---	---	---	---
(12) Castle Valley ESVFSL*	19,037 yd^3 11.8 acres	---	---	---	---	---
(16) Ravola Loam	8,179 yd^3 3.9 acres	---	1,258 yd^3 .6 acres	---	---	---
(17) Ravola - Bunderson Complex	---	1,581 yd^3 .7 acres	---	6,550 yd^3 2.9 acres	71,148 yd^3 31.5 acres	---
(11) Rafael Silty Clay Loam	---	11,906 yd^3 8.2 acres	---	---	---	145 yd^3 .1 acres
(12) Persayo - Chipeta Compllex	---	6,937 yd^3 4.3 acres	---	---	15,972 yd^3 9.9 acres	1,452 yd^3 .9 acres
(2) Chipeta - Persayo Complex	97 yd^3 .3 acres	---	---	---	---	---
(0) Disturbed Land	0 yd^3 .05 acres	---	---	---	---	---
(0) Gullied Land	---	---	---	0 yd^3 .2 acres	---	0 yd^3 .1 acres
TOTALS	35,662 yd^3 24.1 acres	20,424 yd^3 13.2 acres	1,258 yd^3 .6 acres	11,180 yd^3 3.8 acres	88,572 yd^3 42.3 acres	1,865 yd^3 1.3 acres

Topsoil is used here to indicate suitable recoverable surface materials and thus also encompasses (in some cases) the subsoil materials as well.

Numbers in ( ) refer to depth of soil (inches) to be recovered from site.

* Translates to 'Extremely stony very fine sandy loam'.

Total to be disturbed = 85.3 acres

Total recoverable yd^3 for all three sites = 158,961

15.3.4.7 Protection of Air Quality

Fugitive dust emissions from the preparation plant facilities will be controlled using Best Available Control Technology (BACT). The emissions inventory and controls are described in section 15.4.8. Types of controls are also described in section 15.3.2.1. The uncontrolled emissions factor (UEF) and the control efficiencies used are based on information and documentation from 1)the Utah State, Bureau of Air Quality; 2)the EPA; and 3)Environmental Research and Technology, Inc. (ERT).

Summary of Controls

Item	Control
Conveyor Belts	Full Hooded
Transfer Points	Totally Enclosed with Dust Suppression (Water Sprays)
Storage Piles	Concrete Stacking Tubes and Water Sprays
Roads	Watering
Soil Stockpiles	Revegetation

The annual concentration estimate was accomplished using an emissions inventory based on the full production rate of the 700 TPH plant at 2.6 million tons of clean coal per year. Meteorological data used was taken from Hanksville, Utah, which was the site judged by ERT to be most appropriate for this analysis. Twenty-four hour concentration estimates assumed emissions based on production at the rated 700 TPH capacity of the plant for 24 hours. Assumed worst-case meteorlogical conditions were used to evaluate the maximum 24 hour concentrations.

The air quality model was accomplished using the "Wyoming Climatological Dispersion Model". Following is a brief summary of the modeling results. Refer to section 15.4.8 for more detail.

Demonstration of Compliance with

the Secondary NAAQS at the

CONSOL Coal Preparation Plant

Averaging Time	Pollutant	CONSOL	Concentrations ($\mu g/m^3$) Background	Total	NAAQS
Annual	TSP	16	38	54	60
24-hour	TSP	63	76	139	150

Based on the assumptions used in the modeling, the estimates presented conservatively over predict the actual impact of the plant emissions.

15.3.4.8 Subsidence Control

A study has been performed for the ground stability of the proposed slurry pond area situated above 6 south mains and 6 south - 2 west submains of Emery underground mine.

In light of the most current theories on strata control, coal pillar strength, and ground subsidence, the study shows that the area associated with the slurry pond is stable and will remain stable for a long period (+ 20 years).

The study titled "Geomechanics Consideration for the Stability of Proposed Slurry Pond" is in section 15.5.2. Plate 15-16 should be referred to.

15.3.5 Reclamation Plan

15.3.5.1 Soil Removal and Storage

Prior to construction of the plant facilities, topsoil will be removed and stockpiled. The topsoil will be removed with scrapers to the depth recommended in the soil classifier's report (Chapter 8.0). The storage piles will be constructed with broad side slopes (3 Hor.:1 Vert.) and will be revegetated with a permanent vegetation cover. Two stockpile areas have been selected; one is adjacent to the slurry / refuse disposal area and the other is adjacent to the plant site (see Plate 15-1A and 15-1B).

Table 15-1 identifies the soil types found in the construction area and shows the estimated soil volumes that will be removed and stockpiled.

15.3.5.2 Final Abandonment

It is anticipated that the preparation plant will continue operating until final abandonment of the mine in 2010. Reclamation of the plant site will begin in 2011 with removal of the buildings and associated facilities. Regrading of the plant and refuse disposal sites will be conducted following the completion of building removal.

Final abandonment of the refuse disposal area will include replacement of non-toxic material over the refuse material, regrading and soil replacement. The slurry disposal ponds will be allowed to dry out before backfilling and regrading is conducted.

15.3.5.3 Grading

Preparation Plant Site

Prior to regrading the plant site, surface debris will be removed. It is anticipated that this material will be suitable to use as fill for other reclamation sites at the mine. Regrading will consist of shaping the surface so that the final topography is similar to adjacent landscapes. Overall, the predisturbance topography of the site will not be significantly changed by the plant construction operations so the task of regrading will be minimal. During regrading, the predisturbance drainage system will be restored.

Roads

The roads will be left in place until the plant site and refuse disposal sites have been regraded. This will facilitate the reclamation process by allowing access to the sites. When the roads are no longer needed for access they will be removed and regraded. Prior to regrading, the surface paving material will be removed. The road areas will be regraded to a topography consistent with adjacent unaffected lands.

Refuse / Slurry Disposal Site

Contemporaneous regrading will occur at the coarse refuse disposal site as the refuse is deposited. As the refuse disposal bank is constructed, regrading will be conducted on the lower face. A small terrace will be constructed above the regraded face to control drainage. This lower face will be backfilled and reclaimed as construction of the refuse bank progresses.

Final grading of the disposal site will not be conducted until final abandonment of the site. At this time the coarse refuse disposal area will be final graded, backfilled and retopsoiled. The slurry refuse disposal ponds will be allowed to dry before they are backfilled and graded. After the pond cells are thoroughly dry the refuse dikes will be dozed over the site. This material will be compacted and then covered with excess material taken from the earthen dam. The area will be further backfilled with the excavated material originally stockpiled during construction of the disposal site.

(soil for slurry pond)

Sedimentation Pond

The sedimentation pond will be removed and the site regraded when an effective, erosion-controlling plant cover has been established on the preparation plant site. This will be approximately 3 years after the site has been seeded. The approximate original topography of the pond area will be restored.

15.3.5.4 Soil Respreading and Preparation

Soil respreading will be conducted as soon as the area has been final graded. The soil will be respread with scrapers in approximately 6-inch layers until the appropriate uniform depth is reached. Based on the soil volume calculations given on Table 15-1, the following depths will be respread:

Sedimentation Pond Site	15 inches
Preparation Plant Site	11 inches
Coarse Refuse Disposal Site	11 inches
Refuse Haulage Road Site	4 inches
Slurry Pond Site	15 inches

The areas to be respread will be staked at regular intervals to indicate the depth of soil to be respread. This will insure that a uniform soil thickness is attained. (See also section 3.5.5.1, Chapter 3.0).

15.3.5.5 Seedings (Methods, Timing, and Seed Plan)

Refer to section 3.5.5.2 in Chapter 3.0 of the Emery Mine permit application.

15.3.5.6 Mulching

Refer to section 3.5.5.3 of Chapter 3.0 of the Emery Mine permit application for details on mulching for these six sites.

15.3.5.7 Management and Monitoring

Please refer to sections 3.5.5.4 and 3.5.5.5 in Chapter 3.0 of the Emery Mine permit application for details concerning vegetation management and monitoring.

15.3.5.8 Reclamation Timetable

Reclamation of the preparation plant facilities will be performed in the same general time period and in the same way as the present facilities now on site. At the termination of the mine, all facilities will be dismantled and the site reclaimed. Refer to section 3.5.6.1 of the permit application for further information concerning final reclamation timetables.

15.3.5.9 Reclamation Cost Estimate

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Refer to table 15-2 for reclamation cost estimates. These cost estimates apply only to the additional facilities that are being proposed for the Emery Mine area. It is assumed that these costs shall be updated with each permit renewal or revision and therefore, only reflect the cost of reclamation during the permit term. Also see section 3.5.7, Chapter 3.0.

TABLE 15-2
COST ESTIMATE OF EACH STEP OF RECLAMATION
(1981 Dollars)

Item	Cost
Removal of Structures	$266,000
Regrading	$ 72,000
Soil Re-spreading	$172,000
Seedbed Preparation	$ 1,100
Fertilization	$ 1,940
Seeding	$ 11,200
Mulching	$ 4,050
Erosion Control	$ 7,800
Weed Control	$ 920
Reseeding	$ 1,105
Monitoring	$ 9,200
Total cost of reclaiming 85 acres in 1981 dollars	$547,315

15.4 Environmental Resources

15.4.1 Land Use and Postmining Land Use

Approximately 85 acres of native rangeland will be affected by the construction and operation of the preparation plant. This land is presently used for livestock grazing. Land use in the permit area is discussed in section 4.4, Chapter 4.0. Plate 8-3 shows the distribution of land uses in the permit area.

The reclamation plan has been designed to replace the same land uses that existed prior to disturbance. This will be accomplished by regrading the land to the approximate original topography and establishing a diverse vegetative cover capable of sustaining the intended postmining use. The soil surveys have indicated that suitable soil material is available for reclamation. Replacing this soil during reclamation will be important in establishing the intended postmining land use.

15.4.2 Historical and Cultural Resources

The cultural resource survey reports for lands associated with the proposed coal preparation plant and refuse disposal area are contained in Chapter 5.0.

15.4.3 Geology

The general geologic framework and the geology of the project vicinity have been addressed previously (see section 6.1). This section describes the site-specific geology of the proposed refuse disposal area, primarily as it affects the hydrologic characteristics of the area. Plate 15-1C shows geologic information for the area.

The refuse disposal area is underlain by localized unconsolidated deposits which may reach a maximum thickness of 60 feet. These alluvial materials consist of clay, silt, sand, and gravel; flood plain; and stream deposits. Specific soil types include sandy silt, silty sand, sandy gravel, and clay (see Foundation and Materials Investigation, section 15.5). Due to their depositional environment, these deposits are commonly well stratified and lenticular.

Quaternary colluvial deposits composed chiefly of debris from sheet erosion and slope wash occur between the bedrock outcrops south of the disposal area.

The Bluegate Shale underlies these surficial deposits in the proximity of the disposal area. It ranges from 101 feet to 175 feet thick beneath the refuse disposal area and thins towards the southeast before it contacts the underlying Ferron Sandstone. The Bluegate Shale serves as an embankment on the southwest side of the disposal area where it outcrops. Plate 15-1C shows approximate contours on top of the Bluegate Shale based on exploration and impoundment investigation drillhole data. A bedrock low trends approximately east-west through the northern refuse area and then runs northwest-southeast near the eastern perimeter. The Bluegate shale slopes down to this through towards the northeast from its western outcrop; and, down towards the southwest from its eastern outcrop, however, this slope is less defined. The Bluegate shale surface is normally weathered and fractured, but perhaps less so in its subcrop.

The Ferron Sandstone outcrops just west of the mine shop and office area (Plate 15-1C). It is overlain by sand and gravel in the vicinity of the Quitchupah Creek and unnamed tributary confluence.

15.4.4 Hydrology

The surface water and groundwater hydrology in the vicinity of the Emery Underground Mine have been addressed previously (Chapter 7.0). This section is a site-specific assessment of hydrology, both surface water and groundwater, in the vicinity of the proposed refuse disposal area.

15.4.4.1 Surface Water Hydrology

The proposed refuse disposal area lies between the main trunk of Quitchupah Creek and an unnamed tributary which enters from the west, approximately 2000 feet above their confluence (Plate 15-1C).

Streamflow along the main trunk of Quitchupah Creek, above where it flows in the proximity of the proposed disposal area, is influenced by a variety of factors (see section 7.2.3.2). Not noted in the aforementioned discussion, but of significance to the local hydrologic regime is the occurence of excess irrigation runoff at the southeast corner of the flood-irrigated field which occurs just north of the proposed refuse placement area (Plate 7-8 and Plate 15-1C). This runoff is channeled by a minor tributary of Quitchupah Creek to a location approximately 300 feet northeast of the northwest-southeast trending earth embankment, where the local topography allows the flow to seep into the alluvium and form an artificial groundwater mound (Plate 15-1C). This irrigation runoff was observed to be on the order of 0.2 cfs on one occasion.

Water quality data for the irrigation runoff is currently unavailable. TDS concentration of Quitchupah Creek upstream of the confluence with the unnamed tributary ranged from 506 mg/l to 2964 mg/l over the period October, 1979 to June, 1981.

The upper reaches of the major unnamed tributary of Quitchupah Creek are dry most of the year. The segment below the sedimentation pond however, is perennial due to the discharge from the pond. The average daily discharge from the sedimentation pond is 0.56 cfs which contributes an average salt load of approximately 6.5 tons/day. TDS concentration at the sedimentation pond discharge ranged from 2951 mg/l to 4696 mg/l over the same time period for Quitchupah Creek.

15.4.4.2 Groundwater Hydrology

The proposed refuse disposal area is located on and within the proximity of three water-bearing units. These include, from oldest to youngest, the Ferron Sandstone, the Bluegate Shale, and the Quaternary Alluvium.

The Ferron Sandstone, of which its upper portion [Kmf(u)] is most contiguous to the area of refuse placement, outcrops southeast of the impoundment area as noted in section 15.3. Plate 15-1C shows contours of the upper Ferron Sandstone potentiometric surface. Just after the confluence of Quitchupah Creek with its unnamed tributary, water of the upper Ferron Sandstone discharges to Quitchupah Creek.

The Bluegate Shale lies above the Ferron Sandstone and separates it hydraulically from the alluvium, except perhaps very close to their contact where fractures within the Bluegate Shale may conduct water of the Ferron aquifer of higher potentiometric elevation. The thickness of the Bluegate Shale would preclude such transfer in the vicinity of the disposal area (see Section 15.3). Water does occupy surficial fractures however, which has entered from the alluvial groundwater above. These fractures probably do not extend greater than 20 feet below the Bluegate subcrop within the alluvium.

The occurence of groundwater in the alluvium and the determination of its hydrologic characteristics, has come largely by field observation and from the geotechnical investigation to characterize the foundation material to underlie and form the embankments of the proposed clay-lined impoundments (slurry cells).

The material which will underlie the proposed coarse refuse pile and the impoundments consists primarily of sandy silt and silty sand with scattered lenses of clay and gravel.

Consequently, the material on a whole is anisotropic and heterogeneous. Tests of field permeability range from 0.06 ft./day to 2.70 ft./day over the disposal area from the surface to 30 foot depths (see section 15.5). Those materials which will remain intact to form the foundation material for the lined slurry cells average just over 0.5 ft./day. Porosities range from 0.36 to 0.48 as calculated from stated void ratios. Volumetric water contents of inplace materials of the unsaturated zone ranged from 0.03 to 0.20 with most near 0.10.

As previously noted (section 15.4.4.1), excess irrigation runoff has created an artificial groundwater mound northeast of the refuse disposal area. Groundwater was observed standing in the hatched seepage area shown on Plate 15-1C. The surface elevation at this location is 5940 feet. Groundwater elevations in the vicinity of the refuse disposal area are in the range 5920 to 5922 feet and decreasing away from the mound, however slightly. Although data is unavailable, alluvial water table contours would be expected to encircle the recharge area and decrease in all directions. Flow would be expected to occur then from the mound towards the main trunk of Quitchupah Creek (springs unsighted as of the present), to the southwest towards the proposed impoundment area, and even back towards the north and northwest until the primary groundwater gradient would reverse its direction back towards the southeast. Plate 15-1C shows alluvial groundwater contours which could reasonably be drawn based on the available water level data and the knowledge of the intervening artificial recharge source. Southeast of the proposed refuse disposal area the alluvial groundwater moves downgradient where it contributes streamflow to Quitchupah Creek at its lower elevations prior to its confluence with Christiansen Wash.

Consol intends to divert surface water above the refuse disposal area away from the proposed location, including the irrigation runoff which has created high groundwater levels, to the main trunk of Quitchupah Creek by a waste disposal diversion ditch (Plate 15-1C). The removal of the recharge source will result in the dissipation of the groundwater mound and thereby cause artifically high alluvial water table contours to displace further upgradient. This will create a thicker unsaturated zone in the vicinity of the refuse disposal area.

15.4.4.3 Effects of Refuse Disposal on Hydrology

Slurry Seepage and Water Quality

Consol intends to minimize seepage losses from the proposed refuse slurry cells by lining them with 2 feet of compacted shale obtained from the Bluegate Shale outcrop area which borders the southwest portion of the disposal area (see section 15.3.3.2). In order to assess the potential effects of seepage on the local alluvial groundwater system and in turn on the quality of streamflow within Quitchupah Creek, seepage estimations were undertaken.

The governing equation for steady state vertical seepage through a sequence of saturated strata oriented normal to the direction of flow is:

$$q = \frac{\Delta(h+z)}{\sum_{i=1}^{k} \frac{D_i}{K_i}} \qquad \ldots\ldots\ldots\ldots (1)$$

in which D_i = thickness of layer i; K_i = saturated hydraulic conductivity of layer i; (h + z) = the total change in piezometric head across the sequence; k = the number of layers in the series; and q = the volume flux of water (McWhorter and Nelson, 1979).

For the slurry cell #1 case with no fine refuse above the clay liner and a watertable at distance below the bottom of the liner, equation 1 reduces to:

$$q = \frac{y + D_l - h_f}{D_l / K_l} \qquad \ldots\ldots\ldots\ldots (2)$$

where y = pond depth; h_f = pore-water pressure head at the interface between the foundation material and the liner; and subscripts l and f refer to the clay liner and foundation material, respectively.

The value h_f may be approximated for relatively coarse-textured materials for a wide range of seepage rates by the displacement pressure, h_d, or critical pressure head at which the unsaturated K approximately equals the saturated K of the material underlying the clay liner (foundation material). Bouwer (1978) lists values of h_d for structureless loams and clays at between -50 cm and -200 cm or less. A large percentage of the foundation material has been typed as sandy silt to silty sand in texture (see section 15.5). A value of -150 cm (-4.9 ft.) will be assigned to h_d for this material for steady-state seepage estimation through the liner.

Constant-head permeability tests performed on samples of compacted Bluegate Shale material which will comprise the pond liner yielded a conservative K value of 1.5×10^{-4} ft./day (see section 15.5). This value will be used in seepage rate estimation. It should be noted that this value is for the saturated K of the clay liner.

Stage-storage estimates for the slurry cells are available for the first 4 years of operation. During this time the mean pond depth is to vary between 3.0 and 7.4 feet over equal time increments. Beyond the first four years, the mean pond depth is expected to be within this range. The average mean pond depth which will be representative of the equilibrium TDS content of the slurry water is 5.2 feet. This value will be used to estimate seepage.

Inserting these values into equation 2 yields a mean steady-state seepage rate of 9×10^{-4} ft./day through the 2 feet of clay liner. The time required for seepage to penetrate through the clay liner is on the order of 6 years, but could be more or less depending on the change of K_l with time, the effect of the chemical composition of the seepage water on K_l, and proper installation of the liner.

Once the wetting front has penetrated the clay liner, the seepage rate through the underlying foundation material is dependent on several factors. If the volumetric water content, θ, of the foundation material (θ_f) is less than its porosity, n, or if the seepage rate, q, through the liner is less than the K of the foundation material (K_f), unsaturated flow will occur to the water table or an impermeable surface. For purposes of this analysis, flow will be assumed to occur to the water table. This situation implies that h_f is less than h_d of the foundation method.

The mean permeability of the material to underlie the impoundments was measured in the field at 0.54 ft./day. Assuming that the horizontal permeability is five times greater than the vertical permeability, a mean value of the latter would approximate 0.1 ft./day. This value is much more than the previously calculated mean steady-state seepage rate implying that the material behind the wetting front will be unsaturated as seepage occurs to the water table. The value of h_f to be used to estimate seepage in this phase can be computed from:

$$h_f = h_d \left(\frac{q}{K_f} \right)^{-1/(2+3\lambda)} \quad \ldots\ldots\ldots\ldots (3)$$

where λ = pore-size distribution, $1 < \lambda < 3$ (McWhorter and Nelson, 1979) and other symbols are as before. Substituting equation 3 into equation 2 yields:

$$q = \frac{y + D_\ell - h_d \left(\frac{q}{K_f} \right)^{-1/(2+3\lambda)}}{D_\ell / K_\ell} \quad \ldots\ldots (4)$$

A first approximation to the correct value of q to be used in the right-hand side of equation 4 is the mean steady-state seepage rate as calculated through the clay liner (McWhorter and Nelson, 1979). Using this value, 9×10^{-4} ft./day; a mean value of $\lambda = 2$; and previously noted values of h_d and K_f, yields a seepage rate of 1.2×10^{-3} ft./day beneath the clay liner. Second approximation of the seepage rate yields a value of 1.19×10^{-3} ft./day. This value will be used in subsequent calculations.

The effective surface area of slurry cell #1 subject to the ponding depth of 5.2 feet is 207,246 ft.^{2} resulting in a volume rate of seepage through the unsaturated zone of 246.6 ft.^{3}/day (1844.7 gal./day) or 1.28 gpm.

The time required for this volume to traverse the distance from the bottom of the clay liner to the capillary fringe ($D_f + h_d$) can be calculated from:

$$t = \frac{D_f + h_d}{q_m} \left[(n - \theta_r) \left(\frac{q_m}{K_f} \right)^{\lambda/(2+3\lambda)} + (\theta_r + \theta_i) \right] \quad \ldots (5)$$

in which q_m = mean seepage rate; θ_r and θ_i = residual (specific retention) and initial volumetric water contents of the unsaturated zone materials.

The bottom elevation of the clay liner in slurry cell #1 is 5931 feet and the current mean groundwater elevation in slurry cell #1 is 5923 feet yielding D_f = 8 feet and a distance to the capillary fringe of 2.9 feet assuming h_d = -4.9 feet. Measured values of n range from 0.36 to

0.39 for soils which will underlie slurry cell #1 with values of θ_i ranging from 0.07 to 0.13 in the vicinity of slurry cell #1. A n value of 0.37 and a θ_i value of 0.10 will be used to estimate travel time. A θ_r of 0.15 will be assumed. Putting these values into equation 5 yields a travel time through the unsaturated zone of approximately 1 year.

In the slurry cell #2 case, fine refuse will occupy space above the clay liner and further impede vertical seepage. The mean thickness of fine refuse over the first four years of operation is 3.2 feet. The mean water level in the fine refuse will be 0.5 feet below its top which reduces the saturated thickness of the fine refuse (D_{fr}) to 2.7 feet.

For this case, equation 2 becomes:

$$q = \frac{D_{fr} + D_\ell - h_f}{D_{fr}/K_{fr} + D_\ell/K_\ell} \quad \ldots\ldots\ldots (6)$$

where K_{fr} = saturated vertical permeability of the fine refuse and all others are as before. Wahler (1978) reports vertical permeability values of 9×10^{-3} ft./day for fine coal refuse materials. Inputting these values into equation 6 yields a mean steady-state seepage rate through the sequence of 7.0×10^{-4} ft./day.

The seepage rate through the unsaturated zone is first approximated by using $q = 7.0 \times 10^{-4}$ ft./day on the right-hand side of equation 4. This equation becomes:

$$q = \frac{D_{fr} + D_\ell - h_d\left(\frac{q}{K_f}\right)^{-1/(2+3\lambda)}}{D_{fr}/K_{fr} + D_\ell/K_\ell} \quad \ldots\ldots (7)$$

where all symbols are as previously noted. Performance of this first approximation yields a seepage rate of 1.0×10^{-3} ft./day. Second approximation yields essentially the same value.

The effective surface area of slurry cell #2 exposed to the pressure head of 2.7 feet is 236,615 ft.^{2} resulting in a volume rate of seepage through the unsaturated zone beneath slurry cell #2 of 236.6 ft.^{3}/day (1769.8 gal./day) or 1.23 gpm.

The time required for this volume to traverse the distance from the bottom of the clay liner to the capillary fringe ($D_f + h_d$) can be calculated from equation 5 as before.

The bottom elevation of the clay liner in slurry cell #2 is 5934 and the current mean groundwater elevation in cell #2 is 5921 feet yielding D_f = 13 feet and a distance to the capillary fringe of 8.1 feet, again assuming h_d = -4.9 feet. Measured values of n beneath slurry cell #2 average 0.47 and values of θ_i average 0.09. A θ_r of 0.17 will be assumed. Inserting these values into equation 5 yields a travel time through the unsaturated zone of approximately 4 years.

The flow path of the refuse seepage water and its attendant salt load after it reaches the water table is dependent upon if, and to what degree, mounding occurs below the slurry cells. This in turn is dependent upon the seepage rate, the fraction of pore space in the transmission zone that remains available for storage (i.e., n - θ_f), and the tendency for groundwater to spread laterally (McWhorter and Nelson, 1979).

If mounding beneath the slurry cells occurs, seepage rates into the still partially saturated alluvium should be the same. When the mound reaches the liner / alluvium interface increasing pore-water pressures will decrease vertical gradients and subsequently, seepage rates. Horizontal gradients will set up which will promote flow radially away from the mound. In light of the close proximity of discharge boundaries, namely Quitchupah Creek and its tributary, it is likely that slurry cell seepage water would discharge at some nearby point or points along these stream reaches, especially that of the main trunk of Quitchupah Creek.

If mounding does not occur, seepage rates would continue to be controlled by K_1, K_{fr}, and pore-water pressures within the partially saturated alluvium (h_f). They should remain essentially the same as the previously calculated mean values. In this case, the natural groundwater gradient (established after the removal of the artificial irrigation runoff recharge source) would serve to laterally spread seepage water downgradient to where it would ultimately discharge to Quitchupah Creek or its tributary; however, the nature of the discharge would be diffuse.

Estimates of the equilibrium TDS content of the slurry water are within the range 5,000 - 10,000 mg/l. The cumulative seepage discharge from both slurry cells has been previously calculated at approximately 500 ft.^{3}/day. If the TDS of the seepage water were 10,000 mg/l, the total salt load to the alluvial groundwater system and eventually Quitchupah Creek would be approximately 0.16 tons/day. This a fraction of the salt load previously discharged from the sedimentation pond (see section 15.4.4.1).

Discharge from the sedimentation pond will not totally cease. However, it is anticipated to be reduced by 70% when the preparation plant is in full production. This would reduce salt additions to Quitchupah Creek from the current 6.5 tons/day from the mine discharge water to near 2 tons/day from both the mine discharge water and slurry seepage.

Coarse Refuse Pile and Water Quality

As previously noted, Consol intends to divert runoff waters above the refuse disposal area away to the main trunk of Quitchupah Creek. The only surface water which is likely to come in contact with the pile is precipitation and small amounts of runoff water from the Bluegate Shale outcrop contiguous to the pile. Any major runoff amount from the pile would likely be channeled to the slurry cells downgrade of the refuse pile (Plate 15-1C).

In an effort to reduce oxidation of the small amounts of pyrite which are found to exist in the coal and associated strata (see Chapter 6.0), Consol intends to pack the refuse to reduce pore space within the pile.

Also, Consol intends to establish vegetative cover early on in refuse pile construction in an effort to reduce erosion and the creation of excessive amounts of suspended solids. It should be noted however, that any suspended solids which originate within the refuse disposal area will be contained within it by the earth embankment which forms its perimeter.

Because of these measures, Consol anticipates no hydrologic or water quality effects as a result of coarse refuse placement on the surface.

Monitoring

Consol intends to install six alluvial groundwater monitor wells prior to the commencement of the operation of the slurry cells. These wells will provide more information on the surficial and bedrock geology, groundwater depths, and existing water quality within the alluvium. Plate 15-1C shows their proposed locations.

Three wells will be located upgradient of the slurry cells to characterize the nature of flow into the slurry cell area, including its water quality. Three wells will be located downgradient to check on the effectiveness of the liner in minimizing seepage and to define and evaluate the nature of any laterally spreading seepage.

Water levels within these wells will be determined on a monthly basis. Initial water samples obtained from the wells will be submitted for complete major and minor chemical analysis and then be repeated annually. pH, TDS, Na, SO_4, Fe, and Mn determinations will be made monthly as indicators of seepage migration.

15.4.5 Soils

Detailed soil surveys have been conducted on the proposed coal preparation plant construction site. The results of these surveys are contained in Chapter 8.0. Table 15-1 shows the soil types present on each site and the estimated volume to be recovered for reclamation.

15.4.6 Vegetation

The lands to be affected by the proposed coal preparation plant consist of native rangeland. Vegetation studies were conducted on these lands in 1980. The results of these studies are contained in Chapter 9.0. The following table summarizes the vegetation types found on each site:

Vegetation Types on Preparation Plant Construction Site

Preparation Plant Site	
Mixed Desert Shrubland	17.3 acres
Greasewood Shrubland	0.6 acres
Annual Forb Community	6.3 acres
TOTAL	24.1 acres
Slurry Pond Site	
Greasewood Shrubland	33.5 acres
Annual Forb Community	8.8 acres
TOTAL	42.3 acres
Sedimentation Pond Site	
Mixed Desert Shrubland	0.6 acres
TOTAL	0.6 acres
Coarse Refuse Disposal Site	
Greasewood Shrubland	14.4 acres
TOTAL	14.4 acres
Refuse Haulage Road Site	
Riparian Meadow	0.3 acres
Greasewood Shrubland	3.6 acres
TOTAL	3.9 acres

15.4.7 Fish and Wildlife

Please refer to Volume 7, Chapter 10.0 of the Emery Mine permit application for a discussion and detailed information concerning wildlife found in the Emery Mine area.

15.4.8 Climate and Air Quality

15.4.8.1 Climate

See Chapter 11.0.

15.4.8.2 Air Quality

Environmental Research and Technology, Inc. (ERT) was retained to estimate the fugitive particulate emissions associated with the coal preparation plant, and to predict by dispersion modeling, the ambient particulate concentrations due to the plant. The report contained in Appendix 15-1 documents the results of the modeling and discusses the impacts of the proposed plant on the ambient air quality (also see section 15.3.4.7).

15.5 Geotechnical

15.5.1 Foundation and Materials Investigation

A subsurface field investigation was conducted by Rollins, Brown, and Gunnell, Inc. A complete description of the work performed and laboratory test results are included in this section. The report has been copied in its entirety. Impoundment site no. 1 was chosen for the proposed slurry impoundment location. Although the discussion of alternative site no. 2 is included in this report, the site has not been chosen for use at this time. No further reference is made to site no. 2 in this proposed permit.

15.5.2 Subsidence Control at Slurry Pond Site

The following report discusses the geomechanics for stability of the proposed slurry disposal pond. Also refer to Plate 15-16.

GEOMECHANICS CONSIDERATION FOR THE STABILITY OF PROPOSED SLURRY POND

Consol is proposing to install a Slurry Pond of 220 acre feet capacity for storage of refuse slurry with subsequent recovery of water, recycling it to the coal processing plant. The proposed Slurry Pond will be located on the surface above the intersection of 6 south and 2 west. The vertical interval of the strata between the mine workings (elv 5692.4 ft.) and the surface (elv 5 943.5 ft.) is about 251 feet. A copy of the mine workings superimposed on a U.S.G.S. topo map, 400 feet to 1 inch scale, is attached. The workings were developed and mined out during 1978 to 1980. Incidentally, 6 south mains and 2 west submains are planned to be the main arteries of the mine serving the coal reserves situated north - west of the area. Development of 6 south is based on a 6 entry system 80 ft. x 100 ft. centre to centre pillars, with 20 feet wide entries and 8.0 feet of mining height. Submain 2 west and 1 right - 2 west panel have been developed locally on a 5 entry and 4 entry system respectively, with other particulars the same as 6 south mains. The rooms off 1 right - 2 west panel are 20 feet wide; residual pillars are of 50' x 60' centre to centre and mining height has been 10 ft. The thickness of the IJ seam is approximately 18.3 feet in this area, out of which 2 feet of floor coal and about 8 feet of roof coal have been left for floor and roof stability.

The major minerals in the shale - silt stone floor are Illite, Kaolinite and a-Quartz. Illite and Kaolinite when exposed to moisture slackens and results in floor heaving and the structural integrity can be lost very quickly. It has long been a practice to leave about 2 feet of coal to alleviate all such complications. The immediate roof of the IJ seam consists of layers of clay shale, rider seams and sandstone. Drill hole log FC 294 is attached. The shale is of low strength and very susceptible to weathering and can create potential roof control problems. Likewise, it has been a practice to leave about 6 to 8 feet of roof coal for roof stability. Incidentally, this roof coal is high in sulfur and difficult to market, at this time.

The supporting capability of a coal pillar can be conveniently described by the emperical formula after W. A. Hustrulid (Reference: A review of coal pillar strength formulas, Rock Mechanics, Vol. 8, 1976, pages 115-145):

$$P = K(W^b/H^c)$$

p = compressive strength of coal pillars in psi

W = width of residual coal pillar (smallest dimension), in feet

H = mining height in feet

b, c & K = are constants depending on sample and experimentor

With IJ coal seam the value of the constants have been determined in Conoco Mining Research Laboratory, Ponca City, OK as: $b = 0.5$, $c = 1.0$ and $K = 2432$ psi - ft.$^{0.5}$

So, $p = 2432\ (60)^{.5}/8^{1.0} = 2355$ psi for 6 south, 2 west and 1 right - 2 west pillars and $p = 2432\ (30)^{.5}/10^{1.0} = 1332$ psi for pillars supporting rooms in 1 right - 2 west panel.

To achieve stability of the surface slurry pond, the weight of the overburden should very adequately be supported with a margin of safety by the residual coal pillars.

Mathematically, it can be expressed:

$$p\ .\ Ap = FS.r.d.A_T \quad \text{or,} \quad FS = \frac{p\ .\ Ap}{r.d.A_T}$$

Where p = 2355 or 1332 psi compressive strength of coal pillar.

Ap = Area of pillar supporting overburden in square inches.

= 60 x 80 x 144 square inches = 691,200 for 6 south, 2 west and 1 right - 2 west and 4 x 30 x 40 x 144 square inches = 691,200 for rooms in 1 right - 2 west panel.

FS = Factor of safety

r = Weight density of overburden $\frac{158}{144}$ = 1.1 psi/foot

d = Depth of overburden in feet = 251 feet

and A_T = Total area in square inches of solid pillar plus half entry on all sides

= 80 x 100 x 144 square inches = 1152000 square inches for 6 south, 2 west and 1 right - 2 west

and 100 x 120 x 144 square inches = 1728000 square inches for rooms in 1 right - 2 west panel.

Therefore, FS, the factor of safety for 6 south, 2 west and 1 right-2 west coal pillars

$$= \frac{p \times Ap}{r x d x A_T} = \frac{2355 \times 691{,}200}{1.1 x 251 x 1152000} = 5.12$$

and FS, the factor of safety for pillars left in rooms in 1 right - 2 west panel

$$= \frac{p \times Ap}{r x d x A_T} = \frac{1332 \times 691{,}200}{1.1 x 251 x 1728000} = 1.93$$

Ground subsidence effect of 1 right - 2 west rooms: Ratio of excavation width to depth in rooms is 20/251 = 0.08 is less than 0.25. From the findings of the N.C.B.'s subsidence committee, it can be stated that "The ground subsidence (and inferentially damage) will be negligible".

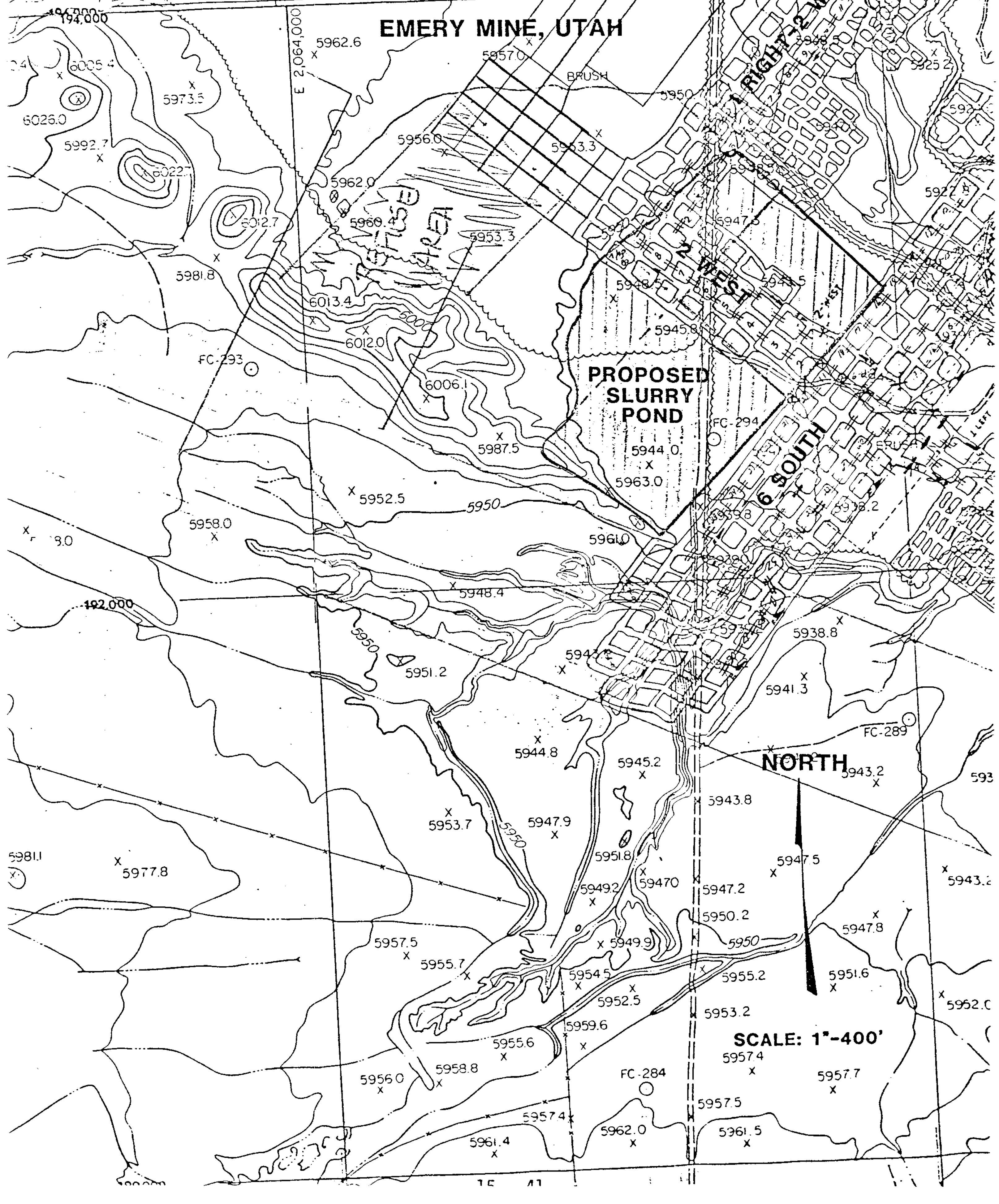
Ideally FS should be more than 1.5 and preferably more than 1.75 for long term (+ 20 years) stability. From the above combination of analyses it can be very safely stated that the proposed slurry pond situated directly above 2 west submains and partly over 6 south mains and 1 right - 2 west panel will remain stable in the long term.

Consol's mining policy places strong emphasis on the stability of underground mine openings and surface structures. Safety of miners, equipment, and remaining in compliance with federal and state mining laws and regulations are Consol's objectives. It is worthwhile to mention here that Consol has installed surface subsidence monitoring stations over the general mining area. These stations are surveyed at regular intervals as part of an ongoing monitoring program.

Gouri Bajpayee
8/17/81

MAP SHOWING SLURRY POND LOCATION IN REFERENCE TO UNDERGROUND WORKS

EMERY MINE, UTAH



SEQ NO = 1 DRILL HOLE NO = FC 294   FORMAT = A   STATE = 43   COUNTY = 015   TWP = 22S   RANGE = 6E   SECTION = 32
SECTION CODE =   SURFACE ELEV. = 5944.15   HOW DET. = 6
N-COORD = 192473   E-COORD = 2065364   SOURCE = 2   LOCATION = 1
THK CORED = 67.00   THK N-CORED = 205.00   USGS =   SZE.CD. =

SEQ NO. = 2 DRILL HOLE NO = FC 294   FORMAT = B   PROPERTY OR FARM =   DRILLER = GRIMM
DRILL CONTR =   DATE DRILLED = 0574
TWP OR PLACE =   COMMENTS =

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SEQ NO.	DRILL HOLE NUMBER	FORMAT	DEPTH FROM	DEPTH TO	THICKNESS	LITHOLOGY CODE	CHARACTERISTICS	SEAM CODE	CORR.	COMMENTS
3	FC 294	C	.00	20.00	20.00	SD	BRN		0	
4	FC 294	C	20.00	20.30	.30	SH	BRN		0	
5	FC 294	C	20.30	29.00	8.70	GR			0	
6	FC 294	C	29.00	32.60	3.60	SH	BRN		0	
7	FC 294	C	32.60	126.10	93.50	SH	GRY		0	
8	FC 294	C	126.10	126.10	.00	SS		TF	0	
9	FC 294	C	126.10	152.90	26.80	SS	GRY		0	
10	FC 294	C	152.90	155.40	2.50	SH	GRY		0	
11	FC 294	C	155.40	181.40	26.00	SS	GRY		0	
12	FC 294	C	181.40	183.90	2.50	SH	GRY		0	
13	FC 294	C	183.90	198.30	14.40	SS	GRY		0	
14	FC 294	C	198.30	200.20	1.90	SH	GRY COL		0	
15	FC 294	C	200.20	205.00	4.80	SS	GRY		0	
16	FC 294	C	205.00	214.70	9.70	SS	CAS		0	CORED
17	FC 294	C	214.70	215.00	.30	ND			0	CORED
18	FC 294	C	215.00	225.00	10.00	SS	LIT GRY HRD		0	CORED
19	FC 294	C	225.00	227.50	2.50	SS	CAS HRD		0	CORED
20	FC 294	C	227.50	231.00	3.50	SH	GRY SDY		0	CORED
21	FC 294	C	231.00	232.00	1.00	SS	LIT GRY HRD		0	CORED
22	FC 294	C	232.00	233.00	1.00	SH	GRY SDY		0	CORED
23	FC 294	C	233.00	234.65	1.65	SS	LIT GRY HRD		0	CORED
24	FC 294	C	234.65	235.00	.35	SS			0	CORED
25	FC 294	C	235.00	236.70	1.70	SS	CAS		0	CORED
26	FC 294	C	236.70	238.20	1.50	SH	CRB SFT		0	CORED
27	FC 294	C	238.20	239.00	.80	CO		J	0	
28	FC 294	C	239.00	239.20	.20	SH	CRB SFT		0	CORED
29	FC 294	C	239.20	240.30	1.10	CS	SFT		0	CORED
30	FC 294	C	240.30	240.60	.30	SH	CRB SFT		0	CORED
31	FC 294	C	240.60	241.60	1.00	BO			0	CORED
32	FC 294	C	241.60	242.00	.40	CO		UI	0	CORED
33	FC 294	C	242.00	248.70	6.70	CO		UI	0	
34	FC 294	C	248.70	249.90	1.20	SH			0	
35	FC 294	C	249.90	256.20	6.30	CO		LI	1	
36	FC 294	C	256.20	256.50	.30	BO			0	CORED

SEQ NO.	DRILL HOLE NUMBER	FORMAT	DEPTH FROM	DEPTH TO	THICKNESS	LITHOLOGY CODE	CHARACTERISTICS	SEAM CODE	CORR.	COMMENTS
37	FC 294	C	256.50	257.30	.80	BO			0	CORED
38	FC 294	C	257.30	257.70	.40	BO			0	CORED
39	FC 294	C	257.70	261.10	3.40	CO		LI	5	CORED
40	FC 294	C	261.10	262.00	.90	SS	CRB		0	CORED
41	FC 294	C	262.00	264.40	2.40	SS	SHY LIT GRY		0	CORED
42	FC 294	C	264.40	264.60	.20	SH	SDY DRK GRY		0	CORED
43	FC 294	C	264.60	265.20	.60	SS	HRD LIT GRY		0	CORED
44	FC 294	C	265.20	268.60	3.40	SH	DRK GRY SFT		0	CORED
45	FC 294	C	268.60	269.10	.50	SS	CAS HRD		0	CORED
46	FC 294	C	269.10	271.60	2.50	SH	DRK GRY SFT		0	CORED
47	FC 294	C	271.60	272.00	.40		BH		0	CORED

PROXIMATE ANALYSIS

SEQ NO.	DRILL HOLE NUMBER	FORMAT	SEAM CODE	SAMP NO	SAMPLE DEPTH FROM	SAMPLE DEPTH TO	ANALYSIS CODE	%MOIS	%VOL	%CARB	%ASH	%SUL	BTU	EQUIL. MOIST	F P
1	FC 294	D	IJ	1	236.70	239.00	1	3.3	.0	.0	52.8	1.93	5859	.00	F
2	FC 294	D	IJ	1	236.70	239.00	2	.0	.0	.0	54.6	2.00	6058	.00	F
3	FC 294	D	IJ	2	239.00	240.30	1	7.7	.0	.0	80.2	1.43	539	.00	F
4	FC 294	D	IJ	2	239.00	240.30	2	.0	.0	.0	86.8	1.55	584	.00	F
5	FC 294	D		3	261.10	262.00	1	1.4	.0	.0	90.8	.07	779	.00	F
6	FC 294	D		3	261.10	262.00	3	.0	.0	.0	92.1	.07	790	.00	F

FLOAT SINK DATA

SEQ NO.	DRILL HOLE NUMBER	FORMAT	SEAM CODE	SAMP NO	SP GR	TYPE CODE	% WT.	% VOL	% ASH	% SUL	BTU	SCREEN SIZE
1	FC 294	G	IJ	1	000160I	DF	8474	.00	8.62	1.20	0	0001
2	FC 294	G	IJ	2	000160I	DF	9954	.00	5.44	1.33	0	0001
3	FC 294	G	IJ	3	000160I	DF	9828	.00	7.85	1.27	0	0001
4	FC 294	G	IJ	4	000160I	DF	9766	.00	8.12	1.44	0	0001
5	FC 294	G	IJ	5	000160I	DF	8368	.00	9.35	.90	0	0001
6	FC 294	G	IJ	6	000160I	DF	9850	.00	5.39	1.00	0	0001
7	FC 294	G	IJ	7	000160I	DF	9804	.00	8.06	.59	0	0001
8	FC 294	G	IJ	8	000160I	DF	9942	.00	7.47	.68	0	0001
9	FC 294	G	IJ	9	000160I	DF	5584	.00	12.57	1.55	0	0001
10	FC 294	G	IJ	0	000160I	DF	9894	.00	8.08	1.93	0	0001
11	FC 294	G	IJ	1	000160I	DF	9062	.00	6.32	.85	0	0001
12	FC 294	G	IJ	2	000160I	DS	1526	.00	66.58	1.15	0	0001
13	FC 294	G	IJ	3	000160I	DS	0046	.00	40.62	3.77	0	0001
14	FC 294	G	IJ	4	000160I	DS	0172	.00	36.98	12.49	0	0001
15	FC 294	G	IJ	5	000160I	DS	0234	.00	46.34	1.19	0	0001
16	FC 294	G	IJ	6	000160I	DS	1632	.00	64.50	1.03	0	0001
17	FC 294	G	IJ	7	000160I	DS	0150	.00	54.71	2.36	0	0001
18	FC 294	G	IJ	8	000160I	DS	0196	.00	45.80	3.72	0	0001
19	FC 294	G	IJ	9	000160I	DS	0058	.00	26.47	.52	0	0001
20	FC 294	G	IJ	0	000160I	DS	4416	.00	64.55	2.28	0	0001
21	FC 294	G	IJ	1	000160I	DS	0106	.00	37.54	4.32	0	0001
22	FC 294	G	IJ	2	000160I	DS	0038	.00	41.88	1.68	0	0001

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FOUNDATION AND MATERIALS INVESTIGATION

SLURRY IMPOUNDMENT PONDS

CONSOLIDATION COAL COMPANY

August 1981

ROLLINS, BROWN AND GUNNELL, INC.
PROFESSIONAL ENGINEERS

1435 WEST 820 NORTH, P.O. BOX 711, PROVO, UTAH 84601
TELEPHONE 374-5771

RBG

FOUNDATION AND MATERIALS INVESTIGATION

SLURRY IMPOUNDMENT PONDS

CONSOLIDATION COAL COMPANY

August 1981

ROLLINS, BROWN AND GUNNELL, INC.
Professional Engineers
1435 West 820 North, P.O. Box 711
Provo, Utah 84601

ROLLINS, BROWN AND GUNNELL, INC.
PROFESSIONAL ENGINEERS

August 6, 1981

Consolidation Coal Company
Western Region
2 Inverness Drive East
Englewood, Colorado 80112

ATTN: Britt Luther

Gentlemen:

The subsurface investigation and laboratory tests have been completed for both the long term and the short term slurry impoundment sites at the Consolidation Company facilities near Emery, Utah. This report outlines the results of the investigation and presents the data obtained during the field and laboratory investigations.

The location of the impoundment sites relative to the mine office is presented in Figure No. 1. The long term site is designated as Impoundment Site No. 1, while the short term site is designated as Impoundment Site No. 2. The results of the field and laboratory tests performed during the investigation are discussed separately for the two impoundment sites, as follows.

I. IMPOUNDMENT SITE NO. 1

A. Characteristics of Subsurface Material Along Proposed Dam Axis

1. Subsurface Drilling. The characteristics of the subsurface material along the proposed dam axis were defined by drilling six test holes to depths of between 30 and 40 feet, at locations as shown in Figure No. 2. The logs for the six test holes are presented in Figure Nos. 3 through 5, and it will be observed that, except for Test Hole No. 6, the profile consisted of unconsolidated materials. It will also be observed from the boring logs that the subsurface material consisted predominantly of silty sands and sandy silts.

During the subsurface investigation, sampling was performed at approximately 3-foot intervals throughout the

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upper 15 feet of the soil profile, and at 5-foot intervals thereafter. Both disturbed and undisturbed samples were obtained during the field operations.

Undisturbed samples were obtained by driving a 2-inch split-spoon sampling tube through a distance of 18 inches, using a 140-pound weight dropped from a distance of 30 inches. The number of blows to drive the sampling spoon through each 6 inches of penetration is presented on the boring logs.

The sum of the last two blow counts, which represents the number of blows to drive the sampling spoon through 12 inches, is defined as the standard penetration value. The standard penetration value provides a reasonable indication of the in-place density of sandy type soils; however, it only provides an indication of the relative stiffness of cohesive type materials, since the penetration resistance of these materials is a function of the moisture content.

Undisturbed samples were obtained by pushing a 2.5-inch thin-walled shelby tube into the subsurface material, using the hydraulic pressure on the drill rig. The location at which undisturbed samples were obtained is presented on the boring logs.

Each sample obtained in the field was classified in the laboratory according to the Unified Soil Classification System. The symbols designating the soil types according to this system are presented on the boring logs. A description of the Unified Soil Classification System is presented in Figure No. 6, and the meaning of the various symbols shown on the boring logs can be obtained from this figure.

It will be observed that the subsurface materials generally classify as SM or ML type soils. Some CL-1 type materials were encountered in the lower portion of the soil profile at this site.

During the subsurface investigation, field permeability tests were performed at 5- to 10-foot intervals throughout the depth investigated. The field permeability tests were performed in accordance with Designation E18 of the U.S. Bureau of Reclamation Earth Manual. The results of the field permeability tests are presented in Table No. 1. It will be observed that the permeability coefficients varied from 48 feet per year to 2,460 feet per year.

The results of the field permeability tests indicate that the subsurface materials were moderately permeable, and that some treatment of the reservoir basin will likely be required to ensure a watertight facility.

2. Laboratory Tests. Classification tests were performed on a number of samples obtained from Drill Hole Nos. 3 and 5, and the results of these tests are presented in Table No. 2, Summary of Test Data. These two test holes represent the range in character of the subsurface material. It will be noted that the major portion of the subsurface material in Test Hole No. 3 classified as an ML type material; however, the material was essentially non-plastic. In Test Hole No. 5, most of the subsurface material was cohesive type soils and classified as a CL-ML, CL-1 or CL-2 type material. Some SM type soils were encountered in the upper portion of the soil profile. The plastic index of the clay materials in this Test Hole is relatively low and does not exceed 15 percent.

The compressibility characteristics of the subsurface material along the dam axis were defined by performing seven consolidation tests on representative samples obtained at 3 feet, 6 feet, 9 feet, 15 feet, 19 feet, 25 feet, and 28 feet. The samples at 3, 6 and 9 feet below the existing ground surface were obtained from test pits. The results of the consolidation tests are presented in Figure Nos. 7 through 13.

The subsurface materials represented by the consolidation tests at 3 through 9 feet in Test Hole No. 5 were silty sands, and exhibited collapsible type characteristics. The remainder of the consolidation tests, which were performed on cohesive type material from Test Hole No. 5, are not highly compressible soils; however, considerable settlement can be expected in these materials if the surface loads are sufficiently great.

Two triaxial shear tests were performed on undisturbed samples obtained from Test Pit No. 3 and Test Pit No. 5, at depths of 3 and 28 feet respectively. The results of these tests are presented in Figure Nos. 14 and 15. It will be noted that the sample obtained from Test Pit No. 3 had a friction angle of 30.6 degrees and a cohesion of 3 psi, while the sample obtained at a depth of 28 feet in Test Pit No. 5 had a friction angle of 27.3 degrees and a cohesion of 2 psi.

The triaxial shear tests performed as indicated above were consolidated, undrained tests with pore pressure measurements. The Mohr Envelopes shown in Figure Nos. 14 and 15 were obtained by subtracting the pore pressures from the total stresses, to obtain the Effective Stress Envelope shown in Figure Nos. 14 and 15.

B. Available Embankment Material

1. Field Investigations. The characteristics of the available embankment material were defined by excavating five test pits to depths of between 12 and 15 feet, at locations as shown in Figure No. 2. It will be noted that Test Pit Nos. 1, 2 and 5 were excavated along the dam axis, while Test Pit Nos. 3 and 4 were excavated in the reservoir basin. The logs for the five test pits are presented in Figure Nos. 16 through 18, and it will be observed that the subsurface material throughout the depth investigated consisted primarily of silty sand and sandy silt.

During the excavation of the test pits, in-place density tests and natural moisture content were determined at various locations throughout the profile. Sampling was performed at approximately 3-foot intervals in each of the test pits, and the classification designation according to the Unified Soil Classification System is presented on the test pit logs.

A description of the Unified Soil Classification System is presented in Figure No. 6, and the meaning of the various symbols shown on the test pit logs can be obtained from this figure.

It will be observed that the subsurface material in the test pits generally classifies as an ML type material; however, some SM type soils exist throughout the area. The in-place density and the natural moisture content were performed on a number of samples during the laboratory investigations, and the results of these tests are presented in Table No. 3, Summary of Test Data.

The moisture-density relationships were performed on six representative samples obtained from Test Pit Nos. 1, 2, 3 and 4, and the results of these tests are presented in Figure Nos. 19 through 24. A summary of the maximum density and the optimum moisture content for each of these tests, along with the classification tests, is presented in Table No. 4.

It will be noted that the in-place unit weight varies from about 104 to 115 pounds per cubic foot, while the optimum moisture content varies from about 12 to 16 percent. It is our opinion that, while this material is not the best kind of material for an earth embankment, it can be used satisfactorily for the proposed facility.

Two triaxial shear tests were performed on compacted samples obtained at a depth of 3 feet below the ground surface, from Test Pit No. 5, and at a depth of between 4 and 12 feet from Test Pit No. 3. The results of these tests are presented in Figure Nos. 25 and 26. The triaxial shear tests performed were consolidated, undrained tests with pore pressure measurements. The pore pressures were subtracted from the total stresses to obtain the Effective Mohr Envelope shown in Figure Nos. 25 and 26. It will be noted that the sample obtained from Test Pit No. 5 had a friction angle of 22.8 degrees and a cohesion of 9 pounds per square inch, while the sample obtained at a depth of 4 to 12 feet in Test Pit No. 3 had a friction angle of 32.3 degrees and a cohesion of 2.5 pounds per square inch. The samples used in the triaxial shear tests were compacted to 95 percent of the maximum laboratory density as determined by ASTM D 698-70.

Laboratory permeability tests were performed on representative samples obtained from Test Pit Numbers 3 and 4. Prior to initiating the permeability tests, the samples were back-pressured to ensure saturation. Permeability tests were performed using either the constant head or the falling head permeameter method. The falling head permeameter method was used on the more permeable soils, while the constant head permeameter method was used on the relatively impervious materials. The results of the laboratory permeability tests are presented in Figure No. 4, Summary of Test Data. It will be noted that permeability coefficients varying from 0.30 to 3.4 feet per year were obtained. It will also be noted that the samples were densified to values ranging from 94 to 97 percent of the maximum laboratory density as determined by ASTM D 698-78.

A hydrometer analysis was performed on four samples from Test Pit Nos. 3 through 5. The results of these tests are presented in Figure Nos. 27 and 28. It will be observed that the major portion of these materials was in the silt and clay size range.

II. IMPOUNDMENT SITE NO. 2

A. Characteristics of the Subsurface Material Along the Proposed Dam Axis

1. Subsurface Drilling. The characteristics of the subsurface material where Site No. 2 will be located were defined by drilling two test borings to a depth of approximately 30 feet at locations as shown in Figure No. 29. The logs for the two test holes are presented in Figure No. 30, and it will be noted that essentially all of Test Hole No. 1 consisted of shale, while the upper part of Test Hole No. 2 consisted of brown, silty, sandy gravel underlain by shale.

Sampling was performed in the unconsolidated materials in the manner described for Impoundment Site No. 1. The results of the standard penetration tests and the classification tests associated with the unconsolidated material are presented on the boring logs. It was not possible to sample the shale material with the standard spoon, and all of the material in these holes was cored an NX core barrel.

Field permeability tests were performed in the test holes at this site in accordance with Designation E18 of the U.S. Bureau of Reclamation Earth Manual, and the results of these tests are presented in Table No. 6. It will be observed that the permeability coefficient in feet per year varied from about 82 feet per year to 631 feet per year in Test Hole No. 1, while the permeability coefficient varied from 123 feet per year to nearly 6,000 feet per year in Test Hole No. 2. It should be noted that the higher permeability coefficients existed in the lower 15 to 30 feet of the soil profile, and that the material in the upper 15 feet of the soil profile was only moderately permeable.

2. Laboratory Tests. Classification tests were performed on the subsurface material in the upper 15 feet of Test Hole No. 1, and the results of these tests are presented in Table No. 7, Summary of Test Data. It will be noted that the shale material in this test hole generally classified as a CL-1 or as a CL-2 type material. The in-place unit weight and the natural moisture content were also determined for four samples of the shale in this test hole. The results of these tests are presented in Table No. 7, and it will be observed that the shale had an in-place unit weight varying from 122 to 125 pounds per cubic foot, while the natural moisture content varied from 15 to 6.5 percent.

Four consolidation tests were performed on representative samples of the shale material at depths of 10, 12, 14 and 15 feet in Test Hole No. 1. The results of the consolidation tests are presented in Figure Nos. 31 through 34. During the performance of the consolidation tests on the shale, the sample was loaded initially at approximately 0.29 tons per square foot. At this point in the loading sequence, the sample was permitted to absorb water to determine if the shale material possessed swelling type properties. It will be noted that, in each of the four consolidation samples tested, the shale swelled substantially. The results of the consoldiation tests indicate that the shales have a swell pressure varying from about 2 to 5 tons per square foot.

No drill holes were performed in the lower portion of the channel where the embankment will be placed. In order to obtain an indication of the strength of the overburden materials in this area, two triaxial shear tests were performed on representative undisturbed samples obtained from Test Pit Nos. 7 and 8 in this area. The results of these tests are presented in Figure Nos. 35 and 36 . It should be noted that the triaxial shear tests were consolidated, undrained tests with pore pressure measurements. The pore pressures were subtracted from the total stress to obtain the Effective Mohr Envelope as shown in each of the figures. It will be noted that a friction angle of 23 degrees and a cohesion of 6 psi was obtained for a sample taken from 1 to 4 feet in Test Pit No. 7, while a friction angle of 34.6 degrees and a cohesion of 4 psi was obtained for a sample taken at 1.5 to 3 feet in Test Pit No. 8.

B. Available Embankment Material

1. Field Investigations. The characteristics of the available embankment material throughout the area were defined by excavating three test pits to depths varying from 2 to 10 feet, at locations as shown in Figure No. 29 . The logs for these three test pits are presented in Figure No. 37. It will be noted that shale was encountered at essentially all depths in Test Pit Nos. 7 and 8, and that sandstone was encountered in Test Pit No. 6. It appears as if a substantial portion of the proposed embankment at this location must be constructed from the weathered shale existing throughout the area.

Classification tests were performed on representative samples of the weathered shale in Test Pit Nos. 7 and 8, and the results of these tests are presented in Table No. 8. It will be noted that the shale classifies as either an ML or a CL-1 type material according to the Unified Soil Classification System.

Soil moisture-density relationships were performed for three samples of the weathered shale obtained from Test Pit Nos. 7 and 8, and the results of these tests are presented in Figure Nos. 38 through 40 . The maximum density, along with the optimum moisture content for these samples, is summarized in Table No. 8, and it will be observed that the maximum density varies from about 106 pounds per cubic foot for the ML material to 116 pounds per cubic foot for the CL-1 type soil. The optimum moisture content varied from 13 to 18 percent.

Triaxial shear tests were performed on compacted samples of the shale material obtained at a depth of 4 to 7 feet in Test Pit No. 7 and at a depth of 3 to 6 feet in Test Pit No. 8. Each of the samples was compacted to 95 percent of the maximum laboratory density as determined by ASTM D 698-70. The results of the triaxial shear tests are presented in Figure Nos. 41 and 42 . It will be noted that the sample obtained from Test Pit No. 7 had a friction angle of 27.3 degrees and a cohesion of 7 psi, while the sample obtained from Test Pit No. 8 had a friction angle of 24.9 degrees and a cohesion of 6 psi. The triaxial shear tests were consolidated, undrained tests with pore pressure measurements. The pore pressures were subtracted from the total stress to obtain the Effective Stress Envelope as shown in Figure Nos. 41 and 42 .

Laboratory permeability tests were performed on two samples obtained from Test Pit Nos. 7 and 8. The samples were compacted to 95± percent of the maximum laboratory density and were back-pressured prior to initiation of the permeability tests. The permeability tests were performed under constant head conditions. The results of the permeability tests are presented in Table No. 8, and it will be observed that the permeability coefficients varied from 0.055 to 0.0075 feet per year. It will also be noted that the samples were compacted at 95.2 and 93.9 percent of the maximum laboratory density as determined by ASTM D 698-78.

A hydrometer analysis was performed on two samples obtained from Test Pit Nos. 7 and 8, and the results of these tests are presented in Figure No. 43. It will be observed from this figure that over 95 percent was less than a 200 Sieve, and nearly 50 percent of the material was in the clay size range.

Two CBR tests were performed on samples obtained by representatives of Consolidation Coal Company from Test Pits designated as Nos. 20 and 21. The results of the CBR tests are presented in Figure Nos. 44 and 46, and it will be observed that the CBR value varied from approximately 1 percent for Test Pit No. 20 to 3.5 percent for Test Pit No. 21. The soil moisture-density relationships for each of the samples used in the CBR tests are presented in Figure Nos. 45 and 47. Each sample was permitted to saturate for a 4-day period prior to the completion of the test. The sample obtained from Test Pit No. 20 classified as a CL-ML soil, while the material obtained from Test Pit No. 21 classified as a CL-1 type material, according to the Unified Soil Classification System. The differences in the CBR values cannot be explained based upon the maximum density of each sample.

It is our opinion that the tests performed during this investigation provide a reasonable indication of the characteristics of the subsurface material in the vicinity of the slurry impoundment ponds, and if there are any questions relative to the information contained herein, please advise us.

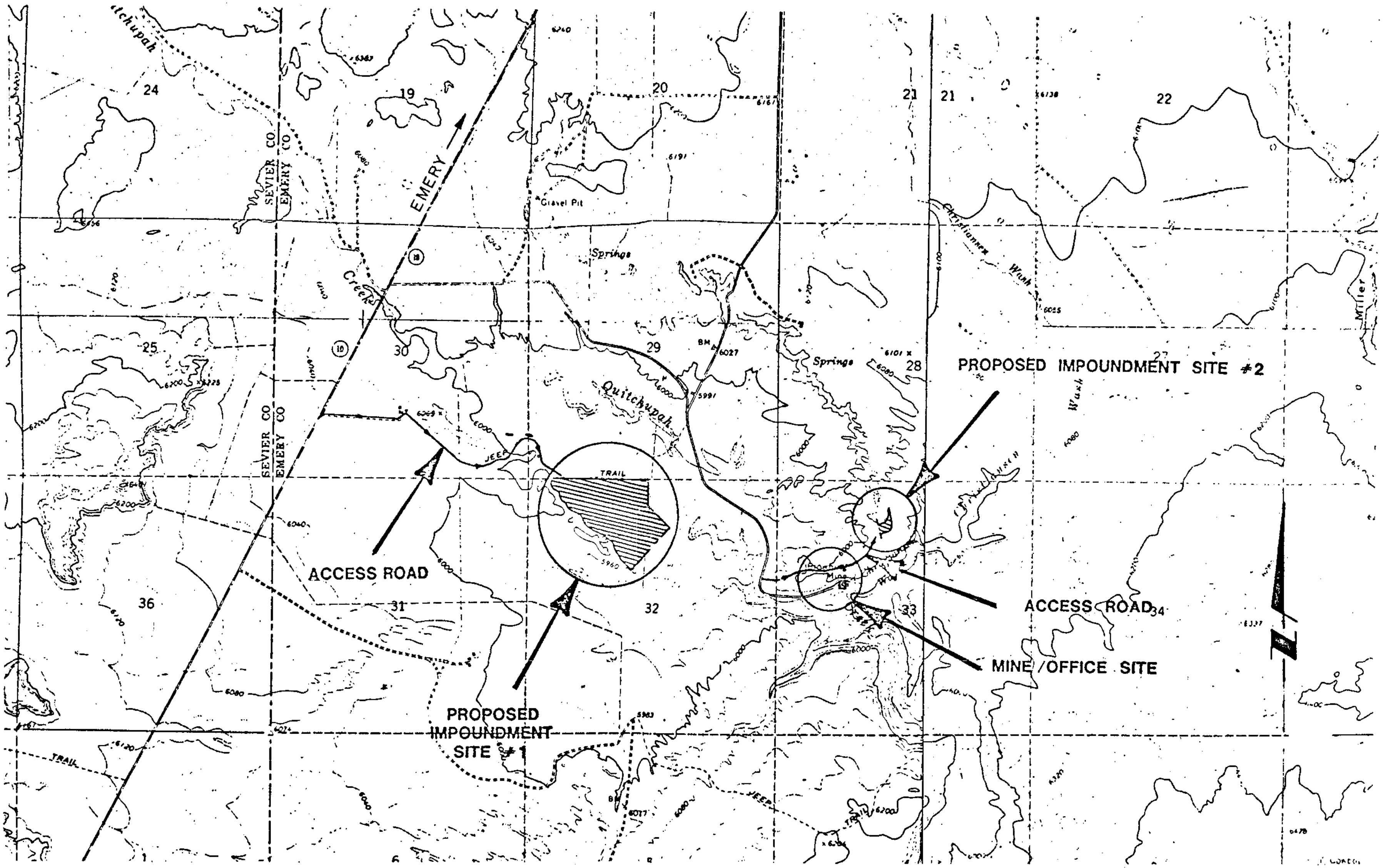
Yours truly,

ROLLINS, BROWN AND GUNNELL, INC.

Ralph L. Rollins

Ralph L. Rollins

kf



SCALE DESIGNED ______ CHECKED ______ DRAWN ______ DATE ______ APPROVED ______ LICENSE NO. ______	**ROLLINS, BROWN & GUNNELL, Inc.** CONSULTING ENGINEERS	CONSOLIDATION COAL COMPANY Location of the Impoundment Sites	Figure No. 1

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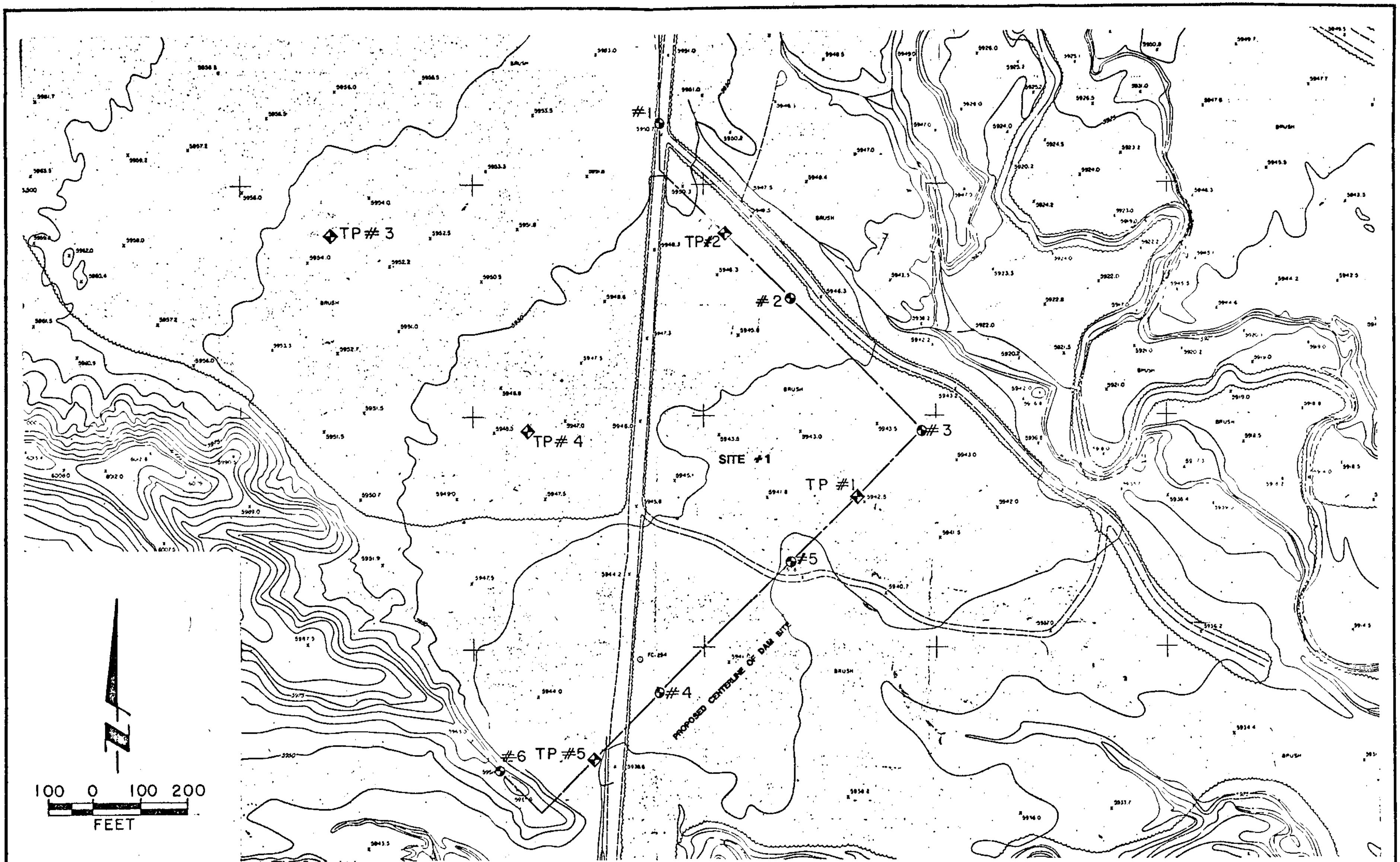

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APPROVED ______ LICENSE NO. ______

ROLLINS, BROWN & GUNNELL, Inc.
CONSULTING ENGINEERS

IMPOUNDMENT SITE NO. 1
Location of Drill Holes and Test Pits

Figure No. 2

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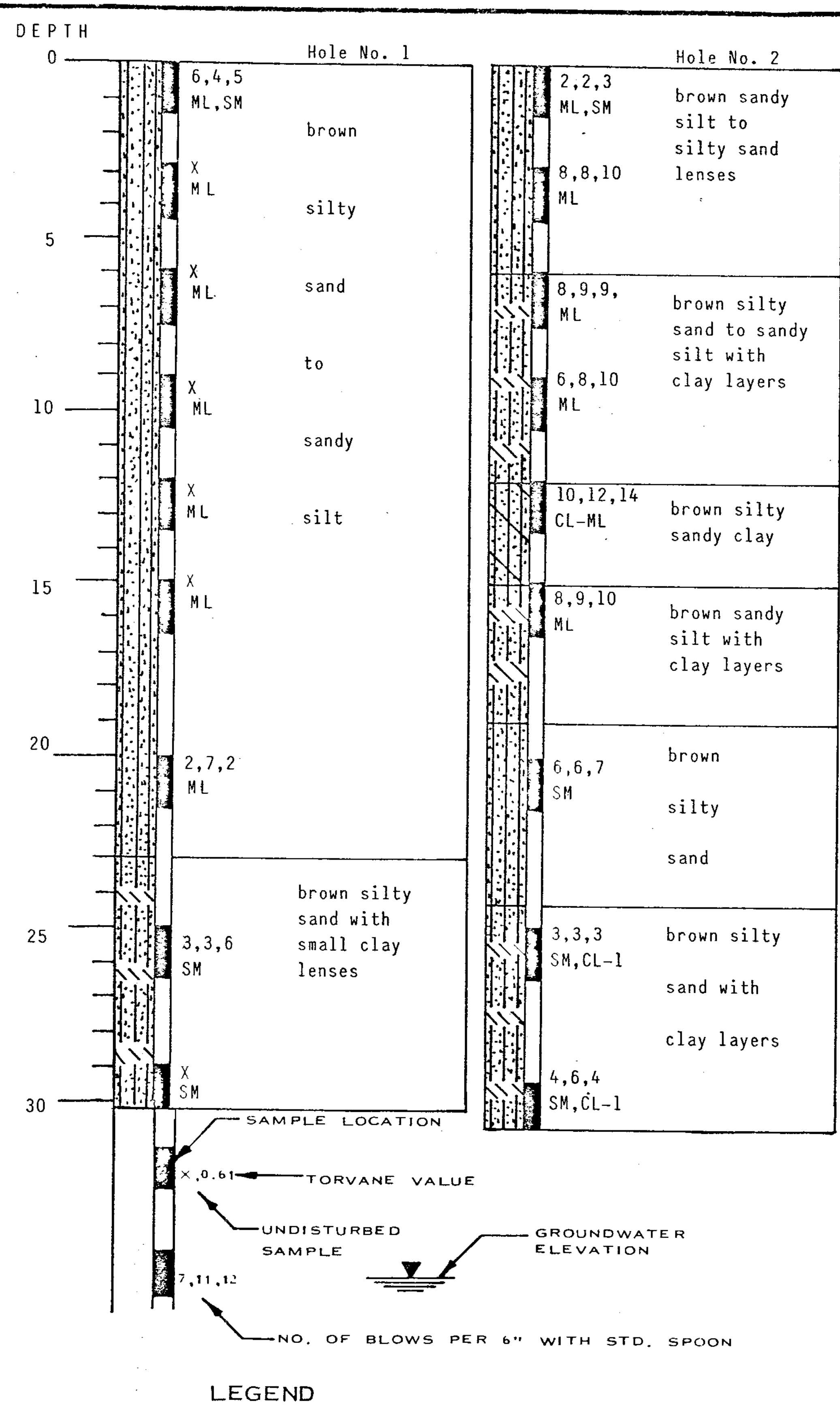
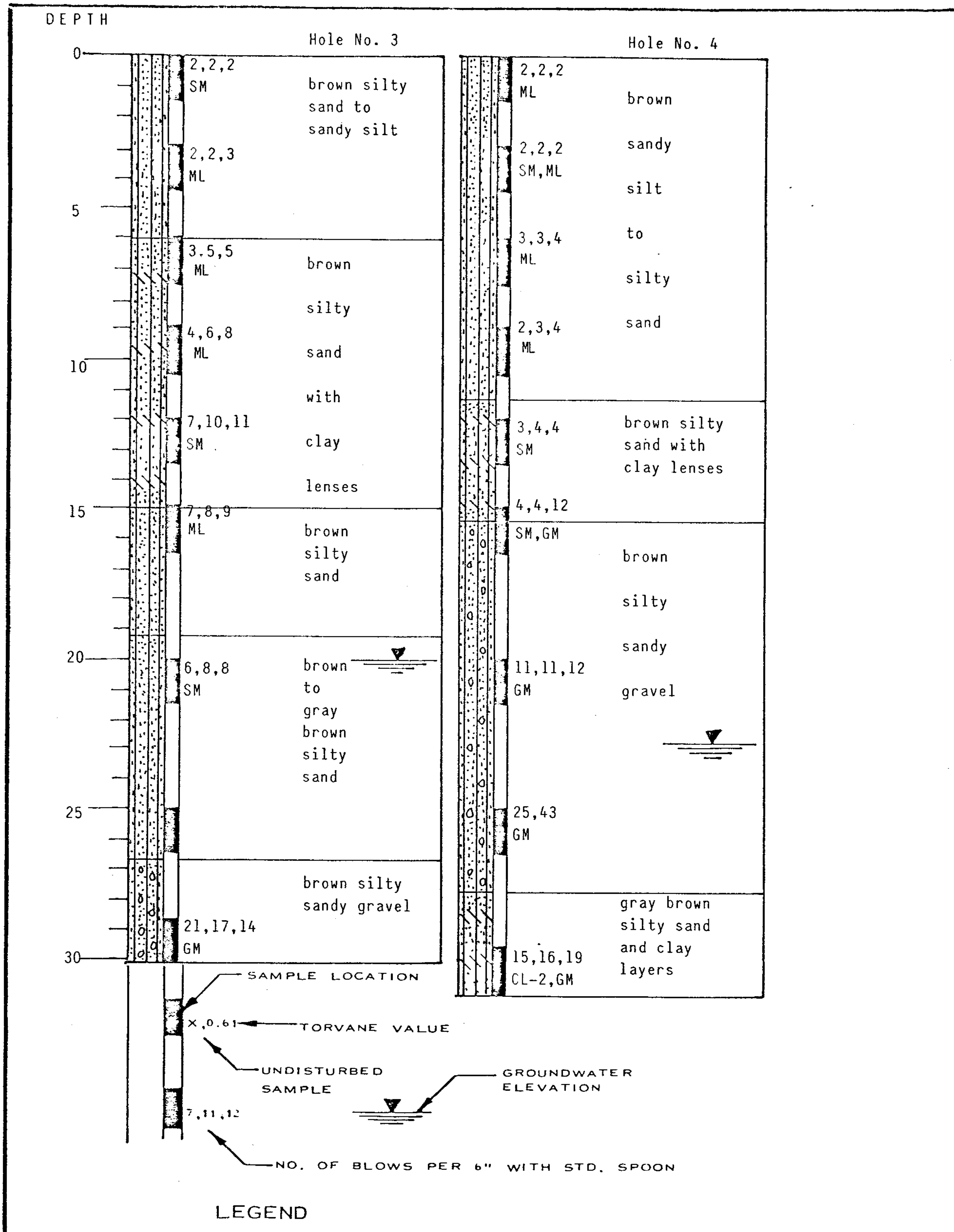
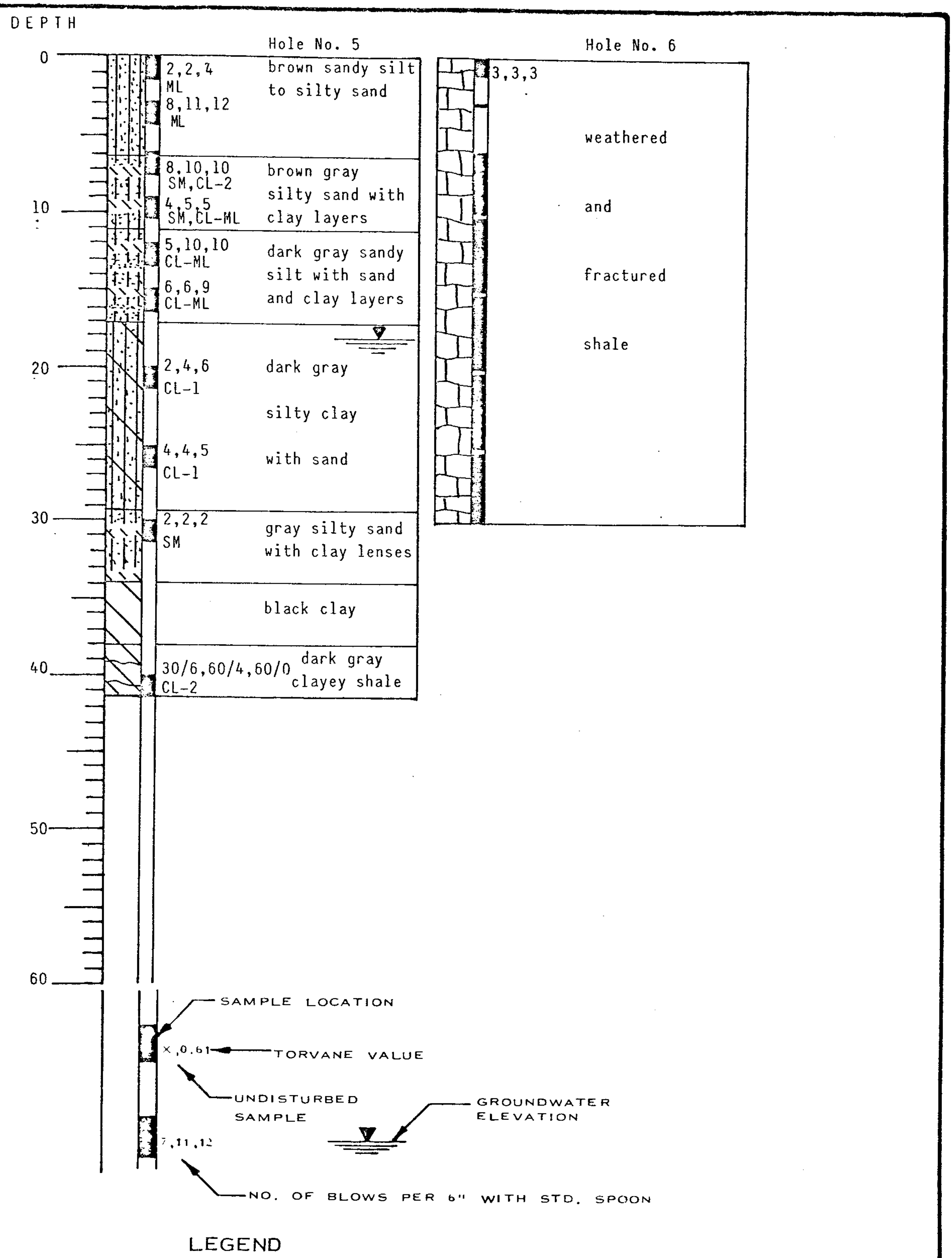


LOG OF BORINGS FOR: Consolidation Coal Co. Impoundment Site 1	ROLLINS, BROWN AND GUNNELL, INC. CONSULTING ENGINEERS	FIGURE No. 3



Log of Borings for: Consolidation Coal Co. Impoundment Site 1	ROLLINS, BROWN AND GUNNELL, INC. Consulting Engineers	Figure No. 4

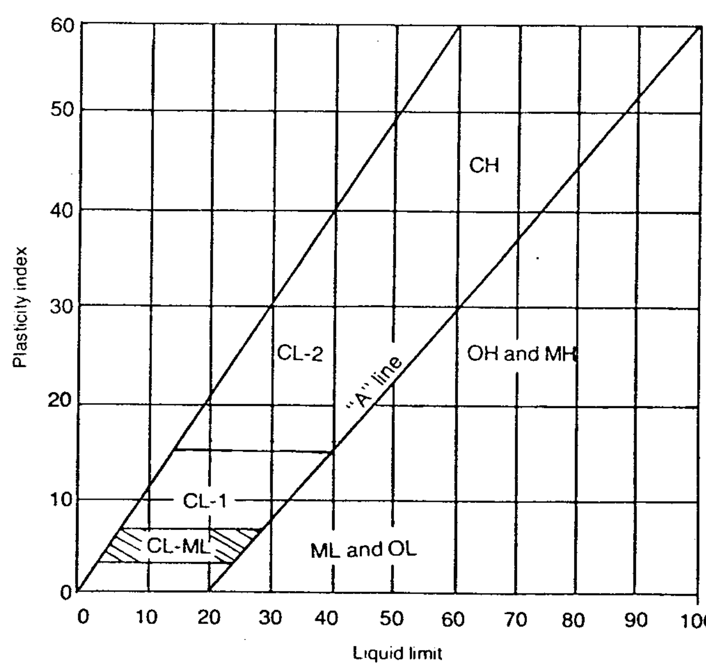


LOG OF BORINGS FOR: Consolidation Coal Co. Impoundment Site 1	ROLLINS, BROWN AND GUNNELL, INC. CONSULTING ENGINEERS	FIGURE No. 5

FIGURE NO. 6

Unified Soil Classification System

Major divisions			Group symbols	Typical names	Laboratory classification criteria		
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent .... GW, GP, SW, SP; More than 12 percent .... GM, GC, SM, SC; 5 to 12 percent .... Borderline cases requiring dual symbols**	$Cu = \frac{D_{60}}{D_{10}}$ greater than 4, $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM* d/u	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines		$Cu = \frac{D_{60}}{D_{10}}$ greater than 6, $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM* d/u	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are borderline cases requiring use of dual sysbols.
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. less than 7	
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity			
			CL 1/2	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity, organic silts			
Highly organic soils			Pt	Peat and other highly organic soils			



Plasticity Chart

*Division of GM and SM groups into subdivisions of d and u for roads and airfields only. Subdivision is based on Atterberg limits, suffix d used when L. L. is 28 or less and the P.I. is 6 or less, the suffix u used when L. L. is greater than 28.

** Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. or example: GW-GC, well-graded gravel-sand mixture with clay binder.

TABLE NO. 1

IMPOUNDMENT SITE NO. 1
RESULTS OF FIELD PERMEABILITY TESTS

Hole No.	Depth (ft)	Permeability (ft/yr)
1	0- 5	328
	5-10	328
	10-15	180
	15-20	176
	20-25	164
	25-30	410
2	0- 5	984
	5-10	273
	10-15	131
	15-20	59
	20-25	82
	25-30	113
3	0- 5	820
	5-10	98
	10-15	106
	15-20	50
	20-25	62
	25-30	80
4	0- 5	656
	5-10	191
	10-15	164
	15-20	82
	20-25	143
	25-30	428
5	0- 5	820
	5-10	328
	10-15	213
	15-20	23
	20-25	456
	25-30	456
6	0- 5	2460
	5-10	547
	10-15	9840
	15-20	82
	15-25	55
	15-30	48

TABLE NO. 2 SUMMARY OF TEST DATA

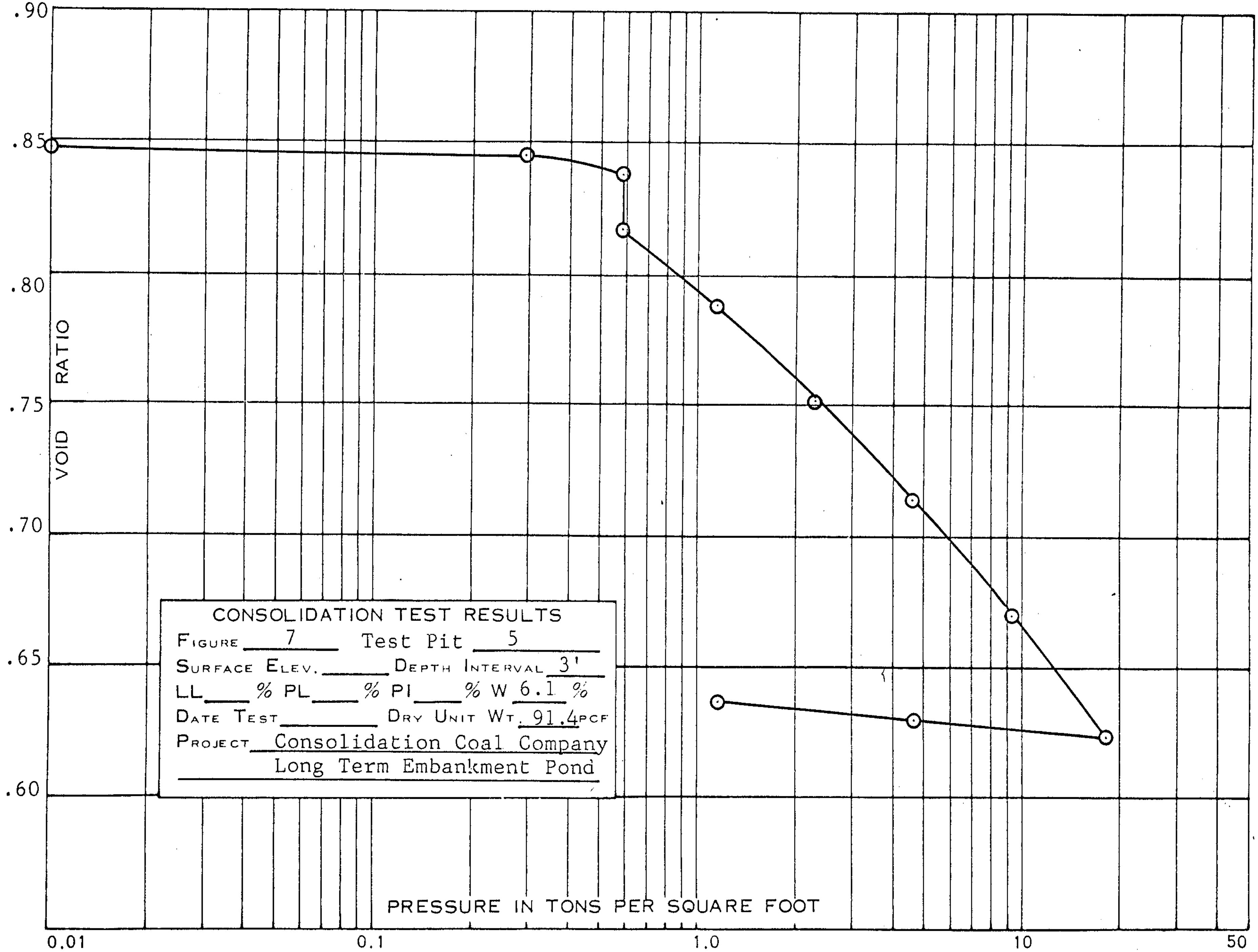
PROJECT Consolidation Coal Co. Long Term Embankment Pond FEATURE Foundations (Drill Holes) LOCATION Emery, Utah

HOLE NO.	DEPTH BELOW GROUND SURFACE	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE UNIT WEIGHT LB/FT^3	IN-PLACE MOISTURE PERCENT	IN-PLACE VOID RATIO	UNCONFINED COMPRESSIVE STRENGTH LB/FT^2	FRICTION ANGLE ϕ	CONSISTENCY LIMITS L.L. %	CONSISTENCY LIMITS P.L. %	CONSISTENCY LIMITS P.I. %	MECHANICAL ANALYSIS % GRAVEL	MECHANICAL ANALYSIS % SAND	MECHANICAL ANALYSIS % SILT & CLAY	UNIFIED SOIL CLASSIFICATION SYSTEM
3	3-4½'							NON	- PLASTIC		0.0	28.1	71.9	ML
	6-7½'							NON	- PLASTIC		0.0	36.4	63.6	ML
	9-10½'							NON	- PLASTIC		0.0	40.8	59.2	ML
	12-13½'							NON	- PLASTIC		0.0	52.7	48.0	SM
	15-16½'							NON	- PLASTIC		0.0	40.0	60.0	ML
	20-21½'							NON	- PLASTIC		0.0	64.7	35.3	SM
5	3-4½'							NON	- PLASTIC		0.0	49.0	51.0	ML
	6-7½'							32.5	17.3	15.2	0.0	24.3	75.7	SM,CL-2
	9-10½'							23.2	16.9	6.3	0.0	22.2	77.8	SM,CL-ML
	12-13½'							22.4	16.3	6.1				CL-ML
	15-16½'	shelby	108.0	18.6				24.5	18.7	5.8				CL-ML
	19-20½'	shelby	108.7	16.4				27.9	16.6	11.3				CL-1
	20-21½'							29.2	17.6	11.6				CL-1
	25-26½'		104.4	19.8				31.7	17.3	14.4				CL-1
	28-29½'		102.5	20.9				29.2	17.0	12.2				CL-1

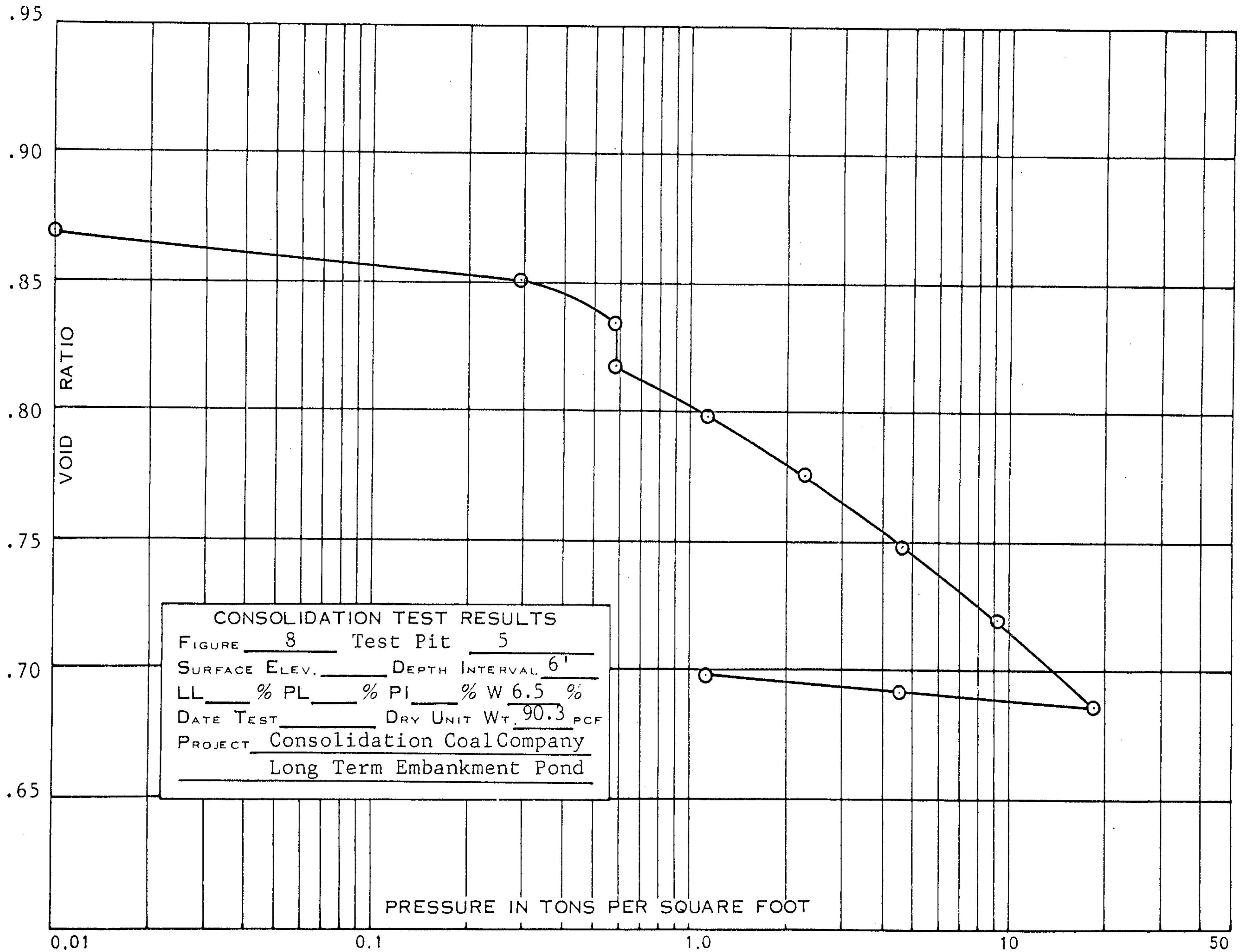
TABLE NO. 2 SUMMARY OF TEST DATA

PROJECT Consolidation Coal Co. Long Term Embankment Pond FEATURE Foundations (Drill Holes) LOCATION Emery, Utah

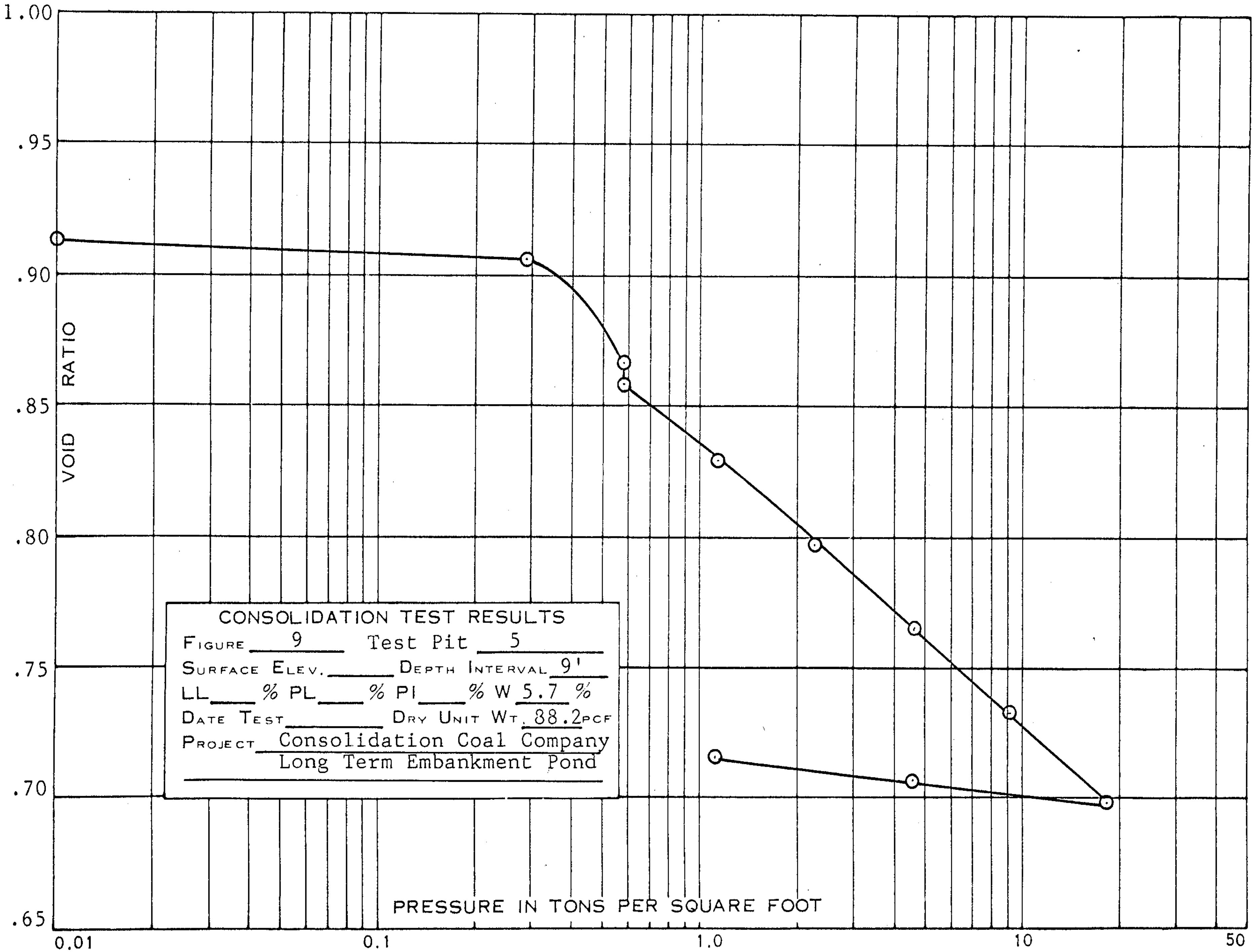
HOLE NO.	DEPTH BELOW GROUND SURFACE	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE UNIT WEIGHT LB/FT^3	IN-PLACE MOISTURE PERCENT	IN-PLACE VOID RATIO	UNCONFINED COMPRESSIVE STRENGTH LB/FT^2	FRICTION ANGLE ϕ	CONSISTENCY LIMITS L.L. %	CONSISTENCY LIMITS P.L. %	CONSISTENCY LIMITS P.I. %	MECHANICAL ANALYSIS % GRAVEL	MECHANICAL ANALYSIS % SAND	MECHANICAL ANALYSIS % SILT & CLAY	UNIFIED SOIL CLASSIFICATION SYSTEM
5	30-31½'	4									0.0	27.1	72.9	ML
	40-41½'	90/10"						40.6	18.8	21.8				CL-2

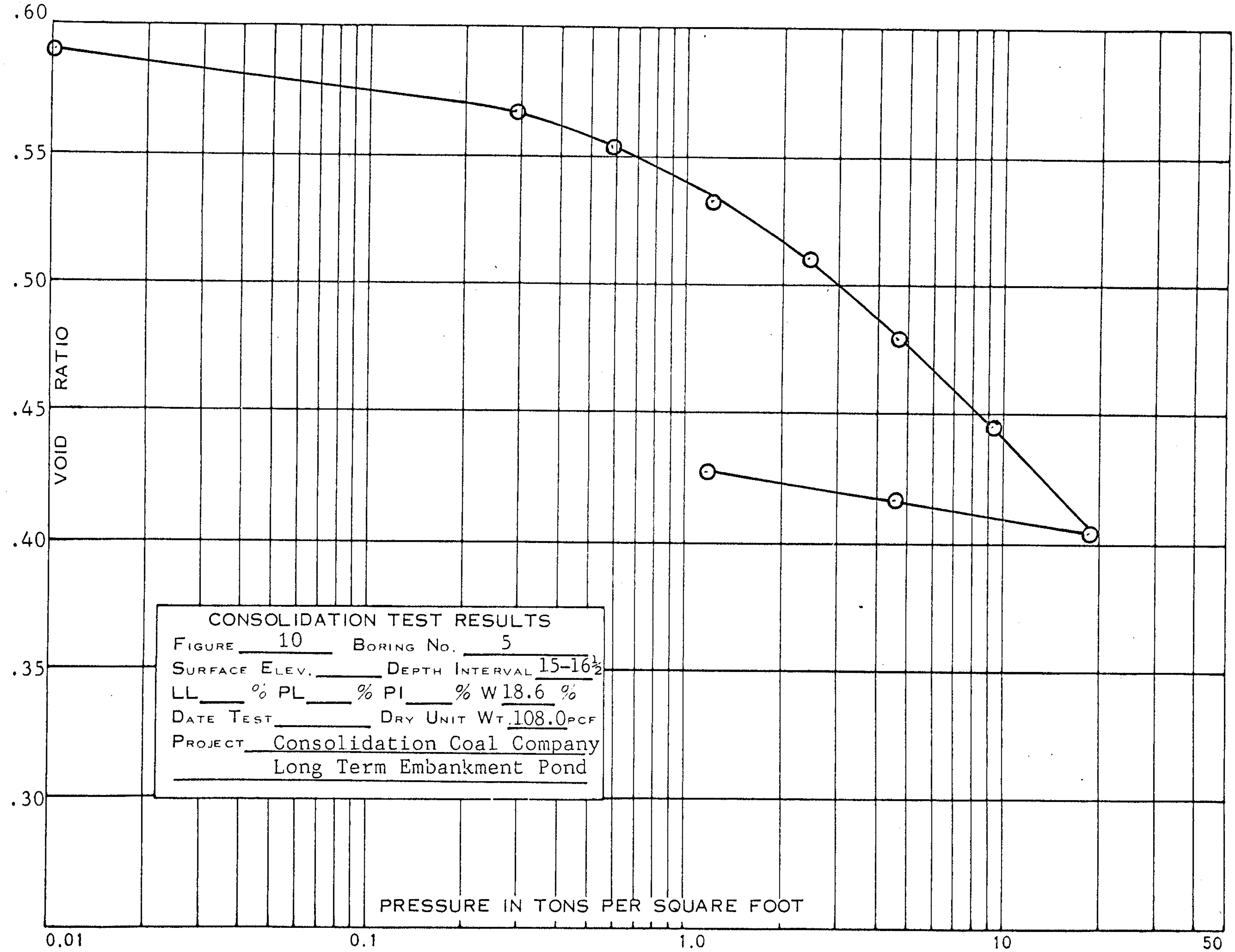


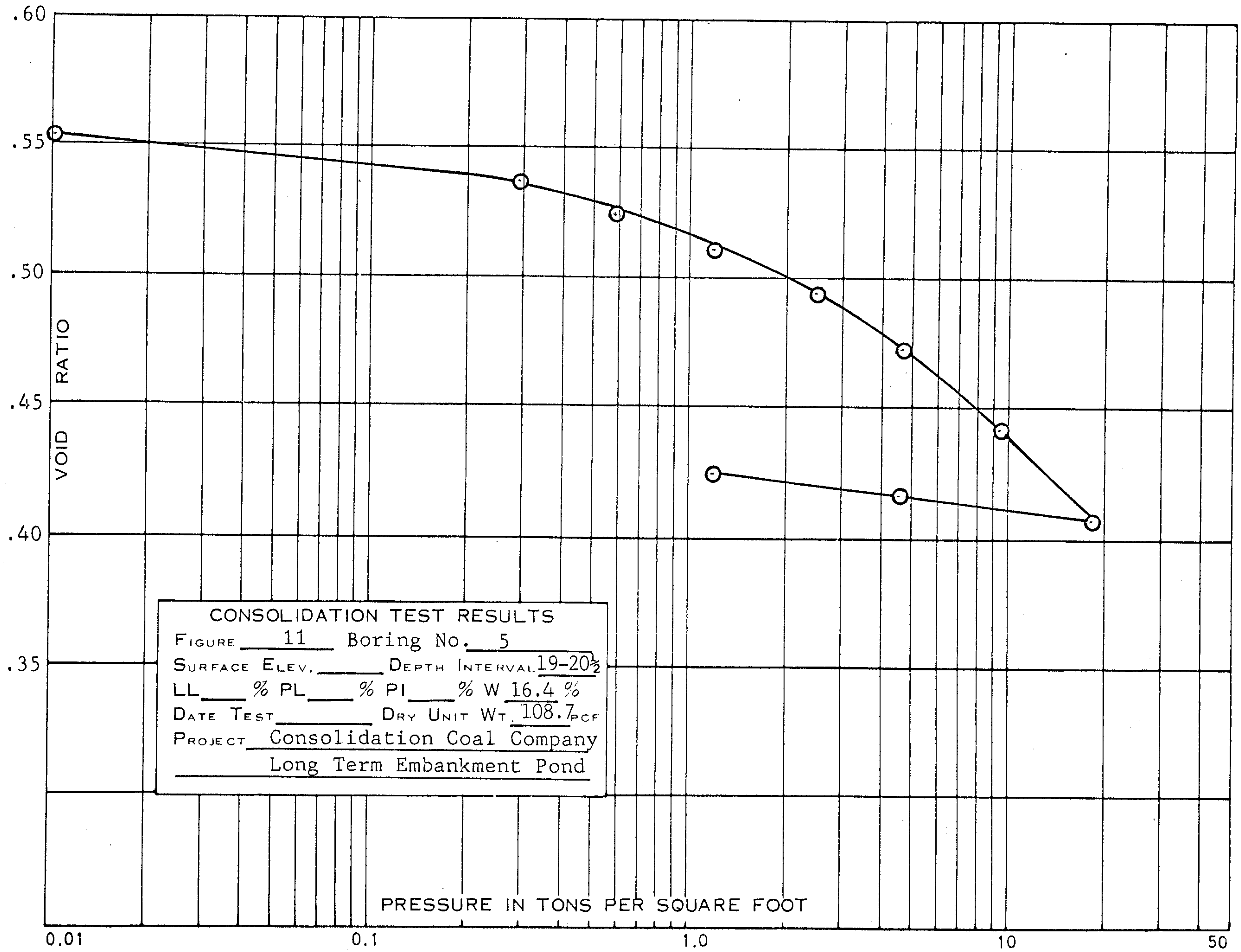
.90
.85
.80
.75
.70
.65
.60
VOID RATIO
CONSOLIDATION TEST RESULTS
FIGURE 7 Test Pit 5
SURFACE ELEV. DEPTH INTERVAL 3'
LL % PL % PI % W 6.1 %
DATE TEST DRY UNIT WT. 91.4 PCF
PROJECT Consolidation Coal Company
Long Term Embankment Pond
PRESSURE IN TONS PER SQUARE FOOT
0.01
0.1
1.0
10
50



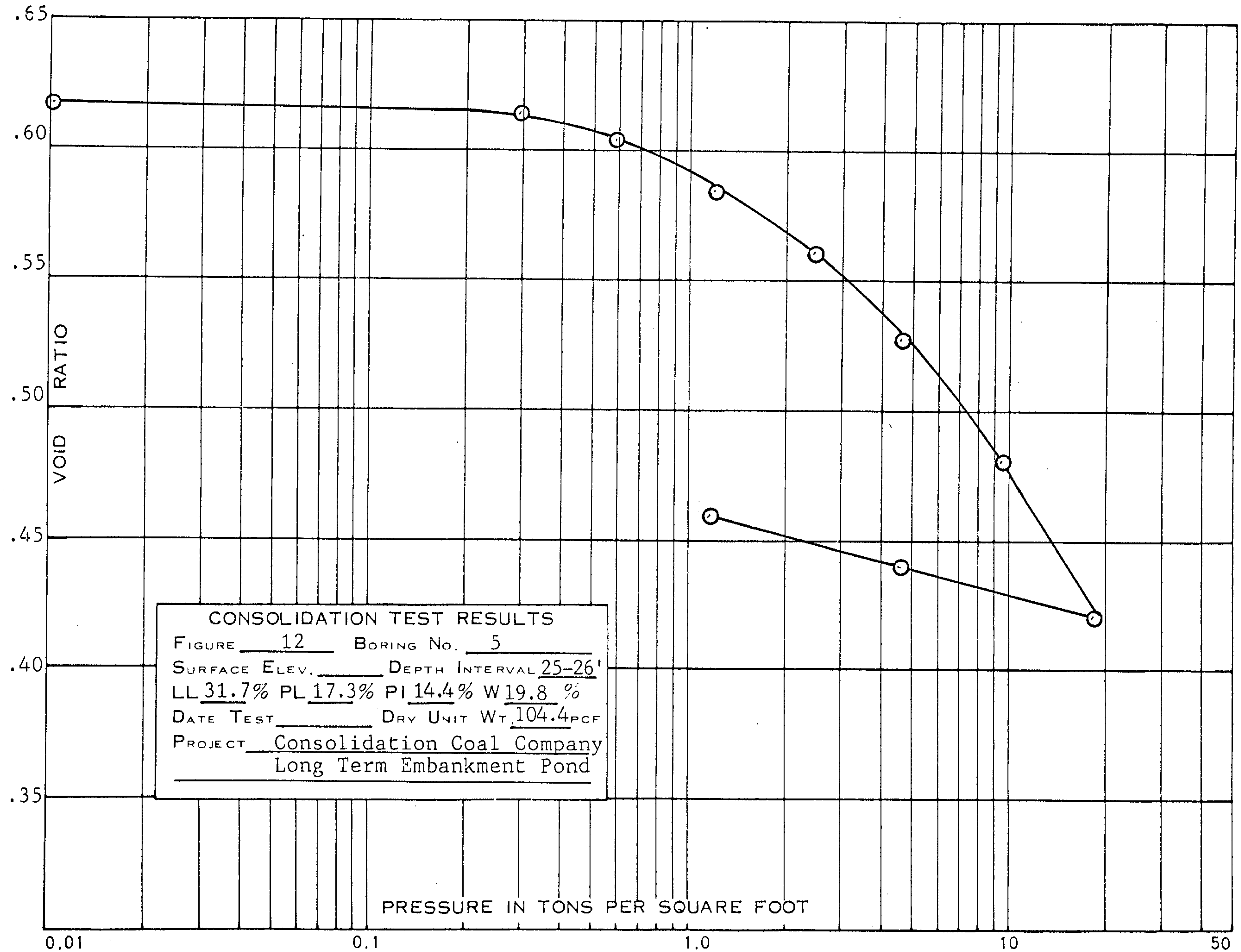
.95
.90
.85
.80
.75
.70
.65
VOID RATIO
CONSOLIDATION TEST RESULTS
FIGURE 8 Test Pit 5
SURFACE ELEV. DEPTH INTERVAL 6'
LL % PL % PI % W 6.5 %
DATE TEST DRY UNIT WT. 90.3 PCF
PROJECT Consolidation Coal Company
Long Term Embankment Pond
PRESSURE IN TONS PER SQUARE FOOT
0.01
0.1
1.0
10
50


CONSOLIDATION TEST RESULTS
FIGURE 9 Test Pit 5
SURFACE ELEV. DEPTH INTERVAL 9'
LL % PL % PI % W 5.7 %
DATE TEST DRY UNIT WT. 88.2 PCF
PROJECT Consolidation Coal Company
Long Term Embankment Pond
VOID RATIO
PRESSURE IN TONS PER SQUARE FOOT
1.00
.95
.90
.85
.80
.75
.70
.65
0.01
0.1
1.0
10
50

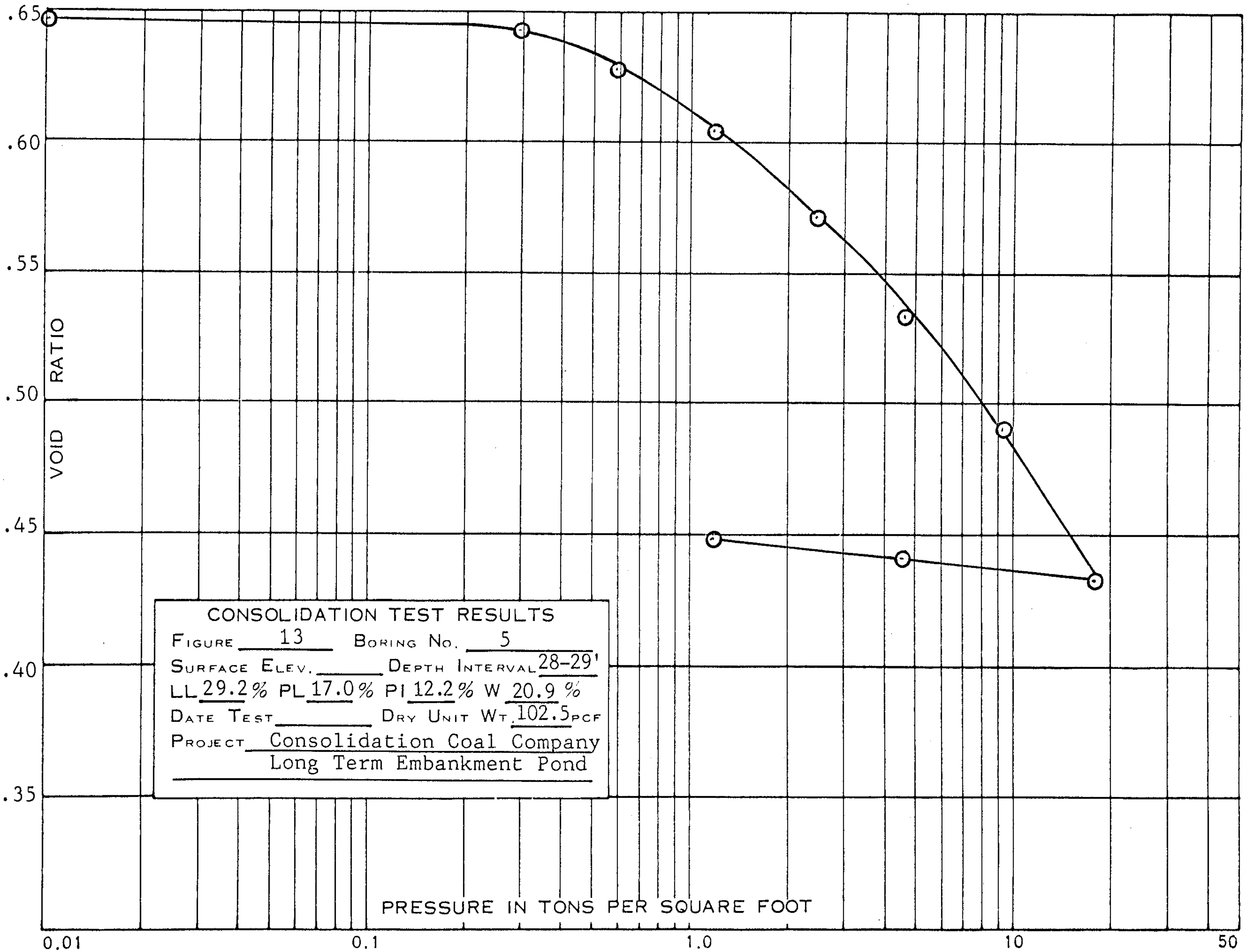

.60
.55
.50
.45
.40
.35
.30
VOID RATIO
PRESSURE IN TONS PER SQUARE FOOT
0.01
0.1
1.0
10
50
CONSOLIDATION TEST RESULTS
FIGURE 10 BORING NO. 5
SURFACE ELEV. ______ DEPTH INTERVAL 15-16½
LL ___ % PL ___ % PI ___ % W 18.6 %
DATE TEST ______ DRY UNIT WT. 108.0 PCF
PROJECT Consolidation Coal Company
Long Term Embankment Pond

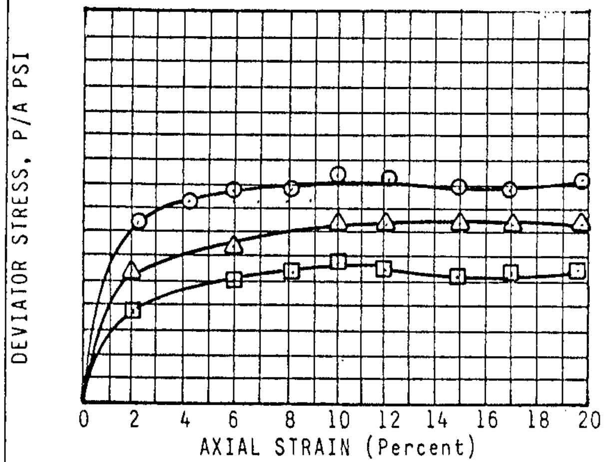


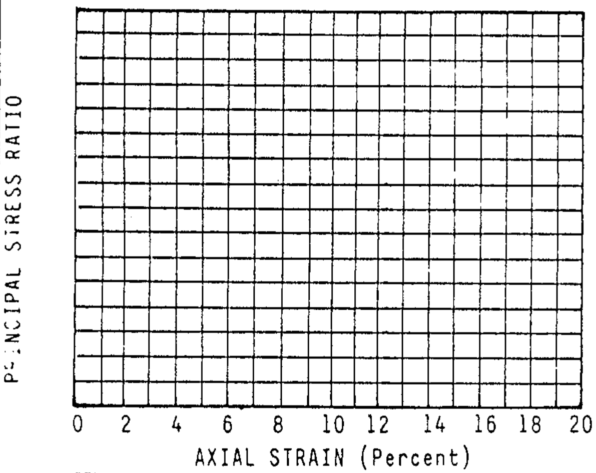
.60
.55
.50
.45
.40
.35
VOID RATIO
CONSOLIDATION TEST RESULTS
FIGURE 11 Boring No. 5
SURFACE ELEV. ____ DEPTH INTERVAL 19-20½
LL ___ % PL ___ % PI ___ % W 16.4 %
DATE TEST ______ DRY UNIT WT. 108.7 PCF
PROJECT Consolidation Coal Company
Long Term Embankment Pond
PRESSURE IN TONS PER SQUARE FOOT
0.01
0.1
1.0
10
50

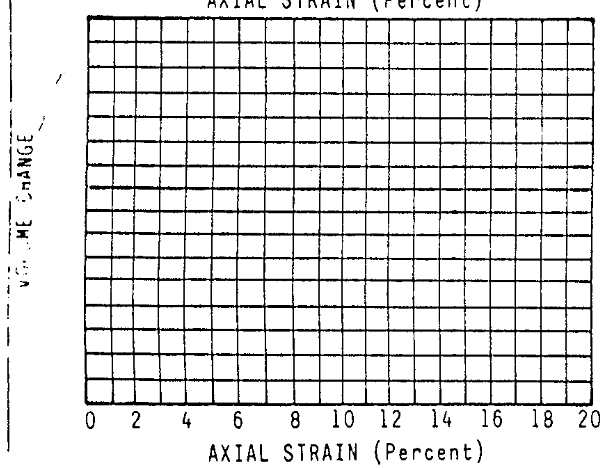


.65
.60
.55
.50
.45
.40
.35
VOID RATIO
CONSOLIDATION TEST RESULTS
FIGURE 12 BORING NO. 5
SURFACE ELEV. DEPTH INTERVAL 25-26'
LL 31.7% PL 17.3% PI 14.4% W 19.8 %
DATE TEST DRY UNIT WT. 104.4 PCF
PROJECT Consolidation Coal Company
Long Term Embankment Pond
PRESSURE IN TONS PER SQUARE FOOT
0.01
0.1
1.0
10
50


.65
.60
.55
.50
.45
.40
.35
VOID RATIO
CONSOLIDATION TEST RESULTS
FIGURE 13 BORING NO. 5
SURFACE ELEV. DEPTH INTERVAL 28-29'
LL 29.2% PL 17.0% PI 12.2% W 20.9 %
DATE TEST DRY UNIT WT. 102.5PCF
PROJECT Consolidation Coal Company
Long Term Embankment Pond
PRESSURE IN TONS PER SQUARE FOOT
0.01
0.1
1.0
10
50

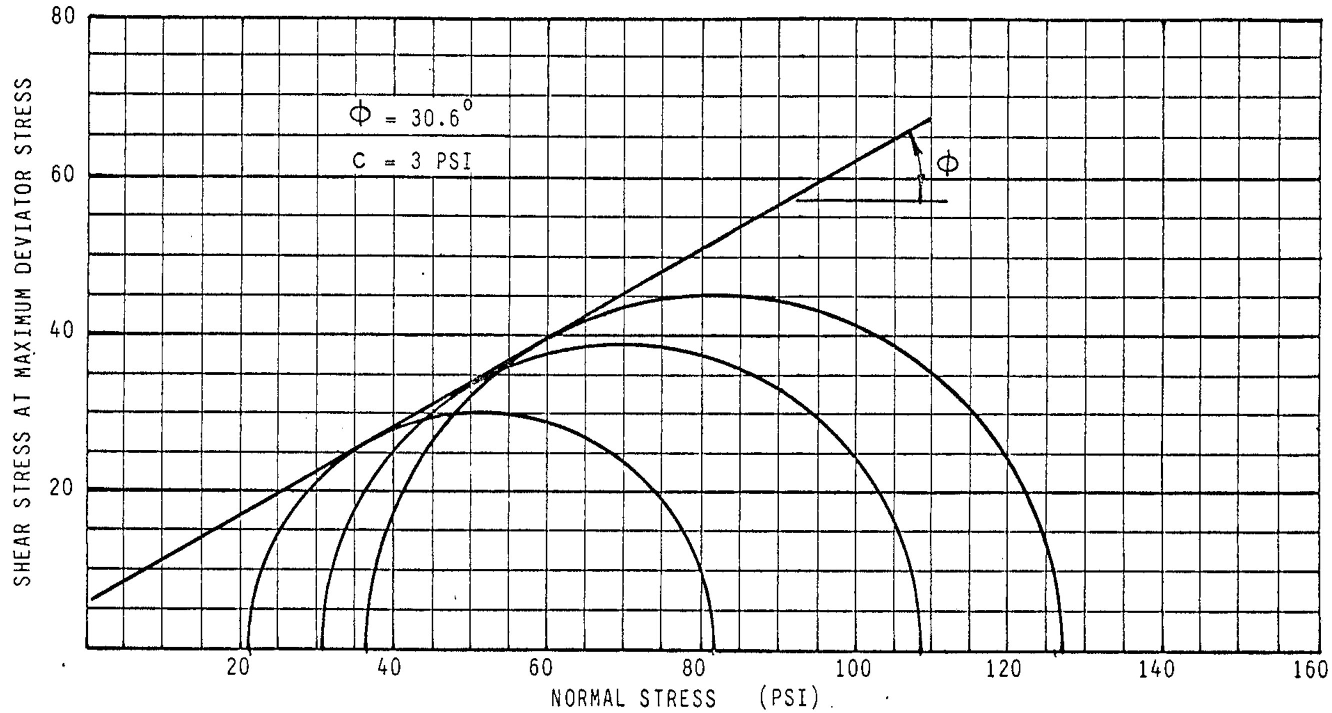






TRIAXIAL SHEAR TEST

SAMPLE NO.



TEST NO. OR SYMBOL	TEST PIT AND DEPTH	SAMPLE DATA: DRY DENSITY (pcf)	MOISTURE % Ini.	MOISTURE % Final	DEGREE OF SATURATION (%)	CONFINING PRESSURE PSI	MAXIMUM DEVIATOR STRESS	MAXIMUM PRINCIPAL STRESS RATIO	VALUES AT MOHR COULOMB FAIL.		SAMPLE SIZE LENGTH/DIA. INCHES	STRAIN RATE INCHES/MIN.
□	TP 3 3	101.7	14.4			40	95.0				2.8/1.32	.006
○	TP 3 3	101.9	14.4			30	73.1				2.8/1.32	.006
△	TP 3 3	101.9	14.4			20	57.4				2.8/1.32	.006

Undisturbed

ROLLINS, BROWN AND GUNNELL, INC.
PROVO, UTAH

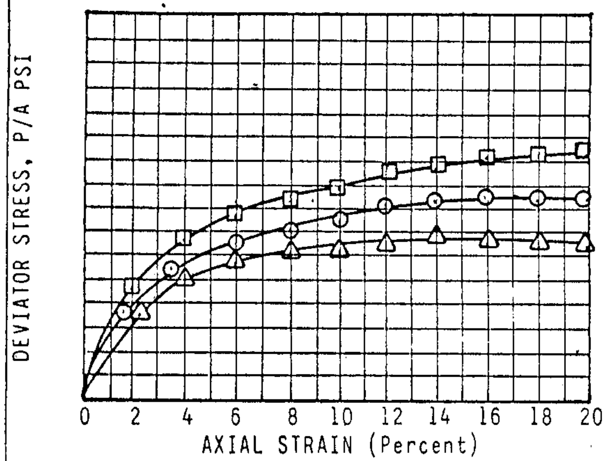
Consulting Engineers

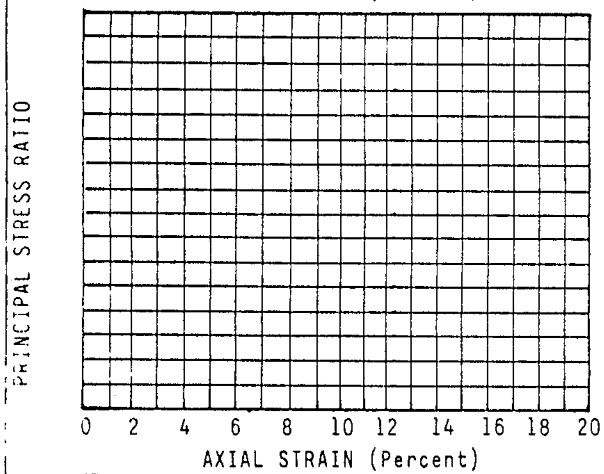
TRIAXIAL SHEAR TEST RESULTS

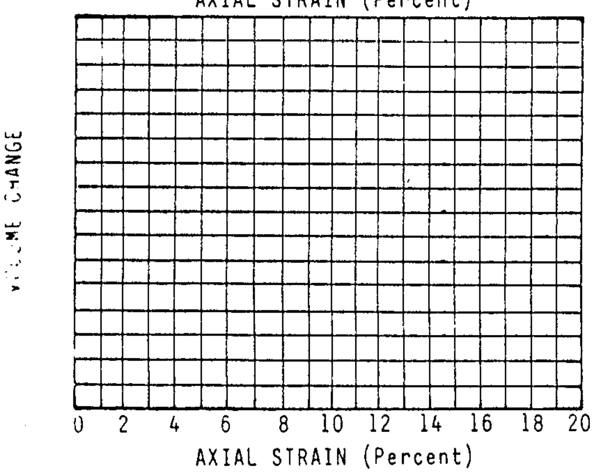
CONSOLIDATION COAL CO.

JOB NO.	DATE

Figure No. 14

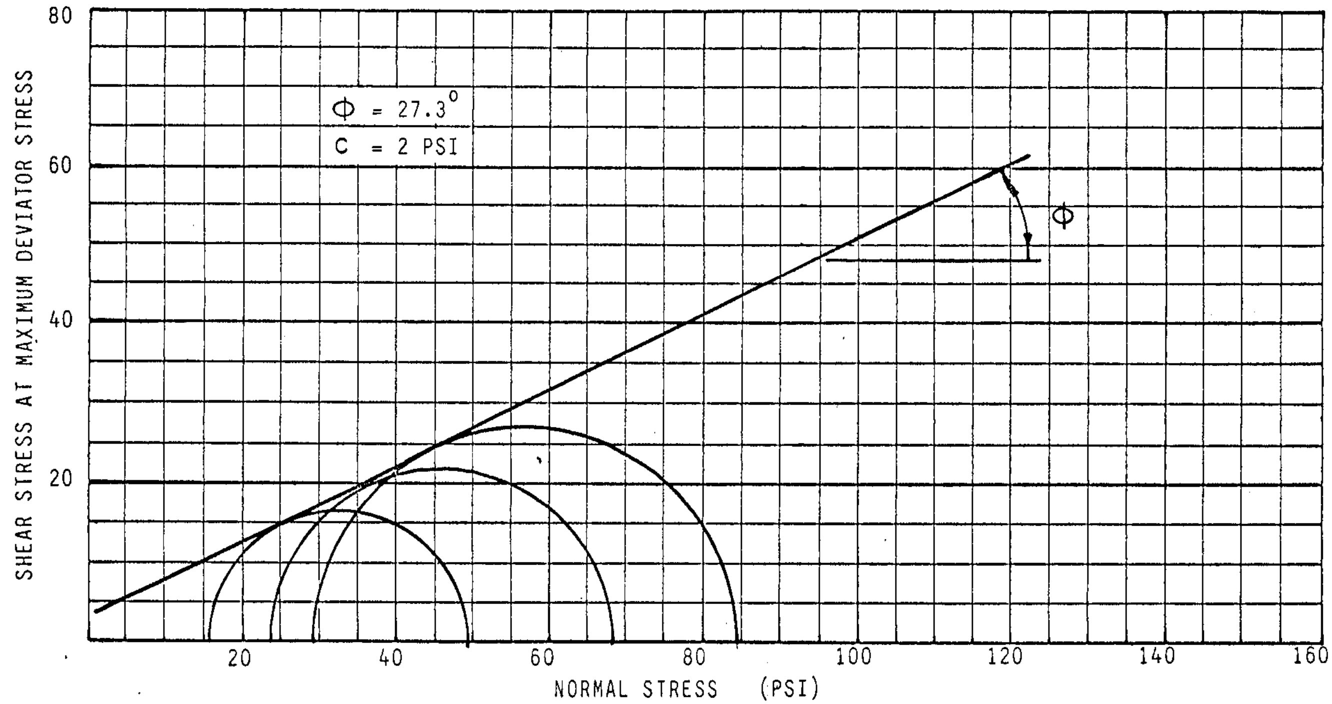






TRIAXIAL SHEAR TEST

SAMPLE NO.



TEST NO. OR SYMBOL	TEST PIT AND DEPTH	SAMPLE DATA: DRY DENSITY (pcf)	SAMPLE DATA: MOISTURE % Ini.	SAMPLE DATA: MOISTURE % Final	DEGREE OF SATURATION (%)	CONFINING PRESSURE PSI	MAXIMUM DEVIATOR STRESS	MAXIMUM PRINCIPAL STRESS RATIO	VALUES AT MOHR COULOMB FAIL.		SAMPLE SIZE LENGTH/DIA. INCHES	STRAIN RATE INCHES/MIN.
□	TP 5 28-29	102.5	20.9			15	35.1				2.8/1.32	.006
○	TP 5 28-29	102.5	20.9			30	44.2				2.8/1.32	.006
△	TP 5 28-29	102.5	20.9			45	55.0				2.8/1.32	.006

Undisturbed

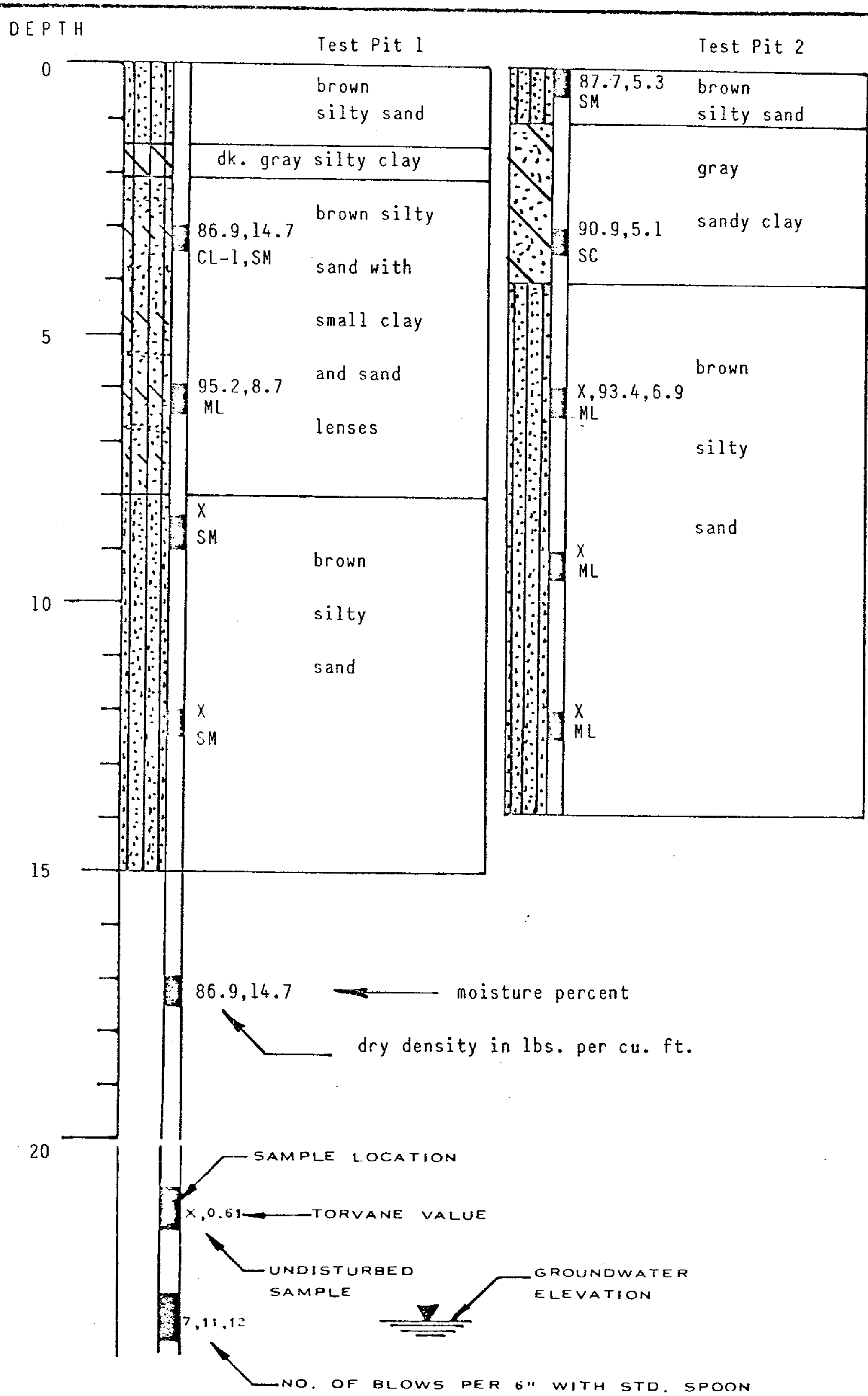
ROLLINS, BROWN AND GUNNELL, INC.
PROVO, UTAH

Consulting Engineers

TRIAXIAL SHEAR TEST RESULTS

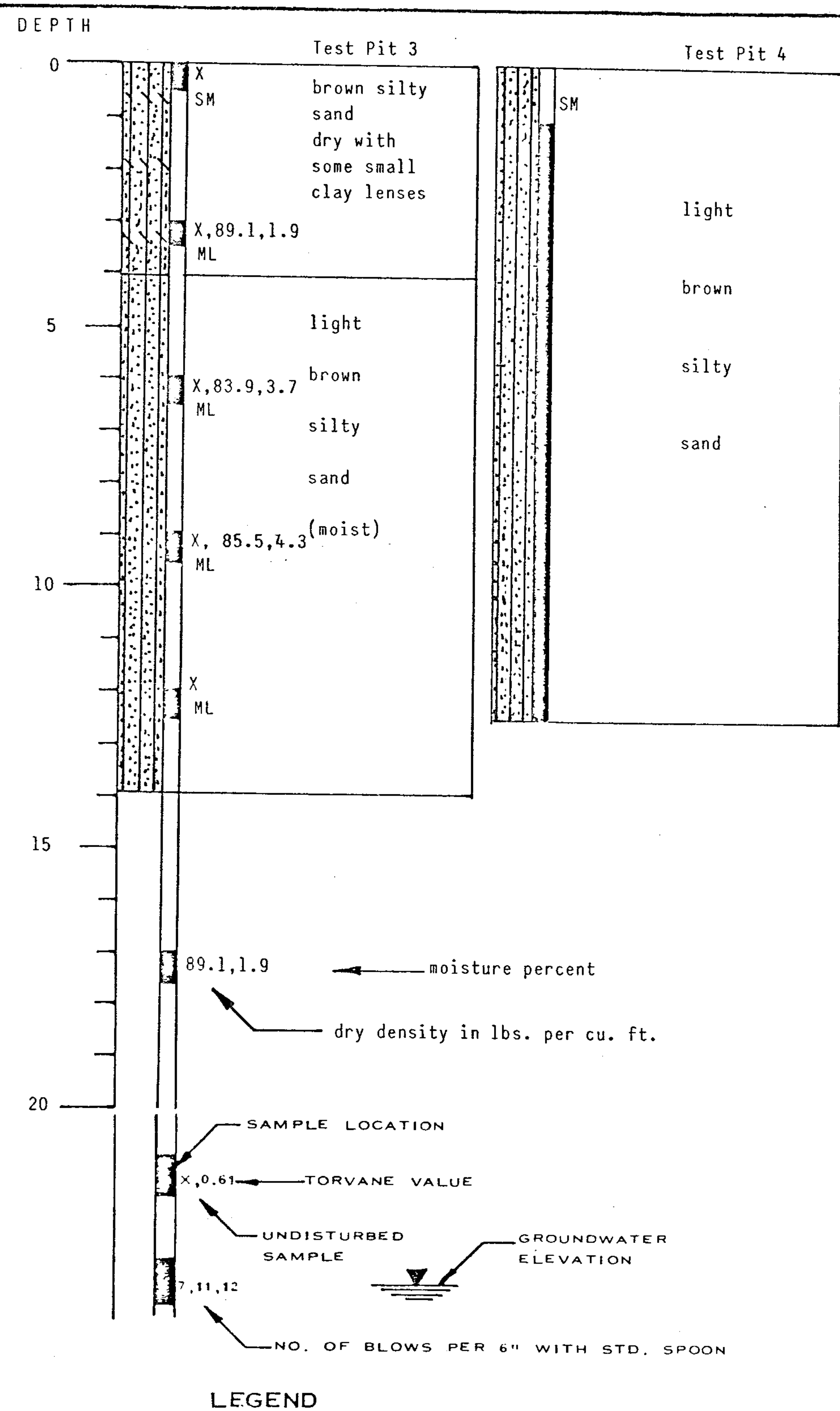
CONSOLIDATION COAL CO.

JOB NO.	DATE	Figure No. 15

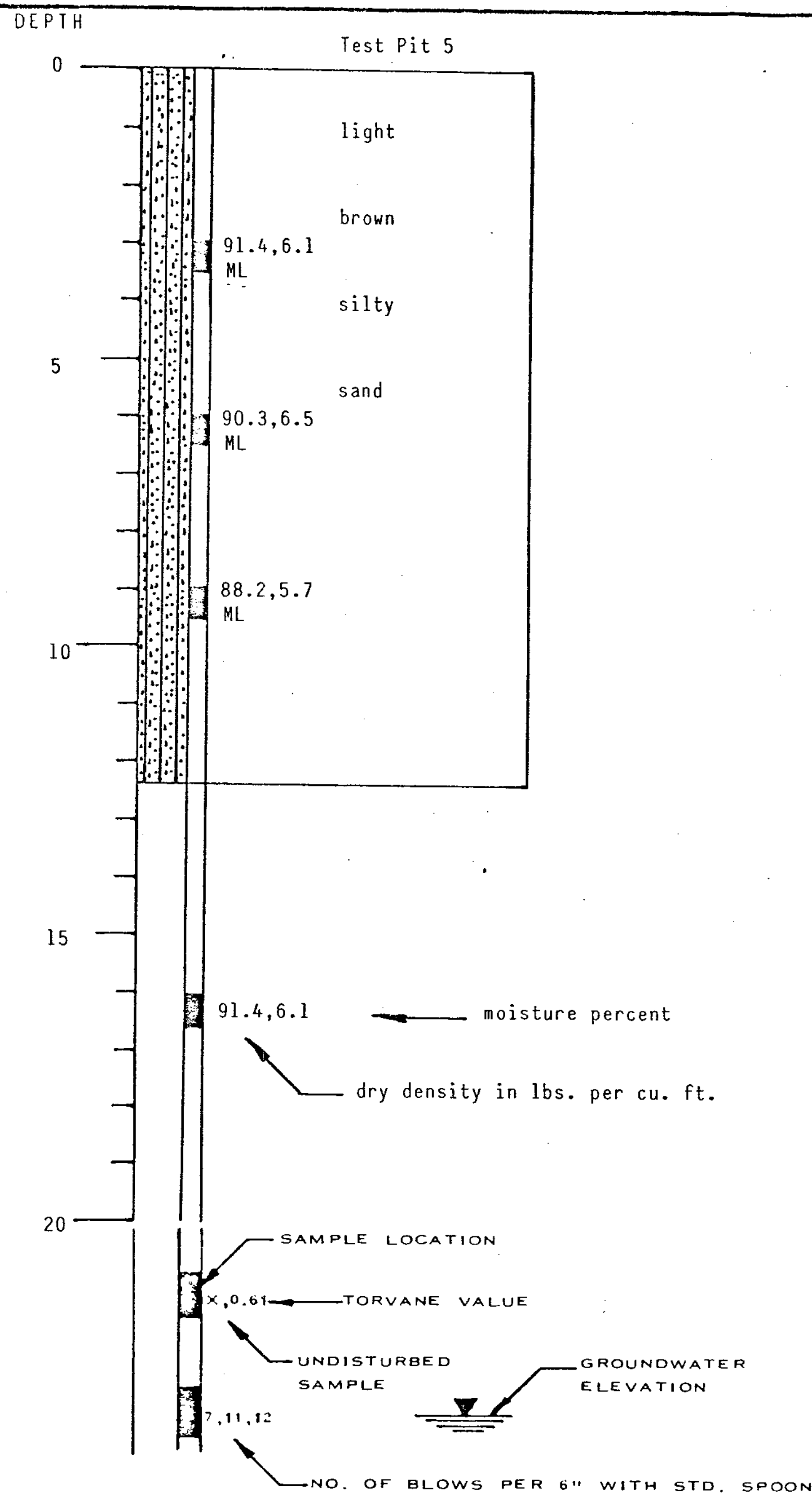


LEGEND

Log of Test Pits for: Consolidation Coal Co.	ROLLINS, BROWN AND GUNNELL, INC. Consulting Engineers	Figure No. 16



Log of Test Pits for: Consolidation Coal Co.	ROLLINS, BROWN AND GUNNELL, INC. Consulting Engineers	Figure No. 17



LEGEND

Log of Test Pits for: Consolidation Coal Co.	ROLLINS, BROWN AND GUNNELL, INC. Consulting Engineers	Figure No. 18

TABLE NO. 3 SUMMARY OF TEST DATA

PROJECT Consolidation Coal Co. Long Term Embankment Pond FEATURE Borrow Material (Test Pits) LOCATION Emery, Utah

TEST PIT NO.	DEPTH BELOW GROUND SURFACE	SAMPLE DESCRIPTION	IN-PLACE DENSITY		ASTM D 698-78		LAB PERMEABILITY		CONSISTENCY LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM
			UNIT WEIGHT LB/FT^3	MOISTURE PERCENT	UNIT WEIGHT LB/FT^3	MOISTURE PERCENT	% COM-PACTED	FT/YR	L.L. %	P.L. %	P.I. %	% GRAVEL	% SAND	% SILT & CLAY	
1	3'		86.9	14.7					26.4	18.3	8.1	0.0	1.7	98.3	CL-1,SM
	6'		95.2	8.7								0.0	32.7	67.3	ML
2	3'		90.9	5.1								0.0	16.8	83.2	ML
	6'		93.4	6.9								0.0	41.1	58.6	ML
	9'											0.0	47.5	52.5	ML
	12'											0.0	45.3	54.7	ML
3	3'		89.1	1.9								0.0	30.4	69.6	ML
	6'		83.9	3.7								0.0	28.9	71.1	ML
	9'		85.3	4.3								0.0	22.5	77.5	ML
5	3'		91.4	6.1								0.0	32.1	67.9	ML
	6'		90.3	6.5								0.0	26.7	73.3	ML
	9'		88.2	5.7								0.0	23.6	76.5	ML
	12'											0.0	35.5	64.5	ML

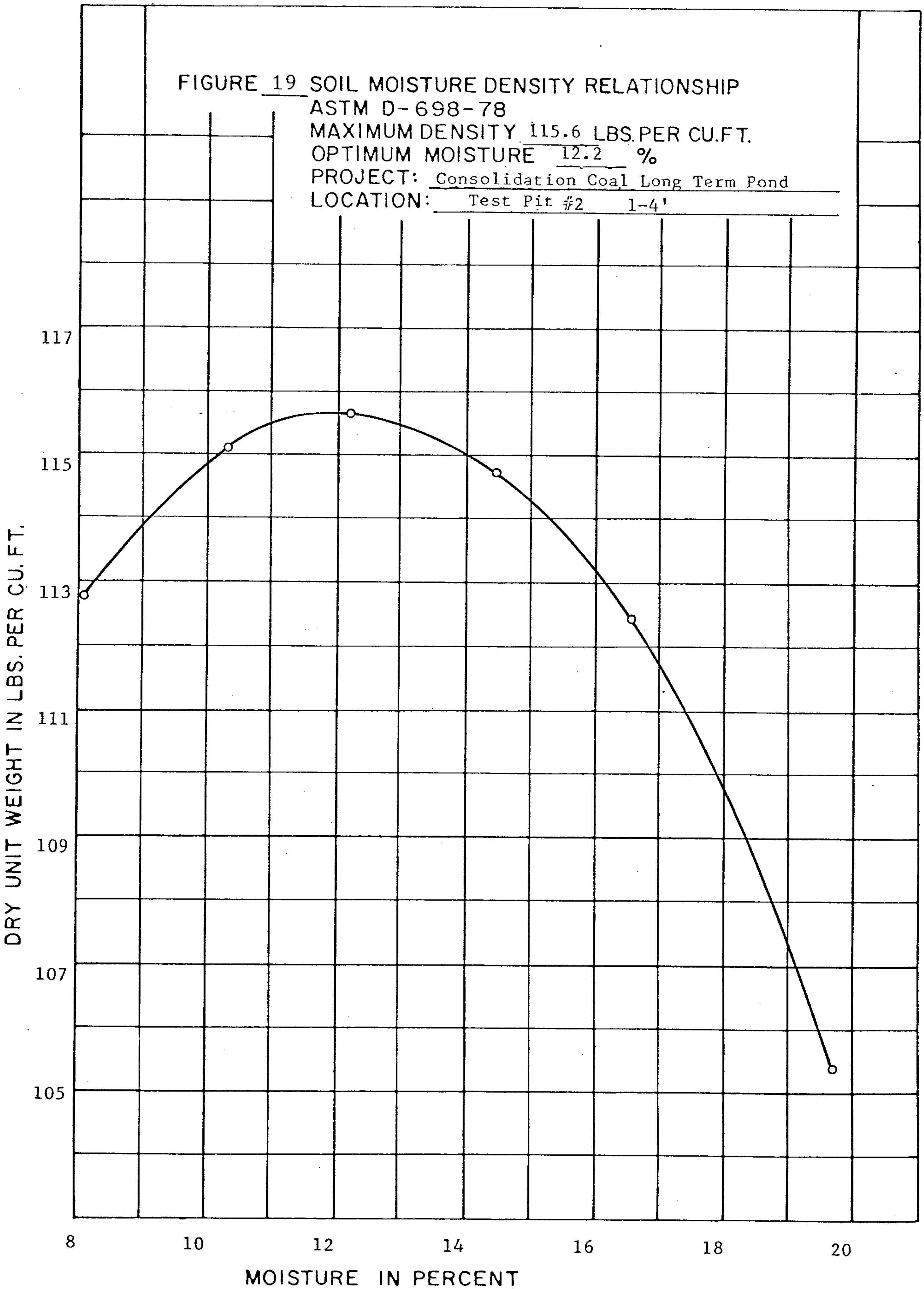


FIGURE 19 SOIL MOISTURE DENSITY RELATIONSHIP
ASTM D-698-78
MAXIMUM DENSITY 115.6 LBS. PER CU. FT.
OPTIMUM MOISTURE 12.2 %
PROJECT: Consolidation Coal Long Term Pond
LOCATION: Test Pit #2 1-4'
117
115
113
111
109
107
105
DRY UNIT WEIGHT IN LBS. PER CU. FT.
8
10
12
14
16
18
20
MOISTURE IN PERCENT

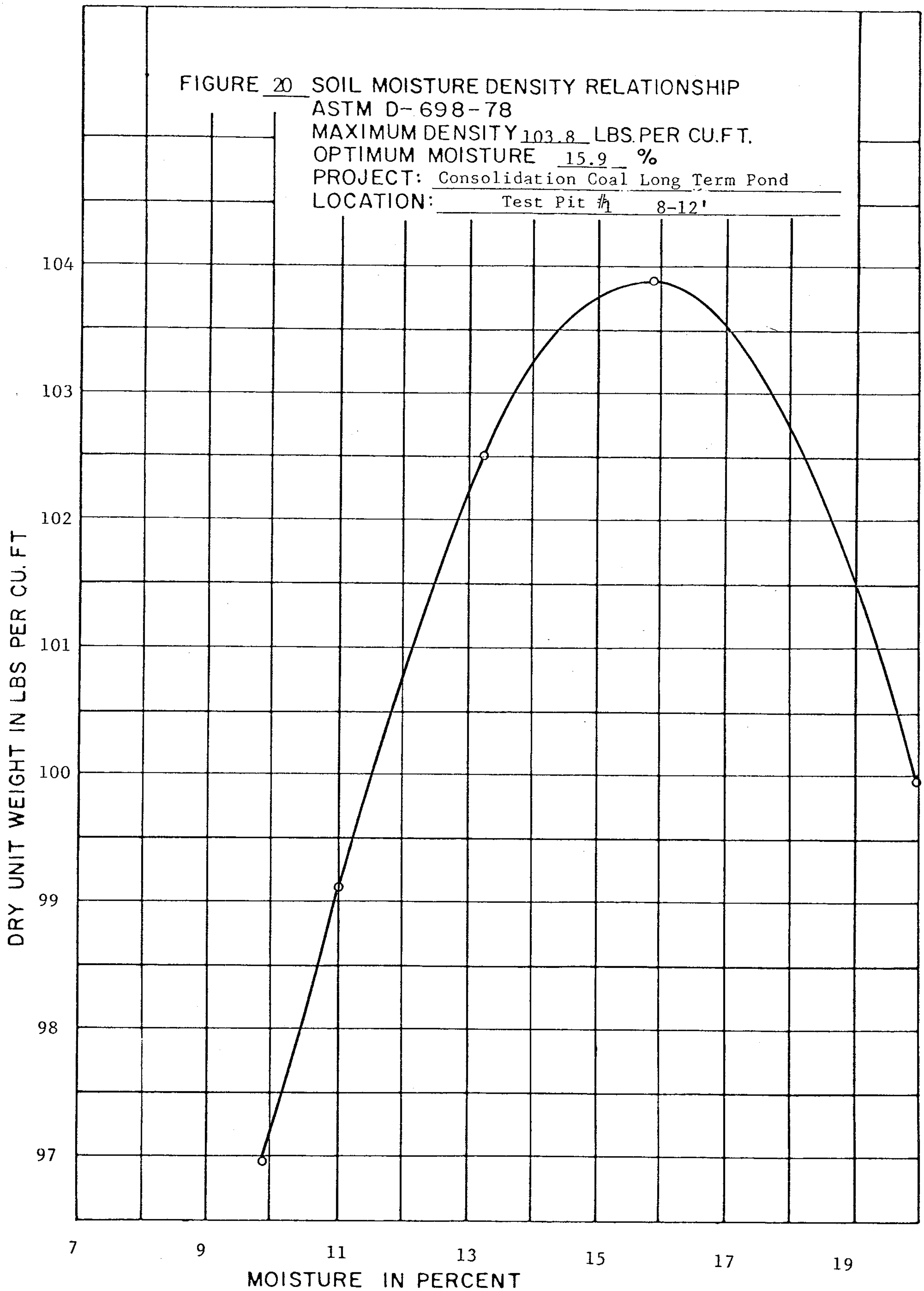


FIGURE 20 SOIL MOISTURE DENSITY RELATIONSHIP
ASTM D-698-78
MAXIMUM DENSITY 103.8 LBS. PER CU.FT.
OPTIMUM MOISTURE 15.9 %
PROJECT: Consolidation Coal Long Term Pond
LOCATION: Test Pit #1 8-12'
104
103
102
101
100
99
98
97
DRY UNIT WEIGHT IN LBS PER CU. FT
7
9
11
13
15
17
19
MOISTURE IN PERCENT

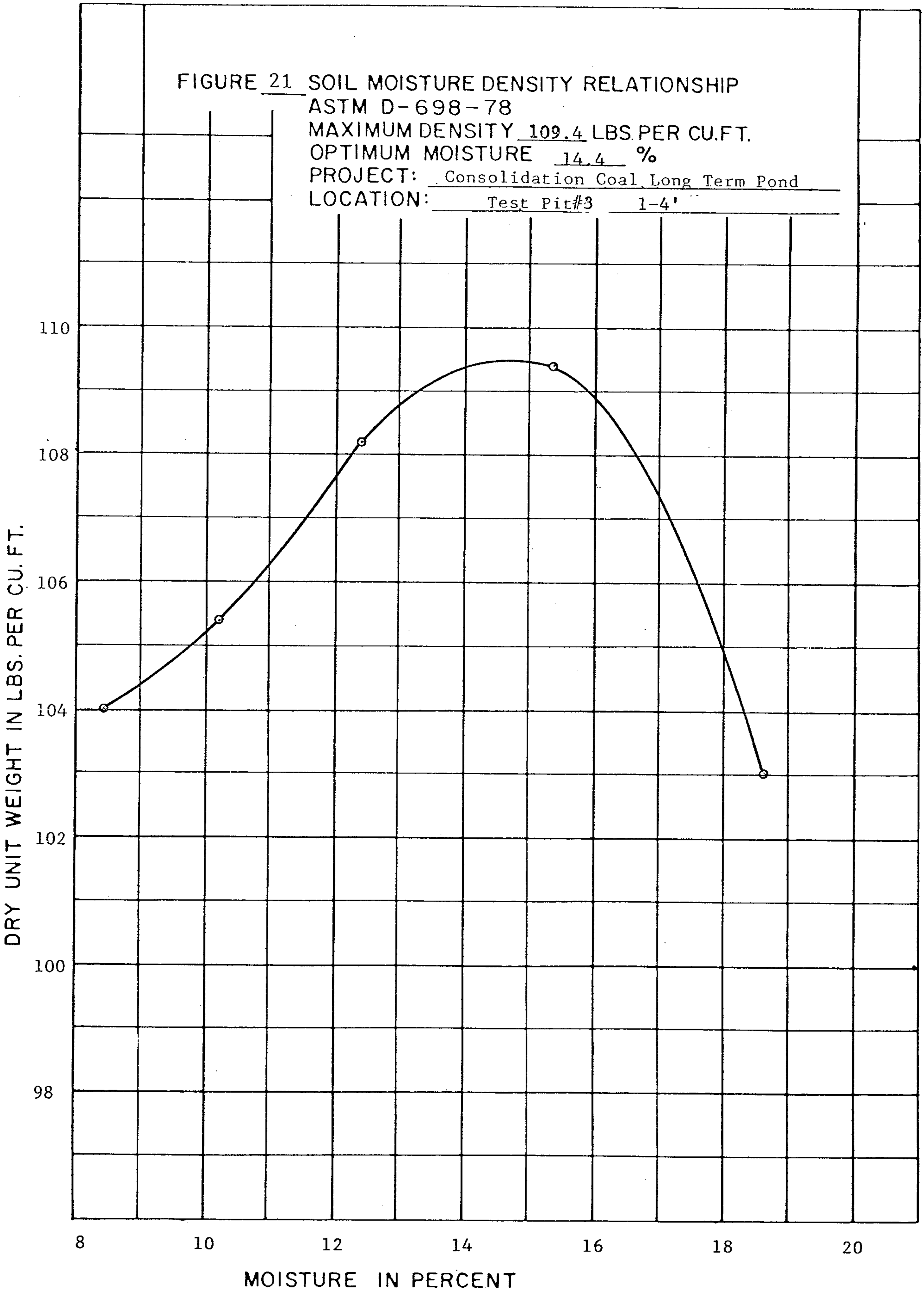


FIGURE 21 SOIL MOISTURE DENSITY RELATIONSHIP
ASTM D-698-78
MAXIMUM DENSITY 109.4 LBS. PER CU. FT.
OPTIMUM MOISTURE 14.4 %
PROJECT: Consolidation Coal Long Term Pond
LOCATION: Test Pit #3 1-4'

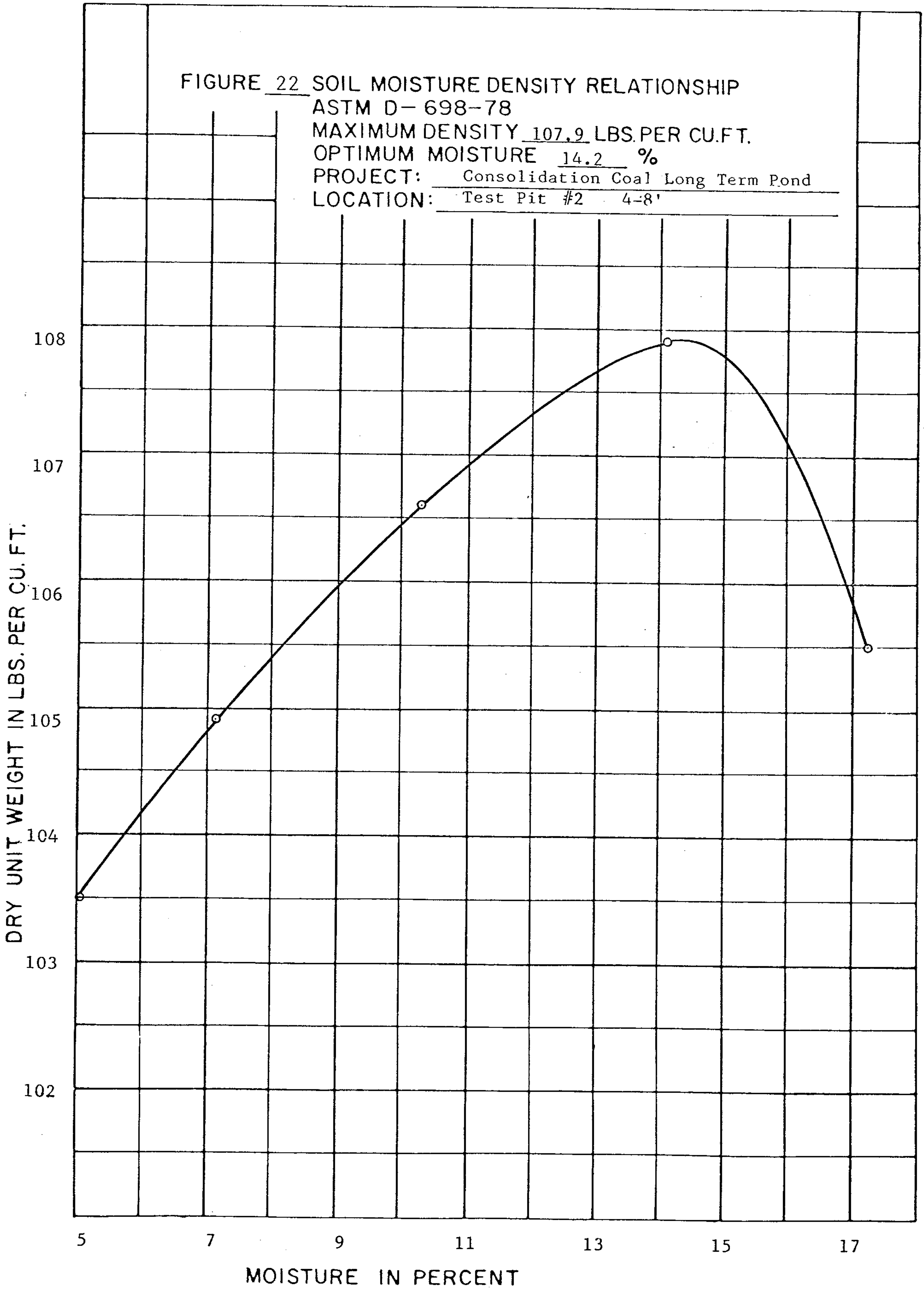


FIGURE 22 SOIL MOISTURE DENSITY RELATIONSHIP
ASTM D-698-78
MAXIMUM DENSITY 107.9 LBS. PER CU.FT.
OPTIMUM MOISTURE 14.2 %
PROJECT: Consolidation Coal Long Term Pond
LOCATION: Test Pit #2 4-8'

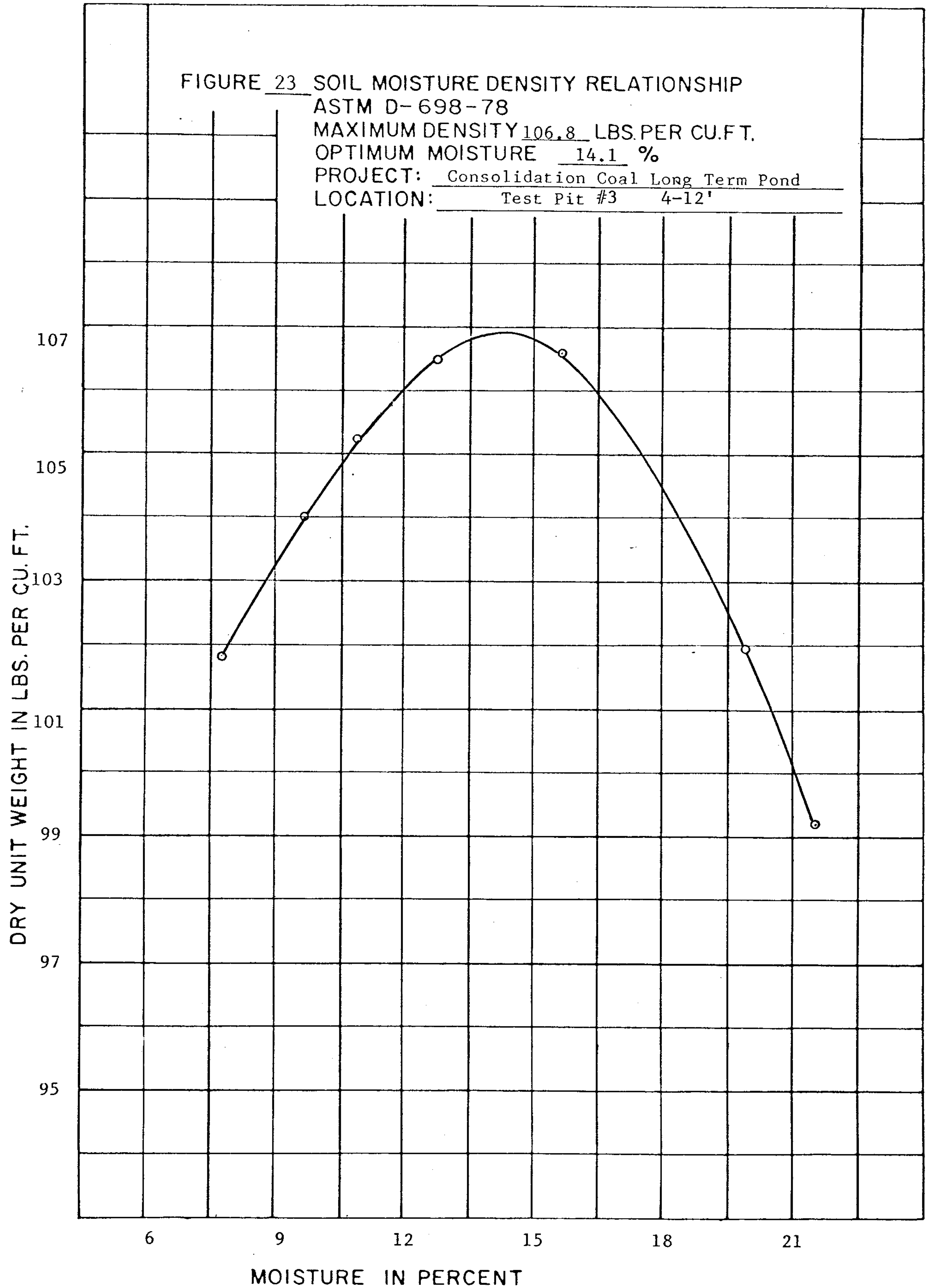


FIGURE 23 SOIL MOISTURE DENSITY RELATIONSHIP
ASTM D-698-78
MAXIMUM DENSITY 106.8 LBS. PER CU. FT.
OPTIMUM MOISTURE 14.1 %
PROJECT: Consolidation Coal Long Term Pond
LOCATION: Test Pit #3 4-12'

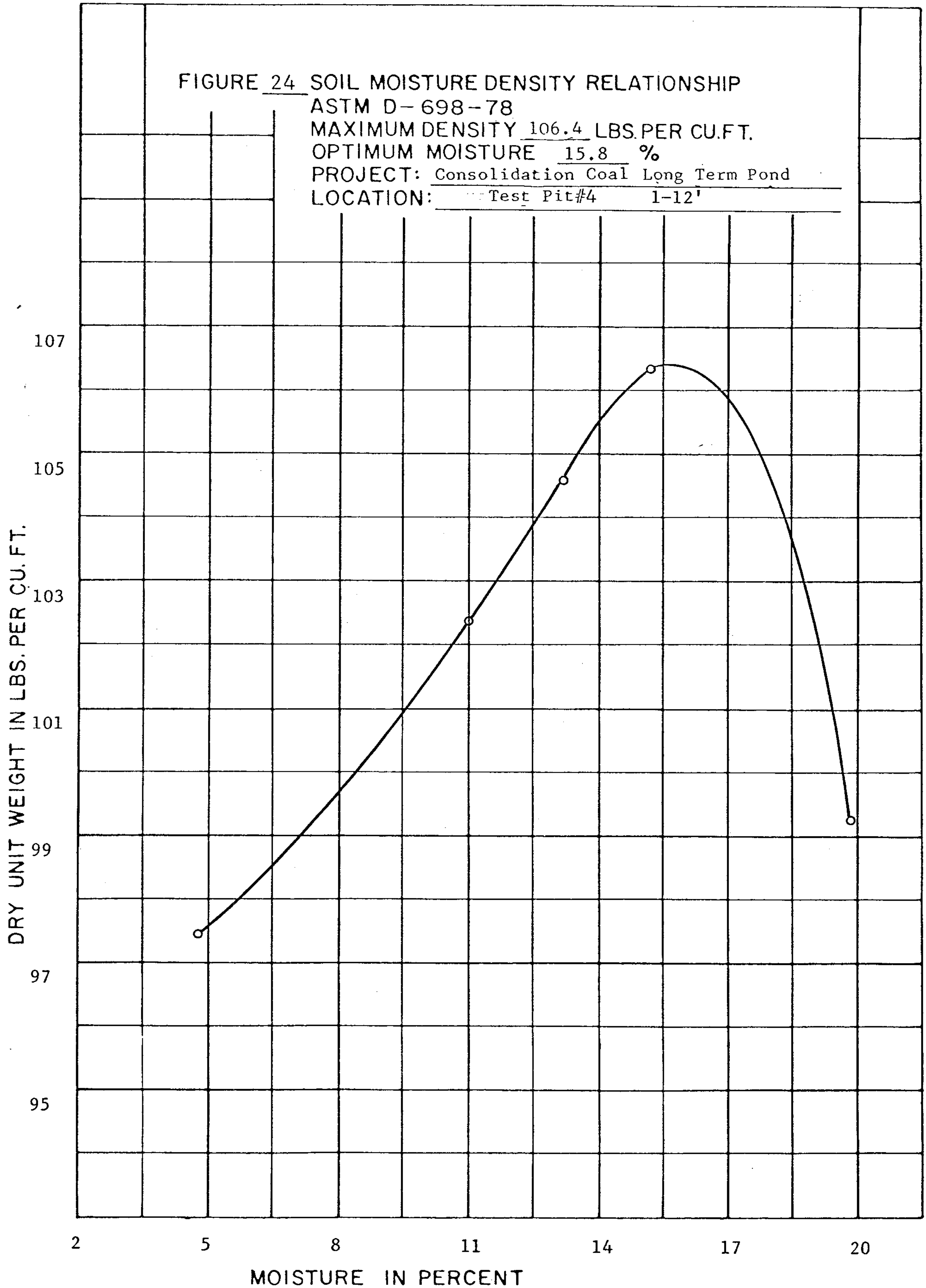
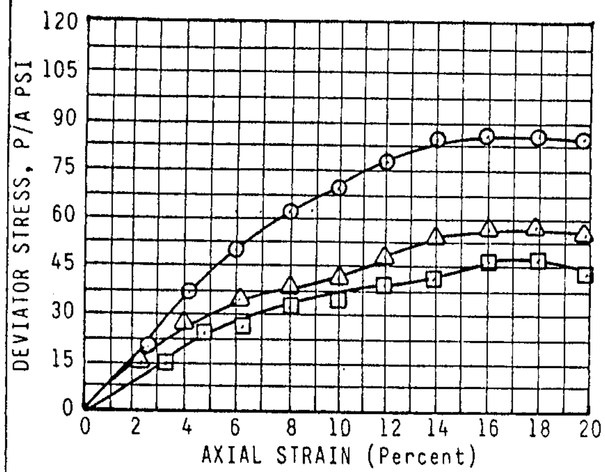


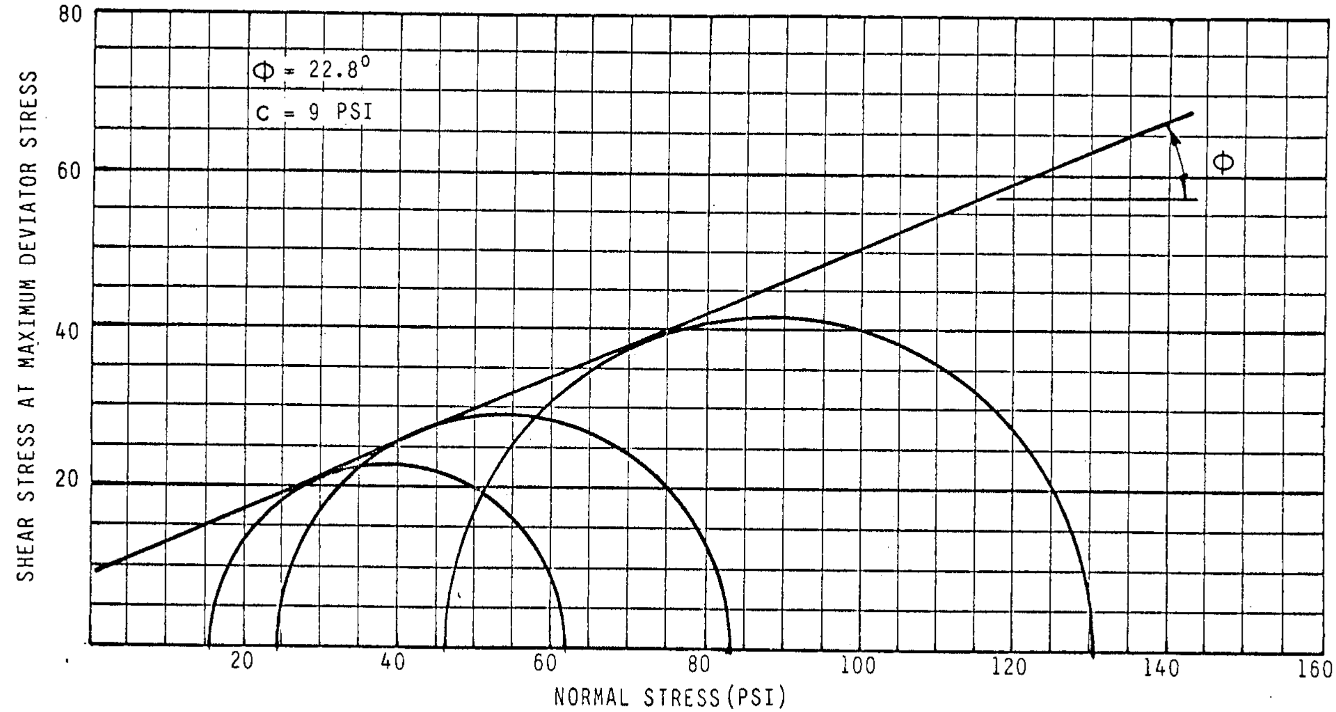
FIGURE 24 SOIL MOISTURE DENSITY RELATIONSHIP
ASTM D-698-78
MAXIMUM DENSITY 106.4 LBS. PER CU. FT.
OPTIMUM MOISTURE 15.8 %
PROJECT: Consolidation Coal Long Term Pond
LOCATION: Test Pit #4 1-12'

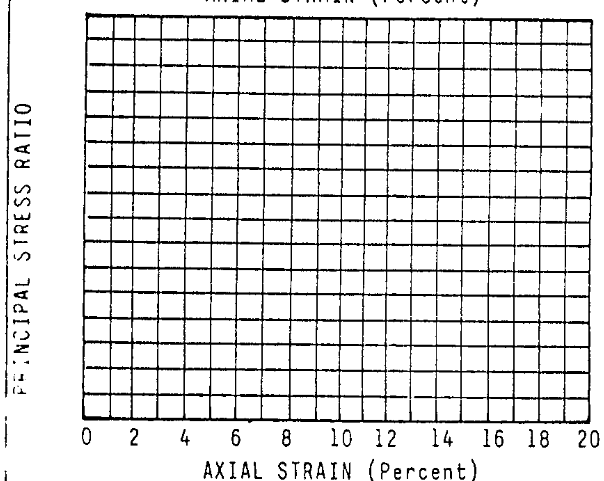
TABLE NO. 4 SUMMARY OF TEST DATA

PROJECT Consolidation Coal Co. Long Term Embankment Pond FEATURE Borrow Material (Test Pits) LOCATION Emery, Utah

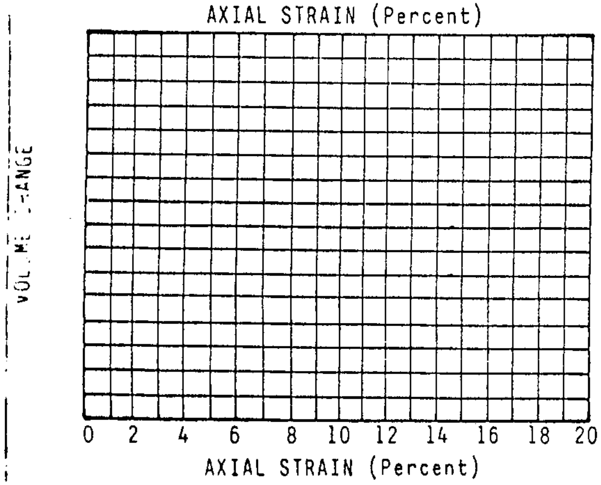
TEST PIT NO.	DEPTH BELOW GROUND SURFACE	SAMPLE DESCRIPTION	ASTM D 698-78				LAB PERMEABILITY		CONSISTENCY LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM
			UNIT WEIGHT LB/FT^3	MOISTURE PERCENT	UNIT WEIGHT LB/FT^3	MOISTURE PERCENT	% COM-PACTED	FT/YR	L.L. %	P.L. %	P.I. %	% GRAVEL	% SAND	% SILT & CLAY	
1	8-12'	BULK SAMPLE	103.8	15.9					NON	- PLASTIC		0.0	36.0	64.1	ML
2	1-4'	BULK SAMPLE	115.6	12.2					22.5	15.7	6.8				CL-1
	4-8'	BULK SAMPLE	107.9	14.2					NON	- PLASTIC		0.0	38.7	61.3	ML
3	1-4'	BULK SAMPLE	109.4	14.4			96.0	2.57				0.0	25.7	74.3	ML
	4-12'	BULK SAMPLE	106.8	14.1			94.0	0.30	NON	- PLASTIC		0.0	42.7	57.3	ML
4	1-12'	BULK SAMPLE	106.4	15.8			97.0	3.40	NON	- PLASTIC		0.0	37.2	62.8	ML
5	1-12'	BULK SAMPLE							NON	- PLASTIC		0.0	36.5	63.5	ML







TEST NO. OR SYMBOL	TEST PIT AND DEPTH	SAMPLE DATA: DRY DENSITY (pcf)	SAMPLE DATA: MOISTURE % Ini.	SAMPLE DATA: MOISTURE % Final	DEGREE OF SATURATION (%)	CONFINING PRESSURE PSI	MAXIMUM DEVIATOR STRESS	MAXIMUM PRINCIPAL STRESS RATIO	VALUES AT MOHR COULOMB FAIL.		SAMPLE SIZE LENGTH/DIA. INCHES	STRAIN RATE INCHES/MIN.
□	TP$_3$5					15	46.4				2.8/1.32	.006
○	TP$_3$5					30	58.2				2.8/1.32	.006
△	TP$_3$5					45	87.3				2.8/1.32	.006



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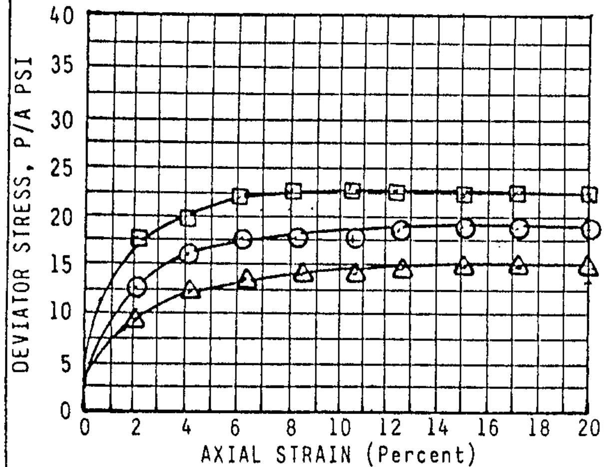
ROLLINS, BROWN AND GUNNELL, INC.
PROVO, UTAH

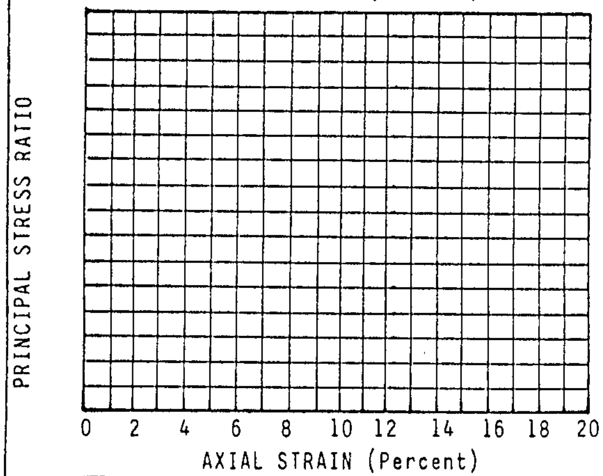
Consulting Engineers

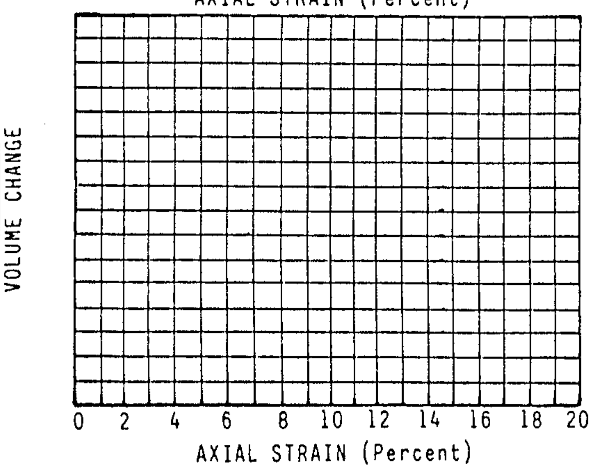
TRIAXIAL SHEAR TEST RESULTS

CONSOLIDATION COAL CO.

JOB NO.	DATE	Figure No. 25

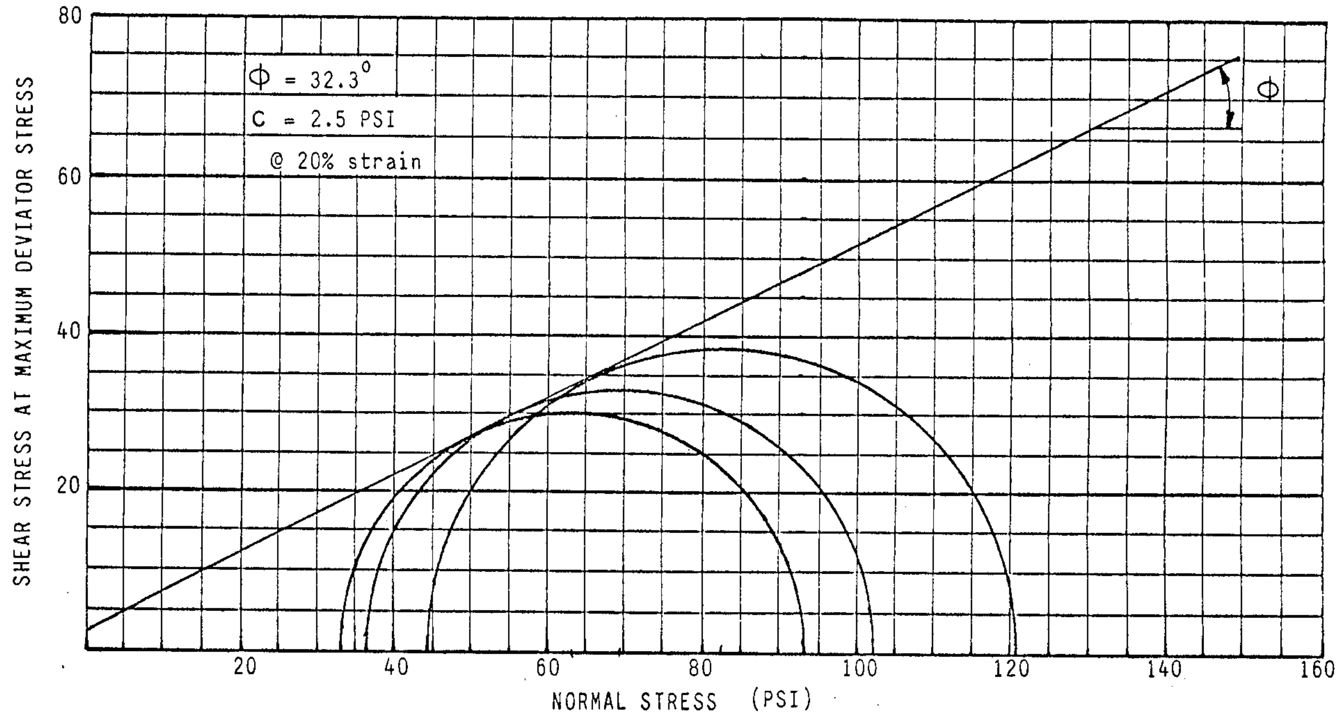






TRIAXIAL SHEAR TEST

SAMPLE NO.



TEST NO. OR SYMBOL	TEST PIT AND DEPTH	SAMPLE DATA DRY DENSITY (pcf)	MOISTURE % Ini.	MOISTURE % Final	DEGREE OF SATURATION (%)	CONFINING PRESSURE PSI	MAXIMUM DEVIATOR STRESS	MAXIMUM PRINCIPAL STRESS RATIO	VALUES AT MOHR COULOMB FAIL.		SAMPLE SIZE LENGTH/DIA. INCHES	STRAIN RATE INCHES/MIN.
□	TP 3 4-12	101.9	14.4			20	59.9				2.8/1.32	.006
○	TP 3 4-12	101.9	14.4			30	77.8				2.8/1.32	.006
△	TP 3 4-12	101.7	14.4			40	91.9				2.8/1.32	.006

Compacted

ROLLINS, BROWN AND GUNNELL, INC.
PROVO, UTAH

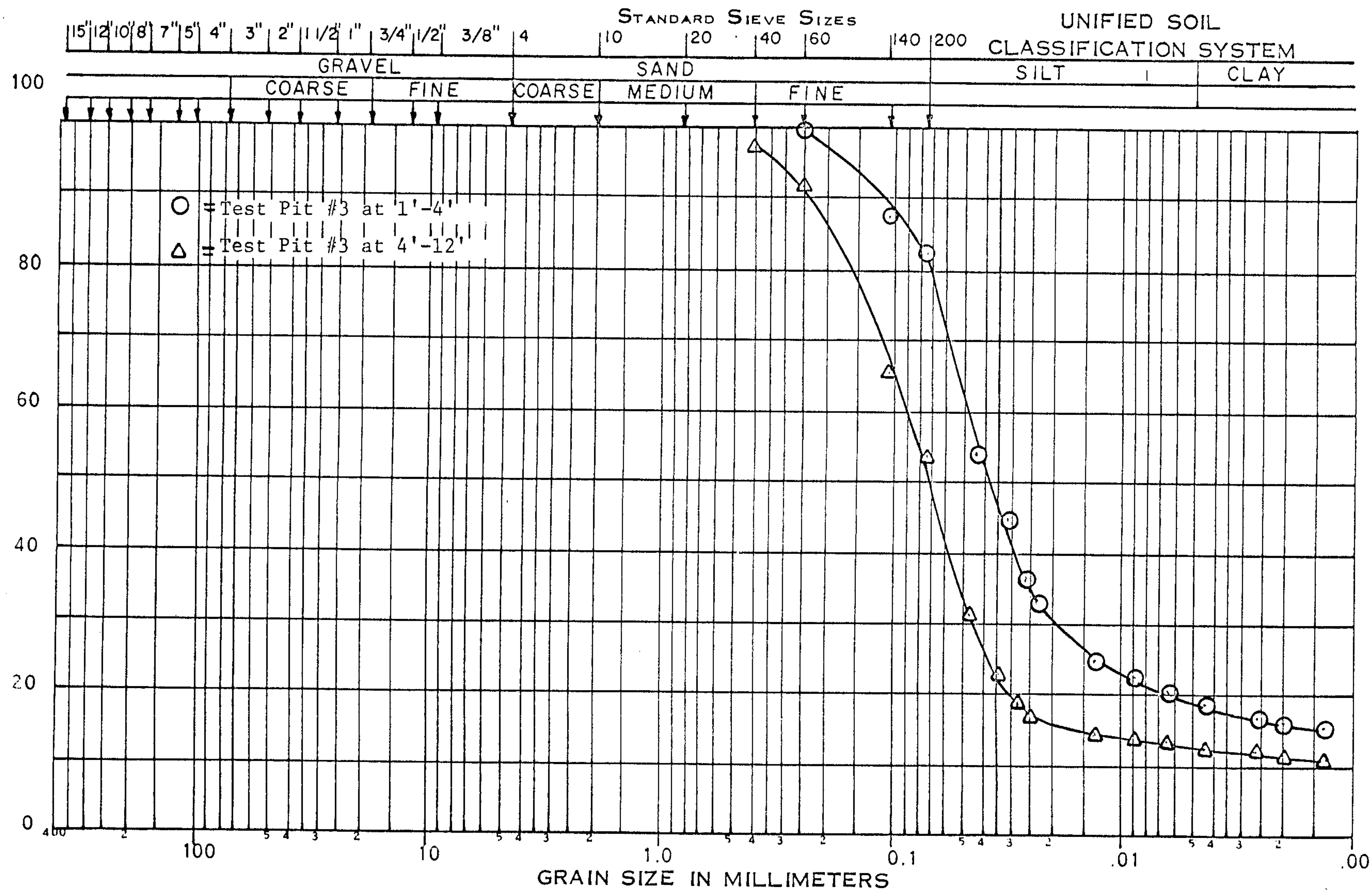
Consulting Engineers

TRIAXIAL SHEAR TEST RESULTS

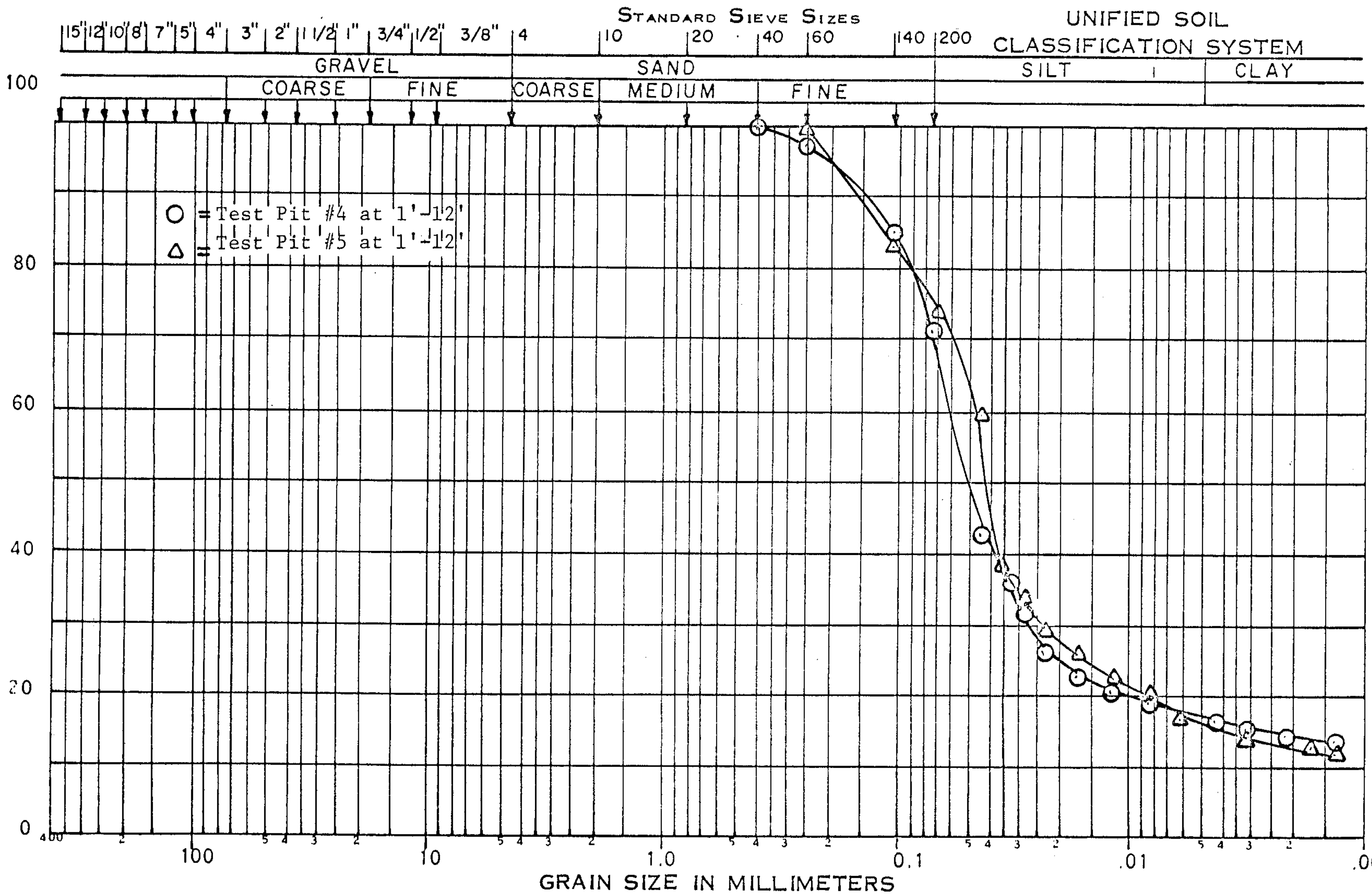
CONSOLIDATION COAL CO.

JOB NO.	DATE

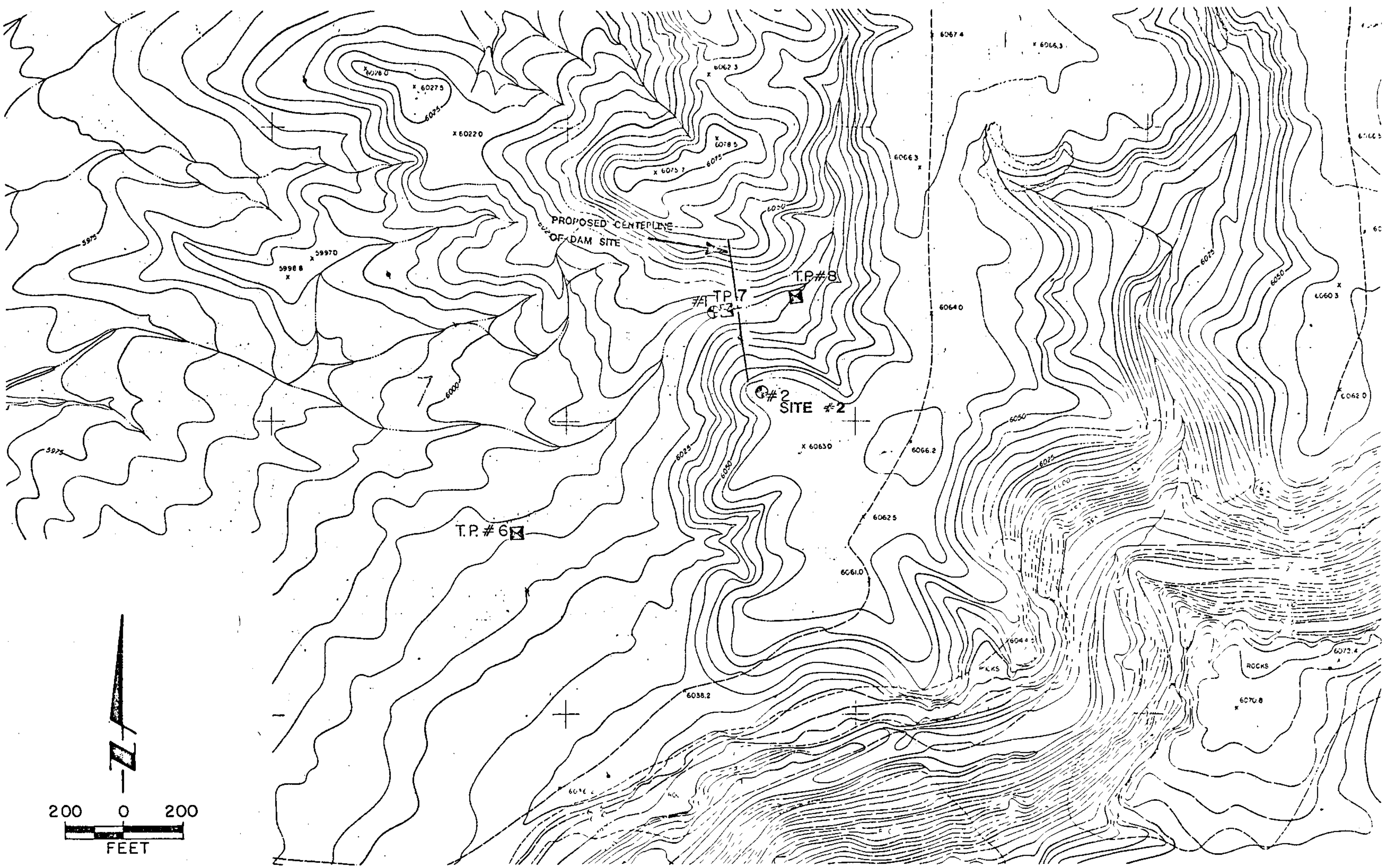
Figure No. 26



ROLLINS, BROWN AND GUNNELL, INC. PROFESSIONAL ENGINEERS	CLIENT Consolidation Coal PROJECT LOCATION Test Pit No. 3	FIGURE 27 GRAIN SIZE DISTRIBUTION CURVE HOLE NO. DEPTH



ROLLINS, BROWN AND GUNNELL, INC. PROFESSIONAL ENGINEERS	CLIENT Consolidation Coal PROJECT LOCATION Test Pits No. 4 and 5	FIGURE 28 GRAIN SIZE DISTRIBUTION CURVE HOLE NO. DEPTH



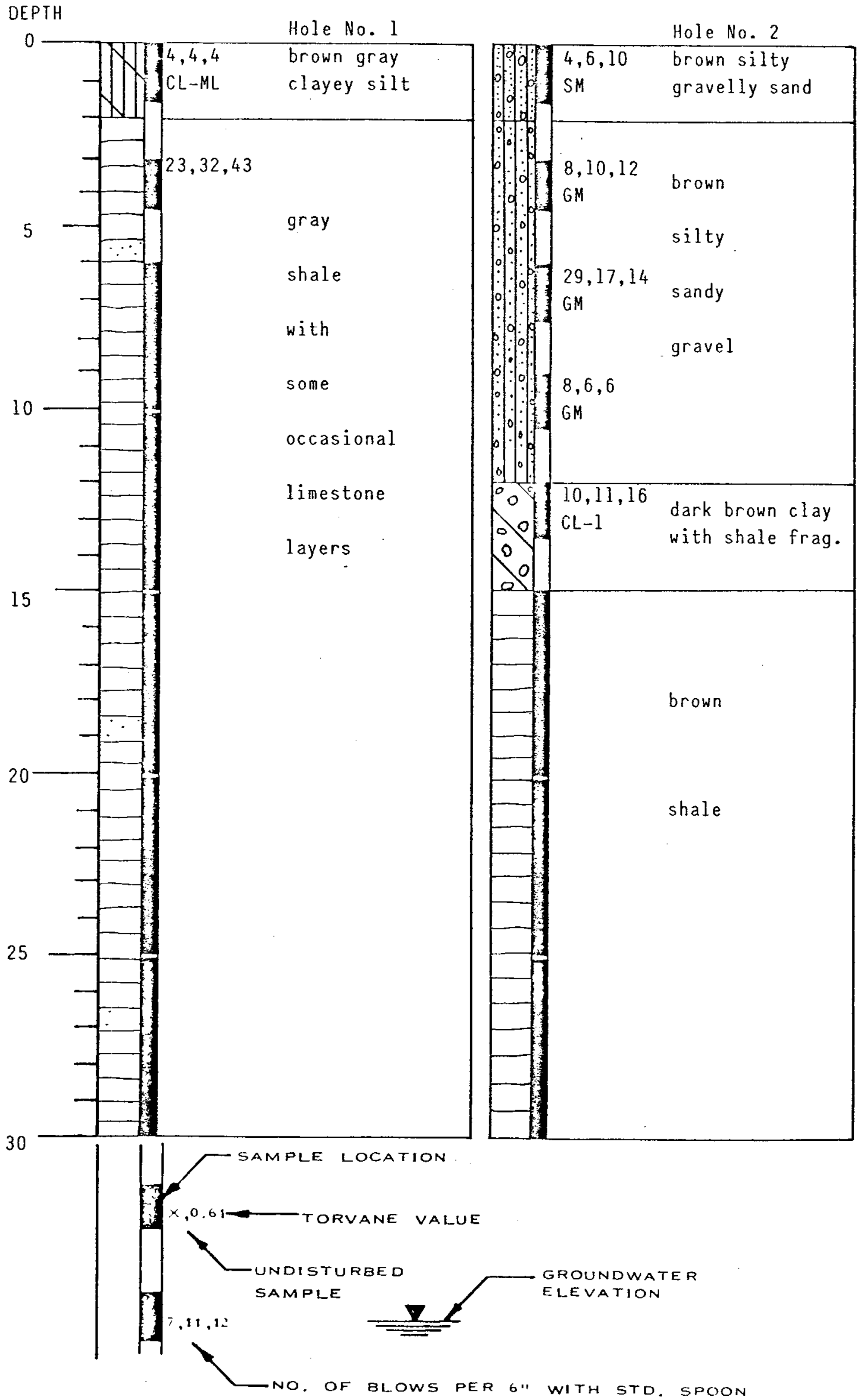
SCALE	
DESIGNED	CHECKED
DRAWN	DATE
APPROVED	LICENSE NO.

ROLLINS, BROWN & GUNNELL, Inc.
CONSULTING ENGINEERS

IMPOUNDMENT SITE NO. 2
Location of Drill Holes and Test Pits

Figure No. 29

Bruning "500"



LEGEND

Log of Borings for: Consolidation Coal Co. Impoundment Site 2	ROLLINS, BROWN AND GUNNELL, INC. Consulting Engineers	Figure No. 30

TABLE NO. 6

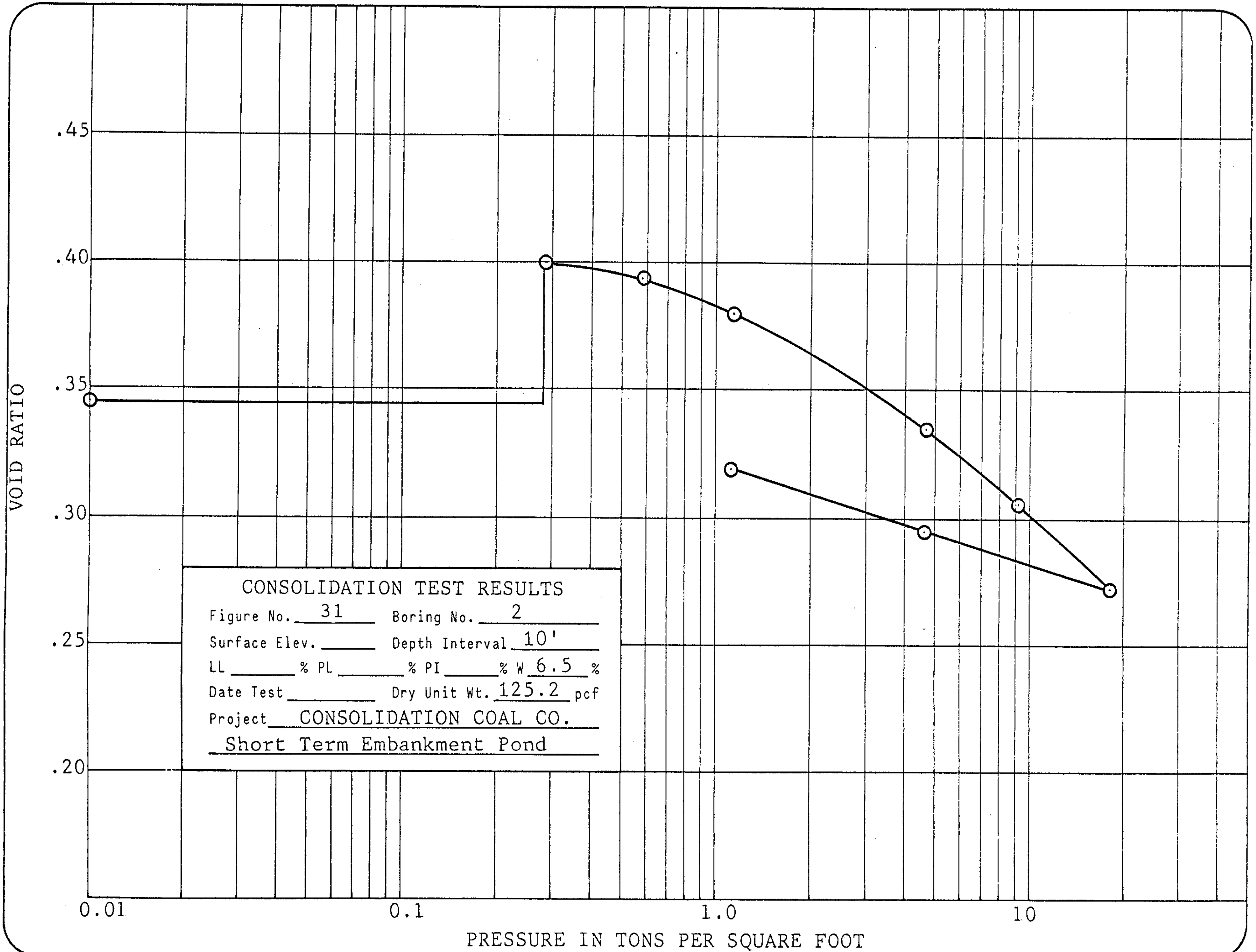
IMPOUNDMENT SITE NO. 2

Hole No.	Depth (ft)	Permeability (ft/yr)
1	0- 5	82
	5-10	128
	15-10	631
	10-20	316
	10-30	191
	10-25	200
2	0- 5	123
	5-10	547
	10-15	344
	15-20	2811
	20-25	3644
	25-30	5964

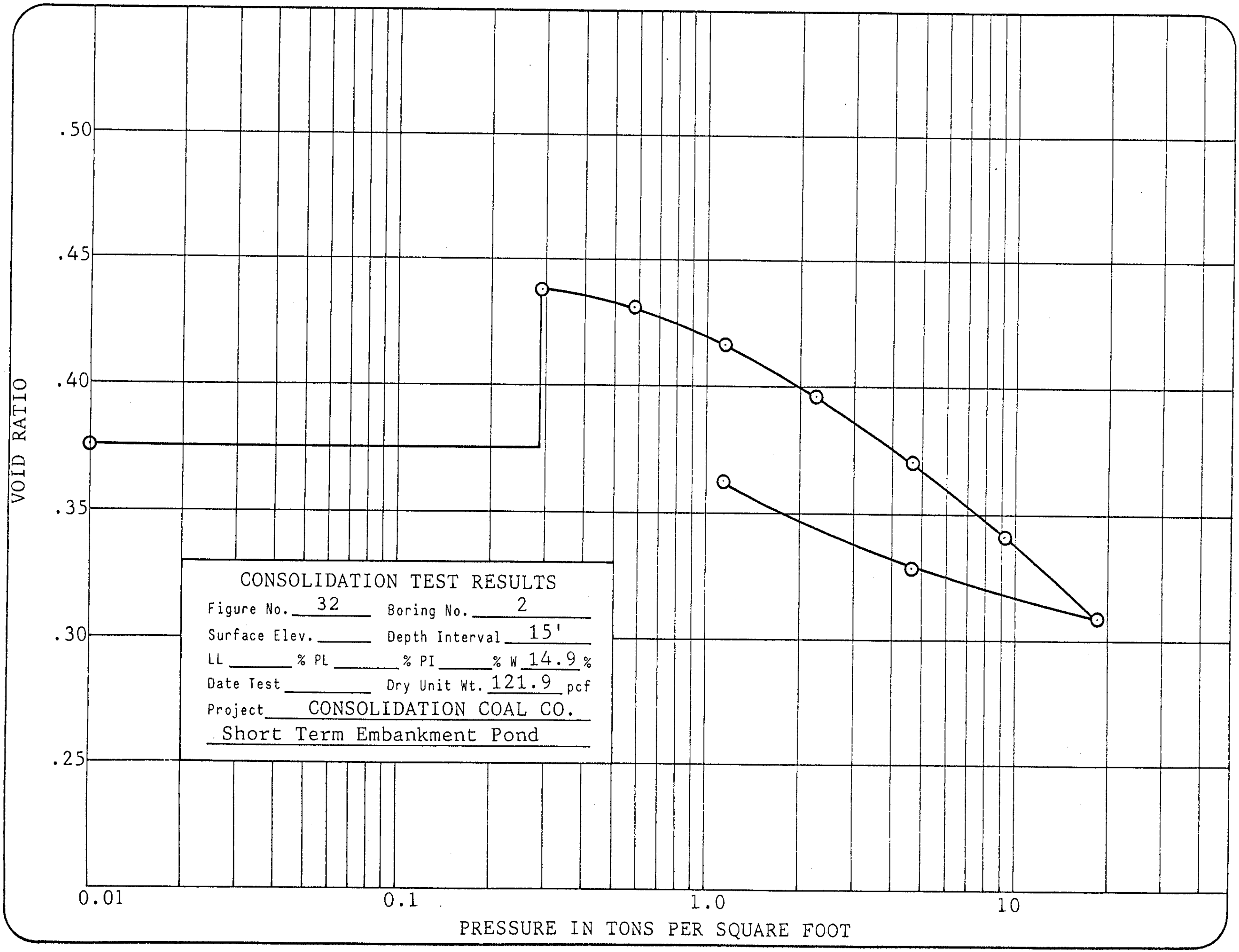
TABLE NO. 7 SUMMARY OF TEST DATA

PROJECT Consolidation Coal Short Term Site FEATURE Foundations (Test Pits) LOCATION Emery, Utah

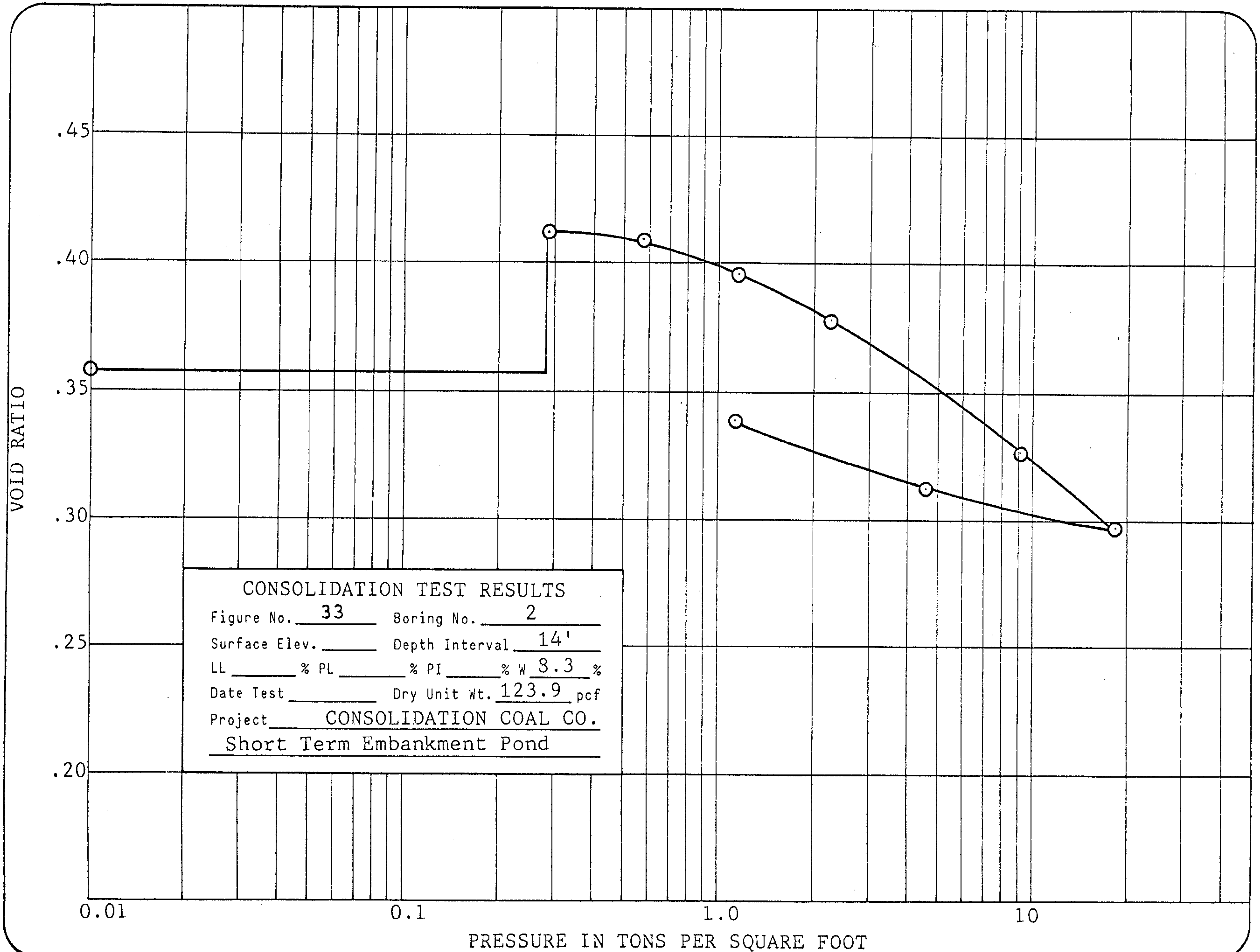
HOLE NO.	DEPTH BELOW GROUND SURFACE	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE			UNCONFINED COMPRESSIVE STRENGTH LB/FT^2	FRICTION ANGLE ϕ	CONSISTENCY LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM
			UNIT WEIGHT LB/FT^3	MOISTURE PERCENT	VOID RATIO			L.L. %	P.L. %	P.I. %	% GRAVEL	% SAND	% SILT & CLAY	
1	3'							28.5	19.6	8.9				CL-1
	8'							32.6	21.4	11.2				CL-1
	10'		125.2	6.5				33.2	19.7	13.5				CL-1
	12'		122.3	7.7				34.3	18.5	15.8				CL-2
	14'		123.9	8.3				33.4	20.1	13.3				CL-1
	15'		121.9	14.9				36.8	22.8	14.0				CL-1



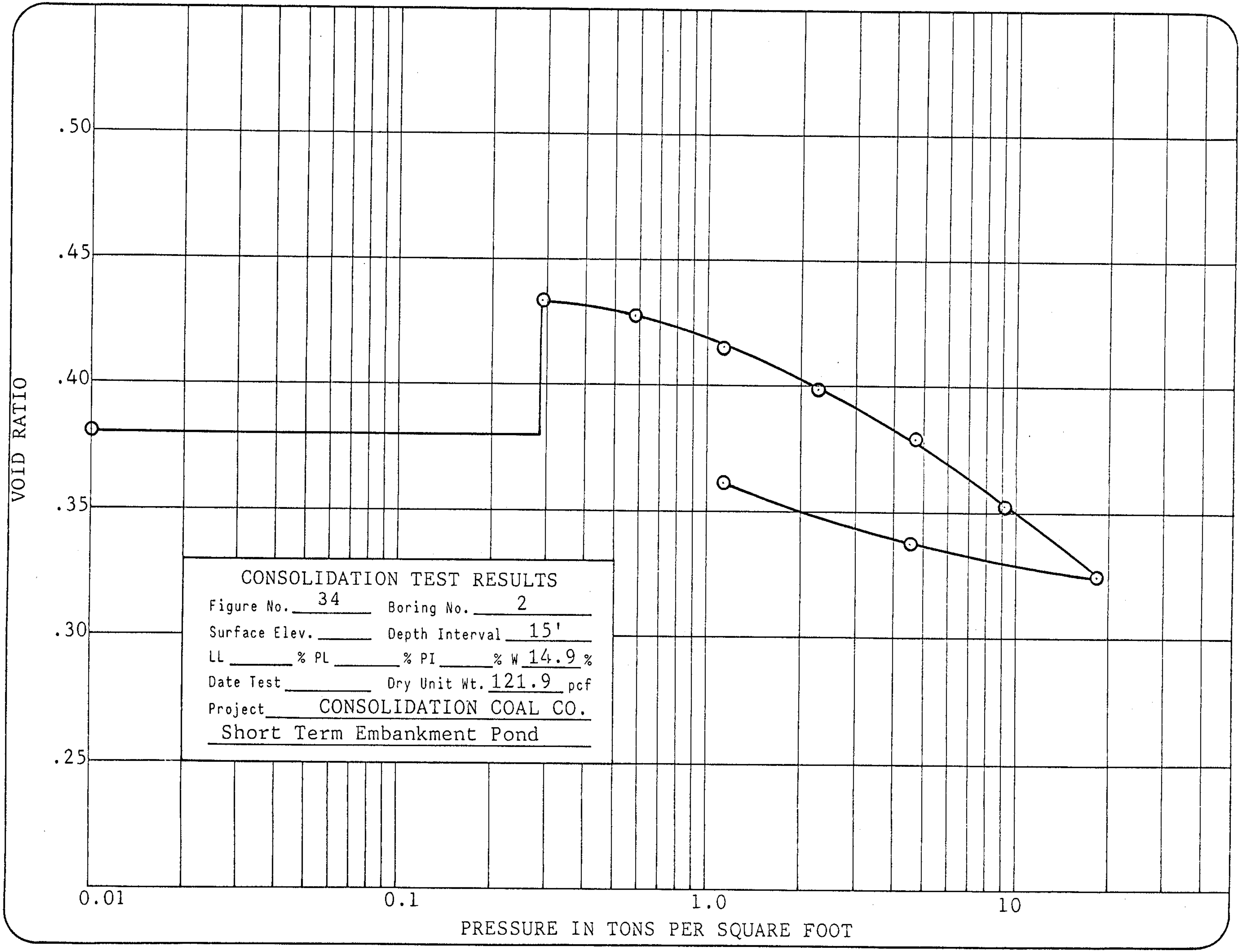
.45
.40
.35
.30
.25
.20
VOID RATIO
0.01
0.1
1.0
10
PRESSURE IN TONS PER SQUARE FOOT
CONSOLIDATION TEST RESULTS
Figure No. 31 Boring No. 2
Surface Elev. Depth Interval 10'
LL % PL % PI % W 6.5 %
Date Test Dry Unit Wt. 125.2 pcf
Project CONSOLIDATION COAL CO.
Short Term Embankment Pond



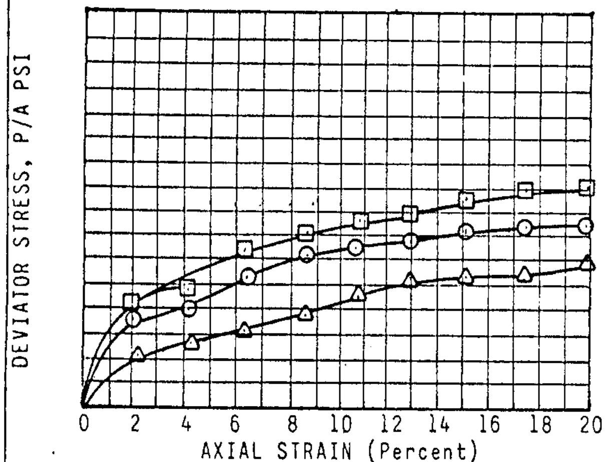
VOID RATIO
.50
.45
.40
.35
.30
.25
0.01
0.1
1.0
10
PRESSURE IN TONS PER SQUARE FOOT
CONSOLIDATION TEST RESULTS
Figure No. 32
Boring No. 2
Surface Elev.
Depth Interval 15'
LL % PL % PI % W 14.9 %
Date Test
Dry Unit Wt. 121.9 pcf
Project CONSOLIDATION COAL CO.
Short Term Embankment Pond

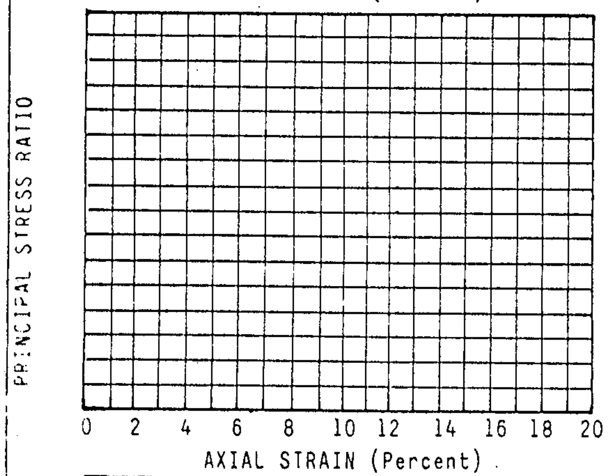


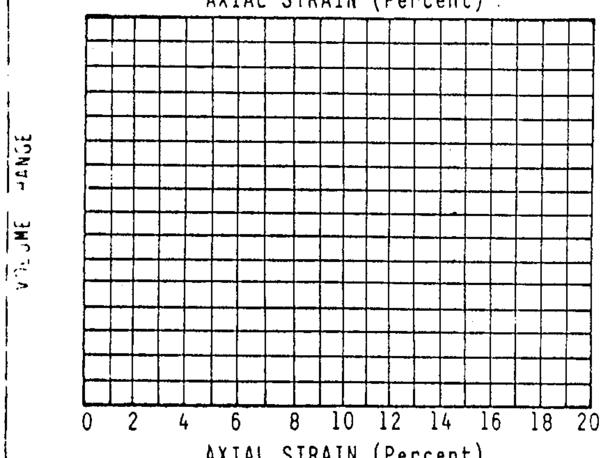
VOID RATIO
.45
.40
.35
.30
.25
.20
0.01
0.1
1.0
10
PRESSURE IN TONS PER SQUARE FOOT
CONSOLIDATION TEST RESULTS
Figure No. 33 Boring No. 2
Surface Elev. ____ Depth Interval 14'
LL ____ % PL ____ % PI ____ % W 8.3 %
Date Test ____ Dry Unit Wt. 123.9 pcf
Project CONSOLIDATION COAL CO.
Short Term Embankment Pond



VOID RATIO
.50
.45
.40
.35
.30
.25
0.01
0.1
1.0
10
PRESSURE IN TONS PER SQUARE FOOT
CONSOLIDATION TEST RESULTS
Figure No. 34 Boring No. 2
Surface Elev. Depth Interval 15'
LL % PL % PI % W 14.9 %
Date Test Dry Unit Wt. 121.9 pcf
Project CONSOLIDATION COAL CO.
Short Term Embankment Pond

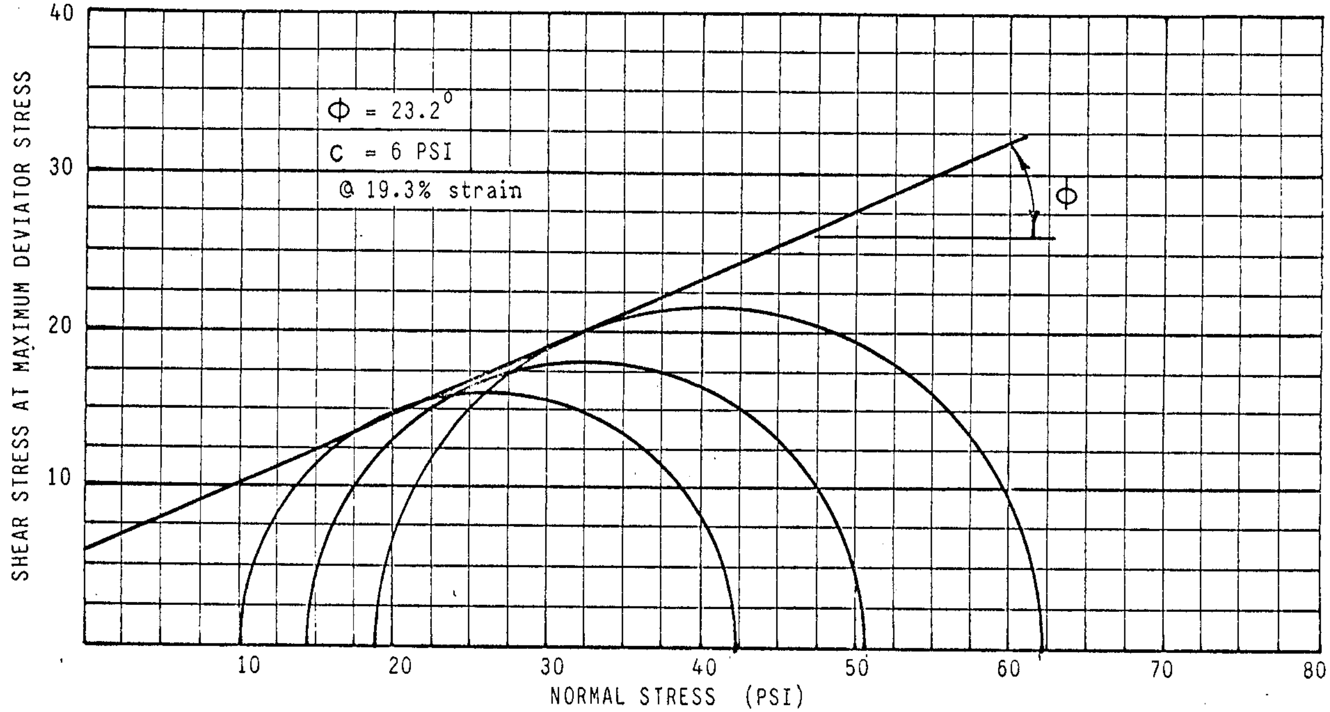






TRIAXIAL SHEAR TEST

SAMPLE NO.



TEST NO. OR SYMBOL	TEST PIT AND DEPTH	SAMPLE DATA: DRY DENSITY (pcf)	MOISTURE %: Ini.	MOISTURE %: Final	DEGREE OF SATURATION (%)	CONFINING PRESSURE PSI	MAXIMUM DEVIATOR STRESS	MAXIMUM PRINCIPAL STRESS RATIO	VALUES AT MOHR COULOMB FAIL.		SAMPLE SIZE LENGTH/DIA. INCHES	STRAIN RATE INCHES/MIN.
□	TP 7 1-4	104.2	14.4			15	31.7				2.8/1.32	.006
○	TP 7 1-4	104.3	14.4			30	37.8				2.8/1.32	.006
△	TP 7 1-4	104.3	14.4			45	46.3				2.8/1.32	.006

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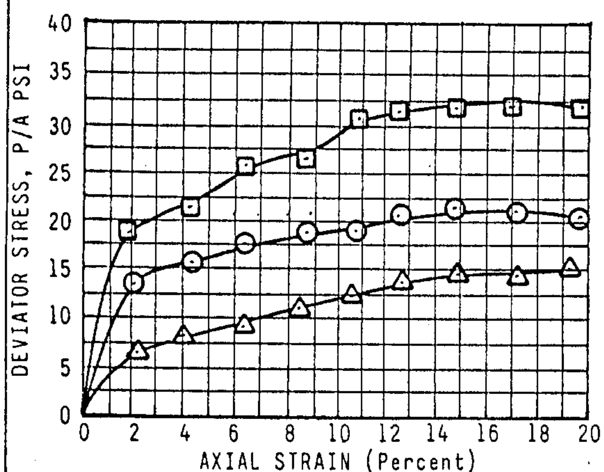
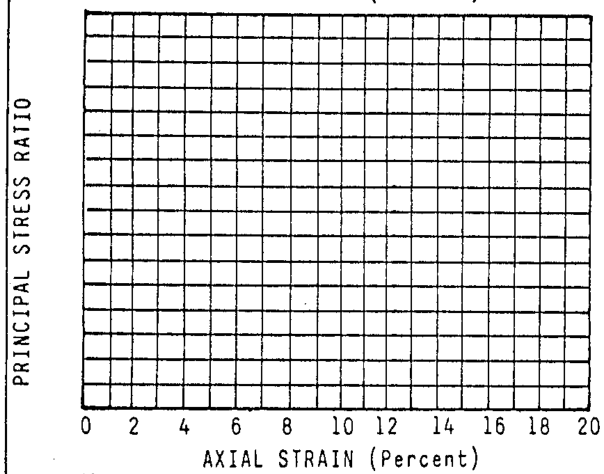
TRIAXIAL SHEAR TEST RESULTS

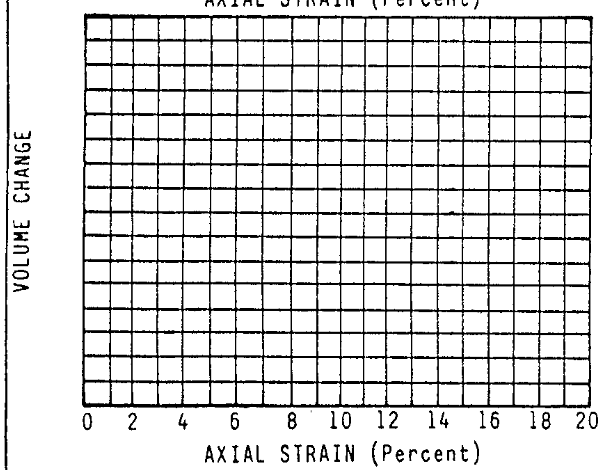
CONSOLIDATION COAL CO.

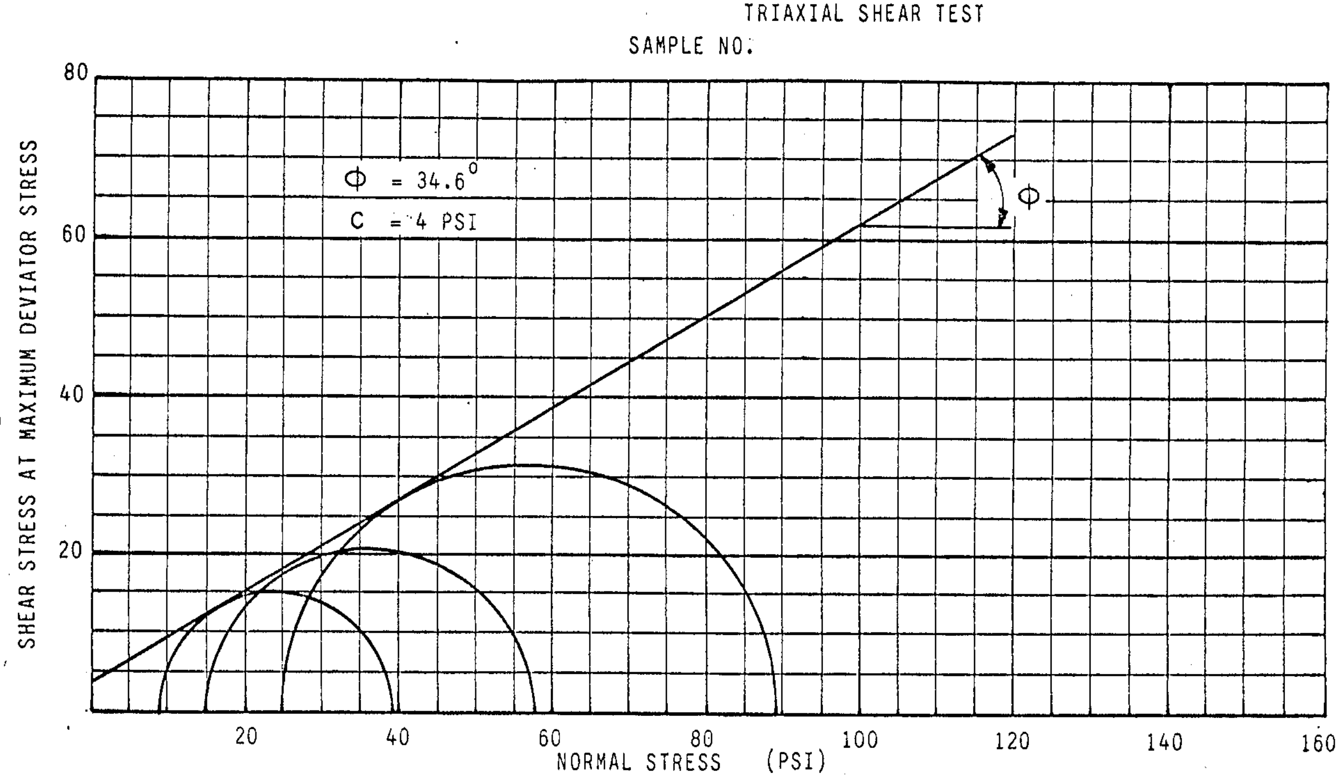
JOB NO.	DATE

Figure No. 35









TEST NO. OR SYMBOL	TEST PIT AND DEPTH	SAMPLE DATA: DRY DENSITY (pcf)	MOISTURE %: Ini.	MOISTURE %: Final	DEGREE OF SATURATION (%)	CONFINING PRESSURE PSI	MAXIMUM DEVIATOR STRESS	MAXIMUM PRINCIPAL STRESS RATIO	VALUES AT MOHR COULOMB FAIL.		SAMPLE SIZE LENGTH/DIA. INCHES	STRAIN RATE INCHES/MIN.
□	TP 8 1.5-3	106.0	18.4			15	30.2				2.8/1.32	.006
○	TP 8 1.5-3	106.0	18.4			30	44.2				2.8/1.32	.006
△	TP 8 1.5-3	106.0	18.4			45	64.7				2.8/1.32	.006

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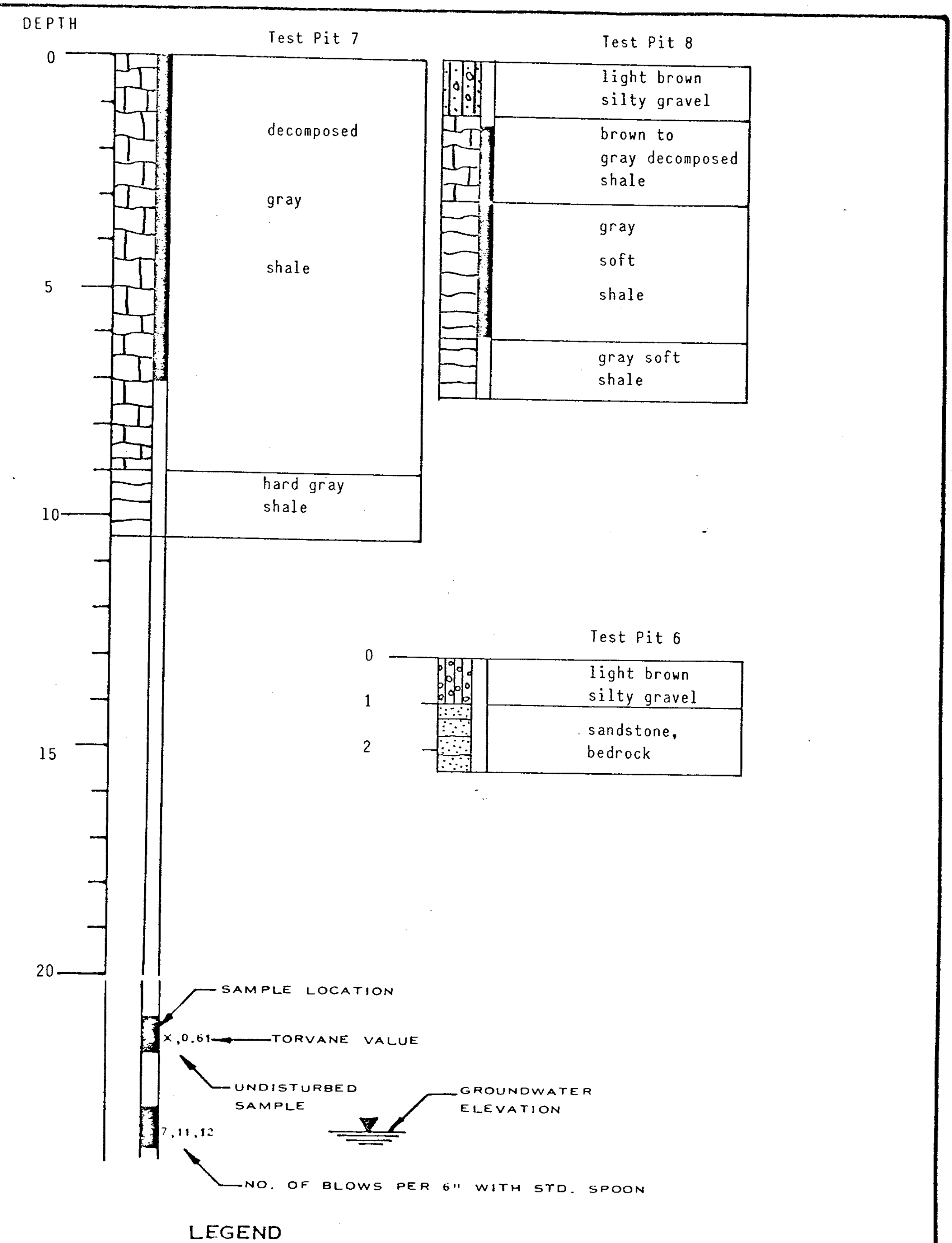
TRIAXIAL SHEAR TEST RESULTS

CONSOLIDATION COAL CO.

JOB NO.	DATE	
		Figure No.36



Log of Test Pits for: Consolidation Coal Co.	ROLLINS, BROWN AND GUNNELL, INC. Consulting Engineers	Figure No. 37

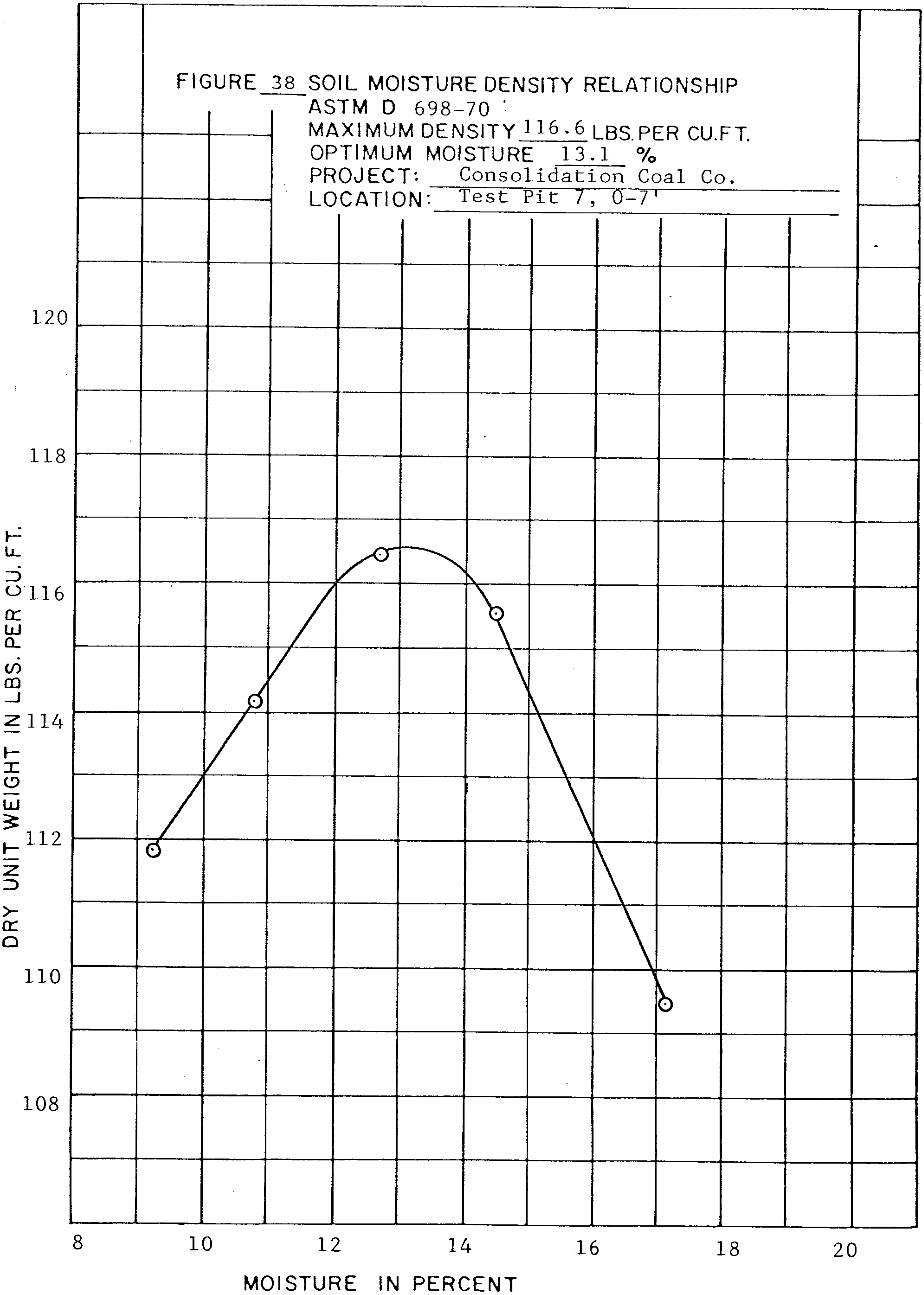


FIGURE 38 SOIL MOISTURE DENSITY RELATIONSHIP
ASTM D 698-70
MAXIMUM DENSITY 116.6 LBS. PER CU.FT.
OPTIMUM MOISTURE 13.1 %
PROJECT: Consolidation Coal Co.
LOCATION: Test Pit 7, 0-7'
DRY UNIT WEIGHT IN LBS. PER CU. FT.
120
118
116
114
112
110
108
8
10
12
14
16
18
20
MOISTURE IN PERCENT

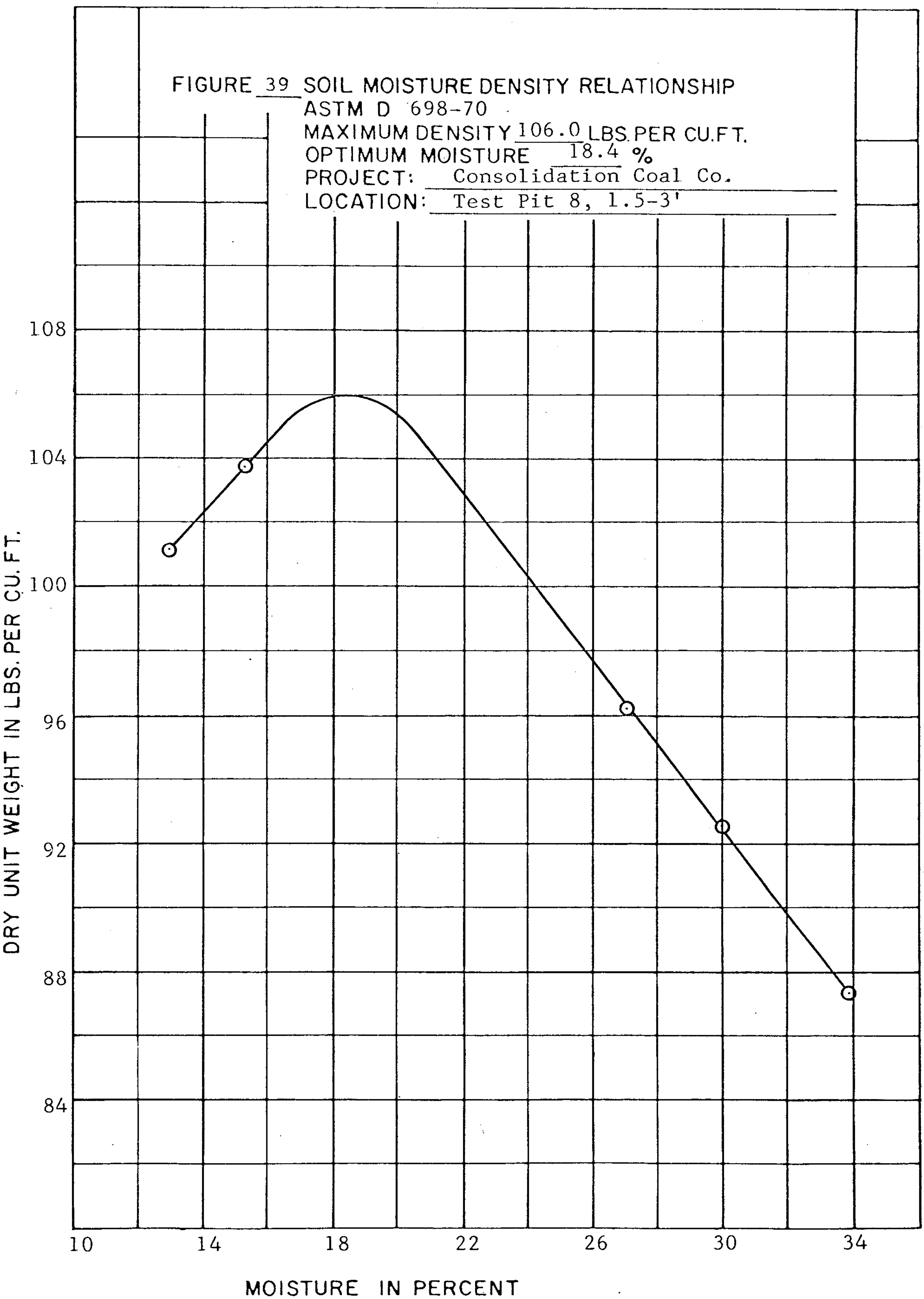


FIGURE 39 SOIL MOISTURE DENSITY RELATIONSHIP
ASTM D 698-70
MAXIMUM DENSITY 106.0 LBS. PER CU. FT.
OPTIMUM MOISTURE 18.4 %
PROJECT: Consolidation Coal Co.
LOCATION: Test Pit 8, 1.5-3'
DRY UNIT WEIGHT IN LBS. PER CU. FT.
108
104
100
96
92
88
84
10
14
18
22
26
30
34
MOISTURE IN PERCENT

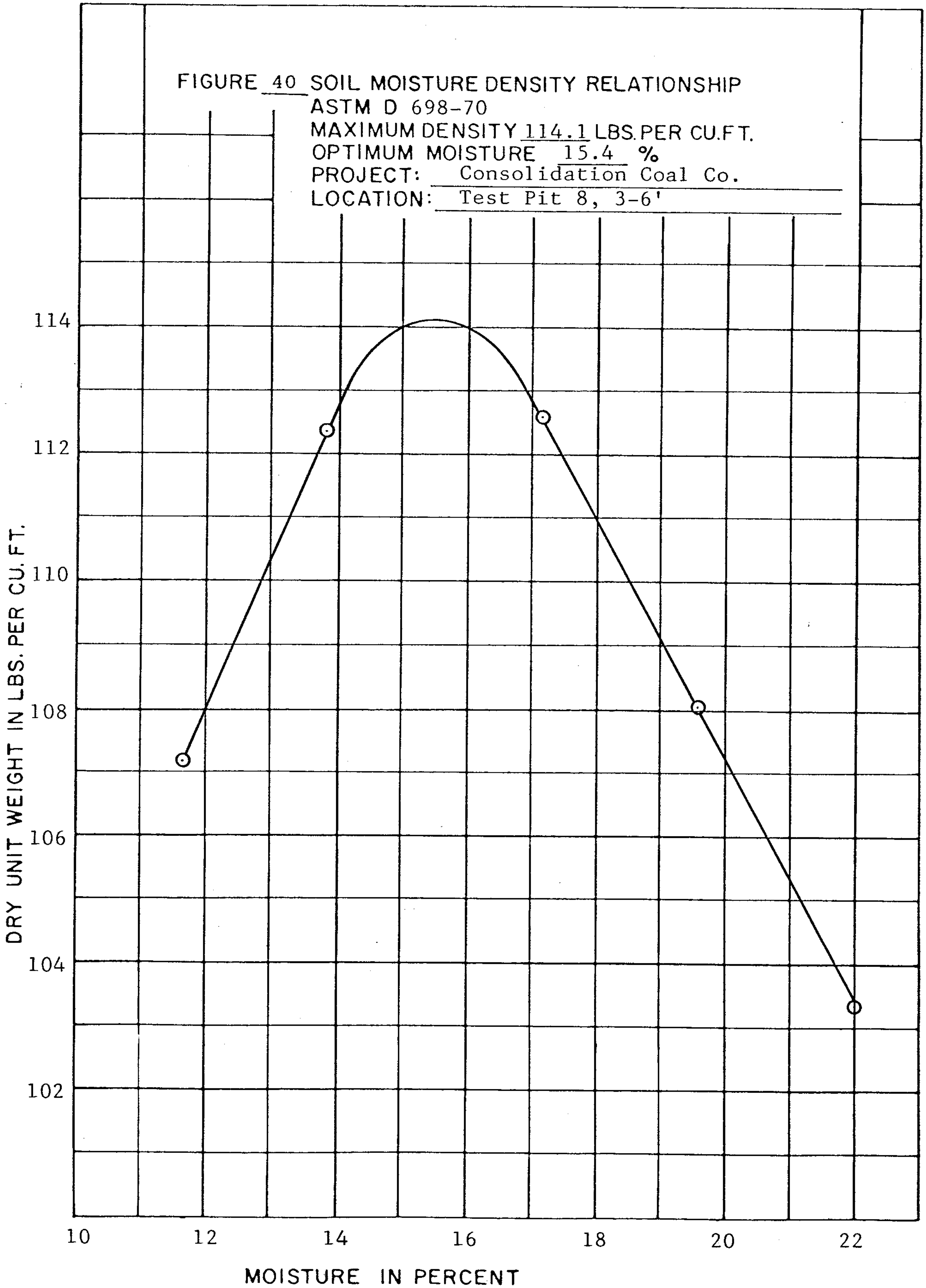
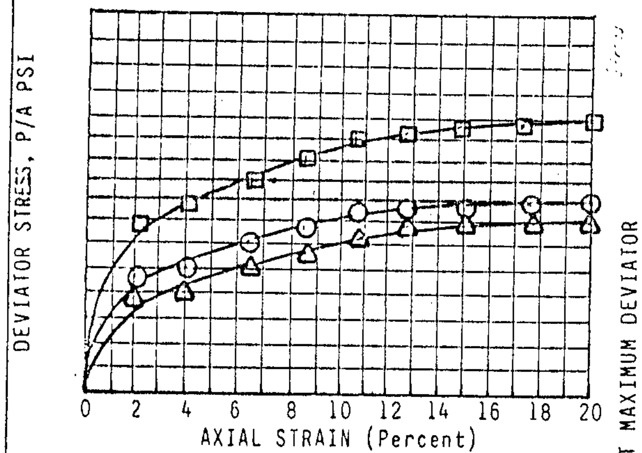


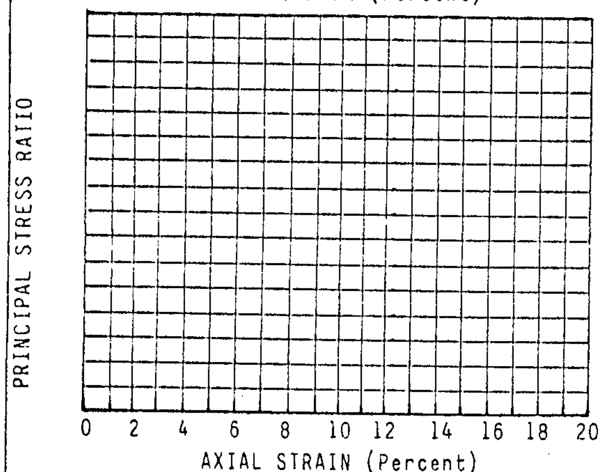
FIGURE 40 SOIL MOISTURE DENSITY RELATIONSHIP
ASTM D 698-70
MAXIMUM DENSITY 114.1 LBS. PER CU.FT.
OPTIMUM MOISTURE 15.4 %
PROJECT: Consolidation Coal Co.
LOCATION: Test Pit 8, 3-6'
DRY UNIT WEIGHT IN LBS. PER CU. FT.
114
112
110
108
106
104
102
10
12
14
16
18
20
22
MOISTURE IN PERCENT

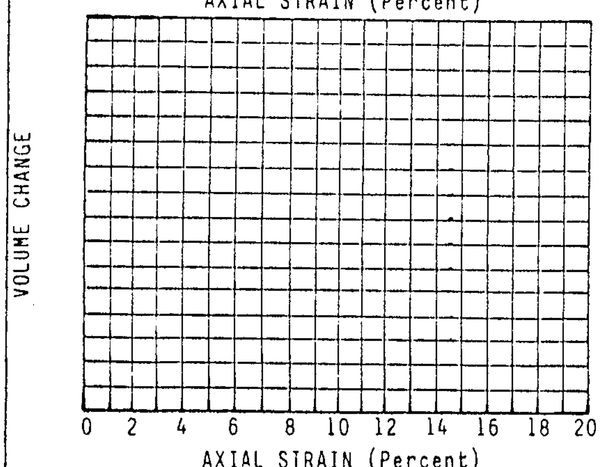
TABLE NO. 8 SUMMARY OF TEST DATA

PROJECT Consolidation Coal Short Term Site FEATURE Foundations (Test Pits) LOCATION Emery, Utah

TEST PIT NO.	DEPTH BELOW GROUND SURFACE	SAMPLE DESCRIPTION	IN-PLACE DENSITY		ASTM D 698-78		LAB PERMEABILITY		CONSISTENCY LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM
			UNIT WEIGHT LB/FT^3	MOISTURE PERCENT	UNIT WEIGHT LB/FT^3	MOISTURE PERCENT	% COM-PACTED	FT/YR	L.L. %	P.L. %	P.I. %	% GRAVEL	% SAND	% SILT & CLAY	
7	0-7'				116.6	13.1	95.2	.055	29.7	18.8	10.9				CL-1
8	1.5-3'				106.0	18.4	93.9	.0075	62.3	31.4	30.9				MH
8	3-6'				114.1	15.4			32.1	19.5	12.6				CC-1
20					124.7	10.9			20.2	14.2	6.0	17.9	31.6	50.5	CL-ML,GM
21					116.3	13.2			26.1	15.4	10.7				CL-1

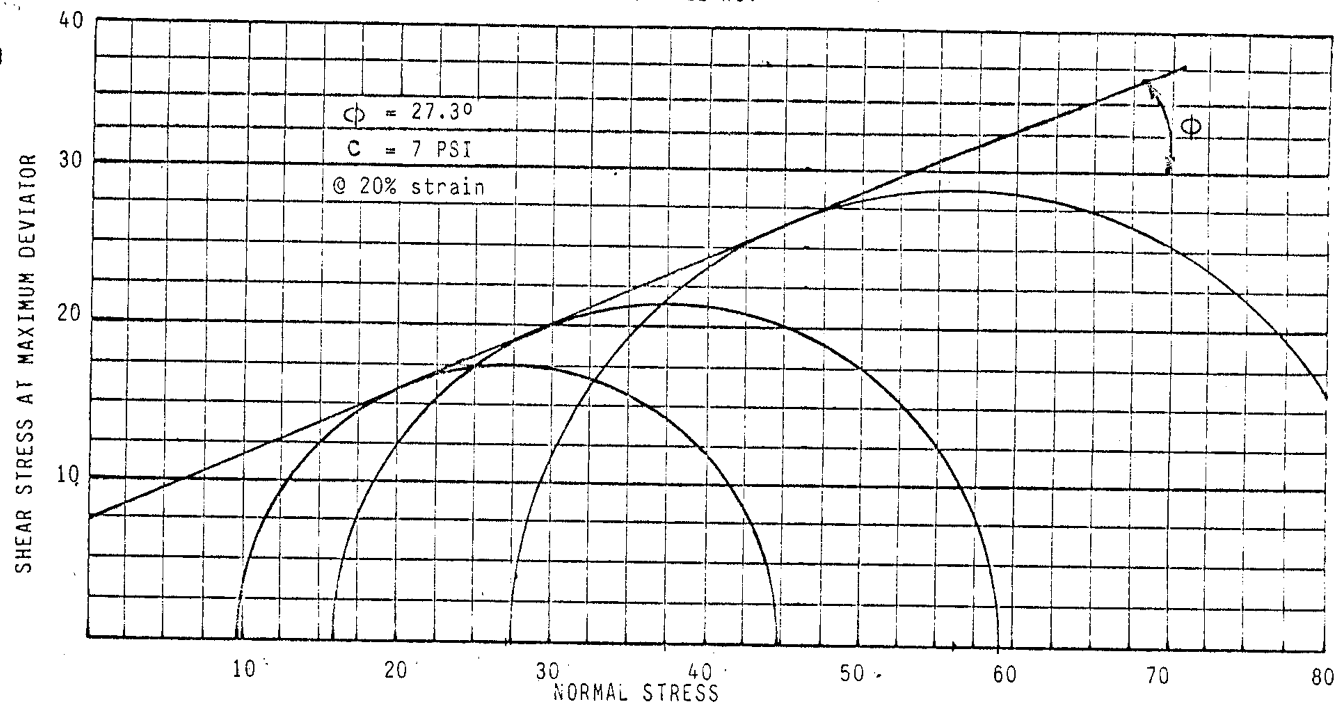






TRIAXIAL SHEAR TEST

SAMPLE NO.



TEST NO. OR SYMBOL	TEST, PIT AND DEPTH	SAMPLE DATA DRY DENSITY (pcf)	MOISTURE % Ini.	MOISTURE % Final	DEGREE OF SATURATION (%)	CONFINING PRESSURE PSI	MAXIMUM DEVIATOR STRESS	MAXIMUM PRINCIPAL STRESS RATIO	VALUES AT MOHR COULOMB FAIL.		SAMPLE SIZE LENGTH/DIA. INCHES	STRAIN RATE INCHES/MIN.
	TP 7 4-7	116.6	13.1			15	36.0				2.8/1.32	.006
	TP 7 4-7	116.6	13.1			30	43.0				2.8/1.32	.006
	TP 7 4-7	116.6	13.1			45	60.4				2.8/1.32	.006

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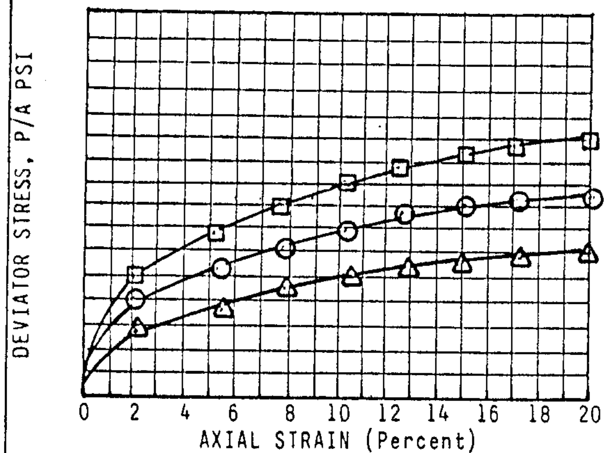
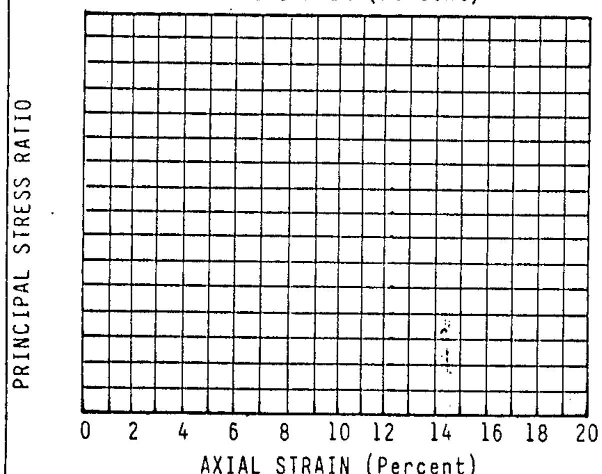
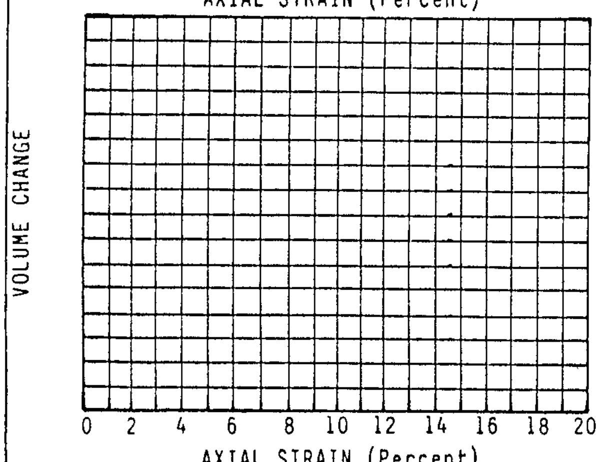
TRIAXIAL SHEAR TEST RESULTS

CONSOLIDATION COAL CO.

JOB NO.	DATE	
		Figure No. 41

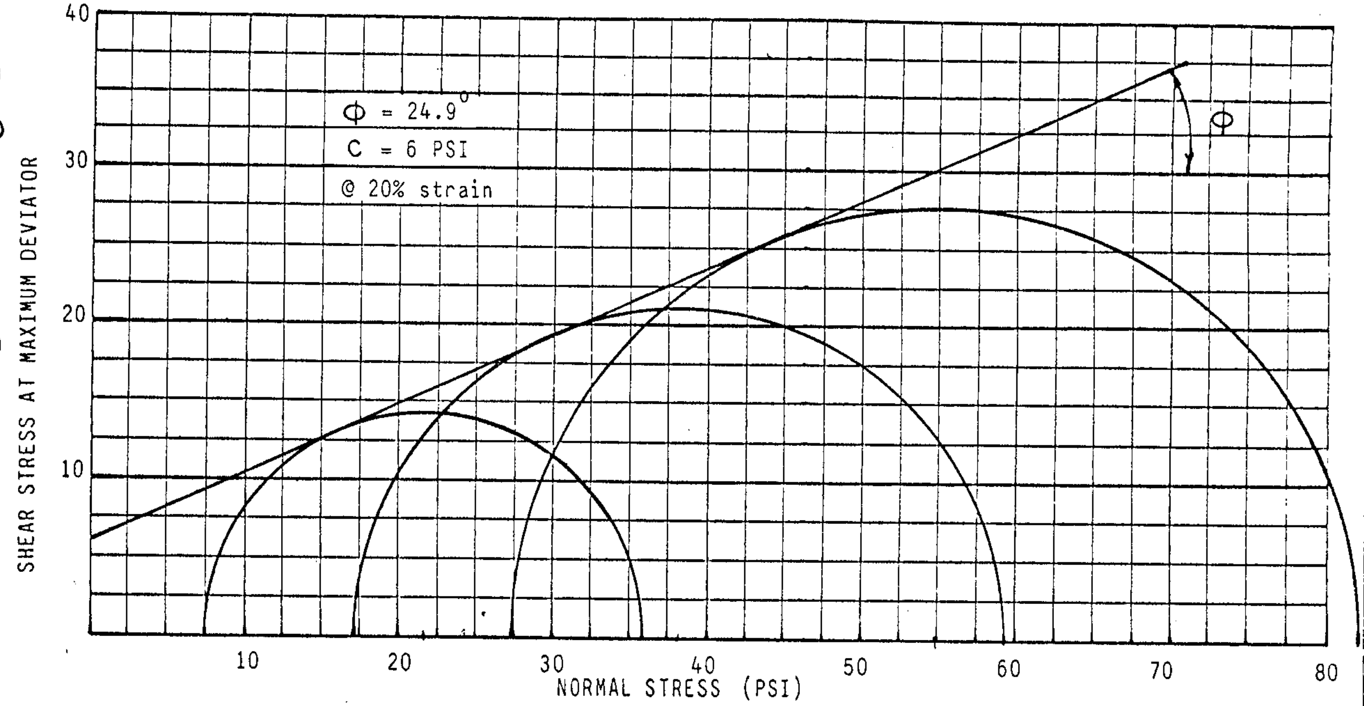






TRIAXIAL SHEAR TEST

SAMPLE NO.



TEST NO. OR SYMBOL	TEST PIT AND DEPTH	SAMPLE DATA DRY DENSITY (pcf)	MOISTURE % Ini.	MOISTURE % Final	DEGREE OF SATURATION (%)	CONFINING PRESSURE PSI	MAXIMUM DEVIATOR STRESS	MAXIMUM PRINCIPAL STRESS RATIO	VALUES AT MOHR COULOMB FAIL.		SAMPLE SIZE LENGTH/ DIA. INCHES	STRAIN RATE INCHES/ MIN.
□	TP 8 3-6	114.1	15.4			15	30.2				2.8/1.32	.006
○	TP 8 3-6	114.1	15.4			30	42.5				2.8/1.32	.006
△	TP 8 3-6	114.1	15.4			45	56.0				2.8/1.32	.006

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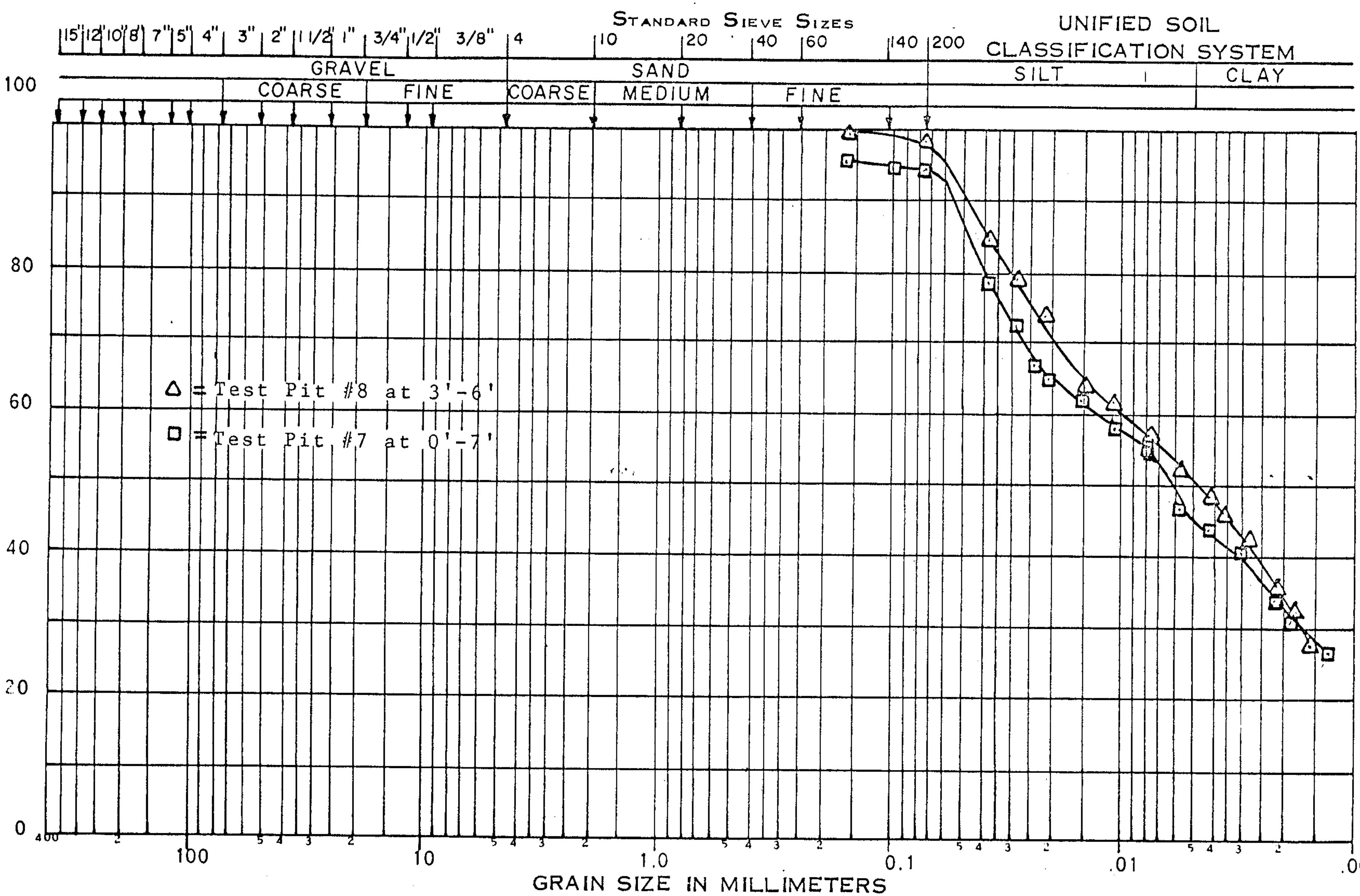
TRIAXIAL SHEAR TEST RESULTS

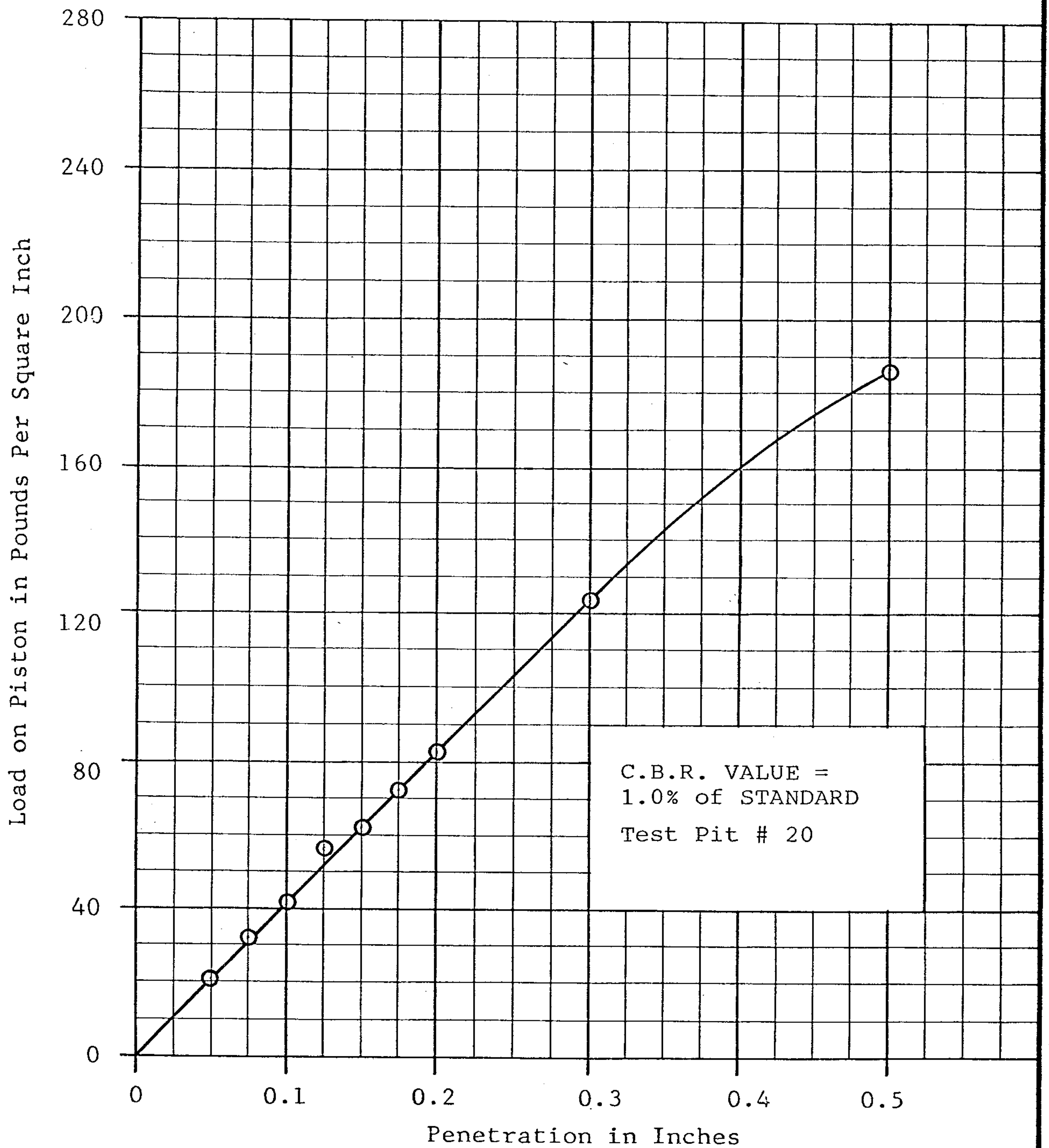
CONSOLIDATION COAL CO.

JOB NO.	DATE	
		Figure No.42



ROLLINS, BROWN AND GUNNELL, INC. PROFESSIONAL ENGINEERS	CLIENT Consolidation Coal PROJECT LOCATION Test Pits No. 7 and 8	FIGURE 43 GRAIN SIZE DISTRIBUTION CURVE HOLE NO. DEPTH

CALIFORNIA BEARING RATIO TEST RESULTS



ROLLINS, BROWN & GUNNELL, INC. **CONSULTING ENGINEERS**	Consolidation Coal	Figure No.44

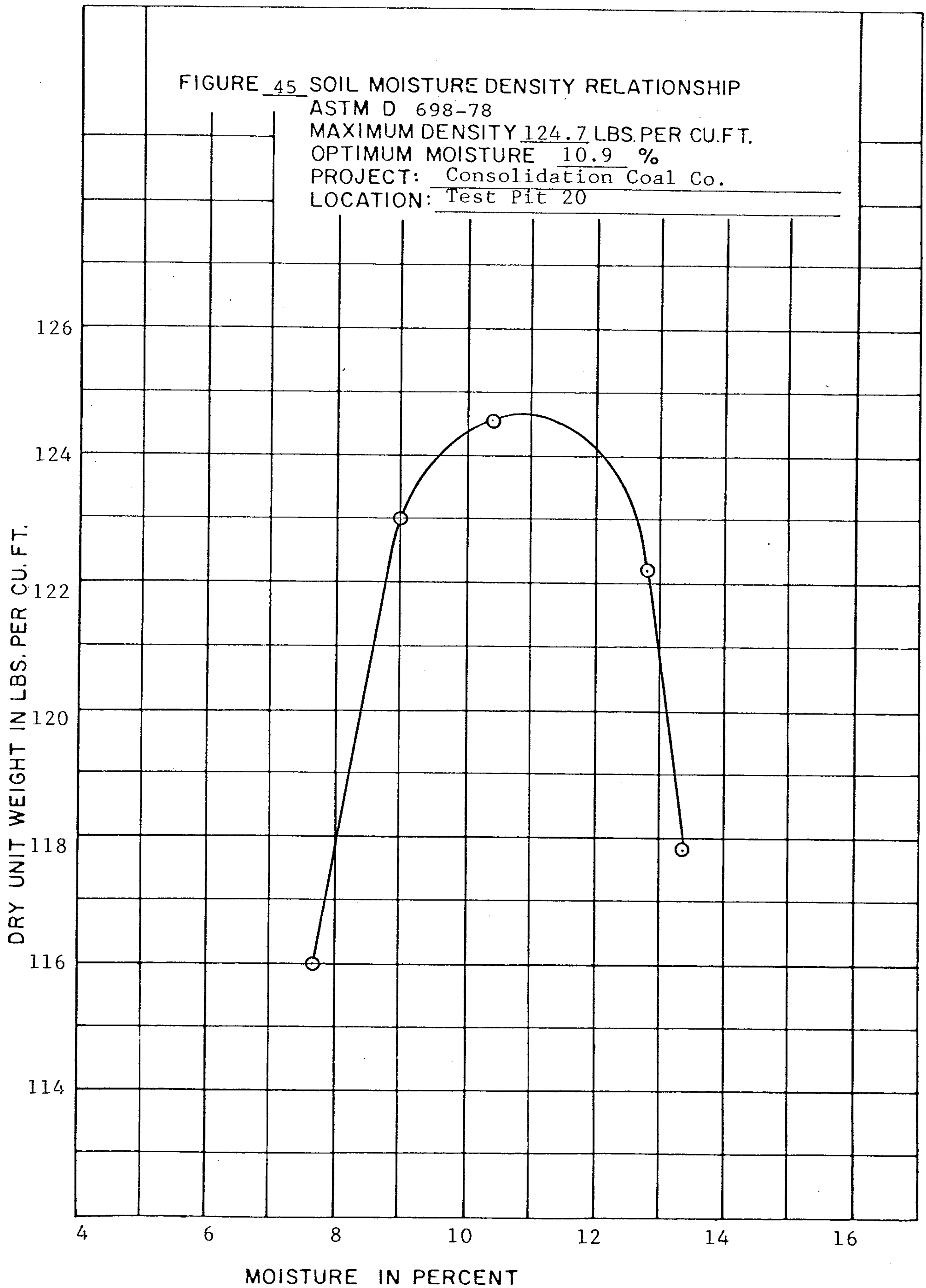
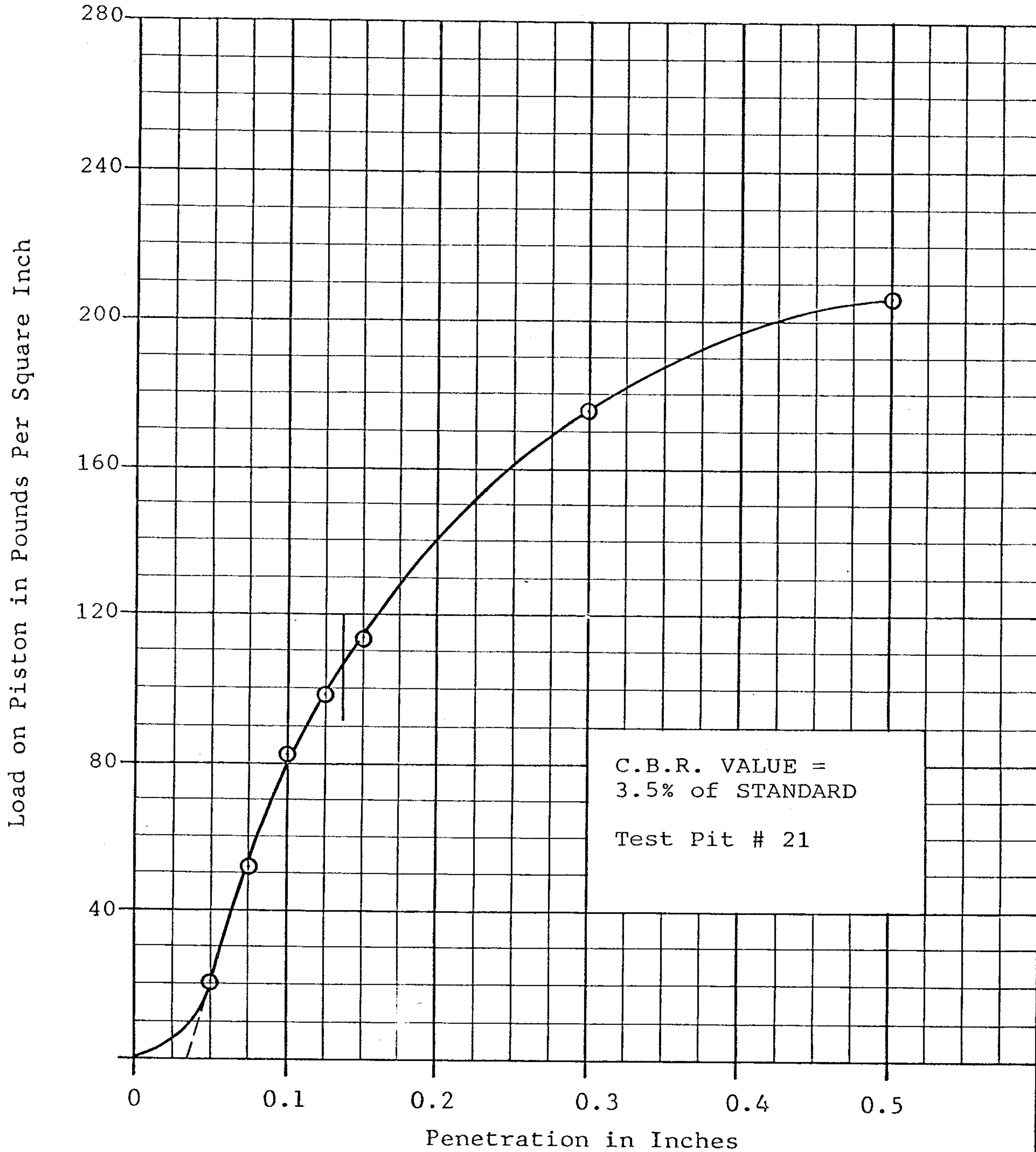


FIGURE 45 SOIL MOISTURE DENSITY RELATIONSHIP
ASTM D 698-78
MAXIMUM DENSITY 124.7 LBS. PER CU. F T.
OPTIMUM MOISTURE 10.9 %
PROJECT: Consolidation Coal Co.
LOCATION: Test Pit 20
DRY UNIT WEIGHT IN LBS. PER CU. FT.
126
124
122
120
118
116
114
4
6
8
10
12
14
16
MOISTURE IN PERCENT

CALIFORNIA BEARING RATIO TEST RESULTS



ROLLINS, BROWN & GUNNELL, INC. CONSULTING ENGINEERS	Consolidation Coal	Figure No. 46

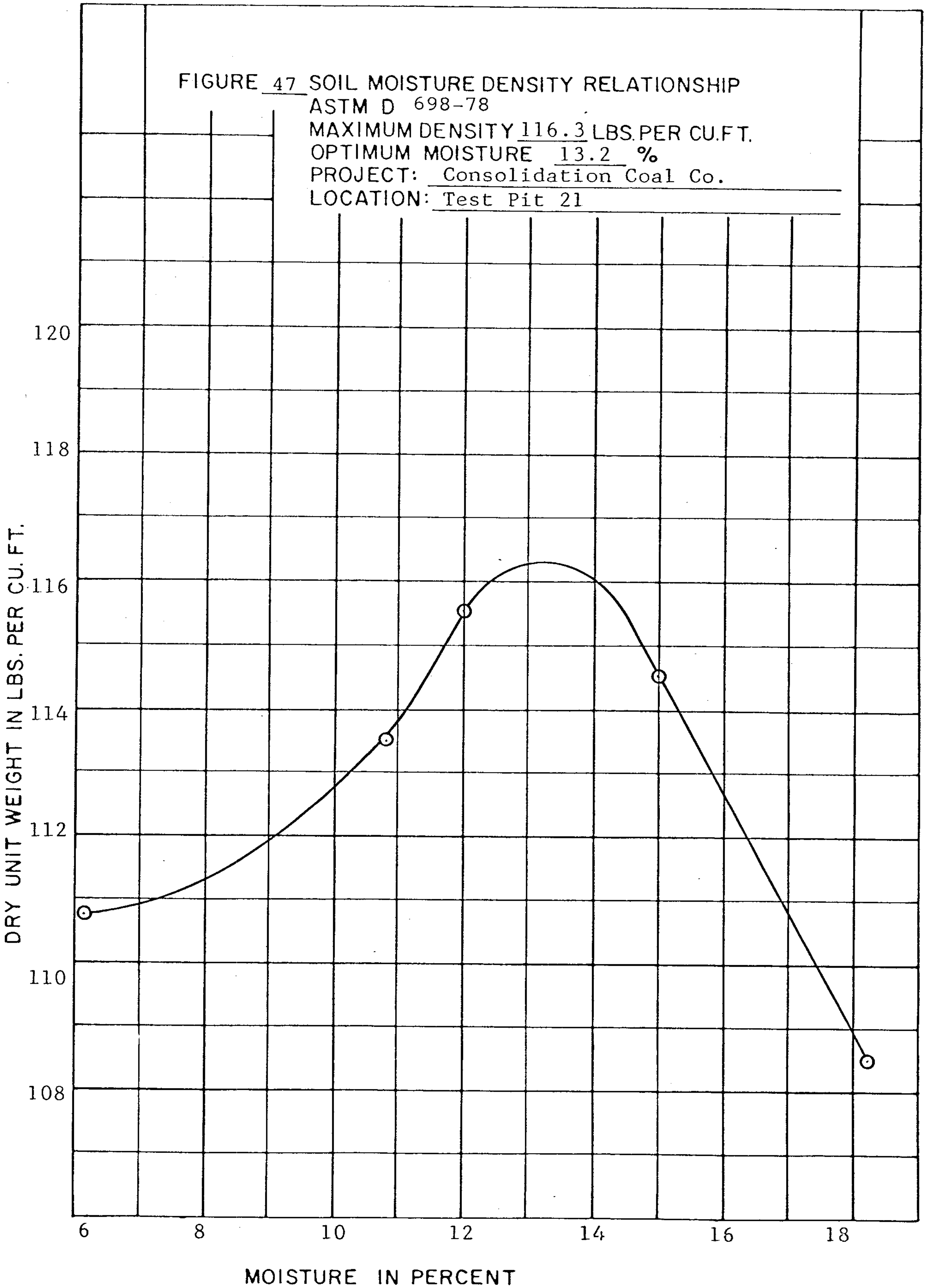


FIGURE 47 SOIL MOISTURE DENSITY RELATIONSHIP
ASTM D 698-78
MAXIMUM DENSITY 116.3 LBS. PER CU. FT.
OPTIMUM MOISTURE 13.2 %
PROJECT: Consolidation Coal Co.
LOCATION: Test Pit 21
DRY UNIT WEIGHT IN LBS. PER CU. FT.
120
118
116
114
112
110
108
6
8
10
12
14
16
18
MOISTURE IN PERCENT

15.6 Designs

Several references and supportive documents were used to prepare the proposed design plans in addition to those listed in section 7.2.4.2. These follow:

1. American Iron and Steel Institute. Handbook of Steel Drainage and Highway Production Products. Washington, D.C., 1971.

2. U.S. Department of the Interior, Mine Safety and Health Administration. Engineering and Design Manual - Coal Refuse Disposal Facilities. D'Appolonia Consulting Engineers, Inc.

3. United States Department of the Interior, Bureau of Mines. Surface Mine Haulage Road Design Study. 1976.

4. U.S. Environmental Protection Agency. Erosion and Sediment Control. EPA - 625/3-76-006, 1976.

15.6.1 Roads and Parking Areas

15.6.1.1 Main Entrance Road

Heavy equipment and truck traffic will access the preparation plant area by the proposed main entrance road. The structure, located on the northern boundary of the facilities area, will be used by coal and refuse haulage trucks. The plan view and profile are shown on Plate 15-3.

The sixty foot wide surface begins at the county road and ends at the yard area. Two lanes, each twenty feet wide, will provide a travel surface for vehicles entering and leaving the plant and loadout areas. A separate lane has been provided for access to and from the scales.

The topsoil material will be removed and stockpiled before construction. A stable compacted subbase will be provided, as shown on Plate 15-4. The base and surface will be composed of 10" of well graded sand and 12" of gravel respectively. The top 6" of gravel will be fine gravel.

Parallel drainage ditches have been designed to collect road surface runoff. The plant diversion discharges into the northern ditch as described in section 15.6.2.2 where it ultimately drains into the natural channel.

Refer to Plates 15-3 and 15-4 for the design details of this proposed structure.

15.6.1.2 Yard Area

The yard is comprised of the plant, loadout areas, stockpiles, and service areas. The entire yard facilities area, shown on Plate 15-1A, will have a gravel surface that covers a variable base and subbase. Three basic types of material may be found throughout the yard; shale, sandstone, and silty sand. The shale areas are to be overlayed with a nonwoven fabric to reduce the loss of rock and stability as time weathers the shales. The silty sand area will be comprised of the same cross section as the main entrance road; a subbase of compacted insitu soil with a sand base and gravel surface. The sandstone will be covered with six inches of crushed rock to provide a continuous travel surface.

15.6.1.3 Coal Refuse Haulage Road

The existing road that serves as access to the mine discharge sediment pond will be upgraded and extended to the north to serve as the waste disposal access road. This proposed structure, the coal refuse haulage road, will be used on a daily basis for the transport of coarse material to the disposal site, and for the inspection of the facilities.

The thirty foot wide road section will be subcut and filled with compacted material as shown on Plate 15-6 to form a suitable subbase for the 28" sand base and 12" gravel surface. Parallel drainage ditches will collect the road surface runoff and convey the water to the natural drainage channel.

Three ten foot diameter pipes are required for the Quitchupah Creek crossing.

Refer to Plates 15-5 and 15-6 for the detailed design drawings of this proposed structure.

15.6.1.4 Plant Access Road

The existing road to the mine substation (previously called the "Tank Road") will be reconditioned to serve as an access road to the preparation plant. In addition, a bypass will be constructed from the county road to the access road in order to facilitate north bound traffic flows. The upgraded access road will begin at the county road and end at the preparation plant yard area. A further section of the existing road will also be upgraded. This section will begin at the preparation plant yard area and extend to the water tank. This section will be known as the tank access extension.

These roads are designed to carry light passenger vehicle traffic. Construction and upgrading will consist of grading the existing ground surface to a width of 24 feet, and stabilizing the road surface with 9 inches of crushed aggregate (see Plate 15-7 for typical cross section and Plan/Profiles). In addition, parallel 1 foot drainage ditches will be constructed to collect surface water runoff.

15.6.2 Sediment Control Structures and Surface Water Management Plan

15.6.2.1 Sediment Pond #5

Proposed sediment pond #5 provides for the collection and control of surface water runoff from disturbed land in the preparation plant facilities area. The detailed plan has been prepared in accordance with applicable regulations. Section 7.2.4.2 which describes the major components of the sediment control and water management plan, identifies the design criteria based on applicable regulations, and summarizes pertinent impoundment design information should be referred to.

The proposed impoundment is located west of the preparation plant facilities area, where it collects surface water runoff from a 115 acre watershed, all disturbed. This embankment type structure will be partially excavated to provide the ultimate storage capacity of 3.6 acre-feet, which will efficiently store the 10 year - 24 hour storm runoff volume plus 3 years of expected sediment accumulation. The pond will be equipped with a 3" polyethylene pipe gate valve decant system with provisions to trap gas and oil. The emergency spillway, designed to pass a 25 year - 24 hour precipitation event, will consist of a 20 foot wide trapezoidal channel. The channel will be riprapped. The minimum freeboard is 1.0 foot. Discharge from this pond will flow westward into the natural drainage channel. An NPDES permit for the discharge point will be obtained.

Refer to Plate 15-9 for the plan view and detailed design drawings of the sediment pond. A design summary sheet has been prepared for this proposed structure and is presented here.

IMPOUNDMENT SUMMARY SHEET

Owner/Operator Consolidation Address

County Emery Date 6/5/81

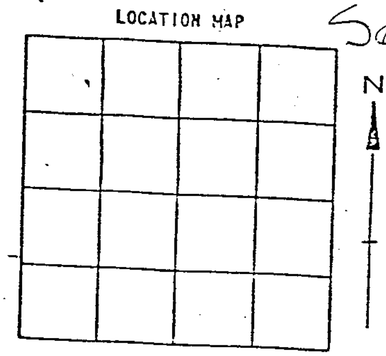
Impoundment Identification Number 22-6-33-A2 - Emery Pond #5

PREPARATION PLANT SEDIMENTATION POND - #5

Location of Impoundment:

LOCATION MAP

See Plate: #15-9



Sec. ______

T. 22 S ~~N~~. R. 6 E ~~W~~.

A. Sediment Storage Volume Estimation

DESIGNING WATER EROSION CONTROL

a. EROSION CALCULATIONS - UNIVERSAL SOIL LOSS EQUATION

Water-shed Subareas	Land use or Cond.	Universal Soil-Loss Equation Factors R	K	L	S	LS	C	P	Est. Soil Loss T/Ac/Yr	Acres in Area	Est. Soil Loss from area Tons/Yr
A		~~50~~ 20	0.42	—	—	2.34	0.20	1.0	3.93	32.2	126.55
B		~~50~~ 20	0.45	—	—	5.67	0.24	1.0	12.25	26.8	328.30
C		~~50~~ 20	0.44	—	—	4.32	0.24	1.0	9.12	56.0	510.72
		~~50~~ 20							Total	115.0 Ac	
		~~50~~ 20									

Total (Gross) 965.6 T/y

Delivery ratio = 40.0 %

Total (Net) 386.2 T/y

Sediment loss volume in acre - ft/year 0.28

Cleanout interval 3 year

Soil loss in acre - feet for design cleanout interval 0.83

b. EROSION CALCULATIONS - 0.1 acre foot per acre disturbed

Disturbed area 115.0 acres.

Soil loss in acre - feet N/A.

Minimum sediment storage capacity 0.83 acre-feet.

B. Hydrologic Data

1. Total drainage area 115.0 acres

2. Disturbed area 115.0 acres

3. Weighted soil cover complex number (CN) = A: 82, B: 77, C: 80
Composite = 80

4. Average watershed slope: A: 4.0 B: 4.0 C: 4.0 %
Composite = 4.0 %

5. Storm Data:

Frequency (years)*	Rainfall (inches)	Q (cfs)			Runoff (A-F)		
		A	B	C	A	B	C
10yr - 24hr	1.5"				0.91	0.47	1.35
					(2.73)		
25yr - 24hr	1.9"	16	8	19			
		(43 cfs)					

* as required

C. Impoundment Data

1. Runoff storage capacity 2.73 (A-F)*

2. Sediment storage capacity 0.87 (A-F)

3. "Dugout" capacity — (A-F)**

4. Maximum surface area of impoundment 0.64 (acres)

5. Estimated theoretical detention time N/A (Hours)**

* at principal spillway crest
** if applicable

D. Embankment Data

1. Top width of embankment ______10______ feet
2. Maximum height of embankment ______10______ feet 1
3. Minimum freeboard ______1.0______ feet
4. Elevations
   a. Upstream toe of dam ______5940______ MSL
   b. Top of dam ______5950______ MSL
   c. Design sediment storage elevation ______5942.5______ MSL
   d. Crest of principal spillway ______N/A______ MSL
   e. Crest of emergency spillway ______5948______ MSL
   f. ℄ of principal spillway outlet ______N/A______ MSL
5. Upstream embankment slope ______3______ : 1
6. Downstream embankment slope ______3______ : 1
7. Width of core trench ______N/A______ feet 2
8. Depth of core trench ______N/A______ feet 2
9. Additional seepage control provisions

____

____

____

1 Measured from upstream toe

2 If applicable

E. Spillway Design — Decant System

1. Principal spillway

   a. Design storm frequency N/A - 10day drawdown

   b. Type of spillway: Polyethylene Pipe

   c. Spillway criteria

      Riser diameter N/A inches

      Box N/A feet x N/A feet

      Barrel diameter 0.25 feet

      Barrel length 180 feet

   d. Spillway capacity N/A cfs

   e. Other Decant - Controled outlet (Gate Valve)

2. Emergency spillway

   a. Design storm frequency 25yr - 24 hr

   b. Type of spillway Open Channel

   c. Spillway criteria

      Length of inlet channel 50' feet

      Length of level section 10 feet

      Slope of inlet channel 16.0 %

      Slope of exit channel 5.0 %

      Bottom width 20 feet

      Side slope 3 : 1

      Riser diameter N/A inches

      Box N/A feet x N/A feet

      Barrel diameter N/A feet

      Barrel length N/A feet

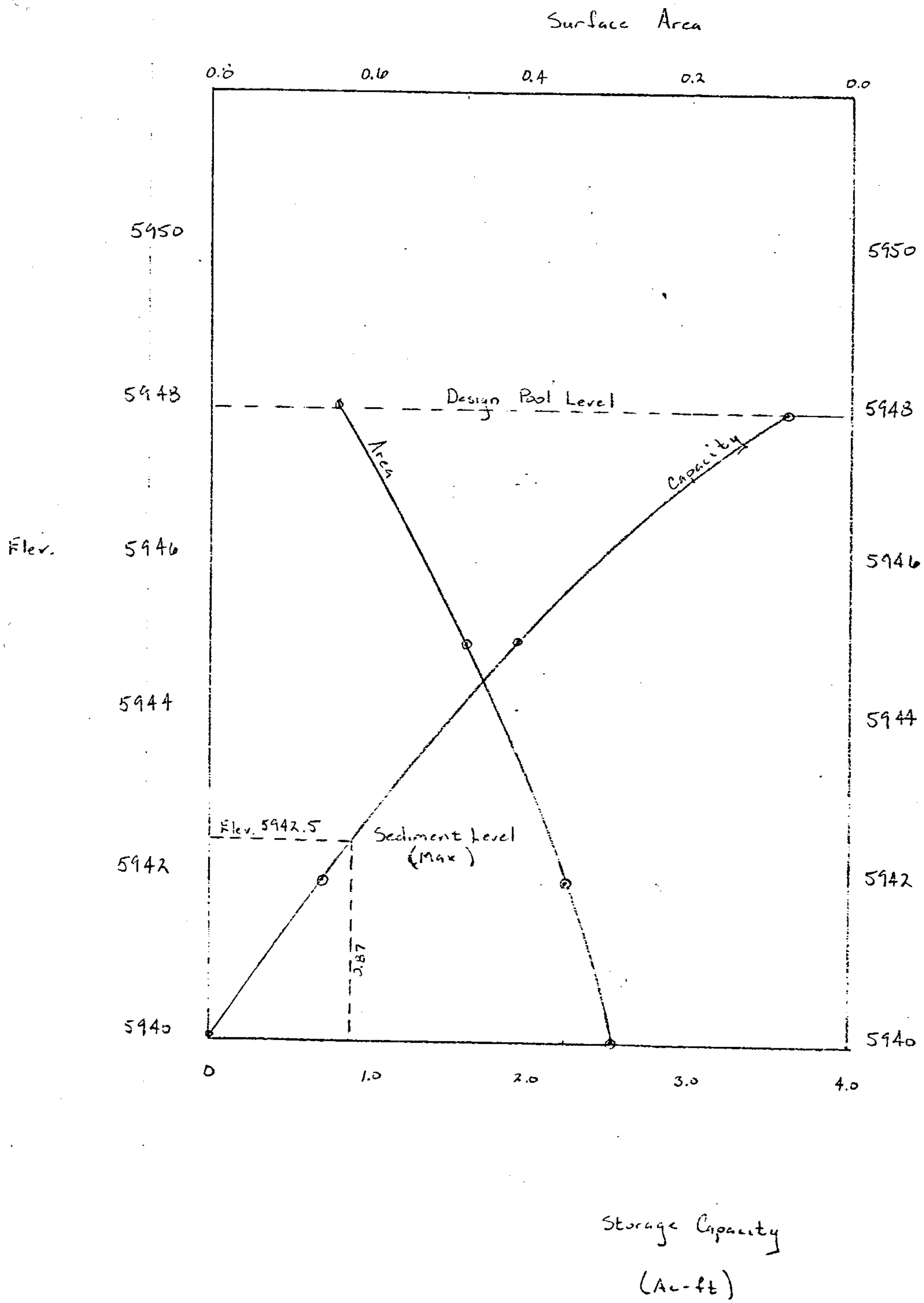
   d. Design discharge 45 cfs

   e. Maximum flow depth above E.S. crest 0.98 feet

Pond #22-6-33-A2
Preparation Plant Sed Pond
POND #5

ELEVATION	AREA (ACRES)	Δ D (FEET)	VOLUME (ACRE-FEET)	Σ VOLUME (AC-FT)
5940	0.30			0
		2'	0.66	0.66
5942	0.36			
		3'	1.26	1.92
5945	0.48			
		3'	1.68	3.60 > 3.56 ok
5948	0.64			

Capacity Curves 6/9/81



15.6.2.2 Preparation Plant Diversion

The proposed preparation plant diversion provides for the collection and conveyance of undisturbed area surface water runoff from a 75.1 acre drainage area upstream of the preparation plant facilities area. The detailed plan has been prepared in accordance with applicable regulations (refer to Section 7.2.4.2). The ditch has been designed to handle the peak discharge from a 10 year - 24 hour design storm event. The proposed diversion is comprised of two sections, referred to as the upper reach and the lower reach.

The upper reach of the diversion has a drainage area of 43.6 acres, all undisturbed land. Due to the small peak discharge of 5.5 cfs, a triangular channel type was chosen. The maximum flow velocity in the channel is based upon 20 cfs with design velocity and flow depth of 1.8 fps and 1.9 feet respectively.

The lower reach of the diversion has been designed to handle the flow from the upper reach plus an additional 31.5 acre drainage area. A trapezoidal channel has been designed for the lower reach with a bottom width of 6 feet and 3:1 side slopes. The maximum flow velocity in the channel is 2.0 fps with a design flow depth of 1.4 feet. This proposed diversion structure serves as the northern ditchline of the proposed main entrance road.

Refer to Plate 15-10 for the plan view and detailed design drawings of the preparation plant diversion. A design summary sheet has been prepared for this proposed structure and is presented here.

DIVERSION INFORMATION SHEET

Owner/Operator Consolidation Coal Co. Address ____________

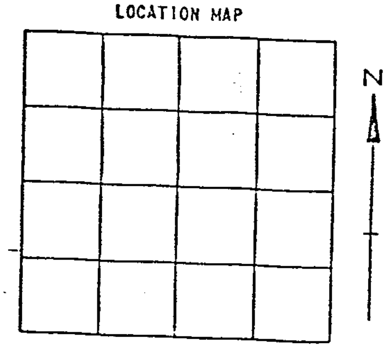
County Emery Date 8/20/81

Diversion Identification Number Upper Drainage Prep Plant Diversion

Location of Diversion:

LOCATION MAP

See plate 15-10



Sec. 33

T. 22 S ~~N~~., R. 6E ~~W~~.

DIVERSIONS AND HAUL ROAD DRAINAGES

1. Total drainage area 43.6 acres
2. Design storm frequency 10 yr-24 hr
3. Design discharge 5.5 cfs
4. Channel type Triangular
5. Base width — feet
6. Sideslope(s) 3 : 1, 3 : 1
7. Channel capacity design

   Design flow depth 1.9 feet
8. Channel velocity design

   Maximum design flow velocity 1.8 fps

Note: Larger design than required.

DIVERSION INFORMATION SHEET

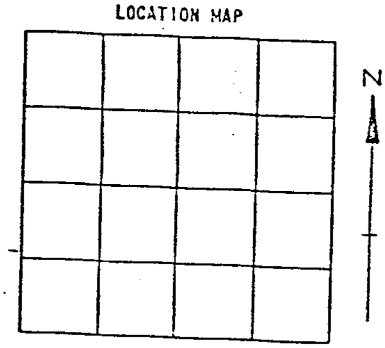
Owner/Operator Consolidation Coal Co. Address

County Emery Date 8/20/81

Diversion Identification Number Lower Drainage Prep Plant Diversion
(Integrated into Main Entrance Road Ditchline)

Location of Diversion:

LOCATION MAP



See plate 15-6

Sec. 32

T. 22 S, R. 6 E

DIVERSIONS AND HAUL ROAD DRAINAGES

1. Total drainage area 75.1 acres
2. Design storm frequency 10 yr - 24 hr
3. Design discharge 20.0 cfs
4. Channel type Trapazoidal
5. Base width 6 feet
6. Sideslope(s) 3 : 1, 3 : 1
7. Channel capacity design

   Design flow depth 1.4 feet
8. Channel velocity design

   Maximum design flow velocity 2.0 fps

15.6.2.3 Waste Disposal Site Diversion Ditch

The proposed waste disposal site diversion ditch will prevent undisturbed area surface runoff from coming into contact with the waste disposal site. The watershed served by the diversion is located north of the disposal site and contains 72.3 acres, comprised of upland scrub and agricultural fields. The overall length of the diversion is 2840 feet and the channel depth is 2 feet. The diversion has been designed to handle the peak discharge from the 'Probable Maximum Thunderstorm'. The probable maximum thunderstorm is a very high intensity, short duration storm designation that is based on the amount of precipitation occurring during one hour. In this area the PMTS will deliver a 6" rainfall. The peak discharge from the storm was calculated to be 75 CFS, based on soil types, vegetative cover and other factors. Please see the attached summary sheets for details.

In order to prevent erosion of the ditch itself, it was determined that a maximum flow of less than 5 FPS would be desirable. To meet this criteria a trapezoidal channel was designed with a bottom width of 12 feet, stable side slopes of 3:1 and an overall grade of approximately 2%. This channel produced a peak flow of 3.7 FPS and a design peak depth of 1.2 feet. This provides for 0.8' of freeboard (see Plate 15-11 for typical section and Proposed Plan and Profile).

It was determined that in order to prevent erosion of the steep topography near Quitchupah Creek a pipe culvert would be used at station 106+80. The culvert is 50 feet long and is at a 34% grade. It utilizes two 42 inch corrugated steel pipes to convey the peak flow down the slope. The culvert utilizes a box type inlet and a splash basin outlet. The overall length of the structure is 71 feet and anchored with concrete. The channel below the culvert has been lined with 6 inches of graded 'rip-rap' to prevent erosion. The diversion will discharge directly into the main channel of Quitchupah Creek (see Plate 15-12 for details of culvert and diversion stations 106+00/108+40).

DIVERSION INFORMATION SHEET

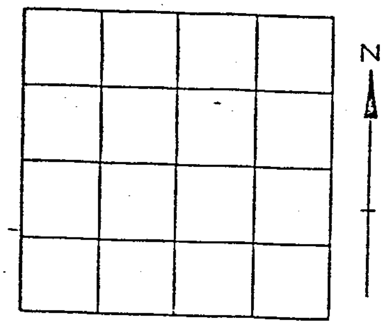
Owner/Operator Consolidation Coal Co Address ____________

County Emery Date 8/20/81

Diversion Identification Number Slurry Diversion

Location of Diversion:

LOCATION MAP



See plates 15-11 and 15-12.

Sec. 32

T. 22 S, R. 6 E

DIVERSIONS AND HAUL ROAD DRAINAGES

1. Total drainage area 72.3 Acres acres
2. Design storm frequency PMTS
3. Design discharge 75 cfs
4. Channel type Trapezoidal
5. Base width 12' feet
6. Sideslope(s) 3 : 1, 3 : 1
7. Channel capacity design

   Design flow depth 1.4 feet
8. Channel velocity design

   Maximum design flow velocity 3.72 fps

15.6.3. Waste Disposal Design Plan

The design of the refuse impoundment is based upon the projected production figures, the efficiency of the plant, and the historical climatic data. The impoundment has a design life of five years starting on January 1, 1982. Yearly production of fine and coarse refuse was determined by the plant engineers and was used in determining the required storage capacity. The rainfall and evaporation rates were gathered from the U.S. Weather Service.

The plant will produce 130 gpm of slurry that contains approximately 3 TPH (tons per hour) of fine refuse, or 8.5% solids. The operating concept of the impoundment is to separate the fines from the slurry and return a constant amount of effluent to the plant as make-up water. In determining the amount of return water four parameters were considered; the amount of rainfall, evaporation rates, slurry production, and the infiltration losses.

Amount of Rainfall

The rainfall was determined from historical records for the minimum, mean, and maximum cases. Curves were plotted from recorded data for the years from 1900 to present to determine these values. The minimum case is used to determine the constant amount of make-up water that can be expected to return to the plant in any one season. The minimum rainfall value was derived from the curves by taking the 20% probability of minimum rainfall occurrence. This minimum value is based upon the occurrence of the event happening only once in any two consecutive seasons. The constant rate values for the return water are determined from the previous seasonal mean which reflects the reservoir capacity and storage characteristics at that stage. The maximum case is used in sizing the reservoir to determine the maximum pool staging. The maximum value case was determined from the rainfall curves by taking the 10% probability of the maximum rainfall event occurring in each consecutive season. In other words, the reservoir is sized for this case occurring every season for five years. This type of analysis provides for a very conservative design and acts to safeguard the environmental concerns by assuring an adequate storage capacity.

Evaporation Rates

The evaporation rates were taken from mean values as supplied by the U.S. Weather Service. Limited data is available from the Service for determination of the rates, therefore, the mean value has been used in determining the design. The seasonal rates of evaporation are 50.4 inches for the summer and 13.8 inches for the winter seasons. In determining the maximum design staging only the evaporation from the summer season was considered due to the possibility of freezing during winter. The make-up water was determined from the yearly evaporation rate which included both seasons.

Slurry Production

The design slurry inflow value for the five year plan is 130 gpm. The slurry will be pumped from the plant to cell #2 where the fines will settle out. The clarified effluent in cell #1 will be returned to the plant for re-use.

Infiltration

Infiltration losses are expected to be minimal due to a clay liner which underlays cell #1, cell #2, and the earth embankment. These losses are not considered to play a significant role in the impoundment's function.

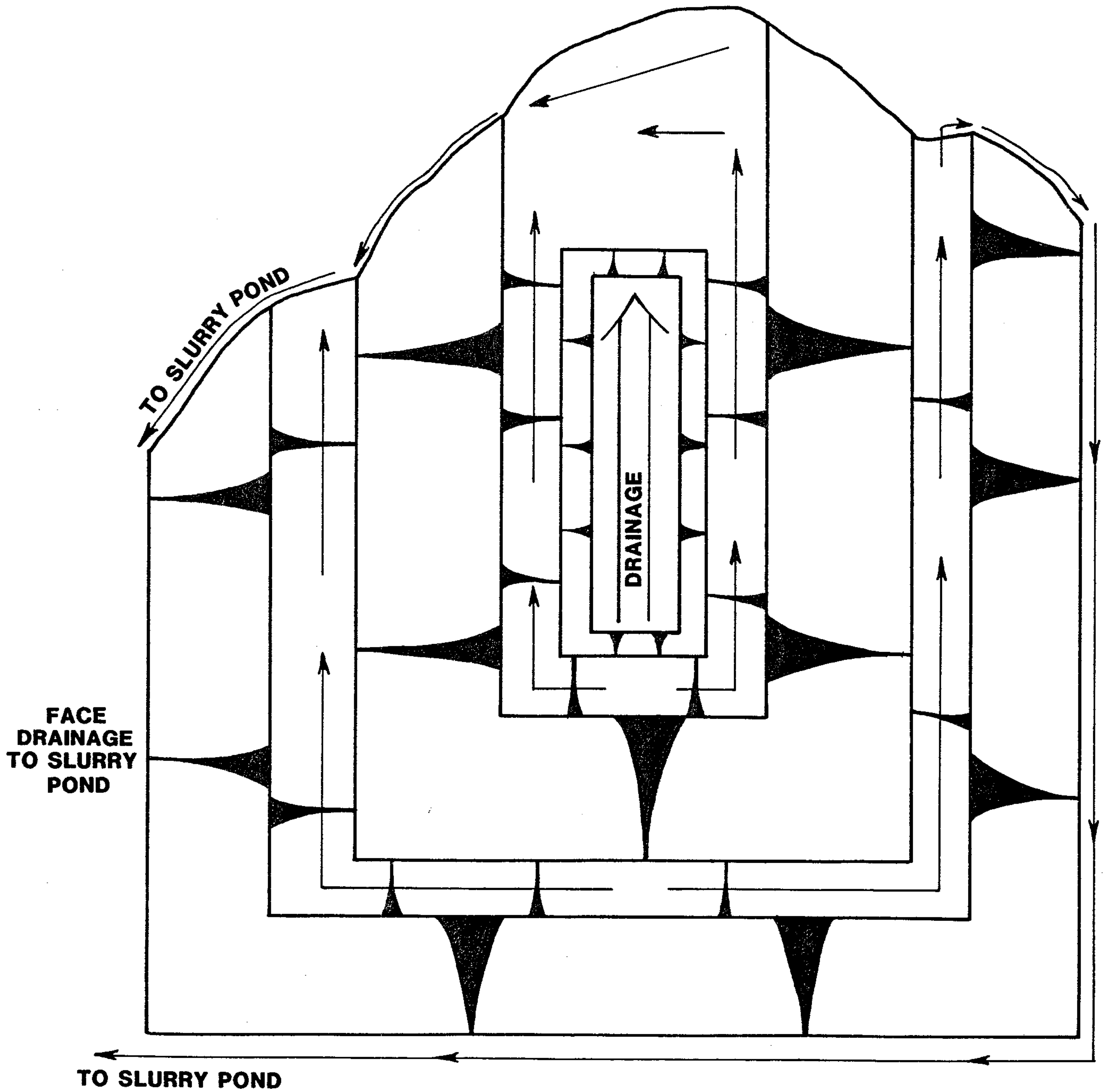
The inflow, outflow, and storage parameters were used to determine the safest, most efficient design plan for this slurry impoundment facility. The ultimate storage capacity of 198 acre-feet assures adequate storage for seasons of high inflow rates (rainfall) and low evaporation rates (evaporation). The minimum constant return summary provides a guide for the efficient staging of the pumping from the pond to the plant. Refer to Table 15-3 for the staged pump rates of return water. The pumping requirement serves two purposes; the drawdown of the reservoir to reduce maximum capacity requirements and the return of effluent for reuse in the plant. As required, unexpected rainfall or effluent fluctuations will be managed by changing the pumpage rate to the plant from a range of 0 gpm to 300 gpm. The design, however, includes a wide range of circumstances to reduce the management of the pond and only in unusual circumstances will any extraneous management be required.

TABLE 15-3
MINIMUM CONSTANT RATE OF RETURN WATER
PUMP STAGING

Season/Year	Pump Rate (gpm)
Winter, 83	50
Summer, 83	50
Winter, 83/84	50
Summer, 84	100
Winter, 84/85	100
Summer, 85	100
Winter, 85/86	125
Summer, 86	125
Winter, 86	125

SUMMARY OF REFUSE PILE DRAINAGE

ALL WATER DRAINED OFF OF THE REFUSE PILE WILL BE IMPOUNDED IN THE SLURRY POND. ALL GRADES WILL BE 1/2% IN THE DIRECTION SHOWN BELOW FOR DRAINAGE FLOW.



NO SCALE

15.6.4 Stability Analyses

The stability analysis for the proposed slurry impoundment at Emery Mine was performed with the STABL2 computer program, using the Modified Bishop method. This program was developed by Ronald A. Siegel, as part of an investigation conducted by the Joint Highway Research Project, Purdue University, in cooperation with the Indiana Highway Commission.

Refer to section 15.5.1 for the laboratory analysis used in defining the material parameters. The analysis and site investigation was performed by Rollins, Brown, and Gunnel, Inc.

Summary of soil types and properties used for the stability analyses:

Material	γ_{wet} (pcf)	γ_{sat} (pcf)	Effective Cohesion c (pcf)	Effective Friction ϕ (deg.)
I. ML	121.9	124.0	432	30.0
II. C	120.0	123.0	500	28.0
III. ML	124.0	126.0	288	27.3
IV. Shale	135.0	135.0	2,000	33.0

I. Earth Embankment
II. Clay Core / Liner
III. Earth Foundation
IV. Shale Subfoundation

A summary of the stability analyses performed for the proposed impounding structure at the critical sections is presented in the following table:

Critical Factors of Safety

	Rapid Drawdown	Steady Seepage Static	Steady Seepage Dynamic
Upstream	2.21	4.73	2.62
Downstream	---	3.41	2.17

The computer printout sheets follow.

EMERY UPSTREAM SLOPE STABILITY

RAPID DRAWDOWN

MINIMUM FACTOR OF SAFETY 2.208

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

PROBLEM DESCRIPTION   EMERY UPSTREAM SLOPE STABILITY RAPID DRA
WDOWN   00000020

BOUNDARY COORDINATES

5 TOP BOUNDARIES
13 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	40.00	42.00	61.50	42.00	1
2	61.50	42.00	118.00	61.50	1
3	118.00	61.50	138.00	61.50	1
4	138.00	61.50	196.00	47.50	1
5	196.00	47.50	230.00	47.50	3
6	40.00	41.50	67.50	41.50	2
7	67.50	41.50	103.50	57.50	2
8	103.50	57.50	119.00	57.50	2
9	40.00	39.50	67.50	39.50	3
10	67.50	39.50	90.00	47.50	3
11	90.00	47.50	119.00	57.50	1
12	90.00	47.50	196.00	47.50	3
13	40.00	1.00	230.00	1.00	4

ISOTROPIC SOIL PARAMETERS

4 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	121.9	124.0	432.0	30.0	0.0	0.0	1
2	120.0	123.0	500.0	28.0	0.0	0.0	1
3	124.0	126.0	288.0	27.3	0.0	0.0	1
4	135.0	135.0	2000.0	33.0	0.0	0.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 11 COORDINATE POINTS

POINT NO.	X-WATER (FT)	Y-WATER (FT)
1	40.00	42.00
2	61.50	42.00
3	106.50	57.50
4	113.50	57.50
5	120.25	51.75
6	148.00	51.00
7	169.00	50.00
8	184.00	49.00
9	193.00	48.00
10	196.00	47.50
11	230.00	47.50

SEARCHING ROUTINE WILL BE LIMITED TO AN AREA DEFINED BY 1 BOUNDARIES
OF WHICH THE FIRST 1 BOUNDARIES WILL DEFLECT SURFACES UPWARD

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)
1	40.00	1.00	230.00	1.00

A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM
TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

25 TRIAL SURFACES HAVE BEEN GENERATED.

5 SURFACES INITIATE FROM EACH OF 5 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN X = 40.00 FT.
AND X = 90.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 115.00 FT.
AND X = 125.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS Y = 0.0 FT.

5.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

SAFETY FACTORS ARE CALCULATED BY THE MODIFIED BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	42.00
2	56.82	39.49
3	61.39	37.44
4	66.14	35.89
5	71.03	34.85
6	76.00	34.32
7	81.00	34.32
8	85.97	34.85
9	90.86	35.90
10	95.62	37.45
11	100.18	39.50
12	104.50	42.01
13	108.53	44.97
14	112.23	48.33
15	115.56	52.06
16	118.48	56.12
17	120.95	60.47
18	121.40	61.50

*** 2.208 *** Minimum Saftey factor

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	42.00
2	56.38	38.85
3	60.60	36.16
4	65.09	33.96
5	69.80	32.29
6	74.67	31.17
7	79.64	30.60
8	84.64	30.60
9	89.61	31.16
10	94.48	32.29
11	99.19	33.96
12	103.69	36.15
13	107.90	38.84
14	111.79	41.99
15	115.29	45.56
16	118.36	49.50
17	120.97	53.77
18	123.08	58.30
19	124.14	61.50

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	42.00
2	56.17	38.61
3	60.22	35.67
4	64.57	33.22
5	69.19	31.29
6	74.00	29.91
7	78.93	29.11
8	83.92	28.88
9	88.91	29.23
10	93.82	30.17
11	98.59	31.67
12	103.16	33.72
13	107.45	36.28
14	111.41	39.32
15	115.00	42.81
16	118.15	46.69
17	120.83	50.91
18	123.00	55.42
19	124.63	60.14
20	124.93	61.50

*** 2.316 ***

FAILURE SURFACE SPECIFIED BY 16 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	65.00	43.21
2	69.27	40.60
3	73.83	38.56
4	78.62	37.12
5	83.55	36.32
6	88.55	36.15
7	93.53	36.63
8	98.40	37.75
9	103.09	39.49
10	107.52	41.81
11	111.61	44.68
12	115.30	48.06
13	118.52	51.89
14	121.22	56.09
15	123.36	60.61
16	123.64	61.50

*** 2.344 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	42.00
2	56.04	38.46
3	59.99	35.41
4	64.30	32.88
5	68.90	30.91
6	73.71	29.55
7	78.66	28.81
8	83.66	28.70
9	88.63	29.23
10	93.49	30.38
11	98.17	32.15
12	102.59	34.49
13	106.67	37.37
14	110.36	40.75
15	113.58	44.57
16	116.30	48.77
17	118.46	53.28
18	120.03	58.03
19	120.70	61.50

*** 2.353 ***

FAILURE SURFACE SPECIFIED BY 22 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	40.00	42.00
2	43.66	38.60
3	47.65	35.58
4	51.91	32.97
5	56.42	30.80
6	61.12	29.09
7	65.97	27.86
8	70.91	27.12
9	75.90	26.88
10	80.90	27.14
11	85.84	27.89
12	90.68	29.14
13	95.38	30.86
14	99.88	33.04
15	104.14	35.66
16	108.11	38.69
17	111.77	42.10
18	115.06	45.87
19	117.96	49.94
20	120.44	54.28
21	122.48	58.84
22	123.36	61.50

*** 2.390 ***

FAILURE SURFACE SPECIFIED BY 15 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	65.00	43.21
2	69.20	40.50
3	73.76	38.44
4	78.57	37.08
5	83.53	36.45
6	88.53	36.57
7	93.46	37.43
8	98.20	39.01
9	102.66	41.27
10	106.73	44.18
11	110.32	47.65
12	113.36	51.62
13	115.77	56.00
14	117.51	60.69
15	117.65	61.38

*** 2.396 ***

FAILURE SURFACE SPECIFIED BY 22 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	40.00	42.00
2	43.62	38.55
3	47.56	35.48
4	51.79	32.81
5	56.26	30.57
6	60.93	28.78
7	65.76	27.47
8	70.69	26.64
9	75.68	26.30
10	80.67	26.45
11	85.63	27.10
12	90.50	28.24
13	95.23	29.85
14	99.78	31.92
15	104.11	34.43
16	108.16	37.36
17	111.90	40.67
18	115.30	44.34
19	118.32	48.33
20	120.93	52.59
21	123.11	57.09
22	124.72	61.50

*** 2.398 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	40.00	42.00
2	43.77	38.71
3	47.87	35.85
4	52.25	33.44
5	56.87	31.52
6	61.66	30.12
7	66.59	29.23
8	71.57	28.88
9	76.57	29.07
10	81.52	29.80
11	86.36	31.06
12	91.03	32.83
13	95.49	35.10
14	99.68	37.83
15	103.54	41.00
16	107.05	44.56
17	110.15	48.49
18	112.80	52.72
19	114.99	57.22
20	116.32	60.92

*** 2.477 ***

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	42.00
2	57.28	40.53
3	62.16	39.45
4	67.12	38.77
5	72.11	38.50
6	77.11	38.63
7	82.08	39.17
8	86.99	40.11
9	91.81	41.44
10	96.50	43.16
11	101.04	45.25
12	105.40	47.71
13	109.54	50.51
14	113.44	53.64
15	117.07	57.07
16	120.42	60.79
17	120.96	61.50

*** 2.492 ***

```
                    Y            A     X     I     S            F     T

                   0.00     28.75     57.50     86.25    115.00    143.75

        X      0.00 +---------+---------+---------+---------+---------+
                    -
                    -
                    -
                    -
                    -
              28.75 +
                    -
                    *             **
                    -            6.
                    -           6 .
                    -          69..1
        A     57.50 +          6 31
                    -         65310*
                    -         6310*4
                    -        63214..
                    -        63214.. .
                    -        652140..
        X     86.25 +        832140..
                    -         321 0..*.
                    -         329170..
                    -          3241.0..
                    -           324190..*
                    -            622110..
        I    115.00 +              32417W9
                    -               32W2**
                    -                  322
                    -
                    -
                    -                    *
        S    143.75 +
                    -                 W
                    -
                    -
                    -
                    -                W
             172.50 +
                    -
                    -                W
                    -
                    -                W
                    -                *
        F    201.25 +
                    -
                    -
                    -
                    -
                    -
        T    230.00 *                *
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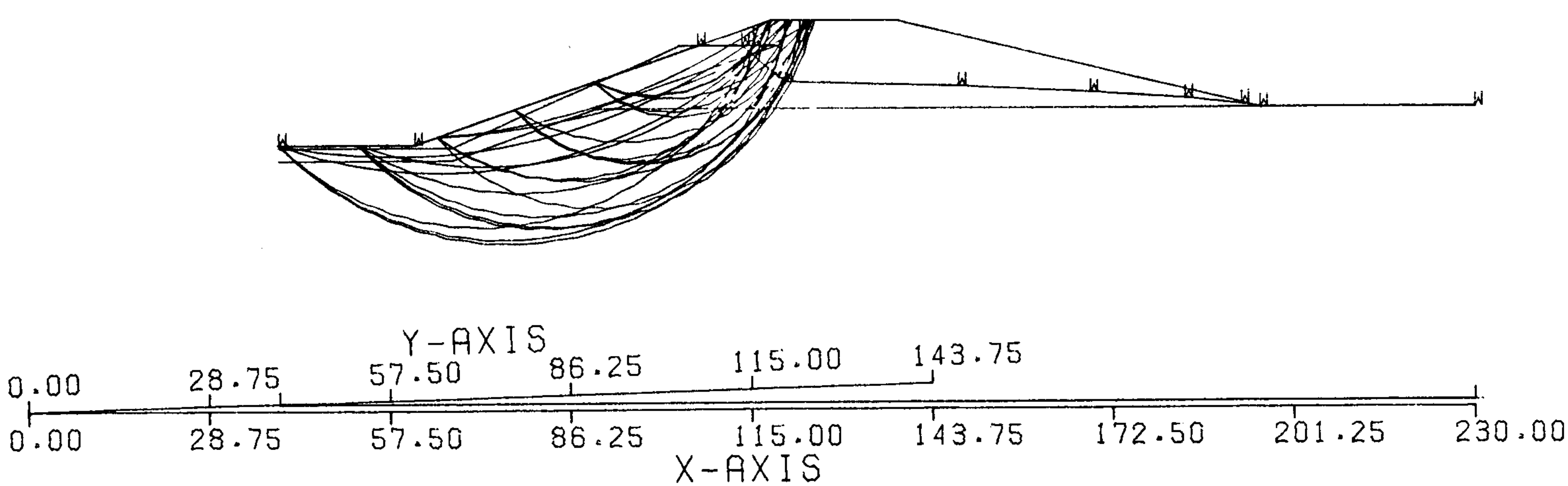
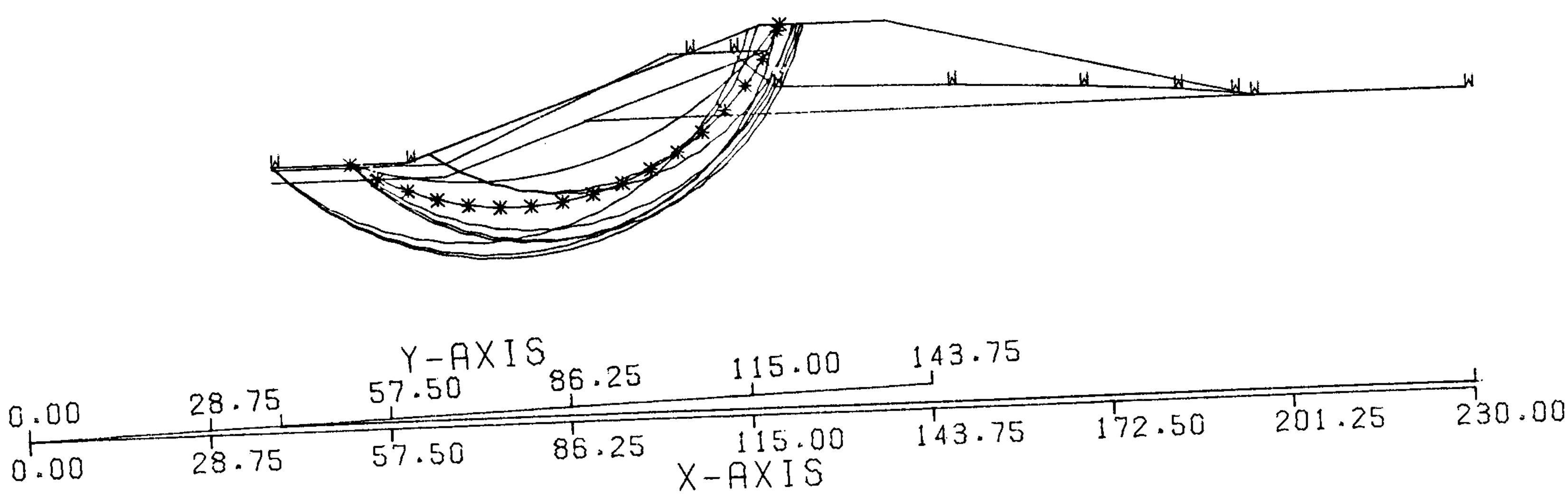
EMERY UPSTREAM SLOPE STABIL'TY RAPID DRA
WDOWN 00000020

25 SURFACES HAVE BEEN GENERATED



10 MOST CRITICAL OF SURFACES GENERATED

MINIMUM FACTOR OF SAFETY = 2.208



EMERY UPSTREAM SLOPE STABILITY

STEADY SEEPAGE

MINIMUM FACTOR OF SAFETY 4.733

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

PROBLEM DESCRIPTION   EMERY UPSTREAM SLOPE STABILITY STEADY SE
EPAGE 00000020

BOUNDARY COORDINATES

5 TOP BOUNDARIES
13 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	40.00	42.00	61.50	42.00	1
2	61.50	42.00	118.00	61.50	1
3	118.00	61.50	138.00	61.50	1
4	138.00	61.50	196.00	47.50	1
5	196.00	47.50	230.00	47.50	3
6	40.00	41.50	67.50	41.50	2
7	67.50	41.50	103.50	57.50	2
8	103.50	57.50	119.00	57.50	2
9	40.00	39.50	67.50	39.50	3
10	67.50	39.50	90.00	47.50	3
11	90.00	47.50	119.00	57.50	1
12	90.00	47.50	196.00	47.50	3
13	40.00	1.00	230.00	1.00	4

ISOTROPIC SOIL PARAMETERS

4 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	121.9	124.0	432.0	30.0	0.0	0.0	1
2	120.0	123.0	500.0	28.0	0.0	0.0	1
3	124.0	126.0	288.0	27.3	0.0	0.0	1
4	135.0	135.0	2000.0	33.0	0.0	0.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 10 COORDINATE POINTS

POINT NO.	X-WATER (FT)	Y-WATER (FT)
1	40.00	57.50
2	106.50	57.50
3	113.50	57.50
4	120.25	51.75
5	148.00	51.00
6	169.00	50.00
7	184.00	49.00
8	193.00	48.00
9	196.00	47.50
10	230.00	47.50

+

SEARCHING ROUTINE WILL BE LIMITED TO AN AREA DEFINED BY 1 BOUNDARIES
OF WHICH THE FIRST 1 BOUNDARIES WILL DEFLECT SURFACES UPWARD

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)
1	40.00	1.00	230.00	1.00

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A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM
TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.


 25 TRIAL SURFACES HAVE BEEN GENERATED.


  5 SURFACES INITIATE FROM EACH OF  5 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN  X =  40.00 FT.
                             AND  X =  90.00 FT.


EACH SURFACE TERMINATES BETWEEN   X = 115.00 FT.
                            AND   X = 125.00 FT.


UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS  Y =  0.0  FT.


 5.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.
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FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

SAFETY FACTORS ARE CALCULATED BY THE MODIFIED BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 16 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	65.00	43.21
2	69.27	40.60
3	73.83	38.56
4	78.62	37.12
5	83.55	36.32
6	88.55	36.15
7	93.53	36.63
8	98.40	37.75
9	103.09	39.49
10	107.52	41.81
11	111.61	44.68
12	115.30	48.06
13	118.52	51.89
14	121.22	56.09
15	123.36	60.61
16	123.64	61.50

*** 4.733 *** Minimum Saftey factor

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	42.00
2	56.82	39.49
3	61.39	37.44
4	66.14	35.89
5	71.03	34.85
6	76.00	34.32
7	81.00	34.32
8	85.97	34.85
9	90.86	35.90
10	95.62	37.45
11	100.18	39.50
12	104.50	42.01
13	108.53	44.97
14	112.23	48.33
15	115.56	52.06
16	118.48	56.12
17	120.95	60.47
18	121.40	61.50

*** 4.740 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	42.00
2	56.38	38.85
3	60.60	36.16
4	65.09	33.96
5	69.80	32.29
6	74.67	31.17
7	79.64	30.60
8	84.64	30.60
9	89.61	31.16
10	94.48	32.29
11	99.19	33.96
12	103.69	36.15
13	107.90	38.84
14	111.79	41.99
15	115.29	45.56
16	118.36	49.50
17	120.97	53.77
18	123.08	58.30
19	124.14	61.50

*** 4.837 ***

FAILURE SURFACE SPECIFIED BY 13 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	77.50	47.52
2	81.88	45.10
3	86.58	43.40
4	91.49	42.46
5	96.49	42.31
6	101.45	42.94
7	106.25	44.35
8	110.76	46.49
9	114.89	49.31
10	118.52	52.75
11	121.56	56.72
12	123.94	61.12
13	124.07	61.50

*** 4.999 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	42.00
2	56.17	38.61
3	60.22	35.67
4	64.57	33.22
5	69.19	31.29
6	74.00	29.91
7	78.93	29.11
8	83.92	28.88
9	88.91	29.23
10	93.82	30.17
11	98.59	31.67
12	103.16	33.72
13	107.45	36.28
14	111.41	39.32
15	115.00	42.81
16	118.15	46.69
17	120.83	50.91
18	123.00	55.42
19	124.63	60.14
20	124.93	61.50

*** 4.999 ***

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	42.00
2	57.28	40.53
3	62.16	39.45
4	67.12	38.77
5	72.11	38.50
6	77.11	38.63
7	82.08	39.17
8	86.99	40.11
9	91.81	41.44
10	96.50	43.16
11	101.04	45.25
12	105.40	47.71
13	109.54	50.51
14	113.44	53.64
15	117.07	57.07
16	120.42	60.79
17	120.96	61.50

*** 5.044 ***

FAILURE SURFACE SPECIFIED BY 22 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	40.00	42.00
2	43.62	38.55
3	47.56	35.48
4	51.79	32.81
5	56.26	30.57
6	60.93	28.78
7	65.76	27.47
8	70.69	26.64
9	75.68	26.30
10	80.67	26.45
11	85.63	27.10
12	90.50	28.24
13	95.23	29.85
14	99.78	31.92
15	104.11	34.43
16	108.16	37.36
17	111.90	40.67
18	115.30	44.34
19	118.32	48.33
20	120.93	52.59
21	123.11	57.09
22	124.72	61.50

*** 5.154 ***

FAILURE SURFACE SPECIFIED BY 22 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	40.00	42.00
2	43.66	38.60
3	47.65	35.58
4	51.91	32.97
5	56.42	30.80
6	61.12	29.09
7	65.97	27.86
8	70.91	27.12
9	75.90	26.88
10	80.90	27.14
11	85.84	27.89
12	90.68	29.14
13	95.38	30.86
14	99.88	33.04
15	104.14	35.66
16	108.11	38.69
17	111.77	42.10
18	115.06	45.87
19	117.96	49.94
20	120.44	54.28
21	122.48	58.84
22	123.36	61.50

FAILURE SURFACE SPECIFIED BY 14 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	77.50	47.52
2	81.25	44.21
3	85.54	41.64
4	90.22	39.89
5	95.15	39.03
6	100.15	39.07
7	105.05	40.03
8	109.71	41.86
9	113.95	44.51
10	117.64	47.88
11	120.65	51.87
12	122.89	56.34
13	124.27	61.15
14	124.31	61.50

*** 5.465 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	42.00
2	56.04	38.46
3	59.99	35.41
4	64.30	32.88
5	68.90	30.91
6	73.71	29.55
7	78.66	28.81
8	83.66	28.70
9	88.63	29.23
10	93.49	30.38
11	98.17	32.15
12	102.59	34.49
13	106.67	37.37
14	110.36	40.75
15	113.58	44.57
16	116.30	48.77
17	118.46	53.28
18	120.03	58.03
19	120.70	61.50

*** 5.518 ***

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            Y            A     X     I     S            F     T

           0.00     28.75     57.50     86.25    115.00    143.75

X      0.00 +---------+---------+---------+---------+---------+
            -
            -
            -
            -
            -
      28.75 +
            -
            *             **    W
            -            7.
            -           7 .
            -          7...2
A     57.50 +          7 52
            -         70526*
            -         7526*1
            -        75321..
            -        75321.. 4
            -        70321694
X     86.25 +        7532164.
            -         532 64.*.
            -         53.194..
            -          531246..
            -           5311.6..*
            -            733126..
I    115.00 +              53126W.
            -               53W3**
            -                  531
            -
            -
            -                    *
S    143.75 +
            -                 W
            -
            -
            -
            -                W
     172.50 +
            -
            -                W
            -
            -                W
            -                *
F    201.25 +
            -
            -
            -
            -
            -
T    230.00 *                *
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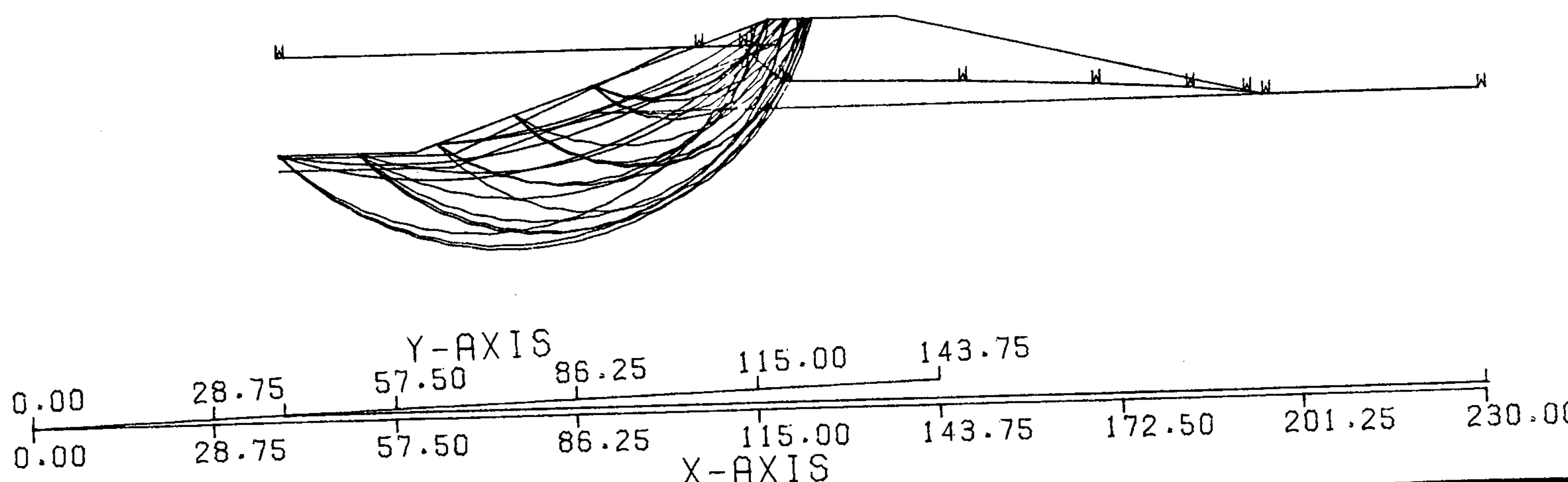
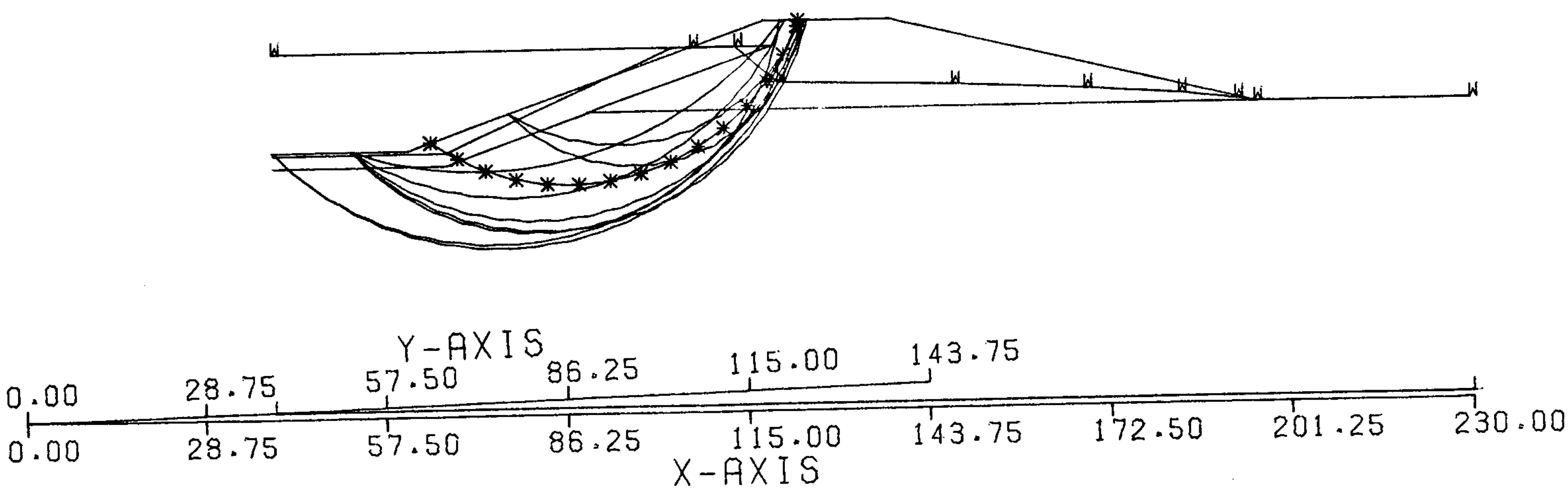
EMERY UPSTREAM SLOPE STABILITY STEADY SE 00000020
EPAGE

25 SURFACES HAVE BEEN GENERATED



10 MOST CRITICAL OF SURFACES GENERATED

MINIMUM FACTOR OF SAFETY = 4.733



EMERY UPSTREAM SLOPE STABILITY

STEADY SEEPAGE WITH EARTHQUAKE

MINIMUM FACTOR OF SAFETY 2.620

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURF. ES

PROBLEM DESCRIPTION EMERY UPSTREAM SLOPE STABILITY STEADY SE
EPAGE WITH EQUAKE 00000020

BOUNDARY COORDINATES

5 TOP BOUNDARIES
13 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	40.00	42.00	61.50	42.00	1
2	61.50	42.00	118.00	61.50	1
3	118.00	61.50	138.00	61.50	1
4	138.00	61.50	196.00	47.50	1
5	196.00	47.50	230.00	47.50	3
6	40.00	41.50	67.50	41.50	2
7	67.50	41.50	103.50	57.50	2
8	103.50	57.50	119.00	57.50	2
9	40.00	39.50	67.50	39.50	3
10	67.50	39.50	90.00	47.50	3
11	90.00	47.50	119.00	57.50	1
12	90.00	47.50	196.00	47.50	3
13	40.00	1.00	230.00	1.00	4

ISOTROPIC SOIL PARAMETERS

4 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	121.9	124.0	432.0	30.0	0.0	0.0	1
2	120.0	123.0	500.0	28.0	0.0	0.0	1
3	124.0	126.0	288.0	27.3	0.0	0.0	1
4	135.0	135.0	2000.0	33.0	0.0	0.0	1

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 10 COORDINATE POINTS

POINT NO.	X-WATER (FT)	Y-WATER (FT)
1	40.00	57.50
2	106.50	57.50
3	113.50	57.50
4	120.25	51.75
5	148.00	51.00
6	169.00	50.00
7	184.00	49.00
8	193.00	48.00
9	196.00	47.50
10	230.00	47.50

A HORIZONTAL EARTHQUAKE LOADING COEFFICIENT
OF0.100 HAS BEEN ASSIGNED

A VERTICAL EARTHQUAKE LOADING COEFFICIENT
OF0.0   HAS BEEN ASSIGNED

CAVITATION PRESSURE =-2117.0 PSF

OF WHICH THE FIRST 1 BOUNDARIES WILL DEFLECT SURFACES UPWARD

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)
1	40.00	1.00	230.00	1.00

A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM
TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

25 TRIAL SURFACES HAVE BEEN GENERATED.

5 SURFACES INITIATE FROM EACH OF 5 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN X = 40.00 FT.
AND X = 90.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 115.00 FT.
AND X = 125.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION
AT WHICH A SURFACE EXTENDS IS Y = 0.0 FT.

5.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

SAFETY FACTORS ARE CALCULATED BY THE MODIFIED BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	42.00
2	56.38	38.85
3	60.60	36.16
4	65.09	33.96
5	69.80	32.29
6	74.67	31.17
7	79.64	30.60
8	84.64	30.60
9	89.61	31.16
10	94.48	32.29
11	99.19	33.96
12	103.69	36.15
13	107.90	38.84
14	111.79	41.99
15	115.29	45.56
16	118.36	49.50
17	120.97	53.77
18	123.08	58.30
19	124.14	61.50

*** 2.620 *** Minimum Saftey factor

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	42.00
2	56.17	38.61
3	60.22	35.67
4	64.57	33.22
5	69.19	31.29
6	74.00	29.91
7	78.93	29.11
8	83.92	28.88
9	88.91	29.23
10	93.82	30.17
11	98.59	31.67
12	103.16	33.72
13	107.45	36.28
14	111.41	39.32
15	115.00	42.81
16	118.15	46.69
17	120.83	50.91
18	123.00	55.42
19	124.63	60.14
20	124.93	61.50

*** 2.641 ***

FAILURE SURFACE SPECIFIED BY 22 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	40.00	42.00
2	43.62	38.55
3	47.56	35.48
4	51.79	32.81
5	56.26	30.57
6	60.93	28.78
7	65.76	27.47
8	70.69	26.64
9	75.68	26.30
10	80.67	26.45
11	85.63	27.10
12	90.50	28.24
13	95.23	29.85
14	99.78	31.92
15	104.11	34.43
16	108.16	37.36
17	111.90	40.67
18	115.30	44.34
19	118.32	48.33
20	120.93	52.59
21	123.11	57.09
22	124.72	61.50

*** 2.650 ***

FAILURE SURFACE SPECIFIED BY 22 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	40.00	42.00
2	43.66	38.60
3	47.65	35.58
4	51.91	32.97
5	56.42	30.80
6	61.12	29.09
7	65.97	27.86
8	70.91	27.12
9	75.90	26.88
10	80.90	27.14
11	85.84	27.89
12	90.68	29.14
13	95.38	30.86
14	99.88	33.04
15	104.14	35.66
16	108.11	38.69
17	111.77	42.10
18	115.06	45.87
19	117.96	49.94
20	120.44	54.28
21	122.48	58.84
22	123.36	61.50

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	42.00
2	56.82	39.49
3	61.39	37.44
4	66.14	35.89
5	71.03	34.85
6	76.00	34.32
7	81.00	34.32
8	85.97	34.85
9	90.86	35.90
10	95.62	37.45
11	100.18	39.50
12	104.50	42.01
13	108.53	44.97
14	112.23	48.33
15	115.56	52.06
16	118.48	56.12
17	120.95	60.47
18	121.40	61.50

*** 2.694 ***

FAILURE SURFACE SPECIFIED BY 16 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	65.00	43.21
2	69.27	40.60
3	73.83	38.56
4	78.62	37.12
5	83.55	36.32
6	88.55	36.15
7	93.53	36.63
8	98.40	37.75
9	103.09	39.49
10	107.52	41.81
11	111.61	44.68
12	115.30	48.06
13	118.52	51.89
14	121.22	56.09
15	123.36	60.61
16	123.64	61.50

*** 2.695 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	42.00
2	56.04	38.46
3	59.99	35.41
4	64.30	32.88
5	68.90	30.91
6	73.71	29.55
7	78.66	28.81
8	83.66	28.70
9	88.63	29.23
10	93.49	30.38
11	98.17	32.15
12	102.59	34.49
13	106.67	37.37
14	110.36	40.75
15	113.58	44.57
16	116.30	48.77
17	118.46	53.28
18	120.03	58.03
19	120.70	61.50

*** 2.795 ***

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	65.00	43.21
2	68.56	39.70
3	72.61	36.77
4	77.06	34.48
5	81.80	32.88
6	86.72	32.02
7	91.72	31.92
8	96.68	32.57
9	101.48	33.95
10	106.02	36.05
11	110.19	38.81
12	113.90	42.16
13	117.06	46.04
14	119.60	50.34
15	121.46	54.98
16	122.60	59.85
17	122.73	61.50

*** 2.869 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	40.00	42.00
2	43.77	38.71
3	47.87	35.85
4	52.25	33.44
5	56.87	31.52
6	61.66	30.12
7	66.59	29.23
8	71.57	28.88
9	76.57	29.07
10	81.52	29.80
11	86.36	31.06
12	91.03	32.83
13	95.49	35.10
14	99.68	37.83
15	103.54	41.00
16	107.05	44.56
17	110.15	48.49
18	112.80	52.72
19	114.99	57.22
20	116.32	60.92

*** 2.961 ***

FAILURE SURFACE SPECIFIED BY 13 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	77.50	47.52
2	81.88	45.10
3	86.58	43.40
4	91.49	42.46
5	96.49	42.31
6	101.45	42.94
7	106.25	44.35
8	110.76	46.49
9	114.89	49.31
10	118.52	52.75
11	121.56	56.72
12	123.94	61.12
13	124.07	61.50

*** 2.998 ***

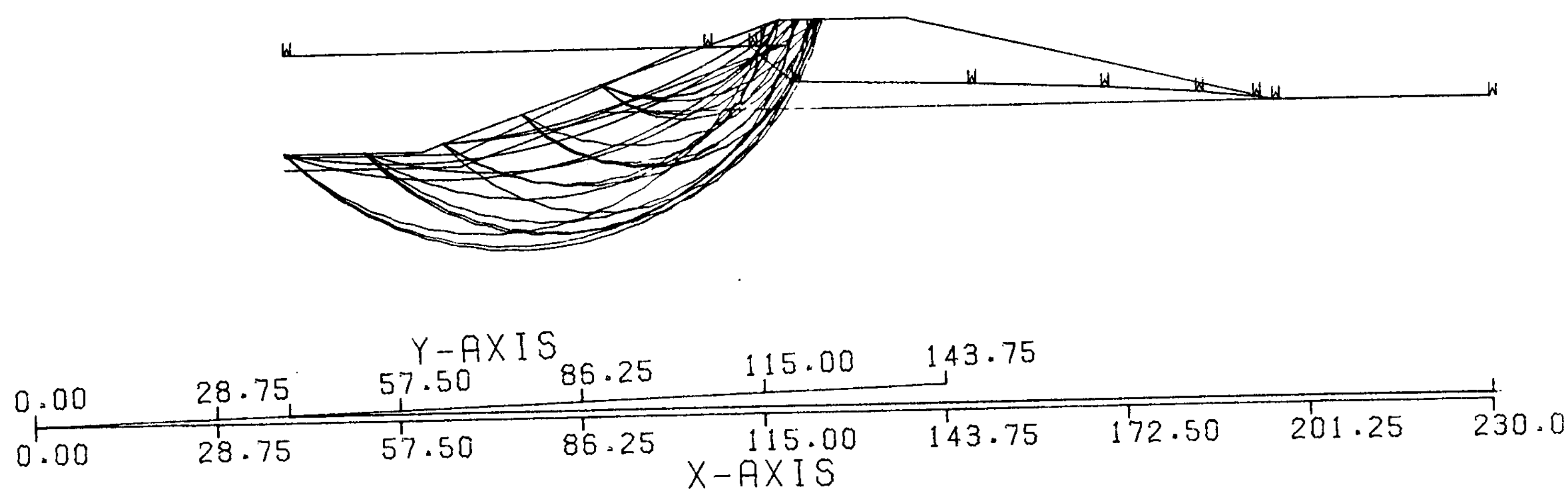
```
            Y            A     X     I     S            F     T

           0.00     28.75     57.50     86.25    115.00    143.75

X      0.00 +---------+---------+---------+---------+---------+
            -
            -
            -
            -
            -
      28.75 +
            -
            *             **    W
            -            3.
            -           3 .
            -          39..1
A     57.50 +          3 21
            -         3721.*
            -         321.*6
            -        32156..
            -        32156.. 0
            -        37156..0
X     86.25 +        32156.0.
            -         215 .0.*.
            -         2195.0..
            -          21650...
            -           21659...*
            -            31155...
I    115.00 +              2165.W9
            -               21W1**
            -                  211
            -
            -
            -                    *
S    143.75 +
            -                 W
            -
            -
            -
            -                W
     172.50 +
            -
            -                W
            -
            -                W
            -                *
F    201.25 +
            -
            -
            -
            -
            -
T    230.00 *                *
```

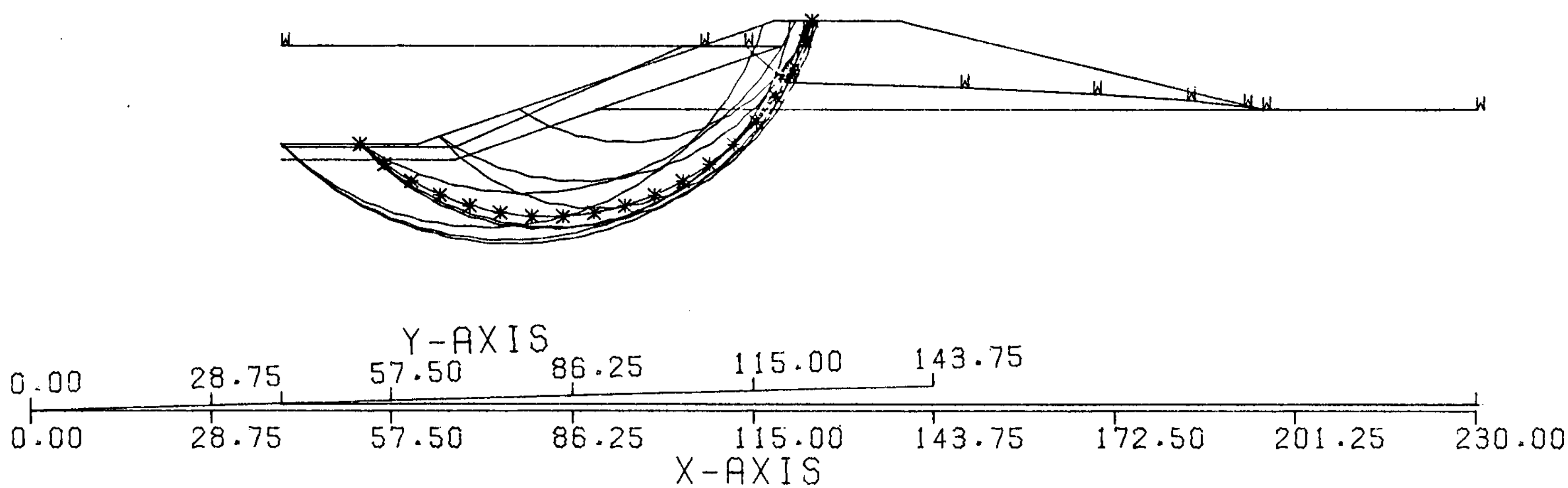
EMERY UPSTREAM SLOPE STABILITY STEADY SE
EPAGE WITH EQUAKE 00000020

25 SURFACES HAVE BEEN GENERATED



10 MOST CRITICAL OF SURFACES GENERATED

MINIMUM FACTOR OF SAFETY = 2.620



EMERY DOWNSTREAM

SLOPE STABILITY

STEADY SEEPAGE

MINIMUM FACTOR OF SAFETY 3.408

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

PROBLEM DESCRIPTION   EMERY STAGE1 DOWNSTREAM SLOPE STABILITY
STEADY SEEPAGE   00000020

BOUNDARY COORDINATES

6 TOP BOUNDARIES
14 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	35.00	38.00	68.50	38.20	3
2	68.50	38.20	127.00	53.00	1
3	127.00	53.00	147.00	53.00	1
4	147.00	53.00	158.50	49.00	1
5	158.50	49.00	203.50	33.50	1
6	203.50	33.50	225.00	33.50	1
7	145.50	49.00	151.50	49.00	2
8	151.50	49.00	197.60	33.00	2
9	197.60	33.00	225.00	33.00	2
10	145.50	49.00	175.00	38.80	1
11	175.00	38.80	197.40	31.00	3
12	197.40	31.00	225.00	31.00	3
13	68.50	38.20	175.00	38.80	3
14	35.00	1.00	225.00	1.00	4

ISOTROPIC SOIL PARAMETERS

4 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	121.9	124.0	432.0	30.0	0.0	0.0	1
2	120.0	123.0	500.0	28.0	0.0	0.0	1
3	124.0	126.0	288.0	27.3	0.0	0.0	1
4	135.0	135.0	2000.0	33.0	0.0	0.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 10 COORDINATE POINTS

POINT NO.	X-WATER (FT)	Y-WATER (FT)
1	35.00	38.00
2	68.50	38.20
3	71.80	39.00
4	81.00	40.00
5	96.00	41.00
6	117.00	42.00
7	144.60	43.00
8	151.50	49.00
9	158.50	49.00
10	225.00	49.00

SEARCHING ROUTINE WILL BE LIMITED TO AN AREA DEFINED BY 1 BOUNDARIES
OF WHICH THE FIRST 1 BOUNDARIES WILL DEFLECT SURFACES UPWARD

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)
1	35.00	1.00	225.00	1.00

A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

25 TRIAL SURFACES HAVE BEEN GENERATED.

5 SURFACES INITIATE FROM EACH OF 5 POINTS EQUALLY SPACED ALONG THE GROUND SURFACE BETWEEN X = 40.00 FT.
AND X = 90.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 115.00 FT.
AND X = 135.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = 0.0 FT.

5.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

SAFETY FACTORS ARE CALCULATED BY THE MODIFIED BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	38.10
2	56.39	34.96
3	60.56	32.20
4	64.97	29.85
5	69.59	27.94
6	74.37	26.48
7	79.28	25.49
8	84.25	24.98
9	89.25	24.94
10	94.23	25.39
11	99.14	26.31
12	103.95	27.70
13	108.59	29.54
14	113.04	31.82
15	117.25	34.52
16	121.18	37.62
17	124.79	41.07
18	128.06	44.86
19	130.95	48.94
20	133.27	53.00

*** 3.408 *** Minimum Saftey factor

FAILURE SURFACE SPECIFIED BY 21 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	38.10
2	56.17	34.71
3	60.17	31.70
4	64.43	29.10
5	68.94	26.92
6	73.63	25.21
7	78.47	23.96
8	83.42	23.20
9	88.41	22.92
10	93.40	23.14
11	98.35	23.86
12	103.21	25.05
13	107.92	26.72
14	112.45	28.84
15	116.74	31.41
16	120.76	34.38
17	124.47	37.73
18	127.83	41.43
19	130.81	45.45

21	134.93	53.00

*** 3.431 ***

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	65.00	38.18
2	69.06	35.26
3	73.42	32.82
4	78.03	30.89
5	82.84	29.49
6	87.77	28.66
7	92.76	28.38
8	97.75	28.68
9	102.67	29.54
10	107.47	30.96
11	112.07	32.91
12	116.42	35.37
13	120.47	38.31
14	124.15	41.70
15	127.42	45.48
16	130.25	49.60
17	132.04	53.00

*** 3.447 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	65.00	38.18
2	68.55	34.66
3	72.54	31.64
4	76.88	29.16
5	81.51	27.28
6	86.35	26.02
7	91.31	25.40
8	96.31	25.43
9	101.26	26.12
10	106.08	27.46
11	110.69	29.41
12	114.99	31.95
13	118.93	35.03
14	122.43	38.60
15	125.44	42.60
16	127.89	46.95
17	129.75	51.59
18	130.11	53.00

*** 3.581 ***

FAILURE SURFACE SPECIFIED BY 24 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	40.00	38.03
2	43.62	34.58
3	47.52	31.46
4	51.68	28.68
5	56.06	26.26
6	60.63	24.23
7	65.35	22.60
8	70.20	21.38
9	75.14	20.58
10	80.12	20.21
11	85.12	20.26
12	90.10	20.74
13	95.02	21.65
14	99.84	22.98
15	104.53	24.71
16	109.05	26.84
17	113.38	29.35
18	117.47	32.21
19	121.31	35.42
20	124.85	38.95
21	128.08	42.77
22	130.97	46.85
23	133.50	51.16
24	134.38	53.00

*** 3.604 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	38.10
2	56.83	35.60
3	61.37	33.50
4	66.07	31.81
5	70.91	30.56
6	75.85	29.75
7	80.83	29.39
8	85.83	29.47
9	90.80	30.01
10	95.71	30.99
11	100.50	32.41
12	105.15	34.26
13	109.61	36.52
14	113.85	39.17
15	117.83	42.19
16	121.52	45.56
17	124.90	49.25
18	127.75	53.00

*** 3.613 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	38.10
2	56.04	34.57
3	59.95	31.46
4	64.20	28.83
5	68.72	26.69
6	73.46	25.09
7	78.35	24.05
8	83.33	23.57
9	88.33	23.66
10	93.28	24.33
11	98.13	25.56
12	102.80	27.34
13	107.24	29.64
14	111.38	32.44
15	115.18	35.69
16	118.58	39.36
17	121.54	43.39
18	124.01	47.73
19	125.97	52.33
20	126.10	52.77

*** 3.622 ***

FAILURE SURFACE SPECIFIED BY 23 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	40.00	38.03
2	43.66	34.63
3	47.61	31.56
4	51.82	28.85
5	56.24	26.52
6	60.85	24.59
7	65.61	23.07
8	70.49	21.97
9	75.45	21.31
10	80.44	21.08
11	85.44	21.29
12	90.40	21.94
13	95.28	23.02
14	100.05	24.53
15	104.66	26.45
16	109.09	28.76
17	113.31	31.46
18	117.26	34.51
19	120.94	37.90
20	124.30	41.60
21	127.33	45.58
22	129.99	49.81
23	131.63	53.00

*** 3.646 ***

FAILURE SURFACE SPECIFIED BY 15 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	65.00	38.18
2	69.01	35.19
3	73.41	32.81
4	78.10	31.09
5	83.00	30.06
6	87.99	29.75
7	92.97	30.16
8	97.84	31.29
9	102.50	33.10
10	106.85	35.57
11	110.80	38.63
12	114.27	42.24
13	117.18	46.30
14	119.47	50.74
15	119.61	51.13

*** 3.741 ***

FAILURE SURFACE SPECIFIED BY 14 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	77.50	40.48
2	81.82	37.96
3	86.43	36.01
4	91.24	34.67
5	96.19	33.95
6	101.19	33.87
7	106.16	34.43
8	111.01	35.62
9	115.68	37.42
10	120.07	39.81
11	124.13	42.73
12	127.78	46.15
13	130.96	50.00
14	132.85	53.00

*** 4.133 ***

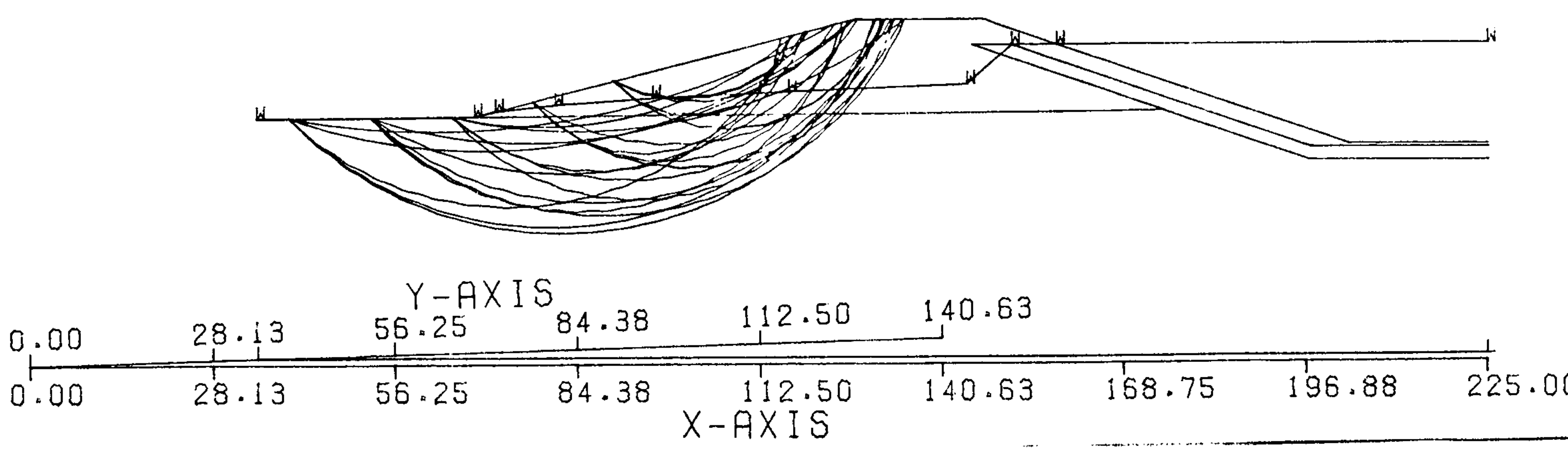
```
            Y            A     X     I     S            F     T

           0.00     28.13     56.25     84.38    112.50    140.63

X      0.00 +---------+---------+---------+---------+---------+
            -
            -
            -
            -
            -
      28.13 +
            *             *
            -
            -           5 5
            -          5 .
            -         5  .1
A     56.25 +        5. 16
            -        5 16.
            -       5.21..3
            -       571443*
            -      581463.
            -      5 143.0W
X     84.38 +      52139.0
            -      521360.. .
            -       2136...W
            -       21396...
            -        2136...
            -         2106...
I    112.50 +         213069..
            -          2137W9.9
            -           2133679.
            -            251146*
            -               2121
            -                  2
S    140.63 +
            -              W * *
            -                *
            -
            -                *
            -
     168.75 +
            -             *
            -
            -
            -
            -
F    196.88 +          **
            -           *
            -
            -
            -
            -
T    225.00 *          **    W
```

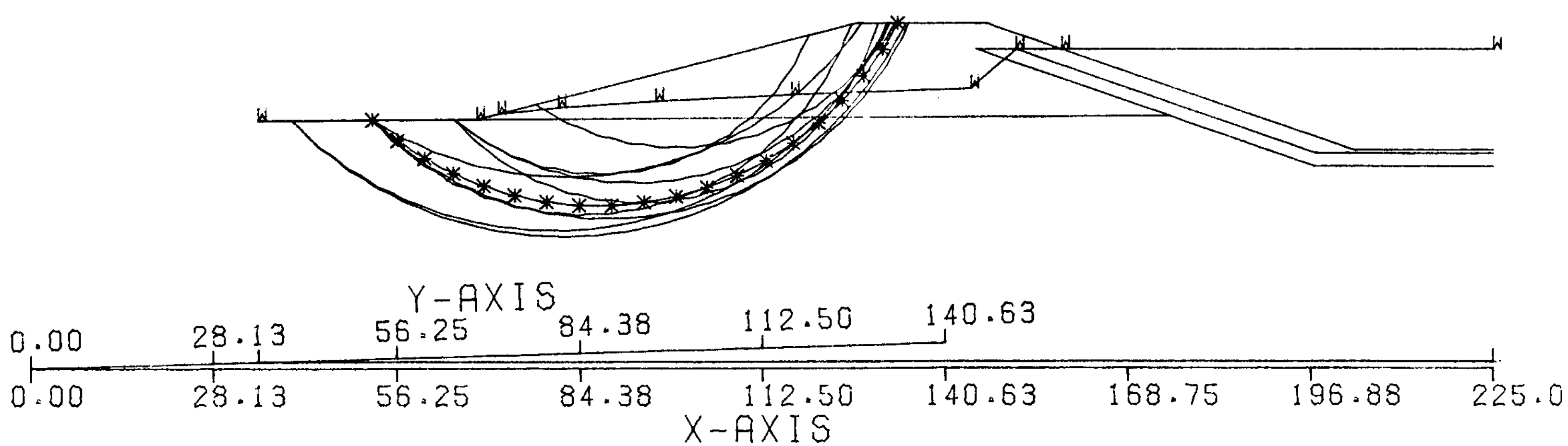
EMERY STAGE1 DOWNSTREAM ..OPE STABILITY
STEADY SEEPAGE 00000020

25 SURFACES HAVE BEEN GENERATED



10 MOST CRITICAL OF SURFACES GENERATED

MINIMUM FACTOR OF SAFETY = 3.408



EMERY DOWNSTREAM

SLOPE STABILITY

STEADY SEEPAGE AND EARTHQUAKE

MINIMUM FACTOR OF SAFETY 2.170

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU METHOD OF SLICES
IRREGULAR FAILURE SURFACES

OBLEM DESCRIPTION EMERY STAGE1 DOWNSTREAM SLOPE STABILITY
STEADY SEEPAGE & EQUAKE 00000020

BOUNDARY COORDINATES

6 TOP BOUNDARIES
14 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)	SOIL TYPE BELOW BND
1	35.00	38.00	68.50	38.20	3
2	68.50	38.20	127.00	53.00	1
3	127.00	53.00	147.00	53.00	1
4	147.00	53.00	158.50	49.00	1
5	158.50	49.00	203.50	33.50	1
6	203.50	33.50	225.00	33.50	1
7	145.50	49.00	151.50	49.00	2
8	151.50	49.00	197.60	33.00	2
9	197.60	33.00	225.00	33.00	2
10	145.50	49.00	175.00	38.80	1
11	175.00	38.80	197.40	31.00	3
12	197.40	31.00	225.00	31.00	3
13	68.50	38.20	175.00	38.80	3
14	35.00	1.00	225.00	1.00	4

ISOTROPIC SOIL PARAMETERS

4 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (PCF)	SATURATED UNIT WT. (PCF)	COHESION INTERCEPT (PSF)	FRICTION ANGLE (DEG)	PORE PRESSURE PARAMETER	PRESSURE CONSTANT (PSF)	PIEZOMETRIC SURFACE NO.
1	121.9	124.0	432.0	30.0	0.0	0.0	1
2	120.0	123.0	500.0	28.0	0.0	0.0	1
3	124.0	126.0	288.0	27.3	0.0	0.0	1
4	135.0	135.0	2000.0	33.0	0.0	0.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNITWEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 10 COORDINATE POINTS

POINT NO.	X-WATER (FT)	Y-WATER (FT)
1	35.00	38.00
2	68.50	38.20
3	71.80	39.00
4	81.00	40.00
5	96.00	41.00
6	117.00	42.00
7	144.60	43.00
8	151.50	49.00
9	158.50	49.00
10	225.00	49.00

A HORIZONTAL EARTHQUAKE LOADING COEFFICIENT
OF0.100 HAS BEEN ASSIGNED

A VERTICAL EARTHQUAKE LOADING COEFFICIENT
OF0.0 HAS BEEN ASSIGNED

CAVITATION PRESSURE =-2117.0 PSF

SEARCHING ROUTINE WILL BE LIMITED TO AN AREA DEFINED BY 1 BOUNDARIES
OF WHICH THE FIRST 1 BOUNDARIES WILL DEFLECT SURFACES UPWARD

BOUNDARY NO.	X-LEFT (FT)	Y-LEFT (FT)	X-RIGHT (FT)	Y-RIGHT (FT)
1	35.00	1.00	225.00	1.00

A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

25 TRIAL SURFACES HAVE BEEN GENERATED.

5 SURFACES INITIATE FROM EACH OF 5 POINTS EQUALLY SPACED ALONG THE GROUND SURFACE BETWEEN X = 40.00 FT.
AND X = 90.00 FT.

EACH SURFACE TERMINATES BETWEEN X = 115.00 FT.
AND X = 135.00 FT.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = 0.0 FT.

5.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

SAFETY FACTORS ARE CALCULATED BY THE MODIFIED BISHOP METHOD.

FAILURE SURFACE SPECIFIED BY 21 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	38.10
2	56.17	34.71
3	60.17	31.70
4	64.43	29.10
5	68.94	26.92
6	73.63	25.21
7	78.47	23.96
8	83.42	23.20
9	88.41	22.92
10	93.40	23.14
11	98.35	23.86
12	103.21	25.05
13	107.92	26.72
14	112.45	28.84
15	116.74	31.41
16	120.76	34.38
17	124.47	37.73
18	127.83	41.43
19	130.81	45.45
20	133.38	49.73
21	134.93	53.00

*** 2.170 *** Minimum Saftey factor

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	38.10
2	56.39	34.96
3	60.56	32.20
4	64.97	29.85
5	69.59	27.94
6	74.37	26.48
7	79.28	25.49
8	84.25	24.98
9	89.25	24.94
10	94.23	25.39
11	99.14	26.31
12	103.95	27.70
13	108.59	29.54
14	113.04	31.82
15	117.25	34.52
16	121.18	37.62
17	124.79	41.07
18	128.06	44.86

20	133.27	53.00

*** 2.188 ***

FAILURE SURFACE SPECIFIED BY 24 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	40.00	38.03
2	43.62	34.58
3	47.52	31.46
4	51.68	28.68
5	56.06	26.26
6	60.63	24.23
7	65.35	22.60
8	70.20	21.38
9	75.14	20.58
10	80.12	20.21
11	85.12	20.26
12	90.10	20.74
13	95.02	21.65
14	99.84	22.98
15	104.53	24.71
16	109.05	26.84
17	113.38	29.35
18	117.47	32.21
19	121.31	35.42
20	124.85	38.95
21	128.08	42.77
22	130.97	46.85
23	133.50	51.16
24	134.38	53.00

*** 2.195 ***

FAILURE SURFACE SPECIFIED BY 23 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	40.00	38.03
2	43.66	34.63
3	47.61	31.56
4	51.82	28.85
5	56.24	26.52
6	60.85	24.59
7	65.61	23.07
8	70.49	21.97
9	75.45	21.31
10	80.44	21.08
11	85.44	21.29
12	90.40	21.94
13	95.28	23.02
14	100.05	24.53
15	104.66	26.45
16	109.09	28.76
17	113.31	31.46
18	117.26	34.51
19	120.94	37.90
20	124.30	41.60
21	127.33	45.58
22	129.99	49.81

*** 2.226 ***

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	65.00	38.18
2	69.06	35.26
3	73.42	32.82
4	78.03	30.89
5	82.84	29.49
6	87.77	28.66
7	92.76	28.38
8	97.75	28.68
9	102.67	29.54
10	107.47	30.96
11	112.07	32.91
12	116.42	35.37
13	120.47	38.31
14	124.15	41.70
15	127.42	45.48
16	130.25	49.60
17	132.04	53.00

*** 2.268 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	38.10
2	56.04	34.57
3	59.95	31.46
4	64.20	28.83
5	68.72	26.69
6	73.46	25.09
7	78.35	24.05
8	83.33	23.57
9	88.33	23.66
10	93.28	24.33
11	98.13	25.56
12	102.80	27.34
13	107.24	29.64
14	111.38	32.44
15	115.18	35.69
16	118.58	39.36
17	121.54	43.39
18	124.01	47.73
19	125.97	52.33
20	126.10	52.77

*** 2.277 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	65.00	38.18
2	68.55	34.66
3	72.54	31.64
4	76.88	29.16
5	81.51	27.28
6	86.35	26.02
7	91.31	25.40
8	96.31	25.43
9	101.26	26.12
10	106.08	27.46
11	110.69	29.41
12	114.99	31.95
13	118.93	35.03
14	122.43	38.60
15	125.44	42.60
16	127.89	46.95
17	129.75	51.59
18	130.11	53.00

*** 2.290 ***

FAILURE SURFACE SPECIFIED BY 18 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	52.50	38.10
2	56.83	35.60
3	61.37	33.50
4	66.07	31.81
5	70.91	30.56
6	75.85	29.75
7	80.83	29.39
8	85.83	29.47
9	90.80	30.01
10	95.71	30.99
11	100.50	32.41
12	105.15	34.26
13	109.61	36.52
14	113.85	39.17
15	117.83	42.19
16	121.52	45.56
17	124.90	49.25
18	127.75	53.00

*** 2.384 ***

FAILURE SURFACE SPECIFIED BY 15 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	65.00	38.18
2	69.01	35.19
3	73.41	32.81
4	78.10	31.09
5	83.00	30.06
6	87.99	29.75
7	92.97	30.16
8	97.84	31.29
9	102.50	33.10
10	106.85	35.57
11	110.80	38.63
12	114.27	42.24
13	117.18	46.30
14	119.47	50.74
15	119.61	51.13

*** 2.463 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (FT)	Y-SURF (FT)
1	40.00	38.03
2	43.77	34.74
3	47.85	31.86
4	52.21	29.41
5	56.79	27.41
6	61.56	25.89
7	66.45	24.87
8	71.42	24.35
9	76.42	24.34
10	81.40	24.84
11	86.30	25.84
12	91.07	27.34
13	95.66	29.32
14	100.03	31.76
15	104.12	34.62
16	107.90	37.90
17	111.33	41.54
18	114.37	45.51
19	116.99	49.77
20	117.37	50.56

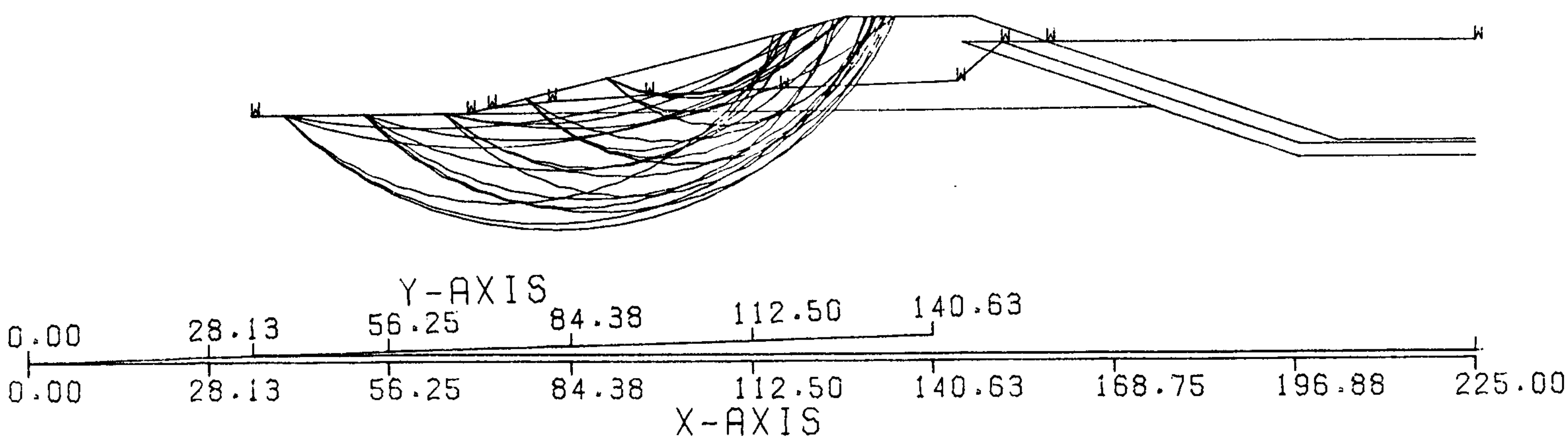
*** 2.513 ***

```
                        Y           A     X     I     S           F     T

                      0.00     28.13     56.25     84.38    112.50    140.63
X       0.00 +---------+---------+---------+---------+---------+
             -
             -
             -
             -
             -
       28.13 +
             *             *
             -
             -           3 3
             -          3 .
             -         3  .1
A      56.25 +        30 18
             -        3 18.
             -       3012..5
             -       361775*
             -      341785.
             -      3 175..W
X      84.38 +      31259..
             -      31258... .
             -       1258...W
             -       12598...
             -        1258...
             -         12.8...
I     112.50 +         125.890.
             -          1256W9.9
             -           1255869.
             -            131278*
             -               1212
             -                  1
S     140.63 +
             -              W * *
             -                *
             -
             -                *
             -
      168.75 +
             -             *
             -
             -
             -
             -
F     196.88 +         **
             -          *
             -
             -
             -
             -
T     225.00 *         **    W
```

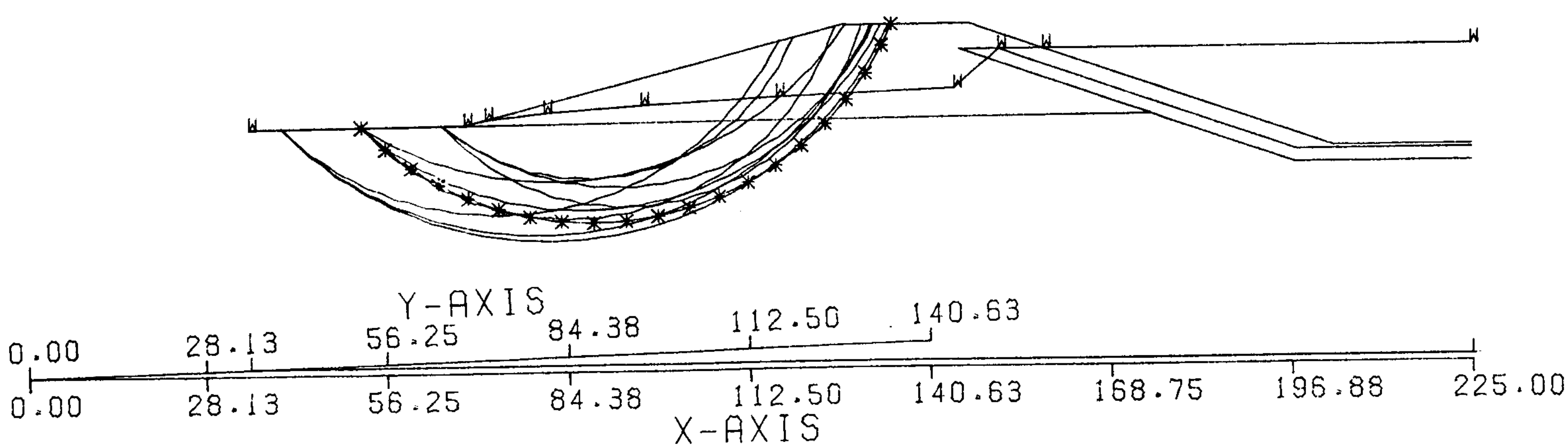
"MERY STAGE1 DOWNSTREAM SLOPE STABILITY
STEADY SEEPAGE & EQUAKE 00000020

25 SURFACES HAVE BEEN GENERATED



10 MOST CRITICAL OF SURFACES GENERATED

MINIMUM FACTOR OF SAFETY = 2.170



15.6.5 General Construction Specifications

1.0 General

1.0.1 The contractor shall comply with applicable federal and state laws, orders, and regulations and shall hold Consolidation Coal Company harmless of any fines liens, suits, or judgements incurred by the contractor.

1.0.2 Movement of crews and equipment within the right-of-way and over routes provided for access to the work shall be performed in a manner to prevent damage to land, crops, or property.

1.0.3 The contractor's construction activities shall be performed by methods that will prevent entrance, or accidental spillage, of solid matter, contaminants, debris, and other objectionable pollutants and wastes into streams, water courses, lakes, and underground water sources.

1.0.4 The contractor shall carry out proper and efficient measures wherever and as often as necessary to reduce the dust nuisance, and to prevent dust which has originated from his operations from damaging crops, orchards, cultivated fields, dwellings, or causing a nuisance to area residents or workers.

1.0.5 The contractor shall exercise care to preserve the natural landscape and shall conduct his construction operations so as to prevent any unnecessary destruction, scarring, or defacing of the natural surroundings in the vicinity of the work.

2.0 Site Work

2.0.1 No trees shall be cut outside the area of construction activity above without specific approval, and all trees designated by Consol shall be protected from damage.

2.0.2 The areas to be occupied by permanent construction required under these specifications and the surfaces of borrow pits, stockpiles and waste sites shall be cleared and grubed of all trees, stumps, roots, brush, rubbish, and other objectionable material as so determined by Consol.

2.0.3 The reservoir area below the pool elevation shall be cleared of all trees, stumps, and brush 5 feet or more in height, regardless of diameter, and 2 inches or more in diameter, regardless of height.

2.0.4 All work areas will be smoothed and graded in a manner to conform to the natural appearance of the landscape.

2.0.5 All rubbish, contractor's equipment, and structures shall be removed from the site. Waste piles shall be leveled and trimmed to regular lines and shaped to provide a neat appearance.

2.0.6 Materials from clearing operations shall become the property of the contractor and shall be, at the contractor's option, buried, removed from the site of work before the date of completion, or disposed of as approved by Consol.

2.0.7 Materials disposed of by burying shall be buried at locations approved by Consol and shall be covered with not less than 2 feet of earth material.

2.0.8 The location, alinement, and grade of construction roads shall be subject to the approval of Consol. When no longer required by the contractor, construction roads shall be made impassible to vehicular traffic and the surfaces shall be scarified and left in a condition which will facilitate natural revegetation. This requirement may be waived due to circumstances as determined by Consol.

2.0.9 Borrow pits shall be operated and left in a condition so as not to impair the usefulness or mar the appearance of any part of the work or any other property.

2.0.10 Borrow pits and quarry sites shall be so excavated that water will not collect and stand therein. Before being abandoned, the sides of the borrow pits and quarry sites shall be brought to stable slopes, with the slope intersections rounded and shaped to provide a natural appearance.

3.0 Earthwork

3.0.1 The cutoff trench, if required, shall be excavated in the dam foundation to a firm formation as shown on the drawings or as directed by the engineer.

3.0.2 Accurate trimming of the foundation slopes of the excavation will not be required, but the excavation shall conform as closely as practicable to the established lines and grades.

3.0.3 All loose rock and debris shall be removed from the foundation excavation and all rock cliffs, ledges, overhangs, and sharp irregularities shall be reduced to provide satisfactory foundation contours.

3.0.4 The entire area to be occupied by the dam embankment except as noted shall be subcut to a sufficient depth, as determined by Consol, to remove all unsuitable materials.

3.0.5 Site grading - do all cutting, filling, backfilling and grading as required to bring the entire project area to subgrade as shown on the drawings. Upon completion of the project, grades will be free of erosion, gullies or excessive rills as determined by the engineer.

3.0.6 All cut areas shall have a minimum of 2 feet of material cut below the final subgrade elevation. The cut will be replaced by 2 feet of compacted fill material to build the road back to the final subgrade elevation. The subgrade and compaction shall be extended 200 feet into any transition from cut to fill or from fill to cut.

3.0.7 Each layer of the material on the embankment shall be compacted by a minimum of 12 passes of the tamping roller.

3.0.8 No material larger than 6 inches will be allowed in the embankment fill unless selectively placed as to the engineer's directions. The distribution and gradation of the materials throughout the dam and road embankments are to be such that the fill will be free from lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from surrounding material.

3.0.9 The material shall be placed in the earthfill in continuous, approximately horizontal layers not more than 6 inches in thickness after being compacted.

3.0.10 No brush, roots, sod, or other perishable or unsuitable materials shall be placed in the embankment.

3.0.11 Care shall be taken to prevent any damage to the drainage blanket of the dam or to any pipe structure.

3.0.12 At the close of each days work or where work is stopped for a period of time, the entire surface of the compacted fill shall be sloped toward the inside grades of not less than 1% nor more than 2% and the surface shall be sealed by several passes of the equipment. If after prolonged rainfall, the top surface is too wet or plastic to work properly, the top material shall be removed to expose firm soil. If dried properly, the material may be used.

3.0.13 At the beginning of each segment of work in which the fill has been sealed to protect the fill, the contractor will either harrow, scarify, or work the surface in a suitable manner to insure the bonding of the next series of lifts.

3.0.14 All excavation for embankment and structure foundation shall be performed in the dry. No excavation shall be made in frozen material without written approval.

3.0.15 No material shall be placed in any portion of the dam embankment until the foundation for each section has been unwatered, stripped, suitably prepared, and has been approved by Consol's representative.

3.0.16 No embankment material shall be placed in the embankment when either the material or the foundation or embankment on which it would be placed is frozen.

3.0.17 All cavities, depressions, and irregularities, either existing or resulting from the removal of rock fragments that are within the area covered by the embankment or structure, shall be filled and compacted to appropriate densities.

4.0 Culverts and Pipe Structures

4.0.1 The structures will be laid to the lines as shown on the drawings.

4.0.2 The pipes shall be laid to the grades as shown on the drawings. If no grade is specified, the pipe shall be laid on a slope slightly greater than the natural grade of the channel.

4.1 Excavation and Backfill

4.1.1 Excavations for pipes will generally be made 12" to 24" wider than the structure to allow room for sufficient compaction and to reduce the amount of fill required. The side wall should be verticle to the structure.

4.1.2 All corregated steel structures shall be placed on a firm base with the lower quarter of the pipe firmly supported. In no case shall the structure be placed on sod, frozen earth, or on a bed with large boulders or rocks. If a firm base cannot be achieved, a base shall be constructed by undercutting the insitu material and placing a granular backfill in place. The area to be cut should be three pipe diameter in width with the two outside thirds being four times as deep as the middle third. The middle third shall be a minimum of 6 inches in thickness.

4.1.3 The backfill shall be of granular material if available. If not available and the backfill material is plastic in nature, the material shall be placed at the optimum moisture content for compaction.

4.1.4 Compaction within 16" to 18" of the pipe shall be done by hand held tampers; heavier hand guided tampers may be used for the remainder of the material out to the trench side. If the area is wide and deep, heavier tractor-powered equipment may be used from 24 inches from the pipe and above the pipe after sufficient cover has been provided to prevent damage.

4.2 Thrust Blocks

4.2.1 All thrust blocks shall be cast-in-place concrete and to the lines and dimensions as shown on the drawings.

4.2.2 The area around the structures shall be compacted in the same manner as specified under section 4.1.4.

4.2.3 All concrete and riebar shall be placed to the dimensions as shown on the drawings, in addition, the materials will meet the criteria as shown in the Technical Specifications.

4.3 Decant Structure

4.3.1 The concrete gate mount shall be made of cast-in-place concrete meeting the lines and dimensions of the drawings and meeting the technical specifications for concrete and reinforcing bar.

4.3.2 A trash rack shall be provided by Consol and installed by the contractor. The rack shall be placed on the inside of the decant gate in the same arrangement as the emergency spillway. No antivortex device shall be used on the decant system.

4.3.3 All welds shall be in accordance with the UBC standards.

4.3.4 All excavation and backfill shall be placed in accordance with section 4.1.

4.4 Emergency Spillway Structure

4.4.1 All excavation and backfill shall be placed in accordance with section 4.1.

5.0 Seeding and Revegetation

5.0.1 Consol will provide and sew all seed.

5.0.2 The contractor will be responsible to have all slopes and borrow areas ready for seeding. The project shall not be accepted or final payment made until all rills, erosion, gullies, etc. have been graded and ready for seeding.

6.0 Concrete

6.1 Concrete Formwork

6.1.1 Forms may be job built or of prefabricated construction.

6.1.2 Forms will conform to the shapes, lines and dimensions called for on the plans and be substantial and tight to prevent leakage. Prior to pouring, concrete forms will be thoroughly wetted or oiled.

6.1.3 Braces and ties will maintain forms in position and shape. Contractor will coordinate with other trades on all inserts, sleeves, anchors, and other embedded items.

6.1.4 Remove forms without damage to concrete.

6.2 Concrete Reinforcement

6.2.1 Reinforcing bars will be deformed, conforming to ASTM "Specifications for Minimum Requirements for the Deformation of Deformed Steel Bars for Concrete Reinforcement," A 305.

6.2.2 Reinforcing bars will comply with ASTM sepcifications for fy = 40,000 psi steel bars or as otherwise shown.

6.2.3 Provide all metal accessories required to hold steel reinforcing in positions as required.

6.2.4 All reinforcing bars will be free from rust and be new.

6.2.5 Welded wire fabric will conform to ASTM "Specifications for Welded Steel Fabric for Concrete Reinforcement," A 185.

6.3 Cast-In-Place Concrete

6.3.1 Portland Cement will conform to ASTM "Sepcifications for Portland Cement," C 150.

6.3.2 Aggregates for concrete will conform to ASTM "Specifications for Concrete Aggregates," C33. Grade course aggregate from 1 inch to 1½ inches.

6.3.3 Water will be clean and free from injurious amounts of deleterious substances.

6.3.4 Concrete will attain a compressive strength of at least 2800 psi at 28 days unless otherwise shown.

6.3.5 Concrete surfaces will be true and level as called for by the drawings with maximum tolerance of 1/8 inches in 6 feet.

6.3.6 Concrete will be maintained in a moist condition for at least three days by water curing followed by a minimum of four days of water curing or membrane curing.

6.3.7 Concrete will be cleaned.

6.3.8 No additional water or additives will be used without written approval of the engineer.

6.3.9 The concrete will have 6% ± 1% entrained air.

6.3.10 Concrete will be finished by float, trowel, and broom as is within reason.

7.0 Earthwork

7.1 Compaction

7.1.1 All compaction except as noted shall be at 95% standard proctor as determined by ASTM 698. Compaction should be performed within ± 3% of the optimum moisture content.

7.1.2 All lifts will be no greater than 6 inches in compacted thickness.

7.2 Filter

7.2.1 Placement of the filter shall be at least 95% of the maximum dry density of standard proctor (ASTM 698).

15.7 Consultation and Coordination

In addition to the discussions and coordination activities undertaken for the permit application submitted in March 1981 (see Chapter 14.0), two special meetings were held to discuss permitting activities required for the coal preparation plant.

July 30, 1981 — Meeting between Utah Division of Oil, Gas, and Mining and Consol.

Participants:

John Higgins	Consol
Sally Kefer	OGM
Carl Muha	Consol
Mary Jo Ormiston	Consol
Tom Tetting	OGM
Jim Thompson	Consol

August 6, 1981 — Pre-design Conference between Utah Dept. of Health, Division of Environmental Health; Utah Division of Oil, Gas, and Mining; and Consol.

Participants:

Mary Bosworth	OGM
Carl Broadhead	Bureau of Air Quality
Dennis Dalley	Div. of Envir. Health
Dennis Downs	Bureau of Hazardous Waste
Michael Georgeson	Bureau of Public Water Supplies
Sally Kefer	OGM
Lynn Kunzler	OGM
Steven McNeal	Bureau of Water Pollution Control
Carl R. Muha	Consol
Mary Jo Ormiston	Consol
Tom Tetting	OGM
Jim Thompson	Consol
Barbara Weidner	Bureau of Hazardous Waste

Environmental Studies, Soils Report:

Harner-White Ecological Consultants
4901 East Dry Creek Road
Littleton, Colorado 80122

Archeology / History:

Archeological-Environmental Research Corporation
588 West South
Bountiful, Utah 84010

MSHA Consultation:

Ed Beck
Mine Safety and Health Administration
Denver Technical Support Center
730 Simms
Lakewood, Colorado

Stephen W. Dmytriw, P.E.
Mine Safety and Health Administration
Denver Technical Support Center
730 Simms
Lakewood, Colorado

Foundation and Materials Investigation:

Rollins, Brown and Gunnell, Inc.
Professional Engineers
1435 West 820 North
P.O. Box 711
Provo, Utah 84601

Consol Personnel:		
	Carl Muha, P.E.	Project Mgr., Plant Design and Layout
	Mary Jo Ormiston	Engineering and Designs
	Britt Luther	Engineering and Designs
	Jeff Meyer	Design
	Gouri Bajpayee	Subsidence Control
	Rick Williamson	Reclamation Planning
	Louis Meschede	Hydrology and Geology
	Dick Klanica	Graphics
	Amy Schneider	Graphics
	Jim Thompson	Permit Coordinator
	Kent Seaton, P.E.	Technical Review

Address for the above mentioned Consol Personnel is 2 Inverness Drive East, Englewood, Coloarado 80112.

Dam Design, Stability Analysis:

Stuart Carter
Project Engineer
Design and Construction
Consol Plaza
Pittsburgh, PA 15241

15.8 References

McWhorter, D.B., and Nelson, J.D., "Unsaturated Flow Beneath Tailings Impoundments", Journal of the Geotechnical Engineering Division, ASCE, Vol. 105, No. GT11, November 1979, pp. 1317-1334.

Bouwer, H., Groundwater Hydrology, McGraw-Hill Book Co., New York, N.Y., 1978, 480 p.

Wahler, W.A., and Associates, "Pollution Control Guidelines for Coal Refuse Piles and Slurry Ponds", U.S. EPA, EPA-600/7-78-222, November 1978, p. 42.

APPENDIX 15-1

PB147

AIR QUALITY IMPACTS OF A COAL PREPARATION FACILITY IN EMERY COUNTY, UTAH

Prepared for

CONSOLIDATION COAL COMPANY
Englewood, Colorado

Prepared by

ENVIRONMENTAL RESEARCH AND TECHNOLOGY, INC.
Fort Collins, Colorado

August 1981

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1.0 INTRODUCTION

Consolidation Coal Company (CONSOL) proposes to build a coal preparation plant with a maximum hourly capacity of 700 tons per hour and a maximum annual production rate of 2.6 million tons of clean coal. The plant will be located adjacent to the existing CONSOL Emery underground mine, approximately four miles south of the Village of Emery in southwestern Emery County, Utah.

CONSOL has retained Environmental Research and Technology, Inc. (ERT) to estimate the fugitive particulate emissions associated with this coal preparation plant, and to use these estimates in appropriate atmospheric dispersion models to predict the ambient particulate concentrations due to the plant. This report summarizes the technical documentation of CONSOL's determination of the impact of the proposed operation on the ambient air quality as required by Section 3.1 of the Utah Air Conservation Regulations.

The proposed plant is not listed as one of the 28 major source catagories specified in the Prevention of Significant Deterioration (PSD) regulations. Because the estimated emissions are less than 250 tons per year, the plant is not subject to Federal or State requirements pertaining to PSD. Utah requres the maximum particulate concentrations to be within the secondary National Ambient Air Quality Standards (NAAQS) of 60 micrograms per cubic meter ($\mu g/m^3$) annual geometric mean and 150 $\mu g/m^3$ twenty-four hour average.

Analytical techniques were discussed with the Utah Department of Health by CONSOL officials in a pre-design conference, and subsequently clarified in discussions between ERT staff and Department personnel. The analysis utilizes emission factors routinely used by the Utah Department of Health and the Environmental Protection Agency (EPA) Region VIII. The dispersion model chosen is a modified version of an EPA Guideline (1978) model which has been successfully applied in Utah and adjoining states.

This report demonstrates compliance with the secondary NAAQS limits at the proposed plant production rates stated above.

2.0 MODELING METHODOLOGY

Federal and state laws require any new development with the potential to affect air quality to conduct an analysis of expected air quality impacts. Such an analysis must reflect not only the expected emissions from the proposed development but also the existing air quality and meteorological conditions in the area. The analysis, therefore, involves the collection of data to characterize existing conditions in the region and the application of a dispersion model to calculate expected pollutant concentrations resulting from plant emissions.

2.1 Model Selection

The most important criteria in selecting an appropriate model are the available data base, the size of the impacted region, the terrain and its influence on the meteorological conditons, and the presence of other nearby emission sources.

Taking these factors into consideration, the Wyoming Climatological Dispersion Model (WCDM) was selected as the most appropriate model from which to calculate expected pollutant concentrations due to emissions from the proposed coal preparation plant. WCDM is a rural version of the EPA Climatological Dispersion Model (Busse and Zimmerman 1973). The Wyoming Division of Air Quality made the necessary modifications to convert the Climatological Dispersion Model from its original urban application to a model more suitable for a rural environment. These changes include:

- Adapting the model to accept 6 stability STAR data with no stratification of neutral stabilities between daytime and nighttime.
- Inclusion of stable plume rise following the standard Briggs formula.
- Assuming unlimited mixing during stable conditions.

A complete description of the modifications incorporated into WCDM is listed in Attachment I.

The Wyoming Climatological Dispersion Model was judged most suitable to analyze the Consolidation Coal preparation plant for the following reasons:

- The most representative meteorological data was available only in annual STAR format. This precluded selection of a model utilizing sequential meteorological data such as the Industrial Source Complex (ISC) model.

- The emissions from the coal preparation plant are generated entirely by low-level fugitive emissions. Since the emission release height is close to ground level and the plumes neutrally buoyant, a flat terrain model like WCDM would predict concentration estimates equivalent to those of a complex terrain model such as VALLEY. On elevated receptors, WCDM is more conservative than VALLEY, which depletes the concentration as the plume rises over terrain.

- WCDM receptor locations are user specified. This allows a more precise determination of the maximum concentration. In some models, such as VALLEY, the location of receptors are fixed around some arbitrary center.

2.2 Selection of Model Options and Meteorological Data

The meteorological input necessary for WCDM includes average morning and afternoon mixing heights, average ambient atmospheric temperature, initial vertical dispersion parameter (σ_z) for each stability class, and a stability wind rose. The parameters selected for this analysis are listed in Table I.

The average mixing heights have been taken from Holzworth (1972) which gives annual average mixing heights for areas throughout the contiguous United States. These data show an average morning mixing height of 300 meters and an average afternoon mixing height of 2,500 meters for the Emery County area.

Although the average ambient atmospheric temperature is a mandatory input to WCDM, it is used only to calculate the plume rise for point sources. Since the modeling for Consolidation Coal involved only area source emissions, the exact value of this parameter has no influence on the calculations. Therefore, an arbitrary ambient temperature of 283°K has been selected.

TABLE I

METEOROLOGICAL INPUT PARAMETERS USED IN CONSOL FUGITIVE DUST MODELING

Parameter	Value
Average Morning Mixing Height	300 m
Average Afternoon Mixing Height	2,500 m
Average Ambient Atmospheric Temperature	283°K
Initial σ_z (all stabilities)	20m
Annual Wind Rose (location)	Hanksville, UT

The initial value of the vertical dispersion parameter (σ_z) is used to represent the vertical dispersion created by surface roughness. This is necessary because the values of σ_z were originally established from diffusion conducted over flat and relatively smooth terrain. Typical inital σ_z values used in WCDM are 20 to 30 meters for low level sources. The more conservative value of 20 meters is used in the Consolidation Coal modeling.

Stability wind roses located close to the site of the preparation plant are available from the towns of Hanksville (80 km southeast), Castle Dale (37 km northeast), and the Caineville-Salt Wash area (65 km south). Although Castle Dale is located closest to the proposed plant site, Hanksville data was judged to be more appropriate for use in fugitive dust modeling. The data at Hanksville was collected near ground level by the National Weather Service, while Castle Dale and Salt Wash data were derived from meteorological tower measurements taken at heights ranging from 60 to 100 meters above ground. Since all of the emissions from the CONSOL facility are from ground level sources, the Hanksville wind rose has been used to calculate annual average impacts.

Assumed worst-case meteorological conditons are used to obtain estimates of 24-hour maximium impact. Pasquill-Gifford stability class F with a 2.5 meter per second wind and six hours persistance has been modeled assuming wind directions of north, south, east, and west. The two wind directions yielding the highest predicted concentrations (indicative of worst-case source to receptor orientation) have also been modeled with stability class D, a 6.9 meter per second wind and twelve hours persistance. The high wind speed-neutral stability case represents a physical condition which typically results in high fugitive dust emissions. Although the stable-low wind speed condition represents the worst-case dispersion period, fugitive dust emissions tend to be reduced under these conditions. For example, wind blown emissions from storage piles (which are physically a function of wind speed) fall to near-zero during stable-low wind conditions. However, such emissions were retained in the modeling, resulting in conservative estimates of 24-hour impacts of the plant during stable conditions.

The wind directions have been chosen to represent the worst-case source receptor orientation without regard for the actual occurrance of each wind direction. The Hanksville data shows a high frequency of northerly winds under stable conditions, and a slightly less frequent northerly component during neutral conditons. By assuming the required persistance for wind directions other than northerly, additional conservatism has been introduced into the analysis.

2.3 Emissions Inventory and Source Geometry

The emission inventory for the fugitive dust sources is developed from emission factors approved by Environmental Protection Agency (EPA) Region VIII for mining operations and emission factors supplied by the Utah Department of Health. A detailed accounting of the emissions inventory, including equations and calculations is presented in Attachment II. The annual emissions inventory is developed assuming a maximum throughput of 2.6 millions tons of clean coal per year. The design rate of 700 tons of clean coal production per hour for 24-hours is used to develop a worst-case twenty-four hour emissions inventory. Calculation of the twenty-four hour emissions inventory is accomplished by ratioing the appropriate annual throughput values listed in Attachment II.

Emissions per ton of throughput are greater along the coal handling system from the existing underground mine than along the future strip mine coal handling system, therefore assuming the 700 tons per hour production is supplied from the existing underground mine represents the worst-case 24-hour emissions inventory. In actuality, the source of the coal during operation of the plant at maximum capacity would come from both systems in combination, resulting in lower total emissions.

The plant area was divided into a grid of twelve 200 meter squares in which the emissions were allocated. The model assumes emissions from all sources located within a single square are distributed equally across the square. Sources which fall in more than one squares, mainly haul roads and conveyor belts, are apportioned among the squares by assigning the percentage of emissions from each source in each square the same value as the percent of total area of each source within each square. A 200 meter grid size has been chosen to give maximum source resolution while minimizing the number of grids. Maps I and II show the grid pattern overlayed on a plot plan of the coal preparation plant and associated facilities. A list of how the source emissions are allocated is contained in Table II. Figures I and II show the layout of the emissions grid for the annual and 24-hour inventories.

Sources of other pollutants (SO_2, NO_x, etc.) are non-existent at the proposed coal preparation plant. Electrical power is available through existing power lines. Existing particulate emission sources, primarily employee traffic to the existing underground mine, are not considered in the emissions inventory. The impact of these emission sources instead is included in the estimation of the background concentration (see Section 2.5). Existing coal handling facilities will be closed prior to operation of the coal preparation plant, and thus are not included in the analysis.

Some of the conservative approaches used in generating this emissions inventory are:

- Assuming one employee per vehicle in estimating employee traffic. This more than offsets emissions from miscellaneous traffic in the plant area which was not included as a seaparte item in the emissions inventory.
- Assuming the coal haul trucks average 40 tons per load, even though their capacity is rated at 45 tons per load.
- Using control efficiencies of 90 percent for totally enclosed emissions and 80 percent for underground emissions.
- Twenty-four hour emission estimates are derived assuming operation at 700 tons per hour for 24-hours.

All of these result in the emissions inventory being an overstatement of the actual emissions.

2.4 Receptor Locations

A total of 98 receptors are utilized in the dispersion modeling analysis. Locations of these receptors have been selected to maximize the probability of locating the highest concentrations and to yield a suitable resolution of the concentration patterns surrounding the plant. Figure III shows the receptor locations in relation to the area source emission grids.

TABLE II

ALLOCATION OF EMISSION SOURCES BY
AREA SOURCE GRID

(See Appendix II for Source Numbering System)

Source		Annual g/sec	24-hour g/sec
Area Source 1			
1. 1/5 of II 5		0.079	0.176
	Total	0.079	0.176
Area Source 2			
1. 1/5 of II 5		0.079	0.176
2. III 2		0.015	0.015
3. III 3		0.031	0.031
4. III 4		0.020	0.020
	Total	0.145	0.242
Area Source 3			
1. 1/5 of II 5		0.079	0.176
	Total	0.079	0.176
Areas Source 4			
1. 1/5 of II 5		0.079	0.176
	Total	0.079	0.176
Areas Source 5			
1. 1/5 of II 5		0.079	0.176
	Total	0.079	0.176
Area Source 6			
1. 1/2 of II 2		0.956	2.251
2. 1/3 of II 3		0.015	0.032
3. 1/2 of II 4		0.036	0.079
	Total	1.007	2.362
Area Source 7			
1. 2/3 of I 18		0.017	0.000
2. I 19		0.045	0.000
3. I 20		0.007	0.007
4. I 21		0.026	0.000
5. I 33		0.258	0.618
6. 1/2 of II 2		0.955	2.251
7. 1/3 of II 3		0.015	0.032
8. 1/2 of II 4		0.036	0.079
	Total	1.359	2.987

TABLE II (CONTINUED)

Source		Annual g/sec	24-hour g/sec
Area Source 8			
1. I 22		0.026	0.000
2. 1/2 of I 26		0.042	0.099
3. I 27		0.037	0.087
4. I 28		0.416	0.983
5. I 29		0.037	0.087
6. I 30		0.037	0.087
7. I 31		0.065	0.154
8. I 32		0.010	0.010
9. I 34		0.000	0.001
10. I 35		0.000	0.000
11. I 36		0.000	0.000
12. I 37		0.001	0.001
13. I 38		0.001	0.003
14. I 39		0.004	0.009
15. I 40		0.001	0.001
16. I 41		0.040	0.088
17. 1/3 of II 3		0.015	0.032
	Total	0.732	1.642
Area Source 9			
1. III 1		0.014	0.014
	Total	0.014	0.014
Area Source 10			
1. 1/2 of I 9		0.019	0.065
2. I 10		0.067	0.229
3. I 11		0.028	0.028
4. I 12		0.038	0.131
5. I 15		0.128	0.000
6. I 16		0.026	0.000
7. I 17		0.026	0.000
8. 1/3 of I 18		0.009	0.000
9. 1/3 of II 1		0.021	0.033
	Total	0.362	0.486
Area Source 11			
1. I 1		0.576	1.966
2. I 2		0.576	1.966
3. I 3		0.058	0.197
4. I 4		0.029	0.099
5. I 5		0.019	0.066
6. I 6		0.034	0.155
7. I 7		0.007	0.007
8. I 8		0.019	0.066
9. 1/2 of I 9		0.019	0.065

TABLE II (CONTINUED)

Source		Annual g/sec	24-hour g/sec
10. I 13		0.058	0.197
11. I 14		0.029	0.099
12. I 23		0.013	0.000
13. I 24		0.026	0.000
14. I 25		0.013	0.000
15. 1/2 of I 26		0.042	0.099
16. 1/3 of II 1		0.031	0.098
	Total	0.181	0.204
<u>Area Source 12</u>			
1. 1/3 of II 1		0.010	0.033
	Total	0.010	0.033

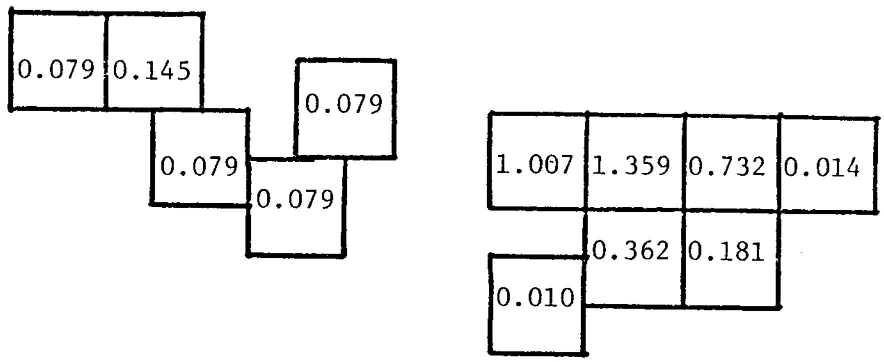

FIGURE I ANNUAL AVERAGE AREA SOURCE EMISSION RATES (g/sec)

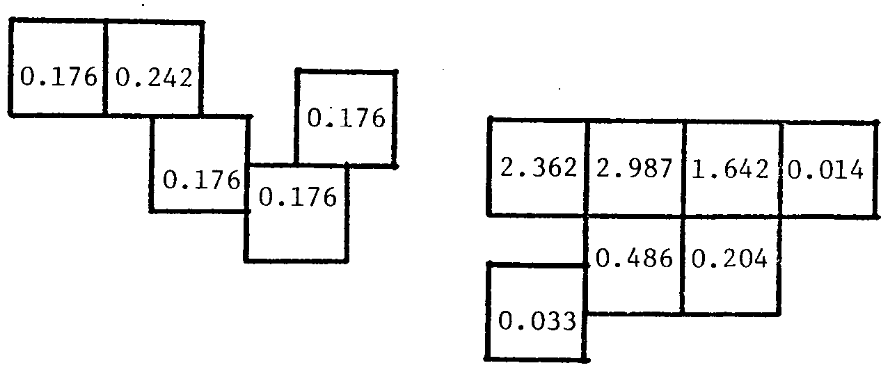

FIGURE II MAXIMUM 24-HOUR AVERAGE AREA SOURCE EMISSION RATES (g/sec)

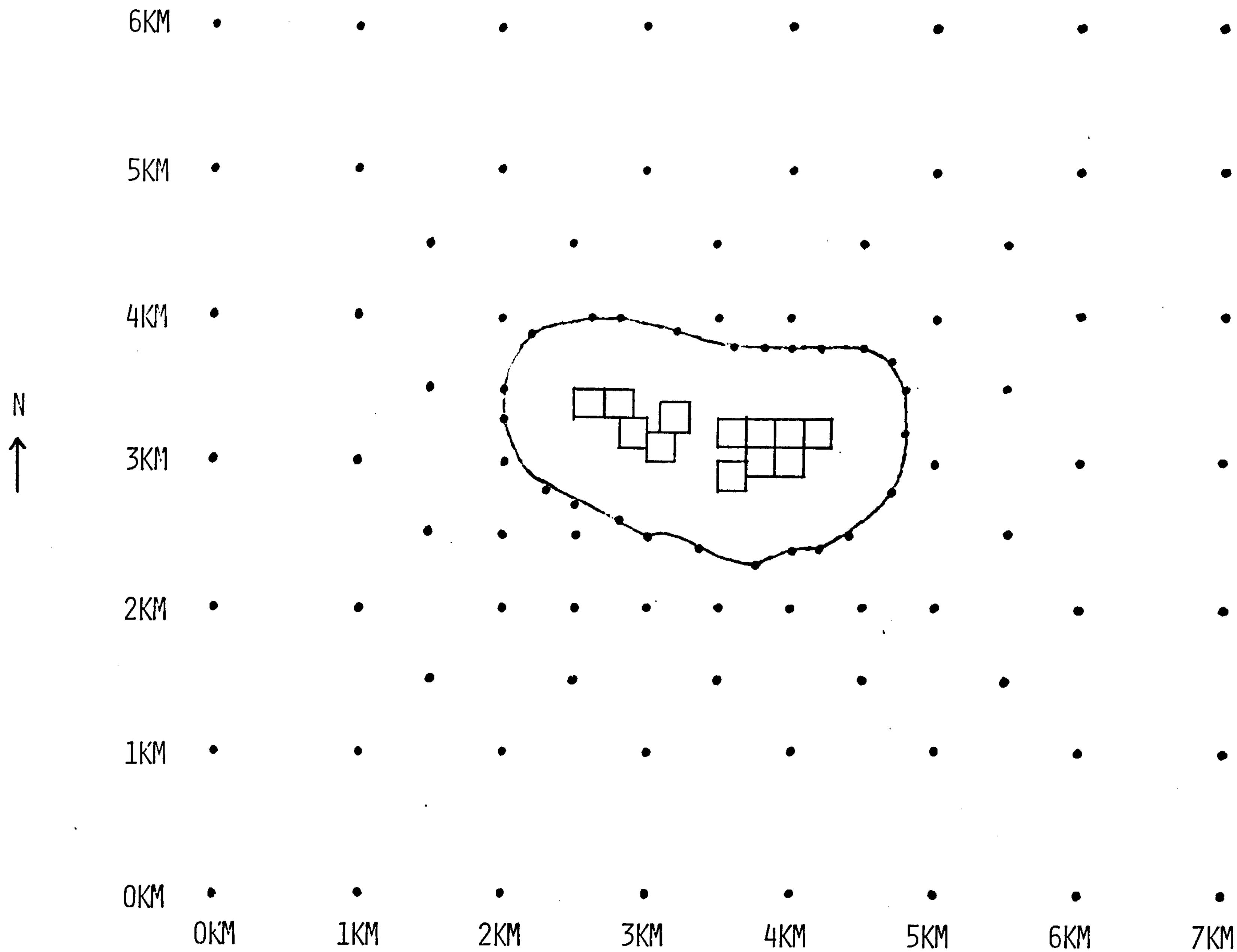

FIGURE III LOCATION OF RECEPTORS IN
WYOMING CDM MODELING

A minimum source-receptor distance of 500 meters is used in defining receptor locations. This is consistent with proceedures established by the Wyoming Department of Environmental Quality (DEQ) for utilization of the Wyoming CDM. The DEQ recognizes that Wyoming CDM fails to account for the important physical phenomena of particulate settling and deposition in the calculations. This deficiency in the modeling leads to greatly overconservative concentration estimates within 500 meters of sources of fugitive dust. Beyond 500 meters, the model results remain conservative because of lack of treatment of particulate settling and deposition, but to a lesser degree.

A large majority of the 500 meter buffer zone contains the area of existing underground mining operations and proposed areas for refuse storage and slurry ponds. These areas are not accessible to the general public. The entire buffer zone is contained within the area of CONSOL's lease holdings.

2.5 Background Concentrations

No ambient monitoring data exist at the plant site from which to make an assessment of background concentrations of particulate matter. However, the Utah Department of Health has operated a particulate monitoring station in the town of Castle Dale, 37 km northeast of the CONSOL site.

These data can be used to conservatively assess the background concentrations in the Emery area. Anthropogenic sources of particulate matter from general human activities and major industrial sources such as the Hunter Power Plant complex influence the measured concentrations at Castle Dale. These influences are much greater in magnitude than the impact CONSOL's existing mining operations have upon particulate concentrations near Emery. Therefore, the use of Castle Dale data to determine a background concentration maintains a large margin of safety in the estimate.

Table III lists the background concentrations assumed for this analysis. The annual background estimate is equal to the 1980 Castle Dale annual geometeric mean as measured by the Utah Department of Health. The 24-hour background is assumed to be twice the annual geometric mean. This value lies between the 90th and 95th percentile of

TABLE III

ESTIMATES OF BACKGROUND PARTICULATE CONCENTRATIONS ($\mu g/m^3$)

Annual Geometric Mean	38
Twenty-four Hour Average	76

(Source: Utah State Department of Health 1981) measured 24-hour values at Castle Dale. Using the second highest measured value to estimate 24-hour particulate background is often inappropriate because the meteorological conditons which occurred during the second-highest day are likely to be vastly different than the assumed worst-case meteorological conditions input to the model.

3.0 RESULTS

3.1 Annual Average Concentrations

The maximum annual average particulate impact from the CONSOL coal preparation plant and background sources is predicted to be 54.07 μg/m^3 as shown in Table IV. Figure IV shows an isopleth map of predicted annual average concentrations (including background) for plant operations at 2.6 million tons per year.

Compliance with the secondary particulate NAAQS of 60 μg/m^3 is demonstrated. Approximately 30 percent of the maximum annual concentration is due to CONSOL emissions with the remainder attributable to background. This percentage is lower at other receptor locations.

The maximum concentrations occur the south and southeast of the plant. The entire isopleth pattern shows the influence of the dominant north-south wind orientation.

3.2 Maximum 24-Hour Concentrations

Predicted 24-hour particulate impacts for each of the six worst-case scenarios are listed in Table V. The highest concentration of 138.56 μg/m^3 occured during a westerly wind under stable-low wind speed dispersion conditions. The major sources of emission are most aligned for this particular condition. The Hanksville wind rose, however, shows a low frequency of westerly winds during class F stability. The most likely worst-case stable condition (as determined by the Hanksville stability wind rose) is a northerly wind during class F stability. The predicted impact from the CONSOL facility is reduced by approximately one-third for this condition as compared to the west wind condition.

An isopleth map of the maximum 24-hour impact concentrations is contained in Figure V. There is a narrow band of maximum concentrations which is typically found during F stability. A full three-shift operation at the rated capacity of 700 tons per hour is assumed to occur during the worst-case dispersion condition.

Compliance with the 24-hour secondary particulate NAAQS of 150 μg/m^3 is demonstrated. Approximately 45 percent of the maximum

TABLE IV

MAXIMUM ANNUAL AVERAGE PARTICULATE IMPACTS ($\mu g/m^3$) IN THE VICINITY OF THE CONSOL COAL PREPARATION PLANT

Maximum CONSOL Impact	Background Concentration	Total Concentration	Secondary NAAQS
16.07	38	54.07	60

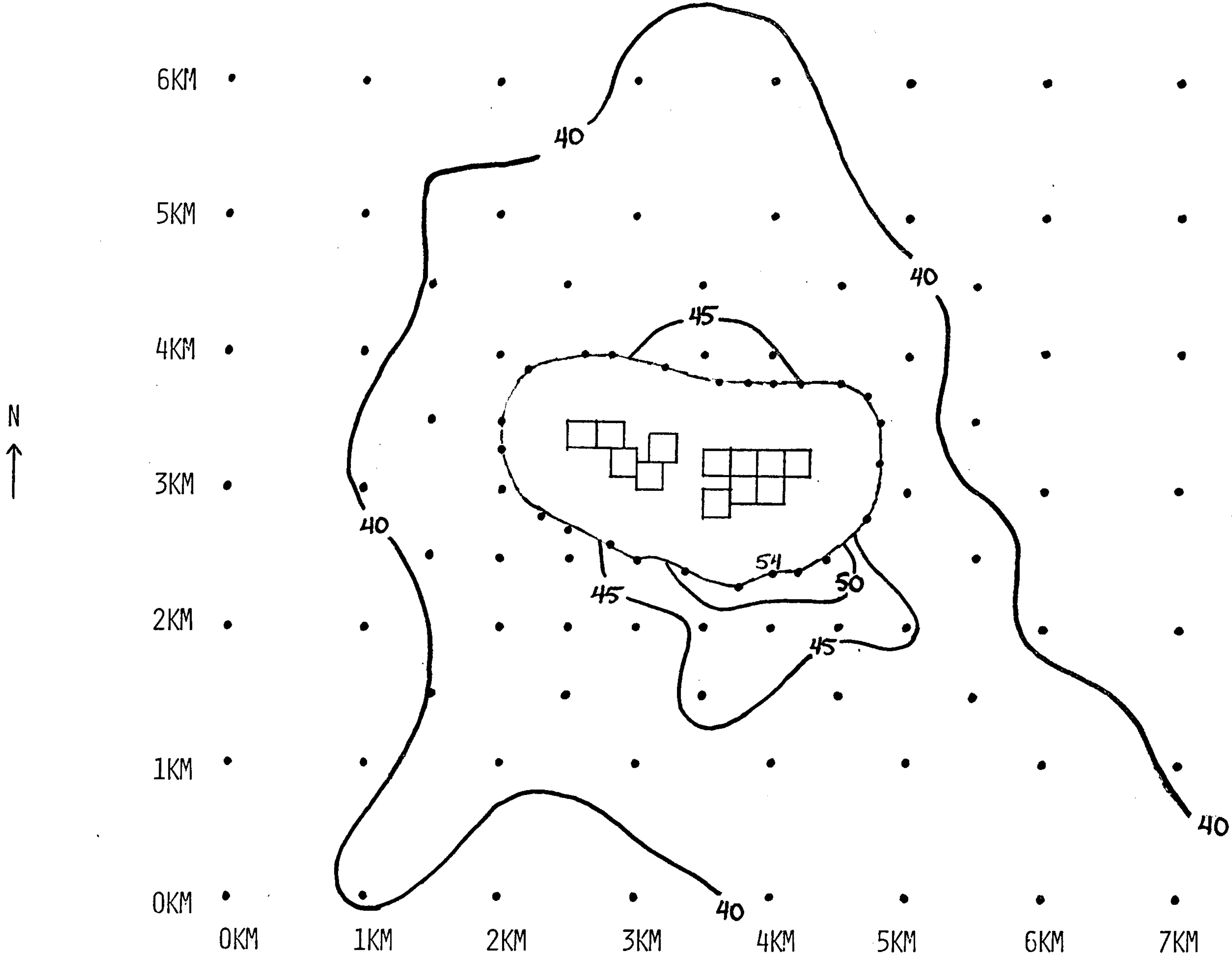

FIGURE IV ANNUAL AVERAGE PARTICULATE CONCENTRATIONS NEAR THE CONSOL COAL PREPARATION PLANT

TABLE V

TWENTY-FOUR HOUR AVERAGE PARTICULATE IMPACTS ($\mu g/m^3$) IN THE VICINITY OF THE CONSOL COAL PREPARATION PLANT

Assumed Meteorological Condition	Maximum CONSOL Impact	Background Concentration	Total Concentration	Secondary NAAQS
F 2.5 East	47.95	76	123.95	150
F 2.5 West	62.56	76	138.56	150
F 2.5 North	42.72	76	118.72	150
F 2.5 South	59.16	76	135.16	150
D 6.9 West	27.05	76	103.05	150
D 6.9 South	27.64	76	103.64	150

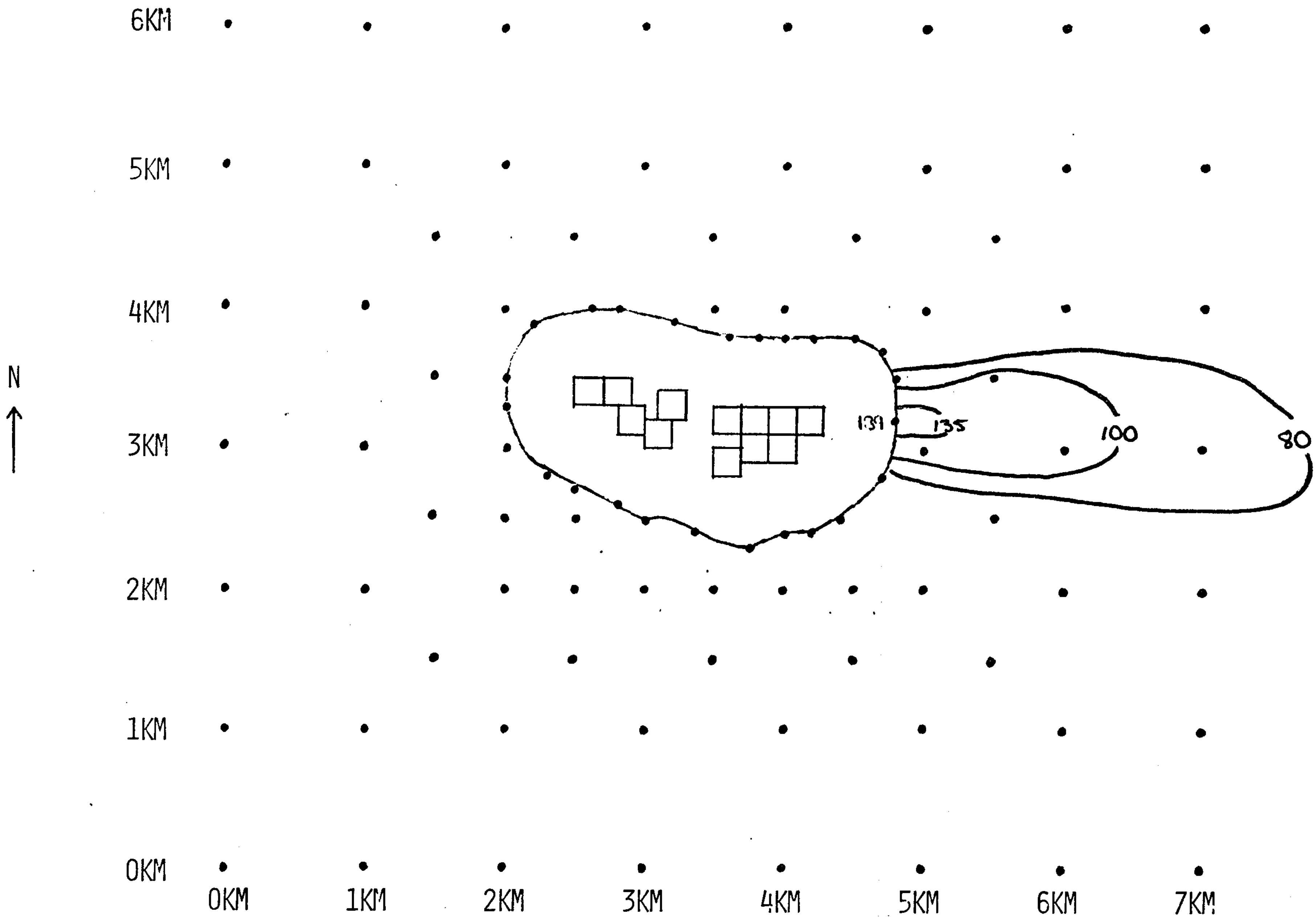

FIGURE V MAXIMUM 24-HOUR PARTICULATE
CONCENTRATIONS NEAR THE CONSOL
COAL PREPARATION PLANT

short-term impact is due to CONSOL emissions with the remainder attributable to background. This percentage is lower at other receptors and during other scenarios.

4.0 CONCLUSIONS

Despite the conservatism of this analysis, it has been shown that operation of the CONSOL coal preparation plant will not result in any exceedances of the secondary NAAQS for particulate matter. These results are summarized in Table VI.

Conservative assumptions employed in this analysis include:

- An emissions inventory using worst-case operational parameters.
- A conservative estimate of background particulate levels.
- A worst-case wind direction aligned along the major emission sources rather than along the most likely wind direction.
- No treatment of particle deposition.

Because of these conservative assumptions, actual concentrations of particulate matter during plant operation will likely be lower than the estimates presented in Table VI.

TABLE VI

DEMONSTRATION OF COMPLIANCE WITH THE SECONDARY NAAQS AT THE CONSOL COAL PREPARATION PLANT

Averging Time	Pollutant	Maximum Predicted Concentrations ($\mu g/m^3$)			
		CONSOL	Background	Total	NAAQS
Annual	TSP	16	38	54	60
24-hour	TSP	63	76	139	150

5.0 LITERATURE CITED

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EPA. 1978. Guidelines on Air Quality Models. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

Holzworth, G. C. 1972. Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States. U.S. Environmental Protection Agency, Office of Air Programs, Research Triangle Park, North Carolina. Publication AP-101.

Utah State Department of Health. 1981. Ambient Particulate Concentrations Measured in Utah. Supplied by Robert Dalley, Utah Bureau of Air Quality.

ATTACHMENT I

CDMW

MAJOR PROGRAM REVISIONS

The CDMW version of CDM has been developed by the Wyoming Division of Air Quality with the purpose of making the model applicable to a rural environment.

The following is a description of the modifications made:

1. Stability class assignments

The original CDM meteorological input required data in the form of a Day-Night STAR. In association with the stability classification an analytical approximation to the curves of Pasquill and Gifford for the vertical dispersion function σ_z is used. The original CDM model computed the following σ_z dispersion parameters in association with the Day-Night STAR Input:

STAR Input Stability	Area Source σ_z - Stability	Point Source σ_z - Stability
A	A	A
B	A	B
C	B	C
D-Day	C	D
D-Night	D	D
E&F	D	D

For area sources the assumption was made that the lower layer of the atmosphere is more unstable in the urban areas than in the corresponding rural area. The area source σ_z calculations were decreased by one stability class towards the unstable except for A stability which remained the same. In both the point and area source calculations, the dispersion parameter calculated was never calculated for a stable atmosphere. Even though the joint frequency input (STAR) was made for stable conditions, the program assumed the vertical dispersion function to be in the neutral or D stability class.

Modification: The program was modified to accept a straight 6 stability STAR program with no separation of D-Day and D-Night and the vertical dispersion parameters were associated with the STAR Input as follows:

STAR Input Stability	Area Source σ_z - Stability	Point Source σ_z - Stability
A	A	A
B	B	B
C	C	C
D	D	D
E	E	E
F	F	F

By making the above modification, each joint frequency function input in the STAR program was associated with the corresponding vertical dispersion parameter developed for the stability class.

2. Plume Rise

The original CDM model incorporated the Briggs plume rise for neutral-unstable conditions as follows:

$$\Delta h = 1.6\ F^{1/3}\ u^{-1}\ x^{2/3} \qquad x \leq 3.5\ x^*$$
$$\Delta h = 1.6\ F^{1/3}\ u^{-1}\ (3.5\ x^*)^{2/3} \qquad x > 3.5\ x^*$$

$$x^* = 14\ F^{5/8} \qquad F \leq 55$$
$$x^* = 34\ F^{2/5} \qquad F > 55$$

where Δh = plume rise (meters)
$F = g\ V_s\ R_s^2\ [(T_s - T_a)/T_s]$
g = acceleration due to gravity (meter/sec^2)
V_s = exit velocity of gases of plume (meter/sec)
R_s = inner radius of stack (meters)
T_s = stack temperature (°K)
T_a = ambient temperature (°K)
U = wind speed at stack height (meter/sec)
X = distance from source to receptor

Briggs stable plume rise equations was not included in the original program as the stable classes was never assumed to exist.

The original program also had available the input of a plume rise calculated by the Holland plume rise equation. The product of the plume rise and wind speed could be input. Adjustment in the plume rise was made internally in the program by stability class. The adjustment was made as follows:

$$\Delta h = (1.4 - 0.1 \cdot S) \cdot \frac{PR}{U}$$

where Δh = plume rise (meters)
PR = product of plume rise and wind speed as calculated by the Holland equation (meters^2/sec)
U = wind speed at stack height
S = stability parameter
A stability = 1
B stability = 2
C stability = 3
D stability = 4
E stability = 5
F stability = 6

Modification: The program was modified to allow the calculation of plume rise in the stable conditions by incorporation of a Briggs stable plume rise formula. The Briggs neutral-unstable plume rise equations were also modified.

The following Briggs plume rise formula are incorporated in CDMW:

Neutral-Unstable Conditions

$$\Delta h = 1.6\ F^{1/3}\ u^{-1}\ x^{2/3} \text{ if } x \leq x^*$$

$$\Delta h = 1.6\ F^{1/3}\ u^{-1}\ x^{*2/3} \left[\frac{2}{5} + \frac{16}{25}\ \frac{x}{x^*} + \frac{11}{5}\left(\frac{x}{x^*}\right)^2\right]\left(1 + \frac{4}{5}\ \frac{x}{x^*}\right)^2$$

if $x^* < x \leq 5x^*$
if $x > 5x^*$; $x = 5x^*$

$$x^* = 2.16\ F^{2/5}\ h_s^{3/5}$$

where Δh = plume rise (meters)
$F = g\ V_s\ \frac{D_s^2}{4}\ \left[(T_s - T_a)/T_s\right]$
g = acceleration of gravity (9.8 m/sec^2)
V_s = exit stack gas velocity (m/sec)
D_s = inner diameter of stack (m)
T_s = stack gas temperature (^{o}K)
T_a = ambient temperature (^{o}K)
u = wind speed at stack height (m/sec)
x = distance between source and receptor (m)
h_s = physical stack height (m)

Stable Conditions

The following stable plume rise equations were considered for stable conditions:

(1) $\Delta h = 1.6\ F^{1/3}\ u^{-1}\ x^{2/3}$ $\quad x \leq 2.4\ u\ s^{-1/2}$

(2) $\Delta h = 2.4\left(\frac{F}{U\ S}\right)^{1/3}$ $\quad x > 2.4\ u\ s^{-1/2}$ final rise

(3) $\Delta h = 5.0\ F^{1/4}\ s^{-3/8}$ final rise

where the selection of final rise would be the lesser of the predicted values from equations (2) and (3) for light wind speeds. Since the minimum wind speed used is 1.5 m/sec, equation (2) always predicts a lower final rise than equation (3). Therefore, equations (1) and (2) are incorporated in CDMW for stable plume rise.

$$s = \frac{9.8}{T_a}\ \frac{d\theta}{d_z}$$

where $\frac{d\theta}{d_z}$ = 0.2 for E stability
= 0.035 for F stability

all other variables have been previously defined

It was also determined that the transition from equation (1) to equation (2) was not a smooth transition. The plume rise calculated by equation (1) at downwind distances approaching 2.4 u $s^{-1/2}$ was greater than the final rise calculated by equation (2).

The transition was made smooth by equating equations (1) and (2) and determining the downwind distance x where the plume rise predicted by equation (1) was equal to the final rise. The distance was found to be:

$$x\ PRIME = 1.837\ u\ s^{-1/2}$$

The program incorporates the above relationship to switch between equations (1) and (2) and makes a smooth transition to the final predicted rise.

No modifications were made in the Holland plume rise capability of CDM in CDMW.

3. Mixing Heights

The original CDM program had the following mixing heights associated with the Day-Night STAR input:

Stability	Mixing Height (meters)
A	1.5 · HT
B	HT
C	HT
D-Day	HT
D-Night	(HT + HMIN)/2
E&F	HMIN

where HT is the climatological mean value of the mixing height as tabulated by Holzworth and HMIN is the nocturnal mixing height.

Modification: Since stable conditions are allowed to occur in CDMW the mixing height scheme was modified in a manner somewhat similar to the VALLEY model. Mixing heights during stable conditions were set at a large value. The mixing height scheme used in CDMW is as follows:

Stability	Mixing Height (meters)
A	1.5 · HT
B	HT
C	HT
D	(HT + HMIN)/2
E	10,000
F	10,000

The assumption being that during stable conditions unlimited mixing occurs. It is difficult to account for diurnal, seasonal and annual variation in mixing heights, however, the above scheme is considered to be a better approximation for rural areas.

4. Initialization of σ_z for point sources

In the original CDM program, an initial value of the dispersion function σ_z (0) is used to represent the vertical dispersion created by urban roughness.

For point sources, the initial value of σ_z is a function of stack height according to the following scheme:

stack height	0-20m	σ_z (0)	= 30m
for stacks	20-50m	σ_z (0)	= 50 - H_s
for stacks	50m or greater	σ_z (0)	= 0

Modification: The CDMW program has the ability to override the initialization of σ_z for point sources. If the override option is chosen, the program will not calculate an initial σ_z (0) regardless of stack height. If the override option is not chosen, the σ_z (0) is calculated as in the original CDM program.

If a source is located in a rural area with a stack height which approaches good engineering practice stack height the initialization is overridden. The Division reviews each application of the model in regard to use of the initial σ_z (0) if stack heights are very short or the source is located in a large complex where possible downwash or increased vertical mixing may occur.

5. Area Source Dimension

The original CDM program was dimensioned to accept a 50 x 50 array of area sources.

Modification: The CDMW program is dimensioned to accept a 100 x 100 array of area sources.

6. Temperature Input

The original CDM program required ambient temperature and stack gas temperature for point sources to be input in °C.

Modification: The CDMW program requires all temperature inputs to be in °K.

7. Deposition Addition

The original CDM program provided only a half-life decay of pollutant concentrations.

Modification: The CDMW program has incorporated an area source deposition equation as presented by Pedco in the "Survey of Fugitive Dust from Coal Mines" February, 1978. The deposition equation is used for area sources only if a deposition velocity is coded on card type 3.

The deposition function has been added to the CDMW program, however, the Division does not recognize the equation and methods as being valid in fugitive emission modeling. The deposition feature is not being used by the Division. Future modification in this area will be made if the Division finds an acceptable method which would be compatible with the model.

8. Fixed STAR Input

The original CDM program required a meteorological deck input with each run.

Modification: The CDMW program contains the following STAR programs in block data. These STAR joint frequency distributions are called by city name or by other identifiers as follows:

Joint Frequency Distributions in Block Data

CHEYENNE
1 ROCK SPRINGS
2 ROCK SPRINGS
LARAMIE
RAWLINS
MOORCROFT
SHERIDAN
CASPER
FT. BRIDGER
CENTRAL CAMPBELL
NO. CAMPBELL

9. Model Output

Modification: The CDMW program has a modified output with the following features:

a) vertical dispersion parametric values printed
b) virtual distance to establish initial σ_z for area sources printed
c) method of area source pollutant removal printed
d) initial σ_z for point sources designated as incorporated or overridden
e) parameters for generating calibrated pollutant concentrations printed
f) joint frequency function identified by name
g) individual stability classes and total frequency summed and printed
h) title and pollutant description added
i) sources numbered and identified as point or area sources
j) total number of receptors processed printed
k) input parameters are printed out in fixed format

10. Error Messages

The CDM program did not provide any error messages for errors encountered during a run.

Modification: The CDMW program incorporates the following diagnostic messages:

1. RAT, TXX INCONSISTANT

From the definitions of the grid conversion parameters RAT · CV = TXX. If this identity does not hold within ± 0.01 for the values coded, the system computes RAT = TXX/CV and continues the run.

2. TOO MANY INTERVAL SPECIFIED

The maximum number of subsectors which can be assigned to each of the 16 wind direction sectors is 20 (DINT). If DINT is specified greater than 20, the message is issued and processing continues using 20 subsectors.

3. STACK TEMPERATURE MUST EQUAL OR EXCEED AMBIENT

If a stack gas temperature is found to be less than the ambient temperature input the above message is printed. After all sources are scanned, the run is terminated.

4. MORE THAN 100 RADIAL INCREMENTS REQUIRED FOR THIS RECEPTOR

The maximum number of radial increments permitted in crossing the area source grid is 100. The size of the increment is defined by DELR. If DELR is chosen too small to cross the defined grid as required for a particular receptor, the above message is printed and the contribution of the first 100 increments is applied to the receptor which follows the message in the tabulation.

5. AREA SOURCE EXTENDS TOO FAR WEST. (ADJUST XG?)

6. AREA SOURCE EXTENDS TOO FAR EAST. (INCREASE TXX?)

7. AREA SOURCE EXTENDS TOO FAR SOUTH. (ADJUST YG?)

8. AREA SOURCE EXTENDS TOO FAR NORTH. (INCREASE TXX?)

At least one of these messages is issued when an area source has been encountered which cannot be contained in the 100 x 100 cell grid. If the problem is not the result of a blunder, the adjustment indicated in parenthesis may be applied to correct the error. Since the loss of a specified source would likely invalidate the results of the run, processing terminates after the remainder of the source inventory has been read.

9. MORE THAN 200 POINT SOURCES SPECIFIED. END OF RUN

This message is issued after the source inventory has been processed if more than 200 point sources have been read. Because of the model storage constraints, only the first 200 will have been edited and stored and the run will terminate without processing any receptors.

10. UNEXPECTED END-OF-DATA ON CARD TYPE 1. END OF RUN

11. UNEXPECTED END-OF-DATA ON CARD TYPE 2. END OF RUN

12. UNEXPECTED END-OF-DATA ON CARD TYPE 3. END OF RUN

13. UNEXPECTED END-OF-DATA ON CITY CARD 4A. END OF RUN

14. SOURCE INVENTORY TERMINATOR NOT LOCATED. END RUN

15. NOT ENOUGH JOINT FREQUENCY CARDS (4B). END OF RUN

One of these messages will be issued if the expected data is not present when the procedure is executed. Since the required information for the run is not present, processing terminates immediately.

ATTACHMENT II

Attachment II

Fugitive Dust Emissions Inventory

Consolidation Coal-Coal Preparation Plant

Assumptions:

1. Worst case years are 1985-1987 (source: CONSOL)
2. Ratio of clean coal thru-put to raw coal thru-put = 0.9
3. Emission factors, unless otherwise noted, are taken from EPA Region VIII, 1979 and the Utah Bureau of Air Quality. These are referenced as (EPA VIII) and (Utah BAQ), respectively. (See references on last page.)

I. Emission Rates for Process Activity:

1. Existing Portal System-Portal Belt

from existing underground mine to transfer point

Thru-put = 2,000,000 tons/year (raw coal)

UEF = 0.02 lb/ton (Utah BAQ)

UER = (2,000,000 ton/year) (0.02 lb/ton) (ton/2,000 lb)
= 20.00 tons/year

control = none

control efficiency = 0%

CER = (20.00 tons/year) (1.0)
= 20.00 tons/year

2. Existing Portal System-Transfer Point

Thru-put = 2,000,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (2,000,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 20.0 tons/year

control = none

control efficiency = 0%

CER = (20.0 tons/year) (1.0)

= 20.0 tons/year

3. Existing Portal System-R.O.M. Transfer Belt

from transfer point to raw coal storage area

thru-put = 2,000,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (2,000,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)

= 20.0 tons/year

control = covered (partially enclosed)

control efficiency = 90% (EPA VIII)

CER = (20.0 tons/year) (0.1)

= 2.00 tons/year

4. Existing Portal System - Transfer Point

Thru-put = 2,000,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (2,000,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)

= 20.0 tons/year

control = totally enclosed and sprayed with water

control efficiency = 90% for enclosure (Utah BAQ)

50% for water (EPA VIII)

CER = (20.0 tons/year) (0.1) (0.5)

= 1.00 tons/year

5. <u>Deep Mine Facilities- Raw Coal Storage Belt</u>

Thru-put = 670,000 tons/year

from transfer point to Raw Coal Storage Area

UEF = 0.02 lb/ton (Utah BAQ)

UER = (670,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 6.70 tons/year

control = covered (partially enclosed)

control efficiency = 90% (EPA VIII)

CER = (6.70 tons/year) (0.1)
= 0.67 tons/year

6. <u>Deep Mine Facilities - Load in to Stockpile</u>

Thru-put = 670,000 tons/year

* UEF = 0.014 lb/ton (EPA VIII 1978)
assumed to be like product dumping

UER = (670,000 tons/year) (.014 lb/ton) (ton/2,000 lb)
= 4.69 tons/year

control = stacking tube (telescopic chute)

* control efficiency = 75% (EPA, 1978)

CER = (4.69 tons/year) (0.25)
= 1.17 tons/year

*Suggested by Fred Longenburger (EPA VIII)

7. <u>Deep Mine Facilities - Raw Coal Stockpile</u>

size of pile = 10,000 tons

radius = 81.25 ft (from Map 1)

angle of repose = 35° (Source: CONSOL)

$$\text{slant height} = \frac{81.25 \text{ ft}}{\cos 35^\circ} = 99.19 \text{ ft}$$

lateral area of a cone = 1/2 (perimeter of base) (slant height)

$$= 1/2\ (2\pi \cdot 81.25 \text{ ft})\ (99.19 \text{ ft})$$
$$= 25318.68 \text{ ft}^2$$

area in acres = (25318.68 ft^2) $(\text{acre}/43560 \text{ ft}^2)$
= 0.58 acres

Using the Universal Soil Loss Equation:

UEF = 0.025 IKCLV (EPA VIII)

I = soil erodibility factor

K = soil ridge roughness factor

C = localized climate factor

L = field width

V = vegetative cover

let K = L = V = 1 (worst case)

I = 38 (rocky gravelly soil)

$$C = \frac{(.345)\ u^3}{(PE)^2}$$

where u = mean windspeed in mph

= 10 (Utah State Climatologist)

PE = Thornthwaite's Precipitation-Evaporation Index

= 20 (AP-42)

$$C = \frac{(.345)\ (10^3)}{20^2} = 0.86$$

UEF = (0.025) (38) (1) (.86) (1) (1)
= 0.82 tons/acre-year

UER = (0.58 acres) (0.82 tons/acre-year)
= 0.48 tons/year

control = watering

control efficiency = 50% (EPA VIII)

CER = (0.48 tons/year) (0.5)

= 0.24 tons/year

8. Deep Mine Facilities - Reclaim System

Thru-put = 670,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ) same as transfer point

UER = (670,000 tons/year) (0.02 lb/ton) (ton/2,000 lbs)

= 6.70 tons/year

control = underground and watered

control efficiency = 80% underground (EPA 1977)
50% watering (EPA VIII)

CER = (6.70 tons/year) (0.2) (0.5)

= 0.67 tons/year

9. Deep Mine Facilities - Raw Coal Storage Belt

Thru-put = 1,330,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (1,330,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)

= 13.30 tons/year

control = covered (partially enclosed)

control efficiency = 90% (EPA VIII)

CER = (13.30 tons/year) (0.1)

= 1.33 tons/year

10. <u>Deep Mine Facilities - Load in to Stockpile</u>

Thru-put = 1,330,000 tons/year

UEF = 0.014 lb/ton (EPA VIII 1978)

UER = (1,330,000) (0.014 lb/ton) (ton/2,000 lb)

= 9.31 tons/year

control = stacking tube

control efficiency = 75% (EPA 1978)

CER = (9.31 tons/year) (0.25)

= 2.33 tons/year

11. <u>Deep Mine Facilities - 50,000-ton Stockpile Using Universal Soil-loss Equation</u>

radius assumed twice that of the 10,000 - ton stockpile
= (2)(81.25) = 162.5 ft

$$\text{slant height} = \frac{162.5 \text{ ft}}{\cos 35°} = 198.4 \text{ ft}$$

$$\text{Area} = 1/2\ (2\pi \cdot 162.5 \text{ ft})\ (198.4 \text{ ft})\ (\text{acre}/43560 \text{ ft}^2)$$

= 2.33 acres

UEF = 0.82 tons/acre-year (Calculation 7)

UER = (2.33 acres) (0.82 tons/acre-year)

= 1.91 tons/year

control = watering
control efficiency = 50% (EPA VIII)

CER = (1.91 tons/year) (.50)

= 0.96 tons/year

12. Deep Mine Facilities - Reclaim System

Thru-put = 1,330,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

assumed like transfer point

UER = (1,330,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 13.30 tons/year

control = underground and watered

control efficiency = 80% underground (EPA 1977)
50% watering (EPA VIII)

CER = (13.30 tons/year) (.20) (.50)
= 1.33 tons/year

13. Deep Mine Facilities - Reclaim Belt

Thru-put = 2,000,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (2,000,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 20.00 tons/year

control = covered (partially enclosed)

control efficiency = 90% (EPA VIII)

CER = (20,000 tons/year) (0.1)
= 2.00 tons/year

14. Deep Mine Facilities - Transfer Point

Thru-put = 2,000,000 tons/year

UEF = 0.02 lb/ton

UER = (2,000,000 tons/year) (0.02 lb/ton) (ton/2,000 lbs)
= 20.00 tons/year

control = enclosed, watered

control efficiency = 90% for enclosure (Utah BAQ)

50% for water (EPA VIII)

CER = (20.00 tons/year) (0.1) (0.5)

= 1.00 tons/year

15. Future Surface Mine - Truck Dump (Bottom Dump)

Raw Coal Dumped = 890,000 tons/year

UEF = 0.02 lb/ton (EPA VIII)

UER = (890,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)

= 8.90 tons/year

control = watering

control efficiency = 50% (EPA VIII)

CER = (8.90 tons/year) (0.5)

= 4.45 tons/year

16. Future Surface Mine - Feeder Breaker (Primary Crushing)

Thru-put = 890,000 tons/year

UEF = 0.02 lb/ton (EPA VIII)

UER = (890,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)

= 8.90 tons/year

control = water spray and underground

control efficiency = 50% for water (EPA VIII)

80% for underground (EPA 1977)

CER = (8.90 tons/year) (0.5) (0.2)

= 0.89 tons/year

17. Future Surface Mine - Transfer Point

Thru-put = 890,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (890,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 8.90 tons/year

control = underground and watered
control efficiency = 80% for underground (EPA 1977)
50% for water (EPA VIII)
CER = (8.90 tons/year) (0.2) (0.5)
= 0.89 tons/year

18. Future Surface Mine - Storage Belt

Thru-put = 890,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (890,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 8.90 tons/year

control = covered (partially enclosed)
control efficiency = 90% (EPA VIII)

CER = (8.90 tons/year) (0.1)
= 0.89 tons/year

19. Future Surface Mine - Load in to Stockpile

Thru-put = 890,000 tons/year

UEF = 0.014 lb/ton (EPA VIII 1978)

UER = (890,000 tons/year) (0.014 lb/ton) (ton/2,000 lb)
= 6.23 tons/year

control = stacking tube
control efficiency = 75% (EPA 1978)

CER = (6.23 tons/year) (0.25)
= 1.56 tons/year

20. Future Surface Mine - 10,000-ton Stockpile

size of pile = 0.58 acres (Calculation 7)
UEF = 0.82 tons/acre-year (Calculation 7)

UER = (0.58 acres) (0.82 tons/acre-year)
= 0.48 tons/year

control = watering
control efficiency = 50% (EPA VIII)

CER = (0.48 tons/year) (0.5)
= 0.24 tons/year

21. Future Surface Mine - Reclaim System

Thru-put = 890,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ) same as transfer point

UER = (890,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 8.90 tons/year

control = underground and watered
control efficiency = 80% underground (EPA 1977)
50% watering (EPA VIII)

CER = (8.90 tons/year) (0.2) (0.5)
= 0.89 tons/year

22. <u>Future Surface Mine - Reclaim Belt</u>

Thru-put = 890,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (890,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 8.90 tons/year

control = covered (partially enclosed)
control efficiency = 90% (EPA VIII)

CER = (8.90 tons/year) (0.1)
= 0.89 tons/year

23. <u>Future Surface Mine - Transfer Point</u>

Thru-put = 890,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (890,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 8.90 tons/year

control = fully enclosed and watered
control efficiency = 90% for enclosure (Utah BAQ)
50% watering (EPA VIII)

CER = (8.90 tons/year) (0.1) (0.5)
= 0.45 tons/year

24. <u>Future Surface Mine - Transfer Belt</u>

Thru-put = 890,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (890,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 8.90 tons/year

control = covered (partially enclosed)
control efficiency = 90% (EPA VIII)
CER = (8.90 tons/year) (0.1) = 0.89 tons/year

25. <u>Future Surface Mine - Transfer Point</u>
Thru-put = 890.000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (890,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 8.90 tons/year

control = fully enclosed, watered
control efficiency = 90% for enclosure (Utah BAQ)
50% for water (EPA VIII)
CER = (8.90 tons/year) (0.1) (0.5)
= 0.45 tons/year

26. <u>Prep Plant System - Plant Feed Belt</u>
Thru-put = 2,890,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (2,890,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 28.9 tons/year

control = covered (partially enclosed)
control efficiency = 90% (EPA VIII)

CER = (28.9 tons/year) (0.1)
= 2.89 tons/year

27. Clean Coal System - Clean Coal Belt

Thru-put = 2,560,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (2,560,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 25.6 tons/year

control = covered (partially enclosed), 5-6% surface moisture
control efficiency = 90% for cover (EPA VIII)
50% mositure (Assumed by ERT)

CER = (25.6 tons/year) (0.1) (0.5)
= 1.28 tons/year

28. Preparation Plant - Dry Screening

Thru-put = 2,890,000 tons/year

UEF = 0.1 lb/ton (EPA VIII)

UER = (2,890,000 tons/year) (0.1 lb/ton) (ton/2,000 lb)
= 144.5 tons/year

control = fully enclosed
control efficiency = 90% (Utah BAQ)

CER = (144.5 tons/year) (0.1)
= 14.45 tons/year

29. Clean Coal System - Sampling System

Thru-put = 2,560,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ) like a transfer point

UER = (2,560,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 25.6 tons/year

control = fully enclosed, 5-6% surface moisture

control efficiency = 90% for enclosure (Utah BAQ)

50% for moisture (ERT)

CER = (25.6 tons/year) (0.1) (0.5)

= 1.28 tons/year

30. <u>Clean Coal System - Storage Belt</u>

Thru-put = 2,560,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (2,560,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)

= 25.6 tons/year

control = covered (partially enclosed), 5-6% surface moisture

control efficiency = 90% for cover (EPA VIII)

50% moisture (ERT)

CER = (25.6 tons/year) (0.1) (0.5)

= 1.28 tons/year

31. <u>Clean Coal System - Load in to Stockpile</u>

Thru-put = 2,560,000 tons/year

UEF = 0.014 lb/ton (EPA 1978)

UER = (2,560,000 tons/year) (.014 lb/ton) (ton/2,000 lb)

= 17.92 tons/year

control = stacking tube, 5-6% surface moisture

control efficiency = 75% for stacking tube (EPA VIII 1978)

50% for surface moisture (ERT)

CER = (17.92 tons/year) (0.25) (0.5)

= 2.24 tons/year

32. <u>Clean Coal System - 20,000-ton Stockpile</u>

radius = 100 ft

angle of repose = 35°

$$\text{slant height} = \frac{100\ \text{ft}}{\cos 35°} = 122.08\ \text{ft}$$

$$\text{surface area} = 1/2\ (2\pi \cdot 100\ \text{ft})\ (122.08\ \text{ft})\ (\text{acre}/43560\ \text{ft}^2)$$
$$= 0.88\ \text{acres}$$

UEF = 0.82 tons/acre-year (Calculation 7)

UER = (0.88 acres) (0.82 tons/acre-year)
= 0.72 tons/year

control = watering

control efficiency = 50% (EPA VIII)

CER = (0.72 tons/year) (0.5)
= 0.36 tons/year

33. <u>Clean Coal System - Front End Loader</u>

Thru-put = 2,560,000 tons/year

UEF = 0.014 lb/ton (EPA VIII 1978)
assumed to be truck load-in

UER = (2,560,000 tons/year) (0.014 lb/ton) (ton/2,000 lb)
= 17.92 tons/year

control = 5-6% surface moisture

control efficiency = 50% (ERT)

CER = (17.92 tons/year) (0.5)
= 8.96 tons/year

34. <u>Stoker Coal System - Stoker Belt</u>

Thru-put = 40,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (40,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 0.40 tons/year

control = covered (partially enclosed), 5-6% surface moisture
control efficiency = 90% for cover (EPA VIII)
50% for moisture (ERT)
CER = (0.40 tons/year) (0.1) (0.5)
= 0.02 tons/year

35. <u>Stoker Coal System - Load in to Storage Bin</u>

Thru-put = 40,000 tons/year

UEF = 0.0002 lb/ton (EPA VIII)

UER = (40,000 tons/year) (.0002 lb/ton) (ton/2,000 lb)
= 0.004 tons/year

control = enclosed, 5-6% surface moisture
control efficiency = 90% (EPA VIII)

CER = (0.004 tons/year) (0.1)
= 0.0004 tons/year

36. <u>Stoker Coal System - Load Out of Storage Bin</u>

Thru-put = 40,000 tons/year

UEF = 0.0002 lb/ton (EPA VIII)

UER = (40,000 tons/year) (0.0002 lb/ton) (ton/2,000 lb)
= 0.004 tons/year

control = enclosed, 5-6% surface moisture

control efficiency = 90% (EPA VIII)

CER = (0.004 tons/year) (0.1)

= 0.0004 tons/year

37. Stoker Coal System - Load Out Belt

Thru-put = 40,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (40,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)

= 0.4 tons/year

control = oil spray, 5-6% surface moisture

control efficiency = 80% for oil (EPA, 1978)

50% for moisture (ERT)

CER = (0.4 tons/year) (0.2) (0.5)

= 0.04 tons/year

38. Stoker Coal System - Truck Loading

Thru-put = 40,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ) like a transfer point

UER = (40,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)

= 0.4 tons/year

control = oil spray, 5-6% surface moisture

control efficiency = 80% for oil spray (EPA, 1978)

50% for moisture (ERT)

CER = (0.4 tons/year) (0.2) (0.5)

= 0.04 tons/year

39. <u>Refuse Facilities - Refuse Belt</u>

Thru-put = 275,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ)

UER = (275,000 tons/year) (0.02 lb/ton) (ton/2,000 lb)
= 2.75 tons/year

control = cover (partially enclosed), 7% surface moisture
control efficiency = 90% for cover (EPA VIII)
50% for moisture (ERT)
CER = (2.75 tons/year) (0.1) (0.5)
= 0.14 tons/year

40. <u>Refuse Facilities - Load in to Refuse Bin</u>

Thru-put = 275,000 tons/year

UEF = 0.0002 lb/ton (EPA VIII)

UER = (275,000 tons/year) (0.0002 lb/ton) (ton/2000 lb)
= 0.03

control = 7% surface moisture
control efficiency = 50% (ERT)

CER = (0.03 tons/year) (0.5)
= 0.02 tons/year

41. <u>Refuse Facilities - Truck Load in</u>

Thru-put = 275,000 tons/year

UEF = 0.02 lb/ton (Utah BAQ) like transfer point

UER = (275,000 tons/year) (0.02 lb/ton) (ton/2000 lb)
= 2.75 tons/year

control = 7% surface moisture

control efficiency = 50% (ERT)

CER = (2.75 tons/year) (0.5)
= 1.38 tons/year

II. Emissions from Traffic on Unpaved Roads:

$$EF = 0.6\ (0.81s)\ \frac{(S)^m}{30}\ \frac{(365-W)}{365}\ \frac{(n)}{4} \qquad \text{lb/VMT} \qquad \text{(EPA VIII)}$$

s = silt content of road in percent

S = vehicle speed in mph

W = mean annual days with >0.01" of rain

n = number of wheels

$$m = \begin{cases} 1 & \text{if } S \geqq 30 \\ 2 & \text{if } S < 30 \end{cases}$$

s = 10% (Utah BAQ)

W = 28 (Utah St. Climatologist)

S,n = variables

$$EF = \frac{(0.6)\ (0.81)\ (10)\ (337)}{(365)\ (4)}\ \frac{(S)^m}{30}\ n$$

$$= 1.122\ \frac{(S)^m}{30}\ n \qquad \text{lb/VMT}$$

1. Preparation Plant Employee Traffic

37 employees, 230 days/year

1-way distance ≅ (2400 ft) (mile/5280 ft) = 0.45 miles

n = 4 wheels

S = 15 mph (posted speed limit)

VMT = (37 employees) (2 trips/emp.-day) (0.45 miles/trip)
= 33.30 VMT/day

= (33.30 VMT/day) (230 days/year)

= 7659.0 VMT/year

UEF = 1.122 $(15/30)^2$ (4)

= 1.12 lb/VMT

UER = (7659.0 VMT/year) (1.12 lb/VMT) (ton/2,000 lb)

= 4.29 tons/year

control = water spray

control efficiency = 50% (EPA VIII)

CER = (4.29 tons/year) (0.5)

= 2.15 tons/year

2. <u>Truck Haulage From Clean Coal Stockpile to Paved Road</u>

Truck payload = 40 tons

Trips= clean coal production/40 tons

= (2,600,000 tons/year)/(40 tons/trip)

= 65,000 trips/year

1-way distance = (1500 ft) (mile/5280 ft) = 0.28 miles

n = 26 wheels

S = 15 mph

UEF = 1.122 $(15/30)^2$(26) = 7.29 lb/VMT

VMT = (65,000 trips/year) (2 runs/trip) (0.28 miles/run)

= 36,400 VMT/year

UER = (36,400 VMT/year) (7.29 lb/VMT) (ton/2,000 lb)

= 132.68 tons/year

control = watering

control efficiency = 50% (EPA VIII)

CER = (132.68 tons/year) (0.50)

= 66.34 tons/year

3. Truck Haulage From Stoker Coal Storage Bins to Paved Road

Truck payload = 40 tons

Trips/year = Stoker coal thru-put/40 tons

= (40,000 tons/year) / (40 tons/trips)

= 1000 trips/year

1-way distance = (2200 ft) (mile/5280 ft) = 0.42 miles

UEF = 7.29 lb/VMT (Calculation 2)

UMT = (1000 trips/year) (2 runs/trip) (0.42 miles/run)

= 840 VMT/year

UER = (840 VMT/year) (7.29 lb/VMT) (ton/2,000 lb)

= 3.06 tons/year

control = watering

control efficiency = 50% (EPA VIII)

CER = (3.06 tons/year) (0.50)

= 1.53 tons/year

4. Refuse Haulage From Refuse Bin to Paved Road

Scraper payload = 20 tons

Trips/year = Refuse production/20 tons

= (275,000 tons/year)/(20 tons/trip)

= 13,750 trips/year

1-way distance (unpaved) = (1700 feet) (mile/5280 ft)
= 0.32 miles

n = 4 wheels
S = 15 mph

UEF = 1.122 $(15/30)^2(4)$ = 1.12 lb/VMT

VMT = (13,750 trips/year) (2 runs/trip) (0.32 miles/run)
= 8800 VMT/year

UER = (8800 VMT/year) (1.12 lb/VMT) (ton/2,000 lb)
= 4.93 tons/year

control = water spray
control efficiency = 50% (EPA VIII)

CER = (4.93 tons/year) (0.50) = 2.47 tons/year

5. Refuse Haulage From Paved Road to Refuse Placement Area

1-way distance = (3400 ft) (mile/5280 ft) = 0.64 miles

UEF = 1.122 $(25/30)^2(4)$ = 3.12 lb/VMT

VMT = (13,750 trips/year) (2 runs/trip) (0.64 miles/run)
= 17,600 VMT/year

UER = (17,600 VMT/year) (3.12 lb/VMT) (ton/2,000 lb)
= 27.46 tons/year

control = water spray
control efficiency = 50% (EPA VIII)

CER = (27.46 tons/year) (0.5)
= 13.73 tons/year

III. Wind Erosion From Topsoil and Subsoil Stockpile Areas:

1. Topsoil From Prep Plant

Size of stockpile = 1.85 acres

UEF = 0.025 IKCLV (Calculation I 7)

I = 47 (topsoil)

K = L = V = 1 (worst case)

C = 0.86 (Calculation I 7)

UEF = 0.025 (47) (0.86)

= 1.01 tons/acre-year

UER = (1.85 acres) (1.0 tons/acre-year)

= 1.87 tons/year

control = revegetation

control efficiency = 75% (EPA VIII)

CER = (1.87 tons/year) (0.25)

= 0.47 tons/year

2. Topsoil in Slurry Area

Size of stockpile = 2.02 acres

UEF = 1.01 tons/acre-year (Calculation 1)

UER = (2.02 acres) (1.01 tons/acre-year)

= 2.04 tons/year

control = revegetation

control efficiency = 75% (EPA VIII)

CER = (2.04 tons/year) (.25)

= 0.51 tons/year

3. <u>Subsoil in Slurry Area</u>

Size of stockpile = 5.23 acres

UEF = 0.025 IKCLV (Calculation 1)

I = 38 (subsoil)

K = L = V = 1 (worst case)

C = 0.86 (Calculation 1)

UEF = 0.025 (38) (0.86)

= 0.82 tons/acre-year

UER = (5.23 acres) (0.82 tons/acre-year)

= 4.29 tons/year

control = revegetation

control efficiency = 75% (EPA VIII)

CER = (4.29 tons/year) (0.25)

= 1.07 tons/year

4. <u>Topsoil/Subsoil in Refuse Area</u>

Size of stockpile = 2.76 acres

UEF = 1.01 tons/acre-year (Calculation 1)

UER = (2.76 acres) (1.01 tons/acre-year)

= 2.79 tons/year

control = revegetation

control efficiency = 75%

CER = (2.79 tons/year) (0.25)

= 0.70 tons/year

V. Conversion Factors for Tons/Year to g/sec

1 ton/year = (1 ton/year) (2000 lb/ton) (454g/lb) (year/365 days) (day/24 hours) (hour/3600 sec)

= 0.0288 g/sec

IV. Summary of Fugitive Dust Emissions

Process	Uncontrolled Emissions (tons/year)	Controlled Emissions (tons/year)	Annual Controlled Emissions (g/sec)	24-Hour Controlled (g/sec)
I 1	20.00	20.00	0.576	1.966
2	20.00	20.00	0.576	1.966
3	20.00	2.00	0.058	0.197
4	20.00	1.00	0.029	0.099
5	6.70	0.67	0.019	0.066
6	4.69	1.17	0.034	0.115
7	0.48	0.24	0.007	0.007
8	6.70	0.67	0.019	0.066
9	13.30	1.33	0.038	0.131
10	9.31	2.33	0.067	0.229
11	1.91	0.96	0.028	0.028
12	13.30	1.33	0.038	0.131
13	20.00	2.00	0.058	0.197
14	20.00	1.00	0.029	0.099
15	8.90	4.45	0.128	--
16	8.90	0.89	0.026	--
17	8.90	0.89	0.026	--
18	8.90	0.89	0.026	--
19	6.23	1.56	0.045	--
20	0.48	0.24	0.007	0.007
21	8.90	0.89	0.026	--
22	8.90	0.89	0.026	--
23	8.90	0.45	0.013	--
24	8.90	0.89	0.026	--
25	8.90	0.45	0.013	--
26	28.90	2.89	0.083	0.197
27	25.60	1.28	0.037	0.087

Process	Uncontrolled Emissions (tons/year)	Controlled Emissions (tons/year)	Annual Controlled Emissions (g/sec)	24-Hour Controlled (g/sec)
28	144.50	14.45	0.416	0.983
29	25.60	1.28	0.037	0.087
30	25.60	1.28	0.037	0.087
31	17.92	2.24	0.065	0.154
32	0.72	0.36	0.010	0.010
33	17.92	8.96	0.258	0.618
34	0.40	0.02	0.000	0.001
35	0.004	0.0004	0.000	0.000
36	0.004	0.0004	0.000	0.000
37	0.40	0.04	0.001	0.001
38	0.40	0.04	0.001	0.003
39	2.75	0.14	0.004	0.009
40	0.03	0.02	0.001	0.001
41	2.75	1.38	0.040	0.088
II 1	4.29	2.15	0.062	0.098
2	132.68	66.34	1.911	4.501
3	3.06	1.53	0.044	0.096
4	4.93	2.47	0.071	0.158
5	27.46	13.73	0.395	0.881
III1	1.87	0.47	0.014	0.014
2	2.04	0.51	0.015	0.015
3	4.29	1.07	0.031	0.031
4	2.79	0.70	0.020	0.020
Total	714.51	190.54	5.491	13.444

REFERENCES

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Utah Bureau of Air Quality. 1981. Telephone Conversations with Montie Keller and Don Robinson.

ATTACHMENT III

VER 2 — W Y O M I N G   C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L — 81/

CONSOLIDATION COAL - ANNUAL IMPACT — RUN 1

ATMOSPHERIC POLLUTANTS MODELED: POLLUTANT 1-TSP POLLUTANT 2-

GEOMETRIC OPERATION PARAMETERS:

MINIMUM AREA SOURCE CELL X-COORDINATE (MAP GRID UNITS)	2.00
MINIMUM AREA SOURCE CELL Y-COORDINATE (MAP GRID UNITS)	2.50
UNIT MAP GRID CELL WIDTH (METRES)	1000.00
UNIT AREA SOURCE CELL WIDTH (METRES)	200.00
RATIO OF EMISSION GRID TO MAP GRID UNIT LENGTHS	.2000
SUBSECTORS FOR INTEGRATION WITHIN EACH 22.5 DEGREE SECTOR	8
ANGULAR WIDTH OF INTEGRATION SUBSECTORS (DEGREES)	2.813
RADIAL INTEGRATION INCREMENTS (METRES)	
DISTANCES FROM 0 TO 2500 METRES	150.00
DISTANCES FROM 2500 TO 5000 METRES	300.00
DISTANCES IN EXCESS OF 5000 METRES	600.00

METEOROLOGICAL OPERATION PARAMETERS:

AMBIENT ATMOSPHERIC TEMPERATURE (DEGREES KELVIN)	283.00
AVERAGE AFTERNOON MIXING HEIGHT (METRES)	2500.00
AVERAGE NOCTURNAL MIXING HEIGHT (METRES)	300.00
RATIO OF AVERAGE DAYTIME TO 24-HR EMISSION RATE	1.00
RATIO OF AVERAGE NIGHTIME TO 24-HR EMISSION RATE	1.00

CENTRAL WIND SPEEDS AT 10 METRE HEIGHT BY CLASS (METRES/SEC)
1: 1.50000 2: 2.45872 3: 4.47040 4: 6.92912 5: 9.61136 6: 12.51712

EXPONENTS FOR WIND SPEED PROFILES BY STABILITY CLASS
A: .10 B: .15 C: .20 D: .25 E: .25 F: .30

INITIAL SIGMA Z FOR AREA SOURCES BY STABILITY CLASS (METRES)
A: 20.00 B: 20.00 C: 20.00 D: 20.00 E: 20.00 F: 20.00

PARAMETRIC VALUES FOR THE VERTICAL DISPERSION FUNCTION

	'A' PARAMETERS			'B' PARAMETERS		
	>5000	500-5000	<500	>5000	500-5000	<500
A -	.0002539	.0002539	.0383000	2.0886000	2.0895000	1.2512000
B -	.0493600	.0493600	.1393000	1.1137000	1.1137000	.9467000
C -	.1154000	.1014200	.1120000	.9109000	.9260000	.9100000
D -	.7368000	.2591000	.0856000	.5642000	.6869000	.8650000
E -	1.2969000	.2527000	.0818000	.4421000	.6341000	.8155000
F -	1.5763000	.2017000	.0545000	.3602000	.6020000	.8124000

VIRTUAL DISTANCE TO ESTABLISH INITIAL SIGMA Z FOR AREA SOURCES (METRES)
A: 132.2 B: 189.9 C: 299.2 D: 559.7 E: 986.0 F:2070.9

AREA SOURCE POLLUTION REMOVAL WILL BE CALCULATED BY TIME DECAY METHOD.
HALF-LIFE (HOURS) TSP - 9999.00 - 9999.00

INITIAL SIGMA Z FOR POINT SOURCES AS A FUNCTION OF STACK HEIGHT WILL BE APPLIED.

PARAMETERS FOR GENERATING CALIBRATED POLLUTANT CONCENTRATIONS
TSP - CNST: 0. FCTR: 1.000000E+00 - CNST: 0. FCTR: 1.000000E+00

W Y O M I N G   C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

METEORCLOGICAL JOINT FRQUENCY FUNCTION AT HANKSVILLE

STABILITY CLASS A

SECTOR \ WIND SPEED	1	2	3	4	5	6
1	.0009500	.0002300	0.0000000	0.0000000	0.0000000	0.0000000
2	.0007500	.0001900	0.0000000	0.0000000	0.0000000	0.0000000
3	.0013200	.0003400	0.0000000	0.0000000	0.0000000	0.0000000
4	.0008000	.0003800	0.0000000	0.0000000	0.0000000	0.0000000
5	.0016900	.0005900	0.0000000	0.0000000	0.0000000	0.0000000
6	.0024200	.0010300	0.0000000	0.0000000	0.0000000	0.0000000
7	.0019500	.0006700	0.0000000	0.0000000	0.0000000	0.0000000
8	.0027000	.0022800	0.0000000	0.0000000	0.0000000	0.0000000
9	.0020000	.0007200	0.0000000	0.0000000	0.0000000	0.0000000
10	.0014300	.0005900	0.0000000	0.0000000	0.0000000	0.0000000
11	.0011000	.0003400	0.0000000	0.0000000	0.0000000	0.0000000
12	.0008700	.0004000	0.0000000	0.0000000	0.0000000	0.0000000
13	.0005700	.0001700	0.0000000	0.0000000	0.0000000	0.0000000
14	.0007500	.0002500	0.0000000	0.0000000	0.0000000	0.0000000
15	.0007000	.0001700	0.0000000	0.0000000	0.0000000	0.0000000
16	.0014700	.0003400	0.0000000	0.0000000	0.0000000	0.0000000

(.0304100)

STABILITY CLASS B

SECTOR \ WIND SPEED	1	2	3	4	5	6
1	.0055600	.0011200	.0006300	0.0000000	0.0000000	0.0000000
2	.0040100	.0011400	.0003200	0.0000000	0.0000000	0.0000000
3	.0063600	.0011000	.0005100	0.0000000	0.0000000	0.0000000
4	.0047000	.0014100	.0004900	0.0000000	0.0000000	0.0000000
5	.0089000	.0019000	.0007200	0.0000000	0.0000000	0.0000000
6	.0092200	.0035200	.0010000	0.0000000	0.0000000	0.0000000
7	.0115000	.0032200	.0008200	0.0000000	0.0000000	0.0000000
8	.0127500	.0043600	.0015000	0.0000000	0.0000000	0.0000000
9	.0132400	.0028700	.0011400	0.0000000	0.0000000	0.0000000
10	.0075200	.0023800	.0012200	0.0000000	0.0000000	0.0000000
11	.0073900	.0014700	.0006900	0.0000000	0.0000000	0.0000000
12	.0035000	.0008000	.0003000	0.0000000	0.0000000	0.0000000
13	.0044200	.0006700	.0003300	0.0000000	0.0000000	0.0000000
14	.0072500	.0013100	.0003600	0.0000000	0.0000000	0.0000000
15	.0090500	.0012900	.0005500	0.0000000	0.0000000	0.0000000
16	.0072900	.0012800	.0004000	0.0000000	0.0000000	0.0000000

(.1635400)

STABILITY CLASS C

SECTOR \ WIND SPEED	1	2	3	4	5	6
1	.0031400	.0016700	.0013500	.0001900	.0000200	.0000200
2	.0013900	.0010700	.0014700	.0003800	.0000200	0.0000000
3	.0027700	.0014100	.0012200	.0001900	.0000200	0.0000000
4	.0019300	.0009700	.0009500	.0000600	.0000200	0.0000000
5	.0025400	.0010700	.0007800	.0000400	0.0000000	0.0000000
6	.0027700	.0024200	.0022300	.0002700	0.0000000	0.0000000
7	.0037100	.0021700	.0021000	.0001300	.0000200	0.0000000
8	.0041200	.0029300	.0033300	.0007000	.0002500	.0000200
9	.0045900	.0019400	.0032700	.0010500	.0002300	.0000100
10	.0029100	.0015200	.0020000	.0021700	.0010300	.0000400
11	.0027200	.0015200	.0024000	.0016600	.0002500	.0000300
12	.0011900	.0009400	.0012800	.0005000	.0000600	0.0000000
13	.0018100	.0008800	.0007000	.0001000	0.0000000	0.0000000
14	.0032200	.0014100	.0021000	.0003400	0.0000000	0.0000000
15	.0045800	.0018800	.0021000	.0002300	.0000600	.0000200
16	.0034100	.0014500	.0014800	.0003200	.0000400	0.0000000

(.1120500)

METEOROLOGICAL JOINT FRQUENCY FUNCTION AT HANKSVILLE

STABILITY CLASS D

SECTOR \ WIND SPEED	1	2	3	4	5	6
1	.0019700	.0023200	.0051600	.0023600	.0006700	.0001700
2	.0008300	.0009900	.0035000	.0025000	.0006300	.0002900
3	.0013800	.0013900	.0033700	.0018500	.0006300	.0002700
4	.0008300	.0007200	.0011600	.0009100	.0001000	0.0000000
5	.0013000	.0007600	.0005000	.0001700	0.0000000	0.0000000
6	.0013400	.0012800	.0022000	.0006900	0.0000000	.0000400
7	.0017000	.0013100	.0025000	.0009700	.0001500	.0000400
8	.0019900	.0021700	.0048100	.0050600	.0014700	.0003200
9	.0017500	.0017900	.0035900	.0055800	.0014700	.0005300
10	.0010000	.0013700	.0062200	.0178100	.0095200	.0042800
11	.0011100	.0010800	.0044700	.0103000	.0042600	.0023600
12	.0009800	.0009500	.0025300	.0032900	.0003900	.0002900
13	.0012300	.0007800	.0021700	.0019600	.0004800	.0003200
14	.0013400	.0015400	.0049300	.0070600	.0021900	.0010800
15	.0027200	.0021300	.0055000	.0101600	.0032700	.0016600
16	.0019700	.0022800	.0038400	.0043400	.0017700	.0007600

(.2170800)

STABILITY CLASS E

SECTOR \ WIND SPEED	1	2	3	4	5	6
1	0.0000000	.0037300	.0034600	0.0000000	0.0000000	0.0000000
2	0.0000000	.0020200	.0020200	0.0000000	0.0000000	0.0000000
3	0.0000000	.0022300	.0016400	0.0000000	0.0000000	0.0000000
4	0.0000000	.0010500	.0004900	0.0000000	0.0000000	0.0000000
5	0.0000000	.0011800	.0003000	0.0000000	0.0000000	0.0000000
6	0.0000000	.0018600	.0005800	0.0000000	0.0000000	0.0000000
7	0.0000000	.0018500	.0008400	0.0000000	0.0000000	0.0000000
8	0.0000000	.0022200	.0013300	0.0000000	0.0000000	0.0000000
9	0.0000000	.0019400	.0018100	0.0000000	0.0000000	0.0000000
10	0.0000000	.0014800	.0025700	0.0000000	0.0000000	0.0000000
11	0.0000000	.0014700	.0031000	0.0000000	0.0000000	0.0000000
12	0.0000000	.0009500	.0014700	0.0000000	0.0000000	0.0000000
13	0.0000000	.0013500	.0016900	0.0000000	0.0000000	0.0000000
14	0.0000000	.0016900	.0029900	0.0000000	0.0000000	0.0000000
15	0.0000000	.0033900	.0048500	0.0000000	0.0000000	0.0000000
16	0.0000000	.0028200	.0024700	0.0000000	0.0000000	0.0000000

(.0626100)

STABILITY CLASS F

SECTOR \ WIND SPEED	1	2	3	4	5	6
1	.0467900	.0057900	0.0000000	0.0000000	0.0000000	0.0000000
2	.0229500	.0030400	0.0000000	0.0000000	0.0000000	0.0000000
3	.0335300	.0038100	0.0000000	0.0000000	0.0000000	0.0000000
4	.0180000	.0021300	0.0000000	0.0000000	0.0000000	0.0000000
5	.0298800	.0015800	0.0000000	0.0000000	0.0000000	0.0000000
6	.0193400	.0022500	0.0000000	0.0000000	0.0000000	0.0000000
7	.0214200	.0024500	0.0000000	0.0000000	0.0000000	0.0000000
8	.0165700	.0020000	0.0000000	0.0000000	0.0000000	0.0000000
9	.0194900	.0022300	0.0000000	0.0000000	0.0000000	0.0000000
10	.0105900	.0014500	0.0000000	0.0000000	0.0000000	0.0000000
11	.0141800	.0022000	0.0000000	0.0000000	0.0000000	0.0000000
12	.0157700	.0014100	0.0000000	0.0000000	0.0000000	0.0000000
13	.0117600	.0019100	0.0000000	0.0000000	0.0000000	0.0000000
14	.0191700	.0023900	0.0000000	0.0000000	0.0000000	0.0000000
15	.0459700	.0061300	0.0000000	0.0000000	0.0000000	0.0000000
16	.0362500	.0045600	0.0000000	0.0000000	0.0000000	0.0000000

(.4157000) (1.00139[illegible])

CONSOLIDATION COAL - ANNUAL IMPACT

EMISSION SOURCE INVENTORY

SOURCE	X COORDINATE (MAP UNITS)	Y COORDINATE (MAP UNITS)	SOURCE WIDTH (METRES)	EMISSION RATE FOR TSP (GRAMS/SEC)	SOURCE RATE FOR (GRAMS/SEC)	EMISSION HEIGHT (METRES)	STACK DIA (METRES)	STACK EXIT VELOCITY (M/SEC)	STACK GAS TEMPERATURE (DEGREES K)	PLUME FACTOR (M**2/S)
1: A	2.50	3.30	200.00	.08	0.00	7.00				
2: A	2.70	3.30	200.00	.15	0.00	7.00				
3: A	2.90	3.10	200.00	.08	0.00	7.00				
4: A	3.[illegible]	3.00	200.00	.08	0.00	7.00				
5: A	3.10	3.20	200.00	.08	0.00	7.00				
6: A	3.50	3.10	200.00	1.01	0.00	7.00				
7: A	3.70	3.10	200.00	1.36	0.00	7.00				
8: A	3.90	3.10	200.00	.73	0.00	7.00				
9: A	4.10	3.10	200.00	.01	0.00	7.00				
10: A	3.70	2.90	200.00	.36	0.00	7.00				
11: A	3.90	2.90	200.00	.18	0.00	7.00				
12: A	3.50	2.80	200.00	.01	0.00	7.00				

TOTAL INVENTORY: 12 AREA SOURCES 0 POINT SOURCES

VER 2 1. W Y O M I N G   C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L 81/08/2

CONSOLIDATION COAL - ANNUAL IMPACT RUN 1

G R O U N D   L E V E L   R E C E P T O R   P O L L U T A N T   C O N C E N T R A T I O N S

P1: TSP P2: (MICROGRAMS PER CUBIC METRE)

MAP COORDINATES		AREA		POINT		TOTAL		CALIBRATED		OBSERVED	
		P 1	P 2	P 1	P 2	P 1	P 2	P 1	P 2	P 1	P 2
0.00	6.00	.82	0.00	0.00	0.00	.82	0.00	.82	0.00	0	0
1.00	6.00	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0	0
2.00	6.00	1.58	0.00	0.00	0.00	1.58	0.00	1.58	0.00	0	0
3.00	6.00	2.30	0.00	0.00	0.00	2.30	0.00	2.30	0.00	0	0
4.00	6.00	2.07	0.00	0.00	0.00	2.07	0.00	2.07	0.00	0	0
5.00	6.00	1.03	0.00	0.00	0.00	1.03	0.00	1.03	0.00	0	0
6.00	6.00	1.08	0.00	0.00	0.00	1.08	0.00	1.08	0.00	0	0
7.00	6.00	.93	0.00	0.00	0.00	.93	0.00	.93	0.00	0	0
0.00	5.00	.94	0.00	0.00	0.00	.94	0.00	.94	0.00	0	0
1.00	5.00	1.80	0.00	0.00	0.00	1.80	0.00	1.80	0.00	0	0
2.00	5.00	2.30	0.00	0.00	0.00	2.30	0.00	2.30	0.00	0	0
3.00	5.00	2.88	0.00	0.00	0.00	2.88	0.00	2.88	0.00	0	0
4.00	5.00	2.70	0.00	0.00	0.00	2.70	0.00	2.70	0.00	0	0
5.00	5.00	1.52	0.00	0.00	0.00	1.52	0.00	1.52	0.00	0	0
6.00	5.00	1.31	0.00	0.00	0.00	1.31	0.00	1.31	0.00	0	0
7.00	5.00	.37	0.00	0.00	0.00	.37	0.00	.37	0.00	0	0
1.50	4.50	2.03	0.00	0.00	0.00	2.03	0.00	2.03	0.00	0	0
2.50	4.50	3.92	0.00	0.00	0.00	3.92	0.00	3.92	0.00	0	0
3.50	4.50	3.68	0.00	0.00	0.00	3.68	0.00	3.68	0.00	0	0
4.50	4.50	2.71	0.00	0.00	0.00	2.71	0.00	2.71	0.00	0	0
5.50	4.50	1.63	0.00	0.00	0.00	1.63	0.00	1.63	0.00	0	0
0.00	4.00	1.34	0.00	0.00	0.00	1.34	0.00	1.34	0.00	0	0
1.00	4.00	1.87	0.00	0.00	0.00	1.87	0.00	1.87	0.00	0	0
2.00	4.00	3.46	0.00	0.00	0.00	3.46	0.00	3.46	0.00	0	0
2.50	4.00	5.08	0.00	0.00	0.00	5.08	0.00	5.08	0.00	0	0
2.80	4.00	6.08	0.00	0.00	0.00	6.08	0.00	6.08	0.00	0	0
3.50	4.00	10.06	0.00	0.00	0.00	10.06	0.00	10.06	0.00	0	0
4.00	4.00	7.03	0.00	0.00	0.00	7.03	0.00	7.03	0.00	0	0
5.00	4.00	2.44	0.00	0.00	0.00	2.44	0.00	2.44	0.00	0	0
6.00	4.00	.79	0.00	0.00	0.00	.79	0.00	.79	0.00	0	0
7.00	4.00	.51	0.00	0.00	0.00	.51	0.00	.51	0.00	0	0
2.20	3.90	3.70	0.00	0.00	0.00	3.70	0.00	3.70	0.00	0	0
3.20	3.90	8.34	0.00	0.00	0.00	8.34	0.00	8.34	0.00	0	0
3.50	3.80	10.11	0.00	0.00	0.00	10.11	0.00	10.11	0.00	0	0
3.80	3.80	9.58	0.00	0.00	0.00	9.58	0.00	9.58	0.00	0	0
4.00	3.80	8.29	0.00	0.00	0.00	8.29	0.00	8.29	0.00	0	0
4.20	3.80	6.76	0.00	0.00	0.00	6.76	0.00	6.76	0.00	0	0
4.50	3.80	4.78	0.00	0.00	0.00	4.78	0.00	4.78	0.00	0	0
4.70	3.70	3.33	0.00	0.00	0.00	3.33	0.00	3.33	0.00	0	0
1.00	3.50	3.31	0.00	0.00	0.00	3.31	0.00	3.31	0.00	0	0
2.00	3.50	4.62	0.00	0.00	0.00	4.62	0.00	4.62	0.00	0	0
4.30	3.50	2.52	0.00	0.00	0.00	2.52	0.00	2.52	0.00	0	0
5.50	3.50	1.54	0.00	0.00	0.00	1.54	0.00	1.54	0.00	0	0
2.00	3.30	5.59	0.00	0.00	0.00	5.59	0.00	5.59	0.00	0	0
4.00	3.20	3.49	0.00	0.00	0.00	3.49	0.00	3.49	0.00	0	0
0.00	3.00	1.66	0.00	0.00	0.00	1.66	0.00	1.66	0.00	0	0
1.00	3.00	2.10	0.00	0.00	0.00	2.10	0.00	2.10	0.00	0	0
2.00	3.00	5.20	0.00	0.00	0.00	5.20	0.00	5.20	0.00	0	0
5.00	3.00	3.24	0.00	0.00	0.00	3.24	0.00	3.24	0.00	0	0
6.00	3.00	1.63	0.00	0.00	0.00	1.63	0.00	1.63	0.00	0	0

VER 2
1.

WYOMING CLIMATOLOGICAL DISPERSION MODEL 81/09/2

CONSOLIDATION COAL - ANNUAL IMPACT RUN 1

GROUND LEVEL RECEPTOR POLLUTANT CONCENTRATIONS

P1: TSP P2: (MICROGRAMS PER CUBIC METRE)

MAP COORDINATES		AREA		POINT		TOTAL		CALIBRATED		OBSERVED	
		P 1	P 2	P 1	P 2	P 1	P 2	P 1	P 2	P 1	P 2
7.00	3.00	.54	0.00	0.00	0.00	.54	0.00	.54	0.00	0	0
2.30	2.80	4.54	0.00	0.00	0.00	4.54	0.00	4.54	0.00	0	0
4.70	2.60	5.86	0.00	0.00	0.00	5.86	0.00	5.86	0.00	0	0
2.00	2.70	5.49	0.00	0.00	0.00	5.49	0.00	5.49	0.00	0	0
2.80	2.60	8.86	0.00	0.00	0.00	8.86	0.00	8.86	0.00	0	0
1.00	2.50	2.30	0.00	0.00	0.00	2.30	0.00	2.30	0.00	0	0
2.00	2.50	2.98	0.00	0.00	0.00	2.98	0.00	2.98	0.00	0	0
2.50	2.50	5.12	0.00	0.00	0.00	5.12	0.00	5.12	0.00	0	0
3.00	2.50	11.12	0.00	0.00	0.00	11.12	0.00	11.12	0.00	0	0
4.40	2.50	14.33	0.00	0.00	0.00	14.33	0.00	14.33	0.00	0	0
5.00	2.50	2.55	0.00	0.00	0.00	2.55	0.00	2.55	0.00	0	0
3.20	2.40	9.76	0.00	0.00	0.00	9.76	0.00	9.76	0.00	0	0
4.00	2.40	16.07	0.00	0.00	0.00	16.07	0.00	16.07	0.00	0	0
4.20	2.40	13.33	0.00	0.00	0.00	13.33	0.00	13.33	0.00	0	0
3.50	2.30	10.91	0.00	0.00	0.00	10.91	0.00	10.91	0.00	0	0
3.30	2.30	12.21	0.00	0.00	0.00	12.21	0.00	12.21	0.00	0	0
[illegible]	2.00	.90	0.00	0.00	0.00	.90	0.00	.90	0.00	0	0
1.00	2.00	1.22	0.00	0.00	0.00	1.22	0.00	1.22	0.00	0	0
2.00	2.00	2.89	0.00	0.00	0.00	2.89	0.00	2.89	0.00	0	0
2.50	2.00	5.64	0.00	0.00	0.00	5.64	0.00	5.64	0.00	0	0
3.00	2.00	5.70	0.00	0.00	0.00	5.70	0.00	5.70	0.00	0	0
3.50	2.00	7.48	0.00	0.00	0.00	7.48	0.00	7.48	0.00	0	0
4.00	2.00	8.74	0.00	0.00	0.00	8.74	0.00	8.74	0.00	0	0
4.50	2.00	7.97	0.00	0.00	0.00	7.97	0.00	7.97	0.00	0	0
5.00	2.00	7.04	0.00	0.00	0.00	7.04	0.00	7.04	0.00	0	0
5.50	2.00	1.70	0.00	0.00	0.00	1.70	0.00	1.70	0.00	0	0
7.00	2.00	1.26	0.00	0.00	0.00	1.26	0.00	1.26	0.00	0	0
1.00	1.50	2.06	0.00	0.00	0.00	2.06	0.00	2.06	0.00	0	0
2.00	1.50	3.26	0.00	0.00	0.00	3.26	0.00	3.26	0.00	0	0
3.00	1.50	8.41	0.00	0.00	0.00	8.41	0.00	8.41	0.00	0	0
4.00	1.50	4.88	0.00	0.00	0.00	4.88	0.00	4.88	0.00	0	0
5.00	1.50	4.46	0.00	0.00	0.00	4.46	0.00	4.46	0.00	0	0
[illegible]	1.50	.67	0.00	0.00	0.00	.67	0.00	.67	0.00	0	0
1.00	1.00	1.45	0.00	0.00	0.00	1.45	0.00	1.45	0.00	0	0
2.00	1.00	2.72	0.00	0.00	0.00	2.72	0.00	2.72	0.00	0	0
3.00	1.00	2.71	0.00	0.00	0.00	2.71	0.00	2.71	0.00	0	0
4.00	1.00	4.33	0.00	0.00	0.00	4.33	0.00	4.33	0.00	0	0
5.00	1.00	3.55	0.00	0.00	0.00	3.55	0.00	3.55	0.00	0	0
5.50	1.00	3.13	0.00	0.00	0.00	3.13	0.00	3.13	0.00	0	0
7.00	1.00	1.84	0.00	0.00	0.00	1.84	0.00	1.84	0.00	0	0
[illegible]	[illegible]	1.32	0.00	0.00	0.00	1.32	0.00	1.32	0.00	0	0
1.00	[illegible]	2.07	0.00	0.00	0.00	2.07	0.00	2.07	0.00	0	0
2.00	[illegible]	1.24	0.00	0.00	0.00	1.24	0.00	1.24	0.00	0	0
3.00	[illegible]	1.70	0.00	0.00	0.00	1.70	0.00	1.70	0.00	0	0
4.00	[illegible]	3.28	0.00	0.00	0.00	3.28	0.00	3.28	0.00	0	0
5.00	[illegible]	2.81	0.00	0.00	0.00	2.81	0.00	2.81	0.00	0	0
5.50	[illegible]	2.70	0.00	0.00	0.00	2.70	0.00	2.70	0.00	0	0
7.00	0.00	2.55	0.00	0.00	0.00	2.55	0.00	2.55	0.00	0	0

98 RECEPTORS PROCESSED

VER 2 W Y O M I N G C L I M A T O L O G I C A L D I S P E R S I O N M O D E L 81/
CONSOLIDATION COAL - 24 HOUR IMPACT RUN 3

ATMOSPHERIC POLLUTANTS MODELED: POLLUTANT 1-TSP POLLUTANT 2-

GEOMETRIC OPERATION PARAMETERS:

MINIMUM AREA SOURCE CELL X-COORDINATE (MAP GRID UNITS) 2.00
MINIMUM AREA SOURCE CELL Y-COORDINATE (MAP GRID UNITS) 2.50
UNIT MAP GRID CELL WIDTH (METRES) 1000.00
UNIT AREA SOURCE CELL WIDTH (METRES) 200.00
RATIO OF EMISSION GRID TO MAP GRID UNIT LENGTHS .... .2000

SUBSECTORS FOR INTEGRATION WITHIN EACH 22.5 DEGREE SECTOR 8
ANGULAR WIDTH OF INTEGRATION SUBSECTORS (DEGREES) 2.813
RADIAL INTEGRATION INCREMENTS (METRES)
DISTANCES FROM 0 TO 2500 METRES 150.00
DISTANCES FROM 2500 TO 5000 METRES 300.00
DISTANCES IN EXCESS OF 5000 METRES 600.00

METEOROLOGICAL OPERATION PARAMETERS:

AMBIENT ATMOSPHERIC TEMPERATURE (DEGREES KELVIN) 283.00
AVERAGE AFTERNOON MIXING HEIGHT (METRES) 2500.00
AVERAGE NOCTURNAL MIXING HEIGHT (METRES) 300.00
RATIO OF AVERAGE DAYTIME TO 24-HR EMISSION RATE 1.00
RATIO OF AVERAGE NIGHTIME TO 24-HR EMISSION RATE 1.00

CENTRAL WIND SPEEDS AT 10 METRE HEIGHT BY CLASS (METRES/SEC)
1: 1.50000 2: 2.45872 3: 4.47040 4: 6.92912 5: 9.61136 6: 12.51712

EXPONENTS FOR WIND SPEED PROFILES BY STABILITY CLASS
A: .10 B: .15 C: .20 D: .25 E: .25 F: .30

INITIAL SIGMA Z FOR AREA SOURCES BY STABILITY CLASS (METRES)
A: 20.00 B: 20.00 C: 20.00 D: 20.00 E: 20.00 F: 20.00

PARAMETRIC VALUES FOR THE VERTICAL DISPERSION FUNCTION

	'A' PARAMETERS			'B' PARAMETERS		
	>5000	500-5000	<500	>5000	500-5000	<500
A -	.0002539	.0002539	.0383000	2.0886000	2.0886000	1.2812000
B -	.0493600	.0493500	.1393000	1.1137000	1.1137000	.9467000
C -	.1154000	.1014000	.1120000	.9109000	.9260000	.9100000
D -	.7368000	.2591000	.0856000	.5642000	.6869000	.8650000
E -	1.2969000	.2527000	.0818000	.4421000	.6341000	.8155000
F -	1.5763000	.2017000	.0545000	.3602000	.6020000	.8124000

VIRTUAL DISTANCE TO ESTABLISH INITIAL SIGMA Z FOR AREA SOURCES (METRES)
A: 132.2 B: 189.9 C: 298.2 D: 559.7 E: 995.0 F:2070.9

AREA SOURCE POLLUTION REMOVAL WILL BE CALCULATED BY TIME DECAY METHOD.
HALF-LIFE (HOURS) TSP - 9999.00 - 9999.00

INITIAL SIGMA Z FOR POINT SOURCES AS A FUNCTION OF STACK HEIGHT WILL BE APPLIED.

PARAMETERS FOR GENERATING CALIBRATED POLLUTANT CONCENTRATIONS
TSP - CNST: 0. FCTR: 2.500000E-01 - CNST: 0. FCTR: 2.500000E-01

VER 2

W Y O M I N G   C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

METEORCLOGICAL JOINT FRGUENCY FUNCTICN AT W F 2.5

STABILITY CLASS A

SECTOR	WIND SPEED 1	2	3	4	5	6
1	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
2	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
4	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
5	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
6	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
7	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
8	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
9	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
10	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
11	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
12	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
13	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
14	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
15	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
16	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

(0.0000000)

STABILITY CLASS B

SECTOR	WIND SPEED 1	2	3	4	5	6
1	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
2	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
4	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
5	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
6	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
7	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
8	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
9	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
10	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
11	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
12	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
13	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
14	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
15	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
16	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

(0.0000000)

STABILITY CLASS C

SECTOR	WIND SPEED 1	2	3	4	5	6
1	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
2	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
4	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
5	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
6	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
7	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
8	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
9	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
10	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
11	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
12	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
13	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
14	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
15	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
16	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

(0.0000000)

METEORCLOGICAL JOINT FRGUENCY FUNCTION AT W F 2.5

STABILITY CLASS D

SECTOR \ WIND SPEED	1	2	3	4	5	6
1	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
2	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
4	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
5	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
6	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
7	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
8	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
9	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
10	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
11	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
12	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
13	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
14	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
15	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
16	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

(0.0000000)

STABILITY CLASS E

SECTOR \ WIND SPEED	1	2	3	4	5	6
1	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
2	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
4	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
5	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
6	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
7	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
8	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
9	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
10	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
11	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
12	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
13	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
14	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
15	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
16	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

(0.0000000)

STABILITY CLASS F

SECTOR \ WIND SPEED	1	2	3	4	5	6
1	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
2	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
3	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
4	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
5	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
6	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
7	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
8	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
9	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
10	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
11	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
12	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
13	0.0000000	1.0000000	0.0000000	0.0000000	0.0000000	0.0000000
14	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
15	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
16	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

(1.0000000) (1.0000000)

VER 2 W Y O M I N G C L I M A T O L O G I C A L D I S P E R S I O N M O D E L E1/

CONSOLIDATION COAL - 24 HOUR IMPACT RUN 3

E M I S S I O N S O U R C E I N V E N T O R Y

SOURCE	X COORDINATE (MAP UNITS)	Y COORDINATE (MAP UNITS)	SOURCE WIDTH (METRES)	RATE FOR TSP (GRAMS/SEC)	RATE FOR (GRAMS/SEC)	EMISSION HEIGHT (METRES)	STACK DIA (METRES)	STACK EXIT VELOCITY (M/SEC)	STACK GAS TEMPERATURE (DEGREES K)	PLUME FACTOR (M**2/S)
1: A	2.50	3.30	200.00	.18	0.00	7.00				
2: A	2.70	3.30	200.00	.24	0.00	7.00				
3: A	2.80	3.10	200.00	.18	0.00	7.00				
4: A	3.00	3.00	200.00	.18	0.00	7.00				
5: A	3.10	3.20	200.00	.18	0.00	7.00				
6: A	3.50	3.10	200.00	2.63	0.00	7.00				
7: A	3.70	3.10	200.00	2.99	0.00	7.00				
8: A	3.90	3.10	200.00	1.64	0.00	7.00				
9: A	4.10	3.10	200.00	.01	0.00	7.00				
10: A	3.70	2.90	200.00	.49	0.00	7.00				
11: A	3.90	2.90	200.00	.20	0.00	7.00				
12: A	3.50	2.80	200.00	.03	0.00	7.00				

TOTAL INVENTORY: 12 AREA SOURCES 0 POINT SOURCES

VER 2
1.

WYOMING CLIMATOLOGICAL DISPERSION MODEL 81/08/2

CONSOLIDATION COAL - 24 HOUR IMPACT RUN 3

GROUND LEVEL RECEPTOR POLLUTANT CONCENTRATIONS

P1: TSP P2: (MICROGRAMS PER CUBIC METRE)

MAP COORDINATES		AREA		POINT		TOTAL		CALIBRATED		OBSERVED	
		P 1	P 2	P 1	P 2	P 1	P 2	P 1	P 2	P 1	P 2
0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
1.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
5.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
5.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
7.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
1.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
5.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
6.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
7.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
1.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
5.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
[illegible]	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
1.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.30	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
5.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
6.00	4.00	2.81	0.00	0.00	0.00	2.81	0.00	.70	0.00	0	0
7.00	4.00	4.53	0.00	0.00	0.00	4.53	0.00	1.13	0.00	0	0
2.20	3.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3.20	3.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3.00	3.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3.00	3.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.20	3.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.00	3.80	1.00	0.00	0.00	0.00	1.00	0.00	.25	0.00	0	0
4.50	3.80	2.60	0.00	0.00	0.00	2.60	0.00	.65	0.00	0	0
4.70	3.70	6.49	0.00	0.00	0.00	6.49	0.00	1.62	0.00	0	0
1.00	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.00	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.30	3.50	37.19	0.00	0.00	0.00	37.19	0.00	9.30	0.00	0	0
5.00	3.50	99.69	0.00	0.00	0.00	99.69	0.00	24.92	0.00	0	0
2.00	3.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.80	3.20	250.24	0.00	0.00	0.00	250.24	0.00	62.56	0.00	0	0
[illegible]	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
[illegible]	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
5.00	3.00	166.89	0.00	0.00	0.00	166.89	0.00	41.72	0.00	0	0
5.00	3.00	136.67	0.00	0.00	0.00	136.67	0.00	34.17	0.00	0	0

VER 2
1.

W Y O M I N G   C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

81/08/2

CONSOLIDATION COAL - 24 HOUR IMPACT

RUN 3

G R O U N D   L E V E L   R E C E P T O R   P O L L U T A N T   C O N C E N T R A T I O N S

P1: TSP   P2:   (MICROGRAMS PER CUBIC METRE)

MAP COORDINATES		AREA P 1	AREA P 2	POINT P 1	POINT P 2	TOTAL P 1	TOTAL P 2	CALIBRATED P 1	CALIBRATED P 2	OBSERVED P 1	OBSERVED P 2
7.00	3.00	47.03	0.00	0.00	0.00	47.03	0.00	11.76	0.00	0	0
2.00	2.80	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.70	2.80	15.45	0.00	0.00	0.00	15.45	0.00	3.86	0.00	0	0
2.50	2.70	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.00	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
1.00	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.00	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.50	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3.00	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.00	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
5.00	2.50	1.09	0.00	0.00	0.00	1.09	0.00	.27	0.00	0	0
3.00	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.00	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.20	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3.50	2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3.00	2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
1.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3.50	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.50	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
5.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
5.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
7.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
1.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
5.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
5.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
5.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
7.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
0.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
1.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
5.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
5.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
7.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0

98 RECEPTORS PROCESSED