SECTION 20

MINING OPERATIONS

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20 MINING OPERATIONS

20.1 Mining Procedures and Techniques

Dragline stripping is the primary mining method used in the Permit Area for multiple coal seam mining. The typical sequence for multiple seam mining is as follows:

1. Vegetation and Topdressing removal (where it exists)
2. Drilling and blasting overburden
3. Overburden removal
4. Drilling and blasting coal
5. Coal removal
6. Drilling and blasting interburden
7. Interburden removal

Steps 6 and 7 are repeated for each additional mineable coal seam.

The coal seams in the Permit Area are exposed in pits ranging in width appropriate for the size of the dragline, in depths from 5 to 240 feet, and in lengths from 1,000 to 15,000 feet. Each pit is stripped by walking draglines in parallel cuts called "strips".

20.1.1 Vegetation and Topdressing Removal

Past soil investigations have revealed that Navajo Mine has only a negligible topsoil resource within its lease. As such, the material that is suitable for plant growth at Navajo Mine is considered a topsoil substitute. Materials to be used as topsoil substitute at Navajo Mine are denoted based upon their *in situ* location in the soil profile. The material found in the top 60 inches of the soil profile is called "topdressing", while the material found deeper than 60 inches in the soil profile is called "regolith".

Navajo Mine will salvage all suitable topdressing for use as topsoil substitute. The maximum extent of allowable disturbance in front of the pit is 1,800 feet beyond the extent of mining (i.e., highwall). Topdressing removal will precede pre-stripping activities where required or to facilitate mining activities where no pre-stripping is required, refer to Overburden Stripping Method in this section. The extent of topdressing removal will fully consider and comply with the applicable hydrology performance standards.

The defined extent of topdressing removal will facilitate the ability to utilize opportunistic direct live haul of topdressing, which may result in increased reclamation success. In addition, the defined extent offers greater flexibility in mining and equipment operations.

Navajo Mine currently has no in situ reserves for Areas 1 and 2. There is in-situ topdressing material remaining in Area 3 and 4 North. This material will be direct hauled to active reclamation areas whenever possible. Topdressing removal activities are conducted in opportunistic blocks that maximize the direct haul and respread of the topdressing into active reclamation plots.

Suitable regolith may be salvaged for use in reclamation as either topsoil substitute or root-zone material, or it may be spoiled if deemed necessary by the operator. Regolith in each resource area (1, 2, and 3) will be salvaged or spoiled depending on the need for topsoil or root-zone material in that specific resource area. Where practical and feasible, regolith that has been found suitable for use as topsoil substitute will be removed for use as topsoil substitute. A large quantity of topdressing and regolith has been salvaged and stockpiled, without segregation in Stockpiles LWR1_RG_N (Lowe Regolith Stockpile #9), LWR4_RG_N (Lowe Regolith Stockpile #10), and DXR1_RG_W (Dixon Regolith Stockpile #3). Regolith stored in these stockpiles has been adequately sampled and consist of materials that are considered suitable for use as topdressing substitute and root-zone material. Therefore, no further sampling and analysis will be required on regolith stored in these specific stockpiles.

If stockpiling of the topdressing and regolith is necessary in the future, the topdressing and regolith will be segregated and stockpiled in separate piles.

20.1.2 Topsoil Substitute - Topdressing Sampling

An intensive pre-salvage soil-sampling program is conducted to identify soil material suitable for topsoil substitute. The methodologies utilized in the sampling program are in part based on the Soil Resources of the Navajo Mine (Part 2 Section 14 – Soil).

Soils are sampled on a square grid basis at 200-foot centers. This spacing results in a sampling density of approximately one sample per acre. The density and location of sampling is based on conditions observed during the development of the detailed soil survey (Part 2 Section 14 – Soil). Badlands and Natrargids, which lack perennial vegetation, are typically unsuitable sources of topsoil substitute at the Navajo Mine; therefore they are not sampled. As personnel at Navajo Mine gain experience with the pre-disturbance sampling and salvage program, efforts will be made to refine the sampling density. Homogeneous mapping units will require less intensive sampling than heterogeneous mapping units. The proposed sampling density is designed to adequately sample the most heterogeneous mapping unit.

At each soil sample site, a pit is excavated to either an observable unsuitable layer (e.g., bedrock, paralithic contact, extreme clay accumulations, rock fragments, or extremely hard consistence) or to a depth of five feet. Five (5) feet is the maximum depth that Navajo Mine will allow personnel to sample within a pit. Depths of greater than 5 feet create a safety hazard because it exposes personnel to the possibility of

collapsing walls. Samples for analyses are taken by a soil scientist from representative soil horizons, except A and E horizons, if present, through the 5-foot profile. Each sample is described as to depth, dry consistence, texture, and other physical characteristics that aid in the classification of the material. Field notes for each sample and soil profile are collected and maintained on file at Navajo Mine. If it is not feasible to remove a sample of the unsuitable layer, the characteristics and depth of the layer are included as part of the field notes. Once an unsuitable layer of soil is identified, sampling does not continue below that depth.

Soil samples are sent to a soil analytical laboratory for the following analyses to determine topsoil substitute suitability.

1. pH
2. Electrical Conductivity (EC)
3. Soluble Ca, Mg, Na - Sodium Absorption Ratio (SAR)
4. Saturation percent
5. Texture
6. Extractable Selenium

The suite of parameters used to evaluate topsoil substitute suitability was revised based upon an analysis of historical sample data, conducted in December 2001, from more than 5,000 samples. This analysis provided the justification for eliminating carbonate percentage, acid-base potential, boron, and total selenium from the analytical suite. The justification showed that eliminating these parameters from analysis would not adversely affect the suitability of reconstructed soils or reclamation success.

The soils are analyzed using the methodology outlined in Table 20-1. Determination of topsoil substitute suitability is based on the OSMRE Topsoil And Topsoil Substitute Suitability Criteria For The Southwestern United States as presented in Table 20-2. Soils that have one or more characteristics that are rated unsuitable are not salvaged for use as topsoil substitute.

Each sampling location is identified in the field by survey lath marked with the pit identification number. A 1:6000 scale map is constructed showing the location of each sample point along with the assigned pit identification number.

Soil analyses received on a yearly cycle from 1 through June 30 will July be forwarded annually to the Office of Surface Mining on or before August 31. The analyses are filed with the corresponding pit identification number and sampling depth. A map showing the location of each sampling site and the field descriptions are also submitted.

20.1.3 Topsoil Substitute - Regolith Sampling

When regolith is to be used as topsoil substitute or root-zone material, it will be sampled in situ and must meet the suitability criteria as outlined in Table 20-2. Regolith will be analyzed for the parameters listed in Table 20-2. Sampling will be conducted with a drill rig using a core barrel auger in areas where the baseline soil survey and pre-strip topdressing survey indicate potential sources of suitable regolith below five feet. Soil samples will be collected in continuous five-foot intervals to bedrock, or the desired sampling depth, from drill holes located on 800-foot centers.

Stockpiled regolith located in Stockpiles LWRI RG N, LWR4 RG N, and DXR1 RG W has been adequately characterized and is considered suitable for use as topsoil substitute and root-zone material. No additional sampling and analysis will be required for regolith materials stored in these particular stockpiles.

Sampling and analysis data for *in situ* material will be submitted on or before August 31 of each year and will include information for the period between July 1 and June 30. After submission of sufficient representative data, an application may be made to OSM to reduce sampling density or eliminate it altogether

20.2 Major Mining Equipment

Table 20-3 lists typical major mining equipment used in the Permit Area at Navajo Mine. The pieces of equipment are subject to change during the permit period due to equipment outages and replacement schedules.

20.3 Coal Production

20.3.1 Overburden Drilling and Blasting

After the suitable topdressing material has been removed, rotary drills are used to drill overburden blast holes. Blast hole diameter ranges from 5 inches to 10-5/8 inches. Blast holes are typically drilled to the top of coal. To prevent coal shattering and accompanying coal loss from overburden blasting, blast holes are drilled until coal is encountered and backfilled with 1 to 10 feet of drill hole stemming. On some cast shots holes may be drilled to a specified elevation of three to seven feet above the coal seam and not backfilled to reduce coal loss due to the movement of the overburden over the coal seam.

Once the rotary drill has completed drilling a block of blast holes, the holes are then loaded with bulk explosives. ANFO or a mixture of ANFO and emulsions are the most widely used blasting agents; however, some slurries may be used in wet areas. The explosive column is detonated by a 1/2 to 3 pound primer initiated with either a non-electric detonating cord, an electric blasting cap, or an electronic blasting cap. Normally, to ensure proper blast sequencing, the shots are controlled using in-hole delays and/or surface delays.

20.3.2 Overburden Stripping Methods

Overburden and interburden material is primarily removed with walking draglines to expose the coal seam by taking parallel strips ranging in width appropriate for the size of the dragline. A minimum pit width of 100 feet is required to facilitate the mining equipment. The overburden is removed using the dragline in a series of blocks the length of which depends on the particular pit geometry. The material is spoiled into the previously mined out strip as shown in Figure 20-1.

Generally, two methods of stripping are employed. The first is conventional side casting, which is generally employed on the upper seams. The second is conventional spoil-side stripping, which is used on the lower seams. The geologic conditions, such as depth of coal and the number of coal seams, along with the size of dragline and basic configurations, determine the methods of stripping employed in any given pit.

In addition to the primary dragline stripping, dozers and trucks are utilized in overburden / interburden removal in conjunction with the dragline methods. Dozer and truck stripping is utilized to buffer inventory lows and to remove overburden in isolated areas where dragline stripping is not logistically practical (e.g. mesas, very short pit lengths, short pit extents, etc.). In addition, trucks and dozers are utilized on thin burdens where dragline operations are not effective (within dragline pits).

20.3.2.1 Typical Strip Layout

At the Navajo Mine, the pit names are also associated with area names such as; Area 1, Area 2 and Area 3. The progression of uncovered coal is in linear strips as shown on Exhibits 2-1 and 2-2. Pre-stripping is done in the deeper parts of Area 3 and Area 2 to keep the total pit depth for the dragline under 200 feet. Pre-Stripping is accomplished using a fleet of end-dump haul trucks and a front-end loader. Pre-Strip material will be removed in front of the active mining strip and placed in final grading areas. Information compiled from Exhibits 2-1 and 2-1 is on Table 20-4 (Areas Mined by Year). The table summarizes pit locations, mining sequences, start and end dates of mining and approximate acres disturbed.

Refer to Exhibit 2-1 for Area 2. The current active pits in this area are Hosteen/Yazzie and Yazzie Overlook. Pre-Stripping with a truck and loader fleet will occur for the entire area. Exhibit 2-2 provides specific stripping sequence by permit term year. Upon finishing the Hosteen/Yazzie and Yazzie Overlook pits, coal-mining activities in Area 2 will be complete.

For Area 3, refer to Exhibit 2-2. The current active pits in Area 3 are Lowe and Dixon pit. Exhibit 2-2 provides specific stripping sequence by permit term year. Pre-Stripping with a truck and loader fleet in Area 3 will continue 4 strips ahead of the active mining strip. Lowe pit will be mined out ahead of Dixon pit. Upon finishing Dixon pit, coal-mining activities in Area 3 will be completed.

For Area-4 North, refer to Exhibit 2-2. Area 4 North will become active in Pit development in Year 1 and will begin mining in Year 2. Area 4 North will remain active throughout the permit term. Upon finishing Area 4 North pit, coal-mining activities in Area 4 North will be complete.

20.3.3 Coal Removal

After the coal is exposed by the stripping operation it is drilled and blasted for subsequent mining. After a block of blast holes is drilled they are normally primed with a booster and detonating cord or non-electric blasting caps. Surface delays are used to ensure proper blast sequencing. Then the holes are loaded with ANFO, or in wet situations with an emulsion/ANFO blend or bagged slurry product. Thin coal seams are normally ripped with dozers rather than blasted. Once the coal is broken up it is mined by front-end loaders. The entire thickness of the coal seam is mined in one pass except where a major shale parting or coal quality makes a distinct division in the coal seam. In this case, the top part of the seam is mined by the front-end loader, then the parting is ripped by dozers and pushed into the adjoining spoil area. Finally the rest of the seam is mined with the front-end loaders. The face of the coal is generally across the width of the pit and is advanced evenly. The top of the coal is cleaned using small front-end loaders with the diluted coal piled on the spoil side of the pit.

Although operations at the Navajo Mine are engineered and designed to recover the maximum amount of coal, a small percent of coal is lost as coal wedges, coal ribs, and the top and bottom of coal seams. There are a number of operational and safety related conditions which necessitate limited coal losses. In general, two types of wedge losses occur; a wedge left on upper seams in multiple seam pits as a safety berm and a wedge left on spoil encroached seams as a spoil barrier. A small percent of coal may be lost on the top and bottom of the coal seam and as coal ribs due to the geologic condition of the coal and due to the equipment utilized in the stripping and mining sequences.

When mining multiple seams, upper seams are mined from benches where the bottom of coal elevation is higher than the toe of the spoil. When these conditions are encountered, a wedge of coal is typically left as a safety berm which prevents trucks and loaders from accidentally going over the highwall. Once the coal seam has been mined out, front-end loaders are used to recover as much of the wedge as possible.

When a seam is spoil encroached the coal wedge acts as a spoil barrier, contributing to spoil stability and reducing the occurrence of loose material rolling into the active pit. Both spoil slides and loose material rolling into the pit are potentially serious safety hazards. Once the seam has been mined out, front-end loaders are used to recover as much of the spoil-side wedges as safely possible.

A mine railroad system and a fleet of bottom-dump trucks constitute the coal haulage system. In most pits, the coal is loaded into the trucks which travel up the pit ramps to the major haul roads where the coal is stockpiled next to the rail system. Within an approximate 6.5 mile radius of the power plant the coal can be hauled directly from the pits to the processing plant.

At the stockpile front-end loaders are used to load the coal into rail cars for dumping at the processing plant. Normally, one electric locomotive pulls approximately 20 cars from the stockpiles to the processing plant.

Navajo Mine has a contract with the owners of the Four Corners Power Plant to provide coal for the power plant through the year 2016. The tonnage per year is subject to change depending on the Four Corners Plant's demand for power, the availability of the mining equipment and possible additional sales generated through future contracts. The anticipated tonnages to be mined from the Permit Area for the five fiscal years of the permit are discussed in this Section.

20.3.4 Annual Coal Production

Navajo Mine has a contract with the Four Corners Power Plant to provide coal for the power plant through July 2016, with the likelihood of extension beyond that date. Table 20-5 lists the anticipated tonnage to be mined from the entire lease for each fiscal year of the permit term and 5-year blocks beyond that time.

Each year's total tonnage may be subject to change depending on the Four Corners Plant's demand for power and availability of mining equipment. Exhibits 2-1 and 2-2 show the anticipated areas to be mined during the permit period.

20.3.5 Historic Coal Combustion By-Products Disposal

Between 1971 and January 2008 NTEC placed Coal Combustion Byproducts (CCB) from Four Corners Power Plant (FCPP) in mined-out pits or ramps at Navajo Mine. NTEC does not intend to use CCB materials for future reclamation within the permit boundary. The following permit text is maintained for historical context.

Under Navajo Mine's fuel supply contract with Arizona Public Service (APS), Navajo Mine accepted Coal Combustion Byproducts (CCB) or ash, from Four Corners Power Plant units 4 and 5 for disposal in final pits and ramps. CCB disposed of at Navajo Mine included: fly ash, scrubber sludge and bottom ash. In general, the major chemical constituents of CCB disposed of at Navajo Mine include: Silicon Dioxide (SiO_2), Aluminum Oxide (Al_2O_3) and Calcium Sulfite ($CaSO_3$) (see the Leach Study, Appendix 20.A).

Fly ash and bottom ash are generated by the combustion of coal at Four Corners Power Plant. The fly ash is collected in emission control baghouses. Fabric bags in the baghouses act as a filter removing the fly ash from the flue gas stream of units 4 and 5. Ash too large to be carried by the flue gas to the baghouse falls to the bottom of the boiler during the combustion process and is removed as bottom ash. Scrubber sludge is the byproduct of removing SO_2 from the flue gas. The SO_2 reacts with lime to form calcium sulfite and calcium sulfate.

20.3.5.1 Ash Disposal Areas

Historic Ash disposal locations at Navajo Mine through January 2008 on interim and permanent program areas are shown on Exhibit 20-1.

20.3.5.2 Ash Disposal Method

The haulage and disposal of CCB utilized any of the equipment listed in Section 11.4 of the PAP. Typically, ash was hauled in 85-ton end dump trucks and is dumped into the pit. A dozer was used to push ash into the backfilled pit and for dump site maintenance. When equipment or other needs dictate, a single lift or multiple lifts were used to backfill the pits and ramps. A grader and water truck were used to maintain the ash haul road and to control fugitive dust.

20.3.5.3 Ash Regulatory Compliance

In 1993 the United States Environmental Protection Agency (U.S.EPA) made a final regulatory determination that CCB are exempt from regulation as a hazardous waste under Subtitle C of the Resource Conservation and Recovery Act (RCRA, 58 FR 42466, August 9, 1993). In its regulatory determination, EPA concluded that the State or Tribal industrial solid waste management programs implemented under Subtitle D of RCRA were adequate regulatory controls for managing the disposal of CCB.

The Navajo Nation codified the Navajo Nation Solid Waste Act on 18 October 1990 (4 N.T.C. 101 as amended by the Navajo Nation Council Resolution No. CJY–51– 97) and finalized their regulations on February 1, 1999. The Navajo Nation Solid Waste Regulations specifically excludes CCB from the definition of a Solid Waste. Based on this exclusion, CCB are not regulated as a solid waste. In accordance with the following documents, NTEC had the right to dump CCB (ash) on leased premises. A mining lease between the Navajo Nation and NTEC (formerly known as BHP, Utah Construction Company) dated July 26, 1957 and the subsequent amendments. Resolution ACAP-43-68 of the Advisory Committee of the Navajo Tribal Council dated April 15, 1968, Approval of Resolution ACAP-43-68 by the Bureau of Indian Affairs dated May 15, 1968. Copies of these documents will be kept on the mine site at all times and may be reviewed by the regulatory authority upon request.

20.3.5.4 Coal Combustion By-Products Characteristics

A description of the physical and chemical properties of the CCB is contained in Appendix 20.A.

20.3.6 Waste Handling, Storage, Transportation, and Disposal

Coal waste materials are routinely cleaned up around the mine and coal plant then disposed of in the mine pit. Disposal of this material performed using end dump trucks with the material placed along the bottom of a pit adjacent to the wedge or spoil side. Coal not meeting contract specifications is disposed of in a mine pit.

20.4 Non-coal Mine Waste Disposal

Municipal trash from Navajo Mine operations is disposed of in the San Juan County Regional landfill (Appendix 20.B). This material is accumulated in dumpsters located around the site and transported to the landfill by a contractor.

Materials classified as hazardous by the Environmental Protection Agency (EPA) are accumulated, managed, and disposed of following applicable U.S. and Navajo Nation EPA (Appendix 20.C), Department of Transportation (DOT), and Office of Safety and Hazard Administration regulations. Non-hazardous materials that can be recycled or reused, are accumulated, managed, and recycled or reused following applicable EPA regulations. The nonhazardous materials that cannot be recycled or reused are accumulated, managed, shipped offsite and disposed of following applicable EPA and DOT regulations. Railroad ties are stored and reused on the mine site or offsite for landscaping. Railroad ties are not disposed of on the mine site. Ties that cannot be reused are disposed of following the applicable environmental standards.

20.5 Blasting Operations

Navajo Mine complies with the following laws governing the use of explosives where applicable:

- 26 CFR Part 181 "Commerce in Explosives",
- 30 CFR Part 77 "Mine Safety and Health Regulations"
- 30 CFR Part 816 "Permanent Program Performance Standards - Surface Mining Activities"

All blasting at the Navajo Mine is conducted under the supervision of OSM certified blasters. The blaster and one other person present at the firing of a blast and all personnel responsible for blasting operations will be familiar with the blasting plan and site specific performance standards.

All drill and blast designs will be approved by a certified blaster. The design will contain drill patterns, delay periods, tie in description, amount and type of explosives used, and pertinent data of the closest structure.

Navajo Mine will prepare and submit a comprehensive blasting plan before blasting within 1,000 feet of any building used as a dwelling, public building, school, church, or community or institutional building outside the Permit Area or within 500 feet of an active or inactive underground mine (see Section 34 – Post-Reclamation Topography). These blasting plans will be submitted to the regulatory authority 45 days prior to the blast occurring. Changes to these plans will be made if required by the regulatory authority.

The location of all the explosives handling and storage areas are shown on Exhibit 23-8.

20.5.1 Preblasting Survey

Navajo Mine notified in writing all known residents located within one-half mile of the Permit Area on how to request a pre-blast survey. All original pre-blast surveys were completed by February 28, 1986. Pre-blast surveys continue to be conducted as requested by new owners or new residents within ½ mile of the Permit Area. A list of all known residences within one-half mile of the Permit Area is included in Appendix 20.D. A map showing the blast areas described in the Public Blast Notice and the location of all known residences can be found on Exhibit 10-3.

20.5.2 Blasting Schedule

All blasting at the Navajo Mine shall conform to the blasting schedule as described in the Public Blast Notice except for emergency situations. Emergency situations warranting detonation outside the specified periods include any situation that constitutes a safety hazard to employees, a safety hazard to non-employees, and/or has the potential to damage equipment, mine or otherwise as a result of blasting.

The Public Blast Notice will be published at regular intervals which will not exceed 12 months, or at least 10 days but not more than 30 days before blasting when the information in the Public Blast Notice changes significantly. Copies of the Public Blast Notice will be distributed to local governments, public utilities, and each residence within one-half mile of the blasting area. A copy of the Public Blast Notice is shown in Appendix 20.E. Proof of publication of the Public Blasting Notice will be kept on the mine site at all times and may be reviewed by the regulatory authority upon request.

20.5.3 Blasting Signs, Warnings and Access Control

Conspicuous signs posted at all entrances to the Navajo Mine contain the following warning "WARNING! EXPLOSIVES IN USE" and lists the audible blast warning and the methods to control blast area access. In

addition, signs indicate that “Loaded holes are barricaded and marked with the warning: DANGER-EXPLOSIVES-KEEP OUT”.

Ten minutes before a blast, a short siren will be sounded for a period of five seconds. An audible blast warning consisting of a long wail siren is started five minutes before the blast. Thirty seconds before the blast, the siren is changed to a yelp. The all clear signal given after the blast area is cleared consists of a series of three, five second audible pulses, broken by five second intervals of silence between each pulse.

Access to the general area of blasting is controlled by posted signs, normally temporary signs reading "DANGER EXPLOSIVES - LOADED HOLES - NO UNAUTHORIZED ENTRY - CALL BLAST FOREMAN BEFORE ENTERING" or some equivalent message to warn the party reading the sign. Access to the immediate area of the blast is controlled by manned roadblocks that deny access to the area by unauthorized personnel. Access is denied at least five minutes prior to the actual explosion and not allowed until the area is cleared.

20.5.4 Control of Adverse Effects

Blasting at the Navajo Mine is conducted so that air blast does not exceed the prescribed limits listed in 30 CFR 816.67(b)(1)(i) at any dwelling, public building, school, church, or community or institutional building outside the Permit Area. Navajo Mine periodically monitors air blast to insure compliance with the standards. At least once per year a coal, interburden, overburden, pre-strip, and cast blast will be monitored for air blast if that type of blast is conducted within the year. All blasts that are monitored for ground vibration are also monitored for air blast.

All blasts at the Navajo Mine are designed so that fly rock does not travel more than one-half the distance to the nearest building or dwelling, beyond the blast area, or off the Permit Area.

Blasting is conducted so that the maximum ground vibration does not exceed the limits listed in 30 CFR 816.67(d)(2)(i) at the location of any dwelling, public building, school, church, or community or institutional building outside the Permit Area. To ensure that the maximum peak particle velocity for ground vibration is not exceeded, the scale-distance equation as described in 30 CFR 816.67(d)(3) is utilized.

Seismic monitoring will not be required when blasting is performed in accordance with the approved scale-distance equation, except for cast blasts which will all be monitored for ground vibration and air blast. When application of the approved scale-distance equation shows that the allowable peak particle velocity may be exceeded, seismic monitoring will be conducted using a seismograph. The data will be included in the blast report for this particular shot.

When blasting in the vicinity of outside pipelines and/or power lines, the peak particle velocity at that location will not exceed five inches per second (White Industrial Seismology, Inc., 1985). The vicinity of the pipeline and/or power lines is defined as any location that is less than 800 feet from the pipeline and/or power line. One of the following methods will be used to show that the peak particle velocity of five inches per second at the location of the pipelines and/or power lines is not exceeded:

1. A seismograph record will be kept for each blast within the vicinity of pipelines and/or power lines, or
2. A previously approved scale-distance factor for maximum peak particle velocities of less than five inches per second will be used when blasting in the vicinity of pipelines and/or power lines. The modified scale-distance factor is DS = 13. (for backup data please see Appendix 20.F).

It is not anticipated that structures other than those mentioned above will be encountered at the Navajo Mine. In the event that other structures are encountered, such as water towers, tunnels, dams, impoundments, underground mines, or other utilities, a maximum peak particle velocity limit will be developed to use in the vicinity of the structure. After obtaining regulatory authority approval, one of the above mentioned methods will be used to show that the maximum allowable peak particle velocity limit is not exceeded at the location of the structure.

The maximum airblast and ground vibration limits will not apply at structures owned by Navajo Mine and not leased to another person. There are no structures owned by Navajo Mine and leased to another person.

20.5.5 Blasting Records

All blasting data is recorded on blast reports which are retained for three years. Copies of sample blast reports are found in Appendix 20.F. Text discussing blasting report practices are also located in Appendix 20.F.

20.6 Combustibles and Coal Mine Waste Fire Control Plans

The Navajo Mine's mining operations do not generate any coal mine waste; therefore, no coal refuse piles have been constructed. Future plans do not require the construction of refuse piles, therefore, a MSHA coal mine waste fire control plan is not required, per 30 CFR 77.214 through 77.215(4).

Spoil fires caused by stripping sequence and spoiling methodology occasionally occur in the spoil rows and previously mined out areas of the pits. Coal spoil fires are controlled or extinguished by covering the burning spoil with non-coal spoil material to smother the fire. Coal spoil fires that cannot be covered, will be manipulated with a dozer to expose the coal spoil material allowing it to burn itself out.

If a coal stockpile fire occurs, the burning coal is removed from the pile and spread out on the ground away from the pile. The fire is smothered by back dragging the material by mine equipment or is left spread out to burn itself out.

Extinguishing operations will be initiated immediately after a coal spoil/stockpile fire is reported. Coal fires are carefully evaluated and deemed safe before equipment and personnel are allowed to enter the area for extinguishing operations. Only experienced personnel conduct extinguishing operations. Coal fires will be monitored until all evidence indicates that the fire has burned itself out or is extinguished.

To ensure safe working conditions all work areas are inspected each work shift by the supervisor in charge of the work area. An inspection log is maintained with follow-up actions for any unsafe conditions identified. This shift inspection is required by MSHA. Any potential fire hazard is identified and reported during this inspection by the on shift supervisor.

References

White Industrial Seismology, Inc. 1985. Letter report from David S. Bowley, consulting geophysicist, to George Gilfillan, blasting engineer, Navajo Mine, dated April 27, 1985. [Permit NM-0003C, Chapter 23, Appendix 23-D]

Table 20-1 Methods of Soil Analysis

Analysis	Method
pH	Page, A.L., Miller, R.H. and Keeney, D.R., eds. Methods of Soil Analysis, Part 2 - Chemical and Microbiological Properties. ASA Monograph No. 9, 2nd edition. Madison, Wisconsin: American Society of Agronomy; 1982. Methods 9-3.1.2, pp. 160-161.
Electrical Conductivity (EC)	Page, A.L., Miller, R.H. and Keeney, D.R., eds. Methods of Soil Analysis, Part 2 - Chemical and Microbiological Properties. ASA Monograph No. 9, 2nd edition. Madison, Wisconsin: American Society of Agronomy; 1982. Methods 9-3.1.2, pp. 160-161. Method 10-2.3.1,; pp 169. Method 10.3.3; pp 172. Richards, L.A., ed. Diagnosis and Improvement of Saline and Alkali Soils. USDA Handbook No. 60. Washington, D.C.: USDA; 1954. Method (4a), pp. 89.
Soluble Ca, Mg, Na	Extraction: USDA Handbook 60, Method 3a-Saturation Extract, pp. 84. Analysis: Inductively Coupled Argon Plasma Atomic Emission Spectrometer (ICP).
Sodium Adsorption Ratio (SAR)	Extraction: USDA Handbook 60, Method 3a-Saturation Extract, pp. 84. Analysis: Inductively Coupled Argon Plasma Atomic Emission Spectrometer (ICP). Equation: USDA Handbook 60, Method 20b - Estimation of Exchangeable Sodium - Percentage and Exchangeable - Potassium - Percentage from Soluble Cations, pp. 102.
Texture	EPA 300/2-78-054. Field and Laboratories Methods Applicable to Overburden and Mine Soils. Method 3.4.3.5, pg 122. Black, C.A., Evans, D.D., White, J.L., Ensminger, L.E., and Clark, F.E. ASA Monograph No. 9; Methods of Soil Analysis, Part One. Method 43-5, p. 562. ASTM D422-68.

Table 20-1 (Continued)

Analysis	Method
Saturation %	Miller, R.H. and Keeny, D.R., eds. Methods of Soil Analysis: Part 2 - Chemical and Microbiological Properties. ASA Monograph No. 9, 2nd edition. Madison, Wisconsin: American Society of Agronomy; 1982: Method G10.2.3 pp. 169. Richards, L.A., ed. Diagnosis and Improvement of Saline and Alkali Soils. USDA Handbook No. 60, Washington, D.C.: USDA; 1954. Method 27a, pp. 107.
Boron	Page, A.L., Miller, R.H., and Keeney, D.R., eds. Methods of Soil Analysis: Part 2 - Chemical and Microbiological Properties. ASA Monograph No. 9. 2nd Edition. Madison, Wisconsin: American Society of Agronomy; 1982. Method 25-9.1, pp. 443-444.
Soluble Selenium	Page, A.L., Miller, R.H., and Keeney, D.R., eds. Methods of Soil Analysis: Part 2 - Chemical and Microbiological Properties. ASA Monograph No. 9. 2nd Edition. Madison, Wisconsin: American Society of Agronomy; 1982. Method 25-9.1, pp. 443-444.
Total Selenium Bajo, Sixto.	Analytical Chemistry, Vol. 50(4), 649-651-1978, Modified.
CaCO3%	USDA. Handbook 60, 1954, Method 23c, pp. 105.
Neutralization Potential	USDA. Handbook 60, 1954, pp. 105, Methodology 23c. EPA 600/2-78-054. Field and laboratory methods applicable to overburden and mine soils method 3.2.3., pp. 47-50.
Erosion Factor	USDA-SCS. National Soils Handbook. July 1983. Method 603.2-1. pp. 603-29.
Coarse Fragment %	Montana Department of State Lands, Reclamation Division. Soils and Overburden Guidelines. 1983. Section 1, E.I.a., pp. 6. Wyoming DEQ, Land Quality Division. Guideline Soil, Topsoil, and Overburden. November, 1984. Section 1, B.5.d, pp. 5.
Total Sulfur	Field and Laboratory Methods Applicable to Overburdens and Mine soils. EPA 600/2-78-054, Method 3.2.6., 1978.

Table 20-1 (Continued)

Analysis	Method
Total Sulfur - Acid Base	Field and Laboratory Methods Applicable to Overburdens and Mine soils. EPA 600/2-78-054, Method 3.2.6. and 1.3.1., 1978. ASTM D 2492-84 with modification.
Sulfate Sulfur %	Field and Laboratory Methods Applicable to Overburdens and Mine soils. EPA 600/2-78-054, Method 3.2.6., 1978. Mine Spoil Potentials for Soils and Water Quality. EPA 670/2-74-070. Pg. 49.
Pyritic Sulfur %	ASTM D 2492-84 with modification. Field and Laboratory Methods Applicable to Overburdens and Mine soils. EPA 600/2-78-054, Method 3.2.6., 1978. Mine Spoil Potentials for Soils and Water Quality. EPA 670/2-74-070. Pg. 49.
Organic Sulfur %	ASTM D 2492-84 with modification. Field and Laboratory Methods Applicable to Overburdens and Mine soils. EPA 600/2-78-054, Method 3.2.6., 1978. Mine Spoil Potentials for Soils and Water Quality. EPA 670/2-74-070. Pg. 49.
Pyritic Sulfur Acid-Base	Field and Laboratory Methods Applicable to Overburdens and Mine soils. EPA 600/2-78-054, Method 1.3.1., 1978.
Pyritic Sulfur Acid-Base-Potential	Field and Laboratory Methods Applicable to Overburdens and Mine soils. EPA 600/2-78-054, Method 1.3.1., 1978.

Table 20-2 Navajo Mine Topsoil and Topsoil Substitute Suitability Criteria[1/2]

	Good	Marginal	Unsuitable
PH	6.0-8.4	5.5-6.0	< 5.5
		8.4-8.8	> 8.8
EC mmhos/cm[3]	< 4.0	4.0-12.0	> 12.0
SAR[4]			
sl & coarser	< 12.0	12.0-18.0	> 18.0
l & cl	< 10.0	10.0-16.0	> 16.0
40% clay	< 8.0	8.0-14.0	> 14.0
Texture	< 35% clay	<45% clay	>45% clay
Saturation %	20-80	20-80	< 20 - > 80
Coarse Fragments[5]			
< 3 inch %	0-15	15-35	> 35
> 3 inch %	0-3	3-10	> 10
Erosion Factor[6]	0.37	0.37	> 0.37
Selenium			
Extractable		0.15 ppm	> 0.15 ppm

1. These suitability criteria may be modified on a case-by-case basis if sufficient data are submitted to support the modifications and the submitted data technically represent the site-specific nature of the modification.
2. When spoil/overburden materials are used as topsoil substitute, then these materials must also be analyzed for total selenium concentration and acid-base potential (ABP). Analysis of these constituents is in addition to the parameters listed in this table. Materials that exceed 0.80 mg/Kg total selenium or have pyritic sulfur ABP < -5t/Kt are unsuitable for use as topsoil substitute.
3. When EC is < 2.0, then SAR cannot be > 18.
4. SAR values can be modified if adequate data is submitted to support proposed modifications.
5. Coarse fragment content will be determined from field ocular estimates. For topsoil substitutes/supplements, percentage can be increased if it is shown that the higher percentage will increase slope stability and/or vegetation establishment. Suitability will be determined on a site specific basis.
6. For each material proposed to reclaim slopes > 25% (4h:1v), a K factor must be determined from the results of appropriate physical and chemical analyses, as outlined in the National Soils Handbook (SCS, 1983). Material suitability will be determined using the Revised Universal Soil Loss Equation (Renard, ARS, 1990).

Table 20-3 Navajo Mine Typical Major Mining Equipment

Item	Quantity
Draglines	3
Overburden Drills	3
Coal Drills	1
Exploration Drill	0
Dozers	12
Rubber Tire Dozers	1
Large Front-end Loaders	7
Small Front-end Loaders	3
Graders	4
Scrapers	3
Coal Haulers	5
End Dumps	8
Mix Trucks	2
Water Trucks	3
Cable Reels	2
Shovels	0
Locomotives	5
Rail Road Cars	57
Stemming Truck	1

Table 20-4 Areas Mined by Year

Location Year	Area	Pit Name	Location Strip #	Approximate Acres Disturbed
1	Area 2	Hosteen / Yazzie	13-17	103
1	Area 3	Lowe	58-60	39
1	Area 3	Dixon	60-62	101
	Sub Total Year 1			**243**
2	Area 2	Hosteen/Yazzie	18-19	19
2	Area 2	Overlook	23-24	10
2	Area 3	Lowe	63-64	29
2	Area 3	Dixon	63-65	82
	Sub Total Year 2			**140**
3	Area 3	Lowe	65-66	29
3	Area 3	Dixon	66-68	76
3	Area 4N	Area 4N	OC-BC1	79
	Sub Total Year 3			**138**
4	Area 3	Lowe	67-68	28
4	Area 3	Corridor Road	1-2	17
4	Area 3	Dixon	69-71	76
4	Area 4N	Area 4N	BC2	22
	Sub Total Year 4			**143**
5	Area 3	Corridor Road	3-5	11
5	Area 3	Dixon	72-75	88
5	Area 4N	Area 4N	BC3, 1-5	85
	Sub Total Year 5			**184**
6-10	Area 3	Dixon	75-86	236
6-10	Area 4N	Area 4N	6-13	335
	Sub Total Years 6-10			**571**

* Table does not include pre-strip disturbance ahead of mining

Year 1 Commences Sept. 1, 2009

Table 20-5 Anticipated Tonnage to be Mined from Lease for Each Fiscal Year of the Permit

Fiscal Year	Estimated Production
2009	8,967,000
2010	8,629,000
2011	8,825,000
2012	8,571,000
2013	8,571,000
14-19	41,600,000
20-24	41,600,000
Total	126,763,000

TYPICAL STRIP LAYOUT

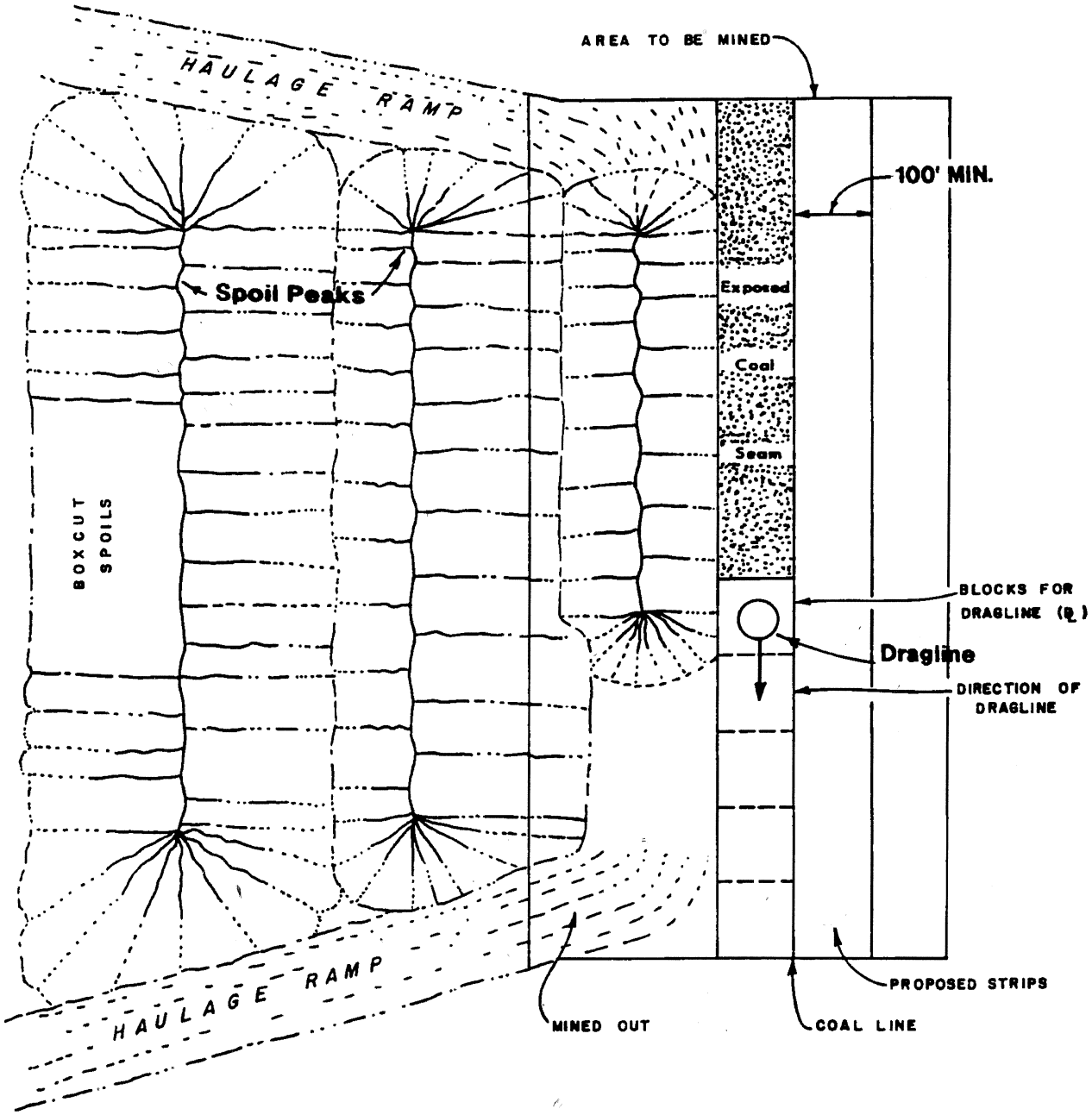


Figure 20-1

(7/98;3/99)

Dodge Pit

Ramp 3

Dodge Pit

Ramp 5

Custer Pit

Ramp 6

Custer Pit

Ramp 7

Bighan Pit

Ramp 8

NOTE :Pinto Pit disposal as of November 2007
Area will be updated following final disposal

Ramp 9

Bighan Pit

Ramp 10

Pinto Pit

Doby Pit

Ramp 12

Doby Pit

Ramp 14

0 625 1,250 2,500 3,750 5,000 Feet

Mine Lease

CCB Placement

Interim

Perm Program

N

Area-I

Area-II

Area-III

Area IV-N

Text

REV. No.	Date Submitted	DRAFT. BY	REVISION DESCRIPTION	ENG.	E.G.	PE
08-A	3-20-08	PJF	Updated Exhibit, added ash disposal in Ramp 3, eastside of Dodge Pit and submitted to OSM for Review	KA	YB	

APPROVALS

EXHIBIT 20-1

BHP NAVAJO COAL COMPANY

NAVAJO MINE SAFETY PAYS

P.O. BOX 1717 FRUITLAND, NEW MEXICO 87416

Historic Coal Combustion
Byproduct (CCB) Placement
Interim & Permanent Program Land

PREPARED BY	CKA	DRAWN BY	CKA	SCALE
APPROVED BY	CKA	DATE	12/07/07	

Appendix 20.A

Leach Study

Appendix 20.A

Leach Study

Due to reformatting of the Navajo Mine PAP, the following references in this appendix (formerly Appendix 27-B under NM-0003C; Appendix 11-K under NM-0003F paper permit) have been changed, deleted or renumbered:

NM-0003F Paper	NM-0003F Electronic
Exhibit 6-6	Exhibit 18-10
Chapter 5 Overburden	Part 2 Section 17
Chapter 6 Groundwater	Part 6 Section 42

LEACH STUDY

Due to reformatting of the Navajo Mine PAP, the following references in this appendix (formerly Appendix 27-B under NM-0003C) have been changed, deleted or renumbered:

NM-0003C Reference	NM-0003D Reference
Exhibit 12-1	Exhibit 6-6
CHAPTER 12	CHAPTER 6
CHAPTER 13	CHAPTER 7

LEACH STUDY

1. Description of Air Pollution Control System

The owners of the Four Corners Power Plant have been required by New Mexico Air Quality Control Regulations 504 and 602 to install new air pollution control equipment to reduce stack emissions of particulates and sulfur dioxide from Units 4 and 5 at the Four Corners Power Plant. The particulate control equipment was required to be operational on Units 4 and 5 by December 31, 1982, while sulfur dioxide removal equipment on Units 4 and 5 was to be operational by December 31, 1984. The solid wastes from these pollution control systems were to be disposed of in the Navajo Mine.

Unit 4 and 5 each was retrofitted with four baghouses for fly ash emission control. Each baghouse contains 4,968 bags, one foot in diameter and 32 feet long. These bags act much like a large filter. Fly ash lacen flue gas enters through the center of the bags and passes through the filter material to the outside. Fly ash is trapped on the inside surface of the bags and is knocked loose by intermittent reverse gas flow through the bags. Fly ash is collected in hoppers at the bottom of the baghouses and pneumatically conveyed to storage silos in the waste processing area. Collection efficiency from the flue gas is greater than 99.9 percent.

The fly ash-free flue gas then passes from the baghouses to SO_2 absorbers. Each unit has four operating absorbers and one spare. Each absorber is 40 feet in diameter and 98 feet high. Normally, 88 percent of the flue gas will be scrubbed; with the remainder bypassed for later recombination with absorber outflow gases to maintain temperature in this exit gas. Lime slurry is produced in slakers and sprayed into the absorbers. The SO_2 in the flue gas is absorbed in the resulting droplets and reacts with the lime to form calcium sulfite or calcium sulfate.

The slurry droplets are collected in the sump at the bottom of the tower and recycled to the spray nozzles for full utilization of the lime.

A portion of the slurry is blown down and goes to a 150-foot-diameter thickener where the solids are separated from the liquid. The overflow from the thickener, which is low in solids, is reused in the absorbers. The underflow, which is about 30 to 35 percent solids, is transferred to the waste processing area. There it is mixed with the fly ash to form a physically stable product for disposal. This mixture composes the sludge/fly ash mixture that was sampled as part of this study.

The underflow or sludge can either be mixed directly with the fly ash or further dewatered in the vacuum filters. The quantities of fly ash and sludge available determine how much additional dewatering is required. The sludge and/or filter cake is mixed with the fly ash in the pugmills and loaded onto the trucks for mine disposal. The addition of dry fly ash increases the overall solids content in the final product to 75 to 85 percent solids.

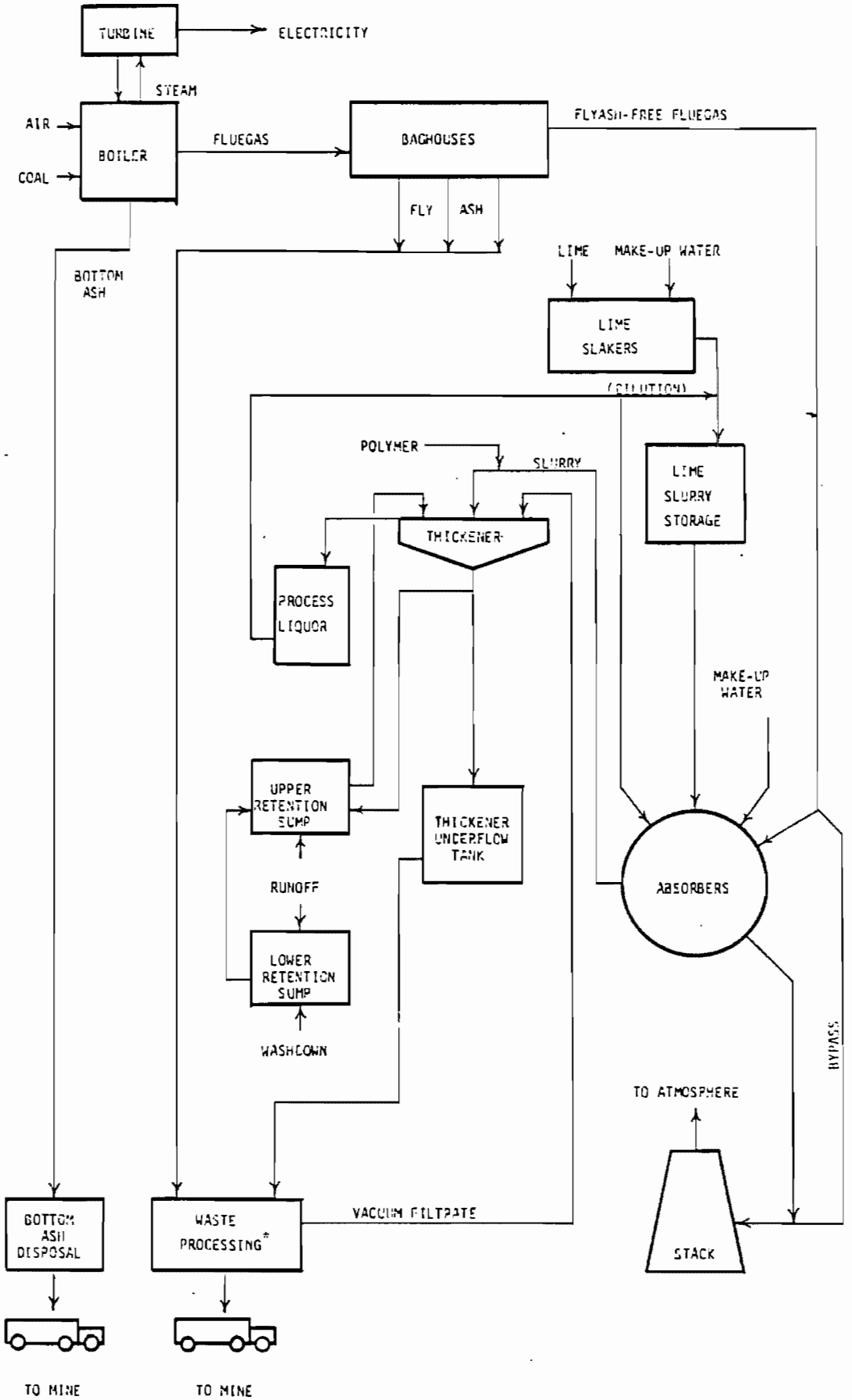
Figure 27-B1 illustrates the interrelation of the air pollution control equipment and describes the flow of wastes to the mine for disposal. Figure 27-B2 shows the details of waste handling in the waste processing area.

2. GEOCHEMICAL EVALUATION OF POWER PLANT WASTE DISPOSAL

2.1 Introduction

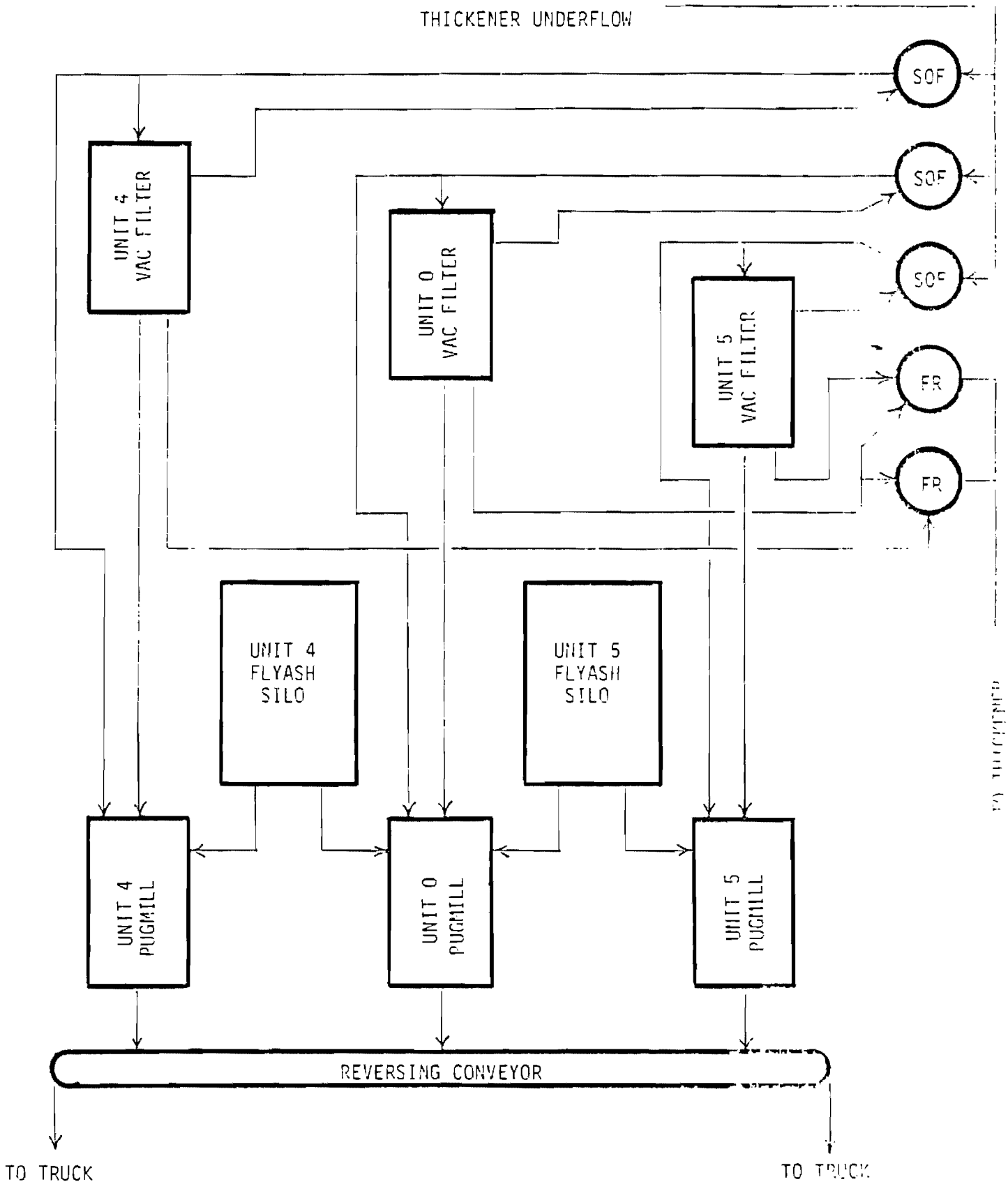
The geochemical evaluation of power plant waste disposal was conducted to quantify the interactions that would take place between the spoils, fly ash, bottom ash, sludge/fly ash, coals and the ground water. The interactions will take place as a result of concurrently burying the power plant wastes in the mined out pits as the mine progresses. The power plant wastes may ultimately be buried in mine pits throughout the

Figure 27-B1



*SEE SEPARATE DRAWING

Figure 27-B2


THICKENER UNDERFLOW
SOF
SOF
SOF
FR
FR
UNIT 4
VAC FILTER
UNIT 0
VAC FILTER
UNIT 5
VAC FILTER
UNIT 4
FLYASH
SILO
UNIT 5
FLYASH
SILO
UNIT 4
PUGMILL
UNIT 0
PUGMILL
UNIT 5
PUGMILL
REVERSING CONVEYOR
TO TRUCK
TO TRUCK

mine area. Waste is hauled from the power plant and placed in the pits by dump truck and covered with spoil material in successive layers to facilitate compaction, placement, access, and construction. With such placement over the long life of the mine and power plant, it can be assumed, for all practical purposes, that the power plant wastes will be evenly mixed with the spoil material as the pits are backfilled and reclaimed. Also, in the long term, after all mining and reclamation is complete and the ground water in the mine area has returned to its premine levels, the chemistry of the water will be determined by its long-term reactions with all the materials that it contacts in its slow migration toward discharge points such as the San Juan River.

The geochemical evaluation began by evaluating existing data for the mine site. These data included ground water and overburden analyses and information on coal geology. Prior to the beginning of the geochemical evaluation, the mine was already well understood with regard to ground water quantities and flow directions. Climatological data was also available along with infiltration studies (Stone, 1984) and in situ permeability data for the coal seams and overburden. Studies had also established that distinct areas within the mine had no ground water and other areas had limited ground water. Exhibit 12-1 notes the dividing line between areas with no saturation and areas with saturation as well as the potentiometric contours of ground water within the individual coal seams.

6-2-16-5

The sampling procedure used for the geochemical evaluation ensured that representative samples of all materials were obtained. All spoil and overburden samples were collected using the EPA guidance document SW 846 "Test Methods for Evaluating Solid Waste". This procedure, based on preliminary chemical analysis of the spoil/overburden, provided guidance on the number of aliquots per sample needed to provide statistical validity to both the sampling and subsequent analysis of the spoil/overburden. Samples were collected from all areas on the mine site.

Before water samples were collected, an evaluation of existing data from mine area wells was conducted to determine if their waters were the same or different chemically. After chemical review of the waters, a review of the geohydrological data in the mine was conducted to determine the relative quantities of the chemically different waters on the mine site. The locations of wells were also evaluated to assure that the well distribution could be representative for the entire mine site. Composite samples of chemically similar waters were collected and mixed in ratios to match their relative ratios within the mine. This was done in an effort to reduce the volume of samples to be analyzed and the batch leaching necessary for the geochemical evaluation.

Coal samples were taken at random from high walls where access was available. All coal seams being mined on the permit area were sampled. Power plant fly ash and bottom ash samples were taken at random from ash storage bins in the power plant. Power plant sludge/fly ash was collected at 12 different times during an eight-week period to establish consistent analytical data for the sludge/fly ash.

Procedures for the geochemical evaluation were divided into two categories: physical and analytical. Physical properties of all solid samples were determined. These properties included: unit weight, permeability, void ratio, porosity, grain size distribution, and moisture density relationships (ASTMD 698-78 Method A and/or ASTMD 4254-83, Method A).

Analytical procedures were conducted to determine the concentration levels within the solids and the water of various parameters listed by the State of New Mexico with regard to human health, irrigation use, other domestic uses, as well as for major ions.

After all analytical and physical testing was complete, batch leach testing of all the solids with all of the various ground waters and one surface water sample was conducted. In addition, mixtures of spoil and

power plant wastes, in their relative disposal ratios, were leached in the batch leaching process with the natural waters from the site. The batch leaching procedures accelerate the leaching process and determine in a short period of time what long-term contact between natural ground water, waste, and spoils will produce in terms of water chemistry. The resultant data from all testing was then evaluated to determine the net geochemical impact expected as a result of the power plant waste disposal at the mine site. The attenuation properties of the solid materials were also evaluated. In some instances, it was found that the addition of power plant waste leachates to existing ground waters actually made a net improvement in water quality.

Utilization of Existing Data

Existing data was used to assist in designing the program developed for geochemical evaluation of waste disposal for this project. Existing data were used to determine which sampling points would be most beneficial and which samples to collect in order to most closely approximate the conditions occurring at the mine site.

Ground water data presented in Chapter 12 was used to select ground water wells to be sampled as well as to determine which of the ground waters should be mixed to form the composite samples needed for analysis and batch leach testing. The samples were evaluated to determine which wells produced water that is chemically similar based on milliequivalent calculations of the ionic constituents. Relative quantities of water available from the various strata were also used to calculate compositing ratios. Chapter 12 provides data on ground water flow directions and quantities. The compositing utilized for sampling ground waters was determined to be as follows:

COMPOSITE NUMBER	WELL NUMBER	COMPOSITE RATIO
1	KF 84 SJ5	None
2*	KF 84 21 (b)	None
3	KF 84 22 (a)	None
4	KF 84 18 (a), (b)	50:50
5	KF 84 20 (a), (c)	58% of total
	KF 84 21 (a), (c)	
	KF 84 22 (b), (c), (d), (e)	42% of total

*Well yields from Well KF 84 21 (b) were not sufficient enough for the collection of the desired ten gallon ground water sample (i.e, only one gallon was obtained).

Overburden/spoil existing data presented in Chapter 11 (1981 interim permit application) was evaluated to determine where and how many samples should be collected to represent the spoil backfill material on the mine site. It was decided that two samples should be collected in the north area where movement of ground water to the San Juan River would be most likely to occur. An additional five samples were evenly distributed throughout the mine site Areas I, II and III (see Exhibit 27-B1). The two overburden samples in the north area had to be collected by drilling because the old mine pits in that area have been backfilled and it was no longer possible to collect samples from the backfilled spoil that would be representative of the different horizontal strata. The drill hole locations (see Exhibit 27-B1) were selected at sites that had not been mined so that a drill rig would be able to cut efficiently for sample collection.

The spoil sample locations were preselected on a map for even distribution. To decide the number of aliquots to collect for each spoil sample, the EPA guidance documents SW-846 "Test Methods for Evaluating Solid Waste" was used. The EPA requires that document preliminary data for the material to be sampled be available. Overburden data from the 1981

interim permit application was therefore analyzed prior to sampling to determine the number of aliquots per sample needed for statistical validity.

The parameter that showed the maximum number of aliquots per sample was selected as the controlling factor. The number of aliquots required was calculated from the mean of the parameter values and the standard deviation and the variance of sample data. Sulfate was the controlling parameter for the available data on overburden with the number of aliquots required at 176. Coal sample points (see Exhibit 27-B2) were selected from the available data on mine site geology as presented in Chapter 11.

Sampling

Overburden/spoil samples were collected by two methods in the field. Samples D-1 and D-2 were drill hole locations where samples were collected using a rotary drill. No drilling fluids were used. All cuttings from the drill were collected on a canvas placed adjacent to the drill hole. After the drill hole was extended to the top of the No. 8 coal seam, drilling was stopped and the cuttings on the canvas thoroughly mixed to represent backfill from the previous mining operations. A large sample (approximately 150 pounds) was then collected from the mixed drill cuttings.

Spoil samples S-1 through S-5 were collected using small scoops to pick up aliquots at random locations over an entire spoil pile area that was exposed near to or at the predesignated sample point. A total of 180 aliquots were collected for each sample over the selected sample area. In the process of collecting aliquots, care was taken to select as many variations of color, site, and particle size as were practical. The aliquots were collected in 30 small pails (6 aliquots per pail) and then dumped onto a canvas and thoroughly mixed before being placed in a large sample container. This procedure was followed for all five spoil samples. Collection of 180 aliquots rather than the calculated 176 was done to facilitate ease of collection.

The size of the spoil sample areas varied, depending upon access and available area adjacent to the predesignated sample points. The samples collected and the area covered at each sample location were as follows:

S-1	4,000 feet by 300 feet
S-2	2,000 feet by 1,000 feet
S-3	2,600 feet by 1,000 feet
S-4	2,200 feet by 200 feet
S-5	2,000 feet by 3000 feet

The large areas represented by the individual samples provided an opportunity for a wide range of the overburden material to be represented in the total sample and thereby improve its approximation of overall postmining conditions.

Coal samples were collected where random as mining operations provided an open pit and access to a coal seam. The pits were selected based on availability of access to a particular seam and the need to distribute the sample points so that field conditions in the seam would be best represented. A total of six coal seams were sampled. Two samples were collected from the No. 8 seam because it is the thickest seam in the mine, the most extensive, and also transmits water directly to the San Juan River. As a result, a total of seven coal samples were collected. A channel sample was collected at each coal sample point. A channel sample is where a pick is used to chip equal amounts of coal from each horizontal layer allowing the chips to fall onto a canvas spread at the base of the seam. These chips were mixed and the sample collected.

Ground water samples were collected in the field from the designated wells by airjet using a trailer-mounted air compressor. Ten gallon samples were collected in nalgen buckets or containers from which all mixing or compositing took place. Leaching samples were set aside for later use. Ground water samples so collected were immediately placed in sample bottles and preserved by the following methods:

PARAMETER	BOTTLE SIZE AND TYPE	PRESERVATIVE	CHILLED TO $4^{o}C$
Phenolics	1 liter amber glass	$CuSO_4$	Yes
	H_3PO_4 to pH $\leq$ 4		
Nitrate	1/2 liter plastic	H_2SO_4 to pH $\leq$ 2	Yes
Cyanide	1/2 liter plastic	H_2SO_4 to pH $\leq$ 2	Yes
Fluoride, Boron Sulfate, Chloride, TDS, Calcium, Mg, Na, K	1 liter plastic	NaOH to pH $\geq$12	Yes
Total Metals	1 liter glass	HNO_3 to pH $\leq$ 2	Yes

As the samples were collected, all bottles were rinsed with sample water, and the rinse discarded. The sample bottles were then filled completely with sample water, preservative added as appropriate, capped tightly, and placed inside a ziploc plastic bag. Both the bag and bottle were labeled with waterproof marker as to sample identification, preservative, and parameters for analysis. The bottles were then placed in large ice chests and cooled to 4 degrees Centigrade with ice prior to shipment to the IT laboratory in Knoxville, Tennessee.

A single ten gallon surface water sample was collected from Chinde Wash at the location shown on the attached map, Exhibit 27-B3. The sample was collected approximately 12 hours after the end of a significant thunderstorm when the flow in the stream was approximately one cubic foot per second (cfs). The surface water sample was taken and preserved using the same methods described above for ground water samples.

Fly ash and bottom ash were sampled concurrently with the water samples. A bottom ash sample (approximately 120 pounds) was collected from the

top of a waste bin as a grab sample. The bottom ash sample collected from a spot in the bin that appeared to have the same physical characteristics as the rest as bin ash material. Sampling of the bin was done when all equipment at the power plant was in continuous operation to ensure that a fresh sample was obtained. The fly ash sample was collected at the discharge point from a storage bin prior to the fly ash being wetted for dust suppression. Approximately 150 pounds of dry fly ash material was collected from the power plant. All of the fly ash material was observed to have the same physical characteristics. Combined sludge/fly ash samples could not be collected on this sample trip because the flue gas scrubbers were not yet operational. When the flue gas scrubbers did become operational, several weeks were allowed to pass before sampling began to ensure that all startup problems had been resolved in the operations. A total of 12 sludge/fly ash samples were collected periodically between December 1984 and February 4, 1985. The samples were collected by extracting sample portions from a belt discharge in the plant where trucks were loaded for disposal. A plastic bucket was passed through the waste stream several times over a period of approximately ten minutes. A total of approximately 120 pounds of sludge/fly ash was collected in this manner for each sample. The samples were sealed in water-tight plastic pails and shipped immediately to the IT laboratory in Knoxville, Tennessee. Upon arrival, the samples were thoroughly mixed to achieve consistency and subdivided for analytical and physical testing.

Sludge/fly ash analytical data were obtained for all 12 samples collected prior to beginning the batch leach testing. For the batch leaching, an aliquot of each of the 12 samples was collected and thoroughly mixed to form a composite sample. This composite was also submitted for analytical testing. By mixing the aliquots from 12 samples taken to form one composite sample for batch leaching, a single sample that was most representative of the actual sludge/fly ash material that is being placed in the pits for burial was produced. This process was used because it was desirable to account for any operational variances that might be occurring.

All of the data collected is presented in tabular form in this section. The tables are organized to show the data for all materials collected: spoil overburden, coal, waste, and water and the results of the batch leach testing. The batch leach testing data is also presented in tabular form so that it can readily be determined what interactions occurred when the various waters contacted different samples of solids.

Physical Testing

Physical testing was performed on all solids samples collected. Information determined included specific gravity, density, permeability, porosity, void ratio, grain size distribution, and moisture-density relationships. The moisture-density relationship provided information on the maximum dry density for the material at an optimum moisture content. The only information determined for the coals were density, specific gravity, and grain size distribution of the sample. The physical test data was used to predict travel times through the backfill materials. All physical data determined is presented in the back of this Appendix.

Chemical Testing

All wastes, spoils, and waters used in this study were analyzed for the chemical parameters listed in Table 27.B1. The table generally is divided into four categories of constituents based upon (1) human health standards; (2) standards for domestic water supply; (3) standards for irrigation waters; and (4) water type or major ionic constituents. These categories reflect the areas of concern in relation to preventing or minimizing impacts upon the hydrologic environment of the mine site and adjacent areas. Other parameters included on the data sheets were simply part of the total information obtained from the ICAP scan and are included here only to demonstrate the total analytical program conducted. Coal samples were also analyzed for these parameters. The coal samples, however, were not used in any of the batch leaching studies.

Table 27-B1

CHEMICAL SPECIES TO BE ANALYZED IN SOLIDS, WATER, AND EXTRACTS*

Human Health Standards

Arsenic (As)	0.5 mg/l	Lead (Pb)	.050 mg/l
Barium (Ba)	1 mg/l	Total Mercury (Hg)	2.0 μg/l
Cadmium (Cd)	.01 mg/l	Nitrate (NO_3 as N)	10 mg/l as N
Chromium (Cr)	.05 mg/l	Selenium (Se)	.01 mg/l
Cyanide (Cn)	0.2 mg/l	Silver (Ag)	.05 mg/l
Fluoride (F)	$\geq$1.7 mg/l variable		

Other Standards for Domestic Water Supply

Chloride (Cl)	250 mg/l	Phenols	0.3 mg/l
Copper (Cu)	1 mg/l	Sulfate (SO_4)	250 mg/l (desirable)
Iron (Fe)	.3 mg/l		
	1.0 mg/l (aquatic life)	Total Dissolved Solids (TDS)	500
Manganese (Mn)	.050 mg/l	Zinc (Zn)	5 mg/l
		pH	5-9 range

Standards for Irrigation Use

Aluminum (Al)	1.0 mg/l	Molybdenum (Mo)	.05 mg/l
Boron (B)	.75 mg/l	Nickel (Ni)	0.01 of 96-hr LC_{50} (aquatic life)
Cobalt (Co)	.2 mg/l		

Major Ions

Calcium (Ca)	(Water type, hardness)	Magnesium (Mg)	(water type, hardness)
Sodium (Na)	(water type)	Potassium (K)	(water type)
Alkalinity	(water type)		

*New Mexico Water Quality Control Commission Regulations, 1982.

Cation exchange capacities (CEC) were determined for all spoil and overburden samples. Since the cation exchange capacities resides primarily in clay minerals and colloidal particles, these values qualitatively indicate the mineralogical composition of the material analyzed. Also, the CEC provides a measure of the ability of the overburden/spoil material to attenuate the movement of cationic species through them.

Results of all analyses presented in Tables 27.B2 through 27.B9 were obtained in accordance with U.S. Environmental Protection Agency analytical procedures. The contractor doing the analytical work operates completely under an approved EPA QA/QC program. This included doing appropriate duplicate and spike samples for this project to ensure adequate QA/QC.

Statistical Evaluation of Data

Assuming that the 12 samples of sludge/fly ash collected as described in Section 2 are representative of sludge/fly ash produced under normal operating conditions, they may be used to infer the chemical composition of sludge/fly ash in the future. Because several of the chemical constituent concentrations exhibit a high degree of variability over the sampling period and accumulation prior to disposal of the sludge/fly ash does not occur after the point in processing where these samples were taken, inferences regarding the future chemical composition should be made regarding the population of means resulting from future similar sample collections. For the present purpose, it is useful to calculate that concentration below which a fixed portion, say 95 percent, of future mean chemical analysis will fall. Further, it is desirable to do so with a specified high degree of confidence, say 90 percent.

Table 27-B2

WATER ANALYSIS SUMMARY

PARAMETER	UNITS	SAMPLE IDENTIFICATION SURFACE WATER	COMPOSITE 1	COMPOSITE 2	COMPOSITE 3
General Chemistry:					
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	NA[3]	<1
Alkalinity	mg/ℓ $CaCO_3$	88	3,100	NA	940
Chloride	mg/ℓ	15	380	7.5	310
Cyanide	mg/ℓ	<0.02	<0.02	<0.01	<0.02
Fluoride	mg/ℓ	1.0	2.2	0.62	2.6
Nitrate	mg/ℓ NO_3-N	9.7	4.5	0.03	1.3
pH	--	7.80	8.80	11.98	8.70
Phenolics	mg/ℓ	<0.01	<0.01	0.07	0.01
Residue:					
Filterable @ 180°C	mg/ℓ	1,900	4,400	7,260	4,100
Specific Conductance	μmhos/cm @ 25°C	2,310	5,900	NA	6,000
Sulfate	mg/ℓ SO_4^{-2}	1,200	22	<1.0	1,500
Metals:					
Aluminum	mg/ℓ	0.69/0.75[2]	0.68	5.0	1.3
Arsenic	mg/ℓ	<0.001	0.004	<0.001	0.008
Barium	mg/ℓ	0.03/0.02	1.5	3.9	0.06
Boron	mg/ℓ	0.31	0.97	<0.01	0.20
Cadmium	mg/ℓ	<0.001/<0.002	<0.001/0.002	<0.004/0.004	0.002/0.002
Calcium	mg/ℓ	230	11	620	36
Chromium	mg/ℓ	0.002	0.001	0.14	0.006
Cobalt	mg/ℓ	<0.001/0.001	0.008/0.002	<0.01/<0.004	0.014/0.012
Copper	mg/ℓ	0.04/0.031	0.02/0.051	<0.02/0.029	<0.01/0.017
Iron	mg/ℓ	0.45	2.8	0.07	3.7/3.8
Lead	mg/ℓ	<0.01/<0.01	0.03/0.03	0.1	0.02/<0.01
Magnesium	mg/ℓ	28	3.6	0.8	4.5
Manganese	mg/ℓ	0.08	0.47	0.06	0.38
Mercury (Total)	mg/ℓ	<0.0002	<0.0002	<0.001	<0.0002
Molybdenum	mg/ℓ	<0.001	0.005	<0.05	0.003
Nickel	mg/ℓ	0.04	0.11	<0.01	0.07
Potassium	mg/ℓ	11	7.2	66	8.4
Selenium	mg/ℓ	<0.001	0.006	<0.018	0.014
Silver	mg/ℓ	<0.001/<0.002	<0.001/<0.002	<0.002	0.001/<0.002
Sodium	mg/ℓ	280	1,600	2,300	1,400
Zinc	mg/ℓ	0.06	0.07	0.04	0.08
Total Alpha	pCi/ℓ[4]	0.5±0.5	1.7±0.6	1.0±0.5	0.8±0.7
Total Beta	pCi/ℓ	4.7±4.7	4.2±4.1	5.2±4.5	4.0±4.3
Total Radium (226 and 228)	pCi/ℓ	0.3±0.6	0.3±0.6	0.5±0.7	0.2±0.5

(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION COMPOSITE 4	COMPOSITE 5
General Chemistry:			
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	510	940
Chloride	mg/ℓ	5,200	2,000
Cyanide	mg/ℓ	<0.02	<0.02
Fluoride	mg/ℓ	0.3	1.3
Nitrate	mg/ℓ NO_3-N	18	11
pH	--	8.20	9.50
Phenolics	mg/ℓ	0.04	0.02
Residue:			
Filterable @ 180°C	mg/ℓ	9,800	4,600
Specific Conductance	μmhos/cm @ 25°C	15,600	8,100
Sulfate	mg/ℓ SO_4^{-2}	120	55
Metals:			
Aluminum	mg/ℓ	<0.01	1.7
Arsenic	mg/ℓ	0.015	0.017
Barium	mg/ℓ	0.92	2.5
Boron	mg/ℓ	0.53	0.42
Cadmium	mg/ℓ	0.001	0.002/<0.001
Calcium	mg/ℓ	140	140
Chromium	mg/ℓ	0.008	0.034
Cobalt	mg/ℓ	0.035/0.034	0.017
Copper	mg/ℓ	<0.01	0.04
Iron	mg/ℓ	0.15	5.6
Lead	mg/ℓ	0.12	0.08
Magnesium	mg/ℓ	32	11
Manganese	mg/ℓ	0.03	0.70/0.70
Mercury (Total)	mg/ℓ	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.025	0.008/0.006
Nickel	mg/ℓ	0.11	0.04/0.04
Potassium	mg/ℓ	19	12
Selenium	mg/ℓ	0.011	0.020
Silver	mg/ℓ	<0.001/<0.002	0.015/<0.002
Sodium	mg/ℓ	3,500	1,600
Zinc	mg/ℓ	0.21/0.22	0.09
Total Alpha	pCi/ℓ[4]	1.9±0.5	<0.1
Total Beta	pCi/ℓ	4.0±3.7	3.9±3.9
Total Radium (226 and 228)	pCi/ℓ	0.4±0.6	0.4±0.6

(1) mg/ℓ = milligrams per liter or parts per million.
(2) The indicated sample was analyzed in duplicate.
(3) Not analyzed.
(4) pCi/ℓ = pico curies per liter.

Table 27-B3

ASH ANALYSIS SUMMARY

PARAMETER	UNIT	ASH FLY ASH (No Sludge)	ASH BOTTOM ASH
Acidity[1]	mg/kg $CaCO_3$	<100[3]	397
Alkalinity[1]	mg/kg $CaCO_3$	11,577	2,976
Chloride[1]	mg/kg	100	124
Cyanide	mg/kg	0.20	0.22
Fluoride	mg/kg	176	81
Nitrate[1]	mg/kg NO_3-N	<1	2
pH		NA[2]	NA
Phenolics	mg/kg	1.29	1.36
Residue:			
Filterable @ 180°C	mg/kg	NA	NA
Specific Conductance @ 25°C	µmhos/cm	NA	NA
Sulfate[1]	mg/kg SO_4^{-2}	1,667	<100
Metals:			
Aluminum	mg/kg	6,600	2,000
Arsenic	mg/kg	11	0.38
Barium	mg/kg	850	420
Boron	mg/kg	160	10
Cadmium	mg/kg	0.4	<0.1
Calcium	mg/kg	12,000	3,000
Chromium	mg/kg	5	<1
Cobalt	mg/kg	2	1
Copper	mg/kg	0.063	0.023
Iron	mg/kg	5,300	2,100
Lead	mg/kg	26	<1
Magnesium	mg/kg	530	150
Manganese	mg/kg	99	32
Mercury	mg/kg	0.2	<0.1
Molybdenum	mg/kg	<6	<6
Nickel	mg/kg	2	<1
Potassium	mg/kg	162	44
Selenium	mg/kg	6.5	<2[4]
Silver	mg/kg	<0.2	<0.2
Sodium	mg/kg	430	84
Zinc	mg/kg	13	5

(1) Water leachable.

(2) NA - not analyzed.

(3) < - less than.

(4) Higher detection limits due to matrix interference.

Table 27-B4

SPOILS AND OVERBURDEN ANALYSIS SUMMARY

PARAMETER	UNIT	S-1	S-2	S-3	S-4	S-5	D-1	D-2
Acidity[1]	mg/kg $CaCO_3$	399	299	197	399	298	399	398
Alkalinity[1]	mg/kg $CaCO_3$	3,293	3,693	3,945	3,593	3,777	7,186	3,877
Chloride[1]	mg/kg	250	150	246	200	248	399	149
Cyanide	mg/kg	0.17	1.18	0.20	0.25	0.20	0.08	0.20
Fluoride	mg/kg	471	463	420	575	503	403	332
Nitrate[1]	mg/kg NO_3-N	29	16	12	20	24	15	20
pH		NA[2]	NA	NA	NA	NA	NA	NA
Phenolics	mg/kg	1.09	1.19	1.09	1.18	1.05	0.90	1.98
Residue:								
Filterable @ 180°C	mg/kg	NA	NA	NA	NA	NA	NA	NA
Specific Conductance @ 25°C	umhos/cm	NA	NA	NA	NA	NA	NA	NA
Sulfate[1]	mg/kg SO_4^{-2}	8,982	7,236	6,410	12,724	6,610	1,946	3,529
Metals:								
Aluminum	mg/kg	8,100	7,400	5,500	6,600	6,600	9,200	6,200
Arsenic	mg/kg	6.5	6.0	36	17	4.3	4.5	4.6
Barium	mg/kg	180	42	130	520	150	110	120
Boron	mg/kg	9	8	4	<3[3]	4	<3	<3
Cadmium	mg/kg	1.0	0.9	1.1	0.9	0.8	1.1	0.9
Calcium	mg/kg	16,000	17,000	7,900	9,500	27,000	14,000	11,000
Chromium	mg/kg	3	3	2	3	3	6	6
Cobalt	mg/kg	7	7	8	7	9	7	6
Copper	mg/kg	11	6	6	15	9	10	0.143
Iron	mg/kg	14,000	13,000	39,000	27,000	14,000	20,000	18,000
Lead	mg/kg	35	32	58	34	32	42	72
Magnesium	mg/kg	2,900	3,100	2,300	2,100	2,900	4,100	6,200
Manganese	mg/kg	200	200	360	190	470	350	250
Mercury	mg/kg	<0.1	<0.1	0.2	0.8	<0.1	0.2	0.2
Molybdenum	mg/kg	<6	<6	<6	<6	<6	<6	<6
Nickel	mg/kg	10	9	13	10	13	10	9
Potassium	mg/kg	1,100	1,400	906	1,200	1,400	903	801
Selenium	mg/kg	<1[4]	<2[4]	<2[4]	<2[4]	<2[4]	<1[4]	<1[4]
Silver	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sodium	mg/kg	2,600	2,700	2,700	3,500	2,700	2,900	1,400
Zinc	mg/kg	66	63	58	71	69	63	56

(1) Water leachable.

(2) NA - not analyzed.

(3) < - less than.

(4) Higher detection limits due to matrix interference.

COAL ANALYSIS SUMMARY

PARAMETER	UNIT	SAMPLE NUMBER C-1	C-2	C-3	C-4	C-5	C-6	C-7
	SEAM NO.	NO. 8	NO. 2	NO. 4	NO. 3	NO. 7	NO. 8	NO. 6
Acidity[1]	mg/kg $CaCO_3$	198	399	399	198	393	295	399
Alkalinity[1]	mg/kg $CaCO_3$	790	2,595	798	100	3,929	4,715	898
Chloride[1]	mg/kg	247	349	175	222	196	196	150
Cyanide	mg/kg	0.05	0.07	2.22	0.30	0.35	0.12	0.20
Fluoride	mg/kg	26	23	13	36	248	380	364
Nitrate[1]	mg/kg $NO_3^{-}N$	5	4	6	5	14	5	3
pH		NA[2]	NA	NA	NA	NA	NA	NA
Phenolics	mg/kg	0.19	0.39	0.10	0.40	0.59	0.29	0.89
Residue:								
Filterable @ 180°C	mg/kg	NA	NA	NA	NA	NA	NA	NA
Specific Conductance @ 25°C	)mhos/cm	NA	NA	NA	NA	NA	NA	NA
Sulfate[1]	mg/kg SO_4^{-2}	524	748	499	3,508	1,965	1,130	<100[3]
Metals:								
Aluminum	mg/kg	290	1,800	650	1,300	720	2,300	680
Arsenic	mg/kg	<0.1	<0.1	<0.1	0.24	<0.2[4]	5.7	4.5
Barium	mg/kg	58	8.9	33	57	38	38	69
Boron	mg/kg	45	110	24	39	40	58	53
Cadmium	mg/kg	<0.1	<0.3	0.2	<0.1	<0.1	0.4	<0.3
Calcium	mg/kg	210	1,300	630	760	780	1,200	670
Chromium	mg/kg	<1	<1	<1	<1	<1	<1	<1
Cobalt	mg/kg	<0.5	2	<0.8[4]	<0.6[4]	3	2	1
Copper	mg/kg	0.020	0.028	0.029	0.033	0.044	0.071	<2
Iron	mg/kg	290	2,800	1,300	3,600	1,600	4,400	1,200
Lead	mg/kg	<1	<1	13	<1	2.6	3.8	<10
Magnesium	mg/kg	100	650	210	360	220	460	210
Manganese	mg/kg	<2	12	2	2	14	4	2
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	mg/kg	<6	<6	<6	<6	<6	<6	<6
Nickel	mg/kg	<1	2	1	<1	4	2	2
Potassium	mg/kg	17	19	17	45	34	102	15
Selenium	mg/kg	0.30	<0.4[4]	1.2	<0.8[4]	<0.8[4]	<0.3[4]	<0.4[4]
Silver	mg/kg	<0.2	<0.2	<0.3[4]	<0.2	<0.2	<0.2	<0.2
Sodium	mg/kg	510	1,000	510	810	690	1,200	1,500
Zinc	mg/kg	5	36	38	11	8	25	9

(1) Water leachable.
(2) NA - not analyzed.
(3) < - less than.
(4) [illegible]

Table 27-B6
ANALYTICAL SUMMARY OF SLUDGE SAMPLES

PARAMETER	UNITS	SLUDGE NO. 1	NO. 2	NO. 3	NO. 4
General Chemistry:					
Acidity	mg/kg $CaCO_3$	3,000	NA	7,600	4,400
Alkalinity	mg/kg $CaCO_3$	2,600	NA	2,800	2,000
Chloride	mg/kg	2,375	1,800	2,375	1.800
Cyanide	mg/kg	0.07	0.05	0.12	0.08
Fluoride	mg/kg	269	39	405	419
Nitrate	mg/kg NO_3-N	5	4.5	5	36
pH		NA(2)	11.37	NA	NA
Phenolics	mg/kg	0.1	<0.01	0.1	0.07
Residue: Filterable @ 180°C	mg/kg	NA	NA	NA	NA
Specific Conductance @ 25°C	µmhos/cm	NA	NA	NA	NA
Sulfate(1)	mg/kg SO_4^{-2}	8,350	3,100	4,200	8,150
Metals:	mg/kg				
Aluminum	mg/kg	9,400	9,900	6,500	8,400
Arsenic	mg/kg	22	11	12	11
Barium	mg/kg	780	650	490	430
Boron	mg/kg	230	300	220	230
Cadmium	mg/kg	0.62	0.73	0.67	0.87
Calcium	mg/kg	19,000	40,000	37,000	39,000
Chromium	mg/kg	10	11	6.7	7.7
Cobalt	mg/kg	2.1	2.3	1.8	2.0
Copper	mg/kg	7.4	8.5	6.5	5.2
Iron	mg/kg	4,300	4,400	2,800	4,400
Lead	mg/kg	16	12	<10(3)	37
Magnesium	mg/kg	760	780	580	700
Manganese	mg/kg	90	120	100	72
Mercury	mg/kg	0.2	<.1	0.2	0.10
Molybdenum	mg/kg	8.6	7.9	<6	7.4
Nickel	mg/kg	3.6	3.5	2.[illegible]	2.0
Potassium	mg/kg	430	270	250	290
Selenium	mg/kg	<2.0	7.0	1.4	6.0
Silver	mg/kg	<3	1.0	<3	<0.2
Sodium	mg/kg	800	1,000	600	790
Zinc	mg/kg	21	18	12	19

(Continued)

PARAMETER	UNITS	SLUDGE NO. 5	NO. 6	NO. 7	NO. 8
General Chemistry:					
Acidity	mg/kg $CaCO_3$	3,200	4,200	2,745	2,559
Alkalinity	mg/kg $CaCO_3$	2,200	2,400	3,725	3,150
Chloride	mg/kg	1,975	1,750	1,961	2,042
Cyanide	mg/kg	0.08	0.08	0.05	0.08
Fluoride	mg/kg	567	532	146	322
Nitrate	mg/kg NO_3-N	31	30.5	26.5	24.6
pH		NA(2)	NA	NA	NA
Phenolics	mg/kg	0.07	0.07	<0.01	<0.01
Residue: Filterable @ 180°C	mg/kg	NA	NA	NA	NA
Specific Conductance @ 25°C	umhos/cm	NA	NA	NA	NA
Sulfate(1)	mg/kg SO_4^{-2}	7,000	7,700	7,598	6,939
Metals:					
Aluminum	mg/kg	7,100	8,100	7,000	6,000
Arsenic	mg/kg	7.8	11	16	7.9
Barium	mg/kg	270	630	1,020	590
Boron	mg/kg	230	220	240	230
Cadmium	mg/kg	0.69	0.39	0.71	0.64
Calcium	mg/kg	63,000	26,000	17,000	48,000
Chromium	mg/kg	5.7	9.0	9.3	7.4
Cobalt	mg/kg	1.6	2.7	2.6	1.8
Copper	mg/kg	3.5	5.5	2.6	2.2
Iron	mg/kg	3,400	3,700	2,900	2,100
Lead	mg/kg	28	17	6.0	25
Magnesium	mg/kg	640	660	670	640
Manganese	mg/kg	57	73	60	40
Mercury	mg/kg	0.13	<0.1	0.12	<0.2(4)
Molybdenum	mg/kg	<6(3)	11	9.1	6.9
Nickel	mg/kg	2.0	3.4	2.0	1.9
Potassium	mg/kg	310	300	220	230
Selenium	mg/kg	4.1	8.3	8.8	3.6
Silver	mg/kg	<0.2	<3	<0.2	<0.2
Sodium	mg/kg	740	750	510	460
Zinc	mg/kg	17	19	16	14

(Continued)

PARAMETER	UNITS	SLUDGE NO. 9	SLUDGE NO. 10	SLUDGE NO. 11
General Chemistry:				
Acidity	mg/kg $CaCO_3$		11,000	11,000
Alkalinity	mg/kg $CaCO_3$		4,600	6,600
Chloride	mg/kg		100	80
Cyanide	mg/kg		<0.5	<0.5
Fluoride	mg/kg		1.0	1.0
Nitrate	mg/kg NO_3-N		7.9	5.1
pH	--		11.50	12.00
Phenolics	mg/kg		1.6	0.75
Residue: Filterable @ 180°C	mg/kg		5,700	6,600
Specific Conductance	umhos/cm @ 25°C		9,520	15,800
Sulfate	mg/kg SO_4^{-2}		1,600	1,400
Metals:				
Aluminum	mg/kg	10,000/9,800	10,000	12,000/12,000
Arsenic	mg/kg	17/14	9.4/9.7	18
Barium	mg/kg	190/230	350	300
Boron	mg/kg	<10/<10	71	121
Cadmium	mg/kg	0.24/0.24	0.33/0.33	0.43
Calcium	mg/kg	98,000/83,000	67,000	20,000
Chromium	mg/kg	12/13	9.3/9.6	13
Cobalt	mg/kg	8.5/7.5	1.4/1.4	2.5
Copper	mg/kg	13/13	9.7	12
Iron	mg/kg	4,400/4,500	4,500/4,400	5,400
Lead	mg/kg	5.0/5.90	9.9	12
Magnesium	mg/kg	820/820	640	750
Manganese	mg/kg	63/63	120	100
Mercury (Total)	mg/kg	0.37/0.25	<0.10	<0.10
Molybdenum	mg/kg	7.5/5.4	4.3	6.1
Nickel	mg/kg	6.3/4.3	<1.0/<1.0	<1.0
Potassium	mg/kg	410/360	310	420
Selenium	mg/kg	6.6/7.6	0.28	7.2/7.7
Silver	mg/kg	0.15/0.15	0.10	0.10
Sodium	mg/kg	1,200/1,000	1,000	1,200
Zinc	mg/kg	22/22	16	23

(Continued)

PARAMETER	UNITS	SLUDGE NO. 12	SLUDGE COMPOSITE SLUDGE
General Chemistry:			
Acidity	mg/kg $CaCO_3$	11,000	32,000
Alkalinity	mg/kg $CaCO_3$	1,000	<5
Chloride	mg/kg	110	110
Cyanide	mg/kg	<0.5	<0.5
Fluoride	mg/kg	2.0	2.0
Nitrate	mg/kg NO_3-N	5.9	5.5
pH	--	16.60	9.20
Phenolics	mg/kg	0.75	0.95
Residue: Filterable @ 180°C	mg/kg	5,300	4,500
Specific Conductance	µmhos/cm @ 25°C	7,950	6,980
Sulfate	mg/kg SO_4^{-2}	2,000	2,200
Metals:			
Aluminum	mg/kg	10,000	11,000
Arsenic	mg/kg	15	17
Barium	mg/kg	150	140/150
Boron	mg/kg	91	<10
Cadmium	mg/kg	0.53	1.5
Calcium	mg/kg	27,000	46,000/46,000
Chromium	mg/kg	11	18
Cobalt	mg/kg	1.7	2.4
Copper	mg/kg	8.7	13/13
Iron	mg/kg	4,900	6,000
Lead	mg/kg	8.8	8.8
Magnesium	mg/kg	680/680	870
Manganese	mg/kg	68	76/77
Mercury (Total)	mg/kg	<0.10/<0.10	<0.10
Molybdenum	mg/kg	4.9	11
Nickel	mg/kg	<1.0	8.7
Potassium	mg/kg	310/310	390
Selenium	mg/kg	3.8	1.4
Silver	mg/kg	0.10	0.10
Sodium	mg/kg	880	950/950
Zinc	mg/kg	15	49/49

(1) Water leachable
(2) NA = not analyzed
(3) < = less than.

Table 27-B7

CATION EXCHANGE CAPACITY AND
EXCHANGEABLE CATIONS FOR
SPOILS AND OVERBURDENS

PARAMETER	UNITS	SAMPLE IDENTIFICATION						
		D-1	D-2	S-1	S-2	S-3	S-4	S-5
Cation Exchange Capacity	$\frac{meq}{100g}$	39	24	52	52	44	59	53
Calcium	mg/kg	3,700	2,800	6,500	7,000	5,800	8,600	7,700
Magnesium	mg/kg	190	520	660	570	520	380	410
Potassium	mg/kg	240	100	240	220	170	310	290
Sodium	mg/kg	4,400	1,100	3,100	2,700	2,400	2,800	2,400

Table 27-B8

RADIOLOGICAL TEST DATA FOR SOLIDS SAMPLES

	Ra226 (pCi/g)[1]	Ra 228 (pCi/g)
Coal C-1	0.6±0.1	0.6±0.2
Coal C-2	1.5±0.1	0.7±0.3
Coal C-3	0.5±0.1	0.4±0.2
Coal C-4	0.8±0.1	0.9±0.3
Coal C-5	0.4±0.1	0.5±0.2
Coal C-6	1.0±0.1	0.3±0.2
Coal C-7	1.0±0.1	1.3±0.3
Spoil S-1	1.3±0.1	0.9±0.5
Spoil S-2	1.4±0.1	1.5±0.5
Spoil S-3	1.4±0.1	1.0±0.5
Spoil S-4	1.5±0.1	2.2±0.4
Spoil S-5	1.0±0.1	1.0±0.2
Overburden D-1	1.3±0.1	2.2±0.6
Overburden D-2	0.8±0.1	2.1±0.6
Fly Ash	3.2±0.1	3.8±0.6
Bottom Ash	2.9±0.1	4.3±0.7
Sludge No. 1	2.1	3.2
Sludge No. 3	2.0	2.7

	Total Radium (pCi/g)
Sludge No. 2	2.1
Sludge No. 4	1.5
Sludge No. 5	1.6
Sludge No. 6	15.5±0.6
Sludge No. 7	6.6±0.6
Sludge No. 8	6.0±0.5
Sludge No. 9	NA[2]
Sludge No. 10	NA
Sludge No. 11	NA
Sludge No. 12	NA

[1] pCi/g = pico curies per gram.

[2] NA = not analyzed

Table 27-B9
SLUDGE PHYSICAL CHARACTERIZATION SUMMARY

SAMPLE IDENTIFICATION	MOISTURE CONTENT (%)	PERCENT SOLIDS (%)	pH (1:1)
Sludge No. 1	18.7/17.8[1]	81.3/82.2	10.84/10.50
Sludge No. 2	13.3/24.2	86.7/75.8	10.96/9.25
Sludge No. 3	23.9/24.7	76.1/75.3	12.05/9.35
Sludge No. 4	20.6/21.8	79.4/78.2	11.11/9.40
Sludge No. 5	25.5/27.6	74.5/72.4	11.21/9.35
Sludge No. 6	15.8/19.2	84.2/80.8	11.44/9.35
Sludge No. 7	10.8/14.6	89.2/85.4	11.20/9.35
Sludge No. 8	21.0/20.6	79.0/79.4	11.37/9.80
Sludge No. 9	24.5/23.7	75.5/76.3	9.15/10.05
Sludge No. 10	11.0	89.0	11.50
Sludge No. 11	11.6	88.4	12.00
Sludge No. 12	16.2	83.8	10.60
Composite	16.7	83.8	9.20

[1] Duplicate analyses performed at different laboratories.

Calculation of the constituent chemical concentration for which one is 90 percent confident that at least 95 percent of the population of future means sets of 12 samples will be less than that value can be achieved through the use of a statistical tolerance limit. Such a limit, L, is calculated as follows:

$$L = \overline{X} + KS$$

Where $\overline{X}$ is the mean concentration, S is the standard deviation of the concentration, and K is the tolerance limit factor corresponding to the number of observations used to calculate S and the desired population percentage and degree of confidence. To ensure that a correct tolerance limit statement is made regarding the distribution of means sets of 12 samples, K is calculated according to the procedure proposed by Wallis.*

Applying this procedure and assuming that the concentration of each chemical constituent is statistically independent, the tolerance limits for those analyzed constituents are presented in Table 27.B10. The assumption of statistical independence among constituents is conservative as significant correlations among constituents would serve to decrease the conditional tolerance limit.

EP Toxicity Extraction Tests

All solid samples underwent the RCRA Extraction Procedure (EP Toxicity Test) as described in the Federal Register, 45 (98), May 19, 1980. The extracts from these tests were analyzed for the chemical constituents presented in Table 27.B1. Table 27.B11 presents the results of the extraction tests. The results are all below the limits for EP toxicity used to classify a material as toxic.

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*Churchill Eisenhart, Mellard W. Hastay, and W. Alley Wallis, ed: Selected Techniques of Statistical Analysis for Scientific and Industrial Research and Production and Management Engineering; McGraw-Hill Book Co., Inc., New York. NY, 1947, pp. 95-110, 59.

Table 27-B10
SLUDGE/FLY ASH CONSTITUENT TOLERANCE
LIMITS FOR 12-SAMPLE MEAN

CONSTITUENT	NUMBER OF SAMPLES	SAMPLE MEAN	STANDARD DEVIATION	95 PERCENT* TOLERANCE LIMIT
Acidity	10.00	6070.40	3690.62	9687.21
Alkalinity	10.00	3107.50	1568.88	4645.01
Chloride	11.00	1488.00	917.20	2361.18
Cyanide	11.00	0.19	0.20	0.38
Fluoride	11.00	245.73	218.81	453.60
Nitrate	11.00	16.55	12.95	28.85
pH	12.00	10.58	0.63	11.17
Phenolics	11.00	0.32	0.51	0.80
Residue	0.00			
Conductance	0.00			
Sulfate	11.00	5276.09	2826.23	7961.01
Aluminum	12.00	8691.67	1800.74	10366.35
Arsenic	12.00	13.06	4.30	17.06
Barium	12.00	489.17	256.18	727.41
Boron	12.00	182.75	87.02	263.68
Cadmium	12.00	0.57	0.19	0.75
Calcium	12.00	41125.00	22567.20	62112.49
Chromium	12.00	9.40	2.26	11.50
Cobalt	12.00	2.524	1.77	4.19
Copper	12.00	7.07	3.49	10.31
Iron	12.00	3933.33	964.91	4830.70
Lead	12.00	15.60	9.69	24.61
Magnesium	12.00	693.33	70.37	758.77
Manganese	12.00	80.25	25.54	104.00
Mercury	12.00	0.15	0.07	0.21
Molybdenum	12.00	7.05	1.88	8.80
Nickel	12.00	2.40	1.31	3.61
Potassium	12.00	310.42	68.97	374.56
Selenium	12.00	4.99	2.85	7.64
Silver	12.00	0.94	1.27	2.12
Sodium	12.00	819.17	229.21	1032.33
Zinc	12.00	18.67	3.31	20.75

*With 90 percent confidence.

(Continued)

PARAMETER	UNIT	SPOIL S-1	S-2	S-3	S-4	S-5
General Chemistry:						
Acidity	mg/ℓ $CaCO_3$	NA	NA	NA	NA	NA
Alkalinity	mg/ℓ $CaCO_3$	NA	NA	NA	NA	NA
Chlorine	mg/ℓ	0.85	1.3	2.2/0.85	2.5/1.3	2.5
Cyanide	mg/ℓ	<0.01	<0.01	<0.01/<0.01	<0.01/<0.01	<0.01
Fluoride	mg/ℓ	0.12	0.13	0.1/0.12	0.10/0.09	0.10
Nitrate	mg/ℓ NO_3-N	0.88	0.75	0.36/0.01	0.85/0.71	1.6
pH		5.17	4.99	5.11/5.23	5.01/4.98	5.00
Phenolics	mg/ℓ	0.01	0.01	0.01/0.01	0.01/0.01	0.01
Residue:						
Filterable @ 180°C	mg/ℓ	2.368	4,606	3,292/2,408	3,277/2,622	3,504
Specific Conductance	umhos/cm at 25°C	NA	NA	NA	NA	NA
Sulfate	mg/ℓ SO_4^{-2}	425	188	512/938	412/362	250
Metals:						
Aluminum	mg/ℓ	3.1	3.2	4.4	1.7/1.9	2.6
Arsenic	mg/ℓ	0.001	<0.001	<0.001/<0.001	0.001/<0.001	0.001
Barium	mg/ℓ	0.152	0.192	0.159	0.066/0.053	0.196
Boron	mg/ℓ	0.05	0.11	0.207	0.12/0.12	0.10
Cadmium	mg/ℓ	<0.004	<0.003	<0.004	<0.003/<0.003	<0.003
Calcium	mg/ℓ	440	900	670	560/500	590
Chromium	mg/ℓ	<0.01	<0.01	<0.01	<0.01/<0.01	<0.01
Cobalt	mg/ℓ	0.03	0.05	0.02	0.04/0.03	0.01
Copper	mg/ℓ	0.02	<0.02	0.02	<0.02/<0.02	<0.02
Iron	mg/ℓ	0.04	0.4	0.04	<0.05/0.1	<0.05
Lead	mg/ℓ	0.1	<0.1	0.2	<0.1/<0.1	<0.1
Magnesium	mg/ℓ	38	46	39	22/21	27
Manganese	mg/ℓ	4.4	9.9	7.3	7.0/6.4	7.2
Mercury	mg/ℓ	<0.001	<0.001	<0.001/<0.001	<0.001/<0.001	<0.001
Molybdenum	mg/ℓ	<0.05	<0.06	<0.05	<0.06/<0.06	<0.06
Nickel	mg/ℓ	0.02	0.04	0.02	0.04/0.05	<0.01
Potassium	mg/ℓ	6.2	9.0	8.2/7.2	11/9.8	10
Selenium	mg/ℓ	<0.009	<0.01	<0.01/<0.008	<0.01/<0.01	<0.01
Silver	mg/ℓ	<0.01	<0.03	<0.01	<0.03/<0.03	<0.03
Sodium	mg/ℓ	170	160	230	170/160	120
Zinc	mg/ℓ	0.077	0.14	0.190	0.14/0.14	0.11

Table 27-B11
EP TOXICITY EXTRACTION ANALYSES

PARAMETER	UNITS	ASH		OVERBURDEN	
		FLY ASH	BOTTOM ASH	D-1	D-2
General Chemistry:					
Acidity	mg/ℓ $CaCO_3$	NA(1)	NA	NA	NA
Alkalinity	mg/ℓ $CaCO_3$	NA	NA	NA	NA
Chlorine	mg/ℓ	1.2	2	10	1.2
Cyanide	mg/ℓ	<0.01	<0.01	<0.01	<0.01
Fluoride	mg/ℓ	2.2	0.1	0.10	0.08
Nitrate	mg/ℓ NO_3-N	<0.01	<0.01	0.17	<0.01
pH		5.02	6.27	5.14	5.49
Phenolics	mg/ℓ	0.01	<0.01	0.01	<0.01
Residue:					
Filterable @ 180°C	mg/ℓ	1,900	316	2,177	868
Specific Conductance	umhos/cm at 25°C	NA	NA	NA	NA
Sulfate	mg/ℓ SO_4^{-2}	82	12	76	375
Metals:					
Aluminum	mg/ℓ	5.8	0.6	1.3	1.1
Arsenic	mg/ℓ	0.014	<0.001	0.001	<0.001
Barium	mg/ℓ	0.447	0.635	0.793	0.101
Boron	mg/ℓ	6.3	0.09	0.14	0.03
Cadmium	mg/ℓ	0.004	<0.004	<0.003	<0.004
Calcium	mg/ℓ	430	62	340	150
Chromium	mg/ℓ	0.03	<0.01	<0.01	<0.01
Cobalt	mg/ℓ	<0.01	<0.01	0.03	0.01
Copper	mg/ℓ	0.02	<0.02	<0.02	<0.02
Iron	mg/ℓ	<0.01	<0.01	0.5	0.02
Lead	mg/ℓ	<0.1	<0.1	<0.1	<0.1
Magnesium	mg/ℓ	4.3	1.3	29	42
Manganese	mg/ℓ	1.2	0.220	5.9	1.7
Mercury	mg/ℓ	<0.001	<0.001	<0.001	<0.001
Molybdenum	mg/ℓ	0.11	<0.05	<0.06	<0.05
Nickel	mg/ℓ	0.02	0.01	0.05	0.01
Potassium	mg/ℓ	0.627	0.333	9	3.4
Selenium	mg/ℓ	0.190	<0.001	<0.005	<0.002
Silver	mg/ℓ	<0.01	<0.01	<0.03	<0.01
Sodium	mg/ℓ	11	3.0	200	71
Zinc	mg/ℓ	0.117	0.105	0.19	0.039

(Continued)

PARAMETER	UNIT	SLUDGE NO. 1	NO. 2	NO. 3	NO. 4	NO. 5
Gen[illegible] Chemistry:						
Acidity	mg/ℓ $CaCO_3$	NA	NA	NA	NA	NA
Alkalinity	mg/ℓ $CaCO_3$	NA	NA	NA	NA	NA
Chlorine	mg/ℓ	2.1	2.9	3.2	5.3/5.8(2)	5.1
Cyanide	mg/ℓ	<0.02	<0.02	<0.02	<0.02	<0.02
Fluoride	mg/ℓ	1.9	1.8	1.5	2.2	2.7
Nitrate	mg/ℓ NO_3-N	0.2	0.2	0.3	0.3	0.5
pH		NA	NA	NA	NA	NA
Phenolics	mg/ℓ	0.04	0.04	0.03	0.03	0.03
Residue:						
Filterable @ 180°C	mg/ℓ	3,900	3,900	4,300	4,500	4,100
Specific Conductance	µmhos/cm at 25°C	NA	NA	NA	NA	NA
Sulfate	mg/ℓ SO_4^{-2}	1,600	1,400	1,600	1,900	1,700
Metals:						
Aluminum	mg/ℓ(1)	22	24	29	26	23
[illegible]nic	mg/ℓ	0.13/0.12(2)	0.08	0.12	0.21	0.20
Barium	mg/ℓ	0.14	0.30	0.20	0.40	0.48
Boron	mg/ℓ	4.2	6.6/7.0	5.4	4.4	5.1
Cadmium	mg/ℓ	0.03	0.03/0.03	0.03	0.04	0.03
Calcium	mg/ℓ	950	810	1,000	1,200	1,000
Chromium	mg/ℓ	0.09	0.10	0.11	0.08/0.08	0.05
Cobalt	mg/ℓ	0.003	0.005	0.003	0.003	0.001
Copper	mg/ℓ	0.11/0.11	0.12	0.12	0.13	0.10
Iron	mg/ℓ	10/10	13	15	7.2	5.1
Lead	mg/ℓ	0.30	0.27	0.32	0.34/0.35	0.33
Magnesium	mg/ℓ	7.8	8.7	9.4	12	15
Manganese	mg/ℓ	1.7/1.7	2.1	2.7	1.5	1.1
Mercury	mg/ℓ	0.0036	0.0025	0.0036	0.0029	0.0004
Molybdenum	mg/ℓ	0.36/0.40	0.34	0.33	0.41	0.31
Nickel	mg/ℓ	0.16	0.13/0.13	0.15	0.16	0.14
Potassium	mg/ℓ	1.8	2.0	1.9	2.0	1.8
Selenium	mg/ℓ	0.20	0.20	0.18	0.18	0.18
[illegible]ver	mg/ℓ	0.04	0.04	0.05	0.05	0.04
Sodium	mg/ℓ	9.9	10	9.5	13	11
Zinc	mg/ℓ	0.21	0.20	0.18	0.21	0.17

(Continued)

PARAMETER	UNIT	SLUDGE NO. 6	NO. 7	NO. 8	NO. 9
General Chemistry:					
Acidity	mg/ℓ $CaCO_3$	NA	NA	NA	NA
Alkalinity	mg/ℓ $CaCO_3$	NA	NA	NA	NA
Chlorine	mg/ℓ	6.1	3.7	5.3/5.6	5.8/6.9
Cyanide	mg/ℓ	<0.02	<0.02	<0.02/<0.02	<0.02/<0.02
Fluoride	mg/ℓ	1.8	1.7	2.2/2.4	3.0/3.0
Nitrate	mg/ℓ NO_3-N	0.3	0.3	0.4/0.5	0.5/0.6
pH		NA	NA	NA	NA
Phenolics	mg/ℓ	0.29	0.05	<0.01/<0.01	0.03/0.02
Residue:					
Filterable @ 180°C	mg/ℓ	4,300	4,300	4,000/3,900	4,100/4,100
Specific Conductance	μmhos/cm at 25°C	NA	NA	NA	NA
Sulfate	mg/ℓ SO_4^{-2}	1,800	1,900	1,800/1,800	1,800/1,800
Metals:					
Aluminum	mg/ℓ	26/26	25	20/20	22/23
Arsenic	mg/ℓ	0.23	0.26	0.28/0.30	0.26/0.26
Barium	mg/ℓ	0.49	0.39	0.41	1.6/0.21
Boron	mg/ℓ	3.7	4.2	3.5/3.9	4.2/4.4
Cadmium	mg/ℓ	0.04	0.04	0.04/0.03	0.04/0.04
Calcium	mg/ℓ	1,200	920	1,000/1,200	1,000/1,100
Chromium	mg/ℓ	0.09	0.07	0.06/0.06	0.05/0.06
Cobalt	mg/ℓ	0.002	0.004	0.003/0.004	0.003/0.004
Copper	mg/ℓ	0.11	0.12	0.11/0.10	0.11/0.12
Iron	mg/ℓ	9.9	8.7	4.8/4.7	6.1/4.9
Lead	mg/ℓ	0.36	0.37	0.28/0.27	0.32/0.31
Magnesium	mg/ℓ	9.7	8.1	12/11	13/11
Manganese	mg/ℓ	1.6	1.3	0.99/0.91	1.1/1.1
Mercury	mg/ℓ	0.0046	0.0044	0.0037/0.0019	0.0025/0.0030
Molybdenum	mg/ℓ	0.44	0.44	0.34/0.35	0.29/0.24
Nickel	mg/ℓ	0.15	0.14	0.11/0.07	0.14/0.10
Potassium	mg/ℓ	1.6	1.6	1.7/2.0	2.4/2.0
Selenium	mg/ℓ	0.24	0.24	0.25/0.22	0.25/0.25
Silver	mg/ℓ	0.05	0.05	0.04/0.05	0.04/0.05
Sodium	mg/ℓ	11	11	11/11	11/11
Zinc	mg/ℓ	0.19	0.17	0.16/0.16	0.17/0.16

(Continued)

PARAMETER	UNITS	SLUDGE NO. 10	SLUDGE NO. 11
General Chemistry:			
Acidity	mg/ℓ[1] $CaCO_3$	960	960
Alkalinity	mg/ℓ $CaCO_3$	140	280
Chloride	mg/ℓ	5.9	3.9
Cyanide	mg/ℓ	<0.02	<0.02
Fluoride	mg/ℓ	1.2	1.2
Nitrate	mg/ℓ NO_3-N	2.0	2.0
pH	--	4.60	4.70
Phenolics	mg/ℓ	0.02	0.02
Residue:			
Filterable @ 180°C	mg/ℓ	4400	4800
Specific Conductance	umhos/cm @ 25°C	3860	4000
Sulfate	mg/ℓ SO_4^{-2}	1,600	1,500
Metals:			
Aluminum	mg/ℓ	24	24
Arsenic	mg/ℓ	0.028/0.030[2]	0.019
Barium	mg/ℓ	0.27	0.29
Boron	mg/ℓ	7.9/7.8	6.5
Cadmium	mg/ℓ	0.005/0.005	0.004
Calcium	mg/ℓ	27	26
Chromium	mg/ℓ	0.064	0.044
Cobalt	mg/ℓ	0.003/0.005	0.003
Copper	mg/ℓ	0.09	0.08
Iron	mg/ℓ	7.7/7.7	6.8
Lead	mg/ℓ	<0.01/<0.01	<0.01
Magnesium	mg/ℓ	10	8.5/8.5
Manganese	mg/ℓ	2.2	3.1
Mercury	mg/ℓ	0.0003	0.0003
Molybdenum	mg/ℓ	0.24	0.16
Nickel	mg/ℓ	0.11/0.13	0.12
Potassium	mg/ℓ	1.3	1.0
Selenium	mg/ℓ	0.019/0.017	0.004
Silver	mg/ℓ	<0.001/<0.001	<0.001
Sodium	mg/ℓ	9.5	7.6
Zinc	mg/ℓ	0.18/0.18	0.15

(Continued)

PARAMETER	UNITS	SLUDGE NO. 12	SLUDGE COMPOSITE
General Chemistry:			
Acidity	mg/ℓ[1] $CaCO_3$	870	2,300
Alkalinity	mg/ℓ $CaCO_3$	<1	<1
Chloride	mg/ℓ	5.9	7.8
Cyanide	mg/ℓ	<0.02	<0.02
Fluoride	mg/ℓ	1.4	1.2
Nitrate	mg/ℓ NO_3-N	2.5	6.8
pH	--	4.50	4.10
Phenolics	mg/ℓ	0.03	<0.02
Residue:			
Filterable @ 180°C	mg/ℓ	4,100	4,300
Specific Conductance	umhos/cm @ 25°C	3,650	4,600
Sulfate	mg/ℓ SO_4^{-2}	1,600	1,600
Metals:			
Aluminum	mg/ℓ	22/22	29/28
Arsenic	mg/ℓ	0.11	0.17
Barium	mg/ℓ	0.29	0.48/0.48
Boron	mg/ℓ	6.9	9.3
Cadmium	mg/ℓ	0.004	0.006
Calcium	mg/ℓ	23	31/31
Chromium	mg/ℓ	0.053	0.097
Cobalt	mg/ℓ	0.003	0.005
Copper	mg/ℓ	0.07	0.12/0.12
Iron	mg/ℓ	9.5	9.3
Lead	mg/ℓ	<0.01	<0.01
Magnesium	mg/ℓ	9.8	10
Manganese	mg/ℓ	1.6	1.9/1.9
Mercury	mg/ℓ	0.0019	0.0033
Molybdenum	mg/ℓ	0.20	0.28/0.28
Nickel	mg/ℓ	0.10	0.28
Potassium	mg/ℓ	1.2	1.8/1.8
Selenium	mg/ℓ	0.015	0.007
Silver	mg/ℓ	<0.001	<0.001
Sodium	mg/ℓ	8.9	11/11
Zinc	mg/ℓ	0.16	0.65

(1) mg/ℓ = milligrams per liter or parts per million.
(2) The indicated sample was analyzed in duplicate.

3. BATCH LEACH TESTING

Introduction

One of the objectives of the study was to assess the ability of the overburden and spoils to attenuate chemical species present in the ground water resulting from contact with the wastes. Attenuation capacities can be expressed in terms of a distribution ratio, K_r. The ratio for a particular chemical species is defined as the mass sorbed onto the solid phase to the mass remaining in solution:

$$K_r = \frac{\text{Mass of Solute on the Solid Phase Per Unit Mass of Solid Phase}}{\text{Concentration of Solute in Solution}}$$

It is conventional to express K_r in units of milliliters of solution per gram of sample.

Testing Method

The laboratory methods generally used to assess K_r are the batch test and column test. The batch test method (jar test) is used to define the distribution ratios for metal species that exhibit absorption/adsorption potential.

Samples for testing were prepared by mixing 0.47 percent bottom ash, 97.30 percent spoil/overburden, and 2.23 percent composite sludge by weight. These percentages for mixing the samples were calculated from the following estimates of wastes generated over the project lifetime:

Total Spoil = 760 million cubic yards (cyd.) weighing;
3,000 pounds per cyd.

Total Ash = 31.6 million tons consisting of 17.5 percent; bottom ash and 82.5 percent fly ash (sludge). Bottom ash weighs 30 pounds per ft^3 and fly ash is 58 pounds per ft^3.

A composite sludge was formed from the 12 sludge samples for use in the leach testing by mixing equal aliquots of sludge from each of the 12 sludge samples. This approach was thought to be more representative of the waste and the number of leach tests that were needed.

Each of the five spoils and the two overburdens were mixed individually with the sludge-bottom ash composite and two duplicates were prepared for quality assurance/quality control. The samples were placed in two liter glass or plastic bottles that had been acid cleaned and thoroughly rinsed with distilled water. All other plastic and glassware used in this study were similarly cleaned.

Each of these mixtures were then mixed with each of the composited ground waters and the one surface water sample. In addition, distilled water was used as a leaching medium. The total number of sample mixtures generated was 42 plus two duplicates. The ratio of solid to water for each test was always kept at 1:4.

In addition to the waste overburden mixtures, similar testing was performed on the spoil/overburden samples alone, as well as the composite sludge, the fly ash, and the bottom ash. The purpose of these experiments was to assess what each individual component might be expected to contribute to the overall chemistry of the composited sample leachates. The experimental procedure for each of these tests was done in the same manner described above. The composition of generated leachates is presented in Tables 27.B13 through 27.B29 for each of the water samples used (one surface water and four composited ground water).

Table 27-B13
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR OVERBURDEN D-1

PARAMETER	UNITS	OVERBURDEN D-1 LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	230	2,700/2,700	860
Chloride	mg/ℓ	27	410/410	160
Cyanide	mg/ℓ	0.02	<0.02/<0.02	<0.02
Fluoride	mg/ℓ	1.3	2.3/2.0	1.8
Nitrate	mg/ℓ NO_3-N	12	2.4/2.2	3.6
pH	--	8.20	9.10/8.60	8.90
Phenolics	mg/ℓ	0.02	0.01/0.01	0.12
Residue:				
Filterable @ 180°C	mg/ℓ	2,500	4,200/4,300	4,100
Specific Conductance	µmhos/cm @ 25°C	3,760	5,980/6,280	6,170
Sulfate	mg/ℓ SO_4^{-2}	1,300	200/100	1,600
Metals:				
Aluminum	mg/ℓ	1.9	1.3/1.8	1.0
Arsenic	mg/ℓ	0.002	0.003/0.010	0.003
Barium	mg/ℓ	0.040	0.092/0.142	0.029
Boron	mg/ℓ	<0.5	0.8/0.7	<0.5
Cadmium	mg/ℓ	<0.001	<0.001/<0.001	<0.001
Calcium	mg/ℓ	41	11/17	30
Chromium	mg/ℓ	0.035	0.028/0.030	0.031
Cobalt	mg/ℓ	0.005	<0.001/0.003	0.008
Copper	mg/ℓ	0.02	<0.01/0.11	0.02
Iron	mg/ℓ	0.59	1.1/0.16	1.2
Lead	mg/ℓ	<0.01	<0.01/<0.01	<0.01
Magnesium	mg/ℓ	5.3	5.5/4.7	5.6
Manganese	mg/ℓ	0.08	0.04/0.05	0.12
Mercury	mg/ℓ	<0.0002	0.0005	<0.0002
Molybdenum	mg/ℓ	0.008	0.021/0.025	<0.001
Nickel	mg/ℓ	<0.01	<0.01/0.01	0.01
Potassium	mg/ℓ	14	17/15	16
Selenium	mg/ℓ	0.020	0.018/0.018	0.012
Silver	mg/ℓ	0.002	<0.001/<0.001	0.002
Sodium	mg/ℓ	740	1,500/1,300	1,100
Zinc	mg/ℓ	0.06	0.09/0.08	0.05

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	420	570	200
Chloride	mg/ℓ	5,200	1,900	20
Cyanide	mg/ℓ	<0.02	0.03	<0.02
Fluoride	mg/ℓ	0.7	1.6	1.2
Nitrate	mg/ℓ NO_3-N	21	2.2	<0.1
pH	--	7.90	8.50	8.15
Phenolics	mg/ℓ	0.02	0.01	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	9,800	4,300	1,300
Specific Conductance	µmhos/cm @ 25°C	17,600	8,070	1,000
Sulfate	mg/ℓ SO_4^{-2}	200	150	100
Metals:				
Aluminum	mg/ℓ	0.9	4.4	3.4
Arsenic	mg/ℓ	0.006	0.001	0.006
Barium	mg/ℓ	0.18	0.14	0.026
Boron	mg/ℓ	0.7	0.5	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	150	16	2
Chromium	mg/ℓ	0.003	0.034	0.018
Cobalt	mg/ℓ	0.052	0.002	0.008
Copper	mg/ℓ	0.02/<0.01	0.04	0.02
Iron	mg/ℓ	0.06	1.4	5.2
Lead	mg/ℓ	0.10	<0.01	<0.01
Magnesium	mg/ℓ	27	3.9	0.9
Manganese	mg/ℓ	0.17	0.06	0.06
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.046	0.030	0.037
Nickel	mg/ℓ	0.02	<0.01	<0.01
Potassium	mg/ℓ	35	16	3.9
Selenium	mg/ℓ	0.034	0.014	0.026
Silver	mg/ℓ	<0.001	<0.001	0.002
Sodium	mg/ℓ	3,000	1,200	230
Zinc	mg/ℓ	0.03	0.08	0.10

Table 27-B14

1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR OVERBURDEN D-2

PARAMETER	UNITS	OVERBURDEN D-2 LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1/<1
Alkalinity	mg/ℓ $CaCO_3$	150	2,600	860/780
Chloride	mg/ℓ	18	190	290/150
Cyanide	mg/ℓ	<0.02	<0.02	<0.02/<0.02
Fluoride	mg/ℓ	0.8	1.8	1.8/1.8
Nitrate	mg/ℓ NO_3-N	9.0	11	5.2/6.9
pH	--	8.10	8.60	8.70/8.40
Phenolics	mg/ℓ	0.04	0.01	0.03/0.01
Residue:				
Filterable @ 180°C	mg/ℓ	2,800	4,200	5,000/5,000
Specific Conductance	µmhos/cm @ 25°C	3,400	6,950	6,470/7,130
Sulfate	mg/ℓ SO_4^{-2}	1,800	400	2,500/2,500
Metals:				
Aluminum	mg/ℓ	<0.1	0.2	0.1/0.1
Arsenic	mg/ℓ	0.001	0.002	0.004/0.003
Barium	mg/ℓ	0.060	0.077	0.062/0.043
Boron	mg/ℓ	<0.5	0.5	<0.5/<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001/0.001
Calcium	mg/ℓ	320	60	190/190
Chromium	mg/ℓ	<0.001	0.002	0.004/<0.001
Cobalt	mg/ℓ	<0.001	<0.001	0.022/0.029
Copper	mg/ℓ	0.02	0.02	0.04/0.02
Iron	mg/ℓ	0.06	0.08	0.10/0.08
Lead	mg/ℓ	<0.01	<0.01	0.02/0.02
Magnesium	mg/ℓ	59	28	40/45
Manganese	mg/ℓ	0.08	0.04	0.26/0.15
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002/<0.0002
Molybdenum	mg/ℓ	0.002	0.005	0.004/0.006
Nickel	mg/ℓ	<0.01	<0.01	0.01/0.02
Potassium	mg/ℓ	14	15	17/17
Selenium	mg/ℓ	0.014	0.008	0.006/0.006
Silver	mg/ℓ	<0.001	<0.001	0.002/0.002
Sodium	mg/ℓ	530	1,400	1,200/1,200
Zinc	mg/ℓ	<0.01	<0.01	0.06/0.03

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	540	560	76
Chloride	mg/ℓ	5,600	2,000	3.9
Cyanide	mg/ℓ	<0.02	<0.02	<0.02
Fluoride	mg/ℓ	0.7	1.3	0.7
Nitrate	mg/ℓ NO_3-N	18	13	6.3
pH	--	8.05	8.20	8.25
Phenolics	mg/ℓ	0.04	<0.01	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	11,000	5,100	1,300
Specific Conductance	umhos/cm @ 25°C	17,800	9,020	1,780
Sulfate	mg/ℓ SO_4^{-2}	1,000	500	980
Metals:				
Aluminum	mg/ℓ	0.4	<0.1	<0.1
Arsenic	mg/ℓ	0.007	0.001	<0.001
Barium	mg/ℓ	0.16	0.063	0.046
Boron	mg/ℓ	0.6	<0.5	<0.5
Cadmium	mg/ℓ	0.001	<0.001	0.005
Calcium	mg/ℓ	340	80	130
Chromium	mg/ℓ	0.041	0.006	0.003
Cobalt	mg/ℓ	0.13	<0.001	<0.001
Copper	mg/ℓ	0.06	0.04	<0.01
Iron	mg/ℓ	0.10	0.07	0.07
Lead	mg/ℓ	0.21	0.02	<0.01
Magnesium	mg/ℓ	77	32	29
Manganese	mg/ℓ	0.38	0.13	0.09
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.008	0.005	0.020
Nickel	mg/ℓ	0.04	<0.01	<0.01
Potassium	mg/ℓ	31	18	9.2
Selenium	mg/ℓ	0.018	0.011	0.014
Silver	mg/ℓ	<0.001	<0.001	<0.001
Sodium	mg/ℓ	3,000	1,500	250
Zinc	mg/ℓ	0.04	<0.01	<0.01

Table 27-B15
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR SPOIL S-1

PARAMETER	UNITS	SPOIL S-1 LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	160	2100	810
Chloride	mg/ℓ	20	420	170
Cyanide	mg/ℓ	0.02	0.08	<0.02
Fluoride	mg/ℓ	1.1	1.4	1.5
Nitrate	mg/ℓ NO_3-N	17	18	17
pH	--	8.10	8.35	8.15
Phenolics	mg/ℓ	0.03	<0.01	<0.01
Residue:				
Filterable @ 180°C	mg/ℓ	5,000	6,200	6,900
Specific Conductance	µmhos/cm @ 25°C	6,010	8,450	8,600
Sulfate	mg/ℓ SO_4^{-2}	3,000	4,000	3,700
Metals:				
Aluminum	mg/ℓ	<0.1	1.4	<0.1
Arsenic	mg/ℓ	0.002	0.003	0.004
Barium	mg/ℓ	0.085	0.039	0.072
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	400	80	360
Chromium	mg/ℓ	0.005	0.055	0.006
Cobalt	mg/ℓ	0.007	0.003	0.012
Copper	mg/ℓ	0.05	0.04	0.06
Iron	mg/ℓ	0.08	0.30	0.08
Lead	mg/ℓ	0.03	0.03	0.05
Magnesium	mg/ℓ	50	34	42
Manganese	mg/ℓ	0.13	0.05	0.15
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.007	0.013	0.013
Nickel	mg/ℓ	0.03	<0.01	0.08
Potassium	mg/ℓ	23	20	23
Selenium	mg/ℓ	0.021	0.012	0.013
Silver	mg/ℓ	0.002	0.002	0.002
Sodium	mg/ℓ	1,000	1,700	1,500
Zinc	mg/ℓ	0.04	0.04	0.04

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	460	530	140
Chloride	mg/ℓ	5,300	2100	12
Cyanide	mg/ℓ	0.05	0.05	<0.02
Fluoride	mg/ℓ	0.8	1.6	2.5
Nitrate	mg/ℓ NO_3-N	31	16	12
pH	--	8.05	8.40	7.90
Phenolics	mg/ℓ	0.04	0.04	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	13,000	6,100	3,500
Specific Conductance	µmhos/cm @ 25°C	22,800	9,670	4,830
Sulfate	mg/ℓ SO_4^{-2}	2,300	1,000	2,200
Metals:				
Aluminum	mg/ℓ	<0.1	0.1	<0.1
Arsenic	mg/ℓ	0.002	0.002	0.001
Barium	mg/ℓ	0.20	0.12	0.10
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	0.002	<0.001	<0.001
Calcium	mg/ℓ	770	130	310
Chromium	mg/ℓ	0.004	0.029	0.004
Cobalt	mg/ℓ	0.096	0.001	0.002
Copper	mg/ℓ	0.05	0.04	0.02
Iron	mg/ℓ	0.24	0.24	0.04
Lead	mg/ℓ	0.25	0.04	0.02
Magnesium	mg/ℓ	79	24	28
Manganese	mg/ℓ	0.34	0.11	0.06
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.016	0.009	0.009
Nickel	mg/ℓ	0.08	0.04	0.03
Potassium	mg/ℓ	40	19	16
Selenium	mg/ℓ	0.022	0.009	0.012
Silver	mg/ℓ	<0.001	<0.001	0.002
Sodium	mg/ℓ	3,400	1,700	770
Zinc	mg/ℓ	0.05	0.03	0.01

Table 27-B16
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR SPOIL S-2

PARAMETER	UNITS	SPOIL S-2 LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	200	2,200	720
Chloride	mg/ℓ	29	390	310
Cyanide	mg/ℓ	0.06	<0.02	<0.02
Fluoride	mg/ℓ	1.0	1.3	1.6
Nitrate	mg/ℓ NO_3-N	8.7	10	9.2
pH	--	7.90	8.90	8.40
Phenolics	mg/ℓ	0.02	0.04	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	3,800	5,000	5,000
Specific Conductance	µmhos/cm @ 25°C	5,300	7,290	6,760
Sulfate	mg/ℓ SO_4^{-2}	2,500	800	2,400
Metals:				
Aluminum	mg/ℓ	<0.1	3.8	3.2
Arsenic	mg/ℓ	0.001	0.001	0.001
Barium	mg/ℓ	0.038	0.045	0.031
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	290	60	110
Chromium	mg/ℓ	0.004	0.049	0.033
Cobalt	mg/ℓ	0.002	0.001	0.001
Copper	mg/ℓ	0.02	0.08	0.02
Iron	mg/ℓ	0.06	0.76	0.50
Lead	mg/ℓ	0.02	0.04	0.04
Magnesium	mg/ℓ	37	20	22
Manganese	mg/ℓ	0.27	0.14	0.20
Mercury	mg/ℓ	0.0004	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.011	0.023	0.020
Nickel	mg/ℓ	<0.01	0.09	<0.01
Potassium	mg/ℓ	26	21	25
Selenium	mg/ℓ	0.014	0.013	0.004
Silver	mg/ℓ	0.002	0.002	0.003
Sodium	mg/ℓ	810	1,400	1,300
Zinc	mg/ℓ	0.02	0.08	0.02

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	370/440	520	170
Chloride	mg/ℓ	5,100/5,300	1,900	11
Cyanide	mg/ℓ	<0.02/<0.02	0.02	<0.02
Fluoride	mg/ℓ	0.6/0.7	1.3	1.2
Nitrate	mg/ℓ NO_3-N	21/19	9.5	2.4
pH	--	8.00/8.10	8.20	8.20
Phenolics	mg/ℓ	0.02/0.03	<0.01	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	11,000/10,000	4,900	1,700
Specific Conductance	µmhos/cm @ 25°C	18,400/17,600	8,460	2,450
Sulfate	mg/ℓ SO_4^{-2}	600/500	400	650
Metals:				
Aluminum	mg/ℓ	<0.1/0.1	0.2	0.6
Arsenic	mg/ℓ	0.004/0.004	<0.001	0.004
Barium	mg/ℓ	0.11/0.16	0.037	0.016
Boron	mg/ℓ	<0.5/0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001/<0.001	<0.001	<0.001
Calcium	mg/ℓ	300/260	60	33
Chromium	mg/ℓ	0.006/0.004	0.004	0.005
Cobalt	mg/ℓ	0.055/0.076	<0.001	<0.001
Copper	mg/ℓ	0.03/0.02	0.04	<0.01
Iron	mg/ℓ	0.06/0.18	0.06	0.12
Lead	mg/ℓ	0.17/0.16	0.02	0.01
Magnesium	mg/ℓ	58/59	17	4.9
Manganese	mg/ℓ	0.50/0.41	0.16	0.07
Mercury	mg/ℓ	<0.0002/<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.025/0.024	0.029	0.012
Nickel	mg/ℓ	0.08/0.08	<0.01	<0.01
Potassium	mg/ℓ	41/40	20	7.1
Selenium	mg/ℓ	0.016/0.017	0.014	0.011
Silver	mg/ℓ	<0.001/<0.001	<0.001	<0.001
Sodium	mg/ℓ	3,200/3,100	1,400	290
Zinc	mg/ℓ	0.04/0.01	0.02	0.03

Table 27-B17
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR SPOIL S-3

PARAMETER	UNITS	SPOIL S-3 LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	200	1,400	860
Chloride	mg/ℓ	29	390	320
Cyanide	mg/ℓ	0.02	0.02	0.02
Fluoride	mg/ℓ	1.3	1.8	2.2
Nitrate	mg/ℓ NO_3-N	12	16	12
pH	--	8.20	8.10	8.30
Phenolics	mg/ℓ	0.01	0.01	<0.01
Residue:				
Filterable @ 180°C	mg/ℓ	2,900	5,300	4,800
Specific Conductance	µmhos/cm @ 25°C	4,130	7,700	6,840
Sulfate	mg/ℓ SO_4^{-2}	1,900	1,000	1,800
Metals:				
Aluminum	mg/ℓ	<0.1	<0.1	0.1
Arsenic	mg/ℓ	0.002	0.001	0.003
Barium	mg/ℓ	0.053	0.093	0.037
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	160	140	110
Chromium	mg/ℓ	<0.001	0.004	0.005
Cobalt	mg/ℓ	0.011	0.004	0.012
Copper	mg/ℓ	0.02	0.02	0.02
Iron	mg/ℓ	0.02	0.06	0.08
Lead	mg/ℓ	0.02	0.02	0.03
Magnesium	mg/ℓ	23	25	19
Manganese	mg/ℓ	0.60	0.19	0.26
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.012	0.002	0.007
Nickel	mg/ℓ	<0.01	0.02	<0.01
Potassium	mg/ℓ	19	18	16
Selenium	mg/ℓ	0.019	0.026	0.020
Silver	mg/ℓ	0.002	0.002	0.002
Sodium	mg/ℓ	750	1,500	1,300
Zinc	mg/ℓ	0.05	0.06	0.05

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	440	630	260
Chloride	mg/ℓ	5,600	2,100	13
Cyanide	mg/ℓ	0.02	<0.02	<0.02
Fluoride	mg/ℓ	0.7	1.9	1.4
Nitrate	mg/ℓ NO_3-N	23	17	52
pH	--	7.90	8.20	8.10
Phenolics	mg/ℓ	<0.01	0.16	<0.01
Residue:				
Filterable @ 180°C	mg/ℓ	11,400	5,100	1,700
Specific Conductance	µmhos/cm @ 25°C	17,900	8,950	2,230
Sulfate	mg/ℓ SO_4^{-2}	1,600	300	650
Metals:				
Aluminum	mg/ℓ	<0.1	0.3	<0.1
Arsenic	mg/ℓ	0.006	<0.001	0.001
Barium	mg/ℓ	0.37	0.078	0.098
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	0.002	<0.001	<0.001
Calcium	mg/ℓ	470	60	50
Chromium	mg/ℓ	<0.001	0.005	0.001
Cobalt	mg/ℓ	0.13	0.002	<0.001
Copper	mg/ℓ	0.03	0.06	<0.01
Iron	mg/ℓ	0.06	0.06	0.02
Lead	mg/ℓ	0.18	0.01	<0.01
Magnesium	mg/ℓ	65	15	6.3
Manganese	mg/ℓ	0.76	0.17	0.11
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.008	0.008	0.013
Nickel	mg/ℓ	0.07	0.03	<0.01
Potassium	mg/ℓ	34	18	8.9
Selenium	mg/ℓ	0.032	0.024	0.026
Silver	mg/ℓ	<0.001	<0.001	<0.001
Sodium	mg/ℓ	3,100	1,500	420
Zinc	mg/ℓ	0.04	0.05	0.05

Table 27-B18
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR SPOIL S-4

PARAMETER	UNITS	SPOIL S-4 LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	200/190	1,800	690
Chloride	mg/ℓ	43/51	410	340
Cyanide	mg/ℓ	0.03/0.02	<0.02	<0.02
Fluoride	mg/ℓ	0.6/0.7	0.9	0.9
Nitrate	mg/ℓ NO_3-N	11/11	11	19
pH	--	7.85/8.00	8.15	7.80
Phenolics	mg/ℓ	0.02/<0.01	<0.01	0.01
Residue:				
Filterable @ 180°C	mg/ℓ	4,600/4,000	8,800	6,700
Specific Conductance	µmhos/cm @ 25°C	5,450/5,120	7,490	8,230
Sulfate	mg/ℓ SO_4^{-2}	2,700/2,800	1,300	3,000
Metals:				
Aluminum	mg/ℓ	<0.1/<0.1	0.7	<0.1
Arsenic	mg/ℓ	0.002/0.002	0.003	0.005
Barium	mg/ℓ	0.038/0.048	0.069	0.046
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001/<0.001	<0.001	<0.001
Calcium	mg/ℓ	640/530	210	460
Chromium	mg/ℓ	<0.001/0.003	0.006	0.001
Cobalt	mg/ℓ	0.006/0.007	0.009	0.024
Copper	mg/ℓ	0.02/<0.01	0.06	<0.01
Iron	mg/ℓ	0.06/0.04	0.31	0.04
Lead	mg/ℓ	<0.01/<0.01	<0.01	0.02
Magnesium	mg/ℓ	37/33	21	27
Manganese	mg/ℓ	0.70/0.86	0.32	0.62
Mercury	mg/ℓ	<0.0002/<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.004/0.005	0.003	0.003
Nickel	mg/ℓ	<0.01/<0.01	0.06	0.03
Potassium	mg/ℓ	31/30	28	32
Selenium	mg/ℓ	0.020/0.020	0.018	0.012
Silver	mg/ℓ	0.002/0.002	0.002	0.002
Sodium	mg/ℓ	850/830	1,500	1,400
Zinc	mg/ℓ	0.04/0.04	0.05	0.04

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	420/780	500	160
Chloride	mg/ℓ	5,500/5,600	2,400	19
Cyanide	mg/ℓ	0.02/<0.02	<0.02	<0.02
Fluoride	mg/ℓ	0.5/0.5	0.7	0.5
Nitrate	mg/ℓ NO_3-N	20/18	11	1.0
pH	--	8.00/7.60	7.85	7.90
Phenolics	mg/ℓ	0.01/0.01	0.04	<0.01
Residue:				
Filterable @ 180°C	mg/ℓ	12,000/13,000	6,800	3,500
Specific Conductance	µmhos/cm @ 25°C	19,100/20,600	9,390	4,140
Sulfate	mg/ℓ SO_4^{-2}	1,300/2,000	1,500	2,000
Metals:				
Aluminum	mg/ℓ	<0.1/<0.1	<0.1	<0.1
Arsenic	mg/ℓ	0.005/0.006	<0.001	<0.001
Barium	mg/ℓ	0.079/0.083	0.051	0.072
Boron	mg/ℓ	0.6/<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001/0.002	<0.001	<0.001
Calcium	mg/ℓ	730/800	410	520
Chromium	mg/ℓ	0.001/<0.001	0.003	0.001
Cobalt	mg/ℓ	0.092	0.017	0.005
Copper	mg/ℓ	0.02/0.02	<0.01	<0.01
Iron	mg/ℓ	0.06/0.06	0.04	0.04
Lead	mg/ℓ	0.19/0.22	0.03	<0.01
Magnesium	mg/ℓ	53/56	27	25
Manganese	mg/ℓ	0.85/0.89	0.46	0.56
Mercury	mg/ℓ	<0.0002/<0.0002	0.0002	0.0004
Molybdenum	mg/ℓ	0.007/0.006	0.003	0.004
Nickel	mg/ℓ	0.08/0.14	0.04	<0.01
Potassium	mg/ℓ	50/50	35	26
Selenium	mg/ℓ	0.020/0.024	0.022	0.022
Silver	mg/ℓ	<0.001/<0.001	<0.001	0.002
Sodium	mg/ℓ	3,200/3,200	1,700	600
Zinc	mg/ℓ	0.04/0.04	0.04	0.03

Table 27-B19
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR SPOIL S-5

PARAMETER	UNITS	SPOIL S-5 LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	180	1,700	670
Chloride	mg/ℓ	27	300	320
Cyanide	mg/ℓ	<0.02	<0.02	0.05
Fluoride	mg/ℓ	0.9	0.9	1.3
Nitrate	mg/ℓ NO_3-N	13	13	12
pH	--	8.20	8.60	8.25
Phenolics	mg/ℓ	0.01	0.06	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	3,500	3,800	5,300
Specific Conductance	µmhos/cm @ 25°C	4,300	5,480	6,960
Sulfate	mg/ℓ SO_4^{-2}	2,300	500	2,100
Metals:				
Aluminum	mg/ℓ	<0.1	<0.1	2.5
Arsenic	mg/ℓ	0.002	0.001	0.003
Barium	mg/ℓ	0.055	0.076	0.048
Boron	mg/ℓ	<0.5	0.6	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	320	100	240
Chromium	mg/ℓ	<0.001	0.006	0.024
Cobalt	mg/ℓ	0.008	0.006	0.022
Copper	mg/ℓ	0.04	0.07	<0.01
Iron	mg/ℓ	0.02	0.06	0.20
Lead	mg/ℓ	<0.01	<0.01	0.02
Magnesium	mg/ℓ	30	17	25
Manganese	mg/ℓ	0.26	0.08	0.12
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.003	0.005	0.005
Nickel	mg/ℓ	0.01	0.03	<0.01
Potassium	mg/ℓ	26	22	27
Selenium	mg/ℓ	0.018	0.020	0.014
Silver	mg/ℓ	0.002	<0.001	0.002
Sodium	mg/ℓ	750	1,400	1,300
Zinc	mg/ℓ	<0.01	0.04	0.02

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	470/440	480	120
Chloride	mg/ℓ	5,600/5,600	2,200	16
Cyanide	mg/ℓ	0.02/<0.02	0.03	<0.02
Fluoride	mg/ℓ	0.6/0.6	1.0	1.0
Nitrate	mg/ℓ NO_3-N	21/25	15	6.0
pH	--	8.25/8.20	8.40	7.85
Phenolics	mg/ℓ	0.09/0.03	0.01	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	11,000/11,000	6,000	2,000
Specific Conductance	µmhos/cm @ 25°C	18,200/17,500	9,310	2,760
Sulfate	mg/ℓ SO_4^{-2}	1,300/800	1,100	1,200
Metals:				
Aluminum	mg/ℓ	<0.1/<0.1	<0.1	<0.1
Arsenic	mg/ℓ	0.006/0.005	0.001	0.001
Barium	mg/ℓ	0.15/0.12	0.075	0.041
Boron	mg/ℓ	0.6/0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001/0.002	<0.001	<0.001
Calcium	mg/ℓ	530/520	210	110
Chromium	mg/ℓ	0.001/0.001	0.021	0.002
Cobalt	mg/ℓ	0.079/0.070	0.002	0.009
Copper	mg/ℓ	0.02/0.02	<0.01	<0.01
Iron	mg/ℓ	0.07/0.07	0.11	0.02
Lead	mg/ℓ	0.28/0.25	<0.01	<0.01
Magnesium	mg/ℓ	57/57	25	11
Manganese	mg/ℓ	0.37/0.37	0.14	0.06
Mercury	mg/ℓ	<0.0002/<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.009/0.010	0.005	0.006
Nickel	mg/ℓ	0.09/0.08	0.01	<0.01
Potassium	mg/ℓ	43/45	28	15
Selenium	mg/ℓ	0.022/0.024	0.018	0.020
Silver	mg/ℓ	<0.001/<0.001	0.002	0.002
Sodium	mg/ℓ	3,200/3,100	1,600	520
Zinc	mg/ℓ	0.03/0.04	0.03	0.03

Table 27-B20
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR FLY ASH

PARAMETER	UNITS	FLY ASH LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	820	2,600	840
Chloride	mg/ℓ	16	360	290
Cyanide	mg/ℓ	<0.02	<0.02	<0.02
Fluoride	mg/ℓ	1.9	1.6	0.4
Nitrate	mg/ℓ NO_3-N	3.3	2.0	2.0
pH	--	12.20	10.30	11.80
Phenolics	mg/ℓ	0.03	0.03	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	2,000	4,300	4,500
Specific Conductance	umhos/cm @ 25°C	5,490	7,470	7,350
Sulfate	mg/ℓ SO_4^{-2}	590	510	1,200
Metals:				
Aluminum	mg/ℓ	0.8	15	16
Arsenic	mg/ℓ	0.009	1.00	0.140
Barium	mg/ℓ	0.49	0.30	0.33
Boron	mg/ℓ	1.0	20	12
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	290	7	80
Chromium	mg/ℓ	0.14	0.24	0.22
Cobalt	mg/ℓ	<0.001	0.005	0.004
Copper	mg/ℓ	<0.01	<0.01	<0.01
Iron	mg/ℓ	0.02	0.07	0.04
Lead	mg/ℓ	<0.01	0.01	0.01
Magnesium	mg/ℓ	0.2	0.8	0.2
Manganese	mg/ℓ	0.02	0.02	<0.01
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	1.4	0.75	0.64
Nickel	mg/ℓ	<0.01	<0.01	<0.01
Potassium	mg/ℓ	17	7.0	9.2
Selenium	mg/ℓ	0.09	0.83	0.32
Silver	mg/ℓ	<0.001/<0.001	<0.001/0.002	0.001
Sodium	mg/ℓ	380	1,300	1,100
Zinc	mg/ℓ	0.01	0.01	0.01

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	960	1,000	1,400
Chloride	mg/ℓ	5,600	2,100	3.9
Cyanide	mg/ℓ	<0.02	0.04	<0.02
Fluoride	mg/ℓ	3.1	1.9	3.3
Nitrate	mg/ℓ NO_3-N	19	3.3	2.5
pH	--	12.00	12.15	12.10
Phenolics	mg/ℓ	0.03	0.05	0.05
Residue:				
Filterable @ 180°C	mg/ℓ	10,000	4,800	1,600
Specific Conductance	μmhos/cm @ 25°C	1,970	12,500	5,710
Sulfate	mg/ℓ SO_4^{-2}	320	370	130
Metals:				
Aluminum	mg/ℓ	0.3	2.0	<0.1
Arsenic	mg/ℓ	0.017	0.030	0.010
Barium	mg/ℓ	1.3	1.7	4.9
Boron	mg/ℓ	6.2	6.2	5.1
Cadmium	mg/ℓ	<0.001	<0.001	<0.001/<0.001
Calcium	mg/ℓ	520	160	590
Chromium	mg/ℓ	0.070	0.118	0.036
Cobalt	mg/ℓ	0.070	0.006	<0.001
Copper	mg/ℓ	<0.01	<0.01	<0.01/0.05
Iron	mg/ℓ	0.04	0.03	0.02
Lead	mg/ℓ	0.19	0.04	<0.01/<0.01
Magnesium	mg/ℓ	0.2	<0.1	0.2
Manganese	mg/ℓ	0.02	<0.01	0.02/0.02
Mercury	mg/ℓ	0.0006	<0.0002	<0.0002
Molybdenum	mg/ℓ	1.5	1.2	1.5
Nickel	mg/ℓ	0.05	<0.01	0.07
Potassium	mg/ℓ	22	14	2.0/2.0
Selenium	mg/ℓ	0.22	0.38	0.24
Silver	mg/ℓ	0.001/0.002	<0.001/0.001	0.016/0.014
Sodium	mg/ℓ	3,000	1,900	41
Zinc	mg/ℓ	0.01	0.01	0.04/0.04

Table 27-B21
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR BOTTOM ASH

PARAMETER	UNITS	BOTTOM ASH LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	80	2900	900
Chloride	mg/ℓ	22	2.4	290
Cyanide	mg/ℓ	<0.02	<0.02	<0.02
Fluoride	mg/ℓ	0.9	1.9	2.1
Nitrate	mg/ℓ NO_3-N	2.5	5.8	3.0
pH	--	8.15	8.90	8.60
Phenolics	mg/ℓ	0.02	0.02	0.04
Residue:				
Filterable @ 180°C	mg/ℓ	2,000	3,800	3,900
Specific Conductance	µmhos/cm @ 25°C	2,350	5,940	5,510
Sulfate	mg/ℓ SO_4^{-2}	940	44	1,100
Metals:				
Aluminum	mg/ℓ	<0.1	<0.1	<0.1
Arsenic	mg/ℓ	<0.001	0.004	<0.001
Barium	mg/ℓ	0.30	1.4	0.13
Boron	mg/ℓ	<0.5	0.8	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	260	18	50
Chromium	mg/ℓ	0.001	0.003	0.001
Cobalt	mg/ℓ	<0.001	0.004	0.005
Copper	mg/ℓ	<0.01	0.02	<0.01
Iron	mg/ℓ	0.03	0.08	0.04
Lead	mg/ℓ	<0.01	<0.01	<0.01
Magnesium	mg/ℓ	28	4.6	6.2
Manganese	mg/ℓ	0.07	0.04	0.06
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.023	0.024	0.003
Nickel	mg/ℓ	0.06	<0.01	0.04
Potassium	mg/ℓ	11	7.7	8.3
Selenium	mg/ℓ	0.046	0.023	0.023
Silver	mg/ℓ	0.004/0.003[2]	<0.001/<0.001	0.002
Sodium	mg/ℓ	330	1,200	1,000
Zinc	mg/ℓ	0.02	0.01	0.02

(Continued)

PARAMETER	UNITS	BOTTOM ASH LEACHED WITH: COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	470	870	40
Chloride	mg/ℓ	5,500	2,100	5.9
Cyanide	mg/ℓ	<0.02	<0.02	<0.02
Fluoride	mg/ℓ	0.7	1.0	0.1
Nitrate	mg/ℓ NO_3-N	15	3.5	0.3
pH	--	8.25	9.50	7.80
Phenolics	mg/ℓ	0.03	0.04	0.05
Residue:				
Filterable @ 180°C	mg/ℓ	8,700	4,500	100
Specific Conductance	μmhos/cm @ 25°C	15,900	8930	157
Sulfate	mg/ℓ SO_4^{-2}	170	210	50
Metals:				
Aluminum	mg/ℓ	<0.1	0.3	0.2
Arsenic	mg/ℓ	<0.001	0.010	<0.001
Barium	mg/ℓ	0.93	0.81	0.30
Boron	mg/ℓ	0.6	0.6	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	170	7	21
Chromium	mg/ℓ	<0.001	0.048	0.002
Cobalt	mg/ℓ	0.076/0.070	0.004	<0.001
Copper	mg/ℓ	0.02	0.02	<0.01
Iron	mg/ℓ	0.05	0.09	0.06
Lead	mg/ℓ	0.24	0.04	<0.01
Magnesium	mg/ℓ	37	4.4	1.4
Manganese	mg/ℓ	0.14	0.02	0.02
Mercury	mg/ℓ	<0.0002	<0.0002	0.0002
Molybdenum	mg/ℓ	0.031	0.019	0.017
Nickel	mg/ℓ	0.08	0.06	0.02
Potassium	mg/ℓ	20	11	0.83
Selenium	mg/ℓ	0.020	0.013	0.006
Silver	mg/ℓ	<0.001/<0.001	<0.001/<0.001	<0.001/<0.001
Sodium	mg/ℓ	3,500	1,300	11
Zinc	mg/ℓ	0.02	0.02	0.01

Table 27-B22
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR COMPOSITED SLUDGE

PARAMETER	UNITS	COMPOSITE SLUDGE LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	96	1,100	160
Chloride	mg/ℓ	55	200	330
Cyanide	mg/ℓ	<0.02	<0.02	<0.02
Fluoride	mg/ℓ	1.8	11	8.5
Nitrate	mg/ℓ NO_3-N	11	2.5	6.1
pH	--	10.40	8.60	9.90
Phenolics	mg/ℓ	0.02	<0.01	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	2,000	4,800	4,700
Specific Conductance	µmhos/cm @ 25°C	2,570	7,300	5,730
Sulfate	mg/ℓ SO_4^{-2}	1,400	1,300	2,600
Metals:				
Aluminum	mg/ℓ	0.3	0.3	0.6
Arsenic	mg/ℓ	0.018	0.223	0.140
Barium	mg/ℓ	0.39	0.53	0.41
Boron	mg/ℓ	3.1	33	14
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	330	130	170
Chromium	mg/ℓ	0.096	0.084	0.081
Cobalt	mg/ℓ	<0.001	<0.001	0.003
Copper	mg/ℓ	<0.01	<0.01	<0.01
Iron	mg/ℓ	0.02	0.12	0.02
Lead	mg/ℓ	<0.01	0.03	0.03
Magnesium	mg/ℓ	0.2	9.5	3.2
Manganese	mg/ℓ	0.05	0.11	0.06
Mercury	mg/ℓ	<0.0002	0.0003	<0.0002
Molybdenum	mg/ℓ	0.90	1.0	0.80
Nickel	mg/ℓ	0.04	0.04	0.05
Potassium	mg/ℓ	18	13	14
Selenium	mg/ℓ	0.018	0.54	0.12
Silver	mg/ℓ	<0.001	<0.001	0.002
Sodium	mg/ℓ	350	1,200	1,100
Zinc	mg/ℓ	0.02	0.04	0.02

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	140/140	210	110
Chloride	mg/ℓ	4,900/4,900	2,200	22
Cyanide	mg/ℓ	<0.02/<0.02	<0.02	<0.02
Fluoride	mg/ℓ	5.7/6.0	5.7	1.6
Nitrate	mg/ℓ NO_3-N	16/16	6.5	2.0
pH	--	9.80/9.60	10.80	10.70
Phenolics	mg/ℓ	0.01/0.03	0.03	<0.01
Residue:				
Filterable @ 180°C	mg/ℓ	9,800/9,800	5,000	520
Specific Conductance	umhos/cm @ 25°C	17,700/17,800	7,950	927
Sulfate	mg/ℓ SO_4^{-2}	400/500	1,500	100
Metals:				
Aluminum	mg/ℓ	0.2/0.5	1.4	0.9
Arsenic	mg/ℓ	0.057/0.057	0.076	0.013
Barium	mg/ℓ	0.88/0.77	0.39	1.0
Boron	mg/ℓ	15/11	15	2.9
Cadmium	mg/ℓ	<0.001/<0.001	<0.001	<0.001
Calcium	mg/ℓ	340/410	120	120
Chromium	mg/ℓ	0.11/0.10	0.14	0.078
Cobalt	mg/ℓ	0.008/0.011	<0.001	<0.001
Copper	mg/ℓ	<0.01/<0.01	<0.01	<0.01
Iron	mg/ℓ	0.04/0.08	0.02	0.02
Lead	mg/ℓ	0.12/0.12	0.04	<0.01
Magnesium	mg/ℓ	2.6/8.3	<0.1	<0.1
Manganese	mg/ℓ	0.07/0.06	0.06	0.05
Mercury	mg/ℓ	<0.0002/<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	1.3/1.4	1.3	1.2
Nickel	mg/ℓ	0.06/0.06	0.05	<0.01
Potassium	mg/ℓ	25/25	17	6.6
Selenium	mg/ℓ	0.14/0.15	0.17	0.045
Silver	mg/ℓ	0.002/0.002	<0.001	<0.001
Sodium	mg/ℓ	2,800/2,800	1,300	44
Zinc	mg/ℓ	0.03/0.04	<0.01	0.03

Table 27-B23
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR COMPOSITED WASTE AND OVERBURDEN D-1

PARAMETER	UNITS	COMPOSITE SLUDGE, BOTTOM ASH, AND OVERBURDEN D-1 LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	140	2,300	740
Chloride	mg/ℓ	25	190	320
Cyanide	mg/ℓ	<0.02	0.04	<0.02
Fluoride	mg/ℓ	3.0	3.0	2.9
Nitrate	mg/ℓ NO_3-N	2.2	2.4	2.2
pH	--	7.85	8.55	8.45
Phenolics	mg/ℓ	0.03	0.02	0.04
Residue:				
Filterable @ 180°C	mg/ℓ	3,000	4,100	4,900
Specific Conductance	µmhos/cm @ 25°C	4,300	6,490	6,660
Sulfate	mg/ℓ SO_4^{-2}	1,700	500	2,100
Metals:				
Aluminum	mg/ℓ	3.3	11	0.6
Arsenic	mg/ℓ	0.003	0.003	0.004
Barium	mg/ℓ	0.036	0.088	0.053
Boron	mg/ℓ	<0.5	0.9	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	110	32	80
Chromium	mg/ℓ	0.010	0 018	0.018
Cobalt	mg/ℓ	0.016	<0.001	0.043
Copper	mg/ℓ	0.03	0.02	0.02
Iron	mg/ℓ	0.38	0.54	0.62
Lead	mg/ℓ	0.02	0.01	0.04
Magnesium	mg/ℓ	8.6	5.8	7.4
Manganese	mg/ℓ	0.10	0.06	0.10
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.026	0.027	0.018
Nickel	mg/ℓ	<0.01	<0.01	<0.01
Potassium	mg/ℓ	18	16	17
Selenium	mg/ℓ	0.013	0.008	0.004
Silver	mg/ℓ	<0.001	<0.001	0.002
Sodium	mg/ℓ	820	1,300	1,200
Zinc	mg/ℓ	0.03	0.03	0.05

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	380/420	490	120
Chloride	mg/ℓ	5,400/5,200	2,100	20
Cyanide	mg/ℓ	<0.02/<0.02	<0.02	<0.02
Fluoride	mg/ℓ	1.4/1.9	2.3	4.3
Nitrate	mg/ℓ NO_3-N	19/16	5.0	<0.1
pH	--	7.80/7.90	8.30	7.70
Phenolics	mg/ℓ	0.02/0.05	<0.01	0.01
Residue:				
Filterable @ 180°C	mg/ℓ	10,000/10,000	5,200	1,700
Specific Conductance	μmhos/cm @ 25°C	20,100/18,000	9,050	2,650
Sulfate	mg/ℓ SO_4^{-2}	1,700/1,900	400	1,000
Metals:				
Aluminum	mg/ℓ	<0.1/<0.1	1.0	4.0
Arsenic	mg/ℓ	0.008/0.003	0.002	0.014
Barium	mg/ℓ	0.17/0.13	0.090	0.12
Boron	mg/ℓ	1.0/1.0	0.8	0.5
Cadmium	mg/ℓ	<0.001/<0.001	<0.001	<0.001
Calcium	mg/ℓ	220/250	50	37
Chromium	mg/ℓ	0.002/<0.001	<0.001	0.032
Cobalt	mg/ℓ	0.013/0.011	<0.001	<0.001
Copper	mg/ℓ	0.02/<0.01	0.03	0.02
Iron	mg/ℓ	0.06/0.04	0.56	1.0
Lead	mg/ℓ	0.18/0.11	0.02	0.01
Magnesium	mg/ℓ	30/28	7.1	2.5
Manganese	mg/ℓ	0.18/0.20	0.10	0.07
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.050/0.029	0.016	0.020
Nickel	mg/ℓ	0.03/0.04	<0.01	<0.01
Potassium	mg/ℓ	38/28	18	9.2
Selenium	mg/ℓ	0.018/0.011	0.006	0.013
Silver	mg/ℓ	<0.001/0.002	<0.001	0.002
Sodium	mg/ℓ	3,100/2,400	1,500	500
Zinc	mg/ℓ	0.03/0.02	0.06	0.08

Table 27-B24
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR COMPOSITED WASTE AND OVERBURDEN D-2

PARAMETER	UNITS	COMPOSITE SLUDGE, BOTTOM ASH, AND OVERBURDEN D-2 LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	130	2,300	730
Chloride	mg/ℓ	22	360	290
Cyanide	mg/ℓ	0.05	0.02	<0.02
Fluoride	mg/ℓ	2.3	2.6	3.0
Nitrate	mg/ℓ NO_3-N	10	4.3	5.4
pH	--	7.80	8.25	7.90
Phenolics	mg/ℓ	0.05	0.03	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	3,700	5,000	5,400
Specific Conductance	umhos/cm @ 25°C	4,300	7,920	8,070
Sulfate	mg/ℓ SO_4^{-2}	2,200	2,000	3,200
Metals:				
Aluminum	mg/ℓ	<0.1	1.4	<0.1
Arsenic	mg/ℓ	<0.001	0.001	<0.001
Barium	mg/ℓ	0.15	0.093	0.075
Boron	mg/ℓ	0.6	1.1	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	500	110	320
Chromium	mg/ℓ	0.004	0.017	0.002
Cobalt	mg/ℓ	<0.001	<0.001	0.002
Copper	mg/ℓ	<0.01	0.06	<0.01
Iron	mg/ℓ	0.04	0.30	0.04
Lead	mg/ℓ	<0.01	0.02	0.03
Magnesium	mg/ℓ	75	37	56
Manganese	mg/ℓ	0.31	0.17	0.39
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.032	<0.001	0.023
Nickel	mg/ℓ	0.02	0.04	0.02
Potassium	mg/ℓ	17	17	18
Selenium	mg/ℓ	0.020	0.014	0.007
Silver	mg/ℓ	<0.001	<0.001	0.002
Sodium	mg/ℓ	550	1,400	1,200
Zinc	mg/ℓ	0.03	0.04	0.02

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	740	480	80
Chloride	mg/ℓ	5,600	2,000	3.9
Cyanide	mg/ℓ	<0.02	0.03	0.03
Fluoride	mg/ℓ	1.9	2.6	2.4
Nitrate	mg/ℓ NO_3-N	16	11	8.5
pH	--	8.00	8.20	7.90
Phenolics	mg/ℓ	0.03	0.02	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	11,000	6,000	2,100
Specific Conductance	μmhos/cm @ 25°C	20,500	9,600	2,470
Sulfate	mg/ℓ SO_4^{-2}	1,400	1,000	1,400
Metals:				
Aluminum	mg/ℓ	0.1	<0.1	<0.1
Arsenic	mg/ℓ	0.005	<0.001	<0.001
Barium	mg/ℓ	0.24	0.12	0.079
Boron	mg/ℓ	0.8	0.8	0.5
Cadmium	mg/ℓ	0.004	<0.001	<0.001
Calcium	mg/ℓ	540	240	340
Chromium	mg/ℓ	0.002	0.006	0.003
Cobalt	mg/ℓ	0.16	<0.001	<0.001
Copper	mg/ℓ	0.03	0.03	<0.01
Iron	mg/ℓ	0.06	0.06	0.04
Lead	mg/ℓ	0.29	0.03	<0.01
Magnesium	mg/ℓ	90	51	46
Manganese	mg/ℓ	0.53	0.28	0.27
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.034	0.016	0.047
Nickel	mg/ℓ	0.08	0.06	<0.01
Potassium	mg/ℓ	30	20	11
Selenium	mg/ℓ	0.019	0.013	0.020
Silver	mg/ℓ	<0.001	<0.001	<0.001
Sodium	mg/ℓ	3,700	1,400	250
Zinc	mg/ℓ	0.02	0.03	<0.01

Table 27-B25
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR COMPOSITE WASTE AND SPOIL S-1

PARAMETER	UNITS	COMPOSITE SLUDGE, BOTTOM ASH AND SPOIL S-1 LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	320	2,100	680
Chloride	mg/ℓ	43	390	340
Cyanide	mg/ℓ	<0.02	0.09	0.02
Fluoride	mg/ℓ	1.3	1.8	1.7
Nitrate	mg/ℓ NO_3-N	14	15	12
pH	--	8.30	8.50	8.00
Phenolics	mg/ℓ	0.03	0.03	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	5,800	6,200	7,400
Specific Conductance	µmhos/cm @ 25°C	6,390	8,040	8,780
Sulfate	mg/ℓ SO_4^{-2}	3,500	1,800	3,900
Metals:				
Aluminum	mg/ℓ	0.3	0.1	0.8
Arsenic	mg/ℓ	0.005	0.003	0.005
Barium	mg/ℓ	0.20	0.26	0.15
Boron	mg/ℓ	<0.5	0.8	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	600	230	450
Chromium	mg/ℓ	0.004	0.005	0.009
Cobalt	mg/ℓ	0.006	0.006	0.007
Copper	mg/ℓ	0.05	0.05	0.11
Iron	mg/ℓ	0.16	0.12	0.22
Lead	mg/ℓ	0.02	0.01	0.04
Magnesium	mg/ℓ	64	36	46
Manganese	mg/ℓ	0.59	0.31	0.55
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.005	0.005	0.006
Nickel	mg/ℓ	0.07	0.07	0.12
Potassium	mg/ℓ	25	22	23
Selenium	mg/ℓ	0.017	0.016	0.010
Silver	mg/ℓ	0.001	0.001	0.001
Sodium	mg/ℓ	900	1,600	1,500
Zinc	mg/ℓ	0.04	0.05	0.12

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	1,100	500	300
Chloride	mg/ℓ	5,700	2,300	35
Cyanide	mg/ℓ	0.04	0.02	<0.02
Fluoride	mg/ℓ	1.1	1.6	1.2
Nitrate	mg/ℓ NO_3-N	21	15	10
pH	--	8.30	8.50	8.10
Phenolics	mg/ℓ	0.03	0.04	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	14,000	8,300	4,400
Specific Conductance	µmhos/cm @ 25°C	20,400	11,400	5,080
Sulfate	mg/ℓ SO_4^{-2}	3,500	2,800	3,000
Metals:				
Aluminum	mg/ℓ	0.1	0.2	0.2
Arsenic	mg/ℓ	0.002	0.003	0.002
Barium	mg/ℓ	0.34	0.26	0.10
Boron	mg/ℓ	<0.5	<0.5	0.8
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	900	570	470
Chromium	mg/ℓ	<0.001	0.011	0.002
Cobalt	mg/ℓ	0.092/0.091	0.007	0.002
Copper	mg/ℓ	0.06	0.05	0.02
Iron	mg/ℓ	0.16	0.08	0.10
Lead	mg/ℓ	0.24	0.04	<0.01
Magnesium	mg/ℓ	94	60	45
Manganese	mg/ℓ	1.2	0.55	0.60
Mercury	mg/ℓ	0.0007	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.007	0.004	0.008
Nickel	mg/ℓ	0.18	0.14	0.01
Potassium	mg/ℓ	41	27	18
Selenium	mg/ℓ	0.010	0.014	0.016
Silver	mg/ℓ	0.001	0.001	0.001
Sodium	mg/ℓ	3,900	2,300	800
Zinc	mg/ℓ	0.04	0.04	0.05

Table 27-B26
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR COMPOSITED WASTE AND SPOIL S-2

PARAMETER	UNITS	COMPOSITE SLUDGE, BOTTOM ASH, AND SPOIL S-2 LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	220	2,000	610
Chloride	mg/ℓ	27	370	320
Cyanide	mg/ℓ	<0.02	0.05	0.04
Fluoride	mg/ℓ	1.5	2.3	1.9
Nitrate	mg/ℓ NO_3-N	9.5	3.5	6.8
pH	--	8.30	8.20	8.05
Phenolics	mg/ℓ	0.03	0.03	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	4,100	5,400	6,200
Specific Conductance	µmhos/cm @ 25°C	4,950	8,270	8,950
Sulfate	mg/ℓ SO_4^{-2}	2,200	1,500	3,400
Metals:				
Aluminum	mg/ℓ	0.4	3.9	0.1
Arsenic	mg/ℓ	0.002	0.003	0.005
Barium	mg/ℓ	0.047	0.097	0.043
Boron	mg/ℓ	<0.5	1.0	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	340	130	310
Chromium	mg/ℓ	<0.001	0.013	<0.001
Cobalt	mg/ℓ	0.003	0.007	0.006
Copper	mg/ℓ	0.05	0.05	0.03
Iron	mg/ℓ	0.07	0.93	0.07
Lead	mg/ℓ	<0.01	<0.01	0.01
Magnesium	mg/ℓ	41	30	44
Manganese	mg/ℓ	0.48	0.21	0.23
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.007	0.009	0.007
Nickel	mg/ℓ	0.04	0.04	0.03
Potassium	mg/ℓ	26	24	27
Selenium	mg/ℓ	0.016	0.010	0.007
Silver	mg/ℓ	0.001	0.001	0.001
Sodium	mg/ℓ	860	1,500	1,300
Zinc	mg/ℓ	0.05	0.05	0.03

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	360/460	460	220
Chloride	mg/ℓ	5,800/5,600	2,300	14
Cyanide	mg/ℓ	0.02/<0.02	0.04	<0.02
Fluoride	mg/ℓ	1.2/1.8	1.6	2.2
Nitrate	mg/ℓ NO_3-N	14/17	6.5	3.0
pH	--	8.35/8.20	8.10	8.25
Phenolics	mg/ℓ	0.04/0.02	0.04	0.04
Residue:				
Filterable @ 180°C	mg/ℓ	12,000/12,000	6,600	3,000
Specific Conductance	μmhos/cm @ 25°C	17,600/18,400	9,950	3,730
Sulfate	mg/ℓ SO_4^{-2}	1,700/1,500	1,700	1,800
Metals:				
Aluminum	mg/ℓ	<0.1/0.2	0.5	0.4
Arsenic	mg/ℓ	<0.001	0.002	<0.001
Barium	mg/ℓ	0.20/0.27	0.096	0.068
Boron	mg/ℓ	<0.5/<0.5	<0.5	<0.5
Cadmium	mg/ℓ	0.056/0.052	<0.001	<0.001
Calcium	mg/ℓ	650/510	270	270
Chromium	mg/ℓ	<0.001/<0.001	0.003	0.004
Cobalt	mg/ℓ	0.11/0.086	0.005	0.002
Copper	mg/ℓ	0.04/0.03	0.05	0.05
Iron	mg/ℓ	0.09/0.07	0.09	0.07
Lead	mg/ℓ	0.23	0.04	<0.01
Magnesium	mg/ℓ	83/76	40	28
Manganese	mg/ℓ	1.1/0.93	0.30	0.29
Mercury	mg/ℓ	<0.0002/<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.012	0.007	0.008
Nickel	mg/ℓ	0.07/0.07	<0.01	0.03
Potassium	mg/ℓ	43/44	29	18
Selenium	mg/ℓ	0.010/0.018	0.014	0.003
Silver	mg/ℓ	0.003/0.005	0.001/0.004	0.001
Sodium	mg/ℓ	3,000/2,800	1,600	580
Zinc	mg/ℓ	0.04/0.03	0.04	0.04

Table 27-B27
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR COMPOSITED WASTE AND SPOIL S-3

PARAMETER	UNITS	COMPOSITE SLUDGE, BOTTOM ASH, AND SPOIL S-3 LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	150	2,000	760
Chloride	mg/ℓ	29	390	380
Cyanide	mg/ℓ	0.05	<0.02	0.04
Fluoride	mg/ℓ	2.0	2.8	2.7
Nitrate	mg/ℓ NO_3-N	13	17	11
pH	--	7.80	8.45	8.20
Phenolics	mg/ℓ	0.04	0.03	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	4,800	5,500	6,800
Specific Conductance	umhos/cm @ 25°C	6,190	8,030	9,300
Sulfate	mg/ℓ SO_4^{-2}	3,200	1,400	3,600
Metals:				
Aluminum	mg/ℓ	<0.1	0.5	0.1
Arsenic	mg/ℓ	0.003	0.003	0.005
Barium	mg/ℓ	0.056	0.058	0.050
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	490	110	430
Chromium	mg/ℓ	0.004	0.004	0.004
Cobalt	mg/ℓ	0.009	0.011	0.031
Copper	mg/ℓ	0.03	0.16	0.03
Iron	mg/ℓ	0.04	0.08	0.06
Lead	mg/ℓ	0.02	0.02	0.04
Magnesium	mg/ℓ	48	23	43
Manganese	mg/ℓ	1.2	0.24	1.2
Mercury	mg/ℓ	0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.033	0.009	0.022
Nickel	mg/ℓ	<0.01	0.04	<0.01
Potassium	mg/ℓ	25	17	22
Selenium	mg/ℓ	0.018	0.019	0.012
Silver	mg/ℓ	0.002	0.002	0.002
Sodium	mg/ℓ	900	1,400	1,300
Zinc	mg/ℓ	0.04	0.05	0.04

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	450	530	130
Chloride	mg/ℓ	5,500	2,200	14
Cyanide	mg/ℓ	0.02	0.09	<0.02
Fluoride	mg/ℓ	1.4	2.1	1.6
Nitrate	mg/ℓ NO_3-N	20	14	10
pH	--	7.85	8.05	7.60
Phenolics	mg/ℓ	0.05	0.03	0.04
Residue:				
Filterable @ 180°C	mg/ℓ	12,000	6,900	3,100
Specific Conductance	umhos/cm @ 25°C	20,200	11,700	3,790
Sulfate	mg/ℓ SO_4^{-2}	1,500	670	1900
Metals:				
Aluminum	mg/ℓ	0.2	0.1	0.2
Arsenic	mg/ℓ	0.006	0.002	0.002
Barium	mg/ℓ	0.18	0.098	0.047
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	540	340	350
Chromium	mg/ℓ	0.004	0.008	<0.001
Cobalt	mg/ℓ	0.035/0.047	0.007	0.003
Copper	mg/ℓ	0.05	0.03	0.02
Iron	mg/ℓ	0.06	0.06	0.02
Lead	mg/ℓ	0.12	0.02	<0.01
Magnesium	mg/ℓ	72	40	34
Manganese	mg/ℓ	1.2	0.72	0.64
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.032	0.020	0.022
Nickel	mg/ℓ	0.12	0.08	<0.01
Potassium	mg/ℓ	35	23	16
Selenium	mg/ℓ	0.023	0.021	0.023
Silver	mg/ℓ	<0.001	<0.001	<0.001
Sodium	mg/ℓ	3,800	2,000	580
Zinc	mg/ℓ	0.03	0.01	0.02

Table 27-B28
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR COMPOSITED WASTE AND SPOIL S-4

PARAMETER	UNITS	COMPOSITE SLUDGE, BOTTOM ASH, AND SPOIL S-4 LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	210/180	1,600	690
Chloride	mg/ℓ	37/16	400	310
Cyanide	mg/ℓ	<0.02/<0.02	<0.02	0.04
Fluoride	mg/ℓ	1.0/1.0	2.2	1.4
Nitrate	mg/ℓ NO_3-N	9.5/11	4.0	7.2
pH	--	7.70/7.90	8.40	8.00
Phenolics	mg/ℓ	0.03/0.02	0.10	0.04
Residue:				
Filterable @ 180°C	mg/ℓ	5,300/5,200	6,000	6,900
Specific Conductance	µmhos/cm @ 25°C	5,970/6,800	8,370	9,560
Sulfate	mg/ℓ SO_4^{-2}	3,200/3,400	2,300	3,800
Metals:				
Aluminum	mg/ℓ	0.2/0.1	3.6	0.1
Arsenic	mg/ℓ	0.003/0.002	0.004	0.005
Barium	mg/ℓ	0.076/0.049	0.025	0.052
Boron	mg/ℓ	<0.5/<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001/<0.001	<0.001	<0.001
Calcium	mg/ℓ	670/680	100	500
Chromium	mg/ℓ	0.027/0.006	0.008	0.004
Cobalt	mg/ℓ	0.015/0.012	0.023	0.042
Copper	mg/ℓ	<0.01/0.02	0.02	0.02
Iron	mg/ℓ	0.02/0.02	0.13	0.02
Lead	mg/ℓ	0.01/0.01	0.02	0.04
Magnesium	mg/ℓ	47/45	24	31
Manganese	mg/ℓ	1.4/1.2	0.08	0.90
Mercury	mg/ℓ	<0.0002/<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.020/0.017	0.007	0.015
Nickel	mg/ℓ	0.02/0.02	0.04	0.06
Potassium	mg/ℓ	32/30	30	30
Selenium	mg/ℓ	0.018/0.013	0.004	0.004
Silver	mg/ℓ	0.002/<0.001	0.002	0.002
Sodium	mg/ℓ	850/870	1,500	1,300
Zinc	mg/ℓ	0.05/0.05	0.03	0.05

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	350	460	110
Chloride	mg/ℓ	5,700	2,200	20
Cyanide	mg/ℓ	<0.02	0.04	<0.02
Fluoride	mg/ℓ	0.9	1.3	1.2
Nitrate	mg/ℓ NO_3-N	15	5.3	4.3
pH	--	7.90	8.20	7.90
Phenolics	mg/ℓ	0.03	0.03	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	12,000	7,600	3,700
Specific Conductance	µmhos/cm @ 25°C	19,800	12,100	4,330
Sulfate	mg/ℓ SO_4^{-2}	2,000	2,300	2,400
Metals:				
Aluminum	mg/ℓ	0.1	<0.1	0.1
Arsenic	mg/ℓ	0.009	0.003	<0.001
Barium	mg/ℓ	0.095	0.093	0.077
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	790	470	530
Chromium	mg/ℓ	0.002	0.002	0.004
Cobalt	mg/ℓ	0.052	0.028	0.005
Copper	mg/ℓ	0.02	<0.01	0.14
Iron	mg/ℓ	0.04	<0.01	0.02
Lead	mg/ℓ	0.15	0.04	<0.01
Magnesium	mg/ℓ	62	33	28
Manganese	mg/ℓ	1.3	0.51	0.78
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.016	0.014	0.020
Nickel	mg/ℓ	0.08	<0.01	<0.01
Potassium	mg/ℓ	49	40	26
Selenium	mg/ℓ	0.016	0.012	0.006
Silver	mg/ℓ	<0.001	0.002	<0.001
Sodium	mg/ℓ	3,100	2,100	610
Zinc	mg/ℓ	0.06/0.06	0.03	0.11/0.10

Table 27-B29
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR COMPOSITED WASTE AND SPOIL S-5

PARAMETER	UNITS	COMPOSITE SLUDGE, BOTTOM ASH, AND SPOIL S-5 LEACHED WITH: SURFACE WATER	COMPOSITE 1	COMPOSITE 3
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	140	1,900	740
Chloride	mg/ℓ	29	360	300
Cyanide	mg/ℓ	<0.02	<0.02	0.08
Fluoride	mg/ℓ	1.8	2.1	2.1
Nitrate	mg/ℓ NO_3-N	14	12	12
pH	--	8.10	8.80	8.05
Phenolics	mg/ℓ	<0.01	0.05	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	4,500	4,900	6,500
Specific Conductance	µmhos/cm @ 25°C	5,210	6,860	9,040
Sulfate	mg/ℓ SO_4^{-2}	3,000	1,400	3,600
Metals:				
Aluminum	mg/ℓ	0.1	1.0	0.2
Arsenic	mg/ℓ	0.003	0.002	0.005
Barium	mg/ℓ	0.080	0.065	0.075
Boron	mg/ℓ	<0.5	0.8	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	550	110	410
Chromium	mg/ℓ	0.002	0.016	0.002
Cobalt	mg/ℓ	0.011	0.008	0.034
Copper	mg/ℓ	0.04	0.07	0.06
Iron	mg/ℓ	0.08	0.27	0.08
Lead	mg/ℓ	0.01	0.01	0.03
Magnesium	mg/ℓ	43	17	33
Manganese	mg/ℓ	0.39	0.08	0.46
Mercury	mg/ℓ	0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.023	0.010	0.020
Nickel	mg/ℓ	<0.01	0.04	0.06
Potassium	mg/ℓ	29	21	29
Selenium	mg/ℓ	0.010	0.003	0.002
Silver	mg/ℓ	<0.001	<0.001	0.002
Sodium	mg/ℓ	800	1,300	1,300
Zinc	mg/ℓ	0.05	0.04	0.03

(Continued)

PARAMETER	UNITS	COMPOSITE 4	COMPOSITE 5	DEIONIZED WATER
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	440	450	90
Chloride	mg/ℓ	5,600	2,100	16
Cyanide	mg/ℓ	0.06	<0.02	<0.02
Fluoride	mg/ℓ	1.3	1.7	1.9
Nitrate	mg/ℓ NO_3-N	17	13	7.8
pH	--	7.95	8.20	7.80
Phenolics	mg/ℓ	0.02	0.02	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	12,000	5,800	3,700
Specific Conductance	μmhos/cm @ 25°C	21,500	10,200	4,670
Sulfate	mg/ℓ SO_4^{-2}	2,000	1,500	2,200
Metals:				
Aluminum	mg/ℓ	<0.1	<0.1	0.2
Arsenic	mg/ℓ	0.008	0.002	<0.001
Barium	mg/ℓ	0.20	0.098	0.11
Boron	mg/ℓ	0.9	0.8	0.6
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	740	310	520
Chromium	mg/ℓ	0.004	0.016	0.002
Cobalt	mg/ℓ	0.096	0.009	0.005
Copper	mg/ℓ	0.06	0.05	0.05
Iron	mg/ℓ	0.09	0.06	0.06
Lead	mg/ℓ	0.20	0.02	<0.01
Magnesium	mg/ℓ	67	30	30
Manganese	mg/ℓ	0.64	0.23	0.12
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.030	0.022	0.042
Nickel	mg/ℓ	0.12	0.04	0.02
Potassium	mg/ℓ	44	29	24
Selenium	mg/ℓ	0.009	0.008	0.003
Silver	mg/ℓ	<0.001	<0.001	<0.001
Sodium	mg/ℓ	3,700	1,600	560
Zinc	mg/ℓ	0.03	<0.01	0.02

The batch test jars with their contents were placed in a tumble agitator and periodically tumbled for a total of 48 hours during a seven-day period. After the seven-day reaction period, the solid-leachate mixtures were centrifuged and the clear supernatants decanted into clean plastic bottles. The remaining supernatant was filtered through a 0.45 membrane filter to remove all sus- pended material from the leachate and placed into the same plastic bottles for chemical analysis.

Distribution Ratio Calculation and Summary of Results

The method for calculating the distribution ratio is given in Table 27.B12. A summary of determined K_r values is presented in Tables 27.B30 through 27.B36.

Discussion and Data Evaluation

Chemical quality was determined for all waters used in this study. This included the surface water collected from Chinde Wash and five composited ground waters. The sampling and compositing procedures are explained in Section 2. Analytical results for these waters were presented in Table 27.B2. Batch attenuation tests were performed on samples of overburden and spoil material to evaluate changes that might be expected from interactions of the various waters with the geomedia alone. These results are presented in Tables 27.B13 through 27.B22.

The existing water that intermittently runs in Chinde Wash is of poor quality. Total dissolved solids (TDS) are high and Federal Drinking Water Standards (FDWS) are exceeded for sulfate, iron, and manganese. Results of batch testing with the spoils/overburden alone in all cases produced changes in the quality of this water. TDS increases to values within the range of 2,500 to 5,000 milligrams per liter (mg/l) and sulfate and manganese levels further increase. However, in most cases, levels of iron fall below FDWS levels and aluminum, copper, and zinc levels decrease, suggesting that colloidal hydroxides are forming. Al-

Table 27-B12
CALCULATION METHOD
BATCH DISTRIBUTION RATIO DETERMINATIONS

The distribution ratio K_r is defined as:

$$K_r = \frac{\text{mass of solute on the solid phase per unit mass of solute}}{\text{concentration of solute in solution}}$$

The method of calculation is outlined as follows:

(1) Calculate the mass of solute on the solid phase: $M = C_o - C_f \times V$

where:

M = mass sorbed in entire sample
C_o = initial concentration of a particular metal
C_f = final concentration in the leachate
V = solution volume.

(2) Reduce the sorbed mass (M) to mass sorbed per gram of sample (m):

$$m = M/\text{mass of sample}$$

(3) Calculate K_r:

$$K_r = \frac{m}{C_f}$$

(4) Convert into standard reported units:

$$\frac{l}{g} \times \frac{1{,}000\ ml}{l} = \frac{1{,}000\ ml}{g}$$

Table 27-B30
BATCH DISTRIBUTION COEFFICIENT
RESULTS FOR OVERBURDEN D-1

PARAMETER	SURFACE WATER	COMPOSITE 1	COMPOSITE 3	COMPOSITE 4	COMPOSITE 5
Aluminum	--(2)	--	4.61	BD(3)	2.80
Arsenic	--	1.33	4.00	3.50/16.00(1)	30.00
Barium	BD/BD	64.18	0.53	17.65/24.31	107.11
Boron	--	0.31	BD	0.0	--
Cadmium	BD	--	4.00	BD	4.00
Chromium	--	--	--	12.00/28.00	132.00
Cobalt	--	28.00	--	6.77/8.73 8.36/8.36	64.00
Copper	1.33	--	--		1.33
Iron	--	16.74	19.87/20.52	6.00/11.00	36.00
Lead	BD	8.00	--	--	12.00
Manganese	--	27.33	176.00	--	24.00
Mercury	BD	BD	BD	BD	BD
Molybdenum	--	--	--	--	--
Nickel	12.00	40.00	--	10.67/7.00	BD
Selenium	--	--	10.00	--	9.33
Silver	--	--	--	--	56.00
Zinc	4.00	5.33	2.40	--	2.00

(1) Duplicate sample.
(2) - no attenuation.
(3) BD = below detection limit in leachate.

Table 27-B31
BATCH DISTRIBUTION COEFFICIENT
RESULTS FOR OVERBURDEN D-2

PARAMETER	SURFACE WATER	COMPOSITE 1	COMPOSITE 3	COMPOSITE 4	COMPOSITE 5
Aluminum	23.60/26.00[1]	--	48.00	--	64.00
Arsenic	BD[3]	12.00	28.00	8.00	64.00
Barium	--[2]	60.52	--	11.33	79.33
Boron	--	--	BD	--	--
Cadmium	BD	BD	4.00	--	4.00
Chromium	--	--	8.00	12.00	18.67
Cobalt	BD	28.00	24.00	--	64.00
Copper	12.00	--	--	--	1.33
Iron	41.00	33.33	366.0/376.0	6.00	369.33
Lead	BD	2.00	--	--	6.67
Manganese	--	7.06	--	--	6.00
Mercury	BD	BD	BD	BD	BD
Molybdenum	--	16.00	--	--	--
Nickel	4.00	7.00	10.00	1.50	--
Selenium	--	--	4.00	--	2.15
Silver	BD	--	--	--	56.00
Zinc	4.00	3.00	12.00	38.00/40.00	8.00

(1) Duplicate sample.
(2) - no attenuation.
(3) BD = below detection limit in leachate.

Table 27-B32
BATCH DISTRIBUTION COEFFICIENT
RESULTS FOR SPOIL S-1

PARAMETER	SURFACE WATER	COMPOSITE 1	COMPOSITE 3	COMPOSITE 4	COMPOSITE 5
Aluminum	5.2/6.0[1]	23.2	2.5	--	30.0
Arsenic	--[2]	1.3	2.4	26.0	18.7
Barium	--	19.1	--	6.8	34.4
Boron	--	0.85	BD[3]	0.24	BD
Cadmium	BD	--	BD	BD	BD
Chromium	--	--	--	28.0	8.4
Cobalt	--	1.3	4.0	--	5.7
Copper	--	--	--	--	--
Iron	7.25	11.0	63.3/65.1	--	276
Lead	--	6.0	--	--	4.0
Manganese	--	2.1	--	--	1.1
Mercury	BD	--	BD	--	BD
Molybdenum	--	--	--	10.3	4.0/2.0
Nickel	--	2.3	--	--	--
Selenium	--	--	1.6	1.6	1.7
Silver	--	--	--	--	56.0
Zinc	2.00	1.6	--	12.8/13.5	5.0

(1) Duplicate sample.
(2) - no attenuation.
(3) BD = below detection limit in leachate.

Table 27-B33
BATCH DISTRIBUTION COEFFICIENT
RESULTS FOR SPOIL S-2

PARAMETER	SURFACE WATER	COMPOSITE 1	COMPOSITE 3	COMPOSITE 4	COMPOSITE 5
Aluminum	2.90/3.50[1]	--	48.00	BD	9.60
Arsenic	--[2]	1.33	2.40	56.00	30.00
Barium	--	57.86	1.58	14.40/9.63	100.17
Boron	--	--	BD	0.24	BD
Cadmium	BD	--	4.00	00	4.0
Chromium	4.00	--	20.00	28.00	41.33
Cobalt	--	--	5.33	--	9.60
Copper	--	--	--	--	--
Iron	21.71	8.04	207.43/213.14	--	244.89
Lead	BD	8.00	4.00	--	4.00
Manganese	--	4.95	2.61	--	5.33
Mercury	--	BD	--	--	--
Molybdenum	--	--	--	4.33	--
Nickel	--	7.00	BD	2.29	12.00
Selenium	--	--	4.00	--	1.71
Silver	--	--	--	--	56.00/11.00
Zinc	0.80	1.60	6.67	--	5.0

(1) Duplicate sample.
(2) - no attenuation.
(3) BD = below detection limit in leachate.

Table 27-B34
BATCH DISTRIBUTION COEFFICIENT
RESULTS FOR SPOIL S-3

PARAMETER	SURFACE WATER	COMPOSITE 1	COMPOSITE 3	COMPOSITE 4	COMPOSITE 5
Aluminum	23.60/26.00[1]	1.44	48.00	--	64.00
Arsenic	--[2]	1.33	2.40	6.00	30.00
Barium	--	BD[3]	0.80	16.44	98.04
Boron	--	--	BD	.24	--
Cadmium	BD	BD	BD	0.00	4.00
Chromium	--	--	2.00	4.00	13.00
Cobalt	--	--	--	--	5.71
Copper	1.33	--	--	BD	1.33
Iron	41.00	136.0	242.67/249.33	369.33	369.33
Lead	--	BD	--	--	12.00
Manganese	--	3.83	--	--	--
Mercury	--	BD	--	BD	BD
Molybdenum	--	--	--	--	--
Nickel	12.00	7.00	24.00	--	--
Selenium	--	--	0.67	--	--
Silver	--	--	--	--	56.00
Zinc	2.00	2.00	4.00	24.00/25.83	32.00

(1) Duplicate sample.
(2) - no attenuation.
(3) BD = below detection limit in leachate.

Table 27-B35

BATCH DISTRIBUTION COEFFICIENT
RESULTS FOR SPOIL S-4

PARAMETER	SURFACE WATER	COMPOSITE 1	COMPOSITE 3	COMPOSITE 4	COMPOSITE 5
Aluminum	9.80/23.60[1] 11.00/26.00	--	48.00	--	64.00
Arsenic	--[2]	--	2.40	2.67	18.67
Barium	--	236.00	0.62	--	103.53
Boron	--	3.76	BD	.24	--
Cadmium	BD[3]	--	4.0	0.00	4.00
Chromium	--	--	2.0	12.00	64.00
Cobalt	--	--	--	--	--
Copper	12.00/4.00	--	--	--	12.00
Iron	86.00	82.15	736.00/756.00	11.00	2,236.0
Lead	--	BD	--	--	4.0
Manganese	--	--	19.50	--	1.49/1.49
Mercury	BD	BD	BD	BD	BD
Molybdenum	--	--	--	--	--
Nickel	4.00	7.00	0.67	1.50	12.00
Selenium	--	2.00	10.00	--	2.67
Silver	--	--	--	--	26.00
Zinc	80	5.33	2.40	--	8.00

(1) Duplicate sample.

(2) - no attenuation.

(3) BD = below detection limit in leachate.

Table 27-B36
BATCH DISTRIBUTION COEFFICIENT
RESULTS FOR SPOIL S-5

PARAMETER	SURFACE WATER	COMPOSITE 1	COMPOSITE 3	COMPOSITE 4	COMPOSITE 5
Aluminum	23.60/26.00[1]	--	22.00	--	64.00
Arsenic	--[2]	4.00	2.40	3.50	30.00
Barium	--	88.31	--	14.40	98.04
Boron	--	0.85	BD	--	--
Cadmium	--	--	4.00	0.00	--
Chromium	--	--	8.00	4.00	4.50
Cobalt	--	--	--	--	3.56
Copper	--	--	--	--	--
Iron	18.50	37.48	181.00/186.00	2.67	369.33
Lead	--	8.00	--	--	12.00
Manganese	--	19.50	--	--	8.17
Mercury	BD[3]	BD	BD	BD	BD
Molybdenum	--	--	--	--	--
Nickel	12.00	7.00	0.67	--	--
Selenium	--	4.00	24.00	0.89	6.00
Silver	--	--	--	--	56.00
Zinc	0.80	3.00	6.67	--	32.00

(1) Duplicate sample.
(2) - no attenuation.
(3) BD = below detection limit in leachate.

though the levels of other metals generally increase, it is reasonable to expect that many of the metals, particularly those that exist in the cationic form, would gradually be attenuated due to sorption and coprecipitation processes, particularly with iron.

The quality of all composited natural ground waters is very poor. Total dissolved solids range from 4,100 to 9,800 mg/l. With the exception of Composite 3 which is sodium-sulfate, all of these waters can be characterized as sodium-bicarbonate type. Drinking water standards are exceeded for chloride, fluoride, and iron in all of the composited waters. Other metals (e.g., barium, manganese, lead, and selenium) exceed FDWS limits in many of the waters. In addition, Composites 4 and 5 are high in nitrate.

Analysis of leachates from the batch testing shows a general increase in total dissolved solids. However, the increase is small in comparison to the original TDS concentration of the waters. For waters reacted with Overburden D-1, the levels of dissolved solids actually decrease or remain constant. In most of the batch tests, leachate levels for barium, iron, and fluoride fall below drinking water standards. The concentrations of other metals such as lead, zinc, nickel, arsenic, cadmium, chromium, manganese, aluminum, boron, and selenium also decrease in some of the tests. This decrease is probably caused by colloidal metal hydroxides that have precipitated and are attenuating many of these species. These hydroxides further increase the already high cation exchange capacities present in the spoils and overburden.

To examine the impact of waste on the chemistry of the hydrologic system, batch tests were performed by adding sludge and bottom ash to spoils and overburden as outlined in Section 3. The results are presented in Tables 27.B23 through 27.B29. Chinde Wash Surface waters exhibit slight to moderate changes in total dissolved solids over the levels observed from reaction with spoils alone. This result is primarily due to increased concentrations of sodium, calcium, sulfate, and bicar-

bonate. The attenuation of metals is consistent with results obtained from the spoils tests and supports the conclusion that the soils are capable of retarding the movement of metals in water. All composited waste matrices show similar behavior when leached with the ground waters. The increases in total dissolved solids are again primarily due to elevated levels of sulfate and calcium. In many cases, levels of metals such as barium, iron, selenium, and lead actually decrease to levels below drinking water standards. This is particularly true for composited waste and spoils that are reacted with the ground water Composite No. 5.

It should also be noted that the levels of cyanide and phenolic compounds observed never exceeded the U.S. Environmental Protection Agency criteria for the protection of human health.

Batch distribution coefficients (K_r) were calculated for trace metal species in all spoil/overburden experiments performed with composited wastes. The results are presented in Tables 27.B30 through 27.B36.

K_r is a measure of the attenuation of a species in solution. The values do not solely represent absorption, but can also include precipitation controlled changes. In both cases, the attenuation of a species is highly dependent upon pH, the oxidizing potential of the solution, temperature, the total chemical composition of the liquid, and the amount and types of solids in contact with the solution. Therefore, K_r values should not remain constant for a particular sample if it is interacting with different waters. Trends, however, can be observed. Iron usually is not attenuated to any large degree by absorption reactions. However, large iron K_r's are noted in many of the samples. Precipitation of iron hydroxides appears to be the mechanism by which this decrease in levels of iron is occurring. It is also known that as colloidal iron hydr- oxides form, they are able to assist in the coprecipitation and sorption of other metals onto their surfaces. This phenomenon also appears to be occurring in many of the samples tested.

Barium also appears to be controlled by precipitation processes. As levels of sulfate increase in the leachate, barium sulfate precipitate can form, thereby reducing the solution concentration of barium.

Similarly, adsorption can help to attenuate various species. Many metals such as silver, cadmium, cobalt, lead, and nickel can be adsorbed by mineral surfaces. Because spoils and overburdens exhibit high cation exchange capacities, it is probable that the concentrations of many of the metals are being significantly reduced by sorption processes.

In addition to whole-sample chemical analyses presented in Table 27.B4, the cation exchange capacities (CEC) were measured for all spoils and overburdens. These values are presented in Table 27.B7. CEC values are generally high and indicate good sorption potential for the cations in the sample. The measurement of CEC is done in a solution buffered to approximately pH of 7. Due to mineral surface reactions, CEC tends to increase with increasing pH. Measured ground water pH is greater than 8.2 in all cases, which suggests that actual CEC values may be higher.

Exchangeable cations were also analyzed in the leachate from the CEC determinations. High levels of monovalent cations such as sodium and potassium are present in all leachates, particularly overburden D-1. In exchange reactions occurring within the ground water system, divalent metals substitute for monovalent cations with considerably more ease than a divalent-divalent exchange. This occurrence further suggests that the overburden and spoils will be capable of attenuating metals resulting from the leaching of waste material at the disposal site.

A second phase of the batch leach testing was so similate the effects of a coal seam on the chemistry of ground waters that have passed through a spoil-sludge matrix. The concept used in the laboratory program was based on infiltration followed by migration, in which ground water passes through spoil and waste and leaches trace quantities of chemical species. Then, the water carries the chemical species into the geologic

formation surrounding the waste, where constituents in the water react with, in this case, the coal seam. If chemical species are leached freely from the waste, it is their reactions with the coal that determine their migratory behavior. This concept was mathematically modeled using the previously defined distribution coefficient and simplifying assumptions concerning the chemical reactions of coal with waste leachate to calculate the migration by flow in the coal with defined velocities.

The selection of spoils and ground waters used was made based upon the location of various sampling points to the San Juan River. Applying this criteria, samples of Overburden D-1, Spoil S-1, Spoil S-4, and ground water Composites 1 and 4 were selected. It is believed that leachates from these locations will migrate to the river faster than leachates from other areas of the mine.

Three mixtures of composite waste were prepared from bottom ash and composite sludge No. 4817. One of the spoil or overburden samples was then added to each of the mixtures to create three samples. The final composition was:

Bottom Ash	-	0.47 Weight Precent
Sludge	-	2.23 Weight Percent
Spoil or Overburden	-	97.30 Weight Percent

Each of the three mixtures was leached with ground water Composite No. 1 and Composite No. 4 (chemical analyses presented in Table 27.B37). One duplicate sample was prepared from the composited waste, Spoil S-4, and ground water Composite 1. A total of seven composited samples underwent an American Society for Testing and Materials (ASTM) type seven-day leach test with 48 hours of agitation. The results of the leachate chemical analyses are presented in Table 27.B38 through 27.B40. Comparison of leachates generated from Phases I and II of the study were in good agreement. Minor differences in analytical data are attributable to the variability of natural materials.

Table 27-B37
WATER ANALYSIS SUMMARY

PARAMETER	UNITS	COMPOSITE WATER NO. 1	COMPOSITE WATER NO. 4
General Chemistry:			
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	3,100	510
Chloride	mg/ℓ	380	5,200
Cyanide	mg/ℓ	<0.02	<0.02
Fluoride	mg/ℓ	2.2	0.3
Nitrate	mg/ℓ NO_3-N	4.5	18
pH	--	8.80	8.20
Phenolics	mg/ℓ	<0.01	0.04
Residue:			
Filterable at 180°C	mg/ℓ	4,400	9,800
Specific Conductance	µmhos/cm @25°C	5,900	15,600
Sulfate	mg/ℓ	22	120
Metals:			
Aluminum	mg/ℓ	0.68	<0.01
Arsenic	mg/ℓ	0.004	0.015
Barium	mg/ℓ	1.5	0.92
Boron	mg/ℓ	0.97	0.53
Cadmium	mg/ℓ	<0.001/0.002[2]	0.001
Calcium	mg/ℓ	11	140
Chromium	mg/ℓ	0.001	0.008
Cobalt	mg/ℓ	0.008/0.002	0.035/0.034
Copper	mg/ℓ	0.02/0.051	<0.01
Iron	mg/ℓ	2.8	0.15
Lead	mg/ℓ	0.03/0.03	0.12
Magnesium	mg/ℓ	3.6	32
Manganese	mg/ℓ	0.47	0.03
Mercury (Total)	mg/ℓ	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.005	0.025
Nickel	mg/ℓ	0.11	0.11
Potassium	mg/ℓ	7.2	19
Selenium	mg/ℓ	0.006	0.011
Silver	mg/ℓ	<0.001/<0.002	<0.001/<0.002
Sodium	mg/ℓ	1,600	3,500
Zinc	mg/ℓ	0.07	0.21/0.22

[1] Milligrams per liter.

[2] Duplicate analysis.

Table 27-B38
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR COMPOSITED WASTE AND SPOIL S-1

PARAMETER	UNITS	COMPOSITE WATER 1	COMPOSITE WATER 4
General Chemistry:			
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	1,800	360
Chloride	mg/ℓ	430	5,700/5,600
Cyanide	mg/ℓ	0.05	<0.02
Fluoride	mg/ℓ	2.0	1.4
Nitrate	mg/ℓ NO_3-N	8.5	7.4
pH	--	7.82	7.84
Phenolics	mg/ℓ	<0.02	<0.02
Residue:			
Filterable at 180°C	mg/ℓ	7,300	14,000
Specific Conductance	umhos/cm @25°C	9,500	20,900
Sulfate	mg/ℓ	3,000/3,000	2,800
Sulfide	mg/ℓ	<0.5	<0.5
Metals:			
Aluminum	mg/ℓ	0.12	0.07
Arsenic	mg/ℓ	0.010	0.002
Barium	mg/ℓ	0.24	0.38
Boron	mg/ℓ	0.8/0.7	0.3
Cadmium	mg/ℓ	0.007	0.038
Calcium	mg/ℓ	400	1,000
Chromium	mg/ℓ	0.012/0.008[2]	0.005
Cobalt	mg/ℓ	0.024/0.016	0.027
Copper	mg/ℓ	0.03/0.03	0.05
Iron	mg/ℓ	0.02	0.06
Lead	mg/ℓ	0.02/0.02	0.17
Magnesium	mg/ℓ	45	94/93
Manganese	mg/ℓ	0.59	1.1
Mercury (Total)	mg/ℓ	<0.0002	0.0002
Molybdenum	mg/ℓ	0.012/0.014	0.031
Nickel	mg/ℓ	0.15	0.16
Potassium	mg/ℓ	20/21	35
Selenium	mg/ℓ	0.025/0.023	0.019
Silver	mg/ℓ	<0.001	<0.001
Sodium	mg/ℓ	2,000/2,000	3,600
Zinc	mg/ℓ	0.03	0.05

[1] Milligrams per liter.

[2] Duplicate analysis.

Table 27-B39
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR COMPOSITED WASTE AND SPOIL S-4

PARAMETER	UNITS	COMPOSITE WATER NO. 1	1[3]	4
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1/<1	<1/<1
Alkalinity	mg/ℓ $CaCO_3$	1,900	1,800/1,700	380
Chloride	mg/ℓ	420	410/420	5,600/5,600
Cyanide	mg/ℓ	0.02	<0.02/<0.02	<0.02
Fluoride	mg/ℓ	2.0	1.8/1.6	1.2/1.2
Nitrate	mg/ℓ NO_3-N	1.1/1/0[2]	0.2	0.8/0.8
pH	--	7.98	8.02	7.76
Phenolics	mg/ℓ	<0.02	<0.02/<0.02	<0.02/<0.02
Residue:				
Filterable at 180°C	mg/ℓ	6,200	6,400/6,000	13,000/13,000
Specific Conductance	µmhos/cm @25°C	8,460	9,010/8,550	20,000/19,900
Sulfate	mg/ℓ	2,200	2,600	2,200
Sulfide	mg/ℓ	<0.5	<0.05/0.7	<0.5/<0.5
Metals:				
Aluminum	mg/ℓ	0.15	0.15	0.10
Arsenic	mg/ℓ	0.006	0.007	0.002
Barium	mg/ℓ	0.39	0.16	0.21
Boron	mg/ℓ	0.4/0.5	0.4	0.8
Cadmium	mg/ℓ	0.005	0.006	0.029
Calcium	mg/ℓ	300	380	910
Chromium	mg/ℓ	0.008	0.008	0.004
Cobalt	mg/ℓ	0.010	0.014	0.035
Copper	mg/ℓ	<0.01	0.02	0.02
Iron	mg/ℓ	<0.01	<0.01	0.06
Lead	mg/ℓ	0.02	0.01	0.12
Magnesium	mg/ℓ	23	27	68
Manganese	mg/ℓ	0.33	0.42	1.1
Mercury (Total)	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.015	0.015	0.019
Nickel	mg/ℓ	0.11	0.07	0.11
Potassium	mg/ℓ	25	28	45
Selenium	mg/ℓ	0.018	0.015	0.015
Silver	mg/ℓ	<0.001	<0.001	<0.001
Sodium	mg/ℓ	1,800	1,800/1,800	3,300
Zinc	mg/ℓ	0.05	0.03	0.05/0.05

[1] Milligrams per liter.

[2] Duplicate analysis.

[3] Duplicate sample.

Table 27-B40
1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR COMPOSITED WASTE AND OVERBURDEN D-1

PARAMETER	UNITS	COMPOSITE WATER NO. 1	COMPOSITE WATER NO. 4
General Chemistry:			
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	2,500	360
Chloride	mg/ℓ	430	5,600
Cyanide	mg/ℓ	0.02	<0.02
Fluoride	mg/ℓ	3.8	1.9
Nitrate	mg/ℓ NO_3-N	0.6/0.6[2]	7.5
pH	--	8.46	8.04
Phenolics	mg/ℓ	<0.02	<0.02
Residue:			
Filterable at 180°C	mg/ℓ	4,900	11,000
Specific Conductance	µmhos/cm @25°C	7,390	18,400
Sulfate	mg/ℓ	850	900
Sulfide	mg/ℓ	<0.5	<0.5
Metals:			
Aluminum	mg/ℓ	0.29	0.40
Arsenic	mg/ℓ	0.003/0.003	0.015/0.020
Barium	mg/ℓ	0.27	0.26
Boron	mg/ℓ	1.3	1.0
Cadmium	mg/ℓ	0.003/0.003	0.056
Calcium	mg/ℓ	54	400
Chromium	mg/ℓ	0.003/0.002	0.004
Cobalt	mg/ℓ	0.004/0.003	0.11
Copper	mg/ℓ	<0.01	0.03/0.02
Iron	mg/ℓ	0.04	0.39/0.36
Lead	mg/ℓ	<0.01	0.34
Magnesium	mg/ℓ	7.2	40/39
Manganese	mg/ℓ	0.05/0.04	0.26
Mercury (Total)	mg/ℓ	<0.0002	0.0003
Molybdenum	mg/ℓ	0.021	0.054
Nickel	mg/ℓ	0.07	0.14
Potassium	mg/ℓ	17	35
Selenium	mg/ℓ	0.024	0.039
Silver	mg/ℓ	<0.001	<0.001
Sodium	mg/ℓ	1,700	3,500
Zinc	mg/ℓ	0.04	0.07

(1) Milligrams per liter.

(2) Duplicate analysis.

The net effect of coal on the overall quality of the waste leachate is relatively small. Slight changes in total dissolved solids may be largely due to decreases in calcium, magnesium, and alkalinity suggesting the precipitation of carbonate minerals has occurred. Slight increases in chloride and sodium concentrations may be due to the dissolution of soluble chloride salts present within the coal. Sulfide, sulfate, the pH levels remain relatively constant suggesting that oxidation of sulfides within the coal is very small. In all samples, nitrate levels decrease following interaction with the coal. The concentrations of phenolic compounds remain below analytical detection limits. Cyanide concentrations increase in only two samples and either decrease or remain below detection in the remaining samples. The increase of cyanide may be due to the variability of concentrations within the coal samples.

Qualitatively, the distribution coefficients show the following attenuation of mobilization of metals due to interaction with the coal:

- Barium, nickel, molybdenum, manganese, and zine were attenuated in all leachates;

- Copper, silver and mercury in the coal leachates were below analytical detection limits in most cases;

- Arsenic, cadmium, and selenium were not attenuated in any of the leachates, however, their increase in concentrations were small;

- Aluminum, boron, copper, iron, and lead were attenuated or slightly mobilized to varying degrees depending upon the composition of the initial waste matrix.

Changes, in concentration for all metal following interaction with the coal are presented in Table 27.B44. Batch distribution coefficients (Table 27.B45) were calculated based upon these changes. As seen, several constituents are retarded or will lab behind the flow of ground water.

Table 27-B41

LEACHATE METAL CONCENTRATION CHANGES FOLLOWING EXPOSURE TO COAL

INITIATE LEACHATE:	S-4 COMPOSITE 1	S-4 COMPOSITE 1	S-4 COMPOSITE 4	S-1 COMPOSITE 1	S-1 COMPOSITE 4	D-1 COMPOSITE 1	D-1 COMPOSITE 4
Aluminum	-0.08[1]	0.03	0	-0.04	0.01	-0.13	-0.35
Arsenic	0.004	0.004	0.029	0.003	0.016	0.0	0.021
Barium	-0.33	-0.12	-0.09	-0.15	-0.23	-0.22	-0.10
Boron	0.1	0.2	0.2	-0.5	0.2	0.0	0.3
Cadmium	0.002	0.002	0.027	0.002	0.018	0.001	0.026
Calcium	-180.0	-230.0	-200.0	-180.0	-120.0	-38.0	-120.0
Chromium	0.0	0.008	-0.002	0.0	0.001	0.002	-0.001
Cobalt	0.001	0.005	-0.004	0.0	-0.001	0.004	-0.074
Copper	0.0	-0.01	0.01	-0.01	-0.03	0.0	0.0
Iron	0.07	0.03	0.0	-0.01	0.0	0.0	-0.36
Lead	0.0	0.02	0.11	0.02	0.08	0.01	-0.08
Magnesium	-5.0	-2.0	4.0	-5.0	3.0	-0.5	5.0
Manganese	-0.30	-0.37	-0.52	-0.46	-0.56	-0.03	-0.15
Mercury	0.0	0.0	0.0	0.0	0.0	0.0	-0.0001
Molybdenum	-0.007	-0.005	-0.007	0.0	-0.008	-0.006	-0.048
Nickel	-0.06	-0.02	-0.01	-0.06	-0.04	-0.05	-0.07
Potassium	-7.0	-8.0	-4.0	-5.0	-4.0	-6.0	-6.0
Selenium	0.036	0.012	0.038	0.004	0.005	0.001	0.018
Silver	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sodium	0.0	0.0	100.0	0.0	300.0	-100.0	300.0
Zinc	-0.03	-0.01	-0.02	0.0	-0.02	-0.02	-0.04

[1] All changes in concentration are reported in milligrams per liter.

Table 27-B42 (Conti.)
LEACHATE FROM COMPOSITE WASTE AND
SPOIL S-1 REACTED WITH COAL SEAM 8

PARAMETER	UNITS	COMPOSITE WATER NO. 1	COMPOSITE WATER NO. 4
General Chemistry:			
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	1,800	340
Chloride	mg/ℓ	450	5,600
Cyanide	mg/ℓ	0.04	<0.02
Fluoride	mg/ℓ	1.5	0.9
Nitrate	mg/ℓ NO_3-N	6.2	6.2/6.6
pH	--	7.89	7.62
Phenolics	mg/ℓ	<0.02	<0.02
Residue:			
Filterable at 180°C	mg/ℓ	7,000	13,000
Specific Conductance	μmhos/cm @25°C	9,670	20,800
Sulfate	mg/ℓ	3,000	3,000
Sulfide	mg/ℓ	<0.5	<0.5
Metals:			
Aluminum	mg/ℓ	0.08	0.08
Arsenic	mg/ℓ	0.013	0.018
Barium	mg/ℓ	0.09	0.15
Boron	mg/ℓ	0.2	0.5
Cadmium	mg/ℓ	0.009	0.056
Calcium	mg/ℓ	210/210[2]	880
Chromium	mg/ℓ	0.011	0.006
Cobalt	mg/ℓ	0.020	0.026
Copper	mg/ℓ	0.02	0.03
Iron	mg/ℓ	<0.01	0.06
Lead	mg/ℓ	0.04	0.25
Magnesium	mg/ℓ	40	96
Manganese	mg/ℓ	0.13	0.54
Mercury (Total)	mg/ℓ	<0.0002/<0.002	<0.0002
Molybdenum	mg/ℓ	0.013	0.023
Nickel	mg/ℓ	0.09	0.12
Potassium	mg/ℓ	16	31
Selenium	mg/ℓ	0.027	0.024
Silver	mg/ℓ	<0.001	<0.001
Sodium	mg/ℓ	2,000	3,900
Zinc	mg/ℓ	0.03	0.03

(1) Milligrams per liter.

(2) Duplicate analysis.

Table 27-B43 (Conti.)

LEACHATE FROM COMPOSITE WASTE AND SPOIL S-4 REACTED WITH COAL SEAM 8

PARAMETER	UNITS	COMPOSITE WATER NO. 1	1[3]	4
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	1,800	1,700	280/360
Chloride	mg/ℓ	430/440	430	5,500/5,500
Cyanide	mg/ℓ	<0.02	0.36	0.08
Fluoride	mg/ℓ	1.6	1.4	0.7
Nitrate	mg/ℓ NO_3-N	0.3	<0.1/<0.1	0.3
pH	--	8.23	8.06	7.74
Phenolics	mg/ℓ	<0.02	<0.02	<0.02
Residue:				
Filterable at 180°C	mg/ℓ	5,800	6,100	12,000
Specific Conductance	µmhos/cm @25°C	8,590	8,890	20,200
Sulfate	mg/ℓ	2,200	2,700	2,200/2,200
Sulfide	mg/ℓ	<0.5	<0.5	<0.5
Metals:				
Aluminum	mg/ℓ	0.07	0.18	0.10
Arsenic	mg/ℓ	0.010	0.011	0.031
Barium	mg/ℓ	0.06	0.04	0.12
Boron	mg/ℓ	0.5	0.2	1.0
Cadmium	mg/ℓ	0.007	0.008	0.056
Calcium	mg/ℓ	120	150/150	710
Chromium	mg/ℓ	0.008	0.016	0.003/0.002
Cobalt	mg/ℓ	0.011	0.019	0.031
Copper	mg/ℓ	<0.01	<0.01	0.03
Iron	mg/ℓ	0.08	0.04	0.06
Lead	mg/ℓ	0.02	0.03	0.23
Magnesium	mg/ℓ	18	25	72
Manganese	mg/ℓ	0.03	0.05	0.58
Mercury (Total)	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.008	0.010	0.012
Nickel	mg/ℓ	0.03/0.05[2]	0.05/0.05	0.10
Potassium	mg/ℓ	18	20	41
Selenium	mg/ℓ	0.054	0.027	0.053
Silver	mg/ℓ	<0.001	<0.001	<0.001
Sodium	mg/ℓ	1,800	1,800	3,400
Zinc	mg/ℓ	0.02	0.02	0.03

[1] Milligrams per liter.

[2] Duplicate analysis.

[3] Duplicate sample.

Table 276-B44
LEACHATE FROM COMPOSITE WASTE AND
OVERBURDEN D-1 REACTED WITH COAL SEAM 8

PARAMETER	UNITS	COMPOSITE WATER NO. 1	COMPOSITE WATER NO. 4
General Chemistry:			
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	2,200	240
Chloride	mg/ℓ	440	5,600
Cyanide	mg/ℓ	<0.02	<0.02
Fluoride	mg/ℓ	2.9	0.9
Nitrate	mg/ℓ NO_3-N	0.2	0.3
pH	--	8.27	7.66
Phenolics	mg/ℓ	<0.02	<0.02
Residue:			
Filterable at 180°C	mg/ℓ	4,700	11,000
Specific Conductance	µmhos/cm @25°C	7,380	19,300
Sulfate	mg/ℓ	1,000	1,200
Sulfide	mg/ℓ	<0.5	<0.5
Metals:			
Aluminum	mg/ℓ	0.16	0.05/0.02[2]
Arsenic	mg/ℓ	0.003	0.036
Barium	mg/ℓ	0.05	0.14/0.16
Boron	mg/ℓ	1.3	1.3
Cadmium	mg/ℓ	0.004	0.082
Calcium	mg/ℓ	16	280
Chromium	mg/ℓ	0.004	0.003
Cobalt	mg/ℓ	0.007	0.036
Copper	mg/ℓ	<0.01	0.02
Iron	mg/ℓ	0.04	0.01/<0.01
Lead	mg/ℓ	0.01	0.26
Magnesium	mg/ℓ	6.7	44
Manganese	mg/ℓ	0.02	0.11
Mercury (Total)	mg/ℓ	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.015	0.006
Nickel	mg/ℓ	0.02	0.07
Potassium	mg/ℓ	11	29/29
Selenium	mg/ℓ	0.025	0.057
Silver	mg/ℓ	<0.001	<0.001/<0.001
Sodium	mg/ℓ	1,600	3,800
Zinc	mg/ℓ	0.02	0.02/0.03

[1] Milligrams per liter.

[2] Duplicate analysis.

Table 27-B45

BATCH DISTRIBUTION COEFFICIENTS FOR LEACHATE EXPOSED TO COAL

INITIAL LEACHATE:	S-4 COMPOSITE 1	S-4[1] COMPOSITE 1	S-4 COMPOSITE 4	S-1 COMPOSITE 1	S-1 COMPOSITE 4	D-1 COMPOSITE 1	D-1 COMPOSITE 4
Aluminum	4.6	-	0.0	2.0	-	3.2	28/76
Arsenic	-[2]	-	-	-	-	0.0/0.0	-/-
Barium	22	12	3.0	6.7	6.1	18	3.4/2.5
Boron	0.0	4.0	-	12/10	-	0.0	-
Cadmium	-	-	-	-	-	-/-	-
Calcium	6.0	6.1	1.1	3.6	0.55	9.5	1.7
Chromium	0.0	-	1.3/4.0	0.36/-	-	-/-	1.3
Cobalt	-	-	0.52	0.80/-	0.15	-/-	8.2
Copper	BD[3]	BD	-	2.0/2.0	6.0	-	2.0/0.0
Iron	-	-	0.0	BD	0.0	0.0	152/140
Lead	0.0	-	-	-/-	-	-	1.2
Magnesium	1.1	0.32	-	0.50	-/-	0.30	-/-
Manganese	40	30	3.6	14	4.2	6.0/4.0	5.4
Mercury (total)	BD	BD	BD	-/BD	BD	BD	BD
Molybdenum	3.5	2.0	2.3	-/0.31	1.4	1.6	32
Nickel	11/4.8[4]	1.6/1.6	0.40	2.7	1.3	10	4.0
Potassium	1.6	1.6	0.39	1.0/1.2	0.52	2.2	0.83/0.83
Selenium	-	-	-	-/-	-	-	-
Silver	BD	BD	BD	BD	BD	BD	BD/BD
Sodium	0.0	0.0/0.0	-	0.0/0.0	-	0.25	-
Zinc	6.0	2.0	2.7	0.0	2.7	4.0	10/5.3

(1) Duplicate sample.

(2) No attenuation, concentration increases in coal leachate.

(3) Below detection in coal leachate.

(4) Duplicate analysis.

For instance, calcium will lag behind the constaminent front by 10^{-2} to 10^{-3} orders-of-magnitude. This indicates that while the ground water is flowing at a rate of 7.2×10^{-2} ft/day towards the San Juan River, iron concentrations would lag behind at a rate of 7.2×10^{-5} ft/day to 7.2×10^{-6} ft/day.

LABORATORY DATA SHEETS

LABORATORY IDENTIFICATION NUMBER
AND CORRESPONDING FIELD SAMPLE NUMBER

LABORATORY NUMBER	FIELD SAMPLE IDENTIFICATION
334-68-1	Sludge No. 2
4765	Sludge No. 4
4770	Sludge No. 5
4774	Sludge No. 6
4785, 334-7	Sludge No. 7
4786, 334-72	Sludge No. 8
334-68-2A and 2B	Sludge No. 1
334-68-3A and 3B	Sludge No. 3
334-66-1A and 1B	Fly Ash
334-66-2A and 2B	Bottom Ash
334-66-3A and 3B	Spoil S-3
334-67-4A and 4B	Spoil S-1
334-67-5A and 5B	Overburden D-1
334-67-6A and 6B	Spoil S-3 Duplicate
334-70-1A and 1B	Overburden D-1 Duplicate
334-70-2A and 2B	Spoil S-5
334-70-3A and 3B	Spoil S-4
334-71-6A and 6B	Water Blank
334-71-4A and 4B	Spoil S-4 Duplicate
334-71-5A and 5B	Spoil S-2
Composite No. 6	Surface Water
4686	Composite No. 4
4789 and 4790	Sludge No. 9
4791	Sludge No. 10
4800	Sludge No. 11
4801	Sludge No. 12
4818	Surface Water
4819	Composite No. 1
4820	Composite No. 3
4821	Composite No. 4
4822	Composite No. 5
4808	Fly Ash
4809	Bottom Ash
4810	Spoil S-1
4811	Spoil S-2
4812	Spoil S-3
4813	Spoil S-4
4814	Spoil S-5
4815	Overburden D-1
4816	Overburden D-2

Chemical Testing Laboratory Data

MATRIX SPIKE PERCENT RECOVERY SUMMARY
FOR UTAH INTERNATIONAL
PROJECT NO. 85-8019

PARAMETER	PERCENT RECOVERY
General Chemistry:	
Chloride	95.3%/98.0%/97.1%/95.3%/95.7% 97.1%/100%/96.7%/98.7%/91.4%
Cyanide	100%/128%/106%/94.4%/94.1%/91.8%/91.8%/ 90.6%/94.1%/97.0%/100%/100%/97.0%/93.9%
Fluoride	96.0%/100%/100%/96.0%/100%/96.0%/ 104%/84.0%/96.0%/84.0%/100%/100%
Phenolics	105%/105%/97.5%/102%/110%/100%/90.0%/97.5% 103%/98.5%/100%/101%/101%/100%/101%/101%
Sulfate	80.0%/105%/120%/120%/135%/135%/ 120%/90.0%/120%/120%/110%/120%
Metals:	
Aluminum	94.4%/102%/106%/103%/88.0%/100%/94.0%/ 84.0/%/93.0%/104%/79.0%/82.0%/94.0%/84.4%
Arsenic	92.0%/78.0%
Barium	101%/98.9%/100%/125%/109%/127%/115%/136%
Boron	92.0/88.0%/100%/92.0%/80.0%/ 60.0%/100%/82.0%/60.0%/60.0%
Cadmium	110%/90.0%
Calcium	102%/82.4%/113%/114%/111%/108%/ 108%115%/110%/112%/112%/107%
Chromium	78.0%
Cobalt	97.6%/84.0%/100%
Copper	100%/100%/100%
Iron	102%/95.6%/99.2%
Lead	48.0%/48.0%/60.0%
Manganese	130%/132%/131%
Magnesium	103%/101%/98.0%/100%/101%/103%/ 99.0%/99.0%/98.0%/98.0%/102%/103%
Mercury (Total)	94.2%
Molybdenum	92.0%/96.0%/100%
Nickel	100%/99.6%/99.6%
Potassium	101%/107%
Selenium	100%
Silver	96.0%
Sodium	100%/100%/99.0%/98.0%/101%/94.0%/ 95.0%/113%/97.0%/96.0%/96.0%/94.0%
Zinc	101%/98.0%/100%

MATRIX SPIKE PERCENT RECOVERY SUMMARY
FOR IT CORPORATION/KNOXVILLE
PROJECT NO. 84-8045
JOB NO. 8549.02

PARAMETER	PERCENT RECOVERY
Aluminum	108%
Arsenic	95.0%
Barium	62.8%
Boron	--(1)
Cadmium	97.4%
Calcium	101%
Chloride	79.8%
Chromium	94.5%
Cobalt	96.0%
Copper	102%
Cyanide	100%
Fluoride	56.0%
Iron	99.2%
Lead	101%
Magnesium	99.6%
Manganese	98.7%
Mercury (Total)	104%
Mercury	110%
Molybdenum	100%
Nickel	101%
Nitrate	100%
Phenolics	97.7%
Potassium	107%
Selenium	95.0%
Silver	93.0%
Sodium	98.0%
Sulfate	110/114%
Zinc	92.0%

(1) The indicated percent recovery was not determined on this sample set.

IT CORPORATION

IT ANALYTICAL SERVICES

5815 Middlebrook Pike • Knoxville Tennessee 37921 • 615-588-6401

CERTIFICATE OF ANALYSIS

TO: IT Enviroscience
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: September 18, 1984
PROJECT CODE: ITEK 18470
ORDER NUMBER:

Sample Description: Six (6) water samples received August 20, 1984

Concentration units are mg/liter (ppm)

	Cyanide
Comp. #1, Cyanide	<0.01
Comp. #2, Cyanide	<0.01
Comp. #3, Cyanide	<0.01
Comp. #4, Cyanide	<0.01
Comp. #5, Cyanide	<0.01
Surface Water, Cyanide	<0.01

	Nitrate
Comp. #1, Nitrate	<0.01
Comp. #2, Nitrate	0.03
Comp. #3, Nitrate	<0.01
Comp. #4, Nitrate	<0.01
Comp. #5, Nitrate	<0.01
Surface Water, Nitrate	3.7

Sworn to and subscribed before me this 18th
day of September, 1984
My commission expires January 16, 1988

Notary Public

Alice K. Moore
Approved by

Laboratory Manager
Title

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TO: IT Enviroscience
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: September 18, 1984
PROJECT CODE: ITEK 18470
ORDER NUMBER:

Sample Description: Five (5) water samples received August 20, 1984

Concentration units are mg/liter (ppm)

	Composite #1	Composite #2	Composite #3	Composite #4	Composite #5
Aluminum	14.	5.0	2.7	170.	47.
Antimony	<0.1	<0.1	0.1	0.1	<0.1
Arsenic	<0.4	<0.4	<0.4	0.5	<0.4
Barium	1.4	3.9	0.085	1.1	3.0
Beryllium	<0.001	<0.001	<0.001	0.030	0.003
Boron	0.72	<0.01	0.19	0.30	0.38
Cadmium	<0.004	<0.004	<0.004	0.016	<0.004
Calcium	23.	620.	15.	300.	100.
Chromium	0.01	0.14	<0.01	0.10	0.16
Cobalt	<0.01	<0.01	<0.01	0.08	0.04
Copper	<0.02	<0.02	<0.02	0.26	0.09
Iron	7.1	0.07	2.3	230.	54.
Lead	<0.1	0.1	<0.1	0.6	0.2
Lithium	0.5	0.7	0.4	0.9	0.6
Magnesium	7.3	0.8	3.5	77.	22.
Manganese	0.56	0.064	0.21	5.2	1.4
Molybdenum	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel	0.01	<0.01	<0.01	0.15	0.06
Selenium	0.3	0.4	0.3	0.3	0.2
Silicon	3.1	1.1	1.6	50.	34.
Silver	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	1700.	2300.	1300.	3500.	1900.
Strontium	0.73	13.	0.65	7.9	2.2
Thallium	<1.	<1.	<1.	<1.	<1.
Tin	<0.5	<0.5	<0.5	<0.5	<0.5
Titanium	<0.02	<0.02	<0.02	0.04	0.05
Vanadium	0.02	<0.02	<0.02	0.29	0.09
Zinc	0.08	0.04	0.02	0.83	0.28
Uranium	<2.	<2.	<2.	<2.	<2.

Sworn to and subscribed before me this 18th
day of September, 1984
My commission expires January 16, 1988

Notary Public

Approved by Alyce K. Moore
Laboratory Manager
Title

Accredited by the American Association for Laboratory Accreditation in the chemical field of testing as listed in the current AALA Directory of Accredited Laboratories

IT CORPORATION

IT ANALYTICAL SERVICES

5815 Middlebrook Pike • Knoxville, Tennessee 37921 • 615-588-6401

CERTIFICATE OF ANALYSIS

TO: IT Enviroscience
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: September 18, 1984
PROJECT CODE: ITEK 18470
ORDER NUMBER:

Sample Description: One (1) water sample received August 20, 1984

Concentration units are mg/liter (ppm)

	Surface Water
Aluminum	12.
Antimony	<0.1
Arsenic	<0.4
Barium	0.12
Beryllium	<0.001
Boron	<0.03
Cadmium	<0.004
Calcium	200.
Chromium	<0.01
Cobalt	<0.01
Copper	<0.02
Iron	10.
Lead	<0.1
Lithium	0.3
Magnesium	30.
Manganese	0.14
Molybdenum	<0.05
Nickel	0.02
Selenium	<0.2
Silicon	2.2
Silver	<0.01
Sodium	330.
Strontium	2.4
Thallium	<1.
Tin	<0.5
Titanium	<0.02
Vanadium	<0.02
Zinc	0.03
Uranium	<2.

Sworn to and subscribed before me this 18th
day of September, 1984
My commission expires January 16, 1988

Notary Public

Approved by

Laboratory Manager

Title

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CERTIFICATE OF ANALYSIS

TO: IT Enviroscience
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: September 18, 1984
PROJECT CODE: ITEK 18470
ORDER NUMBER:

Sample Description: Six (6) water samples received August 20, 1984

Concentration units are mg/liter (ppm)

	Mercury	Arsenic	Selenium	Potassium
Comp #1	<0.001	<0.001	<0.002*	8.7
Comp #2	<0.001	<0.001	<0.018*	66.
Comp #3	<0.001	0.010	0.015	6.4
Comp #4	<0.001	0.105	<0.029*	40.
Comp #5	<0.001	0.011	<0.016*	18.
Comp #6	<0.001	0.005	<0.024*	11.

* = Higher detection limit due to matrix interference

Sworn to and subscribed before me this 18th
day of September, 1984
My commission expires January 16, 1988

Notary Public

Approved by

Laboratory Manager
Title

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CERTIFICATE OF ANALYSIS

TO: IT Enviroscience
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: September 18, 1984
PROJECT CODE: ITEK 18470
ORDER NUMBER:

Sample Description: Six (6) water samples received August 20, 1984

Concentration units are mg/liter (ppm) unless otherwise stated

	Chloride	pH (standard units)	Total Dissolved Solids	Fluoride	Sulfate
Comp. #1, Fluoride-Sulfate	0.75	8.30	4120.	2.1	1.0
Comp. #2, Fluoride-Sulfate	7.5	11.98	7260.	0.62	<1.0
Comp. #3, Fluoirde-Sulfate	2.5	8.05	3640.	2.6	1250.
Comp. #4, Fluoride-Sulfate	5550.	7.61	9110.	0.59	70.
Comp. #5, Fluoride-Sulfate	75.	9.41	5130.	1.3	<1.0
Surface Water, Fluoride-Sulfate	15.5	7.78	2000.	0.92	1200.

	Phenols
Comp. #1, Phenols	<0.01
Comp. #2, Phenols	0.07
Comp. #3, Phenols	0.01
Comp. #4, Phenols	0.01
Comp. #5, Phenols	0.01
Surface Water, Phenols	<0.01

Sworn to and subscribed before me this 18th day of September, 1984
My commission expires January 16, 1988

Janice G. Arwood
Notary Public

Alyce R. Thorne
Approved by
Laboratory Manager
Title

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CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: November 21, 1984
PROJECT CODE: ITEK 18669
ORDER NUMBER: 8549.02

Sample Description: Six (6) water samples received September 19, 1984

Concentration units are pCi/liter

	Total Alpha	Total Beta	Total Radium (226 & 228)
UII - Composite #1	1.7 ± 0.6	4.2 ± 4.1	0.3 ± 0.6
UII - Composite #2	1.0 ± 0.5	5.2 ± 4.5	0.5 ± 0.7
UII - Composite #3	0.8 ± 0.7	4.0 ± 4.3	0.2 ± 0.5
UII - Composite #4	1.9 ± 0.5	4.0 ± 3.7	0.4 ± 0.6
UII - Composite #5	<0.1	3.9 ± 3.9	0.4 ± 0.6
UII - Surface Water	0.5 ± 0.5	4.7 ± 4.7	0.3 ± 0.6

Sworn to and subscribed before me this 21st day of November, 1984
My commission expires March 18, 1985

Alyce F. Thaxe
Notary Public

Approved by
General Manager
Title

Accredited by the American Association for Laboratory Accreditation in the chemical field of testing, as listed in the current AALA Directory of Accredited Laboratories

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IT CORPORATION

CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: December 4, 1984
PROJECT CODE: ITDK 19026
ORDER NUMBER: Ref. #4686

Sample Description: One (1) water sample received November 20, 1984

Concentration units are mg/liter (ppm)

	#4686, 11/19/84
Aluminum	23.
Antimony	0.1
Barium	3.6
Beryllium	0.001
Boron	0.77
Cadmium	<0.004
Calcium	130.
Chromium	<0.01
Cobalt	0.01
Copper	0.03
Iron	25.
Lead	<0.1
Lithium	0.3
Magnesium	42.
Manganese	0.861
Molybdenum	0.06
Nickel	0.01
Silicon	16.
Silver	0.02
Sodium	3300.
Strontium	6.5
Thallium	<1.
Tin	<0.5
Titanium	0.05
Vanadium	0.04
Zinc	0.062

Sworn to and subscribed before me this 4th
day of December, 1984
My commission expires January 16, 1988

Notary Public

Approved by

Laboratory Manager
Title

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1-ed 08 11/8/84

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CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: December 4, 1984
PROJECT CODE: ITDK 19026
ORDER NUMBER: Ref. #4686

Sample Description: One (1) water sample received November 20, 1984

Concentration units are mg/liter (ppm)

	unpreserved sample from groundwater composite # 4 #4686, 11/19/84
Chloride	6500.
Fluoride	0.75
Total Dissolved Solids	9170.
Arsenic	0.005
Mercury	0.002
Potassium	36.
Selenium	<0.01

Sworn to and subscribed before me this 4th day of December, 1984
My commission expires January 16, 1988

Janice Y. Stewart
Notary Public

Approved by

Laboratory Manager
Title

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CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: December 13, 1984
PROJECT CODE: ITEK 18902 Partial Report
ORDER NUMBER: 8544.02

Sample Description: Five (5) spoil samples received October 30, 1984
Concentration units are µg/gram (ppm)

	Spoil S-1	Spoil S-2	Spoil S-3	Spoil S-4	Spoil S-5
Aluminum	8100.	7400.	5500.	6600.	6600.
Antimony	<10.	<10.	<10.	<10.	<10.
Arsenic	6.5	6.0	36.	17.	4.3
Barium	180.	42.	130.	520.	150.
Beryllium	1.0	1.0	1.8	1.3	1.5
Boron	9.	8.	4.	<3.	4.
Cadmium	1.0	0.9	1.1	0.9	0.8
Calcium	16,000.	17,000.	7900.	9500.	27,000.
Chromium	3.	3.	2.	3.	3.
Cobalt	7.	7.	8.	7.	9.
Copper	11.	6.	6.	15.	9.
Iron	14,000.	13,000.	39,000.	27,000.	14,000.
Lead	35.	32.	58.	34.	32.
Lithium	31.	41.	<20.	35.	28.
Magnesium	2900.	3100.	2300.	2100.	2900.
Manganese	200.	200.	360.	190.	470.
Molybdenum	<6.	<6.	<6.	<6.	<6.
Nickel	10.	9.	13.	10.	13.
Selenium	<1.*	<2.*	<2.*	<2.*	<2.*
Silicon	550.	560.	440.	410.	760.
Silver	<3.	<3.	<3.	<3.	<3.
Sodium	2600.	2700.	2700.	3500.	2700.
Strontium	150.	92.	96.	110.	120.
Thallium	<100.	<100.	<100.	<100.	<100.
Tin	<50.	<50.	<50.	<50.	<50.
Titanium	59.	35.	60.	110.	71.
Vanadium	17.	15.	15.	20.	15.
Zinc	66.	63.	58.	71.	69.
Potassium	1100.	1400.	906.	1200.	1400.
Mercury	<0.1	<0.1	0.2	0.8	<0.1

* Higher detection limits due to matrix interference

Sworn to and subscribed before me this 13th
day of December, 1984
My commission expires December 16, 1987

Notary Public

Approved by

Laboratory Manager
Title

Accredited by the American Association for Laboratory Accreditation in the chemical field of testing, as listed in the current AALA Directory of Accredited Laboratories

IT CORPORATION

IT ANALYTICAL SERVICES

5815 Middlebrook Pike • Knoxville Tennessee 37921 • 615-588-6401

CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: December 13, 1984
PROJECT CODE: ITEK 18902 Partial Report
ORDER NUMBER: 8544.02

Sample Description: Five (5) spoil samples received October 30, 1984

Concentration units are mg/liter (ppm)

	Spoil S-1	Spoil S-2	Spoil S-3	Spoil S-4	Spoil S-5
Cyanide	0.17	1.18	0.20	0.25	0.20
Fluoride	471.	463.	420.	575.	503.
Phenols	1.09	1.19	1.09	1.18	1.05
Sulfate (water leachable)	8982.	7236.	6410.	12,724.	6610.
Chloride (water leachable)	250.	150.	246.	200.	248.
Acidity (water leachable)	399.	299.	197.	399.	298.
Alkalinity (water leachable)	3293.	3693.	3945.	3593.	3777.
Nitrate (water leachable)	29.	16.	12.	20.	24.

Sworn to and subscribed before me this 13th
day of December, 1984
My commission expires December 16, 1987

Notary Public

Approved by

Laboratory Manager
Title

Accredited by the American Association for Laboratory Accreditation in the chemical

IT CORPORATION

IT ANALYTICAL SERVICES

5815 Middlebrook Pike • Knoxville, Tennessee 37921 • 615-588-6401

CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: December 13, 1984
PROJECT CODE: ITEK 18902 Partial Report
ORDER NUMBER: 8544.02

Sample Description: Two (2) overburden samples received October 30, 1984

Concentration units are µg/gram (ppm)

	Sample Overburden D-1	Sample Overburden D-2
Aluminum	9200.	6200.
Antimony	<10.	<10.
Arsenic	4.5	4.6
Barium	110.	120.
Beryllium	1.0	0.9
Boron	<3.	<3.
Cadmium	1.1	0.9
Calcium	14,000.	11,000.
Chromium	6.	6.
Cobalt	7.	6.
Copper	10.	<2.
Iron	20,000.	18,000.
Lead	42.	72.
Lithium	<20.	<20.
Magnesium	4100.	6200.
Manganese	350.	250.
Molybdenum	<6.	<6.
Nickel	10.	9.
Selenium	<1.*	<2.*
Silicon	610.	380.
Silver	<3.	<3.
Sodium	2900.	1400.
Strontium	94.	36.
Thallium	<100.	<100.
Tin	<50.	<50.
Titanium	39.	68.
Vanadium	16.	16.
Zinc	63.	56.
Potassium	903.	801.
Mercury	0.2	0.2

* Higher detection limits due to matrix interference

Sworn to and subscribed before me this 13th
day of December, 1984
My commission expires December 16, 1987

Notary Public

Alice K. Moore
Approved by

Laboratory Manager
Title

Accredited by the American Association for Laboratory Accreditation in the chemical

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TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: December 13, 1984
PROJECT CODE: ITEK 18902 Partial Report
ORDER NUMBER: 8544.02

Sample Description: Two (2) overburden samples received October 30, 1984

Concentration units are mg/liter (ppm)

	Sample Overburden D-1	Sample Overburden D-2
Cyanide	0.08	0.20
Fluoride	403.	332.
Phenols	0.90	1.98
Sulfate (water leachable)	1946.	3529.
Chloride (water leachable)	399.	149.
Acidity (water leachable)	399.	398.
Alkalinity (water leachable)	7186.	3877.
Nitrate (water leachable)	15.	20.

Sworn to and subscribed before me this 13th
day of December, 1984
My commission expires December 16, 1987

Notary Public

Alyce K. Moore
Approved by

Laboratory Manager
Title

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TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: December 13, 1984
PROJECT CODE: ITEK 18902 Partial Report
ORDER NUMBER: 8544.02

Sample Description: Two (2) fly ash samples received October 30, 1984

Concentration units are µg/gram (ppm)

	PP #1, Fly Ash	PP #2, Bottom Ash
Aluminum	6600.	2000.
Antimony	<10.	<10.
Arsenic	11.	0.38
Barium	850.	420.
Beryllium	1.5	0.3
Boron	160.	10.
Cadmium	0.4	<0.3
Calcium	12,000.	3000.
Chromium	5.	<1.
Cobalt	2.	1.
Copper	<2.	<2.
Iron	5300.	2100.
Lead	26.	<10.
Lithium	<20.	21.
Magnesium	530.	150.
Manganese	99.	32.
Molybdenum	<6.	<6.
Nickel	2.	<1.
Selenium	6.5	<2.*
Silicon	1200.	670.
Silver	<3.	<3.
Sodium	430.	84.
Strontium	87.	16.
Thallium	<100.	<100.
Tin	<50.	<50.
Titanium	300.	39.
Vanadium	20.	<10.
Zinc	13.	5.
Potassium	162.	44.
Mercury	0.2	<0.1

* Higher detection limits due to matrix interference

Sworn to and subscribed before me this 13th day of December, 1984
My commission expires December 16, 1987

Notary Public

Alyce L. Moore
Approved by

Laboratory Manager
Title

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CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: December 13, 1984
PROJECT CODE: ITEK 18902 Partial Report
ORDER NUMBER: 8544.02

Sample Description: Two (2) fly ash samples received October 30, 1984

Concentration units are mg/liter (ppm)

	PP #1, Fly Ash	PP #2, Bottom Ash
Cyanide	0.20	0.22
Fluoride	176.	81.
Phenols	1.29	1.36
Sulfate (water leachable)	1667.	<100.
Chloride (water leachable)	100.	124.
Acidity (water leachable)	<100.	397.
Alkalinity (water leachable)	11,577.	2976.
Nitrate (water leachable)	<1.	2.

Sworn to and subscribed before me this 13th day of December, 1984
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Notary Public

Approved by

Laboratory Manager
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CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: December 13, 1984
PROJECT CODE: ITEK 18902 Partial Report
ORDER NUMBER: 8544.02

Sample Description: Seven (7) coal samples received October 30, 1984

Concentration units are mg/liter (ppm)

	Coal Sample #C-1 Seam #8, Northface	Coal Sample #C-2 Seam #2	Coal Sample #C-3 Seam #4	Coal Sample #C-4 Seam #3	Coal Sample #C-5 Seam #7	Coal Sample Seam #8, #C-6, South	Coal Sample #C-7 Seam #6
Cyanide	0.05	0.07	2.22	0.30	0.35	0.12	0.20
Fluoride	26.	23.	13.	36.	248.	380.	364.
Phenols	0.19	0.39	0.10	0.40	0.59	0.29	0.86
Sulfate (water leachable)	524.	748.	499.	3508.	1965.	1130.	<100.
Chloride (water leachable)	247.	349.	175.	222.	196.	196.	150.
Acidity (water leachable)	198.	399.	399.	198.	393.	295.	399.
Alkalinity (water leachable)	790.	2595.	798.	100.	3929.	4715.	898.
Nitrate (water leachable)	5.	4.	6.	5.	14.	5.	3.

Sworn to and subscribed before me this 13th day of December, 1984
My commission expires December 16, 1987

Notary Public

Approved by Alice K. Moore
Laboratory Manager
Title

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IT ANALYTICAL SERVICES

5815 Middlebrook Pike • Knoxville, Tennessee 37921 • 615-588-6401

CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: December 13, 1984
PROJECT CODE: ITEK 18902 Partial Report
ORDER NUMBER: 8544.02

Sample Description: Seven (7) coal samples received October 30, 1984
Concentration units are µg/gram (ppm)

	Coal Sample #C-1 Seam #8, Northface	Coal Sample #C-2 Seam #2	Coal Sample #C-3 Seam #4	Coal Sample #C-4 Seam #3	Coal Sample #C-5 Seam #7	Coal Sample Seam #8, #C-6, South	Coal Sample #C-7 Seam #6
Aluminum	290.	1800.	650.	1300.	720.	2300.	680.
Antimony	<10.	<10.	<10.	<10.	<10.	<10.	<10.
Arsenic	<0.1	<0.1	<0.1	0.24	<0.2*	5.7	4.5
Barium	58.	8.9	33.	57.	38.	38.	69.
Beryllium	0.5	0.9	0.4	0.3	0.2	0.8	0.8
Boron	45.	110.	24.	39.	40.	58.	53.
Cadmium	<0.3	<0.3	<0.3	<0.3	<0.3	0.4	<0.3
Calcium	210.	1300.	630.	760.	780.	1200.	670.
Chromium	<1.	<1.	<1.	<1.	<1.	<1.	<1.
Cobalt	<1.	2.	<1.	<1.	3.	2.	1.
Copper	<2.	<2.	<2.	<2.	<2.	<2.	<2.
Iron	290.	2800.	1300.	3600.	1600.	4400.	1200.
Lead	<10.	<10.	13.	<10.	10.	<10.	<10.
Lithium	27.	<20.	24.	23.	<20.	<20.	<20.
Magnesium	100.	650.	210.	360.	220.	460.	210.
Manganese	<2.	12.	2.	2.	14.	4.	2.
Molybdenum	<6.	<6.	<6.	<6.	<6.	<6.	<6.
Nickel	<1.	2.	1.	<1.	4.	2.	2.
Selenium	0.30	<0.4*	1.2	<0.8*	<0.8*	<0.3*	<0.4*
Silicon	40.	310.	120.	140.	150.	240.	100.
Silver	<3.	<3.	<3.	<3.	<3.	<3.	<3.
Sodium	510.	1000.	510.	810.	690.	1200.	1500.
Strontium	17.	40.	22.	27.	32.	41.	62.
Thallium	<100.	<100.	<100.	<100.	<100.	<100.	<100.
Tin	<50.	<50.	<50.	<50.	<50.	<50.	<50.
Titanium	51.	45.	47.	110.	99.	160.	100.
Vanadium	<10.	<10.	<10.	<10.	<10.	10.	<10.
Zinc	5.	36.	38.	11.	8.	25.	9.
Potassium	17.	19.	17.	45.	34.	102.	15.
Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

* Higher detection limits due to matrix interference

Sworn to and subscribed before me this 13th
day of December, 1984
My commission expires December 16, 1987

Notary Public

Approved by

Laboratory Manager
Title

Accredited by the American Association for Laboratory Accreditation in the chemical field of testing as listed in the current AALA Directory of Accredited Laboratories

IT CORPORATION

IT ANALYTICAL SERVICES

5815 Middlebrook Pike • Knoxville Tennessee 37921 • 615-588-6401

CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: January 11, 1985
PROJECT CODE: ITDK 19245
ORDER NUMBER: Project #8549.02

Sample Description: One (1) sludge sample received December 26, 1984

Concentration units are mg/kg, unless otherwise stated

	#2 Sludge Sample #334-68-1, 12/21/84
pH (standard units)	11.37
Total Solids (% by wt.)	81.33
Chloride	1800.
Fluoride	39.
Sulfate	3100.
Cyanide	0.05
Nitrate, as N	4.5
Phenols	<0.01
Potassium	270.
Mercury	<0.1
Selenium	7.0
Arsenic	11.

Sworn to and subscribed before me this 11th
day of January, 1985
My commission expires January 16, 1988

Notary Public

Approved by

Laboratory Manager
Title

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CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: January 11, 1985
PROJECT CODE: ITDK 19245
ORDER NUMBER: Project #8549.02

Sample Description: Three (3) water samples received December 27, 1984

Concentration units are mg/liter (ppm) unless otherwise stated

	EP Toxicity Extract #334-67-4A, 4B 12/20/84	EP Toxicity Extract #334-67-5A, 5B 12/21/84	EP Toxicity Extract #334-67-6A, 6B 12/21/84
pH (standard units)	5.17	5.49	5.23
Total Dissolved Solids	2368.	868.	2408.
Chloride	0.85	1.2	0.85
Fluoride	0.12	0.08	0.12
Sulfate	425.	375.	938.
Cyanide	<0.01	<0.01	<0.01
Nitrate, as N	0.88	<0.01	<0.01
Phenols	0.01	<0.01	0.01
Potassium	6.2	3.4	7.2
Mercury	<0.001	<0.001	<0.001
Selenium	<0.009*	<0.002*	<0.008*
Arsenic	0.001	<0.001	<0.001

* Higher detection limit due to sample matrix interference

Sworn to and subscribed before me this 11th
day of January, 1985
My commission expires January 16, 1988

Notary Public

Alyce R. Moore
Approved by

Laboratory Manager
Title

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CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: January 11, 1985
PROJECT CODE: ITDK 19245
ORDER NUMBER: Project #8549.02

Sample Description: Three (3) water samples received December 27, 1984

Concentration units are mg/liter (ppm) unless otherwise stated

	EP Toxicity Extract #334-66-1A, 1B 12/19/84	EP Toxicity Extract #334-66-2A, 2B 12/19/84	EP Toxicity Extract #334-66-3A, 3B 12/20/84
pH (standard units)	5.02	6.27	5.11
Total Dissolved Solids	1900.	316.	3292.
Chloride	1.2	2.	2.2
Fluoride	2.2	0.1	0.1
Sulfate	82.	12.	512.
Cyanide	<0.01	<0.01	<0.01
Nitrate, as N	<0.01	<0.01	0.36
Phenols	0.01	<0.01	0.01
Potassium	0.627	0.333	8.2
Mercury	<0.001	<0.001	<0.001
Selenium	0.190	<0.001	<0.01*
Arsenic	0.014	<0.001	<0.001

* Higher detection limit due to sample matrix interference

Sworn to and subscribed before me this 11th
day of January, 1985
My commission expires January 16, 1988

Notary Public

Approved by

Laboratory Manager
Title

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IT CORPORATION

IT ANALYTICAL SERVICES

5815 Middlebrook Pike • Knoxville Tennessee 37921 • 615-588-6401

CERTIFICATE OF ANALYSIS

TO: IT Technology Development
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: January 15, 1985
PROJECT CODE: ITDK 19269 Partial Report
ORDER NUMBER: Project #8549.02

Sample Description: Two (2) solid samples received January 2, 1985

Concentration units are mg/kg (ppm)

	#1	#3
	Filter Sludge 01/02/85	
	#334-68-2A & 2B	#334-68-3A & 3B
Aluminum	9400.	6500.
Antimony	10.	<10.
Arsenic	22.	12.
Barium	780.	490.
Beryllium	1.1	0.58
Boron	230.	220.
Cadmium	0.62	0.67
Calcium	19,000.	37,000.
Chromium	10.	6.7
Cobalt	2.1	1.8
Copper	7.4	6.5
Iron	4300.	2800.
Lead	16.	<10.
Lithium	<20.	<20.
Magnesium	760.	580.
Manganese	90.	100.
Molybdenum	8.6	<6.
Nickel	3.6	2.1
Selenium	<2.0	1.4
Silicon	2100.	1900.
Silver	<3.	<3.
Sodium	800.	600.
Strontium	97.	73.
Thallium	<100.	<100.
Tin	<50.	<50.
Titanium	500.	380.
Vanadium	35.	28.
Zinc	21.	12.
Uranium	<200.	<200.
Mercury	0.2	0.2
Potassium	430.	250.

Sworn to and subscribed before me this 15th
day of January, 1985
My commission expires January 16, 1988

Notary Public

Approved by

Laboratory Manager
Title

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DATE REPORTED: January 15, 1985
PROJECT CODE: ITDK 19269 Partial Report
ORDER NUMBER: Project #8549.02

Sample Description: Two (2) solid samples received January 2, 1985

Concentration units are mg/kg (ppm) unless otherwise stated

	#1	#3
	Filter Sludge 01/02/85	
	#334-68-2A & 2B	#334-68-3A & 3B
Alkalinity (mg/liter, water leachable)	2600.	2800.
Acidity (mg/liter, water leachable)	3000.	7600.
Chloride (water leachable)	2375.	2375.
Cyanide	0.07	0.12
Fluoride	269.	405.
Nitrate, as N (water leachable)	5.	5.
Phenols	0.1	0.1
Sulfate (water leachable)	8350.	4200.

Sworn to and subscribed before me this 15th day of January, 1985
My commission expires January 16, 1988

Notary Public

Approved by

Laboratory Manager

Title

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IT ANALYTICAL SERVICES

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CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: January 28, 1985
PROJECT CODE: ITEK 19345
ORDER NUMBER: 8549.02

Sample Description: Two (2) solid samples received January 10, 1985

Concentration units are mg/liter (ppm)

	#4675 Filter Sludge #4, 01/09/85	#4770, Filter Sludge #5, 01/09/85
Cyanide	0.08	0.08
Fluoride	419.	567.
Phenols	0.07	0.07
Sulfate (water leachable)	8150.	7000.
Chloride (water leachable)	1800.	1975.
Acidity (water leachable)	4400.	3200.
Alkalinity (water leachable)	2000.	2200.
Nitrate, as N (water leachable)	36.	31.

Sworn to and subscribed before me this 28th
day of January, 1985
My commission expires March 18, 1985

Alyce K. Moore
Notary Public

Jack R. Hall
Approved by

Laboratory Director
Title

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CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: January 28, 1985
PROJECT CODE ITEK 19345
ORDER NUMBER 8549.02

Sample Description: Two (2) solid samples received January 10, 1985

Concentration units are µg/gram (ppm)

	#4675, Filter Sludge #4, 01/09/85	#4770, Filter Sludge #5, 01/09/85
Aluminum	8400.	7100.
Antimony	<10.	<10.
Arsenic	11.	7.8
Barium	430.	270.
Beryllium	0.86	0.72
Boron	230.	230.
Cadmium	0.87	0.69
Calcium	39,000.	63,000.
Chromium	7.7	5.7
Cobalt	2.0	1.6
Copper	5.2	3.5
Iron	4400.	3400.
Lead	37.	28.
Lithium	<20.	<20.
Magnesium	700.	640.
Manganese	72.	57.
Molybdenum	7.4	<6.
Nickel	2.0	2.0
Selenium	6.0	4.1
Silicon	430.	1000.
Silver	<3.	<3.
Sodium	790.	740.
Strontium	97.	91.
Thallium	<100.	<100.
Tin	<50.	<50.
Titanium	440.	360.
Vanadium	30.	20.
Zinc	19.	17.
Mercury	0.10	0.13
Potassium	290.	310.

Sworn to and subscribed before me this 28th
day of January, 1985
My commission expires March 18, 1985

Alyce L. Moore
Notary Public

Jack R. Hall
Approved by

Laboratory Director
Title

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CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: January 28, 1985
PROJECT CODE: ITEK 19352
ORDER NUMBER: 8549.02

Sample Description: One (1) solid sample received January 11, 1985

Concentration units are µg/gram (ppm)

sample #6

	IT #4774, Filter Sludge
Aluminum	8100.
Antimony	<10.
Arsenic	11.
Barium	630.
Beryllium	0.85
Boron	220.
Cadmium	0.39
Calcium	26,000.
Chromium	9.0
Cobalt	2.7
Copper	5.5
Iron	3700.
Lead	17.
Lithium	<20.
Magnesium	660.
Manganese	73.
Molybdenum	11.
Nickel	3.4
Selenium	8.3
Silicon	840.
Silver	<3.
Sodium	750.
Strontium	84.
Thallium	<100.
Tin	<50.
Titanium	510.
Vanadium	30.
Zinc	19.
Mercury	<0.1
Potassium	300.

Sworn to and subscribed before me this 28th day of January, 1985
My commission expires March 18, 1985

Alyce R. Moore
Notary Public

Jack A. Hall
Approved by

Laboratory Director
Title

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CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: January 28, 1985
PROJECT CODE: ITEK 19352
ORDER NUMBER: 8549.02

Sample Description: One (1) solid sample received January 11, 1985

Concentration units are mg/liter (ppm)

	IT #4774, Filter Sludge Sample #6
Cyanide	0.08
Fluoride (total fusion)	532.
Phenols	0.07
Sulfate (water leachable)	7700.
Chloride (water leachable)	1750.
Acidity (water leachable)	4200.
Alkalinity (water leachable)	2400.
Nitrate, as N (water leachable)	30.5

Sworn to and subscribed before me this 28th day of January, 1985
My commission expires March 18, 1985

Alyce R. Morris
Notary Public

Jack M. Hall
Approved by

Laboratory Director
Title

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CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: January 28, 1985
PROJECT CODE: ITEK 19351
ORDER NUMBER: 8549.02

Sample Description: Two (2) EP Toxicity extract samples received January 11, 1985

Concentration units are µg/ml (ppm)

	EP Toxicity Extract	
	#334-71-4A, 4B	#334-71-5A, 5B
Aluminum	1.9	3.2
Antimony	<0.1	<0.1
Arsenic	<0.001	<0.001
Barium	0.053	0.192
Beryllium	<0.001	<0.001
Boron	0.12	0.11
Cadmium	<0.003	<0.003
Calcium	500.	900.
Chromium	<0.01	<0.01
Cobalt	0.03	0.05
Copper	<0.02	<0.02
Iron	0.1	0.4
Lead	<0.1	<0.1
Lithium	0.34	<0.2
Magnesium	21.	46.
Manganese	6.4	9.9
Molybdenum	<0.06	<0.06
Nickel	0.05	0.04
Selenium	<0.01	<0.01
Silicon	5.0	4.9
Silver	<0.03	<0.03
Sodium	160.	160.
Strontium	2.3	4.3
Thallium	<1.	<1.
Tin	<0.5	<0.5
Titanium	<0.02	<0.02
Vanadium	<0.1	<0.1
Zinc	0.14	0.14
Mercury	<0.001	<0.001
Potassium	9.8	9.0

Sworn to and subscribed before me this 28th
day of January, 1985
My commission expires March 18, 1985

Alyce R. Moore
Notary Public

Jack A. Hall
Approved by
Laboratory Director
Title

Accredited by the American Association for Laboratory Accreditation in the chemical field of testing as listed in the current AALA Directory of Accredited Laboratories

IT CORPORATION

IT ANALYTICAL SERVICES

5815 Middlebrook Pike • Knoxville, Tennessee 37921 • 615-588-6401

CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: January 28, 1985
PROJECT CODE: ITEK 19351
ORDER NUMBER: 8549.02

Sample Description: Two (2) liquid samples received January 11, 1985

Concentration units are mg/liter (ppm) unless otherwise stated

	EP TOX Extract #334-71-4A, 4B	EP TOX Extract #334-71-5A, 5B
Chloride	1.3	1.3
pH (standard units)	4.98	4.99
Total Dissolved Solids	2622.	4606.
Fluoride	0.09	0.13
Sulfate	362.	188.
Phenols	0.01	0.01
Cyanide	<0.01	<0.01
Nitrate, as N	0.71	0.75

Sworn to and subscribed before me this 28th
day of January, 1985
My commission expires March 18, 1985

Alyce R. Moore
Notary Public

Approved by: Joe R. Hall
Laboratory Director
Title

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CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: January 28, 1985
PROJECT CODE: ITEK 19350
ORDER NUMBER: 8549.02

Sample Description: Four (4) EP Toxicity extract samples received January 10, 1985

Concentration units are µg/ml (ppm)

	EP Toxicity Extracts			
	#334-70-1A, 1B	#334-70-2A, 2B	#334-70-3A, 3B	#334-71-6A, 6B
Aluminum	1.3	2.6	1.7	<0.1
Antimony	<0.1	<0.1	<0.1	<0.1
Arsenic	0.001	0.001	0.001	0.001
Barium	0.793	0.196	0.066	<0.003
Beryllium	<0.001	<0.001	<0.001	<0.001
Boron	0.14	0.10	0.12	<0.01
Cadmium	<0.003	<0.003	<0.003	<0.003
Calcium	340.	590.	560.	<0.2
Chromium	<0.01	<0.01	<0.01	<0.01
Cobalt	0.03	0.01	0.04	<0.01
Copper	<0.02	<0.02	<0.02	<0.02
Iron	0.5	<0.05	<0.05	<0.05
Lead	<0.1	<0.1	<0.1	<0.1
Lithium	0.23	0.23	<0.2	<0.2
Magnesium	29.	27.	22.	<0.1
Manganese	5.9	7.2	7.0	<0.02
Molybdenum	<0.06	<0.06	<0.06	<0.06
Nickel	0.05	<0.01	0.04	0.01
Selenium	<0.005*	<0.01*	<0.01*	0.012
Silicon	4.7	5.9	5.2	<0.1
Silver	<0.03	<0.03	<0.03	<0.03
Sodium	200.	120.	170.	0.78
Strontium	2.7	3.2	2.4	<0.001
Thallium	<1.	<1.	<1.	<1.
Tin	<0.5	<0.5	<0.5	<0.5
Titanium	<0.02	<0.02	<0.02	<0.02
Vanadium	<0.1	<0.1	<0.1	<0.1
Zinc	0.19	0.11	0.14	<0.02
Mercury	<0.001	<0.001	<0.001	<0.001
Potassium	9.	10.	11.	9.8

* Higher detection limit due to matrix interference

Sworn to and subscribed before me this 28th
day of January, 1985
My commission expires March 18, 1985

Alyce L. Moore
Notary Public

Approved by
Laboratory Director
Title

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CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: January 28, 1985
PROJECT CODE: ITEK 19350
ORDER NUMBER: 8549.02

Sample Description: Four (4) water samples received January 10, 1985

Concentration units are mg/liter (ppm) unless otherwise stated

	EP TOX Extract #334-70-1A, 1B	EP TOX Extract #334-70-2A, 2B	EP TOX Extract #334-70-3A, 3B	EP TOX Extract #334-71-6A, 6B
Chloride	10.	2.5	2.5	0.8
pH (standard units)	5.14	5.00	5.01	4.63
Total Dissolved Solids	2177.	3504.	3277.	7.
Fluoride	0.10	0.10	0.10	<0.05
Sulfate	76.	250.	412.	138.
Phenols	0.01	0.01	0.01	<0.01
Cyanide	<0.01	<0.01	<0.01	<0.01
Nitrate, as N	0.17	1.6	0.85	<0.01

Sworn to and subscribed before me this 28th
day of January, 1985
My commission expires March 18, 1985

Notary Public

Approved by

Laboratory Director
Title

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CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: February 4, 1985
PROJECT CODE: ITEK 19406
ORDER NUMBER: 8549.02

Sample Description: Two (2) samples of filter sludge received January 18, 1985

Concentration units are µg/gram (ppm) as received basis

	#4785, 334-7, #7	#4786, 334-72, #8
Aluminum	7000.	6000.
Antimony	<10.	<10.
Arsenic	16.	7.9
Barium	1020.	590.
Beryllium	<1.	<1.
Boron	240.	230.
Cadmium	0.71	0.64
Calcium	17,000.	48,000.
Chromium	9.3	7.4
Cobalt	2.6	1.8
Copper	2.6	2.2
Iron	2900.	2100.
Lead	<10.	25.
Lithium	<20.	<20.
Magnesium	670.	640.
Manganese	60.	40.
Molybdenum	9.1	6.9
Nickel	2.0	1.9
Selenium	8.8	3.6
Silicon	1050.	890.
Silver	<3.	<3.
Sodium	510.	460.
Strontium	97.	70.
Thallium	<100.	<100.
Tin	<50.	<50.
Titanium	420.	270.
Vanadium	23.	16.
Zinc	16.	14.
Potassium	220.	230.
Mercury	0.12	<0.2*

* Higher detection limit due to sample matrix interference

Sworn to and subscribed before me this 4th
day of February, 1985
My commission expires January 16, 1988

Notary Public

Approved by Alya R. Moore

Laboratory Manager
Title

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IT CORPORATION

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CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: February 4, 1985
PROJECT CODE: ITEK 19406
ORDER NUMBER: 8549.02

Sample Description: Two (2) solid samples received January 18, 1985

Concentration units are µg/gram (ppm)

	Filter Sludge #4785, 334-7, #7	Filter Sludge #4786, 334-72, #8
Cyanide	0.05	0.08
Fluoride (total fusion)	146.	322.
Phenols	<0.01	<0.01
Sulfate (water leachable)	7598.	6939.
Chloride (water leachable)	1961.	2042.
Acidity, as $CaCO_3$ (water leachable)	2745.	2559.
Alkalinity, as $CaCO_3$ (water leachable)	3725.	3150.
Nitrate, as N (water leachable)	26.5	24.6

Sworn to and subscribed before me this 4th
day of February, 1985
My commission expires January 16, 1988

Janice G. Atwood
Notary Public

Alyce R. Moore
Approved by

Laboratory Manager
Title

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IT CORPORATION

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CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED February 11, 1985
PROJECT CODE ITDK 19341
ORDER NUMBER

Sample Description: One (1) solid sample received December 27, 1984

		Total Radium (pCi/gram)
#2	#334-68-1, 12/21/84	2.1

Sworn to and subscribed before me this 11th
day of February, 1985
My commission expires January 16, 1988

Janice G. Atkins
Notary Public

Approved by

Laboratory Manager
Title

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CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: February 11, 1985
PROJECT CODE: ITEK 19346
ORDER NUMBER: 1870.09

Sample Description: Two (2) solid samples received January 11, 1985

	Total Radium (pCi/gram)
#4765, Filter Sludge #4	1.5
#4770, Filter Sludge #5	1.6

Sworn to and subscribed before me this 11th
day of February, 1985
My commission expires January 16, 1988

Notary Public

Approved by: Laboratory Manager
Title

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CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: February 11, 1985
PROJECT CODE: ITDK 19269
ORDER NUMBER: 8549.02

Sample Description: Two (2) solid samples received January 2, 1985

		Radium 226 (pCi/gram)	Radium 228 (pCi/gram)
1	#334-68-2A & 2B, 01/02/85	2.1	3.2
3	#334-68-3A & 3B, 01/02/85	2.0	2.7

Sworn to and subscribed before me this 11th
day of February, 1985
My commission expires January 16, 1988

Notary Public

Approved by

Laboratory Manager
Title

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CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: February 13, 1985
PROJECT CODE: ITEK 19509
ORDER NUMBER:

Sample Description: Eight (8) solid samples received February 7, 1985

	pH (standard units)
#334-68-1, 12/21/84	10.84
#334-68-2A & 2B, 01/02/85	10.96
#334-68-3A & 3B, 01/02/85	12.09
#4765, Filter Sludge #4, 01/09/85	11.11
#4770, Filter Sludge #5, 01/09/85	11.24
#4774, Filter Sludge	11.44
Filter Sludge #4785, 334-7, #7	11.20
Filter Sludge #4786, 334-72, #8	11.37

Sworn to and subscribed before me this 13th
day of February, 1985
My commission expires March 18, 1985

Notary Public

Approved by: Laboratory Director
Title

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CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: February 15, 1985
PROJECT CODE: ITEK 18902
ORDER NUMBER: 8549.02

Sample Description: Seven (7) coal samples, two (2) flyash samples, two (2) overburden samples, and five (5) spoil samples received October 30, 1984

	Ra 226 (pCi/g)	Ra 228 (pCi/g)
Coal-C-1-Seam #8, N. Face	0.6 ± 0.1	0.6 ± 0.2
Coal-C-2-Seam #2, N. Face	1.5 ± 0.1	0.7 ± 0.3
Coal-C-3-Seam #4, N. Face	0.5 ± 0.1	0.4 ± 0.2
Coal-C-4-Seam #3, N. Face	0.8 ± 0.1	0.9 ± 0.3
Coal-C-5-Seam #7, N. Face	0.4 ± 0.1	0.5 ± 0.2
Coal-C-6-Seam #8, S. Face	1.0 ± 0.1	0.3 ± 0.2
Coal-C-7-Seam #6, S. Face	1.0 ± 0.1	1.3 ± 0.3
Spoil-S-1	1.3 ± 0.1	0.9 ± 0.5
Spoil-S-2	1.4 ± 0.1	1.5 ± 0.5
Spoil-S-3	1.4 ± 0.1	1.0 ± 0.5
Spoil-S-4	1.5 ± 0.1	2.2 ± 0.4
Spoil-S-5	1.0 ± 0.1	1.0 ± 0.2
Sample Overburden-D-1	1.3 ± 0.1	2.2 ± 0.6
Sample Overburden-D-2	0.8 ± 0.1	2.1 ± 0.6
PP #1-Fly Ash	3.2 ± 0.1	3.8 ± 0.6
PP #2-Bottom Ash	2.9 ± 0.1	4.3 ± 0.7

Sworn to and subscribed before me this 15th
day of February, 1984
My commission expires January 16, 1988

Notary Public

Approved by: Laboratory Manager
Title

Accredited by the American Association for Laboratory Accreditation in the chemical field of testing as listed in the current AALA Directory of Accredited Laboratories

IT CORPORATION

IT ANALYTICAL SERVICES

5815 Middlebrook Pike • Knoxville Tennessee 37921 • 615-588-6401

CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Cliff Vaughn
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: February 20, 1985
PROJECT CODE: ITEK 19439
ORDER NUMBER:

Sample Description: Six (6) EP Toxicity extracts from ITEK 19350 and ITEK 19351

Concentration units are mg/liter (ppm)

	#334-70-1A,1B	#334-70-2A,2B	#334-70-3A,3B	#334-71-6A,6B	#334-71-4A,4B	#334-71-5A,5B
Silver	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium	0.002	0.001	0.001	0.001	0.001	0.002
Copper	0.019	0.023	0.023	0.003	0.018	0.026
Iron	*	0.03	0.04	<0.01	*	*
Lead	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Thallium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Vanadium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

* Analysis not requested

Sworn to and subscribed before me this 20th
day of February, 1985
My commission expires January 16, 1988

Notary Public

Approved by: Alyce R. Moore
Laboratory Manager
Title

Accredited by the American Association for Laboratory Accreditation in the chemical tests of testing as listed in the current AALA Directory of Accredited Laboratories

IT CORPORATION

IT ANALYTICAL SERVICES

5815 Middlebrook Pike • Knoxville, Tennessee 37921 • 615-588-6401

CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Cliff Vaughn
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: February 20, 1985
PROJECT CODE: ITEK 19439
ORDER NUMBER:

Sample Description: Three (3) filter sludge samples from ITEK 19352 and ITEK 19406

Concentration units are µg/gram (ppm)

	Filter Sludge #4774	Filter Sludge #4785, 334-7, #7	Filter Sludge #4786, 334-72, #8
Silver	<0.2	<0.2	<0.2
Lead	*	6.0	*
Antimony	0.4	0.6	0.5
Tin	<10.	<10.	<10.
Thallium	<2.	<2.	<2.

* Analysis not requested

Sworn to and subscribed before me this 20th
day of February, 1985
My commission expires January 16, 1988

Notary Public

Approved by

Laboratory Manager
Title

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5815 Middlebrook Pike • Knoxville, Tennessee 37921 • 615-588-6401

CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Cliff Vaughn
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: February 20, 1985
PROJECT CODE: ITEK 19439
ORDER NUMBER:

Sample Description: Sixteen (16) coal, spoil, overburden, fly ash, and bottom ash samples from ITEK 18902

Concentration units are µg/gram (ppm)

	Coal C-1 Seam #8 North	Coal C-2 Seam #2 North	Coal C-3 Seam #4 North	Coal C-4 Seam #3 North	Coal C-5 Seam #7 North	Coal C-6 Seam #8 South
Silver	<0.2	<0.2	<0.3**	<0.2	<0.2	<0.2
Cadmium	<0.1	*	0.2	<0.1	<0.1	*
Cobalt	<0.5	*	<0.8**	<0.6**	*	*
Copper	0.020	0.028	0.029	0.033	0.044	0.071
Lead	<1.	<1.	*	<1.	2.6	3.8
Antimony	0.3	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	<10.	<10.	<10.	<10.	<10.	<10.
Thallium	<2.	<2.	<2.	<2.	<2.	<2.
Vanadium	<2.	<2.	<3.**	<2.	<2.	*

	Coal C-7, Seam #6 South	Spoil S-1	Spoil S-2	Spoil S-3	Spoil S-4	Spoil S-5
Silver	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	<10.	<10.	32.	<10.	<10.	<10.
Thallium	<2.	<2.	<2.	<2.	<2.	<2.

	Sample Overburden D-1	Sample Overburden D-2	PP #1 Fly Ash	PP #2 Bottom Ash
Silver	<0.2	<0.2	<0.2	<0.2
Cadmium	*	*	*	<0.1
Copper	*	0.143	0.063	0.023
Lead	*	*	*	<1.
Antimony	<0.1	<0.1	<0.1	<0.1
Tin	<10.	11.	11.	<10.
Thallium	<2.	<2.	<2.	<2.
Vanadium	*	*	*	<2.

* Analysis not requested
** Detection limit higher than normal due to matrix interference

Sworn to and subscribed before me this 20th day of February, 1985
My commission expires January 16, 1988

Notary Public

Approved by

Laboratory Manager
Title

Accredited by the American Association for Laboratory Accreditation in the chemical field of testing as listed in the current AALA Directory of Accredited Laboratories

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5815 Middlebrook Pike • Knoxville, Tennessee 37921 • 615-588-6401

CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Cliff Vaughn
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: February 20, 1985
PROJECT CODE: ITEK 19439
ORDER NUMBER:

Sample Description: Six (6) water samples from ITEK 18470

Concentration units are mg/liter (ppm)

	Comp #1	Comp #2	Comp #3	Comp #4	Comp #5	Surface Water
Silver	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium	0.002	0.004	0.002	*	<0.001	0.002
Cobalt	0.025	<0.006**	0.012	*	*	<0.005
Copper	0.051	0.029	0.017	*	*	0.031
Lead	0.03	*	<0.01	*	*	<0.01
Antimony	<0.001	<0.001	*	*	<0.001	0.001
Tin	<0.1	<0.1	<0.1	0.3	<0.1	<0.1
Thallium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

* Analysis not requested
** Detection limit higher than normal due to matrix interference

Sworn to and subscribed before me this 20th
day of February, 1985
My commission expires January 16, 1988

Notary Public

Approved by

Laboratory Manager
Title

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CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Cliff Vaughn
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: February 20, 1985
PROJECT CODE: ITEK 19439
ORDER NUMBER:

Sample Description: Two (2) filter sludge samples from ITEK 19345

Concentration units are µg/gram (ppm)

	#4765, 1/09/85 Filter Sludge #4	#4770, 1/09/85 Filter Sludge #5
Silver	<0.2	<0.2
Antimony	0.3	0.5
Tin	32.	21.
Thallium	<2.	<2.

Sworn to and subscribed before me this 20th
day of February, 1985
My commission expires January 16, 1988

Notary Public

Approved by

Laboratory Manager
Title

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CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: March 5, 1985
PROJECT CODE: ITEK 19431
ORDER NUMBER:

Sample Description: Two (2) solid samples received January 11, 1985

	Total Radium (pCi/l)
Filter Sludge #4785, 334-7, #7	6.6 ± 0.6
Filter Sludge #4786, 334-72, #8	6.0 ± 0.5

Sworn to and subscribed before me this 5th
day of March, 1985
My commission expires January 16, 1988

Notary Public

Approved by

Laboratory Manager
Title

Accredited by the American Association for Laboratory Accreditation in the chemical fields of testing as listed in the current AALA Directory of Accredited Laboratories

IT CORPORATION

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CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: March 5, 1985
PROJECT CODE: ITEK 19353
ORDER NUMBER:

Sample Description: One (1) solid sample received January 11, 1985

	Total Radium (pCi/l)
IT #4774, Filter Sludge #6	15.5 ± 0.6

Sworn to and subscribed before me this 5th
day of March, 1985
My commission expires January 16, 1988

Notary Public

Approved by

Laboratory Manager
Title

Accredited by the American Association for Laboratory Accreditation in the chemical field of testing, as listed in the current AALA Directory of Accredited Laboratories

IT CORPORATION

IT ANALYTICAL SERVICES

5815 Middlebrook Pike • Knoxville Tennessee 37921 • 615-588-6401

CERTIFICATE OF ANALYSIS

TO: IT Engineering/Assessment
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED March 5, 1985
PROJECT CODE ITEK 19635
ORDER NUMBER

Sample Description: Eight (8) solid samples received February 26, 1985

Concentration units are mg/liter (ppm)

	% Solids
#334-68-1, 12/21/84	81.3
#334-68-2A & 2B, 01/02/85	86.7
#334-68-3A & 3B, 01/02/85	76.1
#4765, Filter Sludge #4, 01/09/85	79.4
#4770, Filter Sludge #5, 01/09/85	74.5
IT #4774, Filter Sludge	84.2
Filter Sludge #4785, 334-7, #7	89.2
Filter Sludge #4786, 334-72, #8	79.0

Sworn to and subscribed before me this 5th
day of March, 1985
My commission expires January 16, 1988

Notary Public

Approved by

Laboratory Manager
Title

Accredited by the American Association for Laboratory Accreditation in the chemical [illegible] as listed in the current AALA Directory of Accredited Laboratories

IT CORPORATION

IT ANALYTICAL SERVICES

5815 Middlebrook Pike • Knoxville Tennessee 37921 • 615-588-6401

CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED: March 15, 1985
PROJECT CODE: ITDK 19245
ORDER NUMBER: Project #8549.02

Sample Description: Five (5) liquid samples received December 26, 1984

Concentration units are mg/liter (ppm)

	#334-66-1A, 1B	#334-66-2A, 2B	#334-66-3A, 3B	#334-67-4A, 4B	#334-67-5A, 5B
Aluminum	5.8	0.6	4.4	3.1	1.1
Antimony	<0.1	0.1	0.1	<0.1	<0.1
Arsenic	<0.4	<0.4	<0.4	<0.4	<0.4
Barium	0.447	0.635	0.159	0.152	0.101
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	6.3	0.09	0.207	0.05	0.03
Cadmium	0.004	<0.004	<0.004	<0.004	<0.004
Calcium	430.	62.	670.	440.	150.
Chromium	0.03	<0.01	<0.01	<0.01	<0.01
Cobalt	<0.01	<0.01	0.02	0.03	0.01
Copper	0.02	<0.02	0.02	0.02	<0.02
Iron	<0.01	<0.01	0.04	0.04	0.02
Lead	<0.1	<0.1	0.2	0.1	<0.1
Lithium	0.1	0.1	0.1	0.1	0.1
Magnesium	4.3	1.3	39.	38.	42.
Manganese	1.2	0.220	7.3	4.4	1.7
Molybdenum	0.11	<0.05	<0.05	<0.05	<0.05
Nickel	0.02	0.01	0.02	0.02	0.01
Selenium	0.2	<0.2	0.3	<0.2	<0.2
Silicon	19.	2.9	6.4	3.9	1.9
Silver	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	11.	3.0	230.	170.	71.
Strontium	1.0	0.143	3.2	2.7	0.673
Thallium	<1.	<1.	<1.	<1.	<1.
Tin	<0.5	<0.5	<0.5	<0.5	<0.5
Titanium	<0.02	<0.02	<0.02	<0.02	<0.02
Vanadium	0.04	<0.02	<0.02	<0.02	<0.02
Zinc	0.117	0.105	0.190	0.077	0.039

Sworn to and subscribed before me this 15th day of March, 1985
My commission expires March 18, 1985

Notary Public

Authority

Laboratory Director
Title

Approved by the Association for Laboratory Accreditation in the Chemical

IT CORPORATION

IT ANALYTICAL SERVICES

5815 Middlebrook Pike • Knoxville Tennessee 37921 • 615 588 6401

CERTIFICATE OF ANALYSIS

TO: IT Corporation
ATTN: Arie Groen
312 Directors Drive
Knoxville, TN 37923

DATE REPORTED March 15, 1985
PROJECT CODE ITDK 19245
ORDER NUMBER Project #8549.02

Sample Description: One (1) liquid and one (1) solid sample received December 26, 1984

Concentration units are mg/liter (ppm) for liquid; µg/gram (ppm) for solid

	#334-67-6A, 6B	#334-68-1
Aluminum	3.2	9900.
Antimony	0.1	<10.
Arsenic	<0.4	41.
Barium	0.193	650.
Beryllium	0.001	0.94
Boron	0.04	300.
Cadmium	<0.004	0.73
Calcium	470.	40,000.
Chromium	<0.01	11.
Cobalt	0.03	2.3
Copper	0.02	8.5
Iron	0.03	4400.
Lead	<0.1	12.
Lithium	<0.1	28.
Magnesium	42.	780.
Manganese	5.1	120.
Molybdenum	<0.05	7.9
Nickel	0.02	3.5
Selenium	<0.2	20.
Silicon	4.0	350.
Silver	<0.01	1.0
Sodium	170.	1000.
Strontium	2.8	120.
Thallium	<1.	<100.
Tin	<0.5	<50.
Titanium	<0.02	580.
Vanadium	<0.02	37.
Zinc	0.083	18.

Sworn to and subscribed before me this 15th day of March, 1985
My commission expires March 18, 1985
Notary Public

Laboratory Director

IT CORPORATION

Memorandum

To: A. Groen
J. Nuter

Date: March 15, 1985

From: R. M. Burke RMB 3/15/85
J. J. Duck JJD 3/15/85

Subject: Transmittal
Analytical Results for IT Corporation/Utah International
Project No. 85-8019; Job No. 8549.02

The IT Analytical Services (ITAS) Murrysville Laboratory has completed the analysis of the eighteen (18) samples received in our laboratory on February 15, 1985. Results of the analyses are presented in the enclosed tables and were determined in accordance with U.S. Environmental Protection Agency analytical procedures.

Should you have any questions or need additional information, please contact us at the Murrysville Laboratory.

JJD;RMB:ws

TABLE 1

1:4 ASTM LEACHATE ANALYSIS SUMMARY
FOR UTAH INTERNATIONAL
PROJECT NO. 85-8019

PARAMETER	UNITS	SAMPLE IDENTIFICATION BA-4818	BA-4819	BA-4820
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	80	2900	900
Chloride	mg/ℓ	22	2.4	290
Cyanide	mg/ℓ	<0.02	<0.02	<0.02
Fluoride	mg/ℓ	0.9	1.9	2.1
Nitrate	mg/ℓ NO_3-N	2.5	5.8	3.0
pH	--	8.15	8.90	8.60
Phenolics	mg/ℓ	0.02	0.02	0.04
Residue:				
Filterable @ 180°C	mg/ℓ	2,000	3,800	3,900
Specific Conductance	µmhos/cm @ 25°C	2,350	5,940	5,510
Sulfate	mg/ℓ SO_4^{-2}	940	44	1,100
Metals:				
Aluminum	mg/ℓ	<0.1	<0.1	<0.1
Arsenic	mg/ℓ	<0.001	0.004	<0.001
Barium	mg/ℓ	0.30	1.4	0.13
Boron	mg/ℓ	<0.5	0.8	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	260	18	50
Chromium	mg/ℓ	0.001	0.003	0.001
Cobalt	mg/ℓ	<0.001	0.004	0.005
Copper	mg/ℓ	<0.01	0.02	<0.01
Iron	mg/ℓ	0.03	0.08	0.04
Lead	mg/ℓ	<0.01	<0.01	<0.01
Magnesium	mg/ℓ	28	4.6	6.2
Manganese	mg/ℓ	0.07	0.04	0.06
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.023	0.024	0.003
Nickel	mg/ℓ	0.06	<0.01	0.04
Potassium	mg/ℓ	11	7.7	8.3
Selenium	mg/ℓ	0.046	0.023	0.023
Silver	mg/ℓ	0.004/0.003[2]	<0.001/<0.001	0.002
Sodium	mg/ℓ	330	1,200	1,000
Zinc	mg/ℓ	0.02	0.01	0.02

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION BA-4821	BA-4822	BA-DI
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	470	870	40
Chloride	mg/ℓ	5,500	2,100	5.9
Cyanide	mg/ℓ	<0.02	<0.02	<0.02
Fluoride	mg/ℓ	0.7	1.0	0.1
Nitrate	mg/ℓ NO_3-N	15	3.5	0.3
pH	--	8.25	9.50	7.80
Phenolics	mg/ℓ	0.03	0.04	0.05
Residue:				
Filterable @ 180°C	mg/ℓ	8,700	4,500	100
Specific Conductance	μmhos/cm @ 25°C	15,900	8930	157
Sulfate	mg/ℓ SO_4^{-2}	170	210	50
Metals:				
Aluminum	mg/ℓ	<0.1	0.3	0.2
Arsenic	mg/ℓ	<0.001	0.010	<0.001
Barium	mg/ℓ	0.93	0.81	0.30
Boron	mg/ℓ	0.6	0.6	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	170	7	21
Chromium	mg/ℓ	<0.001	0.048	0.002
Cobalt	mg/ℓ	0.076/0.070	0.004	<0.001
Copper	mg/ℓ	0.02	0.02	<0.01
Iron	mg/ℓ	0.05	0.09	0.06
Lead	mg/ℓ	0.24	0.04	<0.01
Magnesium	mg/ℓ	37	4.4	1.4
Manganese	mg/ℓ	0.14	0.02	0.02
Mercury	mg/ℓ	<0.0002	<0.0002	0.0002
Molybdenum	mg/ℓ	0.031	0.019	0.017
Nickel	mg/ℓ	0.08	0.06	0.02
Potassium	mg/ℓ	20	11	0.83
Selenium	mg/ℓ	0.020	0.013	0.006
Silver	mg/ℓ	<0.001/<0.001	<0.001/<0.001	<0.001/<0.001
Sodium	mg/ℓ	3,500	1,300	11
Zinc	mg/ℓ	0.02	0.02	0.01

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION CS-4818	CS-4819	CS-4820
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	96	1,100	160
Chloride	mg/ℓ	55	200	330
Cyanide	mg/ℓ	<0.02	<0.02	<0.02
Fluoride	mg/ℓ	1.8	11	8.5
Nitrate	mg/ℓ NO_3-N	11	2.5	6.1
pH	--	10.40	8.60	9.90
Phenolics	mg/ℓ	0.02	<0.01	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	2,000	4,800	4,700
Specific Conductance	µmhos/cm @ 25°C	2,570	7,300	5,730
Sulfate	mg/ℓ SO_4^{-2}	1,400	1,300	2,600
Metals:				
Aluminum	mg/ℓ	0.3	0.3	0.6
Arsenic	mg/ℓ	0.018	0.223	0.140
Barium	mg/ℓ	0.39	0.53	0.41
Boron	mg/ℓ	3.1	33	14
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	330	130	170
Chromium	mg/ℓ	0.096	0.084	0.081
Cobalt	mg/ℓ	<0.001	<0.001	0.003
Copper	mg/ℓ	<0.01	<0.01	<0.01
Iron	mg/ℓ	0.02	0.12	0.02
Lead	mg/ℓ	<0.01	0.03	0.03
Magnesium	mg/ℓ	0.2	9.5	3.2
Manganese	mg/ℓ	0.05	0.11	0.06
Mercury	mg/ℓ	<0.0002	0.0003	<0.0002
Molybdenum	mg/ℓ	0.90	1.0	0.80
Nickel	mg/ℓ	0.04	0.04	0.05
Potassium	mg/ℓ	18	13	14
Selenium	mg/ℓ	0.018	0.54	0.12
Silver	mg/ℓ	<0.001	<0.001	0.002
Sodium	mg/ℓ	350	1,200	1,100
Zinc	mg/ℓ	0.02	0.04	0.02

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION CS-4821	CS-4822	CS-DI
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	140/140	210	110
Chloride	mg/ℓ	4,900/4,900	2,200	22
Cyanide	mg/ℓ	<0.02/<0.02	<0.02	<0.02
Fluoride	mg/ℓ	5.7/6.0	5.7	1.6
Nitrate	mg/ℓ NO_3-N	16/16	6.5	2.0
pH	--	9.80/9.60	10.80	10.70
Phenolics	mg/ℓ	0.01/0.03	0.03	<0.01
Residue:				
Filterable @ 180°C	mg/ℓ	9,800/9,800	5,000	520
Specific Conductance	µmhos/cm @ 25°C	17,700/17,800	7,950	927
Sulfate	mg/ℓ SO_4^{-2}	400/500	1,500	100
Metals:				
Aluminum	mg/ℓ	0.2/0.5	1.4	0.9
Arsenic	mg/ℓ	0.057/0.057	0.076	0.013
Barium	mg/ℓ	0.88/0.77	0.39	1.0
Boron	mg/ℓ	15/11	15	2.9
Cadmium	mg/ℓ	<0.001/<0.001	<0.001	<0.001
Calcium	mg/ℓ	340/410	120	120
Chromium	mg/ℓ	0.11/0.10	0.14	0.078
Cobalt	mg/ℓ	0.008/0.011	<0.001	<0.001
Copper	mg/ℓ	<0.01/<0.01	<0.01	<0.01
Iron	mg/ℓ	0.04/0.08	0.02	0.02
Lead	mg/ℓ	0.12/0.12	0.04	<0.01
Magnesium	mg/ℓ	2.6/8.3	<0.1	<0.1
Manganese	mg/ℓ	0.07/0.06	0.06	0.05
Mercury	mg/ℓ	<0.0002/<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	1.3/1.4	1.3	1.2
Nickel	mg/ℓ	0.06/0.06	0.05	<0.01
Potassium	mg/ℓ	25/25	17	6.6
Selenium	mg/ℓ	0.14/0.15	0.17	0.045
Silver	mg/ℓ	0.002/0.002	<0.001	<0.001
Sodium	mg/ℓ	2,800/2,800	1,300	44
Zinc	mg/ℓ	0.03/0.04	<0.01	0.03

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION FA-4818	FA-4819	FA-4820
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	820	2,600	840
Chloride	mg/ℓ	16	360	290
Cyanide	mg/ℓ	<0.02	<0.02	<0.02
Fluoride	mg/ℓ	1.9	1.6	0.4
Nitrate	mg/ℓ NO_3-N	3.3	2.0	2.0
pH	--	12.20	10.30	11.80
Phenolics	mg/ℓ	0.03	0.03	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	2,000	4,300	4,500
Specific Conductance	μmhos/cm @ 25°C	5,490	7,470	7,350
Sulfate	mg/ℓ SO_4^{-2}	590	510	1,200
Metals:				
Aluminum	mg/ℓ	0.8	15	16
Arsenic	mg/ℓ	0.009	1.00	0.140
Barium	mg/ℓ	0.49	0.30	0.33
Boron	mg/ℓ	1.0	20	12
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	290	7	80
Chromium	mg/ℓ	0.14	0.24	0.22
Cobalt	mg/ℓ	<0.001	0.005	0.004
Copper	mg/ℓ	<0.01	<0.01	<0.01
Iron	mg/ℓ	0.02	0.07	0.04
Lead	mg/ℓ	<0.01	0.01	0.01
Magnesium	mg/ℓ	0.2	0.8	0.2
Manganese	mg/ℓ	0.02	0.02	<0.01
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	1.4	0.75	0.64
Nickel	mg/ℓ	<0.01	<0.01	<0.01
Potassium	mg/ℓ	17	7.0	9.2
Selenium	mg/ℓ	0.09	0.83	0.32
Silver	mg/ℓ	<0.001/<0.001	<0.001/0.002	0.001
Sodium	mg/ℓ	380	1,300	1,100
Zinc	mg/ℓ	0.01	0.01	0.01

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION FA-4821	FA-4822	FA-DI
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	960	1,000	1,400
Chloride	mg/ℓ	5,600	2,100	3.9
Cyanide	mg/ℓ	<0.02	0.04	<0.02
Fluoride	mg/ℓ	3.1	1.9	3.3
Nitrate	mg/ℓ NO_3-N	19	3.3	2.5
pH	--	12.00	12.15	12.10
Phenolics	mg/ℓ	0.03	0.05	0.05
Residue:				
Filterable @ 180°C	mg/ℓ	10,000	4,800	1,600
Specific Conductance	μmhos/cm @ 25°C	1,970	12,500	5,710
Sulfate	mg/ℓ SO_4^{-2}	320	370	130
Metals:				
Aluminum	mg/ℓ	0.3	2.0	<0.1
Arsenic	mg/ℓ	0.017	0.030	0.010
Barium	mg/ℓ	1.3	1.7	4.9
Boron	mg/ℓ	6.2	6.2	5.1
Cadmium	mg/ℓ	<0.001	<0.001	<0.001/<0.001
Calcium	mg/ℓ	520	160	590
Chromium	mg/ℓ	0.070	0.118	0.036
Cobalt	mg/ℓ	0.070	0.006	<0.001
Copper	mg/ℓ	<0.01	<0.01	<0.01/0.05
Iron	mg/ℓ	0.04	0.03	0.02
Lead	mg/ℓ	0.19	0.04	<0.01/<0.01
Magnesium	mg/ℓ	0.2	<0.1	0.2
Manganese	mg/ℓ	0.02	<0.01	0.02/0.02
Mercury	mg/ℓ	0.0006	<0.0002	<0.0002
Molybdenum	mg/ℓ	1.5	1.2	1.5
Nickel	mg/ℓ	0.05	<0.01	0.07
Potassium	mg/ℓ	22	14	2.0/2.0
Selenium	mg/ℓ	0.22	0.38	0.24
Silver	mg/ℓ	0.001/0.002	<0.001/0.001	0.016/0.014
Sodium	mg/ℓ	3,000	1,900	41
Zinc	mg/ℓ	0.01	0.01	0.04/0.04

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4810C-4818	4810C-4819	4810C-4820
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	320	2,100	680
Chloride	mg/ℓ	43	390	340
Cyanide	mg/ℓ	<0.02	0.09	0.02
Fluoride	mg/ℓ	1.3	1.8	1.7
Nitrate	mg/ℓ NO_3-N	14	15	12
pH	—	8.30	8.50	8.00
Phenolics	mg/ℓ	0.03	0.03	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	5,800	6,200	7,400
Specific Conductance	µmhos/cm @ 25°C	6,390	8,040	8,780
Sulfate	mg/ℓ SO_4^{-2}	3,500	1,800	3,900
Metals:				
Aluminum	mg/ℓ	0.3	0.1	0.8
Arsenic	mg/ℓ	0.005	0.003	0.005
Barium	mg/ℓ	0.20	0.26	0.15
Boron	mg/ℓ	<0.5	0.8	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	600	230	450
Chromium	mg/ℓ	0.004	0.005	0.009
Cobalt	mg/ℓ	0.006	0.006	0.007
Copper	mg/ℓ	0.05	0.05	0.11
Iron	mg/ℓ	0.16	0.12	0.22
Lead	mg/ℓ	0.02	0.01	0.04
Magnesium	mg/ℓ	64	36	46
Manganese	mg/ℓ	0.59	0.31	0.55
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.005	0.005	0.006
Nickel	mg/ℓ	0.07	0.07	0.12
Potassium	mg/ℓ	25	22	23
Selenium	mg/ℓ	0.017	0.016	0.010
Silver	mg/ℓ	0.001	0.001	0.001
Sodium	mg/ℓ	900	1,600	1,500
Zinc	mg/ℓ	0.04	0.05	0.12

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4810C-4821	4810C-4822	4810C-DI
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	1,100	500	300
Chloride	mg/ℓ	5,700	2,300	35
Cyanide	mg/ℓ	0.04	0.02	<0.02
Fluoride	mg/ℓ	1.1	1.6	1.2
Nitrate	mg/ℓ NO_3-N	21	15	10
pH	--	8.30	8.50	8.10
Phenolics	mg/ℓ	0.03	0.04	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	14,000	8,300	4,400
Specific Conductance	µmhos/cm @ 25°C	20,400	11,400	5,080
Sulfate	mg/ℓ SO_4^{-2}	3,500	2,800	3,000
Metals:				
Aluminum	mg/ℓ	0.1	0.2	0.2
Arsenic	mg/ℓ	0.002	0.003	0.002
Barium	mg/ℓ	0.34	0.26	0.10
Boron	mg/ℓ	<0.5	<0.5	0.8
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	900	570	470
Chromium	mg/ℓ	<0.001	0.011	0.002
Cobalt	mg/ℓ	0.092/0.091	0.007	0.002
Copper	mg/ℓ	0.06	0.05	0.02
Iron	mg/ℓ	0.16	0.08	0.10
Lead	mg/ℓ	0.24	0.04	<0.01
Magnesium	mg/ℓ	94	60	45
Manganese	mg/ℓ	1.2	0.55	0.60
Mercury	mg/ℓ	0.0007	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.007	0.004	0.008
Nickel	mg/ℓ	0.18	0.14	0.01
Potassium	mg/ℓ	41	27	18
Selenium	mg/ℓ	0.010	0.014	0.016
Silver	mg/ℓ	0.001	0.001	0.001
Sodium	mg/ℓ	3,900	2,300	800
Zinc	mg/ℓ	0.04	0.04	0.05

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4810S-4818	4810S-4819	4810S-4820
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	160	2100	810
Chloride	mg/ℓ	20	420	170
Cyanide	mg/ℓ	0.02	0.08	<0.02
Fluoride	mg/ℓ	1.1	1.4	1.5
Nitrate	mg/ℓ NO_3-N	17	18	17
pH	—	8.10	8.35	8.15
Phenolics	mg/ℓ	0.03	<0.01	<0.01
Residue:				
Filterable @ 180°C	mg/ℓ	5,000	6,200	6,900
Specific Conductance	µmhos/cm @ 25°C	6,010	8,450	8,600
Sulfate	mg/ℓ SO_4^{-2}	3,000	4,000	3,700
Metals:				
Aluminum	mg/ℓ	<0.1	1.4	<0.1
Arsenic	mg/ℓ	0.002	0.003	0.004
Barium	mg/ℓ	0.085	0.039	0.072
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	400	80	360
Chromium	mg/ℓ	0.005	0.055	0.006
Cobalt	mg/ℓ	0.007	0.003	0.012
Copper	mg/ℓ	0.05	0.04	0.06
Iron	mg/ℓ	0.08	0.30	0.08
Lead	mg/ℓ	0.03	0.03	0.05
Magnesium	mg/ℓ	50	34	42
Manganese	mg/ℓ	0.13	0.05	0.15
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.007	0.013	0.013
Nickel	mg/ℓ	0.03	<0.01	0.08
Potassium	mg/ℓ	23	20	23
Selenium	mg/ℓ	0.021	0.012	0.013
Silver	mg/ℓ	0.002	0.002	0.002
Sodium	mg/ℓ	1,000	1,700	1,500
Zinc	mg/ℓ	0.04	0.04	0.04

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4810S-4821	4810S-4822	4810S-DI
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	460	530	140
Chloride	mg/ℓ	5,300	2100	12
Cyanide	mg/ℓ	0.05	0.05	<0.02
Fluoride	mg/ℓ	0.8	1.6	2.5
Nitrate	mg/ℓ NO_3-N	31	16	12
pH	—	8.05	8.40	7.90
Phenolics	mg/ℓ	0.04	0.04	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	13,000	6,100	3,500
Specific Conductance	µmhos/cm @ 25°C	22,800	9,670	4,830
Sulfate	mg/ℓ SO_4^{-2}	2,300	1,000	2,200
Metals:				
Aluminum	mg/ℓ	<0.1	0.1	<0.1
Arsenic	mg/ℓ	0.002	0.002	0.001
Barium	mg/ℓ	0.20	0.12	0.10
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	0.002	<0.001	<0.001
Calcium	mg/ℓ	770	130	310
Chromium	mg/ℓ	0.004	0.029	0.004
Cobalt	mg/ℓ	0.096	0.001	0.002
Copper	mg/ℓ	0.05	0.04	0.02
Iron	mg/ℓ	0.24	0.24	0.04
Lead	mg/ℓ	0.25	0.04	0.02
Magnesium	mg/ℓ	79	24	28
Manganese	mg/ℓ	0.34	0.11	0.06
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.016	0.009	0.009
Nickel	mg/ℓ	0.08	0.04	0.03
Potassium	mg/ℓ	40	19	16
Selenium	mg/ℓ	0.022	0.009	0.012
Silver	mg/ℓ	<0.001	<0.001	0.002
Sodium	mg/ℓ	3,400	1,700	770
Zinc	mg/ℓ	0.05	0.03	0.01

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4811C-4818	4811C-4819	4811C-4820
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	220	2,000	610
Chloride	mg/ℓ	27	370	320
Cyanide	mg/ℓ	<0.02	0.05	0.04
Fluoride	mg/ℓ	1.5	2.3	1.9
Nitrate	mg/ℓ NO_3-N	9.5	3.5	6.8
pH	--	8.30	8.20	8.05
Phenolics	mg/ℓ	0.03	0.03	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	4,100	5,400	6,200
Specific Conductance	µmhos/cm @ 25°C	4,950	8,270	8,950
Sulfate	mg/ℓ SO_4^{-2}	2,200	1,500	3,400
Metals:				
Aluminum	mg/ℓ	0.4	3.9	0.1
Arsenic	mg/ℓ	0.002	0.003	0.005
Barium	mg/ℓ	0.047	0.097	0.043
Boron	mg/ℓ	<0.5	1.0	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	340	130	310
Chromium	mg/ℓ	<0.001	0.013	<0.001
Cobalt	mg/ℓ	0.003	0.007	0.006
Copper	mg/ℓ	0.05	0.05	0.03
Iron	mg/ℓ	0.07	0.93	0.07
Lead	mg/ℓ	<0.01	<0.01	0.01
Magnesium	mg/ℓ	41	30	44
Manganese	mg/ℓ	0.48	0.21	0.23
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.007	0.009	0.007
Nickel	mg/ℓ	0.04	0.04	0.03
Potassium	mg/ℓ	26	24	27
Selenium	mg/ℓ	0.016	0.010	0.007
Silver	mg/ℓ	0.001	0.001	0.001
Sodium	mg/ℓ	860	1,500	1,300
Zinc	mg/ℓ	0.05	0.05	0.03

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4811C-4821	4811C-4822	4811C-DI
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	360/460	460	220
Chloride	mg/ℓ	5,800/5,600	2,300	14
Cyanide	mg/ℓ	0.02/<0.02	0.04	<0.02
Fluoride	mg/ℓ	1.2/1.8	1.6	2.2
Nitrate	mg/ℓ NO_3-N	14/17	6.5	3.0
pH	—	8.35/8.20	8.10	8.25
Phenolics	mg/ℓ	0.04/0.02	0.04	0.04
Residue:				
Filterable @ 180°C	mg/ℓ	12,000/12,000	6,600	3,000
Specific Conductance	μmhos/cm @ 25°C	17,600/18,400	9,950	3,730
Sulfate	mg/ℓ SO_4^{-2}	1,700/1,500	1,700	1,800
Metals:				
Aluminum	mg/ℓ	<0.1/0.2	0.5	0.4
Arsenic	mg/ℓ	<0.001	0.002	<0.001
Barium	mg/ℓ	0.20/0.27	0.096	0.068
Boron	mg/ℓ	<0.5/<0.5	<0.5	<0.5
Cadmium	mg/ℓ	0.056/0.052	<0.001	<0.001
Calcium	mg/ℓ	650/510	270	270
Chromium	mg/ℓ	<0.001/<0.001	0.003	0.004
Cobalt	mg/ℓ	0.11/0.086	0.005	0.002
Copper	mg/ℓ	0.04/0.03	0.05	0.05
Iron	mg/ℓ	0.09/0.07	0.09	0.07
Lead	mg/ℓ	0.23	0.04	<0.01
Magnesium	mg/ℓ	83/76	40	28
Manganese	mg/ℓ	1.1/0.93	0.30	0.29
Mercury	mg/ℓ	<0.0002/<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.012	0.007	0.008
Nickel	mg/ℓ	0.07/0.07	<0.01	0.03
Potassium	mg/ℓ	43/44	29	18
Selenium	mg/ℓ	0.010/0.018	0.014	0.003
Silver	mg/ℓ	0.003/0.005	0.001/0.004	0.001
Sodium	mg/ℓ	3,000/2,800	1,600	580
Zinc	mg/ℓ	0.04/0.03	0.04	0.04

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4811S-4818	4811S-4819	4811S-4820
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	200	2,200	720
Chloride	mg/ℓ	29	390	310
Cyanide	mg/ℓ	0.06	<0.02	<0.02
Fluoride	mg/ℓ	1.0	1.3	1.6
Nitrate	mg/ℓ NO_3-N	8.7	10	9.2
pH	--	7.90	8.90	8.40
Phenolics	mg/ℓ	0.02	0.04	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	3,800	5,000	5,000
Specific Conductance	µmhos/cm @ 25°C	5,300	7,290	6,760
Sulfate	mg/ℓ SO_4^{-2}	2,500	800	2,400
Metals:				
Aluminum	mg/ℓ	<0.1	3.8	3.2
Arsenic	mg/ℓ	0.001	0.001	0.001
Barium	mg/ℓ	0.038	0.045	0.031
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	290	60	110
Chromium	mg/ℓ	0.004	0.049	0.033
Cobalt	mg/ℓ	0.002	0.001	0.001
Copper	mg/ℓ	0.02	0.08	0.02
Iron	mg/ℓ	0.06	0.76	0.50
Lead	mg/ℓ	0.02	0.04	0.04
Magnesium	mg/ℓ	37	20	22
Manganese	mg/ℓ	0.27	0.14	0.20
Mercury	mg/ℓ	0.0004	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.011	0.023	0.020
Nickel	mg/ℓ	<0.01	0.09	<0.01
Potassium	mg/ℓ	26	21	25
Selenium	mg/ℓ	0.014	0.013	0.004
Silver	mg/ℓ	0.002	0.002	0.003
Sodium	mg/ℓ	810	1,400	1,300
Zinc	mg/ℓ	0.02	0.08	0.02

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4811S-4821	4811S-4822	4811S-DI
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	370/440	520	170
Chloride	mg/ℓ	5,100/5,300	1,900	11
Cyanide	mg/ℓ	<0.02/<0.02	0.02	<0.02
Fluoride	mg/ℓ	0.6/0.7	1.3	1.2
Nitrate	mg/ℓ NO_3-N	21/19	9.5	2.4
pH	--	8.00/8.10	8.20	8.20
Phenolics	mg/ℓ	0.02/0.03	<0.01	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	11,000/10,000	4,900	1,700
Specific Conductance	µmhos/cm @ 25°C	18,400/17,600	8,460	2,450
Sulfate	mg/ℓ SO_4^{-2}	600/500	400	650
Metals:				
Aluminum	mg/ℓ	<0.1/0.1	0.2	0.6
Arsenic	mg/ℓ	0.004/0.004	<0.001	0.004
Barium	mg/ℓ	0.11/0.16	0.037	0.016
Boron	mg/ℓ	<0.5/0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001/<0.001	<0.001	<0.001
Calcium	mg/ℓ	300/260	60	33
Chromium	mg/ℓ	0.006/0.004	0.004	0.005
Cobalt	mg/ℓ	0.055/0.076	<0.001	<0.001
Copper	mg/ℓ	0.03/0.02	0.04	<0.01
Iron	mg/ℓ	0.06/0.18	0.06	0.12
Lead	mg/ℓ	0.17/0.16	0.02	0.01
Magnesium	mg/ℓ	58/59	17	4.9
Manganese	mg/ℓ	0.50/0.41	0.16	0.07
Mercury	mg/ℓ	<0.0002/<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.025/0.024	0.029	0.012
Nickel	mg/ℓ	0.08/0.08	<0.01	<0.01
Potassium	mg/ℓ	41/40	20	7.1
Selenium	mg/ℓ	0.016/0.017	0.014	0.011
Silver	mg/ℓ	<0.001/<0.001	<0.001	<0.001
Sodium	mg/ℓ	3,200/3,100	1,400	290
Zinc	mg/ℓ	0.04/0.01	0.02	0.03

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4812C-4818	4812C-4819	4812C-4820
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	150	2,000	760
Chloride	mg/ℓ	29	390	380
Cyanide	mg/ℓ	0.05	<0.02	0.04
Fluoride	mg/ℓ	2.0	2.8	2.7
Nitrate	mg/ℓ NO_3-N	13	17	11
pH	--	7.80	8.45	8.20
Phenolics	mg/ℓ	0.04	0.03	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	4,800	5,500	6,800
Specific Conductance	µmhos/cm @ 25°C	6,190	8,030	9,300
Sulfate	mg/ℓ SO_4^{-2}	3,200	1,400	3,600
Metals:				
Aluminum	mg/ℓ	<0.1	0.5	0.1
Arsenic	mg/ℓ	0.003	0.003	0.005
Barium	mg/ℓ	0.056	0.058	0.050
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	490	110	430
Chromium	mg/ℓ	0.004	0.004	0.004
Cobalt	mg/ℓ	0.009	0.011	0.031
Copper	mg/ℓ	0.03	0.16	0.03
Iron	mg/ℓ	0.04	0.08	0.06
Lead	mg/ℓ	0.02	0.02	0.04
Magnesium	mg/ℓ	48	23	43
Manganese	mg/ℓ	1.2	0.24	1.2
Mercury	mg/ℓ	0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.033	0.009	0.022
Nickel	mg/ℓ	<0.01	0.04	<0.01
Potassium	mg/ℓ	25	17	22
Selenium	mg/ℓ	0.018	0.019	0.012
Silver	mg/ℓ	0.002	0.002	0.002
Sodium	mg/ℓ	900	1,400	1,300
Zinc	mg/ℓ	0.04	0.05	0.04

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4812C-4821	4812C-4822	4812C-DI
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	450	530	130
Chloride	mg/ℓ	5,500	2,200	14
Cyanide	mg/ℓ	0.02	0.09	<0.02
Fluoride	mg/ℓ	1.4	2.1	1.6
Nitrate	mg/ℓ NO_3-N	20	14	10
pH	--	7.85	8.05	7.60
Phenolics	mg/ℓ	0.05	0.03	0.04
Residue:				
Filterable @ 180°C	mg/ℓ	12,000	6,900	3,100
Specific Conductance	µmhos/cm @ 25°C	20,200	11,700	3,790
Sulfate	mg/ℓ SO_4^{-2}	1,500	670	1900
Metals:				
Aluminum	mg/ℓ	0.2	0.1	0.2
Arsenic	mg/ℓ	0.006	0.002	0.002
Barium	mg/ℓ	0.18	0.098	0.047
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	540	340	350
Chromium	mg/ℓ	0.004	0.008	<0.001
Cobalt	mg/ℓ	0.035/0.047	0.007	0.003
Copper	mg/ℓ	0.05	0.03	0.02
Iron	mg/ℓ	0.06	0.06	0.02
Lead	mg/ℓ	0.12	0.02	<0.01
Magnesium	mg/ℓ	72	40	34
Manganese	mg/ℓ	1.2	0.72	0.64
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.032	0.020	0.022
Nickel	mg/ℓ	0.12	0.08	<0.01
Potassium	mg/ℓ	35	23	16
Selenium	mg/ℓ	0.023	0.021	0.023
Silver	mg/ℓ	<0.001	<0.001	<0.001
Sodium	mg/ℓ	3,800	2,000	580
Zinc	mg/ℓ	0.03	0.01	0.02

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4812S-4818	4812S-4819	4812S-4820
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	200	1,400	860
Chloride	mg/ℓ	29	390	320
Cyanide	mg/ℓ	0.02	0.02	0.02
Fluoride	mg/ℓ	1.3	1.8	2.2
Nitrate	mg/ℓ NO_3-N	12	16	12
pH	--	8.20	8.10	8.30
Phenolics	mg/ℓ	0.01	0.01	<0.01
Residue:				
Filterable @ 180°C	mg/ℓ	2,900	5,300	4,800
Specific Conductance	µmhos/cm @ 25°C	4,130	7,700	6,840
Sulfate	mg/ℓ SO_4^{-2}	1,900	1,000	1,800
Metals:				
Aluminum	mg/ℓ	<0.1	<0.1	0.1
Arsenic	mg/ℓ	0.002	0.001	0.003
Barium	mg/ℓ	0.053	0.093	0.037
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	160	140	110
Chromium	mg/ℓ	<0.001	0.004	0.005
Cobalt	mg/ℓ	0.011	0.004	0.012
Copper	mg/ℓ	0.02	0.02	0.02
Iron	mg/ℓ	0.02	0.06	0.08
Lead	mg/ℓ	0.02	0.02	0.03
Magnesium	mg/ℓ	23	25	19
Manganese	mg/ℓ	0.60	0.19	0.26
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.012	0.002	0.007
Nickel	mg/ℓ	<0.01	0.02	<0.01
Potassium	mg/ℓ	19	18	16
Selenium	mg/ℓ	0.019	0.026	0.020
Silver	mg/ℓ	0.002	0.002	0.002
Sodium	mg/ℓ	750	1,500	1,300
Zinc	mg/ℓ	0.05	0.06	0.05

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4812S-4821	4812S-4822	4812S-DI
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	440	630	260
Chloride	mg/ℓ	5,600	2,100	13
Cyanide	mg/ℓ	0.02	<0.02	<0.02
Fluoride	mg/ℓ	0.7	1.9	1.4
Nitrate	mg/ℓ NO_3-N	23	17	52
pH	--	7.90	8.20	8.10
Phenolics	mg/ℓ	<0.01	0.16	<0.01
Residue:				
Filterable @ 180°C	mg/ℓ	11,400	5,100	1,700
Specific Conductance	µmhos/cm @ 25°C	17,900	8,950	2,230
Sulfate	mg/ℓ SO_4^{-2}	1,600	300	650
Metals:				
Aluminum	mg/ℓ	<0.1	0.3	<0.1
Arsenic	mg/ℓ	0.006	<0.001	0.001
Barium	mg/ℓ	0.37	0.078	0.098
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	0.002	<0.001	<0.001
Calcium	mg/ℓ	470	60	50
Chromium	mg/ℓ	<0.001	0.005	0.001
Cobalt	mg/ℓ	0.13	0.002	<0.001
Copper	mg/ℓ	0.03	0.06	<0.01
Iron	mg/ℓ	0.06	0.06	0.02
Lead	mg/ℓ	0.18	0.01	<0.01
Magnesium	mg/ℓ	65	15	6.3
Manganese	mg/ℓ	0.76	0.17	0.11
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.008	0.008	0.013
Nickel	mg/ℓ	0.07	0.03	<0.01
Potassium	mg/ℓ	34	18	8.9
Selenium	mg/ℓ	0.032	0.024	0.026
Silver	mg/ℓ	<0.001	<0.001	<0.001
Sodium	mg/ℓ	3,100	1,500	420
Zinc	mg/ℓ	0.04	0.05	0.05

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4813C-4818	4813C-4819	4813C-4820
General Chemistry:				
Acidity	mg/ℓ[(1)] $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	210/180	1,600	690
Chloride	mg/ℓ	37/16	400	310
Cyanide	mg/ℓ	<0.02/<0.02	<0.02	0.04
Fluoride	mg/ℓ	1.0/1.0	2.2	1.4
Nitrate	mg/ℓ NO_3-N	9.5/11	4.0	7.2
pH	--	7.70/7.90	8.40	8.00
Phenolics	mg/ℓ	0.03/0.02	0.10	0.04
Residue:				
Filterable @ 180°C	mg/ℓ	5,300/5,200	6,000	6,900
Specific Conductance	µmhos/cm @ 25°C	5,970/6,800	8,370	9,560
Sulfate	mg/ℓ SO_4^{-2}	3,200/3,400	2,300	3,800
Metals:				
Aluminum	mg/ℓ	0.2/0.1	3.6	0.1
Arsenic	mg/ℓ	0.003/0.002	0.004	0.005
Barium	mg/ℓ	0.076/0.049	0.025	0.052
Boron	mg/ℓ	<0.5/<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001/<0.001	<0.001	<0.001
Calcium	mg/ℓ	670/680	100	500
Chromium	mg/ℓ	0.027/0.006	0.008	0.004
Cobalt	mg/ℓ	0.015/0.012	0.023	0.042
Copper	mg/ℓ	<0.01/0.02	0.02	0.02
Iron	mg/ℓ	0.02/0.02	0.13	0.02
Lead	mg/ℓ	0.01/0.01	0.02	0.04
Magnesium	mg/ℓ	47/45	24	31
Manganese	mg/ℓ	1.4/1.2	0.08	0.90
Mercury	mg/ℓ	<0.0002/<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.020/0.017	0.007	0.015
Nickel	mg/ℓ	0.02/0.02	0.04	0.06
Potassium	mg/ℓ	32/30	30	30
Selenium	mg/ℓ	0.018/0.013	0.004	0.004
Silver	mg/ℓ	0.002/<0.001	0.002	0.002
Sodium	mg/ℓ	850/870	1,500	1,300
Zinc	mg/ℓ	0.05/0.05	0.03	0.05

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4813C-4821	4813C-4822	4813C-DI
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	350	460	110
Chloride	mg/ℓ	5,700	2,200	20
Cyanide	mg/ℓ	<0.02	0.04	<0.02
Fluoride	mg/ℓ	0.9	1.3	1.2
Nitrate	mg/ℓ NO_3-N	15	5.3	4.3
pH	--	7.90	8.20	7.90
Phenolics	mg/ℓ	0.03	0.03	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	12,000	7,600	3,700
Specific Conductance	µmhos/cm @ 25°C	19,800	12,100	4,330
Sulfate	mg/ℓ SO_4^{-2}	2,000	2,300	2,400
Metals:				
Aluminum	mg/ℓ	0.1	<0.1	0.1
Arsenic	mg/ℓ	0.009	0.003	<0.001
Barium	mg/ℓ	0.095	0.093	0.077
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	790	470	530
Chromium	mg/ℓ	0.002	0.002	0.004
Cobalt	mg/ℓ	0.052	0.028	0.005
Copper	mg/ℓ	0.02	<0.01	0.14
Iron	mg/ℓ	0.04	<0.01	0.02
Lead	mg/ℓ	0.15	0.04	<0.01
Magnesium	mg/ℓ	62	33	28
Manganese	mg/ℓ	1.3	0.51	0.78
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.016	0.014	0.020
Nickel	mg/ℓ	0.08	<0.01	<0.01
Potassium	mg/ℓ	49	40	26
Selenium	mg/ℓ	0.016	0.012	0.006
Silver	mg/ℓ	<0.001	0.002	<0.001
Sodium	mg/ℓ	3,100	2,100	610
Zinc	mg/ℓ	0.06/0.06	0.03	0.11/0.10

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4813S-4818	4813S-4819	4813S-4820
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	200/190	1,800	690
Chloride	mg/ℓ	43/51	410	340
Cyanide	mg/ℓ	0.03/0.02	<0.02	<0.02
Fluoride	mg/ℓ	0.6/0.7	0.9	0.9
Nitrate	mg/ℓ NO_3-N	11/11	11	19
pH	--	7.85/8.00	8.15	7.80
Phenolics	mg/ℓ	0.02/<0.01	<0.01	0.01
Residue:				
Filterable @ 180°C	mg/ℓ	4,600/4,000	8,800	6,700
Specific Conductance	µmhos/cm @ 25°C	5,450/5,120	7,490	8,230
Sulfate	mg/ℓ SO_4^{-2}	2,700/2,800	1,300	3,000
Metals:				
Aluminum	mg/ℓ	<0.1/<0.1	0.7	<0.1
Arsenic	mg/ℓ	0.002/0.002	0.003	0.005
Barium	mg/ℓ	0.038/0.048	0.069	0.046
Boron	mg/ℓ	<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001/<0.001	<0.001	<0.001
Calcium	mg/ℓ	640/530	210	460
Chromium	mg/ℓ	<0.001/0.003	0.006	0.001
Cobalt	mg/ℓ	0.006/0.007	0.009	0.024
Copper	mg/ℓ	0.02/<0.01	0.06	<0.01
Iron	mg/ℓ	0.06/0.04	0.31	0.04
Lead	mg/ℓ	<0.01/<0.01	<0.01	0.02
Magnesium	mg/ℓ	37/33	21	27
Manganese	mg/ℓ	0.70/0.86	0.32	0.62
Mercury	mg/ℓ	<0.0002/<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.004/0.005	0.003	0.003
Nickel	mg/ℓ	<0.01/<0.01	0.06	0.03
Potassium	mg/ℓ	31/30	28	32
Selenium	mg/ℓ	0.020/0.020	0.018	0.012
Silver	mg/ℓ	0.002/0.002	0.002	0.002
Sodium	mg/ℓ	850/830	1,500	1,400
Zinc	mg/ℓ	0.04/0.04	0.05	0.04

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4813S-4821	4813S-4822	4813S-DI
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	420/780	500	160
Chloride	mg/ℓ	5,500/5,600	2,400	19
Cyanide	mg/ℓ	0.02/<0.02	<0.02	<0.02
Fluoride	mg/ℓ	0.5/0.5	0.7	0.5
Nitrate	mg/ℓ NO_3-N	20/18	11	1.0
pH	--	8.00/7.60	7.85	7.90
Phenolics	mg/ℓ	0.01/0.01	0.04	<0.01
Residue:				
Filterable @ 180°C	mg/ℓ	12,000/13,000	6,800	3,500
Specific Conductance	μmhos/cm @ 25°C	19,100/20,600	9,390	4,140
Sulfate	mg/ℓ SO_4^{-2}	1,300/2,000	1,500	2,000
Metals:				
Aluminum	mg/ℓ	<0.1/<0.1	<0.1	<0.1
Arsenic	mg/ℓ	0.005/0.006	<0.001	<0.001
Barium	mg/ℓ	0.079/0.083	0.051	0.072
Boron	mg/ℓ	0.6/<0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001/0.002	<0.001	<0.001
Calcium	mg/ℓ	730/800	410	520
Chromium	mg/ℓ	0.001/<0.001	0.003	0.001
Cobalt	mg/ℓ	0.092	0.017	0.005
Copper	mg/ℓ	0.02/0.02	<0.01	<0.01
Iron	mg/ℓ	0.06/0.06	0.04	0.04
Lead	mg/ℓ	0.19/0.22	0.03	<0.01
Magnesium	mg/ℓ	53/56	27	25
Manganese	mg/ℓ	0.85/0.89	0.46	0.56
Mercury	mg/ℓ	<0.0002/<0.0002	0.0002	0.0004
Molybdenum	mg/ℓ	0.007/0.006	0.003	0.004
Nickel	mg/ℓ	0.08/0.14	0.04	<0.01
Potassium	mg/ℓ	50/50	35	26
Selenium	mg/ℓ	0.020/0.024	0.022	0.022
Silver	mg/ℓ	<0.001/<0.001	<0.001	0.002
Sodium	mg/ℓ	3,200/3,200	1,700	600
Zinc	mg/ℓ	0.04/0.04	0.04	0.03

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4814C-4818	4814C-4819	4814C-4820
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	140	1,900	740
Chloride	mg/ℓ	29	360	300
Cyanide	mg/ℓ	<0.02	<0.02	0.08
Fluoride	mg/ℓ	1.8	2.1	2.1
Nitrate	mg/ℓ NO_3-N	14	12	12
pH	--	8.10	8.80	8.05
Phenolics	mg/ℓ	<0.01	0.05	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	4,500	4,900	6,500
Specific Conductance	µmhos/cm @ 25°C	5,210	6,860	9,040
Sulfate	mg/ℓ SO_4^{-2}	3,000	1,400	3,600
Metals:				
Aluminum	mg/ℓ	0.1	1.0	0.2
Arsenic	mg/ℓ	0.003	0.002	0.005
Barium	mg/ℓ	0.080	0.065	0.075
Boron	mg/ℓ	<0.5	0.8	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	550	110	410
Chromium	mg/ℓ	0.002	0.016	0.002
Cobalt	mg/ℓ	0.011	0.008	0.034
Copper	mg/ℓ	0.04	0.07	0.06
Iron	mg/ℓ	0.08	0.27	0.08
Lead	mg/ℓ	0.01	0.01	0.03
Magnesium	mg/ℓ	43	17	33
Manganese	mg/ℓ	0.39	0.08	0.46
Mercury	mg/ℓ	0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.023	0.010	0.020
Nickel	mg/ℓ	<0.01	0.04	0.06
Potassium	mg/ℓ	29	21	29
Selenium	mg/ℓ	0.010	0.003	0.002
Silver	mg/ℓ	<0.001	<0.001	0.002
Sodium	mg/ℓ	800	1,300	1,300
Zinc	mg/ℓ	0.05	0.04	0.03

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4814C-4821	4814C-4822	4814C-DI
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	440	450	90
Chloride	mg/ℓ	5,600	2,100	16
Cyanide	mg/ℓ	0.06	<0.02	<0.02
Fluoride	mg/ℓ	1.3	1.7	1.9
Nitrate	mg/ℓ NO_3-N	17	13	7.8
pH	--	7.95	8.20	7.80
Phenolics	mg/ℓ	0.02	0.02	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	12,000	5,800	3,700
Specific Conductance	μmhos/cm @ 25°C	21,500	10,200	4,670
Sulfate	mg/ℓ SO_4^{-2}	2,000	1,500	2,200
Metals:				
Aluminum	mg/ℓ	<0.1	<0.1	0.2
Arsenic	mg/ℓ	0.008	0.002	<0.001
Barium	mg/ℓ	0.20	0.098	0.11
Boron	mg/ℓ	0.9	0.8	0.6
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	740	310	520
Chromium	mg/ℓ	0.004	0.016	0.002
Cobalt	mg/ℓ	0.096	0.009	0.005
Copper	mg/ℓ	0.06	0.05	0.05
Iron	mg/ℓ	0.09	0.06	0.06
Lead	mg/ℓ	0.20	0.02	<0.01
Magnesium	mg/ℓ	67	30	30
Manganese	mg/ℓ	0.64	0.23	0.12
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.030	0.022	0.042
Nickel	mg/ℓ	0.12	0.04	0.02
Potassium	mg/ℓ	44	29	24
Selenium	mg/ℓ	0.009	0.008	0.003
Silver	mg/ℓ	<0.001	<0.001	<0.001
Sodium	mg/ℓ	3,700	1,600	560
Zinc	mg/ℓ	0.03	<0.01	0.02

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4814S-4818	4814S-4819	4814S-4820
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	180	1,700	670
Chloride	mg/ℓ	27	300	320
Cyanide	mg/ℓ	<0.02	<0.02	0.05
Fluoride	mg/ℓ	0.9	0.9	1.3
Nitrate	mg/ℓ NO_3-N	13	13	12
pH	--	8.20	8.60	8.25
Phenolics	mg/ℓ	0.01	0.06	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	3,500	3,800	5,300
Specific Conductance	µmhos/cm @ 25°C	4,300	5,480	6,960
Sulfate	mg/ℓ SO_4^{-2}	2,300	500	2,100
Metals:				
Aluminum	mg/ℓ	<0.1	<0.1	2.5
Arsenic	mg/ℓ	0.002	0.001	0.003
Barium	mg/ℓ	0.055	0.076	0.048
Boron	mg/ℓ	<0.5	0.6	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	320	100	240
Chromium	mg/ℓ	<0.001	0.006	0.024
Cobalt	mg/ℓ	0.008	0.006	0.022
Copper	mg/ℓ	0.04	0.07	<0.01
Iron	mg/ℓ	0.02	0.06	0.20
Lead	mg/ℓ	<0.01	<0.01	0.02
Magnesium	mg/ℓ	30	17	25
Manganese	mg/ℓ	0.26	0.08	0.12
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.003	0.005	0.005
Nickel	mg/ℓ	0.01	0.03	<0.01
Potassium	mg/ℓ	26	22	27
Selenium	mg/ℓ	0.018	0.020	0.014
Silver	mg/ℓ	0.002	<0.001	0.002
Sodium	mg/ℓ	750	1,400	1,300
Zinc	mg/ℓ	<0.01	0.04	0.02

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4814S-4821	4814S-4822	4814S-DI
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	470/440	480	120
Chloride	mg/ℓ	5,600/5,600	2,200	16
Cyanide	mg/ℓ	0.02/<0.02	0.03	<0.02
Fluoride	mg/ℓ	0.6/0.6	1.0	1.0
Nitrate	mg/ℓ NO_3-N	21/25	15	6.0
pH	--	8.25/8.20	8.40	7.85
Phenolics	mg/ℓ	0.09/0.03	0.01	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	11,000/11,000	6,000	2,000
Specific Conductance	μmhos/cm @ 25°C	18,200/17,500	9,310	2,760
Sulfate	mg/ℓ SO_4^{-2}	1,300/800	1,100	1,200
Metals:				
Aluminum	mg/ℓ	<0.1/<0.1	<0.1	<0.1
Arsenic	mg/ℓ	0.006/0.005	0.001	0.001
Barium	mg/ℓ	0.15/0.12	0.075	0.041
Boron	mg/ℓ	0.6/0.5	<0.5	<0.5
Cadmium	mg/ℓ	<0.001/0.002	<0.001	<0.001
Calcium	mg/ℓ	530/520	210	110
Chromium	mg/ℓ	0.001/0.001	0.021	0.002
Cobalt	mg/ℓ	0.079/0.070	0.002	0.009
Copper	mg/ℓ	0.02/0.02	<0.01	<0.01
Iron	mg/ℓ	0.07/0.07	0.11	0.02
Lead	mg/ℓ	0.28/0.25	<0.01	<0.01
Magnesium	mg/ℓ	57/57	25	11
Manganese	mg/ℓ	0.37/0.37	0.14	0.06
Mercury	mg/ℓ	<0.0002/<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.009/0.010	0.005	0.006
Nickel	mg/ℓ	0.09/0.08	0.01	<0.01
Potassium	mg/ℓ	43/45	28	15
Selenium	mg/ℓ	0.022/0.024	0.018	0.020
Silver	mg/ℓ	<0.001/<0.001	0.002	0.002
Sodium	mg/ℓ	3,200/3,100	1,600	520
Zinc	mg/ℓ	0.03/0.04	0.03	0.03

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4815C-4818	4815C-4819	4815C-4820
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	140	2,300	740
Chloride	mg/ℓ	25	190	320
Cyanide	mg/ℓ	<0.02	0.04	<0.02
Fluoride	mg/ℓ	3.0	3.0	2.9
Nitrate	mg/ℓ NO_3-N	2.2	2.4	2.2
pH	--	7.85	8.55	8.45
Phenolics	mg/ℓ	0.03	0.02	0.04
Residue:				
Filterable @ 180°C	mg/ℓ	3,000	4,100	4,900
Specific Conductance	µmhos/cm @ 25°C	4,300	6,490	6,660
Sulfate	mg/ℓ SO_4^{-2}	1,700	500	2,100
Metals:				
Aluminum	mg/ℓ	3.3	11	0.6
Arsenic	mg/ℓ	0.003	0.003	0.004
Barium	mg/ℓ	0.036	0.088	0.053
Boron	mg/ℓ	<0.5	0.9	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	110	32	80
Chromium	mg/ℓ	0.010	0 018	0.018
Cobalt	mg/ℓ	0.016	<0.001	0.043
Copper	mg/ℓ	0.03	0.02	0.02
Iron	mg/ℓ	0.38	0.54	0.62
Lead	mg/ℓ	0.02	0.01	0.04
Magnesium	mg/ℓ	8.6	5.8	7.4
Manganese	mg/ℓ	0.10	0.06	0.10
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.026	0.027	0.018
Nickel	mg/ℓ	<0.01	<0.01	<0.01
Potassium	mg/ℓ	18	16	17
Selenium	mg/ℓ	0.013	0.008	0.004
Silver	mg/ℓ	<0.001	<0.001	0.002
Sodium	mg/ℓ	820	1,300	1,200
Zinc	mg/ℓ	0.03	0.03	0.05

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4815C-4818	4815C-4819	4815C-4820
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	140	2,300	740
Chloride	mg/ℓ	25	190	320
Cyanide	mg/ℓ	<0.02	0.04	<0.02
Fluoride	mg/ℓ	3.0	3.0	2.9
Nitrate	mg/ℓ NO_3-N	2.2	2.4	2.2
pH	--	7.85	8.55	8.45
Phenolics	mg/ℓ	0.03	0.02	0.04
Residue:				
Filterable @ 180°C	mg/ℓ	3,000	4,100	4,900
Specific Conductance	µmhos/cm @ 25°C	4,300	6,490	6,660
Sulfate	mg/ℓ SO_4^{-2}	1,700	500	2,100
Metals:				
Aluminum	mg/ℓ	3.3	11	0.6
Arsenic	mg/ℓ	0.003	0.003	0.004
Barium	mg/ℓ	0.036	0.088	0.053
Boron	mg/ℓ	<0.5	0.9	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	110	32	80
Chromium	mg/ℓ	0.010	0 018	0.018
Cobalt	mg/ℓ	0.016	<0.001	0.043
Copper	mg/ℓ	0.03	0.02	0.02
Iron	mg/ℓ	0.38	0.54	0.62
Lead	mg/ℓ	0.02	0.01	0.04
Magnesium	mg/ℓ	8.6	5.8	7.4
Manganese	mg/ℓ	0.10	0.06	0.10
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.026	0.027	0.018
Nickel	mg/ℓ	<0.01	<0.01	<0.01
Potassium	mg/ℓ	18	16	17
Selenium	mg/ℓ	0.013	0.008	0.004
Silver	mg/ℓ	<0.001	<0.001	0.002
Sodium	mg/ℓ	820	1,300	1,200
Zinc	mg/ℓ	0.03	0.03	0.05

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4815C-4821	4815C-4822	4815C-DI
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1/<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	380/420	490	120
Chloride	mg/ℓ	5,400/5,200	2,100	20
Cyanide	mg/ℓ	<0.02/<0.02	<0.02	<0.02
Fluoride	mg/ℓ	1.4/1.9	2.3	4.3
Nitrate	mg/ℓ NO_3-N	19/16	5.0	<0.1
pH	--	7.80/7.90	8.30	7.70
Phenolics	mg/ℓ	0.02/0.05	<0.01	0.01
Residue:				
Filterable @ 180°C	mg/ℓ	10,000/10,000	5,200	1,700
Specific Conductance	µmhos/cm @ 25°C	20,100/18,000	9,050	2,650
Sulfate	mg/ℓ SO_4^{-2}	1,700/1,900	400	1,000
Metals:				
Aluminum	mg/ℓ	<0.1/<0.1	1.0	4.0
Arsenic	mg/ℓ	0.008/0.003	0.002	0.014
Barium	mg/ℓ	0.17/0.13	0.090	0.12
Boron	mg/ℓ	1.0/1.0	0.8	0.5
Cadmium	mg/ℓ	<0.001/<0.001	<0.001	<0.001
Calcium	mg/ℓ	220/250	50	37
Chromium	mg/ℓ	0.002/<0.001	<0.001	0.032
Cobalt	mg/ℓ	0.013/0.011	<0.001	<0.001
Copper	mg/ℓ	0.02/<0.01	0.03	0.02
Iron	mg/ℓ	0.06/0.04	0.56	1.0
Lead	mg/ℓ	0.18/0.11	0.02	0.01
Magnesium	mg/ℓ	30/28	7.1	2.5
Manganese	mg/ℓ	0.18/0.20	0.10	0.07
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.050/0.029	0.016	0.020
Nickel	mg/ℓ	0.03/0.04	<0.01	<0.01
Potassium	mg/ℓ	38/28	18	9.2
Selenium	mg/ℓ	0.018/0.011	0.006	0.013
Silver	mg/ℓ	<0.001/0.002	<0.001	0.002
Sodium	mg/ℓ	3,100/2,400	1,500	500
Zinc	mg/ℓ	0.03/0.02	0.06	0.08

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4815S-4818	4815S-4819	4815S-4820
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	230	2,700/2,700	860
Chloride	mg/ℓ	27	410/410	160
Cyanide	mg/ℓ	0.02	<0.02/<0.02	<0.02
Fluoride	mg/ℓ	1.3	2.3/2.0	1.8
Nitrate	mg/ℓ NO_3-N	12	2.4/2.2	3.6
pH	--	8.20	9.10/8.60	8.90
Phenolics	mg/ℓ	0.02	0.01/0.01	0.12
Residue:				
Filterable @ 180°C	mg/ℓ	2,500	4,200/4,300	4,100
Specific Conductance	µmhos/cm @ 25°C	3,760	5,980/6,280	6,170
Sulfate	mg/ℓ SO_4^{-2}	1,300	200/100	1,600
Metals:				
Aluminum	mg/ℓ	1.9	1.3/1.8	1.0
Arsenic	mg/ℓ	0.002	0.003/0.010	0.003
Barium	mg/ℓ	0.040	0.092/0.142	0.029
Boron	mg/ℓ	<0.5	0.8/0.7	<0.5
Cadmium	mg/ℓ	<0.001	<0.001/<0.001	<0.001
Calcium	mg/ℓ	41	11/17	30
Chromium	mg/ℓ	0.035	0.028/0.030	0.031
Cobalt	mg/ℓ	0.005	<0.001/0.003	0.008
Copper	mg/ℓ	0.02	<0.01/0.11	0.02
Iron	mg/ℓ	0.59	1.1/0.16	1.2
Lead	mg/ℓ	<0.01	<0.01/<0.01	<0.01
Magnesium	mg/ℓ	5.3	5.5/4.7	5.6
Manganese	mg/ℓ	0.08	0.04/0.05	0.12
Mercury	mg/ℓ	<0.0002	0.0005	<0.0002
Molybdenum	mg/ℓ	0.008	0.021/0.025	<0.001
Nickel	mg/ℓ	<0.01	<0.01/0.01	0.01
Potassium	mg/ℓ	14	17/15	16
Selenium	mg/ℓ	0.020	0.018/0.018	0.012
Silver	mg/ℓ	0.002	<0.001/<0.001	0.002
Sodium	mg/ℓ	740	1,500/1,300	1,100
Zinc	mg/ℓ	0.06	0.09/0.08	0.05

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4815S-4821	4815S-4822	4815S-DI
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	420	570	200
Chloride	mg/ℓ	5,200	1,900	20
Cyanide	mg/ℓ	<0.02	0.03	<0.02
Fluoride	mg/ℓ	0.7	1.6	1.2
Nitrate	mg/ℓ NO_3-N	21	2.2	<0.1
pH	—	7.90	8.50	8.15
Phenolics	mg/ℓ	0.02	0.01	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	9,800	4,300	1,300
Specific Conductance	µmhos/cm @ 25°C	17,600	8,070	1,000
Sulfate	mg/ℓ SO_4^{-2}	200	150	100
Metals:				
Aluminum	mg/ℓ	0.9	4.4	3.4
Arsenic	mg/ℓ	0.006	0.001	0.006
Barium	mg/ℓ	0.18	0.14	0.026
Boron	mg/ℓ	0.7	0.5	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	150	16	2
Chromium	mg/ℓ	0.003	0.034	0.018
Cobalt	mg/ℓ	0.052	0.002	0.008
Copper	mg/ℓ	0.02/<0.01	0.04	0.02
Iron	mg/ℓ	0.06	1.4	5.2
Lead	mg/ℓ	0.10	<0.01	<0.01
Magnesium	mg/ℓ	27	3.9	0.9
Manganese	mg/ℓ	0.17	0.06	0.06
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.046	0.030	0.037
Nickel	mg/ℓ	0.02	<0.01	<0.01
Potassium	mg/ℓ	35	16	3.9
Selenium	mg/ℓ	0.034	0.014	0.026
Silver	mg/ℓ	<0.001	<0.001	0.002
Sodium	mg/ℓ	3,000	1,200	230
Zinc	mg/ℓ	0.03	0.08	0.10

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4816C-4818	4816C-4819	4816C-4820
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	130	2,300	730
Chloride	mg/ℓ	22	360	290
Cyanide	mg/ℓ	0.05	0.02	<0.02
Fluoride	mg/ℓ	2.3	2.6	3.0
Nitrate	mg/ℓ NO_3-N	10	4.3	5.4
pH	--	7.80	8.25	7.90
Phenolics	mg/ℓ	0.05	0.03	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	3,700	5,000	5,400
Specific Conductance	µmhos/cm @ 25°C	4,300	7,920	8,070
Sulfate	mg/ℓ SO_4^{-2}	2,200	2,000	3,200
Metals:				
Aluminum	mg/ℓ	<0.1	1.4	<0.1
Arsenic	mg/ℓ	<0.001	0.001	<0.001
Barium	mg/ℓ	0.15	0.093	0.075
Boron	mg/ℓ	0.6	1.1	<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001
Calcium	mg/ℓ	500	110	320
Chromium	mg/ℓ	0.004	0.017	0.002
Cobalt	mg/ℓ	<0.001	<0.001	0.002
Copper	mg/ℓ	<0.01	0.06	<0.01
Iron	mg/ℓ	0.04	0.30	0.04
Lead	mg/ℓ	<0.01	0.02	0.03
Magnesium	mg/ℓ	75	37	56
Manganese	mg/ℓ	0.31	0.17	0.39
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.032	<0.001	0.023
Nickel	mg/ℓ	0.02	0.04	0.02
Potassium	mg/ℓ	17	17	18
Selenium	mg/ℓ	0.020	0.014	0.007
Silver	mg/ℓ	<0.001	<0.001	0.002
Sodium	mg/ℓ	550	1,400	1,200
Zinc	mg/ℓ	0.03	0.04	0.02

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4816C-4821	4816C-4822	4816C-DI
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	740	480	80
Chloride	mg/ℓ	5,600	2,000	3.9
Cyanide	mg/ℓ	<0.02	0.03	0.03
Fluoride	mg/ℓ	1.9	2.6	2.4
Nitrate	mg/ℓ NO_3-N	16	11	8.5
pH	—	8.00	8.20	7.90
Phenolics	mg/ℓ	0.03	0.02	0.03
Residue:				
Filterable @ 180°C	mg/ℓ	11,000	6,000	2,100
Specific Conductance	µmhos/cm @ 25°C	20,500	9,600	2,470
Sulfate	mg/ℓ SO_4^{-2}	1,400	1,000	1,400
Metals:				
Aluminum	mg/ℓ	0.1	<0.1	<0.1
Arsenic	mg/ℓ	0.005	<0.001	<0.001
Barium	mg/ℓ	0.24	0.12	0.079
Boron	mg/ℓ	0.8	0.8	0.5
Cadmium	mg/ℓ	0.004	<0.001	<0.001
Calcium	mg/ℓ	540	240	340
Chromium	mg/ℓ	0.002	0.006	0.003
Cobalt	mg/ℓ	0.16	<0.001	<0.001
Copper	mg/ℓ	0.03	0.03	<0.01
Iron	mg/ℓ	0.06	0.06	0.04
Lead	mg/ℓ	0.29	0.03	<0.01
Magnesium	mg/ℓ	90	51	46
Manganese	mg/ℓ	0.53	0.28	0.27
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.034	0.016	0.047
Nickel	mg/ℓ	0.08	0.06	<0.01
Potassium	mg/ℓ	30	20	11
Selenium	mg/ℓ	0.019	0.013	0.020
Silver	mg/ℓ	<0.001	<0.001	<0.001
Sodium	mg/ℓ	3,700	1,400	250
Zinc	mg/ℓ	0.02	0.03	<0.01

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4816S-4818	4816S-4819	4816S-4820
General Chemistry:				
Acidity	mg/ℓ(1) $CaCO_3$	<1	<1	<1/<1
Alkalinity	mg/ℓ $CaCO_3$	150	2,600	860/780
Chloride	mg/ℓ	18	190	290/150
Cyanide	mg/ℓ	<0.02	<0.02	<0.02/<0.02
Fluoride	mg/ℓ	0.8	1.8	1.8/1.8
Nitrate	mg/ℓ NO_3-N	9.0	11	5.2/6.9
pH	--	8.10	8.60	8.70/8.40
Phenolics	mg/ℓ	0.04	0.01	0.03/0.01
Residue:				
Filterable @ 180°C	mg/ℓ	2,800	4,200	5,000/5,000
Specific Conductance	µmhos/cm @ 25°C	3,400	6,950	6,470/7,130
Sulfate	mg/ℓ SO_4^{-2}	1,800	400	2,500/2,500
Metals:				
Aluminum	mg/ℓ	<0.1	0.2	0.1/0.1
Arsenic	mg/ℓ	0.001	0.002	0.004/0.003
Barium	mg/ℓ	0.060	0.077	0.062/0.043
Boron	mg/ℓ	<0.5	0.5	<0.5/<0.5
Cadmium	mg/ℓ	<0.001	<0.001	<0.001/0.001
Calcium	mg/ℓ	320	60	190/190
Chromium	mg/ℓ	<0.001	0.002	0.004/<0.001
Cobalt	mg/ℓ	<0.001	<0.001	0.022/0.029
Copper	mg/ℓ	0.02	0.02	0.04/0.02
Iron	mg/ℓ	0.06	0.08	0.10/0.08
Lead	mg/ℓ	<0.01	<0.01	0.02/0.02
Magnesium	mg/ℓ	59	28	40/45
Manganese	mg/ℓ	0.08	0.04	0.26/0.15
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002/<0.0002
Molybdenum	mg/ℓ	0.002	0.005	0.004/0.006
Nickel	mg/ℓ	<0.01	<0.01	0.01/0.02
Potassium	mg/ℓ	14	15	17/17
Selenium	mg/ℓ	0.014	0.008	0.006/0.006
Silver	mg/ℓ	<0.001	<0.001	0.002/0.002
Sodium	mg/ℓ	530	1,400	1,200/1,200
Zinc	mg/ℓ	<0.01	<0.01	0.06/0.03

TABLE 1
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4816S-4821	4816S-4822	4816S-DI
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	540	560	76
Chloride	mg/ℓ	5,600	2,000	3.9
Cyanide	mg/ℓ	<0.02	<0.02	<0.02
Fluoride	mg/ℓ	0.7	1.3	0.7
Nitrate	mg/ℓ NO_3-N	18	13	6.3
pH	--	8.05	8.20	8.25
Phenolics	mg/ℓ	0.04	<0.01	0.02
Residue:				
Filterable @ 180°C	mg/ℓ	11,000	5,100	1,300
Specific Conductance	µmhos/cm @ 25°C	17,800	9,020	1,780
Sulfate	mg/ℓ SO_4^{-2}	1,000	500	980
Metals:				
Aluminum	mg/ℓ	0.4	<0.1	<0.1
Arsenic	mg/ℓ	0.007	0.001	<0.001
Barium	mg/ℓ	0.16	0.063	0.046
Boron	mg/ℓ	0.6	<0.5	<0.5
Cadmium	mg/ℓ	0.001	<0.001	0.005
Calcium	mg/ℓ	340	80	130
Chromium	mg/ℓ	0.041	0.006	0.003
Cobalt	mg/ℓ	0.13	<0.001	<0.001
Copper	mg/ℓ	0.06	0.04	<0.01
Iron	mg/ℓ	0.10	0.07	0.07
Lead	mg/ℓ	0.21	0.02	<0.01
Magnesium	mg/ℓ	77	32	29
Manganese	mg/ℓ	0.38	0.13	0.09
Mercury	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.008	0.005	0.020
Nickel	mg/ℓ	0.04	<0.01	<0.01
Potassium	mg/ℓ	31	18	9.2
Selenium	mg/ℓ	0.018	0.011	0.014
Silver	mg/ℓ	<0.001	<0.001	<0.001
Sodium	mg/ℓ	3,000	1,500	250
Zinc	mg/ℓ	0.04	<0.01	<0.01

(1) mg/ℓ = milligrams per liter or parts per million.
(2) The indicated sample was analyzed in duplicate.

TABLE 2

EP TOXICITY LEACHATE SUMMARY
FOR UTAH INTERNATIONAL
PROJECT NO. 85-8019

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4791, NO. 10	4800, NO. 11
General Chemistry:			
Acidity	mg/ℓ[1] $CaCO_3$	960	960
Alkalinity	mg/ℓ $CaCO_3$	140	280
Chloride	mg/ℓ	5.9	3.9
Cyanide	mg/ℓ	<0.02	<0.02
Fluoride	mg/ℓ	1.2	1.2
Nitrate	mg/ℓ NO_3-N	2.0	2.0
pH	--	4.60	4.70
Phenolics	mg/ℓ	0.02	0.02
Residue:			
Filterable @ 180°C	mg/ℓ	4400	4800
Specific Conductance	μmhos/cm @ 25°C	3860	4000
Sulfate	mg/ℓ SO_4^{-2}	1,600	1,500
Metals:			
Aluminum	mg/ℓ	24	24
Arsenic	mg/ℓ	0.028/0.030[2]	0.019
Barium	mg/ℓ	0.27	0.29
Boron	mg/ℓ	7.9/7.8	6.5
Cadmium	mg/ℓ	0.005/0.005	0.004
Calcium	mg/ℓ	27	26
Chromium	mg/ℓ	0.064	0.044
Cobalt	mg/ℓ	0.003/0.005	0.003
Copper	mg/ℓ	0.09	0.08
Iron	mg/ℓ	7.7/7.7	6.8
Lead	mg/ℓ	<0.01/<0.01	<0.01
Magnesium	mg/ℓ	10	8.5/8.5
Manganese	mg/ℓ	2.2	3.1
Mercury	mg/ℓ	0.0003	0.0003
Molybdenum	mg/ℓ	0.24	0.16
Nickel	mg/ℓ	0.11/0.13	0.12
Potassium	mg/ℓ	1.3	1.0
Selenium	mg/ℓ	0.019/0.017	0.004
Silver	mg/ℓ	<0.001/<0.001	<0.001
Sodium	mg/ℓ	9.5	7.6
Zinc	mg/ℓ	0.18/0.18	0.15

TABLE 3
SOIL ANALYSIS SUMMARY
FOR UTAH INTERNATIONAL
PROJECT NO. 85-8019

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4791, NO. 10	4800, NO. 11
General Chemistry:			
Acidity	mg/kg[1] $CaCO_3$	11,000	11,000
Alkalinity	mg/kg $CaCO_3$	4,600	6,600
Chloride	mg/kg	100	80
Cyanide	mg/kg	<0.5	<0.5
Fluoride	mg/kg	1.0	1.0
Nitrate	mg/kg NO_3-N	7.9	5.1
pH	--	4.65	4.80
Phenolics	mg/kg	1.6	0.75
Residue:			
Filterable @ 180°C	mg/kg	5,700	6,600
Specific Conductance	µmhos/cm @ 25°C	9,520	15,800
Sulfate	mg/kg SO_4^{-2}	1,600	1,400
Metals:			
Aluminum	mg/kg	10,000	12,000/12,000[2]
Arsenic	mg/kg	9.4/9.7	18
Barium	mg/kg	350	300
Boron	mg/kg	71	121
Cadmium	mg/kg	0.33/0.33	0.43
Calcium	mg/kg	67,000	20,000
Chromium	mg/kg	9.3/9.6	13
Cobalt	mg/kg	1.4/1.4	2.5
Copper	mg/kg	9.7	12
Iron	mg/kg	4,500/4,400	5,400
Lead	mg/kg	9.9	12
Magnesium	mg/kg	640	750
Manganese	mg/kg	120	100
Mercury (Total)	mg/kg	<0.10	<0.10
Molybdenum	mg/kg	4.3	6.1
Nickel	mg/kg	<1.0/<1.0	<1.0
Potassium	mg/kg	310	420
Selenium	mg/kg	0.28	7.2/7.7
Silver	mg/kg	0.10	0.10
Sodium	mg/kg	1,000	1,200
Zinc	mg/kg	16	23

TABLE 3
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4810, NO. 12	4817, CS
General Chemistry:			
Acidity	mg/kg[1] $CaCO_3$	11,000	32,000
Alkalinity	mg/kg $CaCO_3$	1,000	<5
Chloride	mg/kg	110	110
Cyanide	mg/kg	<0.5	<0.5
Fluoride	mg/kg	2.0	2.0
Nitrate	mg/kg NO_3-N	5.9	5.5
pH	--	4.60	4.40
Phenolics	mg/kg	0.75	0.95
Residue:			
Filterable @ 180°C	mg/kg	5,300	4,500
Specific Conductance	µmhos/cm @ 25°C	7,950	6,980
Sulfate	mg/kg SO_4^{-2}	2,000	2,200
Metals:			
Aluminum	mg/kg	10,000	11,000
Arsenic	mg/kg	15	17
Barium	mg/kg	150	140/150
Boron	mg/kg	91	<10
Cadmium	mg/kg	0.53	1.5
Calcium	mg/kg	27,000	46,000/46,000
Chromium	mg/kg	11	18
Cobalt	mg/kg	1.7	2.4
Copper	mg/kg	8.7	13/13
Iron	mg/kg	4,900	6,000
Lead	mg/kg	8.8	8.8
Magnesium	mg/kg	680/680	870
Manganese	mg/kg	68	76/77
Mercury (Total)	mg/kg	<0.10/<0.10	<0.10
Molybdenum	mg/kg	4.9	11
Nickel	mg/kg	<1.0	8.7
Potassium	mg/kg	310/310	390
Selenium	mg/kg	3.8	1.4
Silver	mg/kg	0.10	0.10
Sodium	mg/kg	880	950/950
Zinc	mg/kg	15	49/49

(1) mg/kg = milligrams per kilogram or parts per million.
(2) The indicated sample was analyzed in duplicate.

TABLE 3
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4810, NO. 12	4817, CS
General Chemistry:			
Acidity	mg/kg[1] $CaCO_3$	11,000	32,000
Alkalinity	mg/kg $CaCO_3$	1,000	<5
Chloride	mg/kg	110	110
Cyanide	mg/kg	<0.5	<0.5
Fluoride	mg/kg	2.0	2.0
Nitrate	mg/kg NO_3-N	5.9	5.5
pH	--	4.60	4.40
Phenolics	mg/kg	0.75	0.95
Residue:			
Filterable @ 180°C	mg/kg	5,300	4,500
Specific Conductance	µmhos/cm @ 25°C	7,950	6,980
Sulfate	mg/kg SO_4^{-2}	2,000	2,200
Metals:			
Aluminum	mg/kg	10,000	11,000
Arsenic	mg/kg	15	17
Barium	mg/kg	150	140/150
Boron	mg/kg	91	<10
Cadmium	mg/kg	0.53	1.5
Calcium	mg/kg	27,000	46,000/46,000
Chromium	mg/kg	11	18
Cobalt	mg/kg	1.7	2.4
Copper	mg/kg	8.7	13/13
Iron	mg/kg	4,900	6,000
Lead	mg/kg	8.8	8.8
Magnesium	mg/kg	680/680	870
Manganese	mg/kg	68	76/77
Mercury (Total)	mg/kg	<0.10/<0.10	<0.10
Molybdenum	mg/kg	4.9	11
Nickel	mg/kg	<1.0	8.7
Potassium	mg/kg	310/310	390
Selenium	mg/kg	3.8	1.4
Silver	mg/kg	0.10	0.10
Sodium	mg/kg	880	950/950
Zinc	mg/kg	15	49/49

(1) mg/kg = milligrams per kilogram or parts per million.
(2) The indicated sample was analyzed in duplicate.

TABLE 4

GROUND WATER ANALYSIS SUMMARY
FOR UTAH INTERNATIONAL
PROJECT NO. 85-8019

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4818	4819	4820
General Chemistry:				
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	88	3,100	940
Chloride	mg/ℓ	15	380	310
Cyanide	mg/ℓ	<0.02	<0.02	<0.02
Fluoride	mg/ℓ	1.0	2.2	2.6
Nitrate	mg/ℓ NO_3-N	9.7	4.5	1.3
pH	—	7.80	8.80	8.70
Phenolics	mg/ℓ	<0.01	<0.01	0.01
Residue:				
Filterable @ 180°C	mg/ℓ	1,900	4,400	4,100
Specific Conductance	µmhos/cm @ 25°C	2,310	5,900	6,000
Sulfate	mg/ℓ SO_4^{-2}	1,200	22	1,500
Metals:				
Aluminum	mg/ℓ	0.69/0.75[2]	0.68	1.3
Arsenic	mg/ℓ	<0.001	0.004	0.008
Barium	mg/ℓ	0.03/0.02	1.5	0.06
Boron	mg/ℓ	0.31	0.97	0.20
Cadmium	mg/ℓ	<0.001	<0.001	0.002
Calcium	mg/ℓ	230	11	36
Chromium	mg/ℓ	0.002	0.001	0.006
Cobalt	mg/ℓ	<0.001/0.001	0.008	0.014
Copper	mg/ℓ	0.04	0.02	<0.01
Iron	mg/ℓ	0.45	2.8	3.7/3.8
Lead	mg/ℓ	<0.01/<0.01	0.03	0.02
Magnesium	mg/ℓ	28	3.6	4.5
Manganese	mg/ℓ	0.08	0.47	0.38
Mercury (Total)	mg/ℓ	<0.0002	<0.0002	<0.0002
Molybdenum	mg/ℓ	<0.001	0.005	0.003
Nickel	mg/ℓ	0.04	0.11	0.07
Potassium	mg/ℓ	11	7.2	8.4
Selenium	mg/ℓ	<0.001	0.006	0.014
Silver	mg/ℓ	<0.001	<0.001	0.001
Sodium	mg/ℓ	280	1,600	1,400
Zinc	mg/ℓ	0.06	0.07	0.08

TABLE 4
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4821	4822
General Chemistry:			
Acidity	mg/ℓ[1] $CaCO_3$	<1	<1
Alkalinity	mg/ℓ $CaCO_3$	510	940
Chloride	mg/ℓ	5,200	2,000
Cyanide	mg/ℓ	<0.02	<0.02
Fluoride	mg/ℓ	0.3	1.3
Nitrate	mg/ℓ NO_3-N	18	11
pH	--	8.20	9.50
Phenolics	mg/ℓ	0.04	0.02
Residue:			
Filterable @ 180°C	mg/ℓ	9,800	4,600
Specific Conductance	μmhos/cm @ 25°C	15,600	8,100
Sulfate	mg/ℓ SO_4^{-2}	120	55
Metals:			
Aluminum	mg/ℓ	<0.01	1.7
Arsenic	mg/ℓ	0.015	0.017
Barium	mg/ℓ	0.92	2.5
Boron	mg/ℓ	0.53	0.42
Cadmium	mg/ℓ	0.001	0.002
Calcium	mg/ℓ	140	140
Chromium	mg/ℓ	0.008	0.034
Cobalt	mg/ℓ	0.035/0.034	0.017
Copper	mg/ℓ	<0.01	0.04
Iron	mg/ℓ	0.15	5.6
Lead	mg/ℓ	0.12	0.08
Magnesium	mg/ℓ	32	11
Manganese	mg/ℓ	0.03	0.70/0.70
Mercury (Total)	mg/ℓ	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.025	0.008/0.006
Nickel	mg/ℓ	0.11	0.04/0.04
Potassium	mg/ℓ	19	12
Selenium	mg/ℓ	0.011	0.020
Silver	mg/ℓ	<0.001	0.015
Sodium	mg/ℓ	3,500	1,600
Zinc	mg/ℓ	0.21/0.22	0.09

(1) mg/ℓ = milligrams per liter or parts per million.
(2) The indicated sample was analyzed in duplicate.

TABLE 5

PHYSICAL CHARACTERIZATION SUMMARY
FOR UTAH INTERNATIONAL
PROJECT NO. 85-8019

SAMPLE IDENTIFICATION	MOISTURE CONTENT %	PERCENT SOLIDS %	pH 1:1
4791	11.0	89.0	11.50
4800	11.6	88.4	12.00
4801	16.2	83.8	10.60
4817	16.7	83.3	9.20

TABLE 6

MATRIX SPIKE PERCENT RECOVERY SUMMARY
FOR UTAH INTERNATIONAL
PROJECT NO. 85-8019

PARAMETER	PERCENT RECOVERY
General Chemistry:	
Chloride	95.3%/98.0%/97.1%/95.3%/95.7% 97.1%/100%/96.7%/98.7%/91.4%
Cyanide	100%/128%/106%/94.4%/94.1%/91.8%/91.8%/ 90.6%/94.1%/97.0%/100%/100%/97.0%/93.9%
Fluoride	96.0%/100%/100%/96.0%/100%/96.0%/ 104%/84.0%/96.0%/84.0%/100%/100%
Phenolics	105%/105%/97.5%/102%/110%/100%/90.0%/97.5% 103%/98.5%/100%/101%/101%/100%/101%/101%
Sulfate	80.0%/105%/120%/120%/135%/135%/ 120%/90.0%/120%/120%/110%/120%
Metals:	
Aluminum	94.4%/102%/106%/103%/88.0%/100%/94.0%/ 84.0/%/93.0%/104%/79.0%/82.0%/94.0%/84.4%
Arsenic	92.0%/78.0%
Barium	101%/98.9%/100%/125%/109%/127%/115%/136%
Boron	92.0/88.0%/100%/92.0%/80.0%/ 60.0%/100%/82.0%/60.0%/60.0%
Cadmium	110%/90.0%
Calcium	102%/82.4%/113%/114%/111%/108%/ 108%115%/110%/112%/112%/107%
Chromium	78.0%
Cobalt	97.6%/84.0%/100%
Copper	100%/100%/100%
Iron	102%/95.6%/99.2%
Lead	48.0%/48.0%/60.0%
Manganese	130%/132%/131%
Magnesium	103%/101%/98.0%/100%/101%/103%/ 99.0%/99.0%/98.0%/98.0%/102%/103%
Mercury (Total)	94.2%
Molybdenum	92.0%/96.0%/100%
Nickel	100%/99.6%/99.6%
Potassium	101%/107%
Selenium	100%
Silver	96.0%
Sodium	100%/100%/99.0%/98.0%/101%/94.0%/ 95.0%/113%/97.0%/96.0%/96.0%/94.0%
Zinc	101%/98.0%/100%

TABLE 1

SOIL ANALYSIS SUMMARY
FOR IT CORPORATION/KNOXVILLE
PROJECT NO. 84-8045
JOB NO. 8549.02

PARAMETER	UNITS	SAMPLE IDENTIFICATION						
		D-1	D-2	S-1	S-2	S-3	S-4	S-5
Cation Exchange Capacity	$\frac{meq}{100\ g}$ (1)	39	24	52	52	44	59	53
Calcium	mg/kg (2)	3700	2800	6500	7000	5800	8600	7700
Magnesium	mg/kg	190	520	660	570	520	380	410
Potassium	mg/kg	240	100	240	220	170	310	290
Sodium	mg/kg	4400	1100	3100	2700	2400	2800	2400

(1) meq/100 g = milliequivalents per one hundred grams of sample.

(2) mg/kg = milligrams per kilogram or parts per million.

TABLE 2

EP TOXICITY LEACHATE SUMMARY
FOR IT CORPORATION/KNOXVILLE
PROJECT NO. 84-8045
JOB NO. 8549.02

		SAMPLE IDENTIFICATION			
PARAMETER	UNITS	4762	4763	4764	4765
Aluminum	mg/ℓ(1)	22	24	29	26
Arsenic	mg/ℓ	0.13/0.12(2)	0.08	0.12	0.21
Barium	mg/ℓ	0.14	0.30	0.20	0.40
Boron	mg/ℓ	4.2	6.6/7.0	5.4	4.4
Cadmium	mg/ℓ	0.03	0.03/0.03	0.03	0.04
Calcium	mg/ℓ	950	810	1000	1200
Chromium	mg/ℓ	0.09	0.10	0.11	0.08/0.08
Cobalt	mg/ℓ	0.003	0.005	0.003	0.003
Copper	mg/ℓ	0.11/0.11	0.12	0.12	0.13
Iron	mg/ℓ	10/10	13	15	7.2
Lead	mg/ℓ	0.30	0.27	0.32	0.34/0.35
Magnesium	mg/ℓ	7.8	8.7	9.4	12
Manganese	mg/ℓ	1.7/1.7	2.1	2.7	1.5
Mercury	mg/ℓ	0.0036	0.0025	0.0036	0.0029
Molybdenum	mg/ℓ	0.36/0.40	0.34	0.33	0.41
Nickel	mg/ℓ	0.16	0.13/0.13	0.15	0.16
Potassium	mg/ℓ	1.8	2.0	1.9	2.0
Selenium	mg/ℓ	0.20	0.20	0.18	0.18
Silver	mg/ℓ	0.04	0.04	0.05	0.05
Sodium	mg/ℓ	9.9	10	9.5	13
Uranium	mg/ℓ	0.029	0.035	0.041	0.030
Zinc	mg/ℓ	0.21	0.20	0.18	0.21

TABLE 2
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4770	4774	4785	4786
Aluminum	mg/ℓ(1)	23	26/26	25	20/20
Arsenic	mg/ℓ	0.20	0.23	0.26	0.28/0.30
Barium	mg/ℓ	0.48	0.49	0.39	0.41
Boron	mg/ℓ	5.1	3.7	4.2	3.5/3.9
Cadmium	mg/ℓ	0.03	0.04	0.04	0.04/0.03
Calcium	mg/ℓ	1000	1200	920	1000,1200
Chromium	mg/ℓ	0.05	0.09	0.07	0.06/0.06
Cobalt	mg/ℓ	0.001	0.002	0.004	0.003/0.004
Copper	mg/ℓ	0.10	0.11	0.12	0.11/0.10
Iron	mg/ℓ	5.1	9.9	8.7	4.8/4.7
Lead	mg/ℓ	0.33	0.36	0.37	0.28/0.27
Magnesium	mg/ℓ	15	9.7	8.1	12/11
Manganese	mg/ℓ	1.1	1.6	1.3	0.99/0.91
Mercury	mg/ℓ	0.0004	0.0046	0.0044	0.0037/0.0019
Molybdenum	mg/ℓ	0.31	0.44	0.44	0.34/0.35
Nickel	mg/ℓ	0.14	0.15	0.14	0.11/0.07
Potassium	mg/ℓ	1.8	1.6	1.6	1.7/2.0
Selenium	mg/ℓ	0.18	0.24	0.24	0.25/0.22
Silver	mg/ℓ	0.04	0.05	0.05	0.04/0.05
Sodium	mg/ℓ	11	11	11	11/11
Uranium	mg/ℓ	0.027	0.042	0.039	0.033/0.027
Zinc	mg/ℓ	0.17	0.19	0.17	0.16/0.16

TABLE 2
(Continued)

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4789	4790	BLANK 1	BLANK 2
Aluminum	mg/ℓ[1]	22	23/22	<1.0	<1.0
Arsenic	mg/ℓ	0.26	0.26/0.20	<0.01	<0.01
Barium	mg/ℓ	1.6/1.6	0.21/0.23	0.02	0.02
Boron	mg/ℓ	4.2	4.4	<0.1	<0.1
Cadmium	mg/ℓ	0.04	0.04/0.04	<0.01	<0.01
Calcium	mg/ℓ	1000	1100/1200	<1.0	<1.0
Chromium	mg/ℓ	0.05	0.06/0.08	0.01	0.01
Cobalt	mg/ℓ	0.003	0.004/0.003	<0.001	<0.001
Copper	mg/ℓ	0.11	0.12/0.10	0.03	0.03
Iron	mg/ℓ	6.1	4.9/6.7	0.02	0.03
Lead	mg/ℓ	0.32	0.31/0.29	<0.01	<0.01
Magnesium	mg/ℓ	13/13	11/11	0.03	0.04
Manganese	mg/ℓ	1.1	1.1/1.1	<0.01	<0.01
Mercury	mg/ℓ	0.0025	0.0030	<0.0002	<0.0002
Molybdenum	mg/ℓ	0.29	0.24/0.24	0.03	0.02
Nickel	mg/ℓ	0.14	0.10/0.08	0.01	<0.01
Potassium	mg/ℓ	2.4	2.0/1.7	<0.01	<0.01
Selenium	mg/ℓ	0.25	0.25/0.25	<0.01	<0.01
Silver	mg/ℓ	0.04	0.05/0.05	<0.01	<0.01
Sodium	mg/ℓ	11	11/10	0.13	0.17
Uranium	mg/ℓ	0.021	0.027/0.026	<0.001	<0.001
Zinc	mg/ℓ	0.17	0.16/0.15	0.03	<0.01

(1) mg/ℓ = milligrams per liter or parts per million.

(2) The indicated sample was analyzed in duplicate.

TABLE 3

TOTAL METAL ANALYSIS SUMMARY
FOR IT CORPORATION/KNOXVILLE
PROJECT NO. 84-8045
JOB NO. 8549.02

PARAMETER	UNITS	SAMPLE IDENTIFICATION 4789	4790
Aluminum	mg/kg[1]	10,000	9,800/9,800[2]
Arsenic	mg/kg	17	14
Barium	mg/kg	190	230
Boron	mg/kg	<10/<10	<10
Cadmium	mg/kg	0.24	0.24
Calcium	mg/kg	99,000/98,000	83,000/82,000
Chromium	mg/kg	12	13
Cobalt	mg/kg	8.5/8.5	7.5
Copper	mg/kg	13	13/13
Iron	mg/kg	4,400/4,400	4,500/4,500
Lead	mg/kg	5.0/5.9	5.9
Magnesium	mg/kg	820	820
Manganese	mg/kg	63/63	63
Mercury	mg/kg	0.30/0.37	0.25
Molybdenum	mg/kg	7.5	5.4
Nickel	mg/kg	6.3	4.3/5.3
Potassium	mg/kg	410	360/360
Selenium	mg/kg	6.4/6.6	7.8/7.6
Silver	mg/kg	0.15/0.15	0.15
Sodium	mg/kg	1,100/1,200	1,000
Zinc	mg/kg	22	22/22

[1] mg/kg = milligrams per kilogram or parts per million.

[2] The indicated sample was analyzed in duplicate.

TABLE 4

EP TOXICITY LEACHATE SUMMARY
FOR IT CORPORATION/KNOXVILLE
PROJECT NO. 84-8045
JOB NO. 8549.02

PARAMETER	UNITS[1]	SAMPLE IDENTIFICATION					
		4762	4763	4764	4765	4770	4774
Chloride	mg/ℓ	2.1	2.9	3.2	5.3/5.8[2]	5.1	6.1
Cyanide	mg/ℓ	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fluoride	mg/ℓ	1.9	1.8	1.5	2.2	2.7	1.8
Nitrate	mg/ℓ NO_3-N	0.2	0.2	0.3	0.3	0.5	0.3
Phenolics	mg/ℓ	0.04	0.04	0.03	0.03	0.03	0.29
Residue:							
Filterable @ 180°C	mg/ℓ	3900	3900	4300	4500	4100	4300
Sulfate	mg/ℓ SO_4^{-2}	1600	1400	1600	1900	1700	1800

TABLE 4
(Continued)

PARAMETER	UNITS[1]	SAMPLE IDENTIFICATION 4785	4786	4789	4790	BLANK 1	BLANK 2
Chloride	mg/ℓ	3.7	5.3/5.6	5.8	6.9/6.6	<0.5	<0.5
Cyanide	mg/ℓ	<0.02	<0.02/<0.02	<0.02	<0.02/<0.02	<0.02	<0.02
Fluoride	mg/ℓ	1.7	2.2/2.4	3.0	3.0/2.9	<0.1	<0.1
Nitrate	mg/ℓ NO_3-N	0.3	0.4/0.5	0.5	0.6/0.6	<0.1	<0.1
Phenolics	mg/ℓ	0.05	<0.01/<0.01	0.03	0.02/0.02	0.03	0.03
Residue:							
Filterable @ 180°C	mg/ℓ	4300	4000/3900	4100	4100/3600	25	22
Sulfate	mg/ℓ SO_4^{-2}	1900	1800/1800	1800	1800/1600	<1	<1

(1) mg/ℓ = milligrams per liter or parts per million.

(2) The indicated sample was analyzed in duplicate.

TABLE 5

SOIL ANALYSIS SUMMARY
FOR IT CORPORATION/KNOXVILLE
PROJECT NO. 84-8045
JOB NO. 8549.02

SAMPLE IDENTIFICATION	MOISTURE CONTENT %	PERCENT SOLIDS %	pH
4762	17.8	82.2	10.50
4763	24.2	75.8	9.25
4764	24.7	75.3	9.35
4765	21.8	78.2	9.40
4770	27.6	72.4	9.35
4774	19.2/20.8[1]	80.8/79.2	9.35
4785	15.9/14.6	84.1/85.4	9.35
4786	20.6	79.4	9.80
4789	24.5	75.5	9.15
4790	23.7	76.3	10.05

[1] The indicated sample was anayzed in duplicate.

Physical Testing Laboratory Data

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Franklin, Tennessee 615 794-3596
Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date October 5. 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

SPOIL SAMPLES

This report includes the minimum index density test results of sample SS-1 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: S-1

Method: A

Volume of Mold: 0.100 Ft^3

Specific Gravity: 2.55

Minimum Index: 75.9 $lbs./Ft^3$

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Franklin, Tennessee 615 794-3596
Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date September, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

SPOIL SAMPLE S-1

Length = 2.45 in. Weight = 1.028 lbs. Specific Gravity = 2.55

Diameter = 2.88 in. Moisture = 21.4 % Total Volume = 0.00924 Ft^3

$Weight_w$ = 1.028 lbs. - 0.847 = 0.181 lbs.

$Volume_w$ = 0.181 lbs./62.4 lbs./Ft^3 = 0.0029 Ft^3

$Volume_s$ = 0.847 lbs./(62.4 lbs./Ft^3) (2.55) = 0.00532 Ft^3

$Volume_a$ = 0.00924 Ft^3-(0.0029Ft^3 + 0.00532 Ft^3) = 0.00102 Ft^3

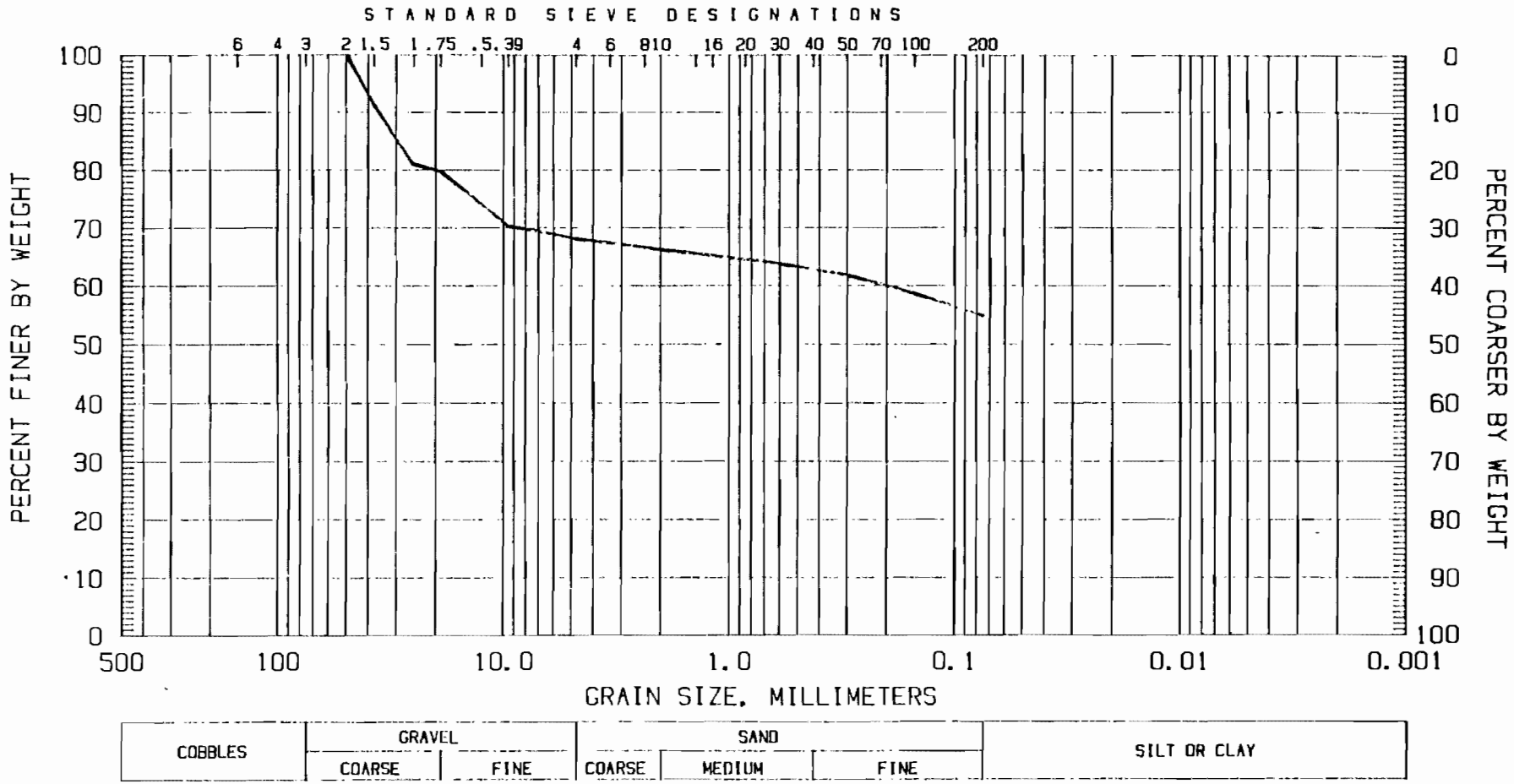
$Volume_v$ = 0.0029 Ft^3 + 0.00102 Ft^3 = 0.00392 Ft^3

$$e = \frac{0.00392}{0.00532} = 0.737$$

$$n = \frac{0.00392}{0.00924} = 42.4 \ \%$$

$$k = \frac{0.6114}{175177} = 3.5 \times 10^{-6} \text{ cm/sec (@ 96.1\% Compaction)}$$

GRAIN SIZE ANALYSIS



PROJECT NO.: 84-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE
SEPTEMBER 17, 1984

SAMPLE: S-1

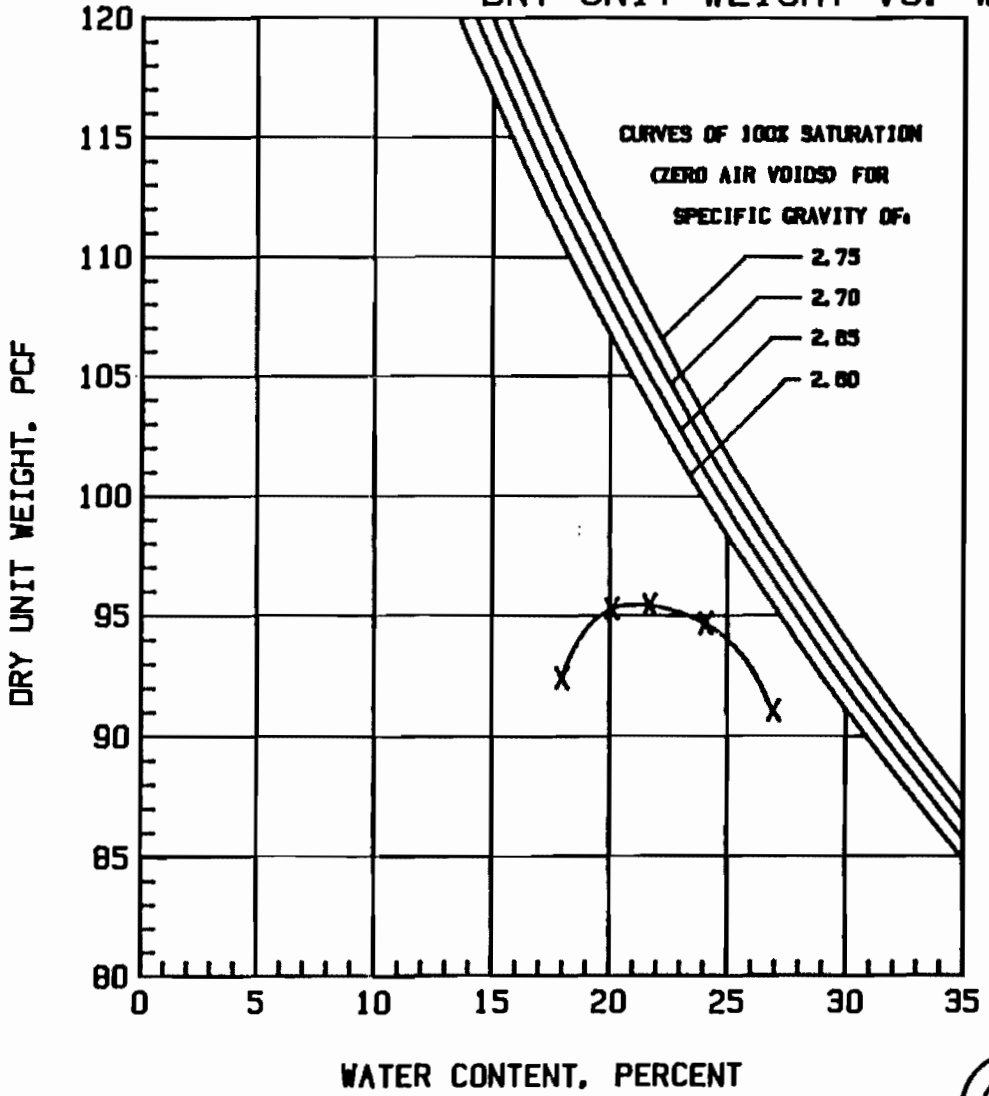
DEPTH: N/A FT

SPOIL
NATURAL MOISTURE CONTENT= 3.7 %

GEOLOGIC ASSOCIATES, INC.

MOISTURE-DENSITY RELATIONSHIP

DRY UNIT WEIGHT vs. WATER CONTENT



PROJECT NO.: 84-3105

UTAH INTERNATIONAL
SOILS TESTING
I.T. ENVIROSCIENCE

SEPTEMBER 17, 1984
CONTROL TEST NUMBER: 5

S-1/SPOIL
NATURAL MOISTURE CONTENT: 3.7 %
TEST PROCEDURE: ASTM D 698
TEST METHOD: C

MAXIMUM DRY DENSITY	OPTIMUM MOISTURE CONTENT
95.5 PCF	21.2 %

NOTE: RESULTS OF THIS TEST WILL BE USED TO DETERMINE COMPACTION PERCENTAGES IN THE FIELD

GEOLOGIC ASSOCIATES, INC.

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Franklin, Tennessee 615 794-3596
Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date October 5, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

SPOIL SAMPLES

This report includes the minimum index density test results of sample SS-2 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: S-2

Method: A

Volume of Mold: 0.100 Ft^3

Specific Gravity: 2.60

Minimum Index: 78.4 $lbs./Ft^3$

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Franklin, Tennessee 615 794-3596
Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date September, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

SPOIL SAMPLE S-2

Length = 3.15 in. Weight = 1.382 lbs. Specific Gravity = 2.60

Diameter = 2.88 in. Moisture = 22.1 % Total Volume = 0.01187 Ft^3

$Weight_w$ = 1.382 lbs.-1.132 lbs. = 0.250 lbs.

$Volume_w$ = 0.250 lbs./62.4 lbs./Ft^3 = 0.004 Ft^3

$Volume_s$ = 1.132 lbs./ (62.4 lbs./Ft^3) (2.60) = 0.00698 Ft^3

$Volume_a$ = 0.01187 Ft^3-(0.004 Ft^3+0.00698 Ft^3) = 0.00089 Ft^3

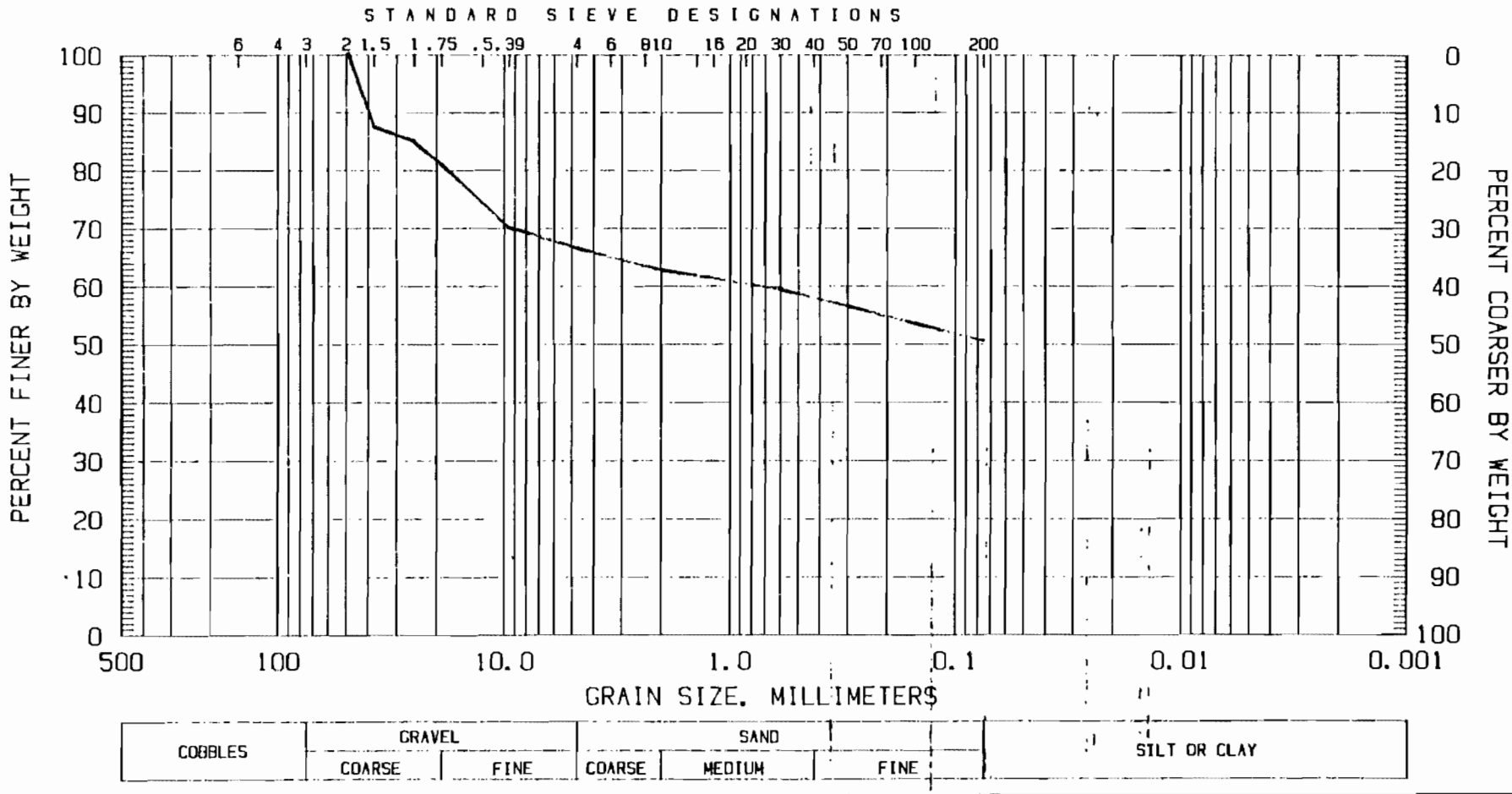
$Volume_v$ = 0.01187 Ft^3-0.00698 Ft^3 = 0.00489 Ft^3

$$e = \frac{0.00489}{0.00698} = 0.701$$

$$n = \frac{0.00489}{0.01187} = 41.2 \ \%$$

$$k = \frac{0.786}{473810.4} = 1.66 \times 10^{-6} \text{ cm/sec (@ 95.9\% Compaction)}$$

GRAIN SIZE ANALYSIS



PROJECT NO.: 84-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE
SEPTEMBER 17, 1984

SAMPLE: S-2

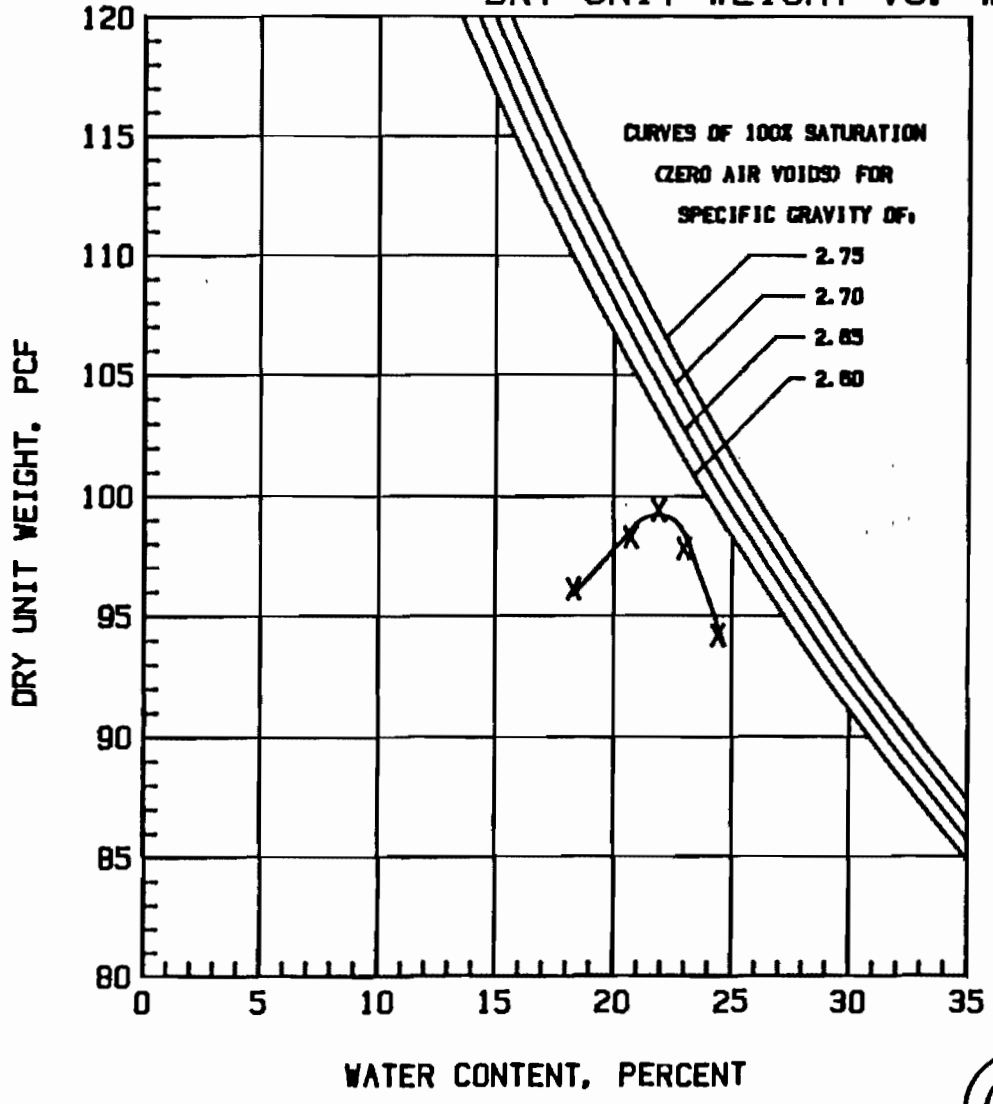
DEPTH: N/A FT

SPOIL
NATURAL MOISTURE CONTENT= 5.2 %

GEOLOGIC ASSOCIATES, INC.

MOISTURE-DENSITY RELATIONSHIP

DRY UNIT WEIGHT vs. WATER CONTENT



PROJECT NO.: 84-3105

UTAH INTERNATIONAL
SOILS TESTING
I.T. ENVIROSCIENCE

SEPTEMBER 17, 1984
CONTROL TEST NUMBER: 6

S-2/SPOIL
NATURAL MOISTURE CONTENT: 5.2 %
TEST PROCEDURE: ASTM D 698
TEST METHOD: C

MAXIMUM DRY DENSITY	OPTIMUM MOISTURE CONTENT
99.4 PCF	21.9 %

NOTE: RESULTS OF THIS TEST WILL BE USED TO DETERMINE COMPACTION PERCENTAGES IN THE FIELD

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Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date October 5, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

SPOIL SAMPLES

This report includes the minimum index density test results of sample SS-3 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: S-3

Method: A

Volume of Mold: 0.100 Ft^3

Specific Gravity: 2.43

Minimum Index: 83.4 $lbs./Ft^3$

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Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date September, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

SPOIL SAMPLE S-3

Length = 3.00 in. Weight = 1.259 lbs. Specific Gravity = 2.43

Diameter = 2.87 in. Moisture = 19.9 % Total Volume = 0.01123 Ft^3

$Weight_w$ = 1.259 lbs. - 1.050 lbs. = 0.209 lbs.

$Volume_w$ = 0.209 lbs./62.4 lbs./Ft^3 = 0.00335 Ft^3

$Volume_s$ = 1.050/(62.4) (2.43) = 0.00693 Ft^3

$Volume_a$ = 0.01123-(0.00335 + 0.00693) = 0.00095 Ft^3

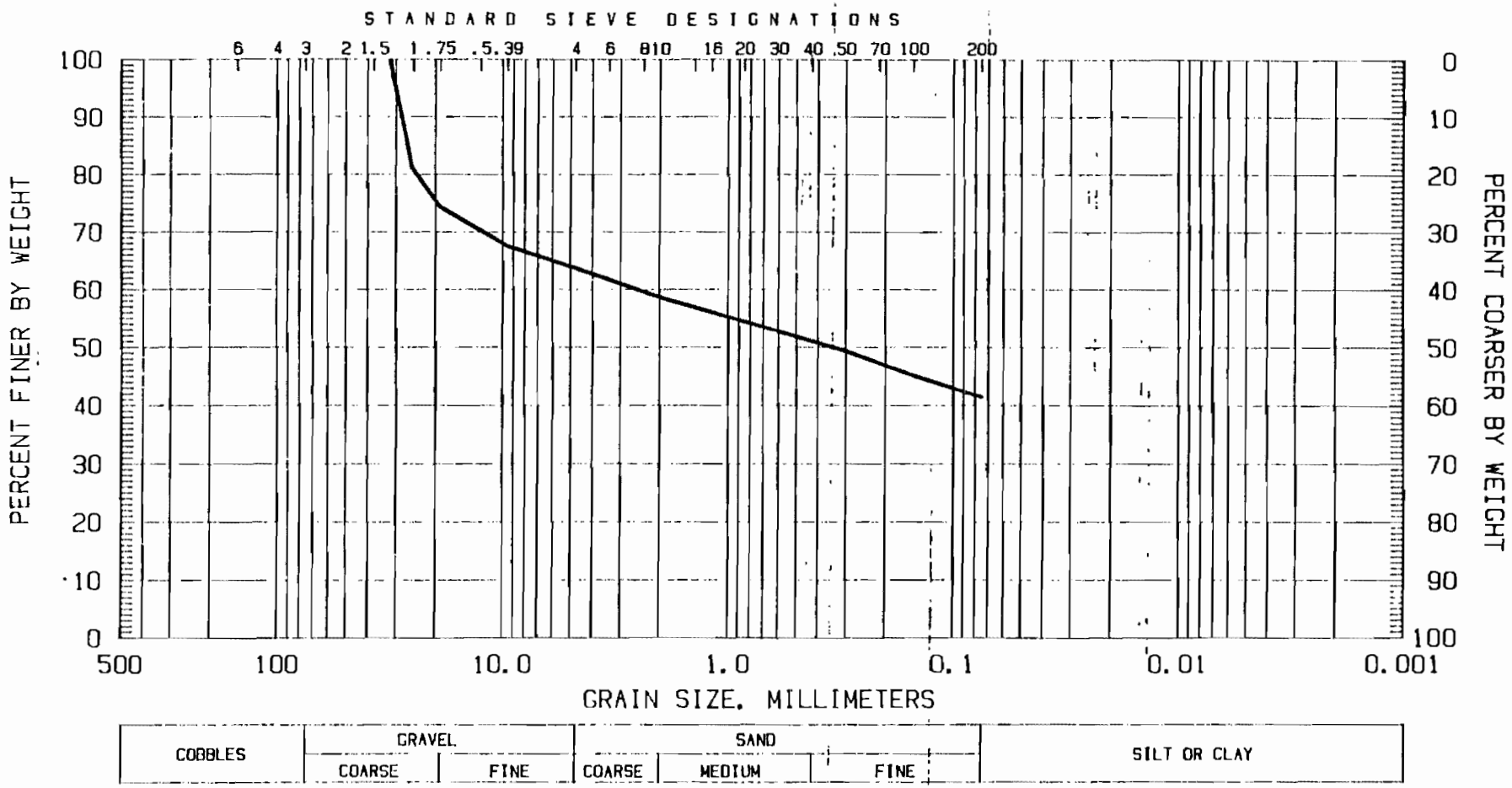
$Volume_v$ = 0.00095 + 0.00335 = 0.0043 Ft^3

$$e = \frac{0.00430}{0.00693} = 0.621$$

$$n = \frac{0.00430}{0.01123} = 38.3\ \%$$

$$k = \frac{0.749}{154291.2} = 4.9 \times 10^{-6}\ \text{cm/sec (@94.7\% Compaction)}$$

GRAIN SIZE ANALYSIS



PROJECT NO.: 84-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE
SEPTEMBER 20, 1984

SAMPLE: S-3

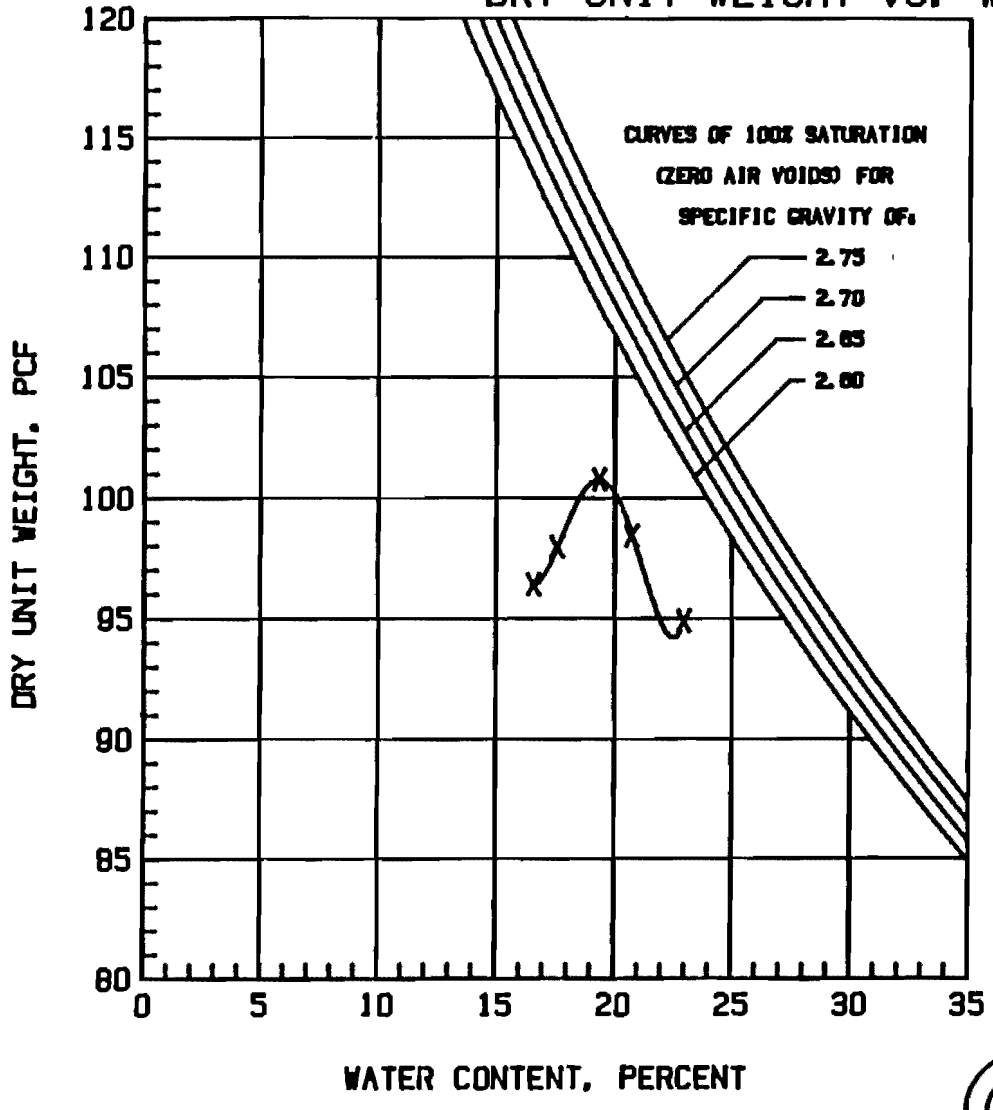
DEPTH: N/A FT

SPOIL
NATURAL MOISTURE CONTENT= 4.0 %

GEOLOGIC ASSOCIATES, INC.

MOISTURE-DENSITY RELATIONSHIP

DRY UNIT WEIGHT vs. WATER CONTENT



PROJECT NO.: 84-3105

UTAH INTERNATIONAL
SOILS TESTING
I.T. ENVIROSCIENCE

SEPTEMBER 20, 1984
CONTROL TEST NUMBER: 7

S-3/SPOIL
NATURAL MOISTURE CONTENT: 4.0 %
TEST PROCEDURE: ASTM D 698
TEST METHOD: C

MAXIMUM DRY DENSITY	OPTIMUM MOISTURE CONTENT
100.8 PCF	19.4 %

NOTE: RESULTS OF THIS TEST WILL BE USED TO DETERMINE COMPACTION PERCENTAGES IN THE FIELD

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Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date October 5, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

SPOIL SAMPLES

This report included the minimum index density test results of sample SS-4 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: S-4

Method: A

Volume of Mold: 0.100 Ft^3

Specific Gravity: 2.56

Minimum Index: 75.6 lbs./Ft^3

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Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date September, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

SPOIL SAMPLE S-4

Length = 2.75 in. Weight = 1.146 lbs. Specific Gravity = 2.55

Diameter = 2.84 in. Moisture = 20.4 % Total Volume = 0.01008 Ft^3

$Weight_w$ = 1.146 lbs. - 0.952 lbs. = 0.194 lbs.

$Volume_w$ = 0.194 lbs./62.4 lbs./Ft^3 = 0.00311 Ft^3

$Volume_s$ = 0.952/(62.4)(2.55) = 0.00598 Ft^3

$Volume_a$ = 0.01008-(0.00311+0.00598) = 0.00099

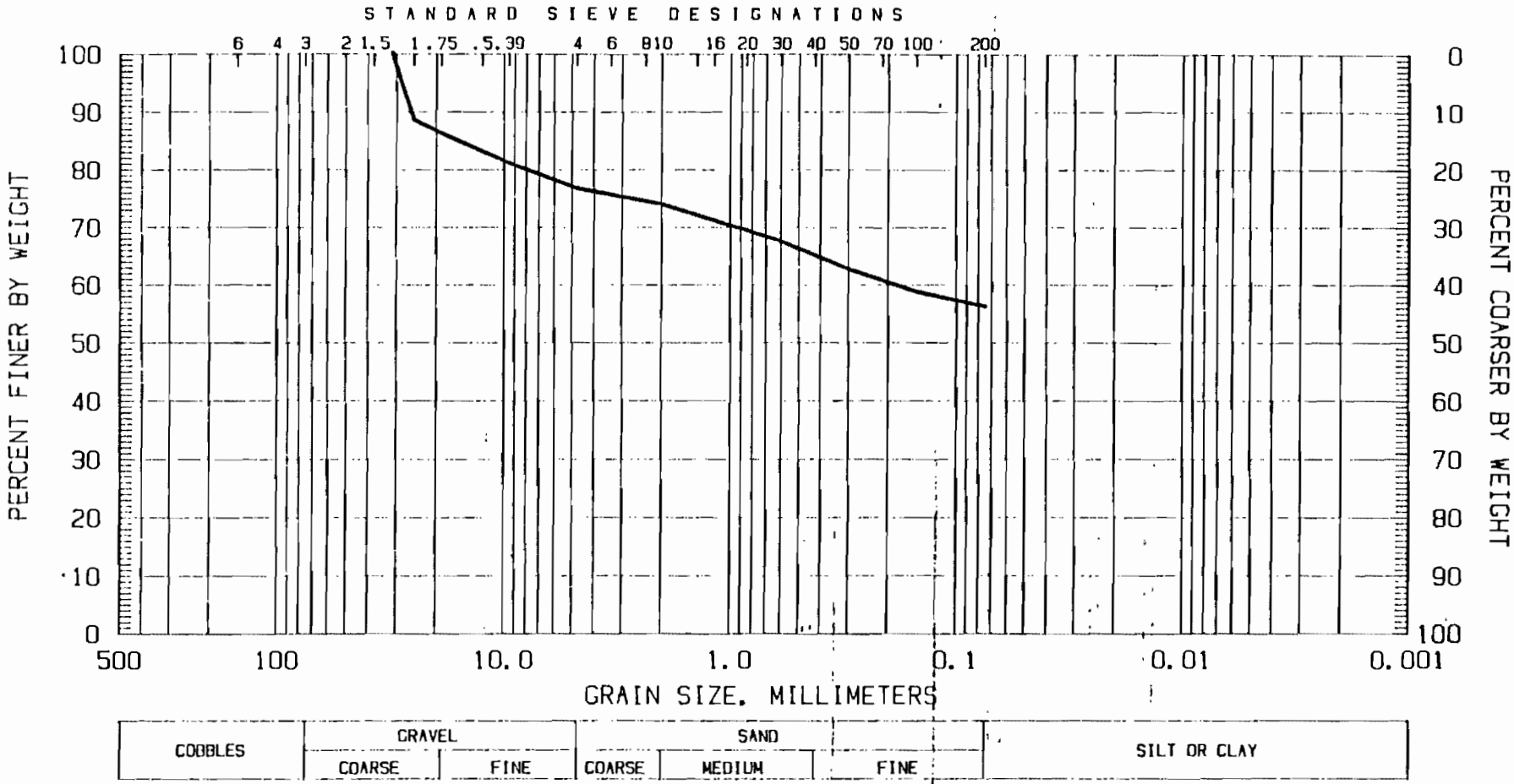
$Volume_v$ = 0.00099 + 0.00311 = 0.0041

$$e = \frac{0.0041}{0.00598} = 0.686$$

$$n = \frac{0.0041}{0.01008} = 40.7 \quad \%$$

$$k = \frac{0.686}{127948.8} = 5.4 \times 10^{-6} \text{ cm/sec (@ 95.8\% Compaction)}$$

GRAIN SIZE ANALYSIS



PROJECT NO.: 84-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE
SEPTEMBER 20, 1984

SAMPLE: S-4

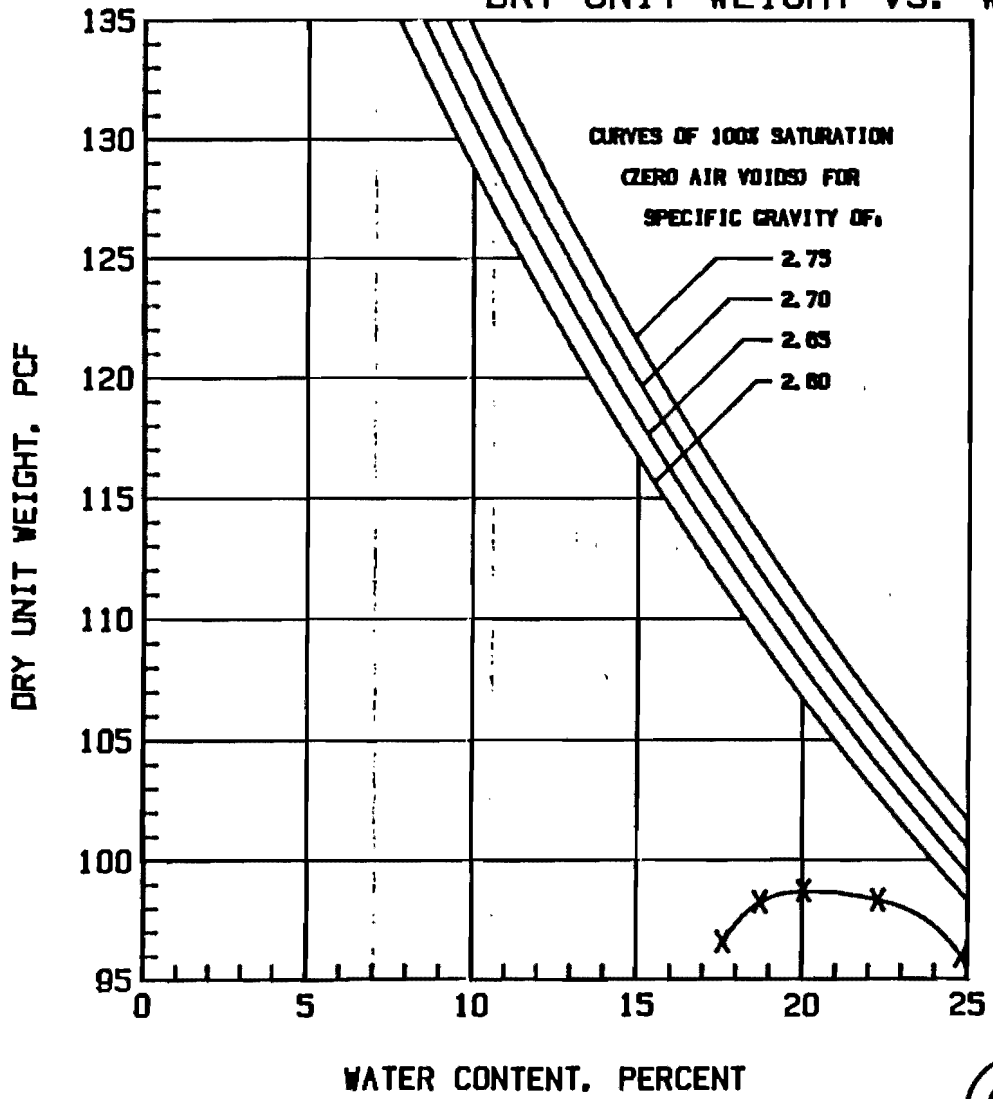
DEPTH: N/A FT

SPOIL
NATURAL MOISTURE CONTENT= 6.3 %

GEOLOGIC ASSOCIATES, INC.

MOISTURE-DENSITY RELATIONSHIP

DRY UNIT WEIGHT vs. WATER CONTENT



PROJECT NO.: 84-3105

UTAH INTERNATIONAL
SOILS TESTING
I.T. ENVIROSCIENCE

SEPTEMBER 20, 1984
CONTROL TEST NUMBER: 8

S-4/SPOIL
NATURAL MOISTURE CONTENT: 6.3 %
TEST PROCEDURE: ASTM D 698
TEST METHOD: C

MAXIMUM DRY DENSITY	OPTIMUM MOISTURE CONTENT
98.7 PCF	20.2 %

NOTE: RESULTS OF THIS TEST WILL BE USED TO DETERMINE COMPACTION PERCENTAGES IN THE FIELD

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Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date October 5, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

SPOIL SAMPLES

This report includes the minimum index density test results of sample SS-5 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: S-5

Method: A

Volume of Mold: 0.100 Ft^3

Specific Gravity: 2.55

Minimum Index: 77.2 $lbs./Ft^3$

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Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I.-T. Corporation Date September, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

SPOIL SAMPLE S-5

Length = 3.15 in. Weight = 1.356 lbs. Specific Gravity = 2.55

Diameter = 2.87 in. Moisture = 21.0 % Total Volume = 0.01179 Ft^3

$Weight_w$ = 1.356 lbs.-1.121 lbs. = 0.235 lbs.

$Volume_w$ = 0.235 lbs./62.4 lbs./Ft^3 = 0.00377 Ft^3

$Volume_s$ = 1.121 lbs./(62.4)(2.55)= 0.00705 Ft^3

$Volume_a$ = 0.01179 Ft^3 - (0.00377 + 0.00705) = 0.00097 Ft^3

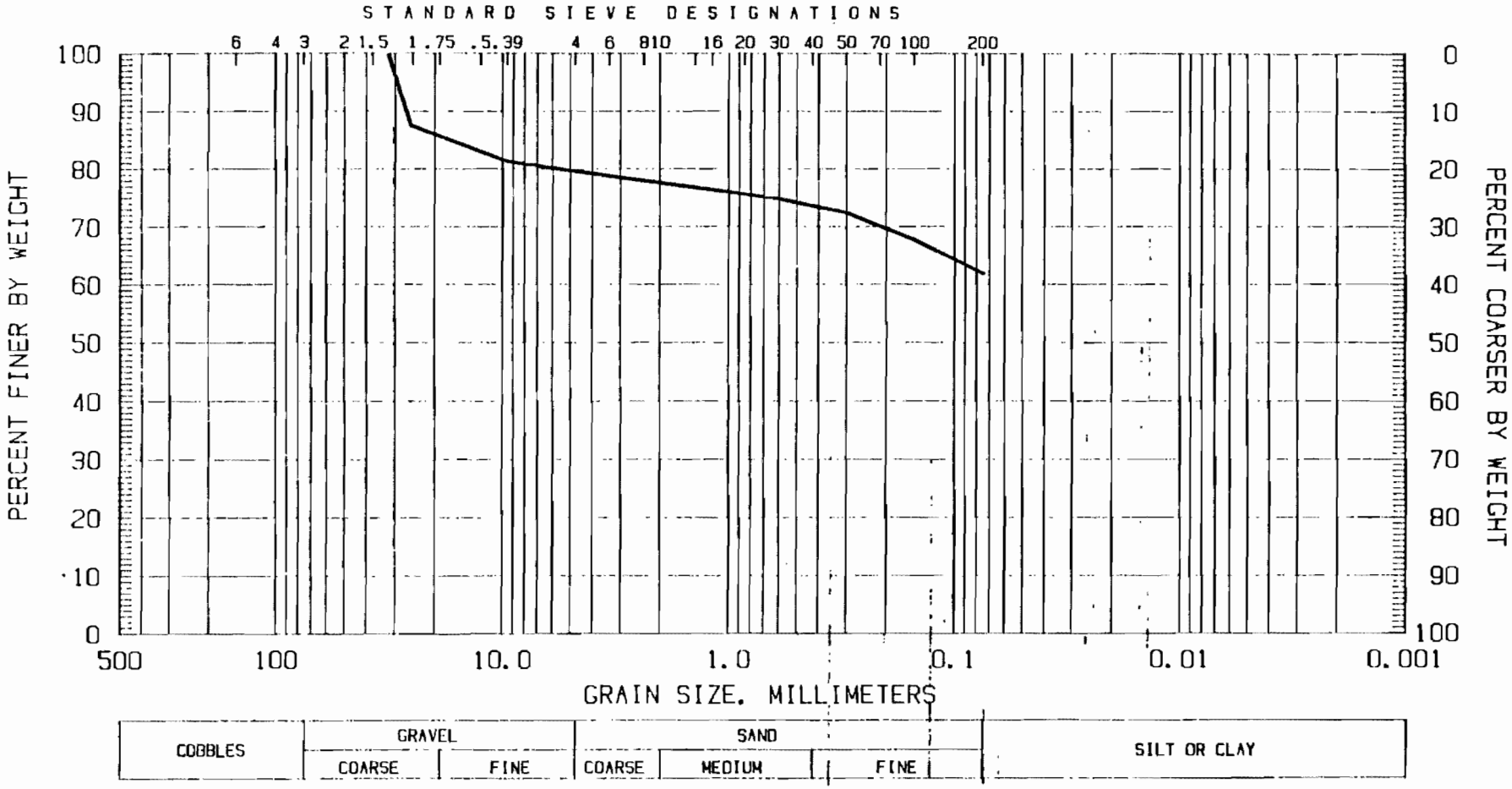
$Volume_v$ = 0.00097 Ft^3 + 0.00377 = 0.00474 Ft^3

$$e = \frac{0.00474}{0.00705} = 0.672$$

$$n = \frac{0.00474}{0.01179} = 40.2\ \%$$

$$k = \frac{0.786}{180336.3} = 4.4 \times 10^{-6}\ \text{cm/sec}\ (@94.0\%\ \text{Compaction})$$

GRAIN SIZE ANALYSIS



PROJECT NO.: 84-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE
SEPTEMBER 26, 1984

SAMPLE: S-5

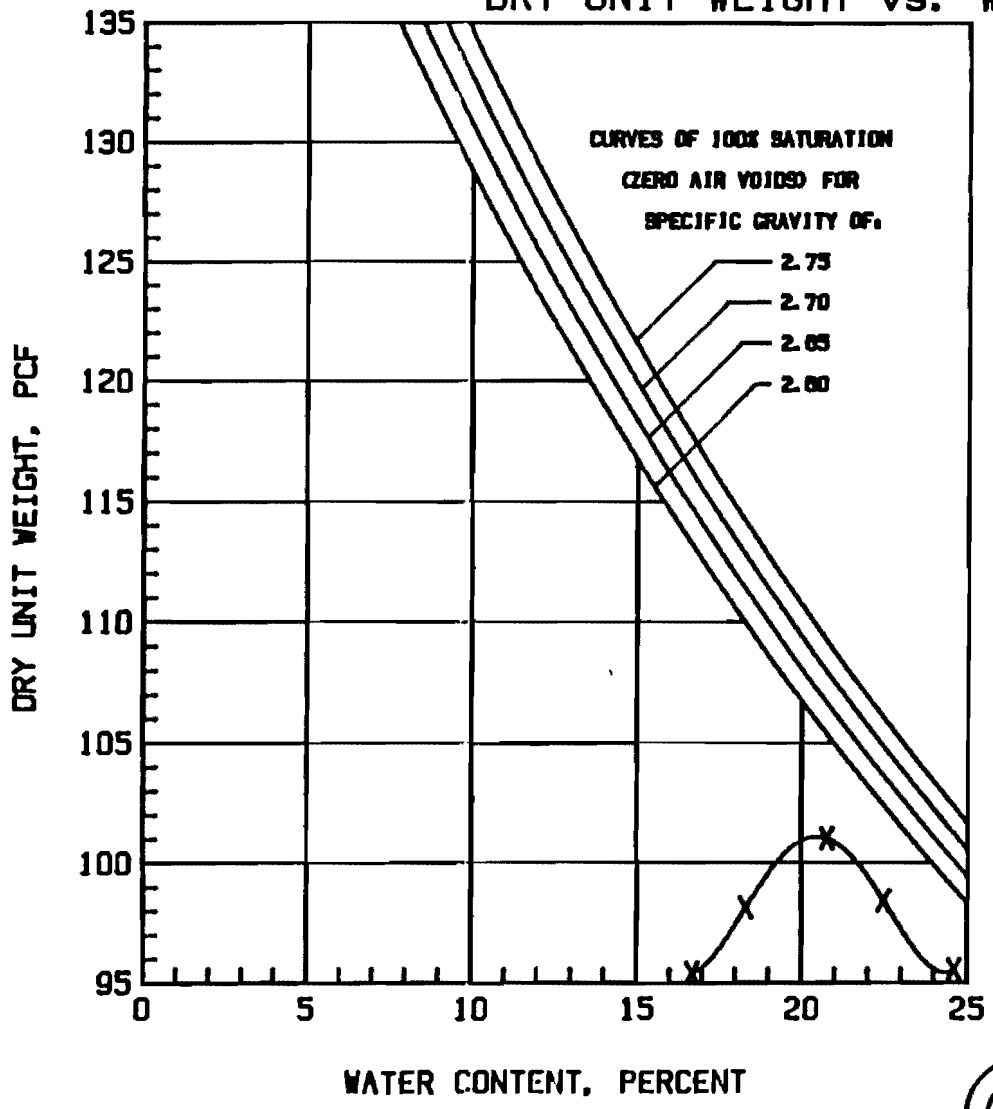
DEPTH: N/A FT

SPOIL
NATURAL MOISTURE CONTENT= 6.1 %
REMARKS:

GEOLOGIC ASSOCIATES, INC.

MOISTURE-DENSITY RELATIONSHIP

DRY UNIT WEIGHT vs. WATER CONTENT



PROJECT NO.: 84-3105

UTAH INTERNATIONAL
SOILS TESTING
I.T. ENVIROSCIENCE

SEPTEMBER 26, 1984
CONTROL TEST NUMBER: 9

S-5/SPOIL
NATURAL MOISTURE CONTENT: 6.1 %
TEST PROCEDURE: ASTM D 698
TEST METHOD: C

MAXIMUM DRY DENSITY	OPTIMUM MOISTURE CONTENT
101.1 PCF	20.5 %

NOTE: RESULTS OF THIS TEST WILL BE USED TO DETERMINE COMPACTION PERCENTAGES IN THE FIELD

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Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date September 18, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of samples D-1 and D-2, as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Methods A and B.

Sample: D-1

Method: B

Volume of Mold: 0.100 ft^3

Specific Gravity: 2.58

Minimum Index: 88.6 PCF

Sample: D-2

Method: A

Volume of Mold: 0.100 ft^3

Specific Gravity: 2.48

Minimum Index: 92.5 PCF

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Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date September, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing Sample D-1 Overburden

Length = 2.63 in. Weight = 1.161 lbs. Specific Gravity = 2.60

Diameter = 2.88 in. Moisture = 17.2 % Total Volume = 0.00991 Ft^3

$Weight_w$ = 1.161 lbs. - 0.9906 lbs. = 0.1704 lbs.

$Volume_w$ = 0.1704 lbs./62.4 lbs/cu.ft. = 0.00273 Ft^3

$Volume_s$ = 0.9906 lbs./(62.4 lbs./cu.ft.) (2.60) = 0.0061 Ft^3

$Volume_a$ = 0.00991 (0.00273 + 0.0061) = 0.00108 Ft^3

$Volume_v$ = 0.00991 - 0.0061 = 0.00381 Ft^3

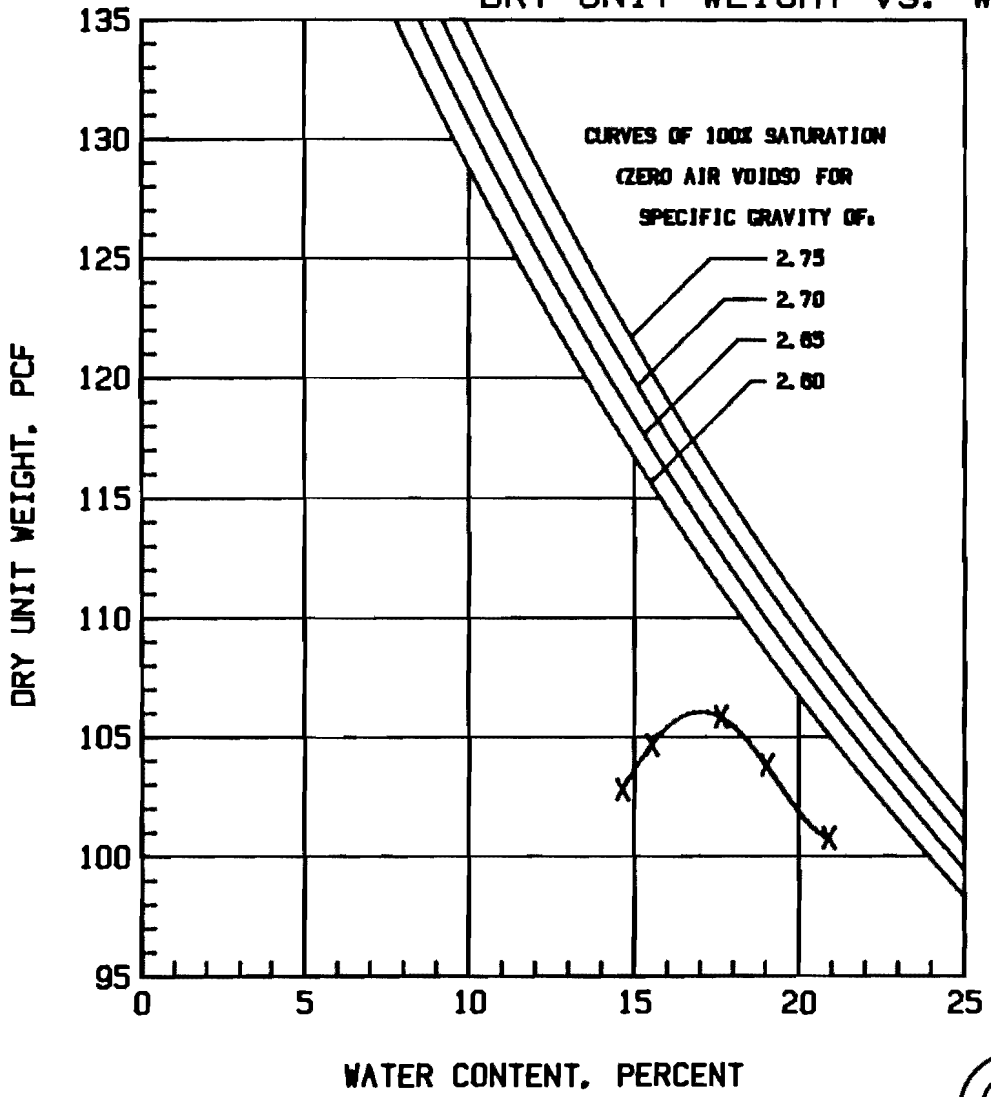
$$e = \frac{0.00381}{0.0061} = 0.625$$

$$n = \frac{0.00381}{0.00991} = 38.5 \ \%$$

$$k = \frac{0.6563}{1305830.4} = 5.03 \times 10^{-7} \text{ cm/sec}$$

MOISTURE-DENSITY RELATIONSHIP

DRY UNIT WEIGHT vs. WATER CONTENT



PROJECT NO.: 84-3105

UTAH INTERNATIONAL
SOILS TESTING
I.T. ENVIROSCIENCE

SEPTEMBER 14, 1984
CONTROL TEST NUMBER: 3

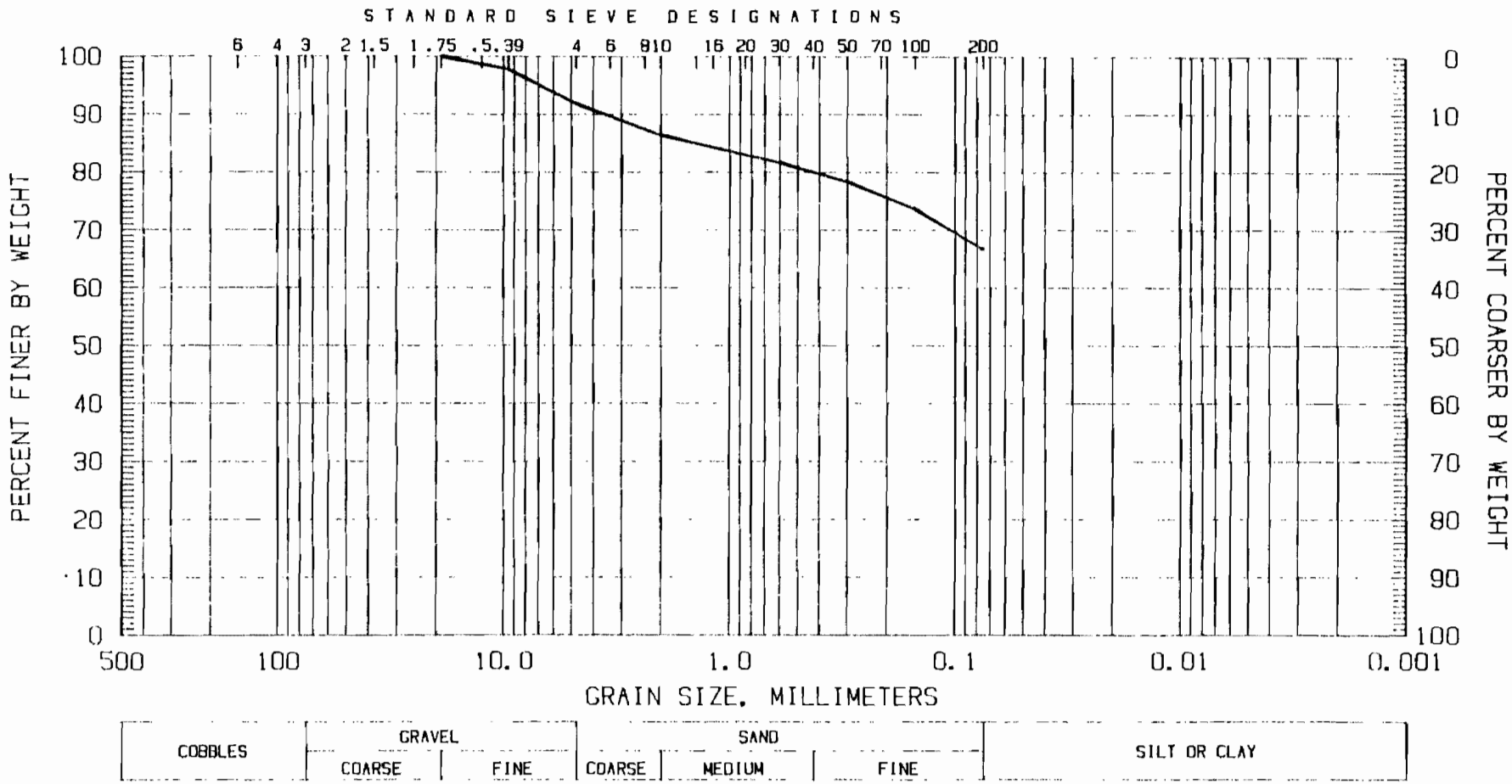
D-1/OVERBURDEN
NATURAL MOISTURE CONTENT: 10.0 %
TEST PROCEDURE: ASTM D 698
TEST METHOD: C

MAXIMUM DRY DENSITY	OPTIMUM MOISTURE CONTENT
106.1 PCF	17.0 %

NOTE: RESULTS OF THIS TEST WILL BE USED TO DETERMINE COMPACTION PERCENTAGES IN THE FIELD

GEOLOGIC ASSOCIATES, INC.

GRAIN SIZE ANALYSIS



PROJECT NO.: 84-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE
SEPTEMBER 14, 1984

SAMPLE: D-1

DEPTH: N/A FT

OVERBURDEN
NATURAL MOISTURE CONTENT= 10.0 %

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Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date September 18, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of samples D-1 and D-2, as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Methods A and B.

Sample: D-1

Method: B

Volume of Mold: 0.100 ft^3

Specific Gravity: 2.58

Minimum Index: 88.6 PCF

Sample: D-2

Method: A

Volume of Mold: 0.100 ft^3

Specific Gravity: 2.48

Minimum Index: 92.5 PCF

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Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date September, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing
Sample D-2 Overburden

Length = 2.66 in. Weight = 1.192 lbs. Specific Gravity = 2.5

Diameter = 2.88 in. Moisture = 15.3 % Total Volume = 0.0100 Ft^3

$Weight_w$ = 1.192 lbs. - 1.034 = 0.158 lbs.

$Volume_w$ = 0.158 lbs./62.4 lbs./cu.ft. = 0.00663 Ft^3

$Volume_s$ = 1.034 lbs./(62.4 lbs./cu.ft.) (2.50) = 0.00663 Ft^3

$Volume_a$ = 0.0100 (0.00253 + 0.00663) = 0.00084 Ft^3

$Volume_v$ = 0.01 - 0.00663 = 0.00337 Ft^3

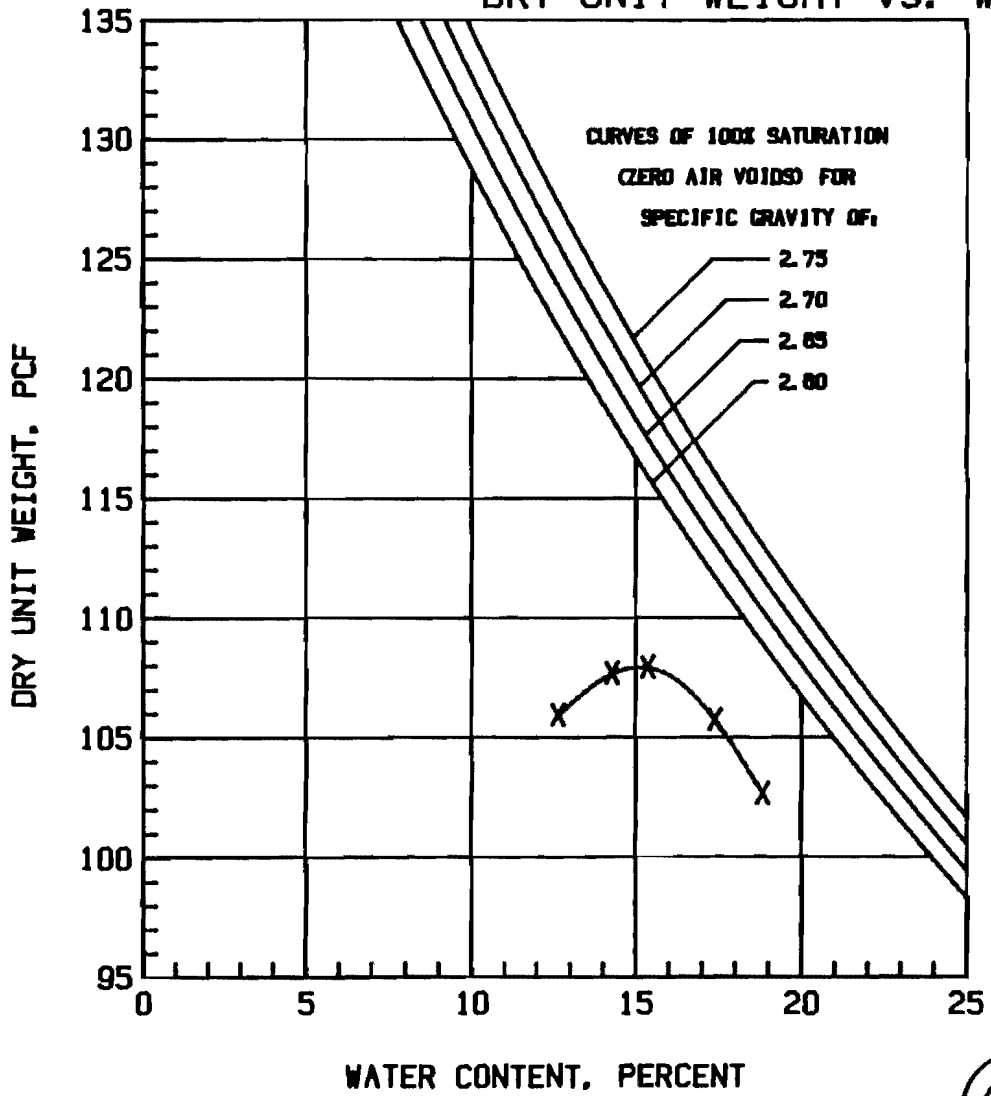
$$e = \frac{0.00337}{0.00663} = 0.508$$

$$n = \frac{0.00337}{0.010} = 33.7\ \%$$

$$k = \frac{0.6524}{1919232} = 3.4 \times 10^{-7}\ cm/sec$$

MOISTURE-DENSITY RELATIONSHIP

DRY UNIT WEIGHT vs. WATER CONTENT



PROJECT NO.: 84-3105

UTAH INTERNATIONAL
SOILS TESTING
I.T. ENVIROSCIENCE

SEPTEMBER 14, 1984
CONTROL TEST NUMBER: 4

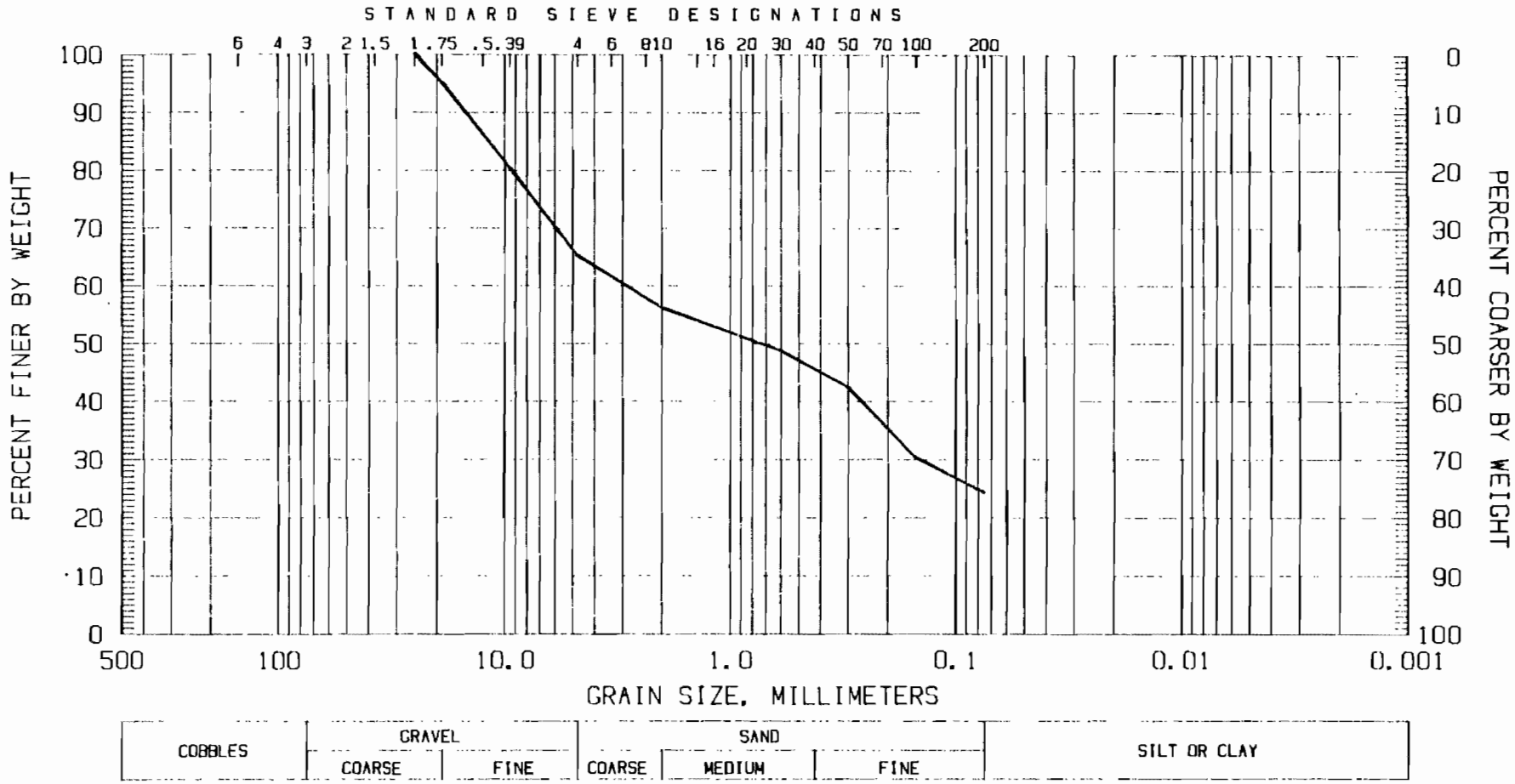
D-2/OVERBURDEN
NATURAL MOISTURE CONTENT: 5.6 %
TEST PROCEDURE: ASTM D 698
TEST METHOD: C

MAXIMUM DRY DENSITY	OPTIMUM MOISTURE CONTENT
108.0 PCF	15.0 %

NOTE: RESULTS OF THIS TEST WILL BE USED TO DETERMINE COMPACTION PERCENTAGES IN THE FIELD

GEOLOGIC ASSOCIATES, INC.

GRAIN SIZE ANALYSIS



PROJECT NO.: 84-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE
SEPTEMBER 14, 1984

SAMPLE: D-2

DEPTH: N/A FT

OVERBURDEN
NATURAL MOISTURE CONTENT= 5.6 %

GEOLOGIC ASSOCIATES, INC.

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Knoxville, Tennessee 615 966-9761

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date September 18, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of samples PP-1 and PP-2, as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Methods B and C.

Sample: PP-1 Fly ash

Method: C

Volume of Mold: 0.100 ft^3

Specific Gravity: 1.89

Minimum Index: 60.6 PCF

Sample: PP-2 Bottom ash

Method: B

Volume of Mold: 0.100 ft^3

Specific Gravity: 1.92

Minimum Index: 41.8 PCF

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Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date September, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing Sample PP-1 Fly Ash

Length = 2.41 in. Weight = .6944 lbs. Specific Gravity = 1.90

Diameter = 2.88 in. Moisture = 21.2 % Total Volume = 0.009054 Ft^3

$Weight_w$ = 0.6944 - 0.5729 = .1215 lbs.

$Volume_w$ = 0.1215 lbs/62.4 PCF = .001947 Ft^3

$Volume_s$ = 5729 lbs/(62.4) (1.8) = .004832 Ft^3

$Volume_a$ = 0.009054 (.001947 + (.004832) = .002275 Ft^3

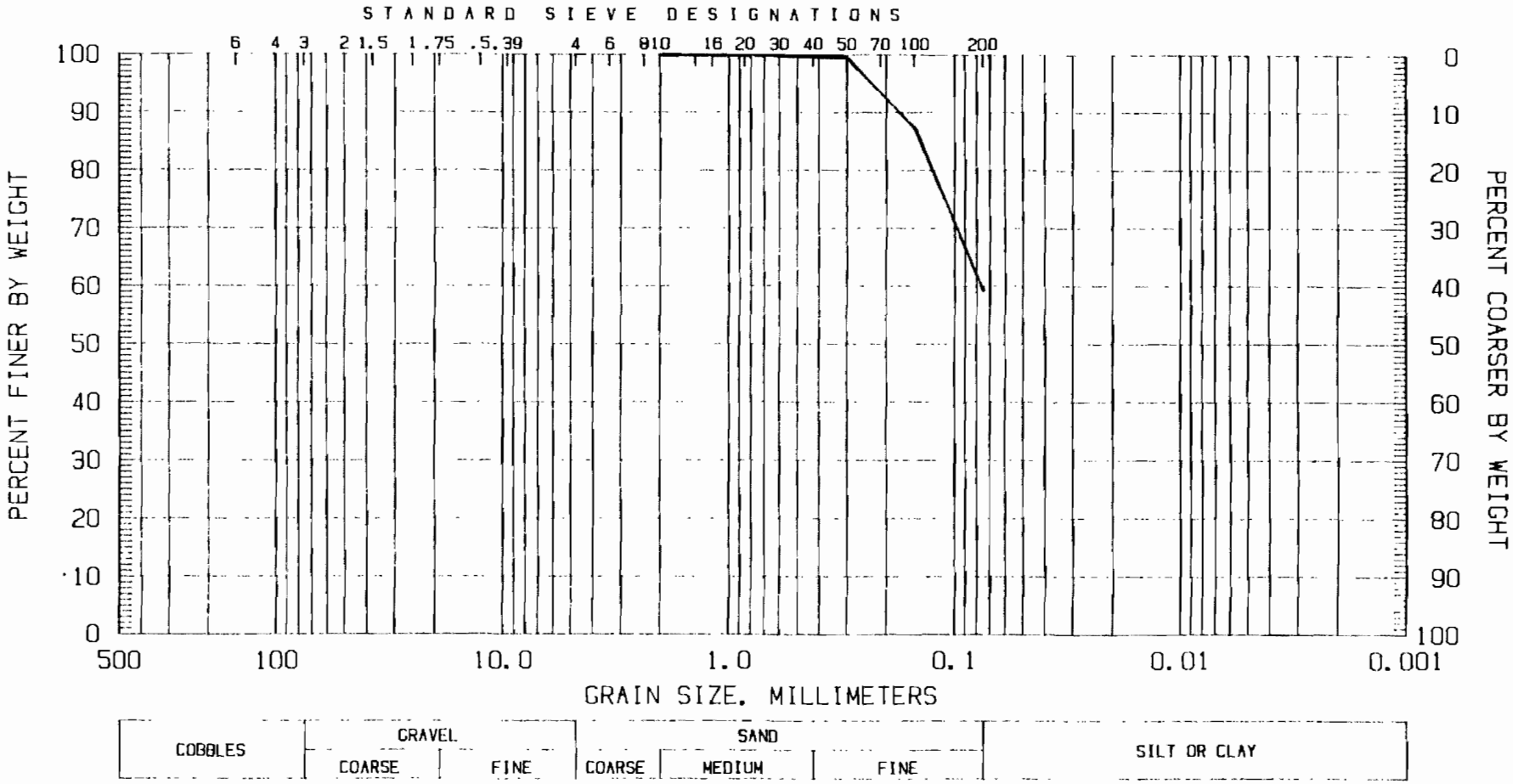
$Volume_v$ = 0.009054 - 0.004832 = 0.004222

$$e = \frac{0.004222}{0.004832} = 0.8737$$

$$n = \frac{0.004222}{0.009054} = 46.6\ \%$$

$$k = \frac{0.6014}{4437.5} = 1.36 \times 10^{-4}\ cm/sec$$

GRAIN SIZE ANALYSIS



PROJECT NO.: 84-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE
SEPTEMBER 14, 1984

SAMPLE: PP1

DEPTH: N/A FT

FLY ASH
NATURAL MOISTURE CONTENT= 16.4 %

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Knoxville, Tennessee 615 573-7383
Hopkinsville Kentucky 502 886-0721

LABORATORY TEST — MOISTURE DENSITY RELATIONSHIP

CLIENT: I.T. Enviroscience DATE: September 4, 1984

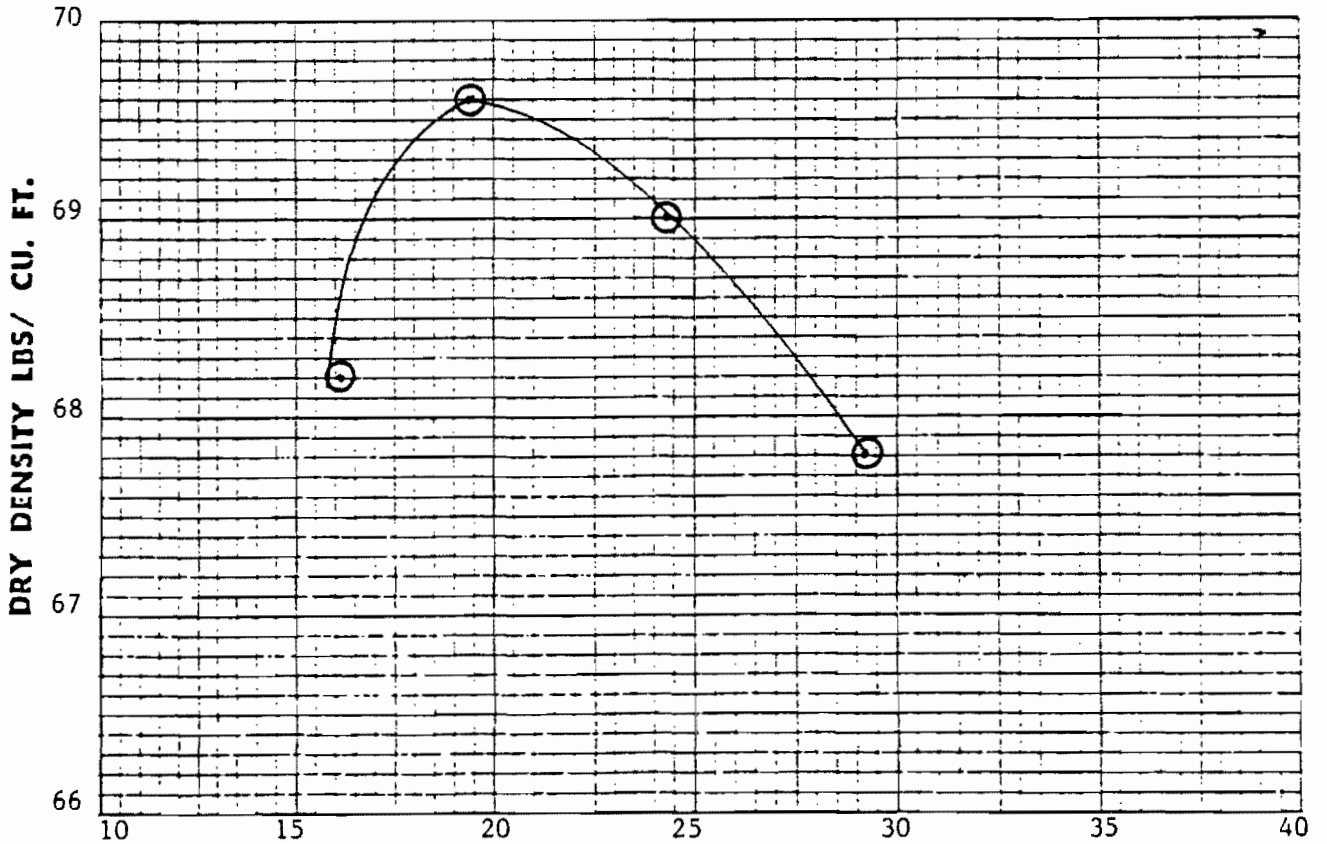
PROJECT: Utah International Soils Testing

SAMPLE LOCATION: PP#1

SAMPLE DESCRIPTION: Fly Ash

TEST METHOD: ASTM D698-78 Method A

MOISTURE DENSITY RELATIONSHIP



MOISTURE CONTENT % BY WEIGHT

OPTIMUM MOISTURE: 19.4 % BY WEIGHT FIELD MOISTURE 0.4 % BY WEIGHT

MAX DRY DENSITY 69.6 LBS/CU. FT.

LAB TEST BY:

REMARKS:

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Franklin, Tennessee 615 794-3596
Knoxville, Tennessee 615 966-9761

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date September 18, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of samples PP-1 and PP-2, as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Methods B and C.

Sample: PP-1 Fly ash

Method: C

Volume of Mold: 0.100 ft^3

Specific Gravity: 1.89

Minimum Index: 60.6 PCF

Sample: PP-2 Bottom ash

Method: B

Volume of Mold: 0.100 ft^3

Specific Gravity: 1.92

Minimum Index: 41.8 PCF

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Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date September, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing PP-2 Bottom Ash

Length = 2.50 in. Weight = 0.6618 lbs. Specific Gravity = 1.92

Diameter = 2.88 in. Moisture = 41.0 % Total Volume = 0.009392 Ft^3

$Weight_w$ = 0.6618 - 0.4694 = 0.1924 lbs.

$Volume_w$ = 0.1924 lbs./62.4 lbs./Ft^3 = 0.00308 Ft^3

$Volume_s$ = 0.4694 lbs./(62.4) (1.92) = 0.00392 Ft^3

$Volume_a$ = 0.009392 - (0.00308 +0.00392) = 0.00239

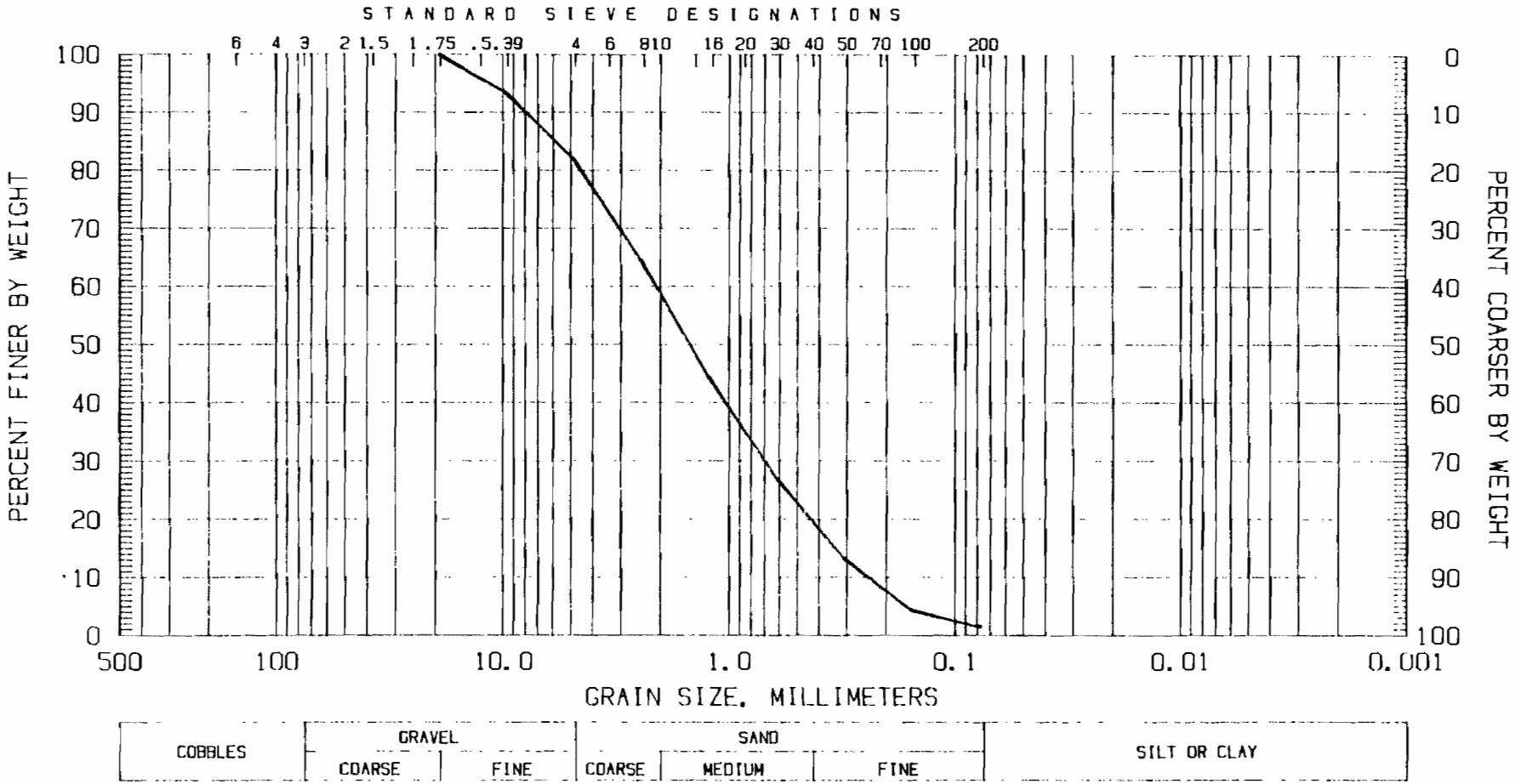
$Volume_v$ = 0.009392 - 0.00392 = 0.005472

$$e = \frac{.005472}{.00392} = 1.396$$

$$n = \frac{.005472}{.009392} = 58.3 \%$$

$$k = \frac{0.6239}{2654.2} = 2.35 \times 10^{-4} \text{ cm/sec}$$

GRAIN SIZE ANALYSIS



PROJECT NO.: 84-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE
SEPTEMBER 14, 1984

SAMPLE: PP2

DEPTH: N/A FT

BOTTOM ASH
NATURAL MOISTURE CONTENT= .4 %

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Franklin, Tennessee 615 794-3556
Knoxville, Tennessee 615 573-7383
Hopkinsville Kentucky 502 886-0721

LABORATORY TEST — MOISTURE DENSITY RELATIONSHIP

CLIENT: I. T. Enviroscience DATE: September 6, 1984

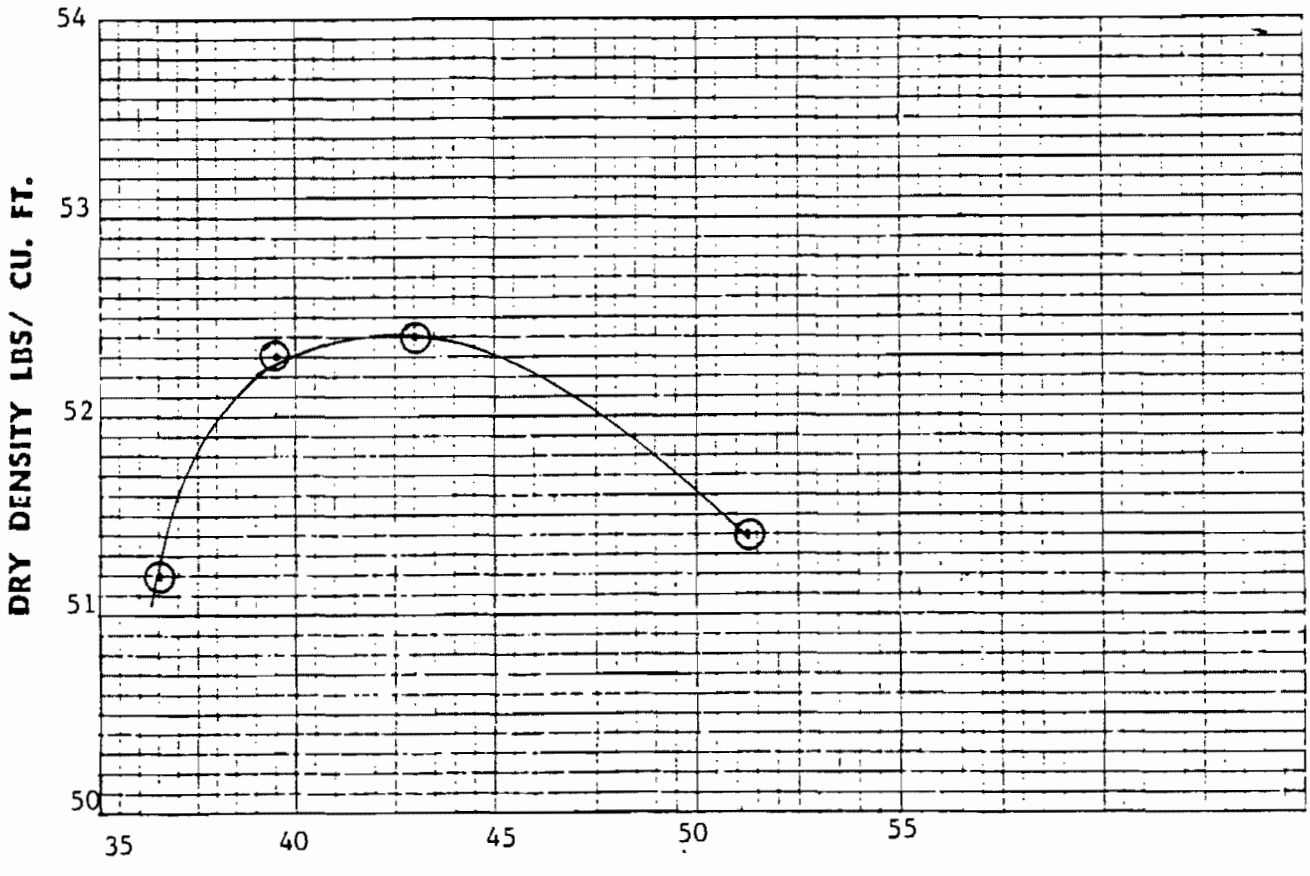
PROJECT: Utah International Soils Testing

SAMPLE LOCATION: PP#2

SAMPLE DESCRIPTION: Bottom ash

TEST METHOD: ASTM D698-78 Method A

MOISTURE DENSITY RELATIONSHIP



OPTIMUM MOISTURE: 42.5 % BY WEIGHT FIELD MOISTURE 16.4 % BY WEIGHT

MAX DRY DENSITY 52.4 LBS/CU. FT.

LAB TEST BY:

REMARKS:

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
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Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date October 18, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample C-1 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: C-1/Seam #8-North

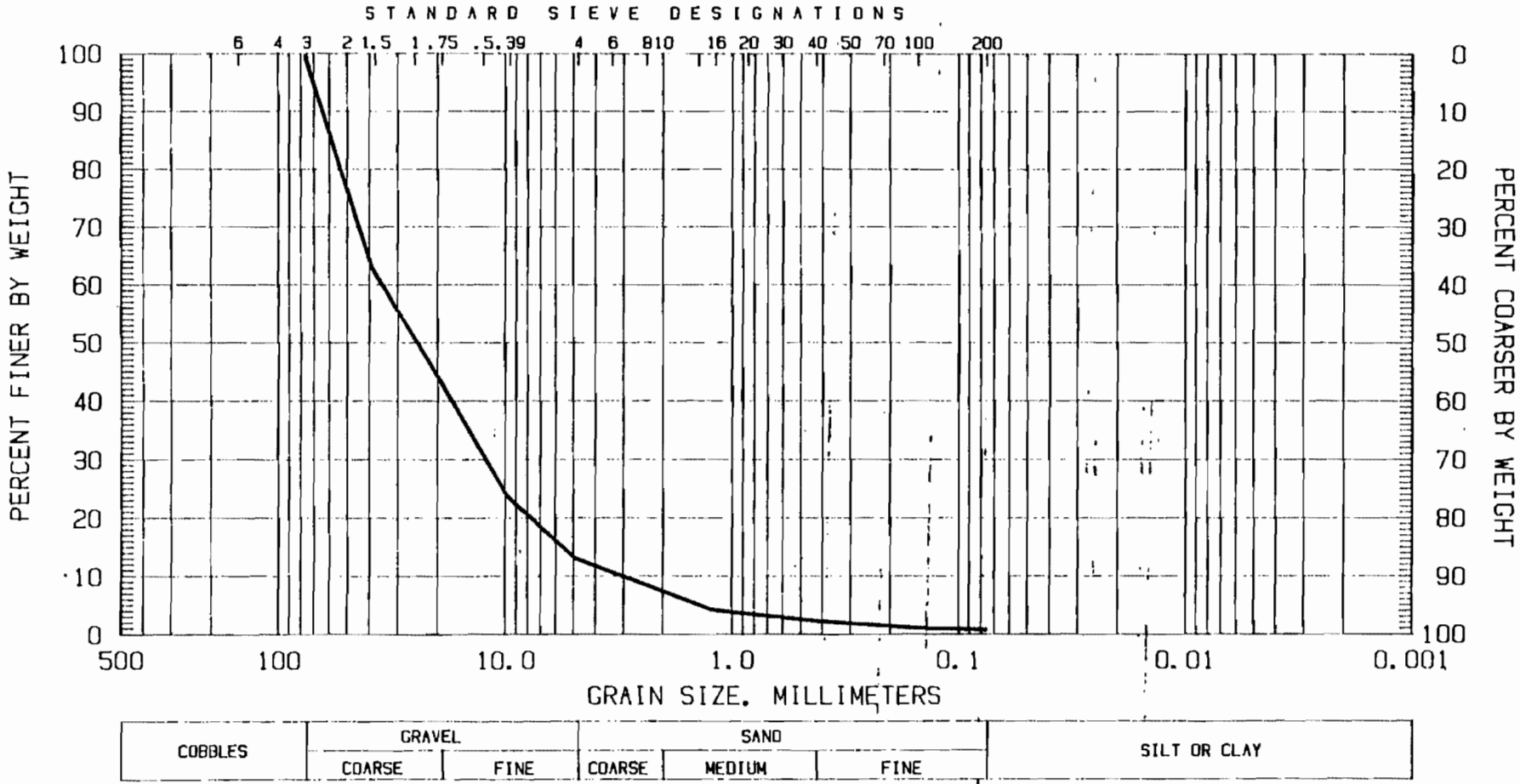
Method: A

Volume of Mold: 0.100 $Ft.^3$

Specific Gravity: 1.48

Minimum Index: 48.1 $lbs/ft.^3$

GRAIN SIZE ANALYSIS



PROJECT NO.: 84-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE CORPORATION
OCTOBER 18, 1984
TEST PIT: C1 SAMPLE: S8
DEPTH: N/A FT

COAL SAMPLE C-1/SEAM NO. 8
REMARKS: SPECIFIC GRAVITY=1.48

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Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date October 18, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample C-2 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: C-2

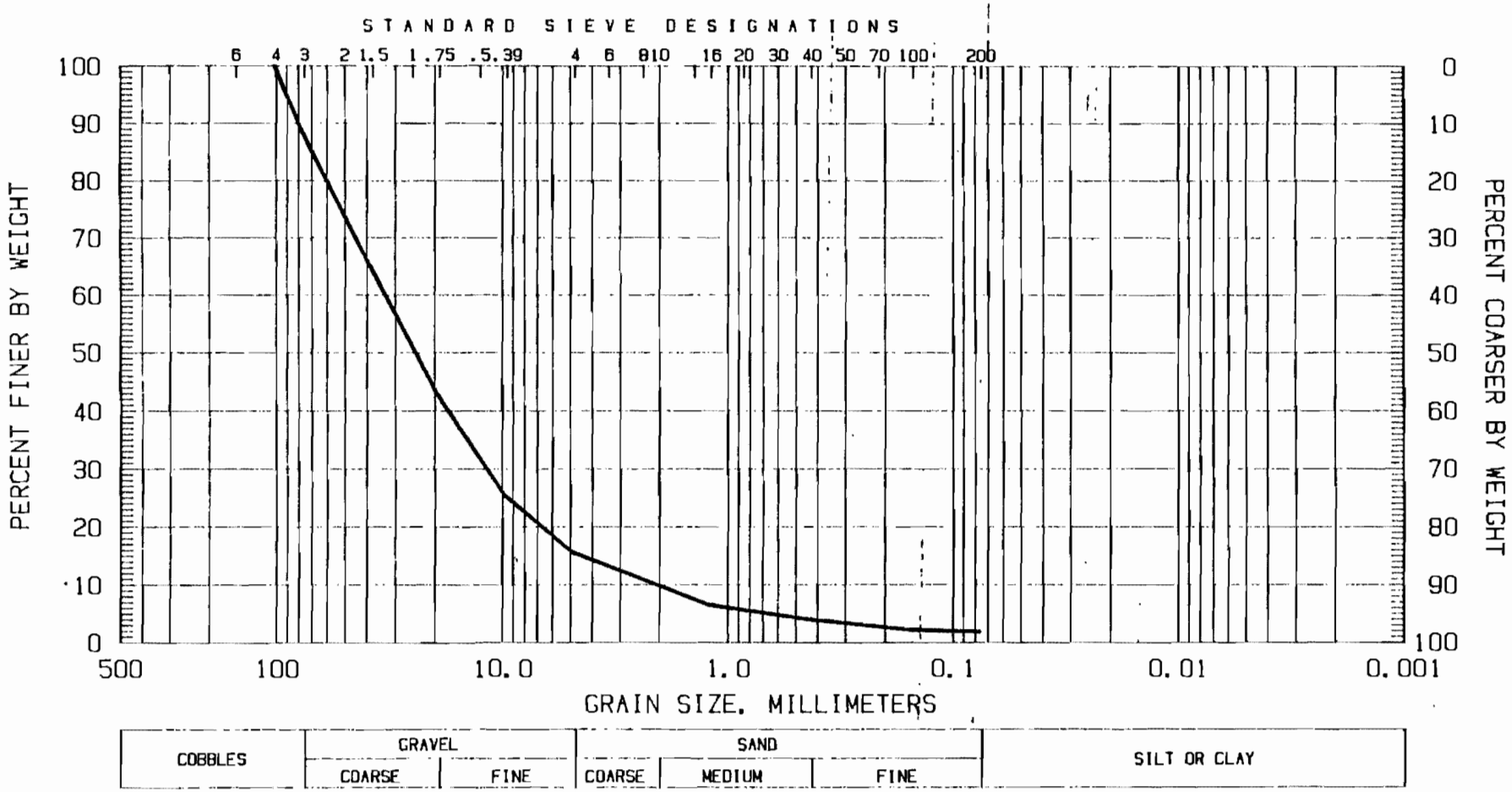
Method: A

Volume of Mold: 0.100 $ft.^3$

Specific Gravity: 1.51

Minimum Index: 49.9 $lbs/ft.^3$

GRAIN SIZE ANALYSIS



PROJECT NO.: 84-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE CORPORATION
OCTOBER 18, 1984
TEST PIT: C2 SAMPLE: S2
DEPTH: N/A FT

COAL SAMPLE C-2/SEAM NO. 2
REMARKS: SPECIFIC GRAVITY=1.51

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Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date October 18, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample C-3 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: C-3, Seam #4

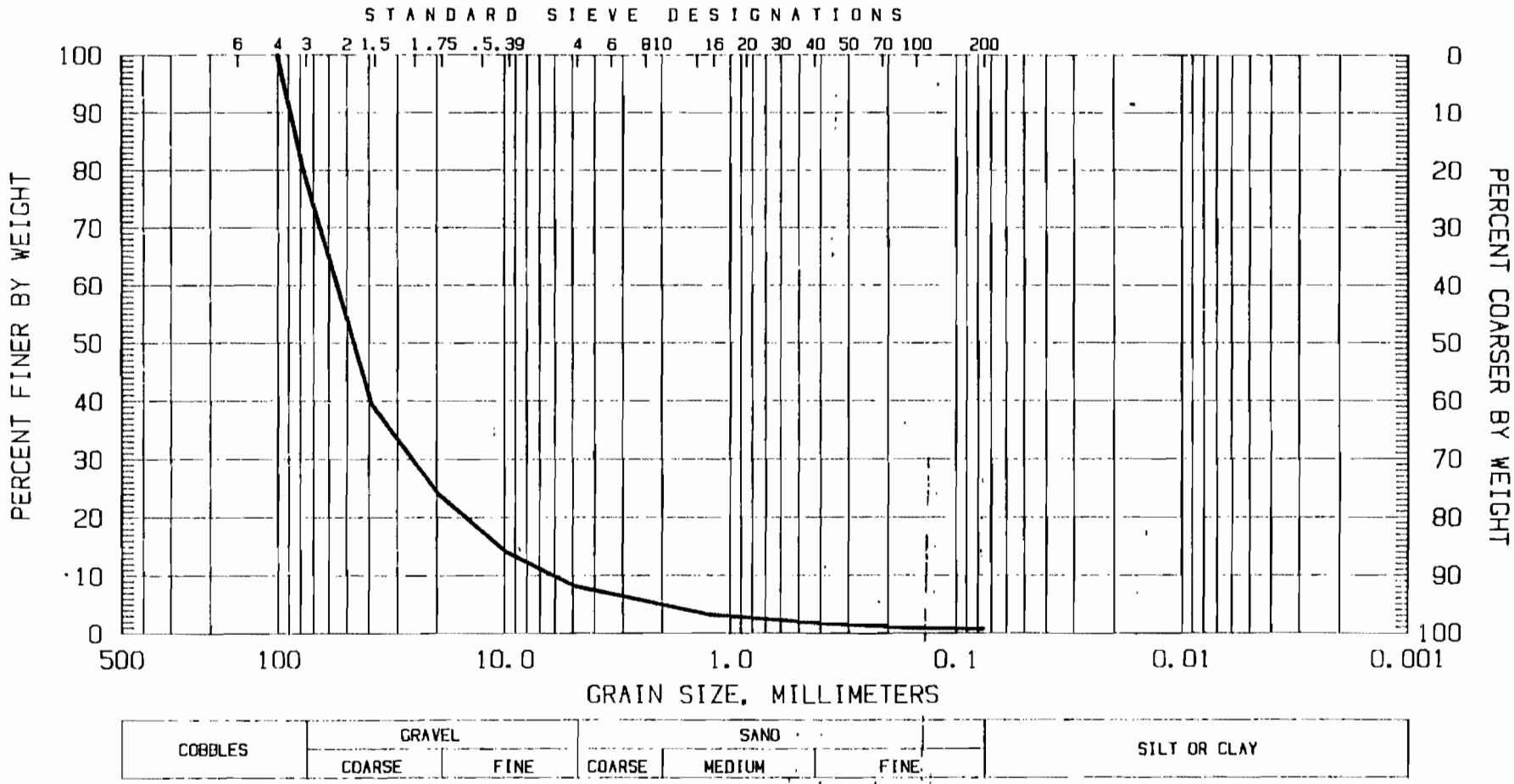
Method: A

Volume of Mold: 0.100 $ft.^3$

Specific Gravity: 1.46

Minimum Index: 50.3 $lbs/ft.^3$

GRAIN SIZE ANALYSIS



PROJECT NO.: B4-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE CORPORATION
OCTOBER 18, 1984
TEST PIT: C3 SAMPLE: S4
DEPTH: N/A FT

COAL SAMPLE C-3/SEAM NO. 4
REMARKS: SPECIFIC GRAVITY=1.46

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Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date October 18, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample C-4 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: C-4/Seam #3

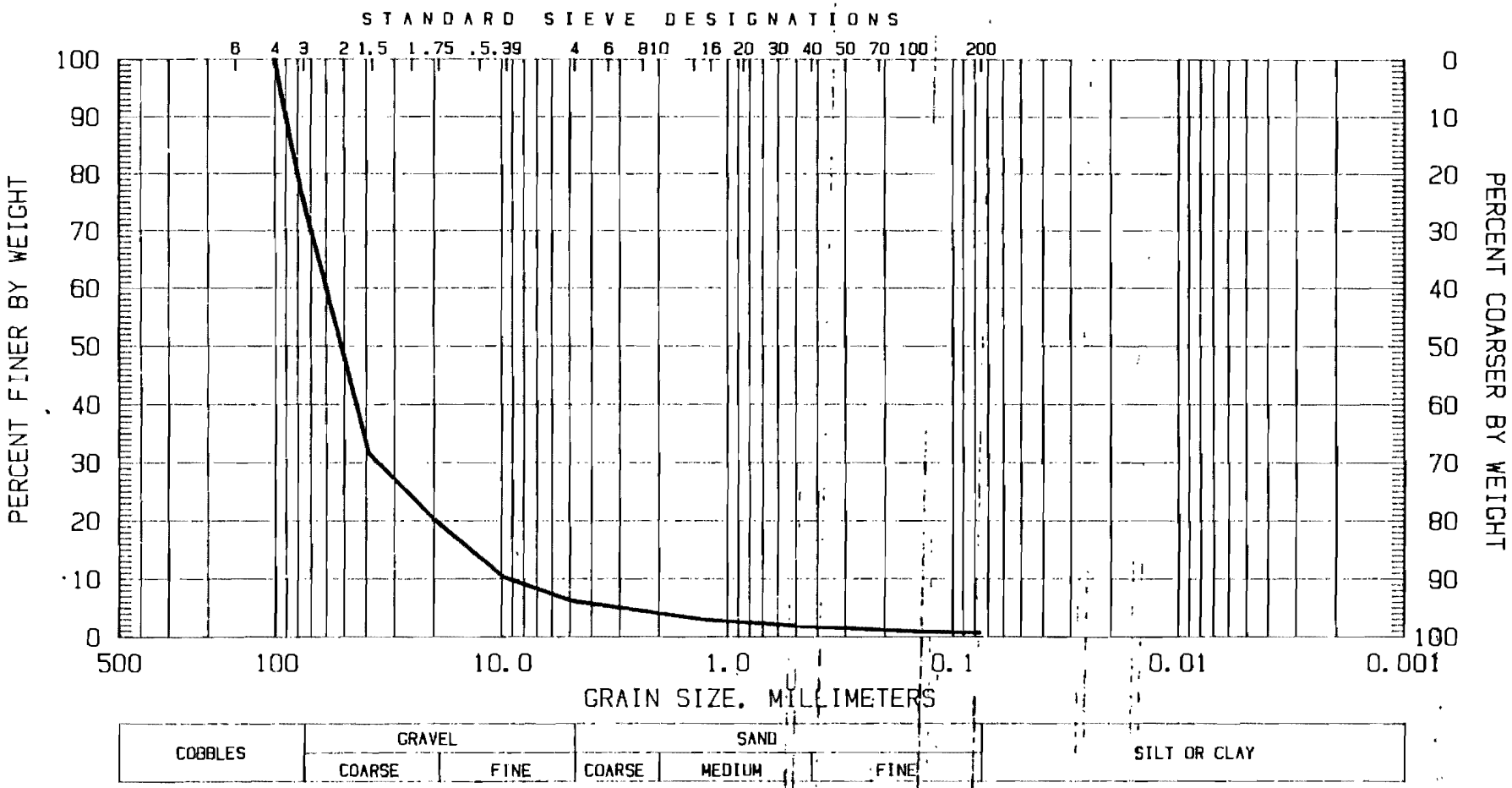
Method: A

Volume of Mold: 0.100 $ft.^3$

Specific Gravity: 1.55

Minimum Index: 53.8 $lbs/ft.^3$

GRAIN SIZE ANALYSIS



PROJECT NO.: 84-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE CORPORATION
OCTOBER 18, 1984
TEST PIT: C4 SAMPLE: S3
DEPTH: N/A FT

COAL SAMPLE C-4/SEAM NO. 3
REMARKS: SPECIFIC GRAVITY=1.55

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REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date October 18, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample C-5 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: C-5/Seam #7

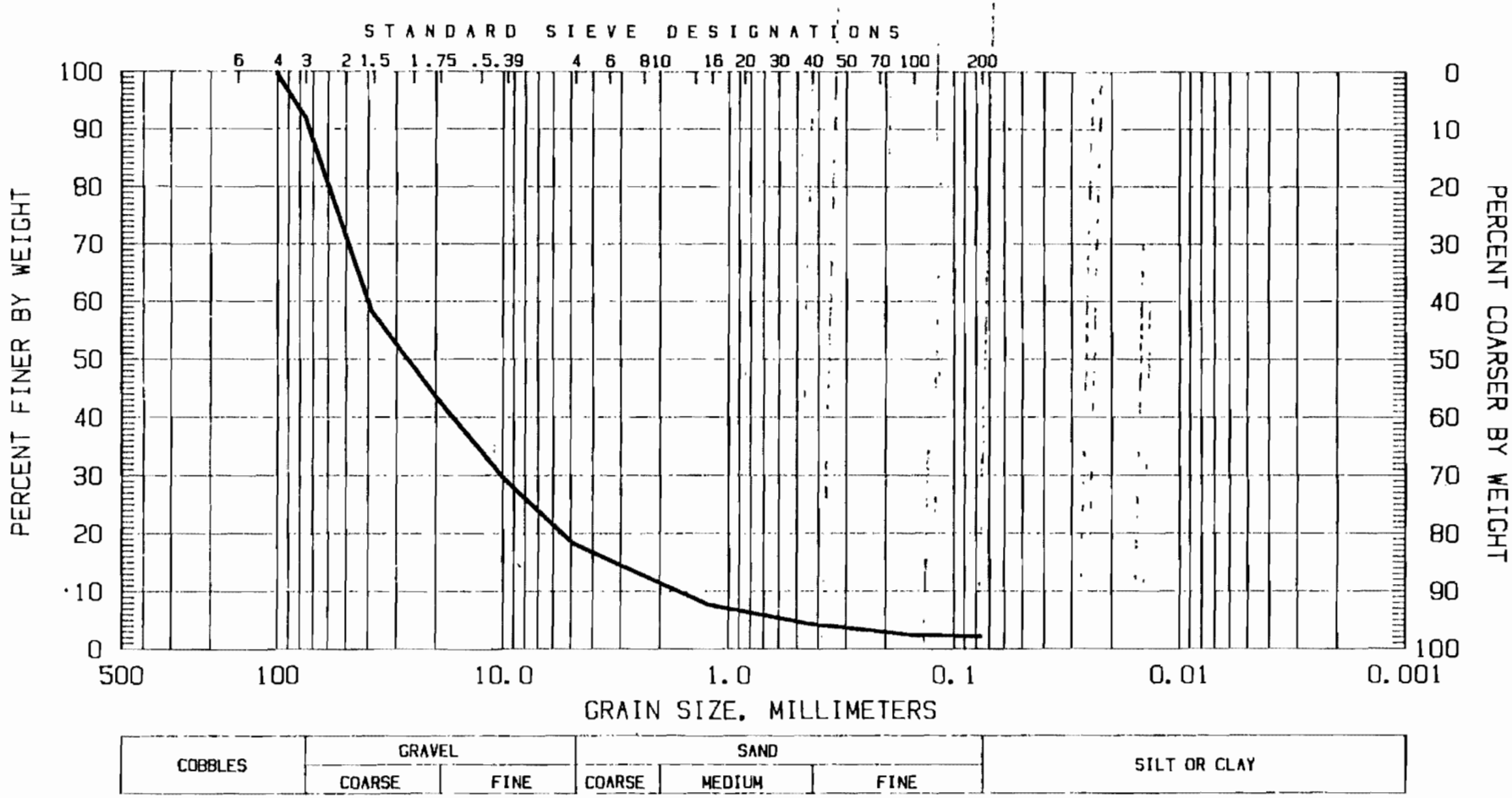
Method: A

Volume of Mold: 0.100 $ft.^3$

Specific Gravity: 1.45

Minimum Index: 54.5 $lbs/ft.^3$

GRAIN SIZE ANALYSIS



PROJECT NO.: 84-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE CORPORATION
OCTOBER 18, 1984
TEST PIT: C5 SAMPLE: S7
DEPTH: N/A FT

COAL SAMPLE C-5/SEAM NO. 7
REMARKS: SPECIFIC GRAVITY=1.45

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Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date October 18, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample C-6 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: C-6/Seam #8-South

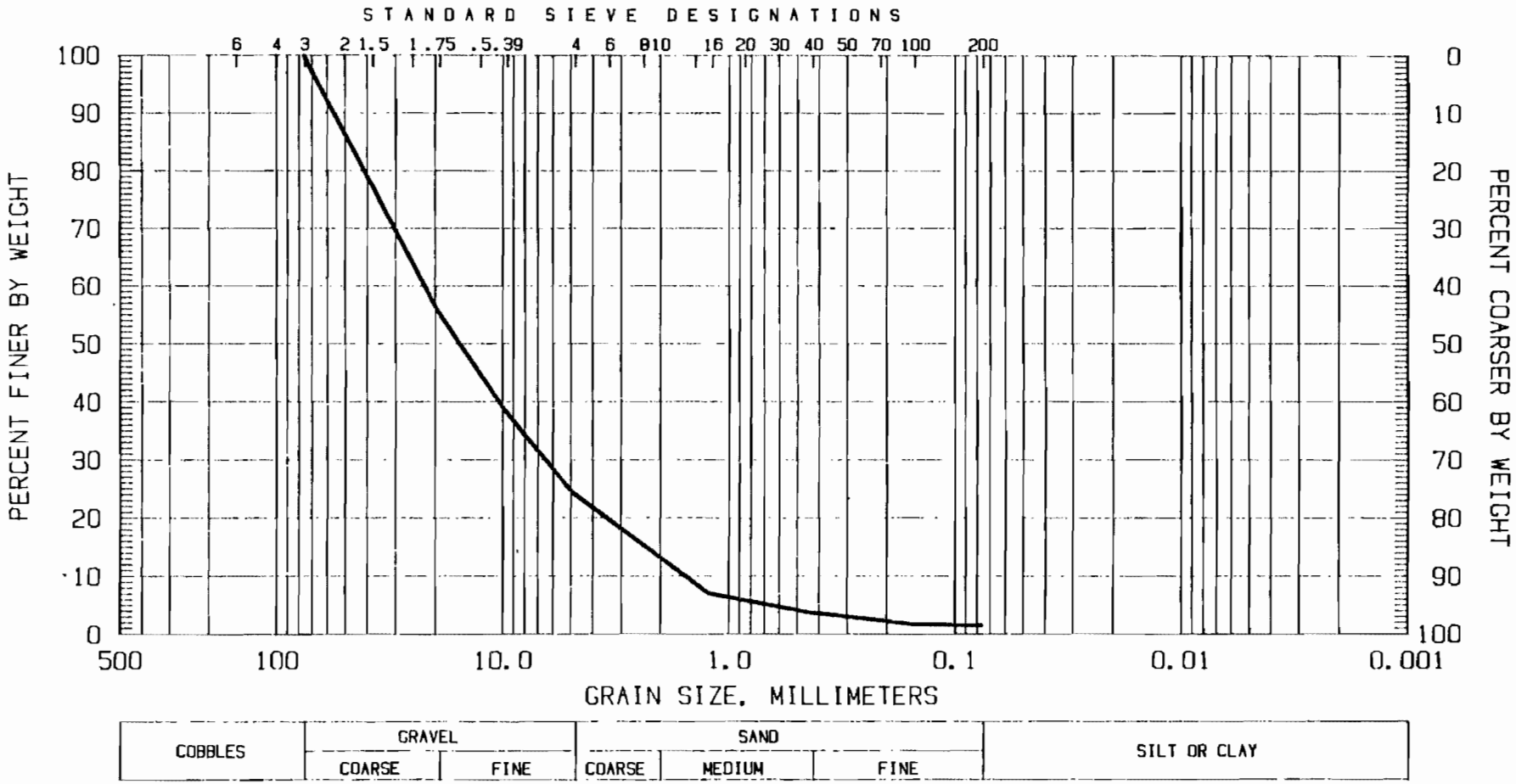
Method: A

Volume of Mold: 0.100 $ft.^3$

Specific Gravity: 1.53

Minimum Index: 58.7 $lbs/ft.^3$

GRAIN SIZE ANALYSIS



PROJECT NO.: 84-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE CORPORATION
OCTOBER 18, 1984
TEST PIT: C6 SAMPLE: S8
DEPTH: N/A FT

COAL SAMPLE C-6/SEAM NO. 8-SOUTH
REMARKS: SPECIFIC GRAVITY=1.53

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Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date October 18, 1984

Project No. 84-3105 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample C-7 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: C-7, Seam #6

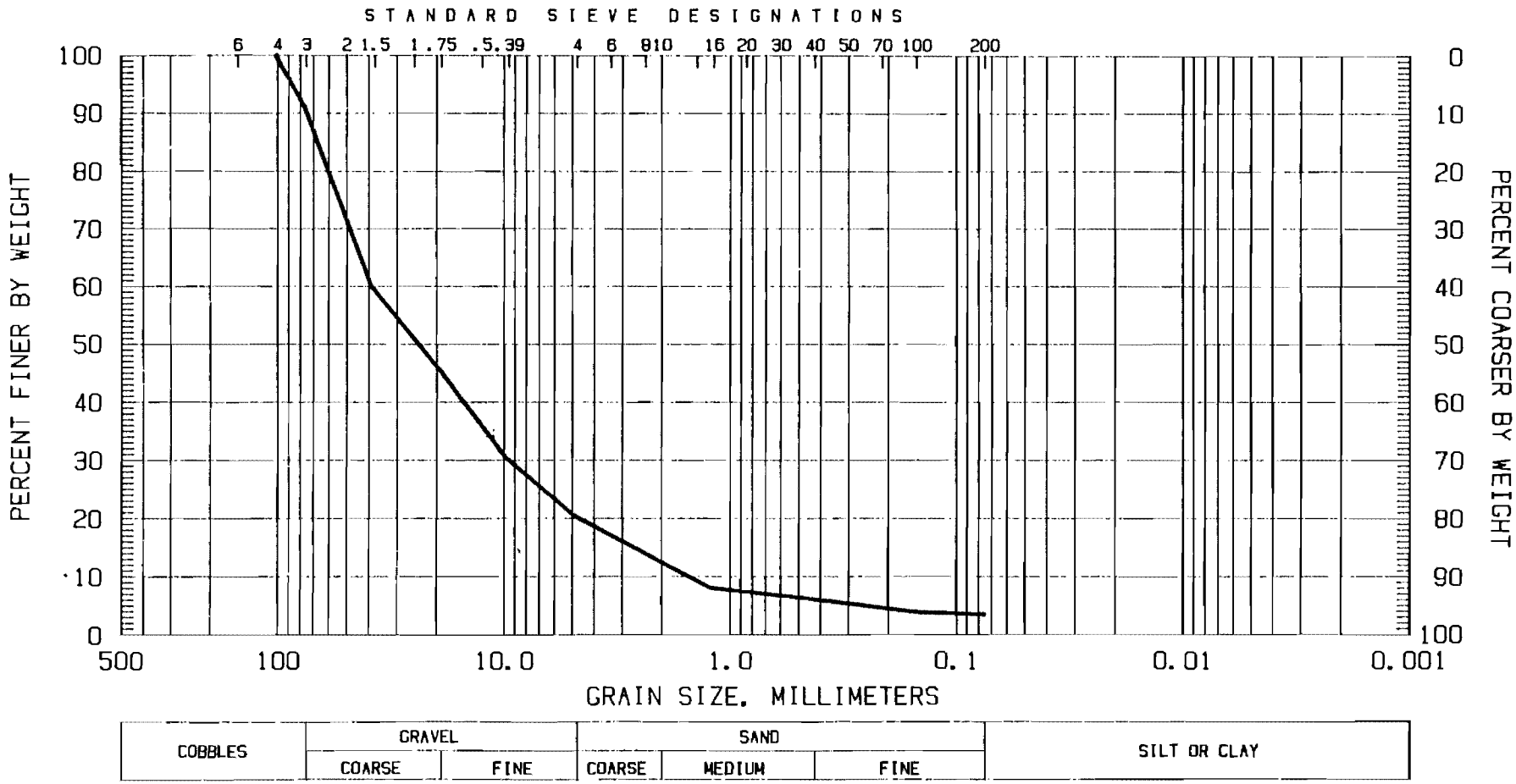
Method: A

Volume of Mold: 0.100 $ft.^3$

Specific Gravity: 1.50

Minimum Index: 57.4 $lbs/ft.^3$

GRAIN SIZE ANALYSIS



PROJECT NO.: 84-3105
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE CORPORATION
OCTOBER 18, 1984
TEST PIT: C7 SAMPLE: S6
DEPTH: N/A FT

COAL SAMPLE C-7/SEAM NO. 6
REMARKS: SPECIFIC GRAVITY=1.50

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Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date January, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample 4762 Study #1 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: Fly Ash Sample No. 4762

Method: A

Volume of Mold: 0.100 Ft^3

Specific Gravity: 2.16

Minimum Index: 48.9 $lbs./Ft^3$

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Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date January, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

Fly Ash Sample No. 4762

Length = 3.00 in. Weight = 0.985 lbs. Specific Gravity = 2.16

Diameter = 2.8 in. Moisture = 28.2 % Total Volume = 0.0107 Ft^3

$Weight_w$ = 0.985 lbs. - 0.768 lbs. = 0.217 lbs.

$Volume_w$ = 0.217 lbs./62.4 lbs./Ft^3 = 0.00348 Ft^3

$Volume_s$ = 0.768 lbs./(62.4)(2.16) = 0.00570 Ft^3

$Volume_a$ = 0.0107 Ft^3 - (0.00348 + 0.00570) = 0.00152 Ft^3

$Volume_v$ = 0.0107 Ft^3 - 0.00570 Ft^3 = 0.005 Ft^3

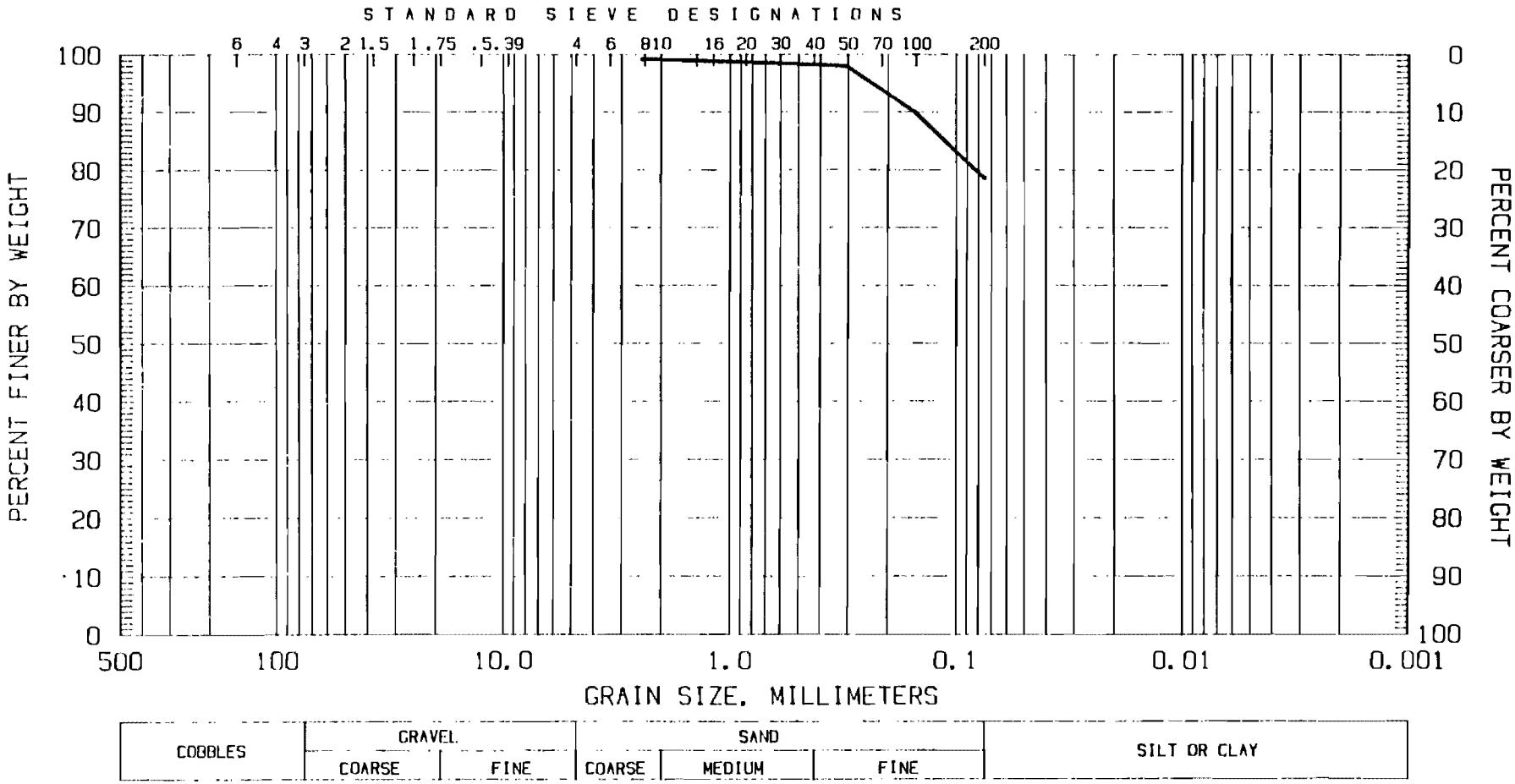
$$e = \frac{0.005}{0.0057} = 0.877$$

$$n = \frac{0.005}{0.0107} = 46.7 \%$$

$$k = 1.1 \times 10^{-5} \text{ cm/sec}$$

NOTE: All permeabilities calculated on samples remolded to 95 ± 1% compaction as determined by the standard Proctor (ASTM D 698-78).

GRAIN SIZE ANALYSIS



PROJECT NO.: 85-3014
UTAH INTERNATIONAL SOILS TESTING
I.T. CORPORATION
JANUARY 28, 1985
TEST PIT: 1 SAMPLE: 2
DEPTH: N/A FT

FLY ASH SAMPLE NO. 4762
NATURAL MOISTURE CONTENT= 24.2 %
REMARKS:

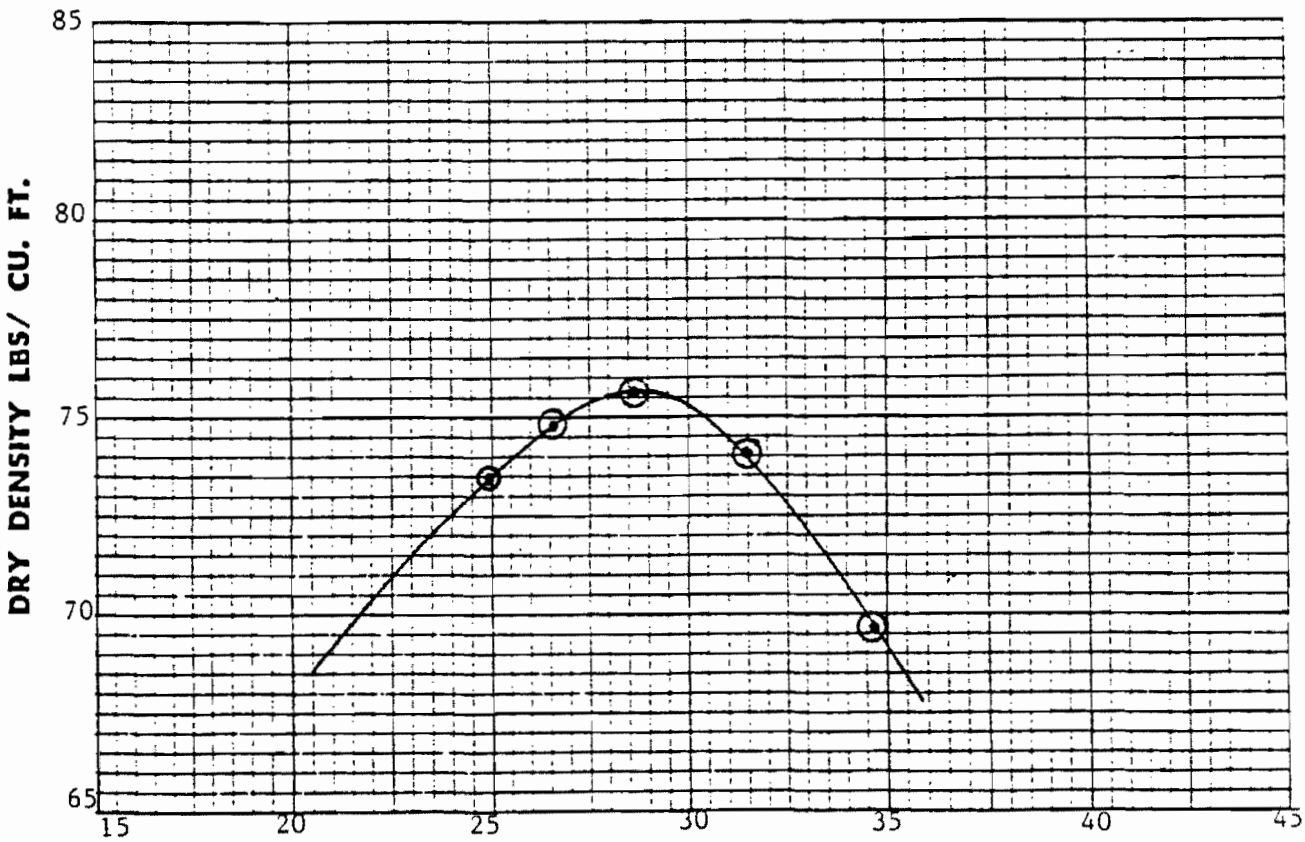
GEOLOGIC ASSOCIATES, INC.

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Knoxville, Tennessee (615)-966-9761

LABORATORY TEST – MOISTURE DENSITY RELATIONSHIP

CLIENT: I. T. Corporation DATE: January, 1985
PROJECT: Utah International Soils Testing
SAMPLE LOCATION: Four Corners Power Plant
SAMPLE DESCRIPTION: Fly ash sample 4762
TEST METHOD: ASTM D 698-78 Method A

MOISTURE DENSITY RELATIONSHIP



OPTIMUM MOISTURE: 28.6 % BY WEIGHT FIELD MOISTURE 24.2 % BY WEIGHT
MAX DRY DENSITY 75.6 LBS/CU. FT.
LAB TEST BY:
REMARKS:

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Franklin, Tennessee 615 794-3596
Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date January, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample 4763 Sludge #2 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: Fly Ash Sample No. 4763

Method: A

Volume of Mold: 0.100 Ft^3

Specific Gravity: 2.21

Minimum Index: 44.7 $lbs./Ft^3$

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Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date January, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

Fly Ash Sample No. 4763

Length = 2.20 in. Weight = 0.661 lbs. Specific Gravity = 2.21

Diameter = 2.8 in. Moisture = 26.2 % Total Volume = 0.0078 Ft^3

$Weight_w$ = 0.661 lbs. - 0.524 lbs. = 0.137 lbs.

$Volume_w$ = 0.137 lbs./62.4 lbs./Ft^3 = 0.0022 Ft^3

$Volume_s$ = 0.524 lbs./(62.4 lbs./Ft^3) (2.21) = 0.0038 Ft^3

$Volume_a$ = 0.0078 Ft^3 - (0.0022 + 0.0038) = 0.0018 Ft^3

$Volume_v$ = 0.0078 Ft^3 - 0.0038 Ft^3 = 0.0040 Ft^3

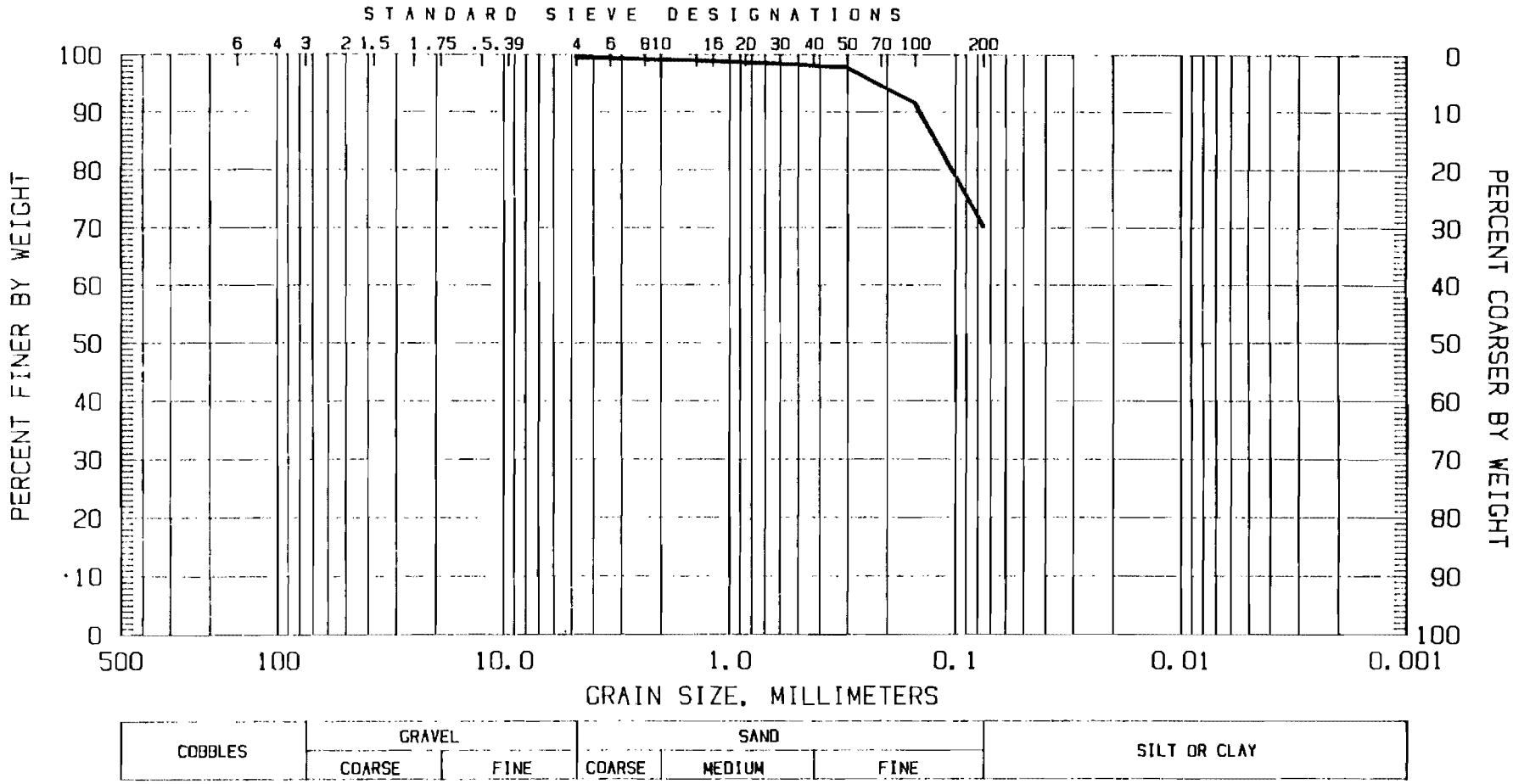
$$e = \frac{0.0040}{0.0038} = 1.053$$

$$n = \frac{0.0040}{0.0078} = 51.3\ \%$$

$$k = 7.6 \times 10^{-6}\ cm/sec$$

NOTE: All permeabilities calculated on samples remolded to 95 ± 1% compaction as determined by the standard Proctor (ASTM D 698-78).

GRAIN SIZE ANALYSIS



PROJECT NO.: 85-3014
UTAH INTERNATIONAL SOILS TESTING
I.T. ENVIROSCIENCE
JANUARY 28, 1985
TEST PIT: 1 SAMPLE: 3
DEPTH: N/A FT

FLY ASH SAMPLE NO. 4763
NATURAL MOISTURE CONTENT= 31.8 %
REMARKS:

GEOLOGIC ASSOCIATES, INC.

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Knoxville, Tennessee (615)-966-9761

LABORATORY TEST — MOISTURE DENSITY RELATIONSHIP

CLIENT: I. T. Corporation DATE: January, 1985

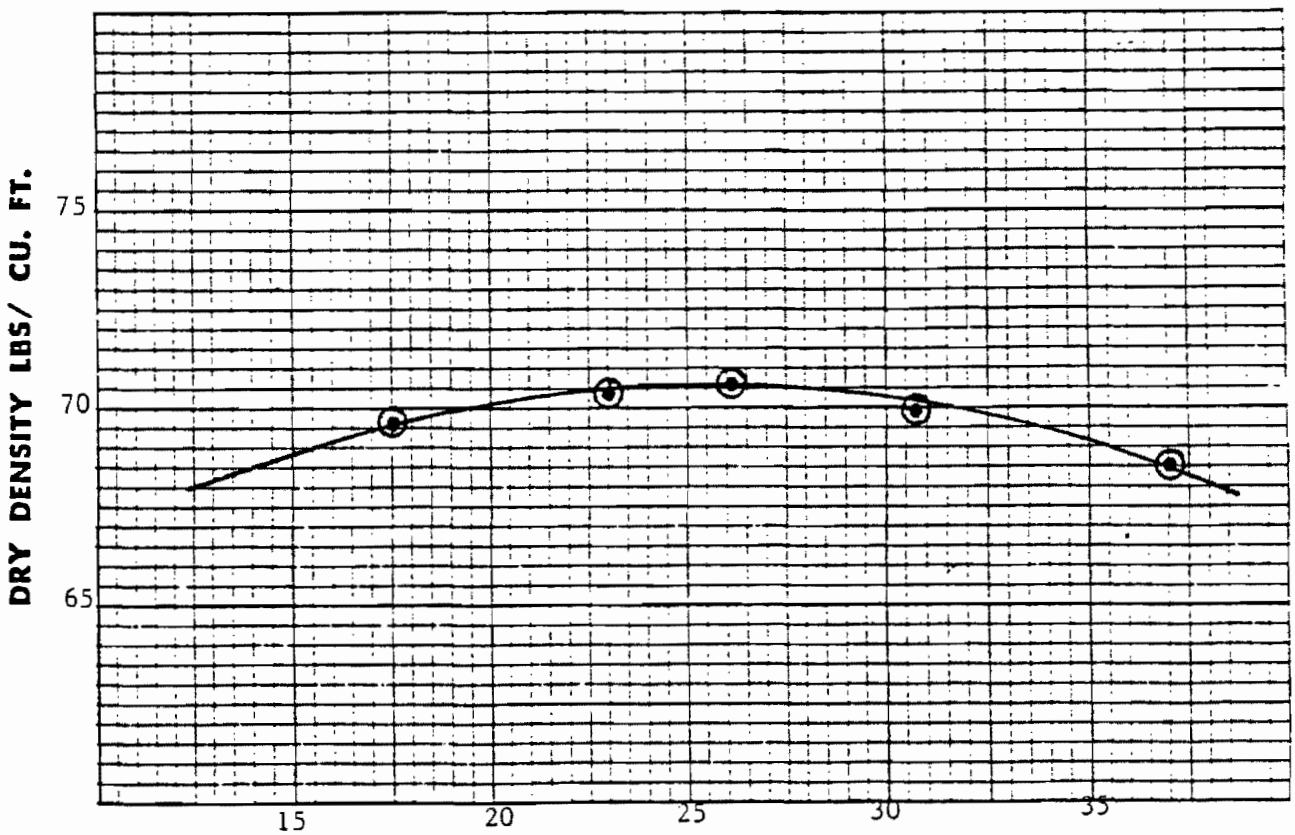
PROJECT: Utah International Soils Testing

SAMPLE LOCATION: Four Corners Power Plant

SAMPLE DESCRIPTION: Fly ash sample 4763

TEST METHOD: ASTM D 698-78 Method A

MOISTURE DENSITY RELATIONSHIP



MOISTURE CONTENT % BY WEIGHT

OPTIMUM MOISTURE: 26.1 % BY WEIGHT FIELD MOISTURE 31.8 % BY WEIGHT

MAX DRY DENSITY 70.6 LBS/CU. FT.

LAB TEST BY:

REMARKS:

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Franklin, Tennessee 615 794-3596
Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date January, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample 4764 Sludge #3 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: Fly Ash Sample No. 4764

Method: A

Volume of Mold: 0.100 Ft^3

Specific Gravity: 2.22

Minimum Index: 50.6 $lbs./Ft^3$

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Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date January, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

Fly Ash Sample No. 4764

Length = 3.13 in. Weight = 0.981 lbs. Specific Gravity = 2.22

Diameter = 2.8 in. Moisture = 23.1 % Total Volume = 0.0112 Ft^3

$Weight_w$ = 0.981 lbs. - 0.797 lbs. = 0.184 lbs.

$Volume_w$ = 0.184 lbs./62.4 lbs./Ft^3 = 0.00295 Ft^3

$Volume_s$ = 0.797 lbs./(62.4 lbs./Ft^3) (2.22) = 0.00575 Ft^3

$Volume_a$ = 0.0112 Ft^3 - (0.00295 + 0.00575) = 0.0025 Ft^3

$Volume_v$ = 0.0112 Ft^3 - 0.00575 Ft^3 = 0.00545 Ft^3

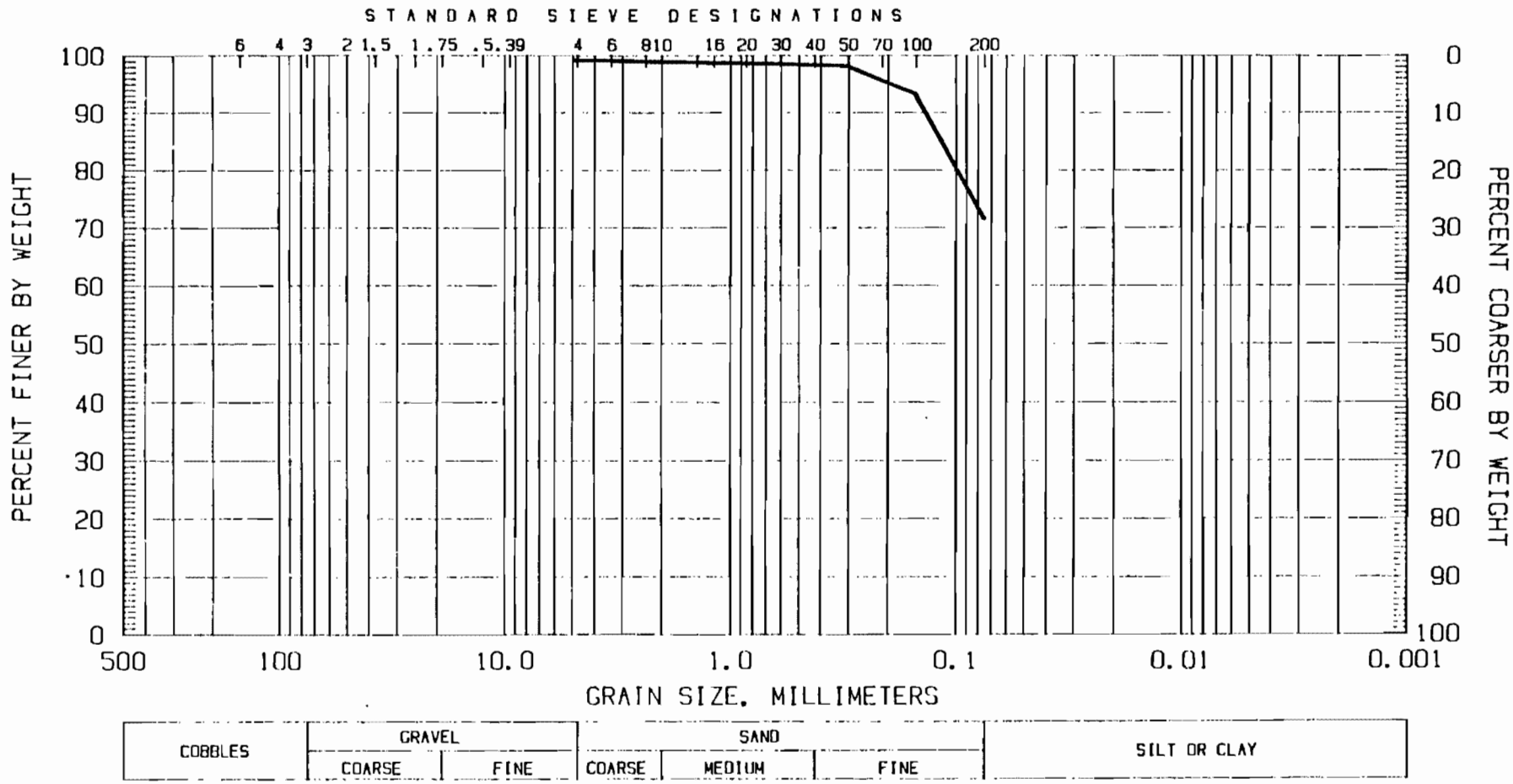
$$e = \frac{0.00545}{0.00575} = 0.948$$

$$n = \frac{0.00545}{0.0112} = 48.7 \%$$

$$k = 9.8 \times 10^{-6} \text{ cm/sec}$$

NOTE: All permeabilities calculated on samples remolded to 95 ± 1% compaction as determined by the standard Proctor (ASTM D 698-78).

GRAIN SIZE ANALYSIS



PROJECT NO.: 85-3014
UTAH INTERNATIONAL SOILS TESTING
I.T. CORPORATION
JANUARY 28, 1985
TEST PIT: 1 SAMPLE: 4
DEPTH: N/A FT

FLY ASH SAMPLE NO. 4764
NATURAL MOISTURE CONTENT= 34.4 %
REMARKS:

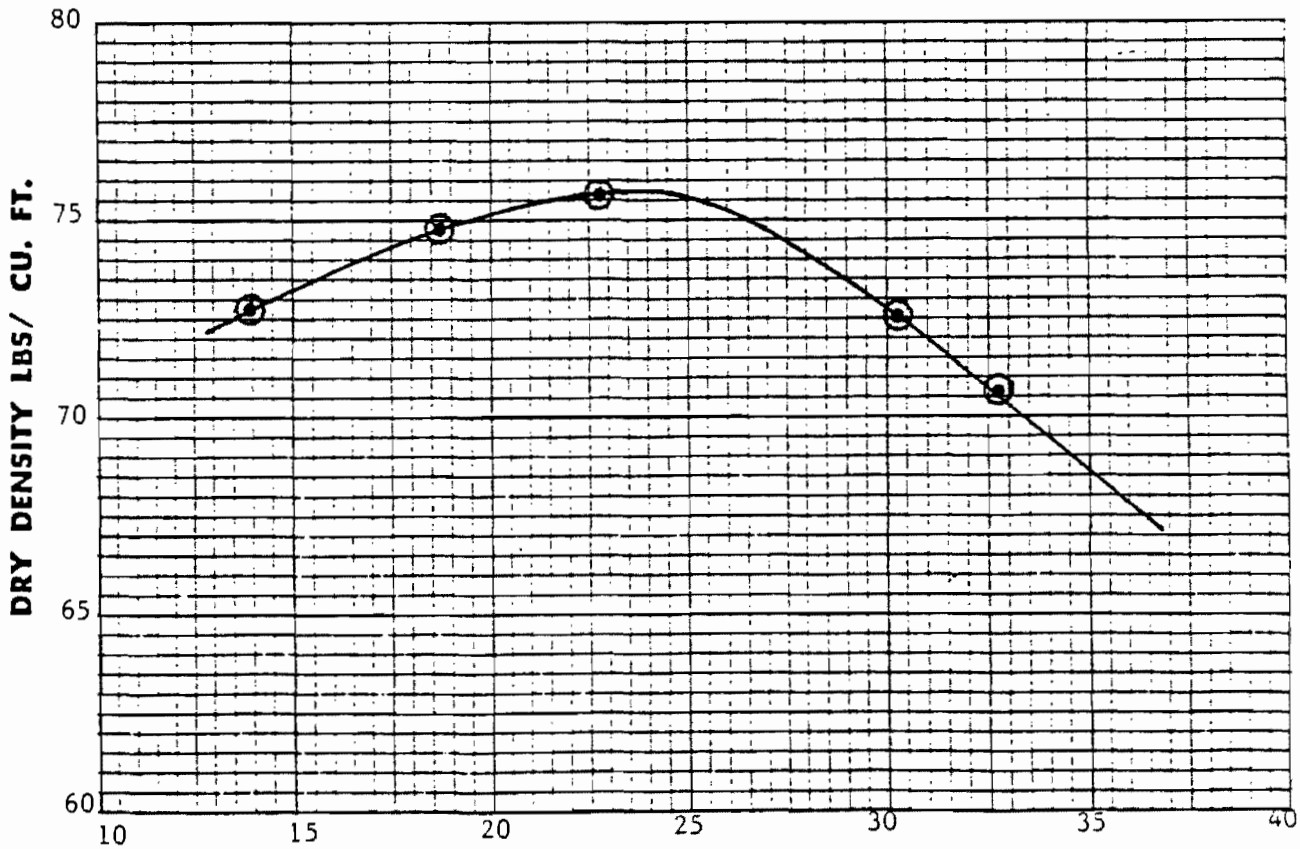
GEOLOGIC ASSOCIATES, INC.

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Knoxville, Tennessee (615)-966-9761

LABORATORY TEST — MOISTURE DENSITY RELATIONSHIP

CLIENT: I.T. Corporation DATE: January, 1985
PROJECT: Utah International Soils Testing
SAMPLE LOCATION: Four Corners Power Plant
SAMPLE DESCRIPTION: Fly ash sample 4764
TEST METHOD: ASTM D 698-78 Method A

MOISTURE DENSITY RELATIONSHIP



OPTIMUM MOISTURE: 22.8 % BY WEIGHT FIELD MOISTURE 34.4 % BY WEIGHT
MAX DRY DENSITY 75.5 LBS/CU. FT.
LAB TEST BY:
REMARKS:

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Franklin, Tennessee 615 794-3596
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Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date January, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample 4765 sludge #4 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: Fly Ash Sample No. 4765

Method: A

Volume of Mold: 0.100 Ft^3

Specific Gravity: 2.3

Minimum Index: 51.1 $lbs./Ft^3$

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Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date January, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

Fly Ash Sample No. 4765

Length = 3.25 in. Weight = 1.069 lbs. Specific Gravity = 2.31

Diameter = 2.8 in. Moisture = 28.3 % Total Volume = 0.01158 Ft^3

$Weight_w$ = 1.069 lbs. - 0.833 lbs. = 0.236 lbs.

$Volume_w$ = 0.236 lbs./ 62.4 lbs./Ft^3 = 0.00378 Ft^3

$Volume_s$ = 0.833 lbs./(62.4 lbs./Ft^3) (2.3) = 0.0058 Ft^3

$Volume_a$ = 0.01158 Ft^3 - (0.00378 + 0.0058) = 0.001996 Ft^3

$Volume_v$ = 0.01158 Ft^3 - 0.0058 Ft^3 = 0.00578 Ft^3

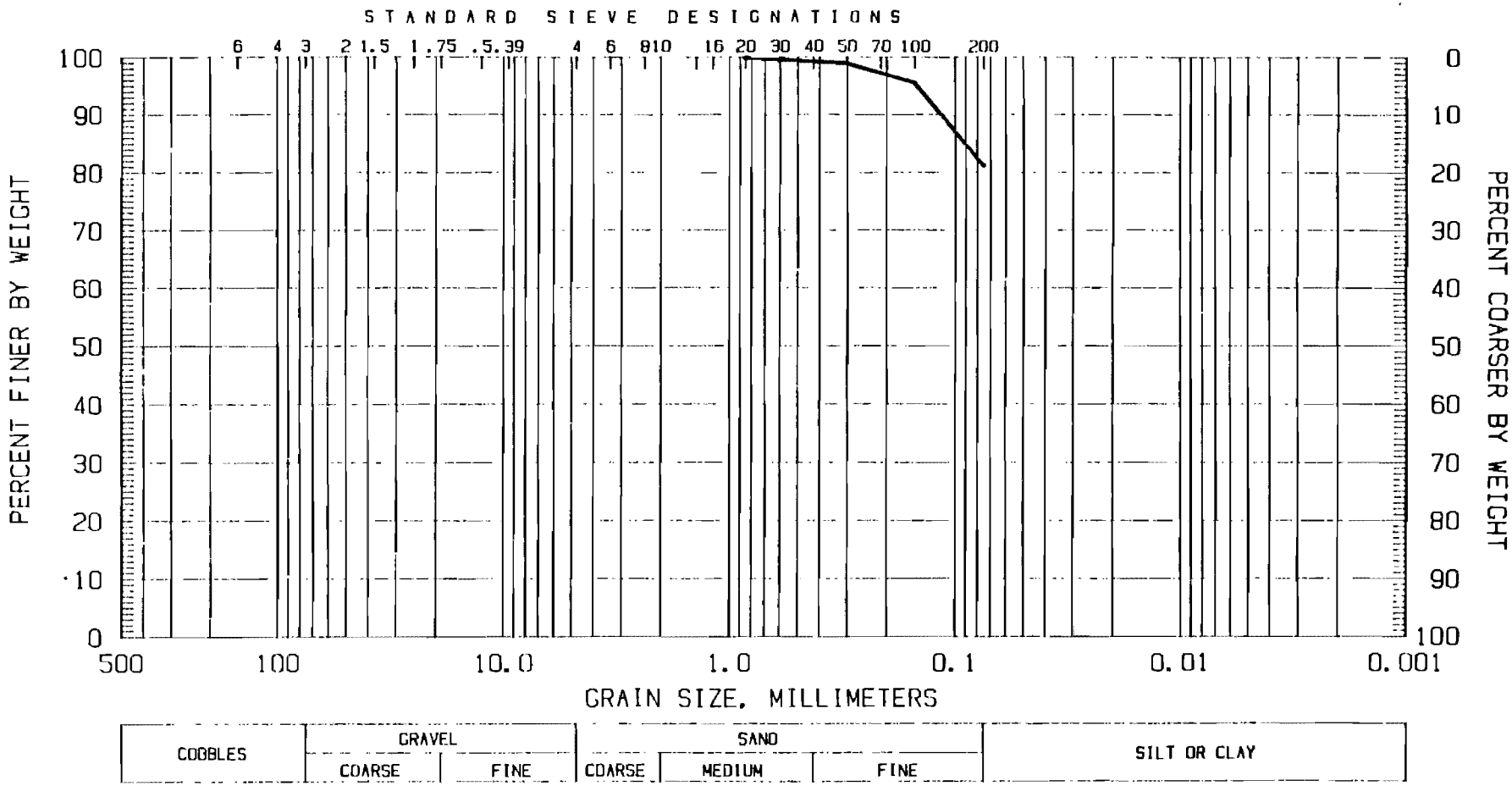
$$e = \frac{0.00578}{0.0058} = 0.997$$

$$n = \frac{0.00578}{0.01158} = 49.9 \quad \%$$

$$k = 8.3 \times 10^{-6} \text{ cm/sec}$$

NOTE: All permeabilities calculated on samples remolded to 95 ± 1% compaction as determined by the standard Proctor (ASTM D 698-78).

GRAIN SIZE ANALYSIS



PROJECT NO.: 85-3014
UTAH INTERNATIONAL SOILS TESTING
I.T. CORPORATION
JANUARY 28, 1985
TEST PIT: 1 SAMPLE: 5
DEPTH: N/A FT

FLY ASH SAMPLE NO. 4765
NATURAL MOISTURE CONTENT= 29.3 %
REMARKS:

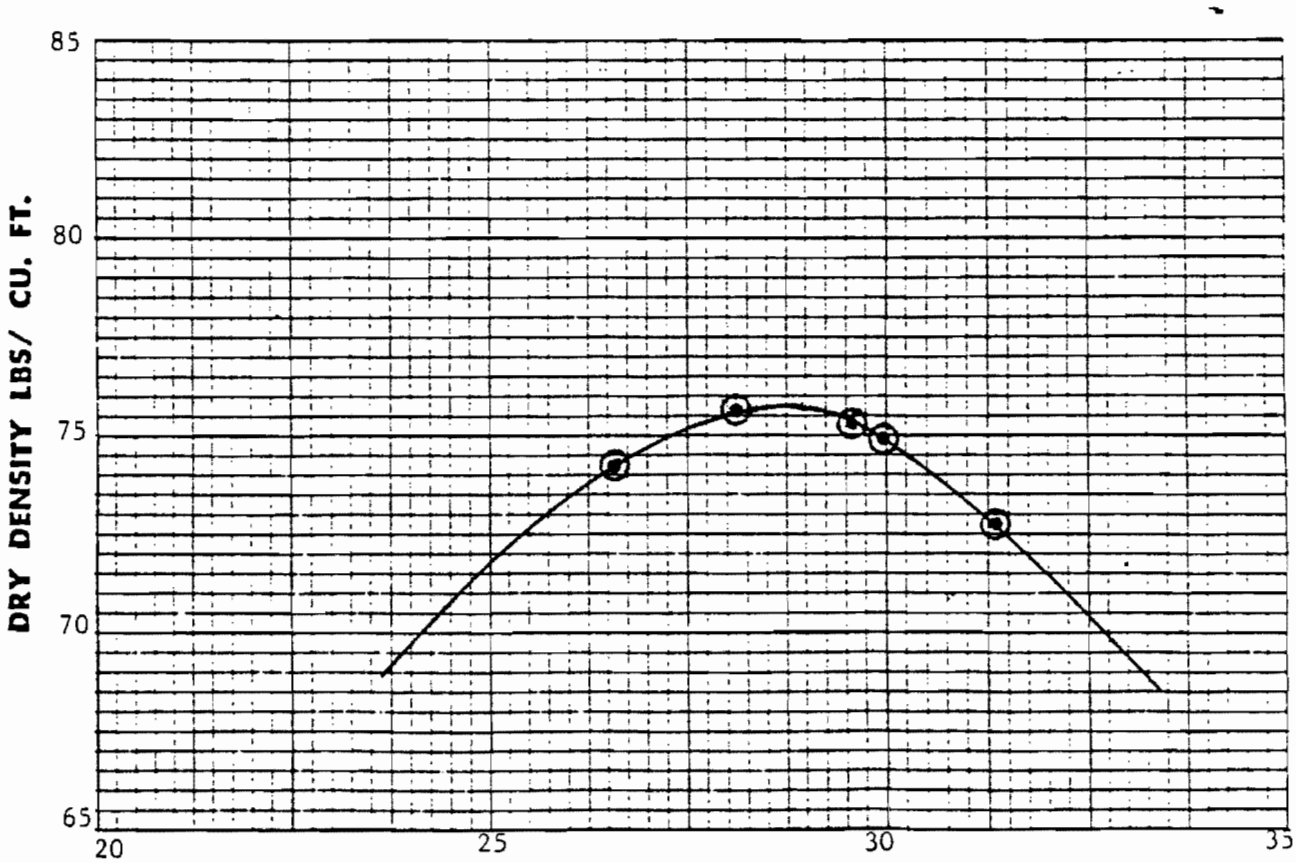
GEOLOGIC ASSOCIATES, INC.

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Knoxville, Tennessee (615)-966-9761

LABORATORY TEST — MOISTURE DENSITY RELATIONSHIP

CLIENT: I. T. Corporation DATE: January, 1985
PROJECT: Utah International Soils Testing 85-3014
SAMPLE LOCATION: Four Corners Power Plant
SAMPLE DESCRIPTION: Fly ash sample 4765
TEST METHOD: ASTM D 698-78 Method A

MOISTURE DENSITY RELATIONSHIP



OPTIMUM MOISTURE: 28.1 % BY WEIGHT FIELD MOISTURE 29.3 % BY WEIGHT
MAX DRY DENSITY 75.6 LBS/CU. FT.
LAB TEST BY:
REMARKS:

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Franklin, Tennessee 615 794-3596
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Kingsport, Tennessee 615 229-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date January, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample 4770 Sludge as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: Fly Ash Sample No. 4770

Method: A

Volume of Mold: 0.100 Ft^3

Specific Gravity: 2.3

Minimum Index: 48.2 $lbs./Ft^3$

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Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date January, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

Fly Ash Sample No. 4770

Length = 3.73 in. Weight = 1.205 lbs. Specific Gravity = 2.3

Diameter = 2.8 in. Moisture = 31.6 % Total Volume = 0.01329 Ft^3

$Weight_w$ = 1.205 lbs. - 0.916 lbs. = 0.289 lbs.

$Volume_w$ = 0.289 lbs./62.4 lbs./Ft^3 = 0.00464 Ft^3

$Volume_s$ = 0.916 lbs./(62.4 lbs./Ft^3) (2.3) = 0.00638 Ft^3

$Volume_a$ = 0.01329 Ft^3 - (0.00464 + 0.00638) = 0.00227 Ft^3

$Volume_v$ = 0.01329 Ft^3 - 0.00638 Ft^3 = 0.00691 Ft^3

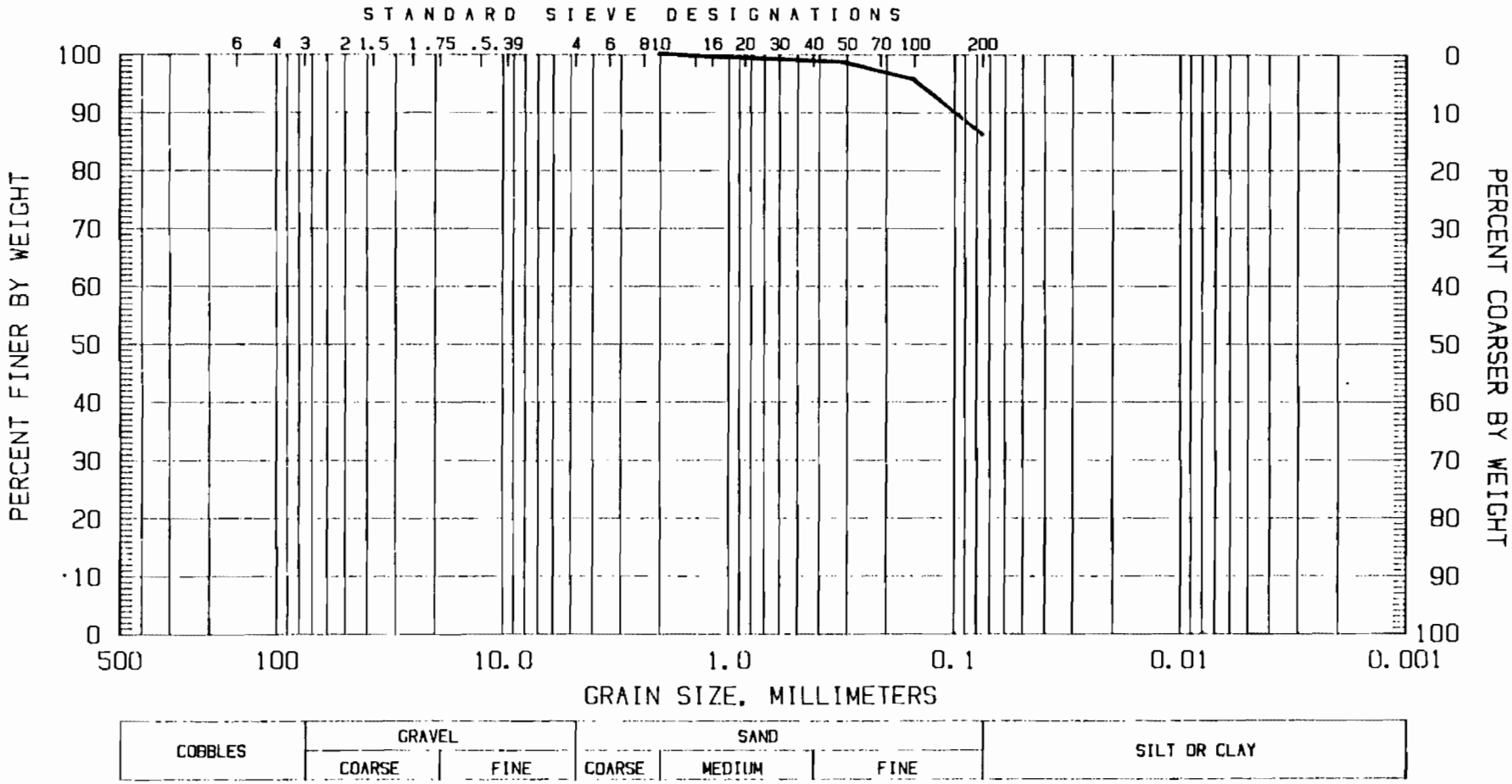
$$e = \frac{0.00691}{0.00638} = 1.083$$

$$n = \frac{0.00691}{0.01329} = 52.0 \ \%$$

$$k = 8.2 \times 10^{-6} \text{ cm/sec}$$

NOTE: All permeabilities calculated on samples remolded to 95 ± 1% compaction as determined by the standard Proctor (ASTM D 698-78).

GRAIN SIZE ANALYSIS



PROJECT NO.: 85-3014
UTAH INTERNATIONAL SOILS TESTING
I.T. CORPORATION
JANUARY 28, 1985
TEST PIT: 1 SAMPLE: 1
DEPTH: N/A FT

FLY ASH SAMPLE NO. 4770
NATURAL MOISTURE CONTENT= 37.4 %
REMARKS:

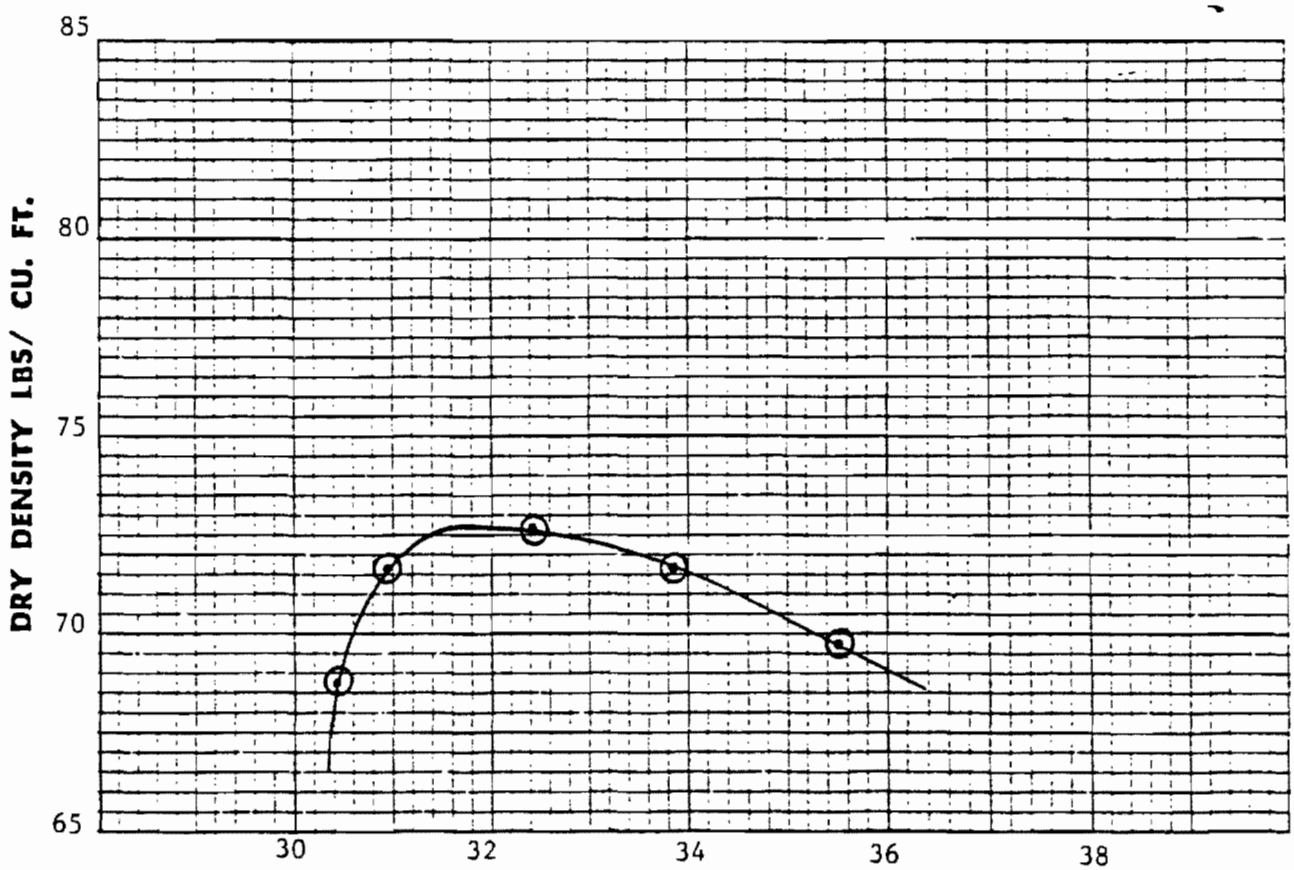
GEOLOGIC ASSOCIATES, INC.

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Knoxville, Tennessee (615)-966-9761

LABORATORY TEST – MOISTURE DENSITY RELATIONSHIP

CLIENT: I. T. Corporation DATE: January, 1985
PROJECT: Utah International Soils Testing
SAMPLE LOCATION: Four Corners Power Plant
SAMPLE DESCRIPTION: Fly Ash Sample No. 4770
TEST METHOD: ASTM D 698-78 Method A

MOISTURE DENSITY RELATIONSHIP



MOISTURE CONTENT % BY WEIGHT

OPTIMUM MOISTURE: 32.4 % BY WEIGHT FIELD MOISTURE 37.4 % BY WEIGHT
MAX DRY DENSITY 72.7 LBS/CU. FT.
LAB TEST BY:
REMARKS:

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Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date January, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample 4774 Study #6 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: Fly Ash Sample No. 4774

Method: A

Volume of Mold: 0.100 Ft^3

Specific Gravity: 2.21

Minimum Index: 50.3 $lbs./Ft^3$

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Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date January, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

Fly Ash Sample No. 4774

Length = 3.50 in. Weight = 1.11 lbs. Specific Gravity = 2.21

Diameter = 2.8 in. Moisture = 25.2 % Total Volume = 0.01247 Ft^3

$Weight_w$ = 1.11 lbs. - 0.0887 lbs. = 0.223 lbs.

$Volume_w$ = 0.223 lbs./62.4 lbs./ft^3 = 0.00358 ft^3

$Volume_s$ = 0.887 lbs./(62.4) (2.21) = 0.00643 ft^3

$Volume_a$ = 0.01247 ft^3 - (0.00358 + 0.00643) = 0.00246 ft^3

$Volume_v$ = 0.01247 ft^3 - 0.00643 ft^3 = 0.00604 ft^3

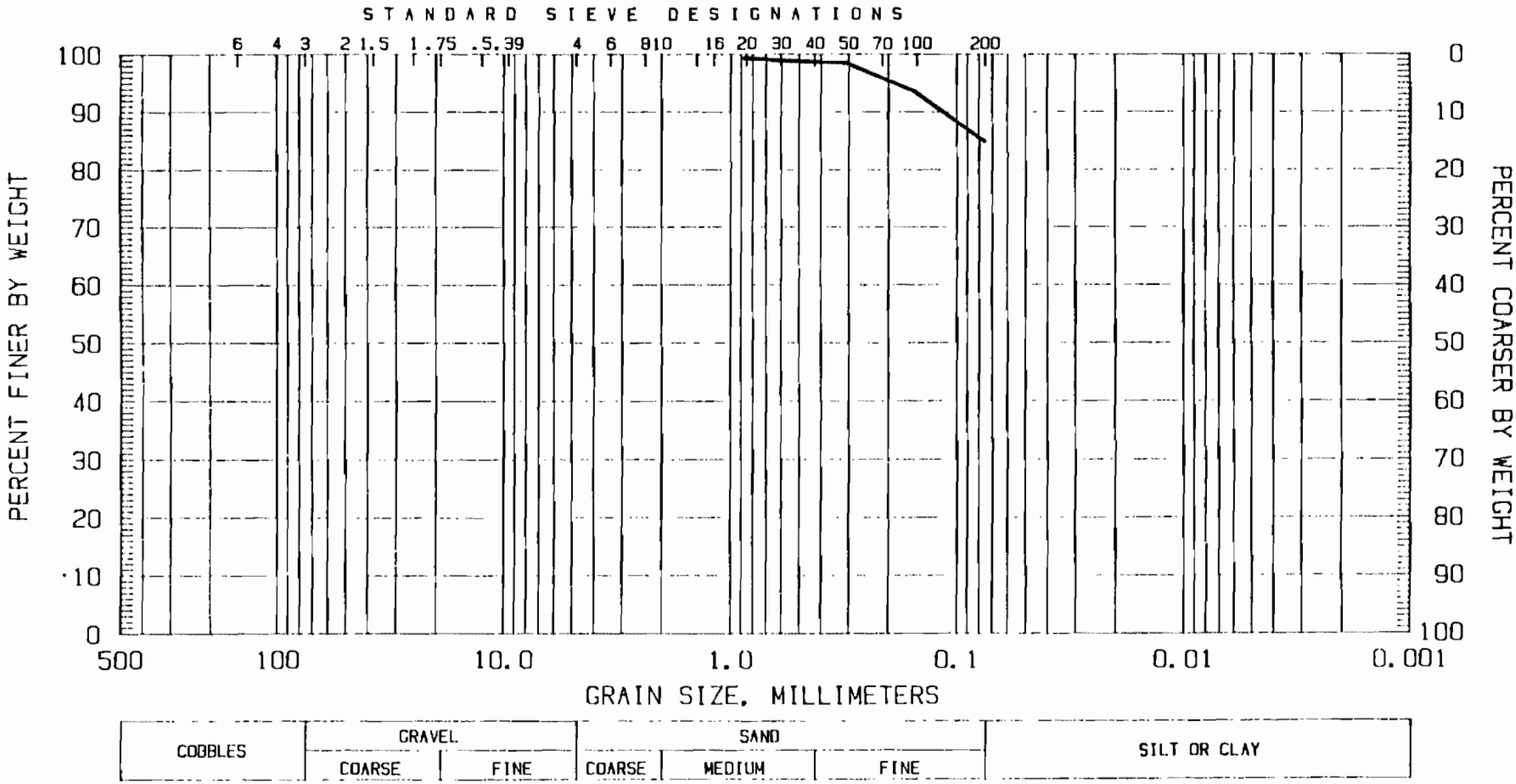
$$e = \frac{0.00604}{0.00643} = 0.939$$

$$n = \frac{0.00604}{0.01247} = 48.4 \quad \%$$

$$k = 7.3 \times 10^{-6} \text{ cm/sec}$$

NOTE: All permeabilities calculated on samples remolded to 95 ± 1% compaction as determined by the standard Proctor (ASTM D 698-78).

GRAIN SIZE ANALYSIS



PROJECT NO.: 85-3014
UTAH INTERNATIONAL SOILS TESTING
I.T. CORPORATION
JANUARY 28, 1985
TEST PIT: 1 SAMPLE: 6
DEPTH: N/A FT

FLY ASH SAMPLE NO. 4774
NATURAL MOISTURE CONTENT= 21.4 %
REMARKS:

GEOLOGIC ASSOCIATES, INC.

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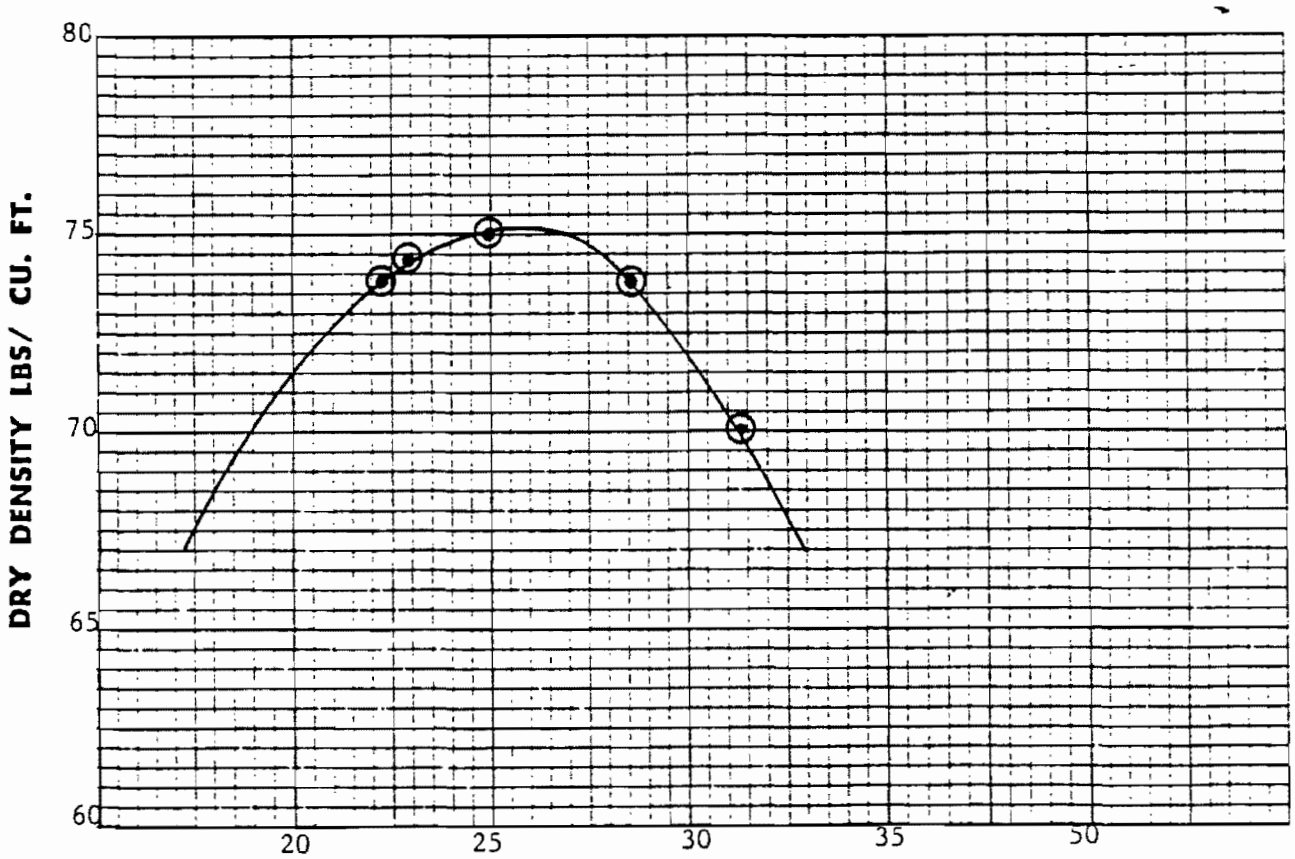
LABORATORY DIVISION
Knoxville, Tennessee (615)-966-9761

LABORATORY TEST — MOISTURE DENSITY RELATIONSHIP

CLIENT: I. T. Corporation DATE: January, 1985
PROJECT: Utah International Soils Testing
SAMPLE LOCATION: Four Corners Power Plant
SAMPLE DESCRIPTION: Fly ash sample 4774
TEST METHOD: ASTM D 698-78 Method A

MOISTURE DENSITY RELATIONSHIP



OPTIMUM MOISTURE: 24.9 % BY WEIGHT FIELD MOISTURE 21.4 % BY WEIGHT
MAX DRY DENSITY 74.9 LBS/CU. FT.
LAB TEST BY:
REMARKS:

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Kingsport, Tennessee 615 229-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date February, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample 4785 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: Fly Ash Sample No. 4785 - Sludge # 7

Method: A

Volume of Mold: 0.100 Ft^3

Specific Gravity: 2.11

Minimum Index: 51.4 lbs/Ft^3

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Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date February, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

Fly Ash Sample No. 4785

Length = 3.50 in. Weight = 1.105 lbs. Specific Gravity = 2.11

Diameter = 2.8 in. Moisture = 28.5 % Total Volume = 0.01247 Ft^3

$Weight_w$ = 1.105 lbs.-0.860 lbs. = 0.245 lbs.

$Volume_w$ = 0.245 lbs./62.4 lbs./Ft^3 = 0.00393 Ft^3

$Volume_s$ = 0.860 lbs./(2.11) (62.4 lbs/Ft^3) = 0.00653 Ft^3

$Volume_a$ = 0.01247 Ft^3 - (0.00393 + 0.00653) = 0.00201 Ft^3

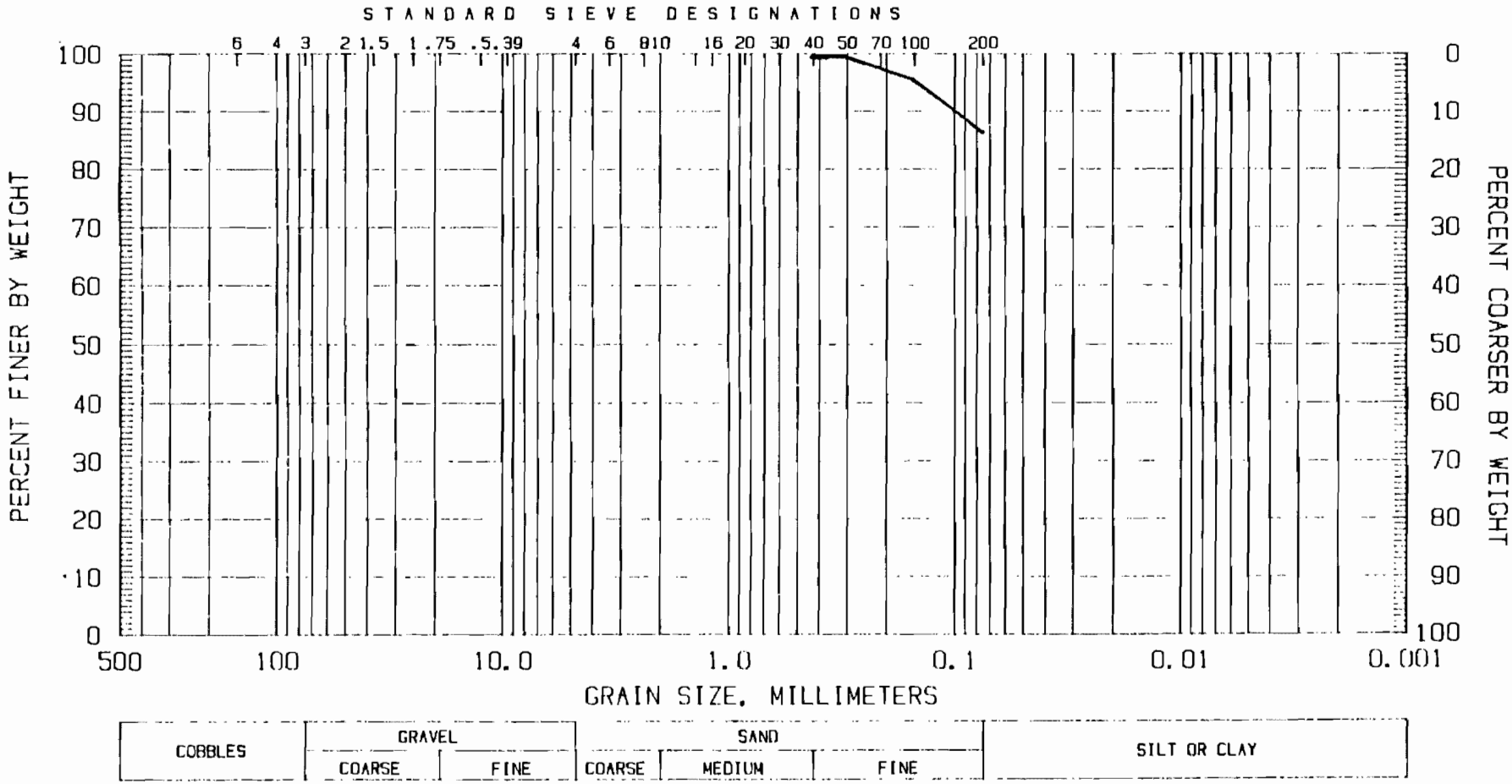
$Volume_v$ = 0.01247 Ft^3 - 0.00653 Ft^3 = 0.00594

$$e = \frac{0.00594}{0.00653} = 0.9096$$

$$n = \frac{0.00594}{0.01247} = 47.6 \%$$

$$k = 4.9 \times 10^{-6} \text{ cm/sec}$$

GRAIN SIZE ANALYSIS



PROJECT NO.: 85-3014K
UTAH INTERNATIONAL SOILS TESTING
I.T. CORPORATION
FEBRUARY 27, 1985
TEST PIT: 2 SAMPLE: 1
DEPTH: N/A FT

FLY ASH SAMPLE NO. 4785
NATURAL MOISTURE CONTENT= 20.1 %
REMARKS:

GEOLOGIC ASSOCIATES, INC.

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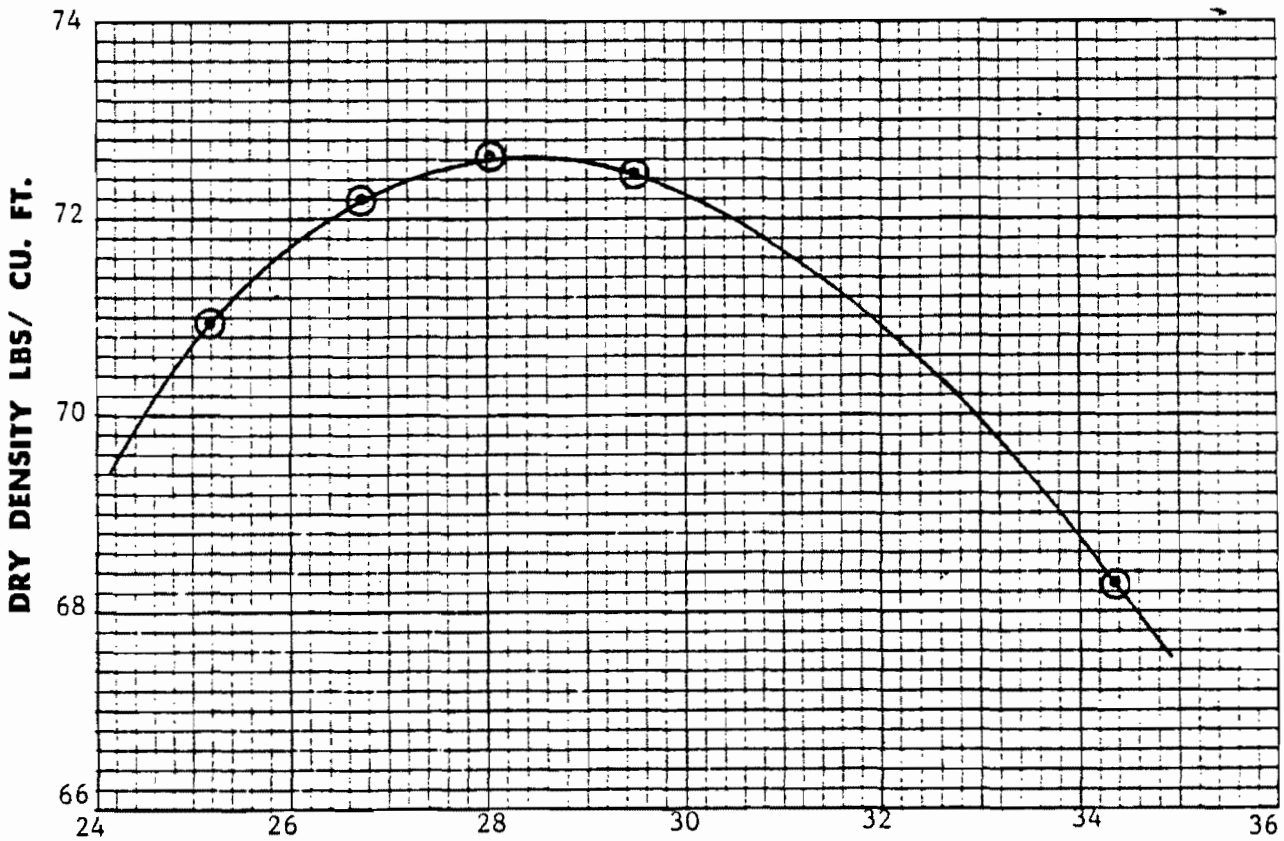
LABORATORY DIVISION
Knoxville, Tennessee (615)-966-9761

LABORATORY TEST — MOISTURE DENSITY RELATIONSHIP

CLIENT: I. T. Corporation DATE: February, 1985
PROJECT: Utah International Soils Testing 85-3014
SAMPLE LOCATION: Four Corners Power Plant
SAMPLE DESCRIPTION: Fly Ash Sample No. 4785
TEST METHOD: ASTM D698-78 Method A

MOISTURE DENSITY RELATIONSHIP



OPTIMUM MOISTURE: 28.2 % BY WEIGHT FIELD MOISTURE 20.1 % BY WEIGHT
MAX DRY DENSITY 72.7 LBS/CU. FT.
LAB TEST BY:
REMARKS:

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Franklin, Tennessee 615 794-3576
Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 229-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date February, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample 4786 -Sheet #8 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: Fly Ash Sample No. 4786

Method: A

Volume of Mold: 0.100 Ft^3

Specific Gravity: 2.12

Minimum Index: 53.1 lbs./Ft^3

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Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date February, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

Fly Ash Sample No. 4786

Length = 3.44 in. Weight = 1.142 lbs. Specific Gravity = 2.12

Diameter = 2.8 in. Moisture = 22.9 % Total Volume = 0.01225 Ft^3

$Weight_w$ = 1.142 lbs.-0.929 lbs. = 0.213 lbs.

$Volume_w$ = 0.213 lbs./62.4 lbs./Ft^3 = 0.00341 Ft^3

$Volume_s$ = 0.929 lbs./(2.12)(62.4 lbs./Ft^3) = 0.00702 Ft^3

$Volume_a$ = 0.01225 Ft^3-(0.00341 + 0.00702) = 0.00182 Ft^3

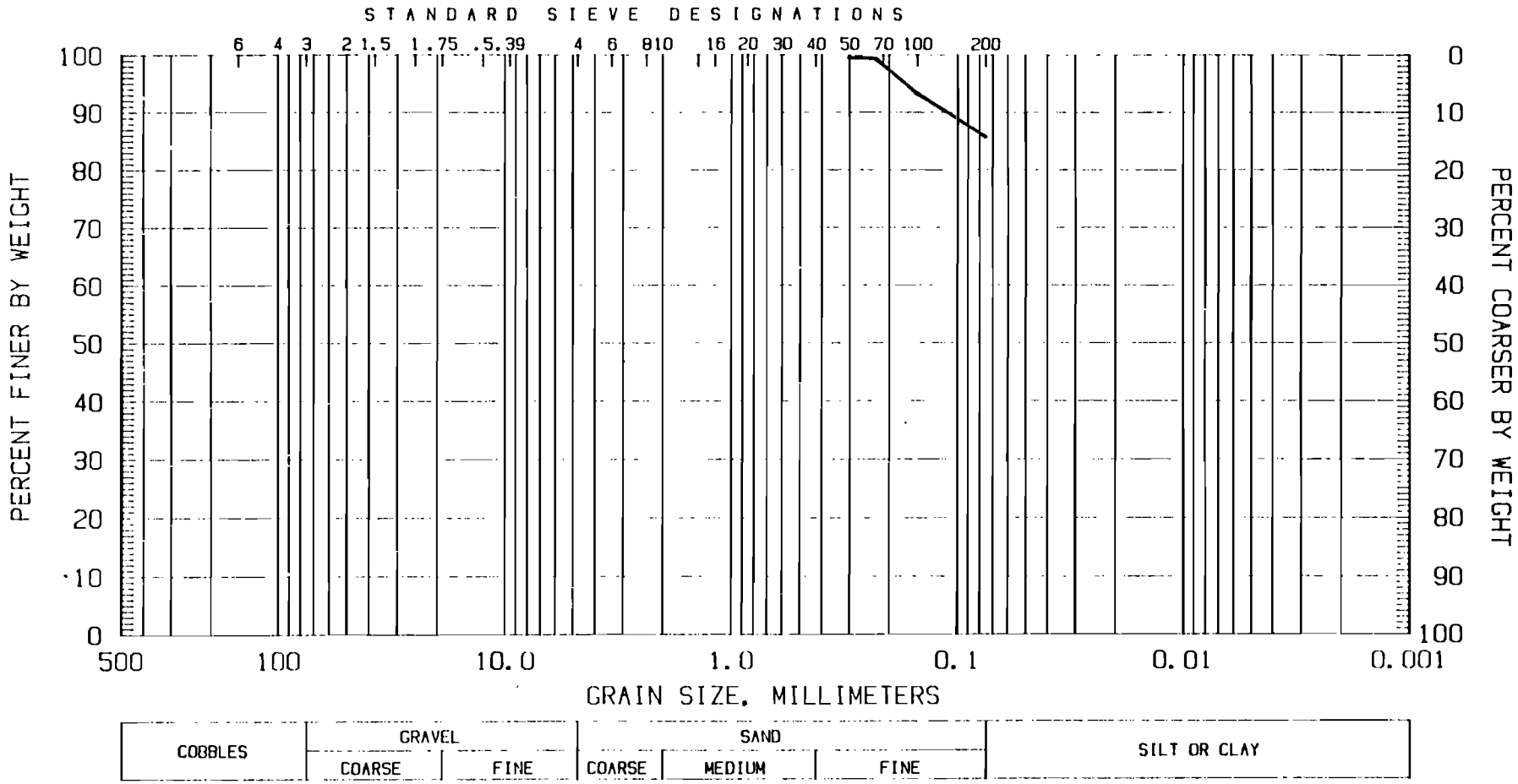
$Volume_v$ = 0.01225 Ft^3 - 0.00702 Ft^3 = 0.00523 Ft^3

$$e = \frac{0.00523}{0.00702} = 0.745$$

$$n = \frac{0.00523}{0.01225} = 42.7\ \%$$

$$k = 4.9 \times 10^{-6}\ cm/sec$$

GRAIN SIZE ANALYSIS



PROJECT NO.: 85-3014K
UTAH INTERNATIONAL SOILS TESTING
I.T. CORPORATION
FEBRUARY 27, 1985
TEST PIT: 2 SAMPLE: 2
DEPTH: N/A FT

FLY ASH SAMPLE NO. 4786
NATURAL MOISTURE CONTENT= 31.5 %
REMARKS:

GEOLOGIC ASSOCIATES, INC.

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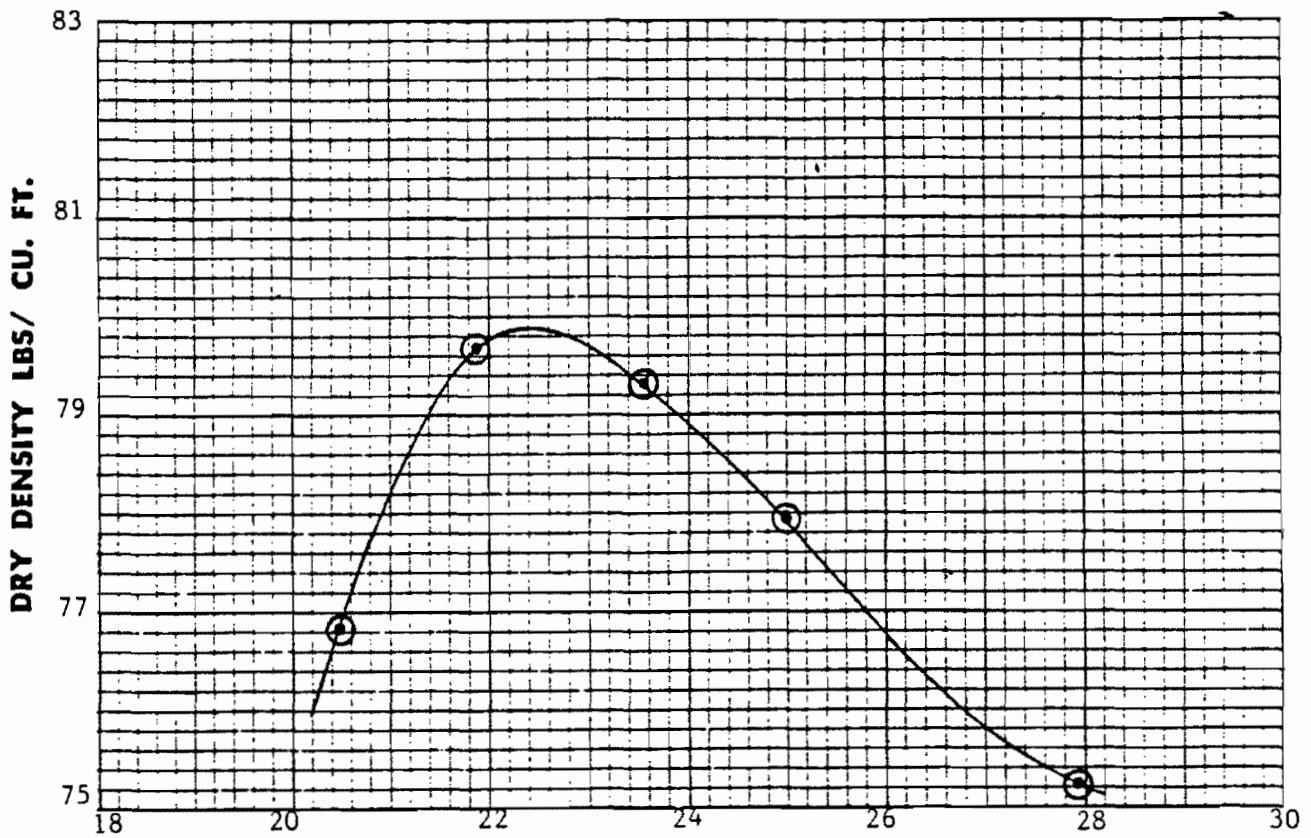
LABORATORY DIVISION
Knoxville, Tennessee (615)-966-9761

LABORATORY TEST — MOISTURE DENSITY RELATIONSHIP

CLIENT: I. T. Corporation DATE: February, 1985
PROJECT: Utah International Soils Testing 85-3014
SAMPLE LOCATION: Four Corners Power Plant
SAMPLE DESCRIPTION: Fly Ash Sample No. 4786
TEST METHOD: ASTM D698-78 Method A

MOISTURE DENSITY RELATIONSHIP



OPTIMUM MOISTURE: 22.5 % BY WEIGHT FIELD MOISTURE 31.5 % BY WEIGHT
MAX DRY DENSITY 79.9 LBS/CU. FT.
LAB TEST BY:
REMARKS:

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Franklin, Tennessee 615 794-3596
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Kingsport, Tennessee 615 227-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date February, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample 4789 Study # 0 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: Fly Ash Sample No. 4789

Method: A

Volume of Mold: 0.100 Ft^3

Specific Gravity: 2.22

Minimum Index: 56.6 $lbs./Ft^3$

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Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date February, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

Fly Ash Sample No. 4789

Length = 3.59 in. Weight = 1.190 lbs. Specific Gravity = 2.22

Diameter = 2.8 in. Moisture = 28.3 % Total Volume = 0.01279 Ft^3

$Weight_w$ = 1.19 lbs. - 0.928 lbs. = 0.262 lbs.

$Volume_w$ = 0.262 lbs./62.4 lbs./cu. ft^3 = 0.0042 cu. ft^3

$Volume_s$ = 0.928 lbs./(2.22) (62.4 lbs./cu. ft^3) = 0.0067 cu. ft^3

$Volume_a$ = 0.01279 Ft^3 (0.0042 + 0.0067) = 0.00189 Ft^3

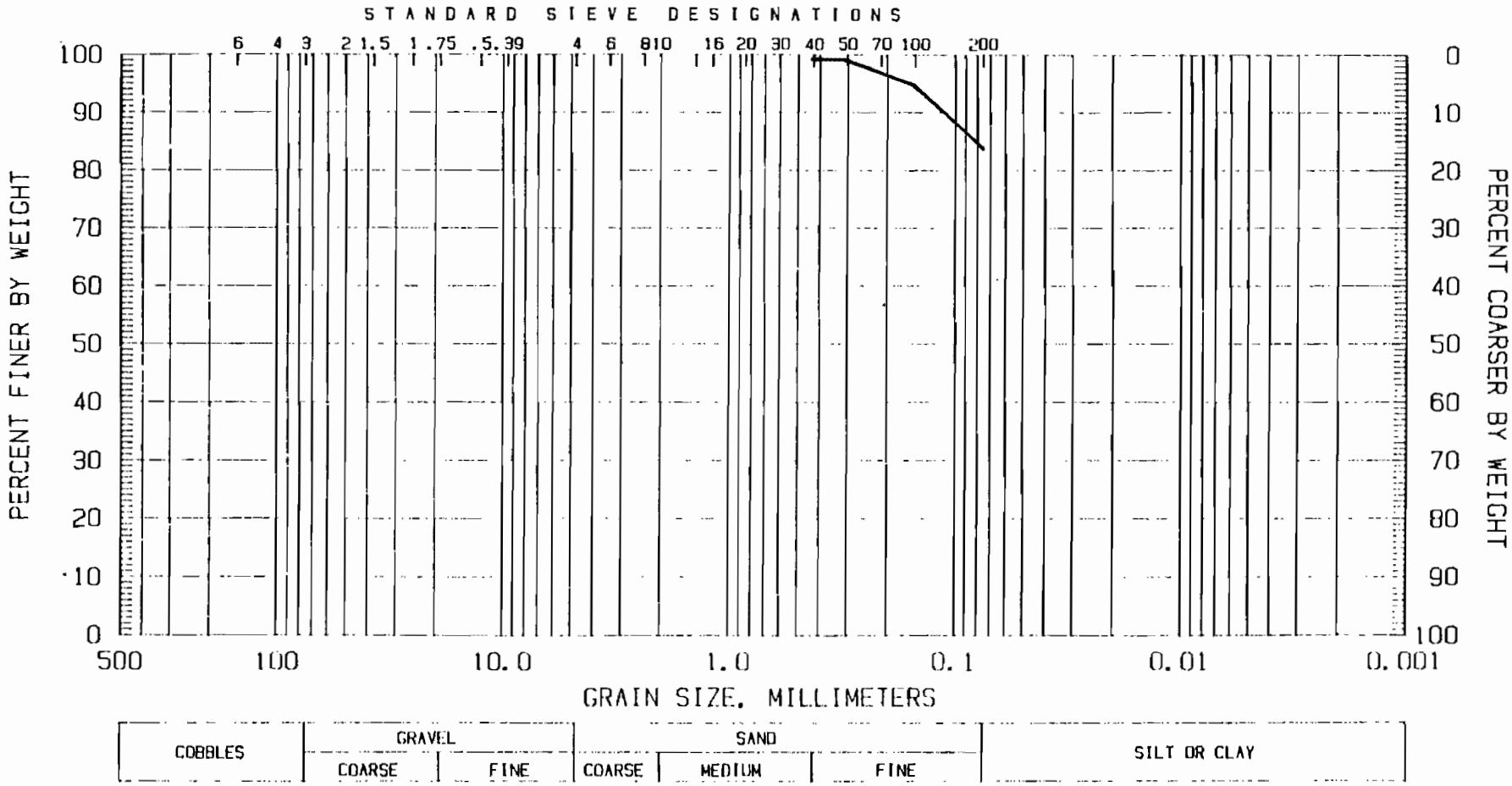
$Volume_v$ = 0.01279 Ft^3 - 0.0067 Ft^3 = 0.00609 Ft^3

$$e = \frac{0.00609}{0.00670} = 0.909$$

$$n = \frac{0.00609}{0.01279} = 47.6\%$$

$$k = 4.6 \times 10^{-6} \text{ cm/sec}$$

GRAIN SIZE ANALYSIS



PROJECT NO.: 85-3014K
UTAH INTERNATIONAL SOILS TESTING
I.T. CORPORATION
FEBRUARY 27, 1985
TEST PIT: 2 SAMPLE: 3
DEPTH: N/A FT

FLY ASH SAMPLE NO. 4789
NATURAL MOISTURE CONTENT= 33.4 %
REMARKS:

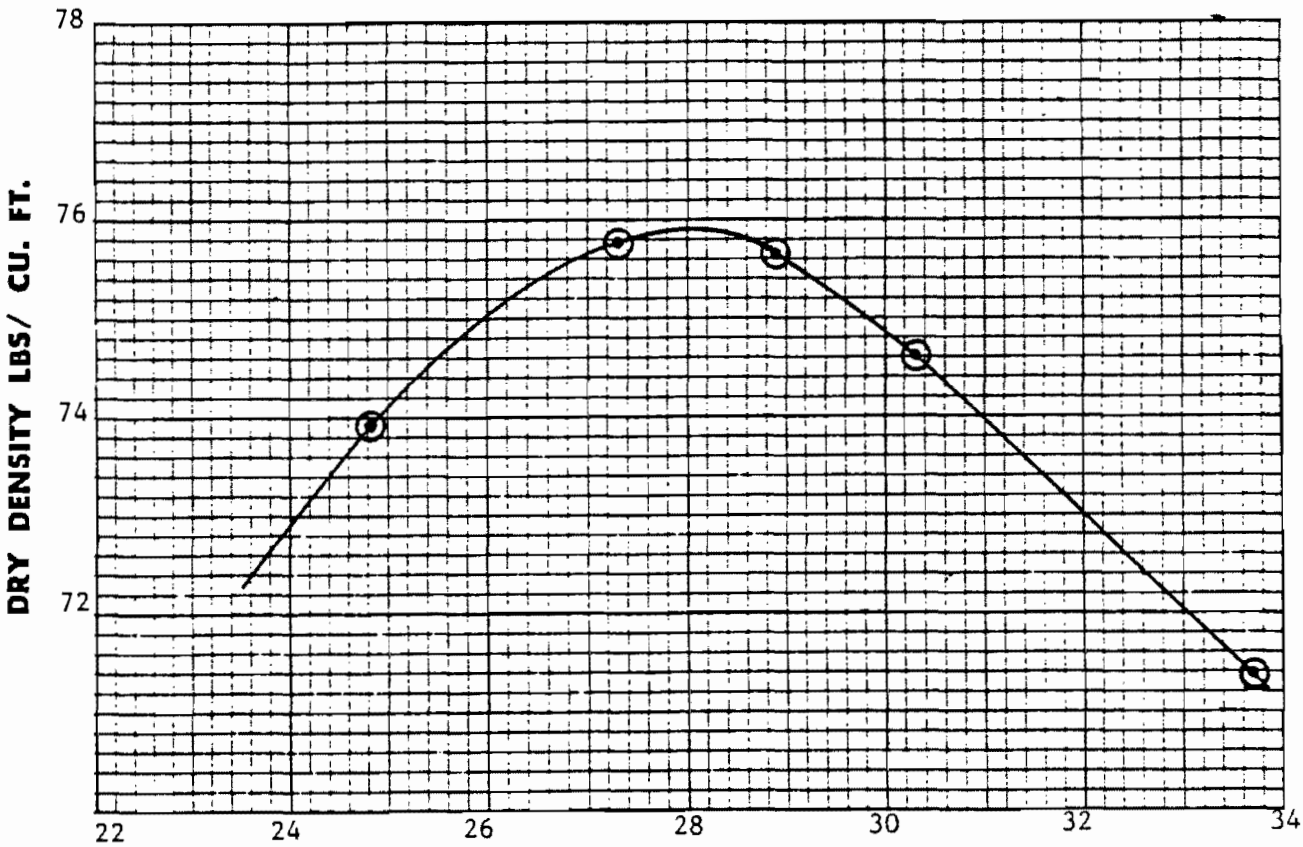
GEOLOGIC ASSOCIATES, INC.

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Knoxville, Tennessee (615)-966-9761

LABORATORY TEST — MOISTURE DENSITY RELATIONSHIP

CLIENT: I. T. Corporation DATE: February, 1985
PROJECT: Utah International Soils Testing 85-3014
SAMPLE LOCATION: Four Corners Power Plant
SAMPLE DESCRIPTION: Fly Ash Sample No. 4789
TEST METHOD: ASTM D698-78 Method A

MOISTURE DENSITY RELATIONSHIP



OPTIMUM MOISTURE: 28.1 % BY WEIGHT FIELD MOISTURE 33.4 % BY WEIGHT
MAX DRY DENSITY 75.9 LBS/CU. FT.
LAB TEST BY:
REMARKS:

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Franklin, Tennessee 615 794-3596
Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 239-3192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date March, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample 4791 Study #16 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: Fly Ash Sample No. 4791

Method: A

Volume of Mold: 0.100 Ft^3

Specific Gravity: 2.20

Minimum Index: 51.2 lbs/Ft^3

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Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date March, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

Fly Ash Sample No. 4791

Length = 4.00 in. Weight = 1.232 lbs. Specific Gravity = 2.20

Diameter = 2.8 in. Moisture = 25.5 % Total Volume = 0.01425 Ft^3

$Weight_w$ = 1.232 lbs.-0.981 lbs. = 0.251 lbs.

$Volume_w$ = 0.251 lbs./62.4 lbs./cu.ft.^{3} = 0.00402 cu.ft.^{3}

$Volume_s$ = 0.981 lbs./(62.4 lbs./cu.ft.^{3}) (2.20) = 0.00715 cu.ft.^{3}

$Volume_a$ = 0.01425 Ft^3 - (0.00402 + 0.00715) = 0.00308 Ft^3

$Volume_v$ = 0.01425 Ft^3 - 0.00715 Ft^3 = 0.0071 Ft^3

$$e = \frac{0.00710}{0.00715} = 0.993$$

$$n = \frac{0.00710}{0.01425} = 49.8 \ \%$$

$$k = 6.2 \times 10^{-6} \text{ cm/sec}$$

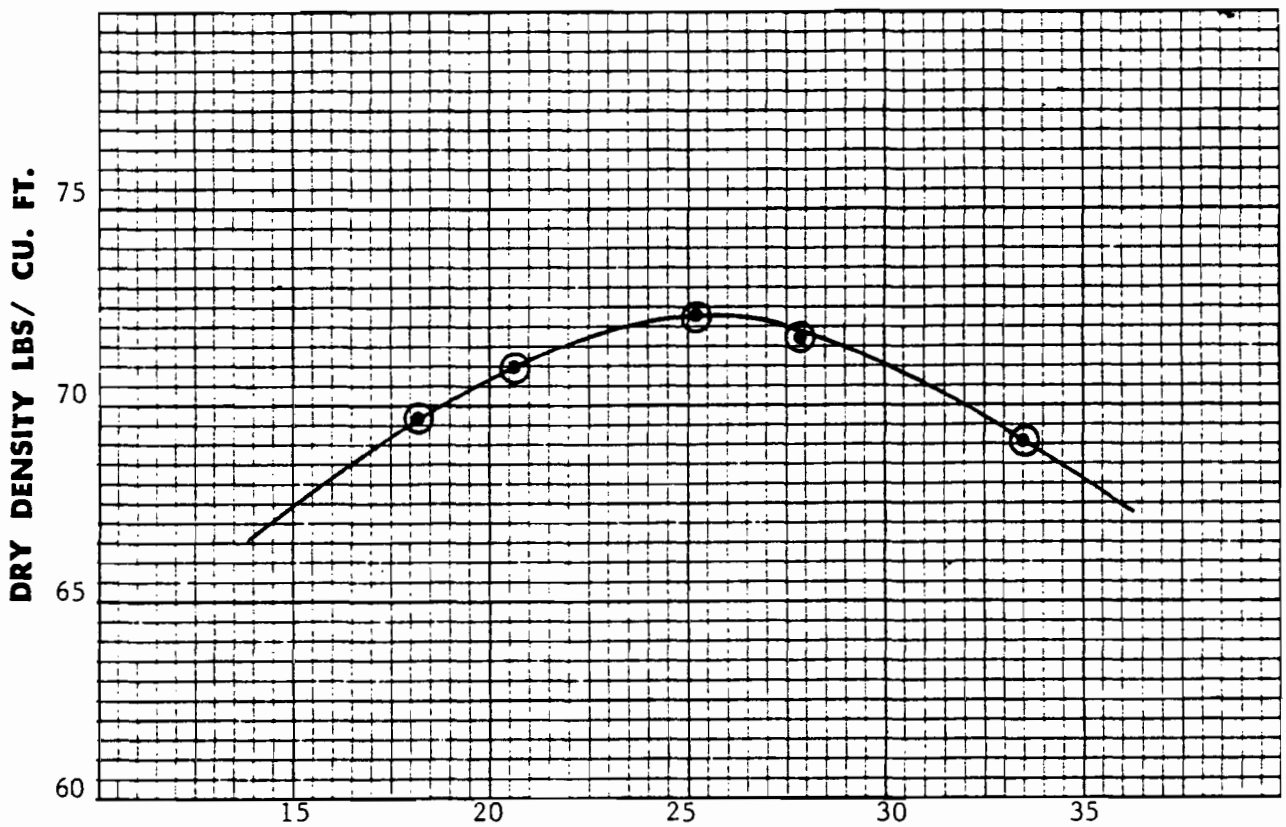
NOTE: All permeability tests conducted were remolded to 95%±1% of the maximum dry density as determined by the standard Proctor (ASTM D698-78).

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Knoxville, Tennessee (615)-966-9761

LABORATORY TEST — MOISTURE DENSITY RELATIONSHIP

CLIENT: I. T. Corporation DATE: March, 1985
PROJECT: Utah International Soils Testing
SAMPLE LOCATION: Four Corners Power Plant
SAMPLE DESCRIPTION: Fly Ash Sample No. 4791
TEST METHOD: ASTM D698-78 Method A

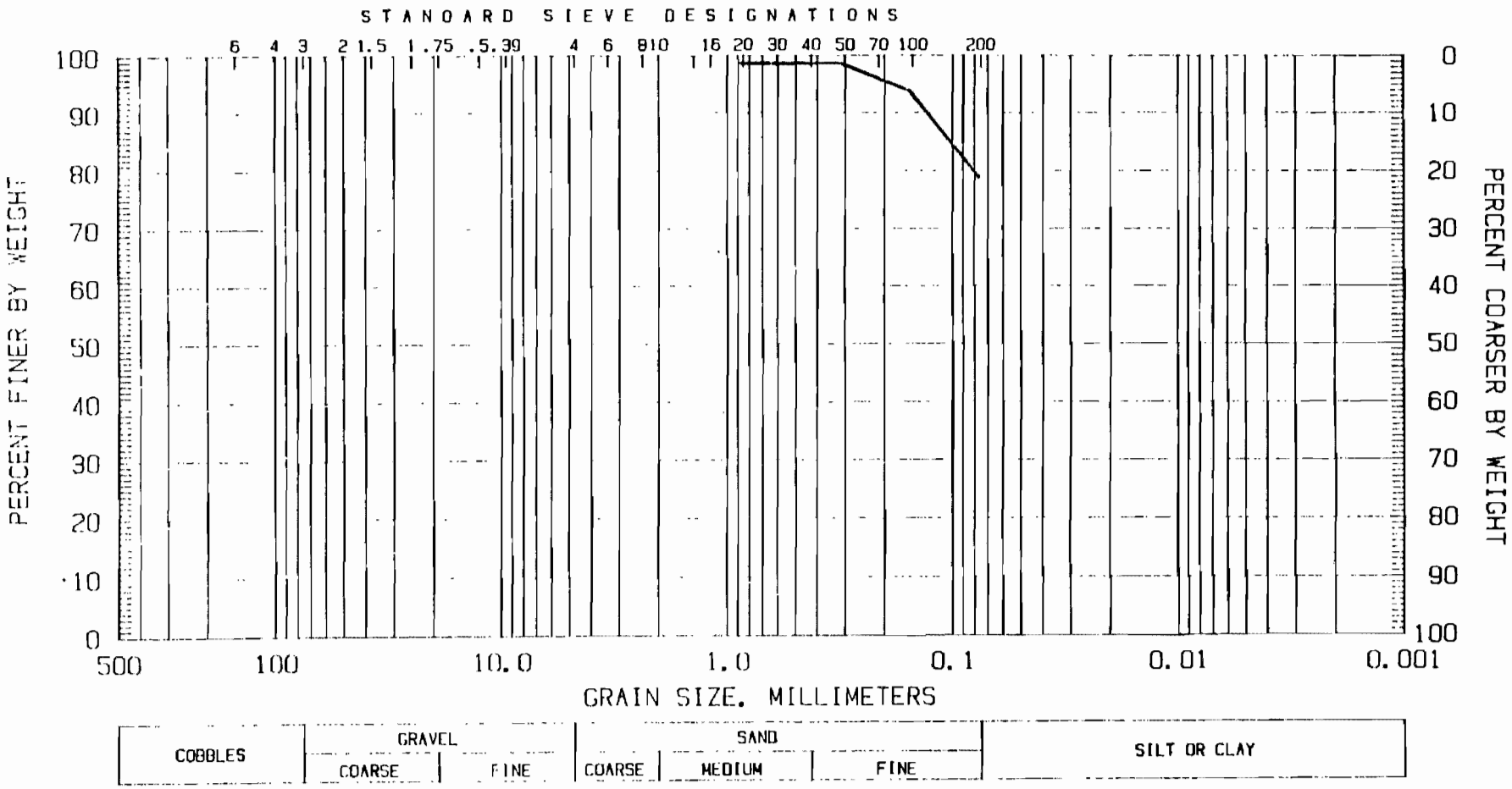
MOISTURE DENSITY RELATIONSHIP



MOISTURE CONTENT % BY WEIGHT

OPTIMUM MOISTURE: 25.1 % BY WEIGHT FIELD MOISTURE 18.5 % BY WEIGHT
MAX DRY DENSITY 72.4 LBS/CU. FT.
LAB TEST BY:
REMARKS:

GRAIN SIZE ANALYSIS



PROJECT NO.: 85-3014K
UTAH INTERNATIONAL SOILS TESTING
I.T. CORPORATION
MARCH 8, 1985
TEST PIT: 3 SAMPLE: 1
DEPTH: N/A FT

FLY ASH SAMPLE NO. 4791
NATURAL MOISTURE CONTENT= 18.5 %
REMARKS:

GEOLOGIC ASSOCIATES, INC.

GEOLOGIC ASSOCIATES. INC.
LABORATORY DIVISION
Franklin, Tennessee 615 794-3596
Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date March, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample 4800 Sludge #11 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: Fly Ash Sample No. 4800

Method: A

Volume of Mold: 0.100 $Ft.^3$

Specific Gravity: 2.10

Minimum Index: 48.8 $lbs./Ft.^3$

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Franklin, Tennessee 615 794-3596
Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date March, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

Fly Ash Sample No. 4800

Length = 3.84 in. Weight = 1.188 lbs. Specific Gravity = 2.10

Diameter = 2.8 in. Moisture = 29.9 % Total Volume = 0.01368 Ft^3

$Weight_w$ = 1.188 lbs. - 0.915 lbs. = 0.273 lbs.

$Volume_w$ = 0.273 lbs./62.4 lbs./cu.ft.^{3} = 0.00438 Ft.^{3}

$Volume_s$ = 0.915 lbs./(62.4 lbs./cu.ft.^{3}) (2.10) = 0.00698 Ft.^{3}

$Volume_a$ = 0.01368 Ft.^{3} - (0.00438 + 0.00698) = 0.01136 Ft.^{3}

$Volume_v$ = 0.01368 Ft.^{3} - 0.00698 Ft.^{3} = 0.0067 Ft.^{3}

$$e = \frac{0.0067}{0.00698} = 0.96$$

$$n = \frac{0.0067}{0.01368} = 49.0 \ \%$$

$$k = 6.6 \times 10^{-6} \text{ cm/sec}$$

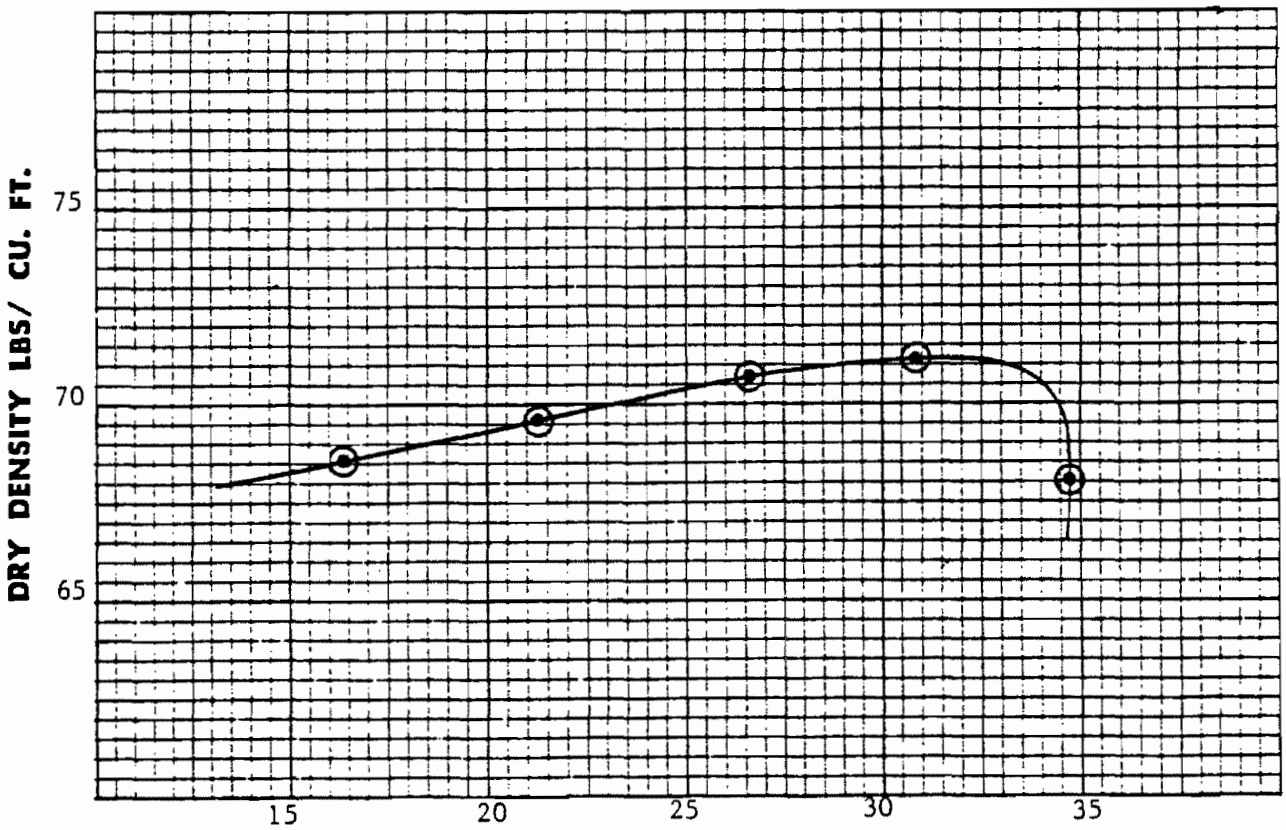
NOTE: All permeability tests conducted were remolded to 95%±1% of the maximum dry density as determined by the standard Proctor (ASTM D698-78).

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Knoxville, Tennessee (615)-966-9761

LABORATORY TEST — MOISTURE DENSITY RELATIONSHIP

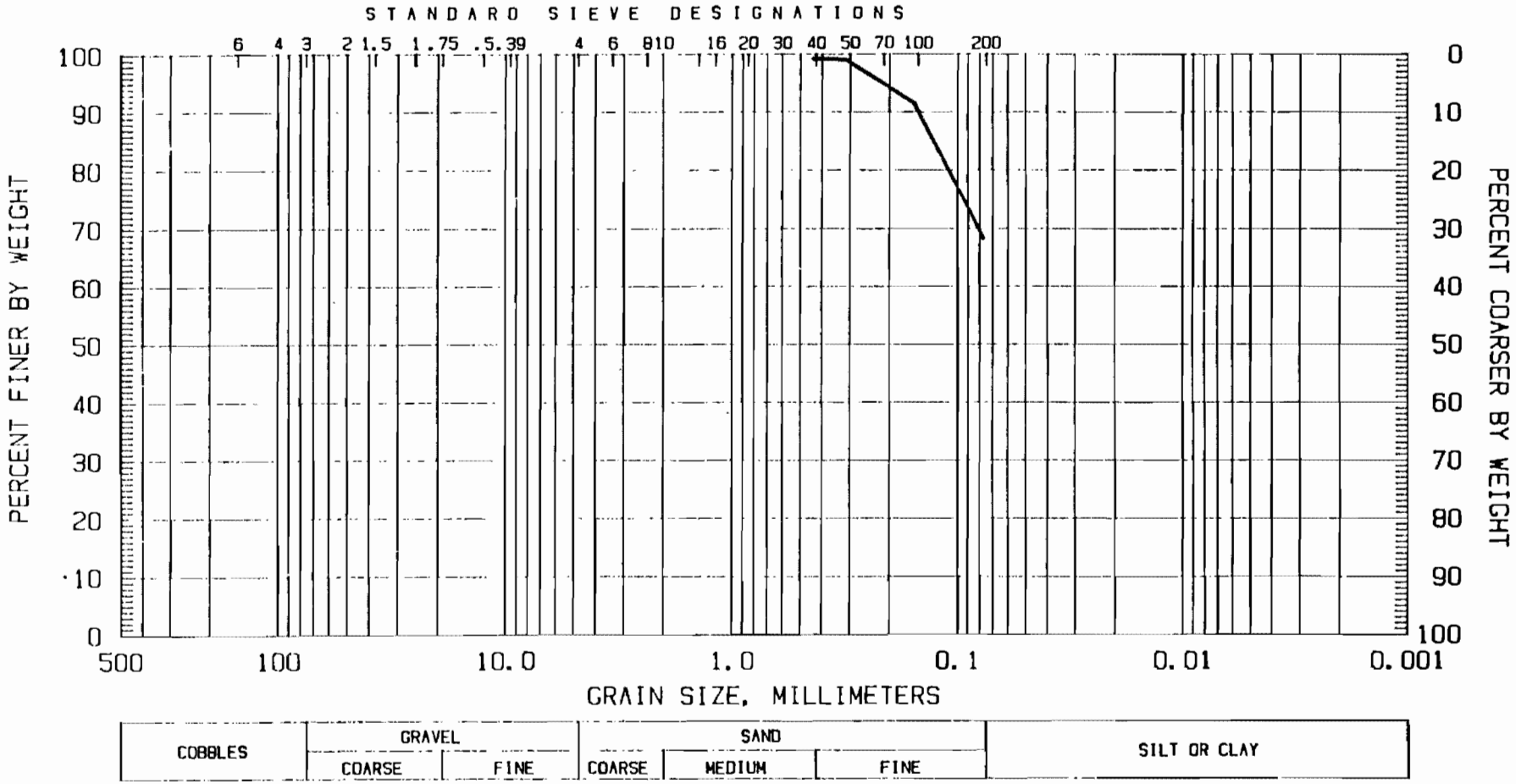
CLIENT: T. T. Corporation DATE: March, 1985
PROJECT: Utah International Soils Testing
SAMPLE LOCATION: Four Corners Power Plant
SAMPLE DESCRIPTION: Sample No. 4800
TEST METHOD: ASTM D698-78 Method A

MOISTURE DENSITY RELATIONSHIP



OPTIMUM MOISTURE: 30.8 % BY WEIGHT FIELD MOISTURE 16.1 % BY WEIGHT
MAX DRY DENSITY 70.8 LBS/CU. FT.
LAB TEST BY:
REMARKS:

GRAIN SIZE ANALYSIS



PROJECT NO.: 85-3014K
UTAH INTERNATIONAL SOILS TESTING
I.T. CORPORATION
MARCH 8, 1985
TEST PIT: 3 SAMPLE: 2
DEPTH: N/A FT

FLY ASH SAMPLE NO. 4800
NATURAL MOISTURE CONTENT= 16.1 %
REMARKS:

GEOLOGIC ASSOCIATES, INC.

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Franklin, Tennessee 615 794-3596
Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF MINIMUM INDEX DENSITY OF SOILS

ASTM D 4254-83

Client I. T. Enviroscience Date March, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

This report includes the minimum index density test results of sample 4801 Sludge #12 as delivered by I. T. Enviroscience. These tests were conducted in accordance with ASTM D 4254-83, Method A.

Sample: Fly Ash Sample No. 4801

Method: A

Volume of Mold: 0.100 $Ft.^3$

Specific Gravity: 2.14

Minimum Index: 52.3 $lbs./Ft.^3$

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Franklin, Tennessee 615 794-3596
Knoxville, Tennessee 615 966-9761
Kingsport, Tennessee 615 239-5192

Report No. _____

REPORT OF POROSITY AND PERMEABILTY CALCULATIONS

Client I. T. Corporation Date March, 1985

Project No. 85-3014 Project Name & Location Utah International Soils Testing

Fly Ash Sample No. 4801

Length = 4.09 in. Weight = 1.304 lbs. Specific Gravity = 2.14

Diameter = 2.8 in. Moisture = 29.1 % Total Volume = 0.01457 Ft^3

$Weight_w$ = 1.304 lbs. - 1.01 lbs. = 0.294 lbs.

$Volume_w$ = 0.294 lbs./62.4 lbs./$Ft.^3$ = 0.0047 $Ft.^3$

$Volume_s$ = 1.01 lbs./(62.4 lbs./$Ft.^3$) (2.14) = 0.00756 $Ft.^3$

$Volume_a$ = 0.01457 $Ft.^3$ - (0.0047 + 0.00756) = 0.00231 $Ft.^3$

$Volume_v$ = 0.01457 $Ft.^3$ - 0.00756 $Ft.^3$ = 0.00701 $Ft.^3$

$$e = \frac{0.00701}{0.00756} = 0.927$$

$$n = \frac{0.00701}{0.01457} = 48.1 \%$$

$$k = 6.2 \times 10^{-6} \text{ cm/sec}$$

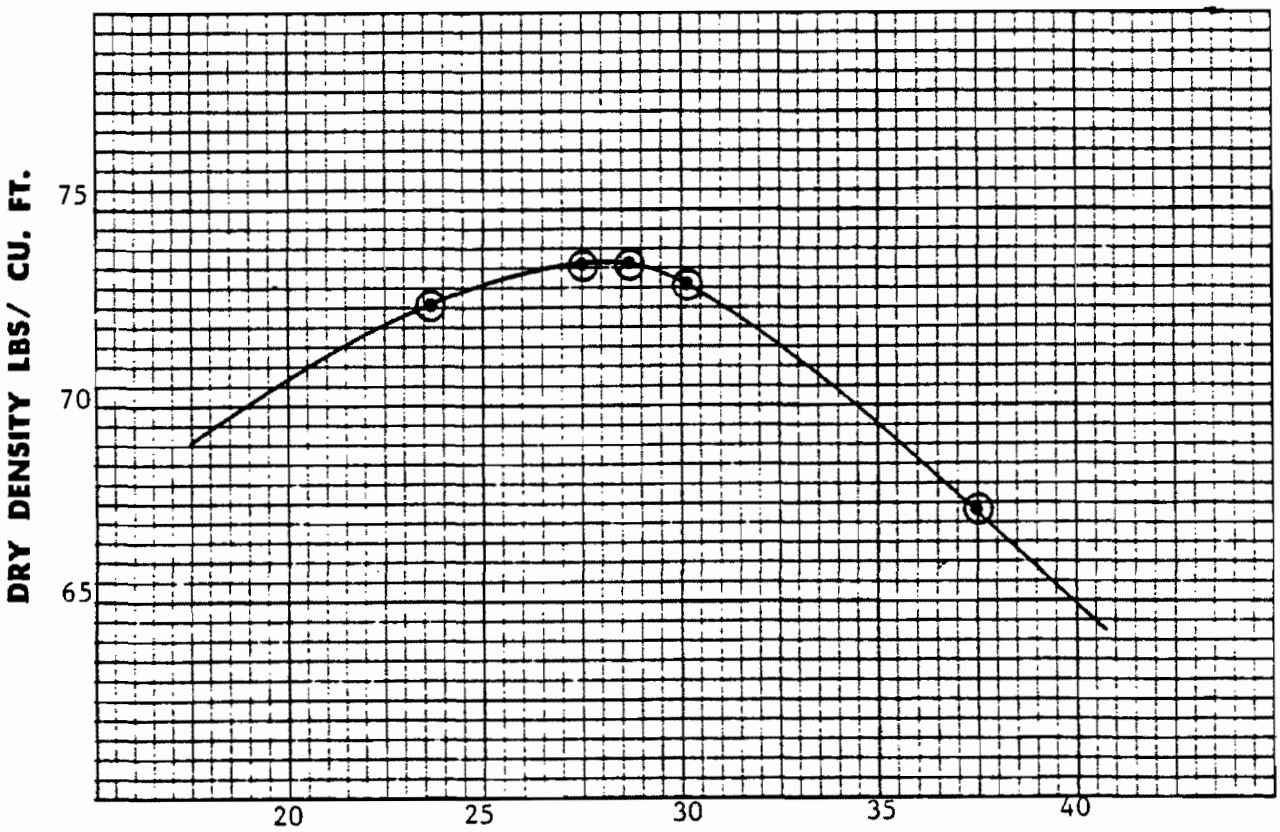
NOTE: All permeability tests conducted were remolded to 95%±1% of the maximum dry density as determined by the standard Proctor (ASTM D698-78).

GEOLOGIC ASSOCIATES, INC.
LABORATORY DIVISION
Knoxville, Tennessee (615)-966-9761

LABORATORY TEST – MOISTURE DENSITY RELATIONSHIP

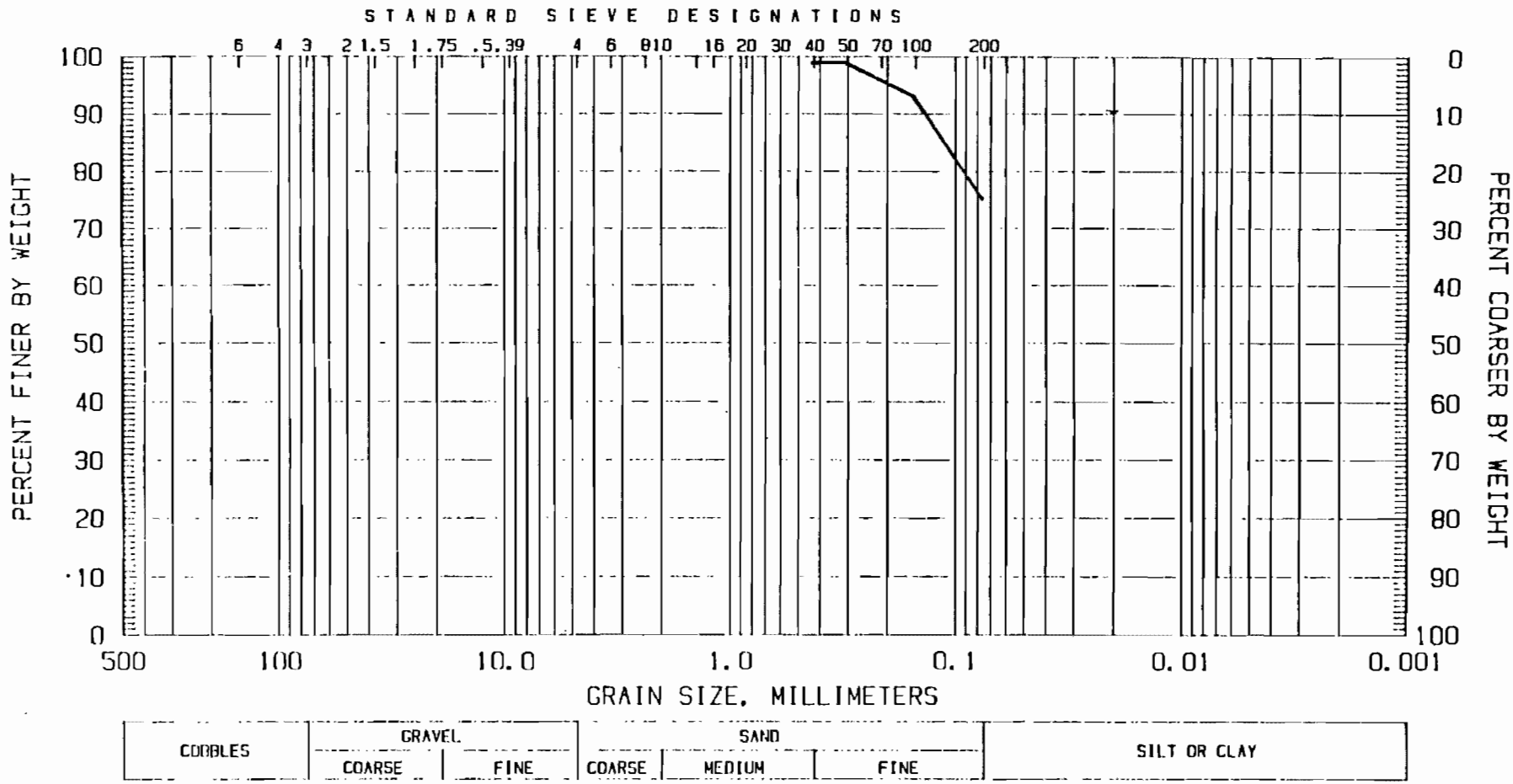
CLIENT: I. T. Corporation DATE: March, 1985
PROJECT: Utah International Soils Testing
SAMPLE LOCATION: Four Corners Power Plant
SAMPLE DESCRIPTION: Fly Ash Sample No. 4801
TEST METHOD: ASTM D698-78 Method A

MOISTURE DENSITY RELATIONSHIP



OPTIMUM MOISTURE: 28.7 % BY WEIGHT FIELD MOISTURE 19.4 % BY WEIGHT
MAX DRY DENSITY 73.6 LBS/CU. FT.
LAB TEST BY:
REMARKS:

GRAIN SIZE ANALYSIS



PROJECT NO.: 85-3014K
UTAH INTERNATIONAL SOILS TESTING
I.T. CORPORATION
MARCH 8, 1985
TEST PIT: 3 SAMPLE: 3
DEPTH: N/A FT

FLY ASH SAMPLE NO. 4801
NATURAL MOISTURE CONTENT= 19.4 %
REMARKS:

GEOLOGIC ASSOCIATES, INC.

Appendix 20.B

Certificate of Registration for San Juan Regional Landfill

NEW MEXICO
HEALTH AND ENVIRONMENT
DEPARTMENT

Post Office Box 968
Santa Fe, New Mexico 87504-0968

COMMUNITY SUPPORT BUREAU
SOLID WASTE MANAGEMENT UNIT

GARREY CARRUTHERS
Governor

LARRY GORDON
Secretary

CARLA L. MUTH
Deputy Secretary

CERTIFICATE OF REGISTRATION

This is to certify that San Juan County's Crouch Mesa Sanitary Landfill has filed an application with the Environmental Improvement Division in compliance with Section 103 of the New Mexico Environmental Improvement Board, Solid Waste management Regulations.

DATE: January 21, 1988

Phillip L. Westen
Certification Officer

COMMENTS:

See attached letter

NEW MEXICO
HEALTH AND ENVIRONMENT
DEPARTMENT

Post Office Box 968
Santa Fe, New Mexico 87504-0968

ENVIRONMENTAL IMPROVEMENT DIVISION

Michael J. Burkhart
Director

GARREY CARRUTHERS
Governor

LARRY GORDON
Secretary

CARLA L. MUTH
Deputy Secretary

Certified/Return Receipt Requested

January 21, 1988

Mr. C. C. Cash
Director of Publi Works
San Juan County
112 S. Mesa Verde
Aztec, New Mexico 87410

Dear Mr. Cash:

Enclosed is a Certificate of Registration for your landfill located on Crouc Mesa.

It is recommended that upon completion and final closure of the landfill, that notification is submitted to the County Assessor's Office indicating this parcel of land was used as a landfill. The notification should be placed in any file that would be reviewed in a title search or when the property is sold. A copy of the notification should be sent to this office.

Finally, it should be noted that compliance with the New Mexico Solid Waste Management Regulations will not assure compliance with regulations under the Resource Conservation and Recovery Act.

If you have any questions, please feel free to contact Phillip Westen at 827-2780.

Sincerely,

Jon F. Thompson, Chief
Community Services Bureau

xc: Richard Mitzelfelt, Chief, Groundwater Bureau
Tito Madrid, Albuquerque District I Manager
Dave Tomko, Health Program Manager - Farmington
Thomas W. Merlan, State Historic Preservation Officer
Nicholas J. Black, State Land Office

R. E. KARLIN
Chairman

ROBERT A. SMITH
Chairman Pro Tem

DONALD BENALLY
Member

MICHAEL B. SULLIVAN
Member

QUINCY C. CORNELIUS
Member

San Juan County

112 S. MESA VERDE
AZTEC, NEW MEXICO 87410

JIM NEBLETT
Manager
505-334-9481

January 15, 1988

Philip L. Westen
Environmental Scientist
New Mexico Health and Environmental Department
Environmental Improvement Division
P. O. Box 968
Santa Fe, New Mexico 87504-0968

Re: Proposed Landfill

Dear Mr. Westen:

In response to Mr. Mitzelfelt's latest communication dated January 8, 1988, this letter will be considered an amendment to San Juan County's Crouch Mesa landfill application which was sent to your office on September 2, 1987.

Access to the Crouch Mesa landfill will be controlled by a guard at the gate during normal hours of operation. All vehicles with refuse entering the landfill will be monitored. No liquid wastes or industrial process wastes will be allowed to be disposed of at the site.

Since we are under a February 1, 1988 closure by the Bureau of Land Management of our present landfills, I hope this amendment will suffice to receive immediate approval on our landfill application.

Sincerely,

R E Karlin

R. E. Karlin, Chairman
Board of County Commissioners

REK:cr

cc: Governor Garrey Carruthers
Richard Mitzelfelt, Chief
Ground Water Bureau

Appendix 20.C

Navajo Mine RCRA Permit

and

Hazardous Waste Generator Status Permits

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 9, H-2-1
75 HAWTHORNE STREET
SAN FRANCISCO, CA 94105

EPA RCRA ID NUMBER STATEMENT

DATE: 03/07/96

MAGED SAID, ENV MGR
BHP MINERALS NAVAJO MINE
P O BOX 155
FRUITLAND , NM 87416

The U.S. Environmental Protection Agency (EPA) has updated the information for your installation under the EPA Identification (ID) Number already assigned to your location (see below). EPA has updated the information according to your EPA Notification of Regulated Waste Activity Form (Form 8700-12) received from your installation on 12/01/95.

By submitting the Form 8700-12, your installation has notified EPA of the Resource Conservation and Recovery Act (RCRA) regulated waste activities shown below in accordance with Section 3010 of RCRA. The EPA ID number for this location is also referred to as a 'RCRA ID number' and is to be used on transport manifests and any other hazardous waste management documents required under Subtitle C of RCRA.

The following RCRA ID Number: NND042993725
is assigned to: BHP MINERALS NAVAJO MINE
16 MI SW OF FRUITLAND N M, FRUITLAND NM

EPA has listed your status as:
Conditionally Exempt Small Quantity Generator - less than 100 kg. (220 lbs. or 25 gallons) of hazardous waste per month or less than 1 kg.(2.2 lbs) of acutely hazardous waste per month.

Installation's waste activity:

D000 D001 D035 F003 F005

RCRA waste codes submitted on Form 8700-12: (Note: Not every waste code your installation submitted on Form 8700-12 may fit in the space above).

PLEASE SEE THE REVERSE FOR ADDITIONAL INFORMATION ON RCRA ID NUMBER POLICY.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 9
75 Hawthorne Street
San Francisco, CA 94105
(For mailing address see below.)

RCRA ID NUMBER STATEMENT

The following RCRA ID number: NND 042993725

has been assigned to: BHP MINERALS NAVAJO MINE
16 MI SW OF FRUITLAND NM
FRUITLAND NM 87416

X **Generator** (VS QG) → Conditionally Exempt Small Quantity Generator.

( ) **Transporter**

( ) **TSD Facility**

( ) **Other** _____

This permanent RCRA ID number is site-specific and is to be used for the regulated waste activity at the above site only. If there are any changes to the information your installation submitted on the EPA Notification of Regulated Waste Activity (Form 8700-12), you are required to notify the EPA by submitting a new Form 8700-12. Each section of the new Form 8700-12 must be filled out completely.

If your installation has a change of location, then note the following: do not use the RCRA ID number assigned to this location to manifest RCRA waste at the new location. Before conducting regulated waste activity at the new location, you must notify the EPA by submitting a Form 8700-12 for the new location. Your new location will be assigned a RCRA ID number specific to that location.

If in the future your installation's regulated waste activity at this location ceases because of closure or change of location, then submit a letter (deactivation letter) requesting deactivation of the RCRA ID number assigned to this location. The deactivation letter should be on company letterhead. Be sure to specify the following information regarding this location: the RCRA ID number to be deactivated, name of installation, location or address of installation, the date that regulated waste activity ceased, and an original ink signature (a deactivation letter with a photocopied or faxed signature will not be accepted).

If you have any questions, or need to submit a new Form 8700-12 or a deactivation letter, or if you need to obtain a current version of the Form 8700-12, then please contact:

U.S. EPA Region 9
RCRA Notifications
75 Hawthorne Street (H-3-4/PRC)
San Francisco, CA 94105

Questions? ☎ (415) 495-8895

Appendix 20.D

List of Residents

LIST OF RESIDENTS

This list includes all known residences within one-half mile of the Permit Area.

1.	Jane Boone, c/o Shirley Begay	P.O. Box 487, Fruitland, NM 87416
2.	Mary Louise Benally	P.O. Box 402, Fruitland, NM 87416
3.	Domasita Allen	P.O. Box 1054, Waterflow, NM 87421
4.	Shirley Begay	P.O. Box 487, Fruitland, NM 87416
5	Jay Yazzie Jr.	P.O. Box 1173, Fruitland, NM 87416
6	Ronald Smith	P.O. Box 2477, Shiprock, NM 87420
7	John Lowe	P.O. Box 394, Fruitland, NM 87416
8	Katie Dobey	P.O. Box 2213, Fruitland, NM 87416
9	Alice D. Gilmore	P.O. Box 297, Fruitland, NM 87416
10	Louise Benally	P.O. Box 772, Fruitland, NM 87416

Appendix 20.E

Public Blast Notice

NAVAJO MINE
PUBLIC BLAST NOTICE
2013/2014

Pursuant to Title 30 of the Code of Federal Regulations Section 816.64 pertaining to blasting, the following Schedule of anticipated blasting for the Navajo Mine covering the period of July 01, 2013 through June 30, 2014 is published.

The general area of blasting shall be the Navajo Mine located in San Juan County approximately eighteen (18) miles west of Farmington, New Mexico. The actual area, more specifically defined is:

PINTO - DOBY

Beginning at a monument marked P11-E from which the North 1/4 Corner of Section 6, T26N, R15W, N.M.P.M., San Juan County, New Mexico, bears S03°44'34"W, 54276.7 feet, thence S89°27'51"E, 1466.7 feet (P-10-A), thence N89°41'24"E, 342.7 feet (L-43), thence N89°51'07"E, 3827.0 feet (L-34), thence South 1321.1 feet (L-36), thence S89°58'58"W, 1320.7 feet (L-38), thence S00°04'05"E, 5281.7 feet (L-40), thence S89°52'20"W, 3832.8 feet (L-59), thence N01°00'00"E, 1320.0 feet (L-57), thence N89°54'16"W, 747.6 feet (E-8D), thence N02°32'48"E, 5297.9 feet to the point of beginning.

HOSTEEN - YAZZIE

Beginning at a monument marked L-75 from which the North 1/4 Corner of Section 6, T26N, R15W, N.M.P.M., San Juan County, New Mexico, bears S03°42'33"E, 39711.3 feet, thence S89°57'54"E, 2640.0 feet (L-73), thence N89°56'58"E, 7803.3 feet (L-52), thence S00°01'36"E, 320.0 feet (E-18-B), thence S00°04'58"E, 1000.4 feet (L-54), thence S89°59'25"W, 1723.6 feet (B-1), thence S00°35'34"E, 1511.0 feet (B-2), thence S57°21'57"W, 4828.68 feet (B-3), thence S00°21'50"E, 1074.6 feet (B-4), thence S48°08'13"W, 2119.9 feet, to a point, thence S89°58'10"W, 572.1 feet (L-62), thence S89°58'10"W, 2526.7 feet (L-64), thence N00°00'05"E, 7921.3 feet to the point of beginning.

NORTH BARBER - SOUTH BARBER - MASON

Beginning at a monument marked L-64 from which the North 1/4 Corner of Section 6, T26N, R15W, N.M.P.M., San Juan County, New Mexico bears S04°37'57"E, 31810.8 feet, thence N89°58'10"E, 2526.7 feet (L-62), thence N89°58'10"E, 572.1 feet to a point, thence S48°08'13"W, 5934.1 feet (L-70), thence S59°30'44"W, 6130.2 feet (B-5), thence S00°00'26"W, 2171.5 feet (L-80), thence N89°54'05"W, 1320.4 feet (L-82), thence S00°00'39"W, 1320.8 feet (L-84), thence N89°59'49"W, 2640.9 feet (L-86), thence S89°58'46"W, 1318.0 feet (L-105), thence South 203.3 feet (E-14-A), thence S89°53'49"W, 1647.2 feet (E-14-B), thence N00°00'53"E, 4160.6 feet (E-14-C), thence N89°58'39"E, 326.5 feet (L-101), thence N89°58'39"E, 1319.7 feet (L-99), thence N00°00'25"E, 1319.6 feet (L-97), thence N00°00'28"E, 5282.1 feet (L-95), thence N89°55'24"E, 1320.2 feet (L-93), thence N89°59'16"E, 2640.9 feet (L-91), thence N89°59'10"E, 7921.0 feet to the point of beginning.

AREA III

Beginning at the North 1/4 Corner of Section 6, T26N, R15W, N.M.P.M., San Juan Country, New Mexico, which is also called L-120, thence S00°09'59"E, 5278.7 feet to a point called L-122, thence N90°00'00"W,

10487.8 feet to a point called L-127, thence N00°02'47"W, 1320.6 feet to a point called L-125, thence S89°59'54"W, 1320.8 feet to a point called L-123, thence N44°56'56"W, 1438.9 feet to a point called P-2, thence N00°28'49"E, 838.47 feet to a point called D-1, thence S87°50'18"W, 1986.62 feet to a point called opD-2, thence N00°53'55"E, 410.0 feet to a point called D-3, thence S87°50'18"W, 2290.0 feet to a point called E-15-A, thence N00°11'59"W, 1855.6 feet to a point called L-117, thence N00°11'15"W, 5303.3 feet to a point called L-115, thence N89°59'25"E, 1319.9 feet to a point called L-113, thence N00°00'29"W, 5280.0 feet to a point called L-111, thence N00°00'32"E, 5281.6 feet to a point called L-109, thence S89°56'49"E, 1319.2 feet to a point called L-107, thence S89°54'44"E, 1321.4 feet to a point called L-88, thence N89°56'06"E, 1320.4 feet to a point called L-90, thence S00°00'33"E, 1320.2 feet to a point called L-92, thence S89°59'33"E, 1319.98 feet to a point called L-94, thence S00°00'42"W, 1320.4 feet to a point called L-96, thence S89°58'36"E, 1320.9 feet to a point called L-98, thence S00°00'17"E, 1320.3 feet to a point called L-100, thence N89°59'18"E, 1320.3 feet to a point called L-102, thence N89°59'18"E, 500 feet to a point, thence S00°00'37"E, 820.21 feet to a point, thence N89°59'23"E, 1320.59 feet to a point, thence S00°02'02"E, 5782.39 feet to a point, thence S00°02'01"E, 1320.1 feet to a point, thence N89°57'58"E, 820.4 feet to a point called L-112, thence S00°01'36"E, 1320.3 feet to a point called L-114, thence N89°59'42"E, 2641.2 feet to a point called L-116, thence N89°59'59"E, 2563.1 feet to a point called L-118, thence S00°03'06"E, 2663.0 feet to the point of beginning.

Area IV-North

Beginning at a point called P-2 on the Navajo Mine Lease Boundary from which the North 1/4 Corner of Section 6, T26N, R15W, N.M.P.M., San Juan County, New Mexico, bears N77°04'33"E, 13143.86 feet; thence S44°56'56"E, 1438.90 feet to a point called L-123, thence N89°59'54"E, 1320.80 feet to a point called L-125, thence S00°02'47"E, 1320.60 feet to a point called L-127, thence N90°00'00"E, 2936.21 feet to a point, thence S27°49'16"E, 1121.86 feet to a point, thence S90°00'00"W, 9662.92 feet to a point, thence S66°33'04"E, 1835.48 feet to a point, thence S89°36'20"W, 490.72 feet to a point, thence S00°01'27"W, 1075.33 feet to a point, thence S89°55'25"W, 428.08 feet to a point, thence N00°00'35"E, 1071.86 feet to a point, thence S89°38'30"W, 509.85 feet to a point, thence N00°32'20"W, 97.90 feet to a point called P-4, thence N00°23'07"E, 949.94 feet to a point called P-3, thence N66°33'00"E, 7599.72 feet to the point of beginning.

Burnham Road Closures - Areas III and IV-North

Pursuant to Title 30 of the Code of Federal Regulations Section 816.66 (c) pertaining to blasting, sections of the N-5082 Burnham Road will be subject to temporary closures due to blasting activities in Area III and IV-North.

The temporary closures will take place at any time between sunrise and sunset on any day of the week. Generally the road closures will occur between 11am and 3pm (MST) but may take place outside these hours based on operational circumstances. The temporary closures typically last in duration from 30 minutes to 2 hours

NAVAJO MINE
PUBLIC BLAST NOTICE
2013/2014

BLASTING PROCEDURES / WARNING SIGNALS / EMERGENCIES

During this period blasting may occur at any time between sunrise and sunset on any day of the week. Access to the general area of blasting is controlled by posted signs, both permanent and temporary, reading "**BLASTING AREA**" and "**DANGER - EXPLOSIVES - NO ENTRY**". Access to the immediate area of the blast is controlled by manned roadblocks that deny access to the area by unauthorized personnel. Access is not allowed ten (10) minutes prior to the actual blast (and immediately after the blast) and not resumed until the area has been inspected and cleared.

An audible blast signal is used for immediate notice of intent to blast. Ten (10) minutes before the blast a long wail siren will be sounded for five (5) seconds. Five (5) minutes before the blast the long wail siren will be sounded continuously until thirty (30) seconds before the blast, when the siren is changed to a yelp. The all clear signal given after the blast area is cleared consists of three (3), five (5) second audible pulses, broken by five (5) second intervals of silence between each pulse.

All blasting conforms to the blasting schedule, except for emergency situations. Emergency situations warranting detonation outside the specified periods include any situation that constitutes a safety hazard to employees, a safety hazard to non-employees, and/or has the potential to damage equipment, mine or otherwise as a result of blasting.

BHP Navajo Coal Company - Navajo Mine
Post Office Box 1717
Fruitland, New Mexico 87416
Telephone Number: (505) 598-4200

AFFIDAVIT OF PUBLICATION

Ad No. 69134

STATE OF NEW MEXICO
County of San Juan:

JOHN ELCHERT, being duly sworn says: That HE is the PUBLISHER of THE DAILY TIMES, a daily newspaper of general circulation published in English at Farmington, said county and state, and that the hereto attached Legal Notice was published in a regular and entire issue of the said DAILY TIMES, a daily newspaper duly qualified for the purpose within the meaning of Chapter 167 of the 1937 Session Laws of the State of New Mexico for publication and appeared in the Internet at The Daily Times web site on the following day(s):

Monday, June 17, 2013

And the cost of the publication is $368.51

ON 6/24/13 JOHN ELCHERT appeared before me, whom I know personally to be the person who signed the above document.

Wynell E. Corey

OFFICIAL SEAL
WYNELL E COREY
Notary Public
State of New Mexico
My Comm. Expires 7/16/16

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NAVAJO MINE
PLUBLIC BLAST NOTICE
2013/2014

Pursuant to Title 30 of the Code of Federal Regulations Section 816.64 pertaining to blasting, the following Schedule of anticipated blasting for the Navajo Mine covering the period of July 01, 2013 through June 30, 2014 is published.

The general area of blasting shall be the Navajo Mine located in San Juan County approximately eighteen (18) miles west of Farmington, New Mexico. The actual area, more specifically defined is:

PINTO - DOBY

Beginning at a monument marked P11-E from which the North 1/4 Corner of Section 6, T26N, R15W, N.M.P.M., San Juan County, New Mexico, bears S03°44'34"W, 54276.7 feet, thence S89°27'51"E, 1466.7 feet (P-10-A), thence N89°41'24"E, 342.7 feet (L-43), thence N89°51'07"E, 3827.0 feet (L-34), thence South 1321.1 feet (L-36), thence S89°58'58"W, 1320.7 feet (L-38), thence S00°04'05"E, 5281.7 feet (L-40), thence S89°52'20"W, 3832.8 feet (L-59), thence N01°00'00"E, 1320.0 feet (L-57), thence N89°54'15"W, 747.6 feet (E-8D), thence N02°32'48"E, 5297.9 feet to the point of beginning.

HOSTEEN - YAZZIE

Beginning at a monument marked L-75 from which the North 1/4 Corner of Section 6, T26N, R15W, N.M.P.M., San Juan County, New Mexico, bears S03°42'33"E, 39711.3 feet, thence S89°57'54"E, 2640.0 feet (L-73), thence N89°56'58"E, 7803.3 feet (L-52), thence S00°01'36"E, 320.0 feet (E-18-B), thence S00°04'58"E, 1000.4 feet (L-54), thence S89°59'25"W, 1723.6 feet (B-1), thence S00°35'34"E, 1511.0 feet (B 2), thence S57°21'57"W, 4828.68 feet (B-3), thence S00°21'50"E, 1074.6 feet (B-4), thence S48°08'13"W, 2119.9 feet, to a point, thence S89°58'10"W, 572.1 feet (L-62), thence S89°58'10"W, 2526.7 feet (L-64), thence N00°00'05"E, 7921.3 feet to the point of beginning.

NORTH BARBER - SOUTH BARBER - MASON

Beginning at a monument marked L-64 from which the North 1/4 Corner of Section 6, T26N, R15W, N.M.P.M., San Juan County, New Mexico bears S04°37'57"E, 31810.8 feet, thence N89°58'10"E, 2526.7 feet (L-62), thence N89°58'10"E, 572.1 feet to a point, thence S48°08'13"W, 5934.1 feet (L-70), thence S59°30'44"W, 6130.2 feet (B-5), thence S00°00'26"W, 2171.5 feet (L-80), thence N89°54'05"W, 1320.4 feet (L-82), thence S00°00'39"W, 1320.8 feet (L-84), thence N89°59'49"W, 2640.9 feet (L-86), thence S89°58'46"W, 1318.0 feet (L-105), thence South 203.3 feet (E-14-A), thence S89°53'49"W, 1647.2 feet (E-14-B), thence N00°00'53"E, 4160.6 feet (E-14-C), thence N89°58'39"E, 326.5 feet (L-101), thence N89°58'39"E, 1319.7 feet (L-99), thence N00°00'25"E, 1319.6 feet (L-97), thence N00°00'28"E, 5282.1 feet (L-95), thence N89°55'24"E, 1320.2 feet (L-93), thence N89°59'16"E, 2640.9 feet (L-91), thence N89°59'10"E, 7921.0 feet to the point of beginning.

AREA III

Beginning at the North 1/4 Corner of Section 6, T26N, R15W, N.M.P.M., San Juan Country, New Mexico, which is also called L-120, thence S00°09'59"E, 5278.7 feet to a point called L-122, thence N90°00'00"W, 10487.8 feet to a point called L-127, thence N00°02'47"W, feet to a point called L-98, thence S00°00'17"E, 1320.3 feet to a point called L-100, thence N89°59'18"E, 1320.3 feet to a point called L-102, thence N89°59'18"E, 500 feet to a point, thence S00°00'37"E, 820.21 feet to a point, thence N89°59'23"E, 1320.59 feet to a point, thence S00°02'02"E, 5782.39 feet to a point, thence S00°02'01"E, 1320.1 feet to a point, thence N89°57'58"E, 820.4 feet to a point called L-112, thence S00°01'36"E, 1320.3 feet to a point called L-114, thence N89°59'42"E, 2641.2 feet to a point called L-116, thence N89°59'59"E, 2563.1 feet to a point called L-118, thence S00°03'06"E, 2663.0 feet to the point of beginning.

Area IV-North

Beginning at a point called P-2 on the Navajo Mine Lease Boundary from which the North 1/4 Corner of Section 6, T26N, R15W, N.M.P.M., San Juan County, New Mexico, bears N77°04'33"E, 13143.86 feet; thence S44°56'56"E, 1438.90 feet to a point called L-123, thence N89°59'54"E, 1320.80 feet to a point called L-125, thence S00°02'47"E, 1320.60 feet to a point called L-127, thence N90°00'00"E, 2936.21 feet to a point, thence S27°49'16"E, 1121.86 feet to a point, thence S90°00'00"W, 9662.92 feet to a point, thence S66°33'04"E, 1635.48 feet to a point, thence S89°36'20"W, 490.72 feet to a point, thence S00°01'27"W, 1075.33 feet to a point, thence S89°55'25"W, 428.08 feet to a point, thence N00°00'35"E, 1071.86 feet to a point, thence S89°38'30"W, 509.85 feet to a point, thence N00°32'20"W, 97.90 feet to a point called P-4, thence N00°23'07"E, 949.94 feet to a point called P-3, thence N66°33'00"E, 7599.72 feet to the point of beginning.

Burnham Road Closures - Areas III and IV-North

Pursuant to Title 30 of the Code of Federal Regulations Section 816.66 (c) pertaining to blasting, sections of the N-5082 Burnham Road will be subject to temporary closures due to blasting activities in Area III and IV-North.

The temporary closures will take place at any time between sunrise and sunset on any day of the week. Generally the road closures will occur between 11am and 3pm (MST) but may take place outside these hours based on operational circumstances. The temporary closures typically last in duration from 30 minutes to 2 hours

BLASTING PROCEDURES / WARNING SIGNALS / EMERGENCIES

During this period blasting may occur at any time between sunrise and sunset on any day of the week. Access to the general area of blasting is controlled by posted signs, both permanent and temporary, reading **"BLASTING AREA"** and **"DANGER EXPLOSIVES - NO ENTRY"**. Access to the immediate area of the blast is controlled by manned roadblocks that deny access to the area by unauthorized personnel. Access is not allowed ten (10) minutes prior to the actual blast (and immediately after the blast) and not resumed until the area has been inspected and cleared.

An audible blast signal is used for immediate notice of intent to blast. Ten (10) minutes before the blast a long wail siren will be sounded for five (5) seconds. Five (5) minutes before the blast the long wail siren will be sounded continuously until thirty (30) seconds before the blast, when the siren is changed to a yelp. The all clear signal given after the blast area is cleared consists of three (3), five (5) second audible pulses, broken by five (5) second intervals of silence between each pulse.

All blasting conforms to the blasting schedule, except for emergency situations. Emergency

point called L-127, thence N00°02'47"W, 1320.6 feet to a point called L-125, thence S89°59'54"W, 1320.8 feet to a point called L-123, thence N44°56'56"W, 1438.9 feet to a point called P-2, thence N00°28'49"E, 838.47 feet to a point called D-1, thence S87°50'18"W, 1986.62 feet to a point called opD-2, thence N00°53'55"E, 410.0 feet to a point called D-3, thence S87°50'18"W, 2290.0 feet to a point called E-15-A, thence N00°11'59"W, 1855.6 feet to a point called L-117, thence N00°11'15"W, 5303.3 feet to a point called L-115, thence N89°59'25"E, 1319.9 feet to a point called L-113, thence N00°00'29"W, 5280.0 feet to a point called L-111, thence N00°00'32"E, 5281.6 feet to a point called L-109, thence S89°56'49"E, 1319.2 feet to a point called L-107, thence S89°54'44"E, 1321.4 feet to a point called L-88, thence N89°56'06"E, 1320.4 feet to a point called L-90, thence S00°00'33"E, 1320.2 feet to a point called L-92, thence S89°59'33"E, 1319.98 feet to a point called L-94, thence S00°00'42"W, 1320.4 feet to a point called L-96, thence S89°58'36"E, 1320.9

except for emergency situations. Emergency situations warranting detonation outside the specified periods include any situation that constitutes a safety hazard to employees, a safety hazard to non-employees, and/or has the potential to damage equipment, mine or otherwise as a result of blasting.

BHP Navajo Coal Company - Navajo Mine
Post Office Box 1717
Fruitland, New Mexico 87416
Telephone Number: (505) 598-4200

Legal No. 69134 published in The Daily Times on June 17, 2013.

time between sunrise and sunset on any day of the week. Generally the road closures will occur between 11am and 3pm (MST) but may take place outside these hours based on operational circumstances. The temporary closures typically last in duration from 30 minutes to 2 hours

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BHP Navajo Coal Company - Navajo Mine
Post Office Box 1717
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Telephone Number: (505) 598-4200

Legal No. 67725 published in The Daily Times on June 18, 2012.

Appendix 20.F

Blasting Procedures

TABLE OF CONTENTS

Sample Blast Reports 11-C-1
Scale Distance Factor Approvals 11-C-13
Blast Reporting Practices at Navajo Mine 11-C-23

Sample Blast Reports

BHP Minerals
COAL BLASTING REPORT

Job: 51DX7B-C1

Date: 06/24/2005	Pit and Seam: Dixon / 7B	Strip: 51	Blaster: Toledo, Victor
Time: 01:24 PM	Station: 181+00 to 174+00		License:
Shift: Day	Material: Coal		
Crew Size: 7	Total Manhours: 36	Holes/Manhour: 17	Signature: Victor Toledo

DESIGN INFORMATION

Burden:	14	Hole Diameter: 8.00	Total Holes:	610	Drill: SE-3132
Spacing:	14	Stem Height: 3.00	Total Rows:	10	
Average Depth:	5	Stem Material: Hole Cuttings	Holes/Row:	61	

EXPLOSIVES TYPE	POUNDS
ANFO WESCO	7,758
Total Weight of Explosives	7,758

BOOSTERS	WT	QTY	POUNDS
LP-8-2 Trojan	0.50	604	302
Total Boosters		604	302

TOTALS	
Total Explosives Weight	8,060
Powder Factor (lbs/ton)	0.33
Number Holes Loaded	604
Average Pounds / Hole	13
Estimated Tons (Factor .0405)	24,210

ACCESSORIES		
Category	Description	Quantity
Detonating Cord	ZAP Ensign Bickford	8
EB InHole Delays	EBMS #4 Ensign Bickford	1
EB Surface Delays	MS-009 Ensign Bickford	30
EB Surface Delays	MS-042 Ensign Bickford	18

OTHER

Initiation Type
ZAP Ensign Bickford

Legal Weight & Distance
Max. Charge per 8ms Interval: 256
No. Holes per 8ms Interval: 16
Scaled Distance: 65
Minimum Distance: 1,040

Nearest Structure
Name: M. Yazzie
Type: Dwelling
Distance: 10,110
Direction: WNW

Weather
Sky Conditions: Clear
Temperature: 90
Wind Speed: 5
Wind Direction: E

Blasting Mats: No

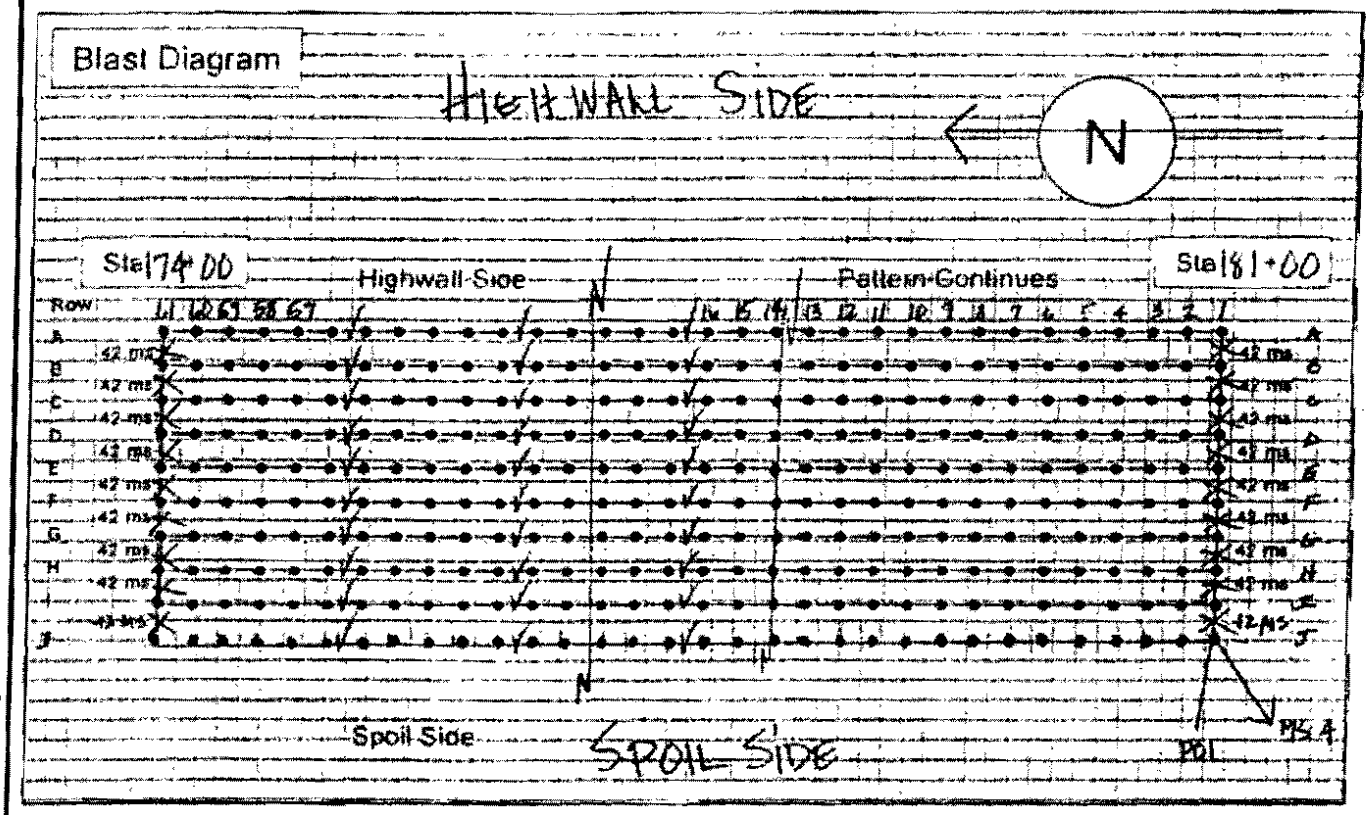
Reasons for unscheduled shot (if applicable) / Other Comments:

6 LOSE HOLE
NO IN HOLE DELAY

COAL BLASTING REPORT

Job 51DX7B-C1 Date 6-24-05

Blast Diagram



Seismograph Information: Not monitored

Comments:

X - MS-42 WERE USED ON BOTH END OF BLOCK.

√ - MS-9 WERE USED IN BETWEEN ROW 3 TIMES.

→ - MS-4 LEADLINE.

NOTE 16 HOLE FATERVAL
NO IN-HOLE DELAY.
6 LOSE HOLE

10 rows

Job Data	Hole No	Blasthole Data A	B	C	Rows D	E	F	G	H	I	J	K	L
Date:	1												
5-24-05	2												
JOB NUMBER	3												
COAL 1	4												
Block:	5												
A	6												
From Station:	7												
181+00	8												
To Station:	9												
173+00	10	5	5	5	5	4	4	5	4	5	5		
	11	5	5	5	5	5	4	5	4	5	4		
	12	5	5	5	5	5	5	5	4	5	4		
	13	5	5	5	5	5	5	4	5	5	4		
	14	5	5	5	5	5	4	5	5	4	4		
	15	5	5	5	5	5	5	5	5	5	5		
	16	5	5	5	5	4	5	5	5	5	5		
	17	5	5	4	5	4	5	5	5	5	5		
	18	5	5	4	5	4	5	5	5	5	5		
	19	5	5	5	5	5	5	5	5	5	5		
	20	5	5	5	5	5	5	5	5	5	5		
	21	4	5	5	5	5	5	5	5	5	5		
	22	5	5	5	5	5	5	5	5	5	5		
	23	5	5	5	5	5	5	5	5	5	5		
	24	5	5	5	5	5	5	5	5	5	5		
	25	5	5	4	4	4	5	5	5	5	5		
	26	5	5	5	5	5	5	5	5	5	5		
	27	6	5	5	5	5	5	5	5	5	5		
	28	4	5	5	5	4	4	5	5	5	5		
	29	4	5	5	5	5	5	5	5	5	5		
	30	6	5	4	4	4	5	5	5	5	5		
	31	4	4	4	5	4	4	5	5	5	5		
	32	5	5	5	5	4	4	4	5	5	5		
	33	6	5	0	5	5	5	5	5	5	5		
	34	5	5	4	4	4	5	4	5	5	5		
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	42	6	5	5	5	5	5	5	5	5	5		
	43	5	5	5	5	5	5	5	5	5	5		
	44	6	5	4	4	4	5	5	5	4	4		
	45	5	5	5	5	5	5	5	5	5	5		
	46	6	5	5	5	5	5	5	5	5	5		
	47	4	4	5	4	4	5	5	5	5	5		
	48	6	5	5	5	5	5	5	6	5	5		
	49	5	5	6	5	5	5	5	5	5	5		
	50	5	5	6	5	5	5	5	5	5	5		

51	6	5	5	5	6	6	5	5	4	5
52	5	5	6	6	6	6	5	4	5	5
53	6	6	6	5	4	6	5	5	5	5
54	5	5	6	6	6	5	4	4	6	5
55	6	6	6	5	5	5	4	4	4	5
56	6	5	5	5	5	6	5	4	4	5
57	5	5	5	6	6	6	5	5	6	5
58	4	5	6	6	6	6	5	5	6	5
59	6	6	6	5	5	6	6	6	6	5
60	5	5	6	6	6	5	5	4	5	5
61	6	6	6	5	5	5	5	5	6	4
62	6	6	6	6	5	5	5	6	6	4
63	5	6	6	6	6	5	5	4	6	4
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65	6	5	4	5	4	6	5	4	6	5
66	5	5	6	6	5	6	5	4	5	4
67	6	6	6	6	6	5	4	4	5	4
68	5	5	6	6	6	6	5	5	6	5
69	6	5	4	5	5	6	5	4	4	4
70	6	6	6	5	4	5	0	0	0	0
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101										
102										

BHP Minerals

Mix Truck Load Sheet

Job: COAL-1 Block: A

Row	Hole	Stm	Bottom Formula	Bottom Chg	Top Formula	Top Chg
A	010	3.2	ANFO WESCO	13		
A	011	3.2	ANFO WESCO	13		
A	012	3.2	ANFO WESCO	13		
A	013	3.2	ANFO WESCO	13		
A	014	3.2	ANFO WESCO	13		
A	015	3.2	ANFO WESCO	13		
A	016	3.2	ANFO WESCO	13		
A	017	3.2	ANFO WESCO	13		
A	018	3.2	ANFO WESCO	13		
A	019	3.2	ANFO WESCO	13		
A	020	3.2	ANFO WESCO	13		
A	021	2.6	ANFO WESCO	10		
A	022	3.2	ANFO WESCO	13		
A	023	3.2	ANFO WESCO	13		
A	024	3.2	ANFO WESCO	13		
A	025	3.2	ANFO WESCO	13		
A	026	3.2	ANFO WESCO	13		
A	027	3.9	ANFO WESCO	15		
A	028	2.6	ANFO WESCO	10		
A	029	2.6	ANFO WESCO	10		
A	030	3.9	ANFO WESCO	15		
A	031	2.6	ANFO WESCO	10		
A	032	3.2	ANFO WESCO	13		
A	033	3.9	ANFO WESCO	15		
	034	3.2	ANFO WESCO	13		
	035	3.9	ANFO WESCO	15		
A	036	2.6	ANFO WESCO	10		
A	037	3.2	ANFO WESCO	13		
A	038	3.2	ANFO WESCO	13		
A	039	2.6	ANFO WESCO	10		
A	040	3.2	ANFO WESCO	13		
A	041	3.9	ANFO WESCO	15		
A	042	3.9	ANFO WESCO	15		
A	043	3.2	ANFO WESCO	13		
A	044	3.9	ANFO WESCO	15		
A	045	3.2	ANFO WESCO	13		
A	046	3.9	ANFO WESCO	15		
A	047	2.6	ANFO WESCO	10		
A	048	3.9	ANFO WESCO	15		
A	049	3.2	ANFO WESCO	13		
A	050	3.2	ANFO WESCO	13		
A	051	3.9	ANFO WESCO	15		
A	052	3.2	ANFO WESCO	13		
A	053	3.9	ANFO WESCO	15		
A	054	3.2	ANFO WESCO	13		
A	055	3.9	ANFO WESCO	15		
A	056	3.9	ANFO WESCO	15		
A	057	3.2	ANFO WESCO	13		
A	058	2.8	ANFO WESCO	10		
	059	3.9	ANFO WESCO	15		
	060	3.2	ANFO WESCO	13		
A	061	3.9	ANFO WESCO	15		
A	062	3.9	ANFO WESCO	15		
A	063	3.2	ANFO WESCO	13		
A	064	3.9	ANFO WESCO	15		
A	065	3.9	ANFO WESCO	15		
A	066	3.2	ANFO WESCO	13		
A	067	3.9	ANFO WESCO	15		
A	068	3.2	ANFO WESCO	13		
A	069	3.9	ANFO WESCO	15		
A	070	3.9	ANFO WESCO	15		
B	010	3.2	ANFO WESCO	13		
B	011	3.2	ANFO WESCO	13		
B	012	3.2	ANFO WESCO	13		
B	013	3.2	ANFO WESCO	13		
B	014	3.2	ANFO WESCO	13		
B	015	3.2	ANFO WESCO	13		
B	016	3.2	ANFO WESCO	13		
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B	023	3.2	ANFO WESCO	13		
B	024	3.2	ANFO WESCO	13		
B	025	3.2	ANFO WESCO	13		
B	026	3.2	ANFO WESCO	13		
B	027	3.2	ANFO WESCO	13		
B	028	3.2	ANFO WESCO	13		
B	029	3.2	ANFO WESCO	13		
B	030	3.2	ANFO WESCO	13		
B	031	2.6	ANFO WESCO	10		
B	032	3.2	ANFO WESCO	13		
B	033	3.2	ANFO WESCO	13		
B	034	3.2	ANFO WESCO	13		
B	035	3.2	ANFO WESCO	13		
B	036	3.2	ANFO WESCO	13		
B	037	2.6	ANFO WESCO	10		
B	038	3.2	ANFO WESCO	13		
B	039	3.2	ANFO WESCO	13		
B	040	2.6	ANFO WESCO	10		
B	041	3.2	ANFO WESCO	13		
B	042	3.2	ANFO WESCO	13		
B	043	3.2	ANFO WESCO	13		
B	044	3.2	ANFO WESCO	13		
B	045	3.2	ANFO WESCO	13		
B	046	3.2	ANFO WESCO	13		
B	047	2.6	ANFO WESCO	10		
B	048	3.2	ANFO WESCO	13		
B	049	3.2	ANFO WESCO	13		
B	050	3.2	ANFO WESCO	13		
B	051	3.2	ANFO WESCO	13		
B	052	3.2	ANFO WESCO	13		

BHP Minerals

Mix Truck Load Sheet

Job: COAL-1 Block: A

			Bottom		Top	
Row	Hole	Stm	Formula	Chg	Formula	Chg
	053	3.9	ANFO WESCO	15		
B	054	3.2	ANFO WESCO	13		
B	055	3.9	ANFO WESCO	15		
B	056	3.2	ANFO WESCO	13		
B	057	3.2	ANFO WESCO	13		
B	058	3.2	ANFO WESCO	13		
B	059	3.9	ANFO WESCO	15		
B	060	3.2	ANFO WESCO	13		
B	061	3.9	ANFO WESCO	15		
B	062	3.9	ANFO WESCO	15		
B	063	3.9	ANFO WESCO	15		
B	064	3.9	ANFO WESCO	15		
B	065	3.2	ANFO WESCO	13		
B	066	3.2	ANFO WESCO	13		
B	067	3.9	ANFO WESCO	15		
B	068	3.2	ANFO WESCO	13		
B	069	3.2	ANFO WESCO	13		
B	070	3.9	ANFO WESCO	15		
C	010	3.2	ANFO WESCO	13		
C	011	3.2	ANFO WESCO	13		
C	012	3.2	ANFO WESCO	13		
C	013	3.2	ANFO WESCO	13		
C	014	3.2	ANFO WESCO	13		
C	015	3.2	ANFO WESCO	13		
C	016	3.2	ANFO WESCO	13		
C	017	2.6	ANFO WESCO	10		
C	018	2.6	ANFO WESCO	10		
C	019	3.2	ANFO WESCO	13		
C	020	3.2	ANFO WESCO	13		
C	021	3.2	ANFO WESCO	13		
C	022	3.2	ANFO WESCO	13		
C	023	3.2	ANFO WESCO	13		
C	024	3.2	ANFO WESCO	13		
C	025	2.6	ANFO WESCO	10		
C	026	3.2	ANFO WESCO	13		
C	027	3.2	ANFO WESCO	13		
C	028	3.2	ANFO WESCO	13		
C	029	3.2	ANFO WESCO	13		
C	030	2.6	ANFO WESCO	10		
C	031	2.6	ANFO WESCO	10		
C	032	3.2	ANFO WESCO	13		
C	033	0.0	Lost			
C	034	2.6	ANFO WESCO	10		
C	035	3.2	ANFO WESCO	13		
C	036	3.2	ANFO WESCO	13		
C	037	3.2	ANFO WESCO	13		
C	038	3.2	ANFO WESCO	13		
C	039	2.6	ANFO WESCO	10		
C	040	2.6	ANFO WESCO	10		
C	041	3.2	ANFO WESCO	13		
C	042	3.2	ANFO WESCO	13		
C	043	3.2	ANFO WESCO	13		

			Bottom		Top	
Row	Hole	Stm	Formula	Chg	Formula	Chg
C	044	2.6	ANFO WESCO	10		
C	045	3.2	ANFO WESCO	13		
C	046	3.2	ANFO WESCO	13		
C	047	3.2	ANFO WESCO	13		
C	048	3.2	ANFO WESCO	13		
C	049	3.9	ANFO WESCO	15		
C	050	3.9	ANFO WESCO	15		
C	051	3.2	ANFO WESCO	13		
C	052	3.9	ANFO WESCO	15		
C	053	3.9	ANFO WESCO	15		
C	054	3.9	ANFO WESCO	15		
C	055	3.9	ANFO WESCO	15		
C	056	3.2	ANFO WESCO	13		
C	057	3.2	ANFO WESCO	13		
C	058	3.9	ANFO WESCO	15		
C	059	3.9	ANFO WESCO	15		
C	060	3.9	ANFO WESCO	15		
C	061	3.9	ANFO WESCO	15		
C	062	3.9	ANFO WESCO	15		
C	063	3.9	ANFO WESCO	15		
C	064	3.9	ANFO WESCO	15		
C	065	2.6	ANFO WESCO	10		
C	066	3.9	ANFO WESCO	15		
C	067	3.9	ANFO WESCO	15		
C	068	3.9	ANFO WESCO	15		
C	069	2.6	ANFO WESCO	10		
C	070	3.9	ANFO WESCO	15		
D	010	3.2	ANFO WESCO	13		
D	011	3.2	ANFO WESCO	13		
D	012	3.2	ANFO WESCO	13		
D	013	3.2	ANFO WESCO	13		
D	014	3.2	ANFO WESCO	13		
D	015	3.2	ANFO WESCO	13		
D	016	3.2	ANFO WESCO	13		
D	017	3.2	ANFO WESCO	13		
D	018	3.2	ANFO WESCO	13		
D	019	3.2	ANFO WESCO	13		
D	020	3.2	ANFO WESCO	13		
D	021	3.2	ANFO WESCO	13		
D	022	3.2	ANFO WESCO	13		
D	023	3.2	ANFO WESCO	13		
D	024	3.2	ANFO WESCO	13		
D	025	2.6	ANFO WESCO	10		
D	026	3.2	ANFO WESCO	13		
D	027	3.2	ANFO WESCO	13		
D	028	3.2	ANFO WESCO	13		
D	029	3.2	ANFO WESCO	13		
D	030	2.6	ANFO WESCO	10		
D	031	3.2	ANFO WESCO	13		
D	032	3.2	ANFO WESCO	13		
D	033	3.2	ANFO WESCO	13		
D	034	2.6	ANFO WESCO	10		

06/24/2005

BHP Minerals

Mix Truck Load Sheet

Job: COAL-1 Block: A

Row	Hole	Stm	Bottom Formula	Bottom Chg	Top Formula	Top Chg
D	035	3.2	ANFO WESCO	13		
D	036	3.2	ANFO WESCO	13		
D	037	3.2	ANFO WESCO	13		
D	038	3.2	ANFO WESCO	13		
D	039	3.2	ANFO WESCO	13		
D	040	3.2	ANFO WESCO	13		
D	041	3.2	ANFO WESCO	13		
D	042	3.2	ANFO WESCO	13		
D	043	3.2	ANFO WESCO	13		
D	044	2.6	ANFO WESCO	10		
D	045	3.2	ANFO WESCO	13		
D	046	3.2	ANFO WESCO	13		
D	047	2.6	ANFO WESCO	10		
D	048	3.2	ANFO WESCO	13		
D	049	3.2	ANFO WESCO	13		
D	050	3.2	ANFO WESCO	13		
D	051	3.2	ANFO WESCO	13		
D	052	3.9	ANFO WESCO	15		
D	053	3.2	ANFO WESCO	13		
D	054	3.9	ANFO WESCO	15		
D	055	3.2	ANFO WESCO	13		
D	056	3.2	ANFO WESCO	13		
D	057	3.9	ANFO WESCO	15		
D	058	3.9	ANFO WESCO	15		
	059	3.2	ANFO WESCO	13		
	060	3.9	ANFO WESCO	15		
D	061	3.2	ANFO WESCO	13		
D	062	3.9	ANFO WESCO	15		
D	063	3.9	ANFO WESCO	15		
D	064	3.2	ANFO WESCO	13		
D	065	3.2	ANFO WESCO	13		
D	066	3.9	ANFO WESCO	15		
D	067	3.9	ANFO WESCO	15		
D	068	3.9	ANFO WESCO	15		
D	069	3.2	ANFO WESCO	13		
D	070	3.2	ANFO WESCO	13		
E	010	2.6	ANFO WESCO	10		
E	011	3.2	ANFO WESCO	13		
E	012	3.2	ANFO WESCO	13		
E	013	3.2	ANFO WESCO	13		
E	014	3.2	ANFO WESCO	13		
E	015	3.2	ANFO WESCO	13		
E	016	2.6	ANFO WESCO	10		
E	017	2.6	ANFO WESCO	10		
E	018	2.6	ANFO WESCO	10		
E	019	3.2	ANFO WESCO	13		
E	020	3.2	ANFO WESCO	13		
E	021	3.2	ANFO WESCO	13		
E	022	3.2	ANFO WESCO	13		
	023	3.2	ANFO WESCO	13		
	024	3.2	ANFO WESCO	13		
E	025	2.6	ANFO WESCO	10		

Row	Hole	Stm	Bottom Formula	Bottom Chg	Top Formula	Top Chg
E	026	3.2	ANFO WESCO	13		
E	027	3.2	ANFO WESCO	13		
E	028	2.6	ANFO WESCO	10		
E	029	3.2	ANFO WESCO	13		
E	030	2.6	ANFO WESCO	10		
E	031	2.6	ANFO WESCO	10		
E	032	2.6	ANFO WESCO	10		
E	033	3.2	ANFO WESCO	13		
E	034	2.6	ANFO WESCO	10		
E	035	3.2	ANFO WESCO	13		
E	036	3.2	ANFO WESCO	13		
E	037	3.2	ANFO WESCO	13		
E	038	3.2	ANFO WESCO	13		
E	039	3.2	ANFO WESCO	13		
E	040	3.2	ANFO WESCO	13		
E	041	3.2	ANFO WESCO	13		
E	042	3.2	ANFO WESCO	13		
E	043	3.2	ANFO WESCO	13		
E	044	2.6	ANFO WESCO	10		
E	045	3.2	ANFO WESCO	13		
E	046	3.2	ANFO WESCO	13		
E	047	2.6	ANFO WESCO	10		
E	048	3.2	ANFO WESCO	13		
E	049	3.2	ANFO WESCO	13		
E	050	3.2	ANFO WESCO	13		
E	051	3.9	ANFO WESCO	15		
E	052	3.9	ANFO WESCO	15		
E	053	2.6	ANFO WESCO	10		
E	054	3.9	ANFO WESCO	15		
E	055	3.2	ANFO WESCO	13		
E	056	3.2	ANFO WESCO	13		
E	057	3.9	ANFO WESCO	15		
E	058	3.9	ANFO WESCO	15		
E	059	3.2	ANFO WESCO	13		
E	060	3.9	ANFO WESCO	15		
E	061	3.2	ANFO WESCO	13		
E	062	3.2	ANFO WESCO	13		
E	063	3.9	ANFO WESCO	15		
E	064	2.6	ANFO WESCO	10		
E	065	2.6	ANFO WESCO	10		
E	066	3.2	ANFO WESCO	13		
E	067	3.9	ANFO WESCO	15		
E	068	3.9	ANFO WESCO	15		
E	069	3.2	ANFO WESCO	13		
E	070	2.6	ANFO WESCO	10		
F	010	2.6	ANFO WESCO	10		
F	011	2.6	ANFO WESCO	10		
F	012	3.2	ANFO WESCO	13		
F	013	3.2	ANFO WESCO	13		
F	014	2.6	ANFO WESCO	10		
F	015	3.2	ANFO WESCO	13		
F	016	3.2	ANFO WESCO	13		

BHP Minerals

Mix Truck Load Sheet

Job: COAL-1 Block: A

			Bottom		Top	
Row	Hole	Stm	Formula	Chg	Formula	Chg
	017	3.2	ANFO WESCO	13		
F	018	3.2	ANFO WESCO	13		
F	019	3.2	ANFO WESCO	13		
F	020	3.2	ANFO WESCO	13		
F	021	3.2	ANFO WESCO	13		
F	022	3.2	ANFO WESCO	13		
F	023	3.2	ANFO WESCO	13		
F	024	3.2	ANFO WESCO	13		
F	025	3.2	ANFO WESCO	13		
F	026	3.2	ANFO WESCO	13		
F	027	3.2	ANFO WESCO	13		
F	028	2.6	ANFO WESCO	10		
F	029	3.2	ANFO WESCO	13		
F	030	3.2	ANFO WESCO	13		
F	031	2.6	ANFO WESCO	10		
F	032	2.6	ANFO WESCO	10		
F	033	3.2	ANFO WESCO	13		
F	034	3.2	ANFO WESCO	13		
F	035	3.2	ANFO WESCO	13		
F	036	3.2	ANFO WESCO	13		
F	037	3.2	ANFO WESCO	13		
F	038	0.0	Lost			
F	039	3.2	ANFO WESCO	13		
F	040	3.2	ANFO WESCO	13		
	041	3.2	ANFO WESCO	13		
	042	3.2	ANFO WESCO	13		
F	043	3.2	ANFO WESCO	13		
F	044	3.2	ANFO WESCO	13		
F	045	3.2	ANFO WESCO	13		
F	046	3.2	ANFO WESCO	13		
F	047	3.2	ANFO WESCO	13		
F	048	3.2	ANFO WESCO	13		
F	049	3.2	ANFO WESCO	13		
F	050	3.2	ANFO WESCO	13		
F	051	3.9	ANFO WESCO	15		
F	052	3.9	ANFO WESCO	15		
F	053	3.9	ANFO WESCO	15		
F	054	3.2	ANFO WESCO	13		
F	055	3.2	ANFO WESCO	13		
F	056	3.9	ANFO WESCO	15		
F	057	3.9	ANFO WESCO	15		
F	058	3.9	ANFO WESCO	15		
F	059	3.9	ANFO WESCO	15		
F	060	3.2	ANFO WESCO	13		
F	061	3.2	ANFO WESCO	13		
F	062	3.2	ANFO WESCO	13		
F	063	3.2	ANFO WESCO	13		
F	064	3.9	ANFO WESCO	15		
F	065	3.9	ANFO WESCO	15		
	066	3.9	ANFO WESCO	15		
	067	3.2	ANFO WESCO	13		
F	068	3.9	ANFO WESCO	15		

			Bottom		Top	
Row	Hole	Stm	Formula	Chg	Formula	Chg
F	069	3.9	ANFO WESCO	15		
F	070	3.2	ANFO WESCO	13		
G	010	3.2	ANFO WESCO	13		
G	011	3.2	ANFO WESCO	13		
G	012	3.2	ANFO WESCO	13		
G	013	2.6	ANFO WESCO	10		
G	014	3.2	ANFO WESCO	13		
G	015	3.2	ANFO WESCO	13		
G	016	3.2	ANFO WESCO	13		
G	017	3.2	ANFO WESCO	13		
G	018	3.2	ANFO WESCO	13		
G	019	3.2	ANFO WESCO	13		
G	020	3.2	ANFO WESCO	13		
G	021	3.2	ANFO WESCO	13		
G	022	3.2	ANFO WESCO	13		
G	023	3.2	ANFO WESCO	13		
G	024	3.2	ANFO WESCO	13		
G	025	3.2	ANFO WESCO	13		
G	026	3.2	ANFO WESCO	13		
G	027	3.2	ANFO WESCO	13		
G	028	3.2	ANFO WESCO	13		
G	029	3.2	ANFO WESCO	13		
G	030	3.2	ANFO WESCO	13		
G	031	3.2	ANFO WESCO	13		
G	032	2.6	ANFO WESCO	10		
G	033	3.2	ANFO WESCO	13		
G	034	2.6	ANFO WESCO	10		
G	035	3.2	ANFO WESCO	13		
G	036	3.2	ANFO WESCO	13		
G	037	3.2	ANFO WESCO	13		
G	038	0.0	Lost			
G	039	3.2	ANFO WESCO	13		
G	040	3.2	ANFO WESCO	13		
G	041	3.2	ANFO WESCO	13		
G	042	3.2	ANFO WESCO	13		
G	043	3.2	ANFO WESCO	13		
G	044	3.2	ANFO WESCO	13		
G	045	3.2	ANFO WESCO	13		
G	046	3.2	ANFO WESCO	13		
G	047	3.2	ANFO WESCO	13		
G	048	3.2	ANFO WESCO	13		
G	049	3.2	ANFO WESCO	13		
G	050	3.2	ANFO WESCO	13		
G	051	3.2	ANFO WESCO	13		
G	052	3.2	ANFO WESCO	13		
G	053	3.2	ANFO WESCO	13		
G	054	2.6	ANFO WESCO	10		
G	055	2.6	ANFO WESCO	10		
G	056	3.2	ANFO WESCO	13		
G	057	3.2	ANFO WESCO	13		
G	058	3.2	ANFO WESCO	13		
G	059	3.9	ANFO WESCO	15		

BHP Minerals

Mix Truck Load Sheet

Job: COAL-1 Block: A

			Bottom		Top	
Row	Hole	Stm	Formula	Chg	Formula	Chg
G	060	3.2	ANFO WESCO	13		
G	061	3.2	ANFO WESCO	13		
G	062	3.2	ANFO WESCO	13		
G	063	3.2	ANFO WESCO	13		
G	064	3.2	ANFO WESCO	13		
G	065	3.2	ANFO WESCO	13		
G	066	3.2	ANFO WESCO	13		
G	067	2.6	ANFO WESCO	10		
G	068	3.2	ANFO WESCO	13		
G	069	3.2	ANFO WESCO	13		
G	070	0.0	Lost			
H	010	2.6	ANFO WESCO	10		
H	011	2.6	ANFO WESCO	10		
H	012	2.6	ANFO WESCO	10		
H	013	3.2	ANFO WESCO	13		
H	014	3.2	ANFO WESCO	13		
H	015	3.2	ANFO WESCO	13		
H	016	3.2	ANFO WESCO	13		
H	017	3.2	ANFO WESCO	13		
H	018	3.2	ANFO WESCO	13		
H	019	3.2	ANFO WESCO	13		
H	020	3.2	ANFO WESCO	13		
H	021	3.2	ANFO WESCO	13		
H	022	3.2	ANFO WESCO	13		
H	023	3.2	ANFO WESCO	13		
H	024	3.2	ANFO WESCO	13		
H	025	3.2	ANFO WESCO	13		
H	026	3.2	ANFO WESCO	13		
H	027	3.2	ANFO WESCO	13		
H	028	3.2	ANFO WESCO	13		
H	029	3.2	ANFO WESCO	13		
H	030	3.2	ANFO WESCO	13		
H	031	3.2	ANFO WESCO	13		
H	032	3.2	ANFO WESCO	13		
H	033	3.2	ANFO WESCO	13		
H	034	3.2	ANFO WESCO	13		
H	035	3.2	ANFO WESCO	13		
H	036	3.2	ANFO WESCO	13		
H	037	3.9	ANFO WESCO	15		
H	038	3.9	ANFO WESCO	15		
H	039	3.9	ANFO WESCO	15		
H	040	3.2	ANFO WESCO	13		
H	041	3.2	ANFO WESCO	13		
H	042	3.2	ANFO WESCO	13		
H	043	3.2	ANFO WESCO	13		
H	044	3.2	ANFO WESCO	13		
H	045	3.2	ANFO WESCO	13		
H	046	3.2	ANFO WESCO	13		
H	047	3.2	ANFO WESCO	13		
H	048	3.9	ANFO WESCO	15		
H	049	3.2	ANFO WESCO	13		
H	050	3.2	ANFO WESCO	13		
H	051	3.2	ANFO WESCO	13		
H	052	2.6	ANFO WESCO	10		
H	053	3.2	ANFO WESCO	13		
H	054	2.6	ANFO WESCO	10		
H	055	2.6	ANFO WESCO	10		
H	056	2.6	ANFO WESCO	10		
H	057	3.2	ANFO WESCO	13		
H	058	3.2	ANFO WESCO	13		
H	059	3.9	ANFO WESCO	15		
H	060	2.6	ANFO WESCO	10		
H	061	3.2	ANFO WESCO	13		
H	062	3.9	ANFO WESCO	15		
H	063	2.6	ANFO WESCO	10		
H	064	2.6	ANFO WESCO	10		
H	065	2.6	ANFO WESCO	10		
H	066	2.6	ANFO WESCO	10		
H	067	2.6	ANFO WESCO	10		
H	068	3.2	ANFO WESCO	13		
H	069	2.6	ANFO WESCO	10		
H	070	0.0	Lost			
I	010	3.2	ANFO WESCO	13		
I	011	3.2	ANFO WESCO	13		
I	012	3.2	ANFO WESCO	13		
I	013	3.2	ANFO WESCO	13		
I	014	2.6	ANFO WESCO	10		
I	015	3.2	ANFO WESCO	13		
I	016	3.2	ANFO WESCO	13		
I	017	3.2	ANFO WESCO	13		
I	018	3.2	ANFO WESCO	13		
I	019	3.2	ANFO WESCO	13		
I	020	3.2	ANFO WESCO	13		
I	021	3.2	ANFO WESCO	13		
I	022	3.2	ANFO WESCO	13		
I	023	3.2	ANFO WESCO	13		
I	024	3.2	ANFO WESCO	13		
I	025	3.2	ANFO WESCO	13		
I	026	3.2	ANFO WESCO	13		
I	027	3.2	ANFO WESCO	13		
I	028	3.2	ANFO WESCO	13		
I	029	3.2	ANFO WESCO	13		
I	030	3.2	ANFO WESCO	13		
I	031	3.2	ANFO WESCO	13		
I	032	3.2	ANFO WESCO	13		
I	033	3.2	ANFO WESCO	13		
I	034	3.2	ANFO WESCO	13		
I	035	3.2	ANFO WESCO	13		
I	036	3.2	ANFO WESCO	13		
I	037	2.6	ANFO WESCO	10		
I	038	3.2	ANFO WESCO	13		
I	039	3.2	ANFO WESCO	13		
I	040	2.6	ANFO WESCO	10		
I	041	3.2	ANFO WESCO	13		

BHP Minerals

Mix Truck Load Sheet

Job: COAL-1 Block: A

Row	Hole	Stm	Bottom Formula	Bottom Chg	Top Formula	Top Chg
I	042	3.2	ANFO WESCO	13		
I	043	3.2	ANFO WESCO	13		
I	044	2.6	ANFO WESCO	10		
I	045	3.2	ANFO WESCO	13		
I	046	3.2	ANFO WESCO	13		
I	047	3.2	ANFO WESCO	13		
I	048	3.2	ANFO WESCO	13		
I	049	3.2	ANFO WESCO	13		
I	050	3.2	ANFO WESCO	13		
I	051	2.6	ANFO WESCO	10		
I	052	3.2	ANFO WESCO	13		
I	053	3.2	ANFO WESCO	13		
I	054	3.9	ANFO WESCO	15		
I	055	2.6	ANFO WESCO	10		
I	056	2.6	ANFO WESCO	10		
I	057	3.9	ANFO WESCO	15		
I	058	3.9	ANFO WESCO	15		
I	059	3.9	ANFO WESCO	15		
I	060	3.2	ANFO WESCO	13		
I	061	3.9	ANFO WESCO	15		
I	062	3.9	ANFO WESCO	15		
I	063	3.9	ANFO WESCO	15		
I	064	3.9	ANFO WESCO	15		
I	065	3.9	ANFO WESCO	15		
I	066	3.2	ANFO WESCO	13		
I	067	3.2	ANFO WESCO	13		
I	068	3.9	ANFO WESCO	15		
I	069	2.6	ANFO WESCO	10		
I	070	0.0	Lost			
J	010	3.2	ANFO WESCO	13		
J	011	2.6	ANFO WESCO	10		
J	012	2.6	ANFO WESCO	10		
J	013	2.6	ANFO WESCO	10		
J	014	2.6	ANFO WESCO	10		
J	015	3.2	ANFO WESCO	13		
J	016	3.2	ANFO WESCO	13		
J	017	3.2	ANFO WESCO	13		
J	018	3.2	ANFO WESCO	13		
J	019	3.2	ANFO WESCO	13		
J	020	3.2	ANFO WESCO	13		
J	021	3.2	ANFO WESCO	13		
J	022	3.2	ANFO WESCO	13		
J	023	3.2	ANFO WESCO	13		
J	024	3.2	ANFO WESCO	13		
J	025	3.2	ANFO WESCO	13		
J	026	3.2	ANFO WESCO	13		
J	027	3.2	ANFO WESCO	13		
J	028	3.2	ANFO WESCO	13		
J	029	3.2	ANFO WESCO	13		
	030	3.2	ANFO WESCO	13		
J	031	3.2	ANFO WESCO	13		
J	032	3.2	ANFO WESCO	13		

Row	Hole	Stm	Bottom Formula	Bottom Chg	Top Formula	Top Chg
J	033	3.2	ANFO WESCO	13		
J	034	3.2	ANFO WESCO	13		
J	035	3.2	ANFO WESCO	13		
J	036	2.6	ANFO WESCO	10		
J	037	3.2	ANFO WESCO	13		
J	038	3.2	ANFO WESCO	13		
J	039	3.2	ANFO WESCO	13		
J	040	2.6	ANFO WESCO	10		
J	041	3.9	ANFO WESCO	15		
J	042	3.2	ANFO WESCO	13		
J	043	3.2	ANFO WESCO	13		
J	044	2.6	ANFO WESCO	10		
J	045	3.2	ANFO WESCO	13		
J	046	3.2	ANFO WESCO	13		
J	047	3.2	ANFO WESCO	13		
J	048	3.2	ANFO WESCO	13		
J	049	3.2	ANFO WESCO	13		
J	050	3.2	ANFO WESCO	13		
J	051	3.2	ANFO WESCO	13		
J	052	3.2	ANFO WESCO	13		
J	053	3.2	ANFO WESCO	13		
J	054	3.2	ANFO WESCO	13		
J	055	3.2	ANFO WESCO	13		
J	056	3.2	ANFO WESCO	13		
J	057	3.2	ANFO WESCO	13		
J	058	3.2	ANFO WESCO	13		
J	059	3.2	ANFO WESCO	13		
J	060	3.2	ANFO WESCO	13		
J	061	2.6	ANFO WESCO	10		
J	062	2.6	ANFO WESCO	10		
J	063	2.6	ANFO WESCO	10		
J	064	3.2	ANFO WESCO	13		
J	065	3.2	ANFO WESCO	13		
J	066	2.6	ANFO WESCO	10		
J	067	2.6	ANFO WESCO	10		
J	068	3.2	ANFO WESCO	13		
J	069	2.6	ANFO WESCO	10		
J	070	0.0	Lost			

BHP Minerals

Mix Truck Load Sheet Totals

Job: COAL-1 Block: A

Formula Name	Total Pounds
ANFO WESCO	7,758

BHP Minerals
BLASTING REPORT

b: 67NB6B-5

Date: 07/28/2004	Pit and Seam: North Barber / 6B	Strip: 67	Blaster: Chandley, Sterling
Time: 09:29AM	Station: 42+50 to 70+00		License:
Shift: Day	Material: PitFloor		
Crew Size: 4	Total Manhours: 16	Holes/Manhour: 8.94	Signature:

ITEM	BLOCK A	BLOCK B	BLOCK C	BLOCK D	TOTAL
Hole Diameter	10.63				
Burden	26				
Spacing	34				
Total Depth	3148				
Average Depth	22				
Total Holes	143				143
Volume Blasted	103,002				103,002
Stemming Height	11.7				
#1 Deck					
#2 Deck					
Stemming Material	Hole Cuttings				
EXPLOSIVES TYPE	POUNDS	POUNDS	POUNDS	POUNDS	TOTAL POUNDS
26% Emul WESCO	60,288				60,288
Total Weight of Explosives	60,288				60,288

BOOSTERS	WT	QTY	POUNDS	QTY	POUNDS	QTY	POUNDS	QTY	POUNDS	QTY	POUNDS
P-32 Booster	2.00	140	280							140	280
Total Boosters		140	280							140	280

TOTALS					
Total Explosives Weight	60,568				60,568
Powder Factor (lbs/bcy)	0.59				0.59
Number Holes Loaded	140				140
Average Pounds / Hole	432				432

OTHER

Initiation Type
ZAP Ensign Bickford

Legal Weight & Distance
Max. Chg / 8ms Interval: 7,425 Scaled Distance: 65
No. Holes / 8ms Interval: 15 Min. Distance: 5,601

Blasting Mats: No

Nearest Structure
Name: J. Lowe Distance: 11,798
Type: Dwelling Direction: SSW

Weather
Sky Conditions: Cloudy Wind Speed: 5
Temperature: 74 Wind Direction: N

Reasons for unscheduled shot (if applicable) / Other Comments
3 HOLES LOST NOT PRIMED.

BHP Minerals
BLASTING REPORT

Job: 67NB6B-5

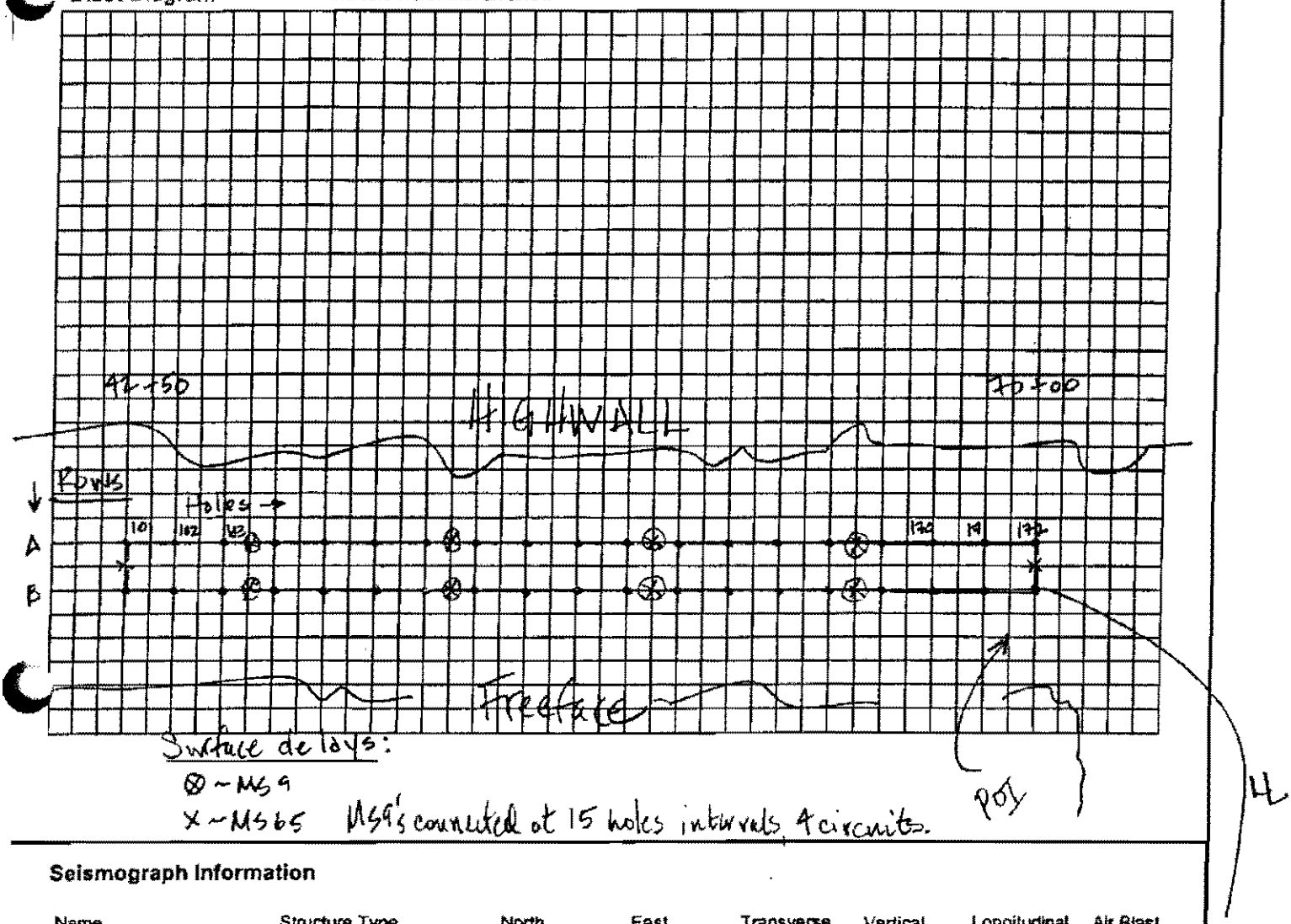
Category	Description	Quantity
Detonating Cord	ZAP Ensign Bickford	6
EB InHole Delays	EBMS #4 Ensign Bickford	1
EB Surface Delays	MS-009 Ensign Bickford	8
EB Surface Delays	MS-065 Ensign Bickford	2

BHP Minerals
BLASTING REPORT

Job: 67NB6B-5

N

Blast Diagram Indicate North with an arrow



Surface delays:
⊗ ~ MS 9
X ~ MS 65 MS9's connected at 15 holes intervals, 4 circuits.

Seismograph Information

Name	Structure Type	North	East	Transverse	Vertical	Longitudinal	Air Blast (dB)
				PPV(ips) / Freq(Hz)			
Not Monitored							

BHP Minerals
BLASTING REPORT

Iob: 67NB6B-5

Block	Row	Number	Position	Depth	Status	Stem Ht	Charge Type	Charge Wt.
A	A	101	Bottom	0	Lost			
	A	102	Bottom	23	Dry	12	26% Emul WESCO	441
	A	103	Bottom	22	Dry	11	26% Emul WESCO	420
	A	104	Bottom	22	Dry	11	26% Emul WESCO	420
	A	105	Bottom	22	Dry	11	26% Emul WESCO	420
	A	106	Bottom	22	Dry	11	26% Emul WESCO	420
	A	107	Bottom	22	Dry	11	26% Emul WESCO	420
	A	108	Bottom	23	Dry	12	26% Emul WESCO	441
	A	109	Bottom	23	Dry	12	26% Emul WESCO	441
	A	110	Bottom	22	Dry	11	26% Emul WESCO	420
	A	111	Bottom	22	Dry	11	26% Emul WESCO	420
	A	112	Bottom	22	Dry	11	26% Emul WESCO	420
	A	113	Bottom	22	Dry	11	26% Emul WESCO	420
	A	114	Bottom	23	Dry	12	26% Emul WESCO	441
	A	115	Bottom	23	Dry	12	26% Emul WESCO	441
	A	116	Bottom	22	Dry	11	26% Emul WESCO	420
	A	117	Bottom	22	Dry	11	26% Emul WESCO	420
	A	118	Bottom	22	Dry	11	26% Emul WESCO	420
	A	119	Bottom	22	Dry	11	26% Emul WESCO	420
	A	120	Bottom	23	Dry	12	26% Emul WESCO	441
	A	121	Bottom	23	Dry	12	26% Emul WESCO	441
	A	122	Bottom	23	Dry	12	26% Emul WESCO	441
	A	123	Bottom	23	Dry	12	26% Emul WESCO	441
	A	124	Bottom	23	Dry	12	26% Emul WESCO	441
	A	125	Bottom	23	Dry	12	26% Emul WESCO	441
	A	126	Bottom	23	Dry	12	26% Emul WESCO	441
	A	127	Bottom	22	Dry	11	26% Emul WESCO	420
	A	128	Bottom	22	Dry	11	26% Emul WESCO	420
	A	129	Bottom	23	Dry	12	26% Emul WESCO	441
	A	130	Bottom	22	Dry	11	26% Emul WESCO	420
	A	131	Bottom	23	Dry	12	26% Emul WESCO	441
	A	132	Bottom	23	Dry	12	26% Emul WESCO	441
	A	133	Bottom	23	Dry	12	28% Emul WESCO	441
	A	134	Bottom	24	Dry	12	26% Emul WESCO	462
	A	135	Bottom	22	Dry	11	26% Emul WESCO	420
	A	136	Bottom	23	Dry	12	28% Emul WESCO	441
	A	137	Bottom	23	Dry	12	28% Emul WESCO	441
	A	138	Bottom	24	Dry	12	26% Emul WESCO	462
	A	139	Bottom	24	Dry	12	26% Emul WESCO	462
	A	140	Bottom	23	Dry	12	26% Emul WESCO	441
	A	141	Bottom	23	Dry	12	26% Emul WESCO	441
	A	142	Bottom	23	Dry	12	26% Emul WESCO	441
	A	143	Bottom	23	Dry	12	26% Emul WESCO	441
	A	144	Bottom	24	Dry	12	26% Emul WESCO	462
	A	145	Bottom	24	Dry	12	26% Emul WESCO	462
	A	146	Bottom	24	Dry	12	28% Emul WESCO	462
	A	147	Bottom	25	Dry	13	26% Emul WESCO	495
	A	148	Bottom	23	Dry	12	26% Emul WESCO	441
	A	149	Bottom	25	Dry	13	26% Emul WESCO	495
	A	150	Bottom	25	Dry	13	26% Emul WESCO	495
	A	151	Bottom	22	Dry	11	26% Emul WESCO	420
	A	152	Bottom	22	Dry	11	26% Emul WESCO	420
	A	153	Bottom	22	Dry	11	26% Emul WESCO	420
	A	154	Bottom	22	Dry	11	28% Emul WESCO	420

BHP Minerals
BLASTING REPORT

ob: 67NB6B-5

Block	Row	Number	Position	Depth	Status	Stem Ht	Charge Type	Charge Wt.
A	A	155	Bottom	22	Dry	11	26% Emul WESCO	420
	A	156	Bottom	22	Dry	11	26% Emul WESCO	420
	A	157	Bottom	22	Dry	11	26% Emul WESCO	420
	A	158	Bottom	22	Dry	11	26% Emul WESCO	420
	A	159	Bottom	22	Dry	11	26% Emul WESCO	420
	A	160	Bottom	23	Dry	12	26% Emul WESCO	441
	A	161	Bottom	22	Dry	11	26% Emul WESCO	420
	A	162	Bottom	22	Dry	11	26% Emul WESCO	420
	A	163	Bottom	22	Dry	11	26% Emul WESCO	420
	A	164	Bottom	22	Dry	11	26% Emul WESCO	420
	A	165	Bottom	20	Dry	10	26% Emul WESCO	378
	A	166	Bottom	22	Dry	11	26% Emul WESCO	420
	A	167	Bottom	23	Dry	12	26% Emul WESCO	441
	A	168	Bottom	22	Dry	11	26% Emul WESCO	420
	A	169	Bottom	22	Dry	11	26% Emul WESCO	420
	A	170	Bottom	22	Dry	11	26% Emul WESCO	420
	A	171	Bottom	22	Dry	11	26% Emul WESCO	420
	A	172	Bottom	23	Dry	12	26% Emul WESCO	441
	B	101	Bottom	0	Lost			
	B	102	Bottom	0	Lost			
	B	103	Bottom	22	Dry	11	26% Emul WESCO	420
	B	104	Bottom	21	Dry	11	26% Emul WESCO	399
	B	105	Bottom	21	Dry	11	26% Emul WESCO	399
	B	106	Bottom	22	Dry	11	26% Emul WESCO	420
	B	107	Bottom	22	Dry	11	26% Emul WESCO	420
	B	108	Bottom	22	Dry	11	26% Emul WESCO	420
	B	109	Bottom	23	Dry	12	26% Emul WESCO	441
	B	110	Bottom	21	Dry	11	26% Emul WESCO	399
	B	111	Bottom	22	Dry	11	26% Emul WESCO	420
	B	112	Bottom	22	Dry	11	26% Emul WESCO	420
	B	113	Bottom	22	Dry	11	26% Emul WESCO	420
	B	114	Bottom	22	Dry	11	26% Emul WESCO	420
	B	115	Bottom	22	Dry	11	26% Emul WESCO	420
	B	116	Bottom	23	Dry	12	26% Emul WESCO	441
	B	117	Bottom	22	Dry	11	26% Emul WESCO	420
	B	118	Bottom	22	Dry	11	26% Emul WESCO	420
	B	119	Bottom	22	Dry	11	26% Emul WESCO	420
	B	120	Bottom	22	Dry	11	26% Emul WESCO	420
	B	121	Bottom	24	Dry	12	26% Emul WESCO	462
	B	122	Bottom	23	Dry	12	26% Emul WESCO	441
	B	123	Bottom	19	Dry	10	26% Emul WESCO	357
	B	124	Bottom	22	Dry	11	26% Emul WESCO	420
	B	125	Bottom	18	Dry	9	26% Emul WESCO	336
	B	126	Bottom	22	Dry	11	26% Emul WESCO	420
	B	127	Bottom	23	Dry	12	26% Emul WESCO	441
	B	128	Bottom	23	Dry	12	26% Emul WESCO	441
	B	129	Bottom	23	Dry	12	26% Emul WESCO	441
	B	130	Bottom	22	Dry	11	26% Emul WESCO	420
	B	131	Bottom	23	Dry	12	26% Emul WESCO	441
	B	132	Bottom	22	Dry	11	26% Emul WESCO	420
	B	133	Bottom	22	Dry	11	26% Emul WESCO	420
	B	134	Bottom	22	Dry	11	26% Emul WESCO	420
	B	135	Bottom	22	Dry	11	26% Emul WESCO	420
	B	136	Bottom	23	Dry	12	26% Emul WESCO	441

BHP Minerals
BLASTING REPORT

Job: 67NB6B-5

Block	Row	Number	Position	Depth	Status	Stem Ht	Charge Type	Charge Wt.
A	B	137	Bottom	23	Dry	12	26% Emul WESCO	441
	B	138	Bottom	23	Dry	12	26% Emul WESCO	441
	B	139	Bottom	24	Dry	12	26% Emul WESCO	462
	B	140	Bottom	24	Dry	12	26% Emul WESCO	462
	B	141	Bottom	24	Dry	12	26% Emul WESCO	462
	B	142	Bottom	25	Dry	13	26% Emul WESCO	495
	B	143	Bottom	24	Dry	12	26% Emul WESCO	462
	B	144	Bottom	23	Dry	12	26% Emul WESCO	441
	B	145	Bottom	24	Dry	12	26% Emul WESCO	462
	B	146	Bottom	22	Dry	11	26% Emul WESCO	420
	B	147	Bottom	22	Dry	11	26% Emul WESCO	420
	B	148	Bottom	25	Dry	13	26% Emul WESCO	495
	B	149	Bottom	23	Dry	12	26% Emul WESCO	441
	B	150	Bottom	24	Dry	12	26% Emul WESCO	462
	B	151	Bottom	22	Dry	11	26% Emul WESCO	420
	B	152	Bottom	22	Dry	11	26% Emul WESCO	420
	B	153	Bottom	22	Dry	11	26% Emul WESCO	420
	B	154	Bottom	22	Dry	11	26% Emul WESCO	420
	B	155	Bottom	22	Dry	11	26% Emul WESCO	420
	B	156	Bottom	22	Dry	11	26% Emul WESCO	420
	B	157	Bottom	22	Dry	11	26% Emul WESCO	420
	B	158	Bottom	21	Dry	11	26% Emul WESCO	399
	B	159	Bottom	23	Dry	12	26% Emul WESCO	441
	B	160	Bottom	23	Dry	12	26% Emul WESCO	441
	B	161	Bottom	22	Dry	11	26% Emul WESCO	420
	B	162	Bottom	22	Dry	11	26% Emul WESCO	420
	B	163	Bottom	22	Dry	11	26% Emul WESCO	420
	B	164	Bottom	22	Dry	11	26% Emul WESCO	420
	B	165	Bottom	19	Dry	10	26% Emul WESCO	357
	B	166	Bottom	22	Dry	11	26% Emul WESCO	420
	B	167	Bottom	23	Dry	12	26% Emul WESCO	441
	B	168	Bottom	23	Dry	12	26% Emul WESCO	441
	B	169	Bottom	22	Dry	11	26% Emul WESCO	420
	B	170	Bottom	21	Dry	11	26% Emul WESCO	399
	B	171	Bottom	24	Dry	12	26% Emul WESCO	462
Totals for		143		3,148		12		60,288
Totals for Job		143		3,148				60,288

SCALE DISTANCE FACTOR APPROVALS

23-D-1

Xerox Copy to
C. Ellefson
B. Kaatz
S. Gregan
J. Francis
Then File

XC [redacted]
Garth W.

United States Department of the Interior
OFFICE OF SURFACE MINING
Reclamation and Enforcement
BROOKS TOWERS
1020 15TH STREET
DENVER, COLORADO 80202

MAY 9 1985

Mr. R. C. Diederich
Mine Manager, Navajo Mine
Utah International Inc.
P.O. Box 155
Fruitland, New Mexico 87416

Dear Mr. Diederich,

The purpose of this letter is to approve the proposed blasting plan submitted on May 9, 1985 for blasting adjacent to the Texas-New Mexico Pipeline Company's Petroleum Pipeline that is within your permit boundary. My staff has performed a technical evaluation of the "Seismic Study in the Bighan Pit Area" which included a regression analysis of the seismic data contained in the report. This analysis confirmed that blasting with a scaling factor of 13 would keep the peak particle velocity at the petroleum pipeline below the recommended 5 inch per second limit.

If you have any questions concerning this matter please feel free to contact me or Keith Kirk of my staff who was responsible for the technical evaluation of this material.

Sincerely,

Allen D. Klein
Administrator

cc: Robert Hagen
Ed Kelly

UTAH INTERNATIONAL INC.
NAVAJO MINE
POST OFFICE BOX 155 • FRUITLAND, NEW MEXICO 87416
(505) 598-5561

May 09, 1985

Mr. Allen D. Klein, Administrator
Western Technical Center
Office of Surface Mining
Brooks Towers
1020 15th Street
Denver, CO 80202

Dear Mr. Klein:

Utah International Inc., Navajo Mine, is requesting approval of a modififed scaled distance factor Ds=13 to be used when blasting in the vicinity of the Texas-New Mexico Pipeline and the Public Service Company of New Mexico Powerlines (see map) as per CFR 30 Section 816.67 (d)(3)(ii).

In support of this request we are submitting the attached "Seismic Study in the Bighan Pit Area". A scaled distance factor Ds=10 is the result when the 59 seismic data points are analyzed according to the 95 confidence level criteria. We are requesting approval of a scaled distance factor Ds=13 because it includes the maximum positive deviation and will insure that the peak particle velocity is not exceeded.

Sincerely,

R.C. Diederich
Mine Manager
Navajo Mine

plb

White Industrial Seismology, Inc.
2431 RANGELINE SUITE A-B
P.O. BOX 1256
JOPLIN, MO 64802-1256
PH. (417) 624-0164

April 27, 1985

Utah International, Inc.
Navajo Mine
P. O. Box 155
Fruitland, New Mexico 87416

Attention: Mr. George Gilfillan, Mine Engineer

Dear Mr. Gilfillan:

You have requested that we suggest an upper limit for your blast vibration effects. This limit is to be directed toward safety for large power transmission lines and a buried pipeline in the vicinity of the Big Han area of the Navajo Mine of Utah International, Inc.

A search of literature reveals that blast tests imposing over 100 inches per second peak particle velocity on buried pipelines have been carried out without any damage being sustained by the lines. My own experience has been that buried pipelines can withstand much higher ground vibration levels than those that are considered dangerous for residental structures. On several occasions, I have witnessed mine blasting being conducted within very short distances of petroleum products lines with no occurrence of blasting damage being noted.

Large power transmission lines mounted on poles or towers are designed to sustain severe wind loading. Mining directly adjacent to power lines gives rise to more concern for protecting blasters from electric shock than from possible damage to the lines by blasting.

The ability of these two facilities to withstand severe vibration loading should be self evident. However, as a matter of prudence, we feel that an upper limit of five inches per second peak particle velocity would be a reasonable limit for either of these two structures. Five inches per second peak particle velocity is sufficient enough to provide a wide margin of safety for either structure but liberal enough that you should be able to devise an economically feasible blasting program to meet this limit.

We refer you to the following literature in support of this blast vibration level as a limit:

1. Glasstone, S. and P. J. Dolan, Eds., The Effects of Nuclear Weapons, United States Department of Defense and the United States Department of Energy, 1977.

2. Langefors, U. and B. Kihlstrom, The Modern Technique of Rock Blasting, John H. Wiley and Sons, New York, 1973.

3. Wada, M., "Behavior of Submarine Steel Pipelines Subjected to Shock Pressure of Underwater Blasting. 3. Analysis of Experimental Results and Discussion," Journal of the Industrial Explosives Society, Japan, Vol. 41, 1980, pp. 106 - 23. Translated from Japanese to English by P. R. Kanada, for the USBM, Amerind Publishing Company, Pvt. Ltd., New Delhi, 1983.

4. Wustine, P. S., E. D. Esparza and A. B. Wenzel, Analysis and Testing of Pipe Response to Buried Explosive Detonations, Southwest Research Institute, San Antonio, 1978.

Please do not hesitate to call if we can be of further help.

Very truly yours,

WHITE INDUSTRIAL SEISMOLOGY, INC.

David S. Bowling, C.P.G.S.
Consulting Geophysicist

DSB/tj

White Industrial Seismology, Inc.
2431 RANGELINE SUITE A-B
P.O. BOX 1256
JOPLIN, MO 64802-1256
PH. (417) 624-0164

April 27, 1985

SUBJECT: Measurements of Blast Effects
Utah International, Inc.
Navajo Mine
April 3 and 4, 1985

TO: Utah International, Inc.
Navajo Mine
P. O. Box 155
Fruitland, New Mexico 87416

Attention: Mr. George Gilfillan

AUTHORITY AND PURPOSE

On April 3 and 4, 1985, at the request of Mr. George Gilfillan, personnel from White Industrial Seismology, Inc. visited the Coal Mining operation of Utah International, Inc.'s Navajo Mine, located near Farmington, New Mexico. The purpose of this visit was to secure measurements of earthborne and airborne effects produced by blasting at this operation. It was the further purpose of this study to relate these measurements to a suggested ground vibration limit of 5.0 inches per second with regard to underground pipelines and overhead power lines.

INSTRUMENTATION

Ten full waveform seismographs were provided by White to measure the seismic and acoustic effects produced by the blasts fired on these dates. The sensing elements of each of these instruments consists of a triaxial seismometer and a condenser microphone. These sensing elements simultaneously measure three components of ground motion, two horizontal and one vertical, plus the airblast effects. The measured signals are amplified and recorded on magnetic tape by a four track recording system. The magnetic tape becomes a time history of the ground vibration and airblast effects produced at the recording point. These tapes may be transcribed to visual seismograms, or they may be analyzed directly by a computer for peak amplitude, frequency content, or other parameters of interest.

In addition to their hard copy tape storage, each seismograph is also provided with a direct reading meter by which the peak particle velocity amplitude of ground vibration may be read directly at the time of a test. These meters are designed with peak holding capability eliminating the necessity for an immediate observation at shot moment.

Instrumentation - Continued

The instruments used during this study consisted of White Seismo Sentinel Units, Models ST-4; Seismo Tape III units, Models SM-4; and Seismo Tape I and II units, Models BT-4. All of the instruments provided were manufactured by Dallas Instruments, Inc. The Dallas Instruments seismographs have been tested for accuracy and response characteristics by the United States Bureau of Mines. These tests are noted in the USBM's reports of investigation, RI 8506, "Measurements of Blast Induced Ground Vibration and Seismograph Calibration," and RI 8508, "Airblast Instrumentation and Measurement Techniques for Surface Mine Blasting."

Manufacturer's instrument specifications for these seismographs are presented as Appendix I.

SHOT DATA

Six blasts were fired to produce the data for this study. The blasts ranged from a single hole to two multi-hole shots. Five were loaded and fired on April 3, 1985. The sixth shot, which was the largest in terms of number of holes and total pounds, was fired April 4, 1985. Pertinent details of each shot were provided by Utah International, Inc. Copies of the shot reports are included in Appendix II.

INSTRUMENT POSITIONS

Instrument positions were predetermined from topographic maps provided by the mine. These positions were staked and surveyed by the mine surveyors.

The recording site selections were made to cover three different directions. Two of the directions were at approximate right angles to each other. The third was along an azimuth between the quadrant formed by the two perpindicular lines.

Instrument positions along each azimuth were staggered so that all would provide measurements at points of increasing distance from each blast. The shot to instrument distances for the entire study ranged from 194 feet to 2167 feet.

The ground surface lying east of the blast area was primarily a sand. In order to assure a similar couple at all stations, a hole of 12 to 15 inches deep was dug at each station. The seismic sensors were spiked to the earth in the bottom of each hole by means of a three inch spike attached to the bottom of the case. The holes were then filled and tamped solid.

A sketch map has been prepared showing the locations of the blasts and the instruments. This is included in Appendix II.

MEASUREMENTS

Peak particle velocity amplitude measurements with peak airblast overpressure measurements are listed in the summaries of blast details and vibration measurements. These are found in Appendix III. Each of the magnetic tape recordings obtained during this study has been computer analyzed for peak amplitudes and frequency. Fifty-nine computer plotted and analyzed seismograms are included with this report as Appendix IV.

There was one instrument station that did not obtain a measurement for Shot #6. This occurred at Station C2. The unit placed at this station was equipped with both airblast and ground vibration triggering capability. The wind became quite strong on April 4, which caused excessive triggering of the instrument. Both the hard copy tape recording and the memory storage capacity were exceeded and the shot measurements were lost.

An intermittent malfunction occurred on the vertical channel in the instrument placed at Station A3. This malfunction occurred on Shots #2, #3 and #4. The data recorded on Shots #1, #5 and #6 appear to be accurate. As a consequence of this malfunction, this instrument, ID 141, has been submitted to the manufacturer for repair and validation of the radial and transverse measurements for Shots #2, #3 and #4. We believe these measurements to be accurate. The manufacturers statement will be submitted when received. Use of the measurement on the radial channel for these three shots should not introduce significant error to this study.

GENERAL TECHNICAL DISCUSSION

The peak particle velocity of ground motion which may be produced at a given point within the general vicinity of a blasting operation is heavily dependent on both the quantity of explosives fired at a single instant in time and the distance between the shot and the point of interest. Other factors such as the quality of explosives, placement of blast holes and lateral changes in the lithology may also affect the peak velocity amplitude. However, quantity of explosives and distance between the shot and a point of interest are the primary controlling factors of particle velocity amplitude.

When a shot is fired in an operation, the earth and rock surrounding this shot, that is not fractured by the blast, behaves as an elastic carrier to disperse the residual energy. As the ground vibration wave is transmitted away from the shot site, the volume of earth that is affected becomes a hemisphere of rapidly increasing radius. The quantity of energy that was originally released as a seismic pulse is accordingly dispersed in the increasingly greater volume contained within this hemisphere.

Typically, the lateral distance from a confined hole in a shot at which rock fracturing ceases is approximately 30 - 35 hole diameters. From the instant of formation, the amplitude of the seismic pulse decreases rapidly

General Technical Discussion - Continued

with increasing distance as it travels away from the source. The peak particle velocity amplitude which is representative of the energy levels contained within this pulse or wave train is essentially dispersed within ten burden distances from a shot, although perceptible ground vibrations may persist for several thousand feet. The dispersal of seismic energy resulting from these test shots is amply illustrated by Figures I and II in Appendix V.

Both the USBM and other researchers have shown that peak ground vibration amplitudes and peak airblast overpressures decrease exponentially with distance from the shot. The peak particle velocity amplitudes produced by a blast may be estimated by an equation of the form $V = I(D)^S$, where V = particle velocity amplitude, D = blast to instrument distance, S = the slope or rate of amplitude decrease with distance and I is a constant of proportionality equal to the peak particle velocity at unit distance. This standard propagation equation, which applies to a single blast, will also apply to other shots in a blasting operation, when an equalizing or scaling factor is applied.

A site specific equation can be developed for a particular mine site. Such equations are useful for estimating the probable peak particle velocity for a particular set of blasting conditions. Such an equation is dependent upon the determination of site specific constants S and I. The scaling factor for use in determining these two site specific constants is generally referred to as a scaled distance and has been designated D_s by the USBM as a standard symbol which has become extensively used throughout the industry. Mathematically it is $D_s = D/W^{1/2}$ where D_s = scaled distance, D = radial distance from a shot to a recording point, and W = the maximum charge weight of explosives fired at a single instant. The USBM requires a minimum delay time of eight milliseconds between elements of a multi-delay element blast. By securing extensive measurements of variable charge weights at varying distances and by substituting D_s values for D in the standard equation, values for the slope S and intercept I can be determined graphically. By substituting D_s for D in the standard equation, a site specific equation now becomes $V = I(D_s)^S$ where values for I and S have been determined by the above procedure.

The airblast overpressure obeys a similar propagation law. However, overpressure is greatly affected by wind, temperature and other rapidly changing factors in the atmosphere. It is also affected by terrain conditions which absorb or reflect the acoustic pulse. Overpressure obeys a cube root scaling law. The other parameters stated above are the same. In establishing an airblast propagation equation $D_s = D/W^{1/3}$.

DATA ANALYSIS AND DISCUSSION

The data obtained and our analyses of these fifty-nine seismic measurements have been presented in charts and graphs included in Appendix V. In Figure I, of Appendix V, the peak measurements obtained from Shots #1, #2

Data Analysis and Discussion - Continued

#3 and #4 are plotted in rectangular coordinates with PPV amplitude as a function of distance. It is evident that the PPV amplitude levels of Shots #2 and #3 increased approximately proportional to the increase in charge weights. Shot #4 did not show an increase in overall amplitude above that of Shot #3, except in the direction of Line B. The overall amplitude of Shot #4 appears to be slightly lower than Shot #3. We are inclined to believe that a possible low order detonation occurred on one or more holes in Shot #4.

In Figure II, we have plotted the measurements from Shots #1, #3, #5 and #6 as a function of distance. It is evident from this graph that the delay patterns used are sufficient to assure the peak particle velocity is primarily a function of the maximum load per delay.

In Figure III, we have plotted the PPV measurements as a function of scaled distance in accordance with the standard equation. The site specific equation has been determined and is shown in this graph. You will note the scaled distance associated with five inches per second PPV along the mean trend line is five. The maximum positive deviation however falls at a D_s value of 13.0. If we take a 95% confidence factor including the point from A4 Shot #6, it will intersect the 5.0 inches per second PPV level at $D_s = 10$.

It appears that adherence to a scaled distance of 13.0 for blast load design will provide a virtual certainty that the peak particle velocity of 5.0 inches per second will not be produced on either the power lines or the pipelines.

There are some salient points that should be made. First, the maximum deviation line is caused by the single measurement produced at Station A4, 2167 feet from the closest part of Shot #6. An examination of this seismogram reveals the peak amplitude occurred well into the wave train produced by this very long duration blast. We believe this to be due to an additive effect uniquely related to the extra long duration of the single hole delay pattern of Shot #6. The measurement at Station A3 is also higher than would normally be expected at these distances which tends to confirm a surge or an additive effect. Regardless of the cause, the distance is so great and the measurement so low that we do not see this point as significant in developing a number for reasonable control at close range.

A second point to be made is that a peak particle velocity in excess of 5.0 inches per second was only measured at distances less than 400 feet.

A third point to be made is that, based on this study, the power lines that supply your machines, must have at one time or another sustained ground vibrations well in excess of 5.0 inches per second. In March 1985, David Bowling observed a Navajo Mine blast similar to those fired on the 3rd and 4th of April. Based on the data obtained from our April study, we believe this

Data Analysis and Discussion - Continued

blast would have imposed a PPV level of 5.0 inches per second or more on your power line since the blast was located within 200 feet of it.

A fourth point to be made about this Figure III is that only three points fall above a line intersecting 5.0 inches per second at a D_s value of 8. These consist of the measurement from Shot #1, Station A1 and Shot #6, Stations A3 and A4.

CONCLUSIONS AND RECOMMENDATIONS

Based on this study, it is our conclusion that adherence to a scaled distance of 10 or greater when designing shots proximal to either the power lines or pipelines will assure a PPV less than 5.0 inches per second. It is possible that aderence to a D_s of 8 would provide a reasonable assurance that the upside limit of 5.0 inches per second would not be exceeded.

The most rational approach would be to secure a portable seismograph, with a direct reading meter or printout to set up on either the power lines or the pipelines for each shot and design your shots to assure no measurement reaches or exceeds 5.0 inches per second. We believe this approach would maximize your coal extraction with the minimum modification of your blasting technique.

The following items are attached as appendices and complete this report:

Appendix I	Instrument Specifications
Appendix II	Copies of Blasters Logs and Sketch Map
Appendix III	6 Summary of Blast Measurement Tables
Appendix IV	59 Computer Drawn and Analyzed Seismograms
Appendix V	Figures I, II and III

Respectfully submitted,

WHITE INDUSTRIAL SEISMOLOGY, INC.

Randall M. Wheeler

Randall M. Wheeler
Manager of Technical Services

David S. Bowling

David S. Bowling, C.P.G.S.
Consulting Geophysicist

RMW/DSB/tj

BLAST REPORTING PRACTICES AT NAVAJO MINE

General Shot Planning and Design

Shot planning and design at the Navajo Mine consists of the steps outlined below, and is based on attaining maximum shot performance while insuring complete compliance with all pertinent regulations.

Evaluation of blast area based on:

- Material Type
- Material Thickness
- Proximity to lease lines, etc.
- Distance to nearest structure (Preliminary estimate of maximum lega1 charge per 8 ms period).

This leads to selection of initiation system used.

- Instantaneous blasting is done with surface delays in most non-critical partings.
- And in-hole delay system is used in cast shots or critical partings.

If an in-hole delay is to be used, a timing analysis is done. Timing is fine tuned to insure that the maximum number of holes firing in any 8 ms period is within compliance and to provide maximum shot performance.

The drill pattern design is then done based on either the burdens determined through the timing analysis or on a 'typical' burden for a given parting depth. Drill pattern dimensions are then evaluated on the basis of the resultant energy factor and stem heights, to insure acceptable shot performance and control.

Once the initial timing and drill dimensions are determined, a load sheet (Exhibit 1) is developed. This sheet shows the following:

- Hole Depth.
- Pounds of each explosive type to be loaded in a hole of given depth.
- Resultant Powder Factor.
- Legal Holes per Delay. This is based on input for shot coordinates and coordinates for the nearest structure (Exhibit 2). This design information for coordinates is taken from a scaled distance spreadsheet (Exhibit 3) that is developed for each strip. This scaled distance sheet is generated by taking survey information for coal line coordinates by station, and then calculating the distance to the structures proximate to each pit.
- Design Stem Height.
- Resultant Energy Factor.
- Relative Confinement Factor. In all 'critical shots', this factor must exceed 1.4 to be acceptable. Design parameters will be changed as necessary to reach this level.

After the load sheet is generated, the appropriate range of hole depths will be checked to insure that the legal holes per delay does not come within a factor of two holes per delay to the design holes per delay. (i.e. if the legal holes per delay is 9 and the design calls for 7 holes per 8 ms period, the design will be reevaluated to see if a larger safety factor between the legal and design numbers can be reached).

If shot requirements dictate that the design is not able to be 'backed off to a level that insures a sufficient safety margin, BNCC will monitor the shot and attach the seismograph report to the Blast Report.

Once the design is complete a package consisting of a copy of the drill plan, all load sheets, and a scaled distance sheet is forwarded to the Blast Foremen for their field use.

BHP Navajo Coal Company

Memorandum

Date 20 March 2009

To Gene Hay, OSM Mining Engineer

CC Greg Perkins, Production Coordinator
Kent Applegate, Environmental Coordinator
Shawn Goeckner, Chief Engineer
Bill Jenkins, General Blasting Foreman
Valdez Nez, Assistant Production Superintendent-Stripping
Steve Hough; Production Superintendent

From Desiree Smiley, Drill and Blast Engineer

Detail Procedures for Airblast and Flyrock Control When Cast Blasting

The cast blasting procedures currently followed are intended to adequately mitigate the loss of confinement typically occuring through the face or stemming column (the path of least resistance). The design parameters are:

- Minimum of 19 feet of face burden when drilling 10.625" holes
- Using the minimum stemming lengths of 17 ft when loading with ANFO and 19 ft when loading with HANFO for 10.625" blast holes
- Bobbing the holes when loading cast to ensure proper stem height. If overloading occurs, dilution of explosive product to adjust to proper stem height
- Pre-blast face burden profiling can be used to determine proper collar location of the blast holes

Current Procedures for Airblast and Flyrock Control When Blasting Thin Seams (overburden and interburden)

- When blasting parting greater than 20 ft OR outside of the 1,000 ft zone
    - 10.625" drill holes are used
    - All parting less than 5 ft is ripped
    - All wet holes are stemmed with crushed rock

    - A minimum of 50% of hole depth is used for stemming length
    - Drilling parameters for 10.625” drill holes are variable due to the rock type and depth. A range of burden and spacing given below encompasses the variations of the drill pattern designs
        - Burden (ft) = (20 to 40) * 10.625”/12
        - Spacing (ft) = (1 to 1.8) * Burden
- When blasting within 1,000 ft of the lease line or stream buffer zone and parting is under 20 feet
    - 6.75” drill holes are used with a tighter pattern
    - All holes are stemmed with crushed rock
    - A minimum of 50% of hole depth is used for stemming length
    - All parting less than 5 ft is ripped
    - Drilling parameters for 6.75” drill holes are variable due to the rock type and depth. A range of burden and spacing given below encompasses the variations of the drill pattern designs
        - Burden (ft) = (20 to 40) * 6.75”/12
        - Spacing (ft) = (1 to 1.8) * Burden

Current Procedures for Airblast and Flyrock Control When Blasting Thin Seams (coal)

- 5” drill holes are used with a 14’ x 14’ pattern
- All coal under 5 ft is ripped
- A minimum of 65% of hole depth is used for stemming length

Future Procedures for Airblast and Flyrock Control When Cast Blasting

The future procedures will be the same as above with the following additions and enhancements:

- All cast shots will have pre-blast face burden profiling to determine the proper collar location of the blast holes
- All wet holes will be stemmed with crushed rock
- If high wall issues have occurred after drilling is complete, holes near the face will only be toe loaded
- Loading blast holes from the back of the shot first (future high wall side) and moving across the pit to the front of the shot (current high wall side) in case the current highwall face changes before shot is made
- When adverse geologic conditions are present, the area with issues will be loaded as close to the shot time as practical

Future Procedures for Airblast and Flyrock Control When Blasting Thin Seams (overburden and interburden)

Due to the current procedures successfully controlling the amount of flyrock and airblast, there is no change required.

Future Procedures for Airblast and Flyrock Control When Blasting Thin Seams (coal)

Due to the current procedures successfully controlling the amount of flyrock and airblast, there is no change required.

PIT	S. BARBER	STA 146+00 —> STA 169+00			DRY
SEAM	8A				
STRIP	60	60SB8A-B			
HOLE DIAMETER	9.875		26 % EMUL	TOP MODE	MIX
DRILL BURDEN	27.0	(avg)	26 % EMUL	TOE MODE	MIX
DRILL SPACING	30.0			STANDOFF	0.0
DIST. TO STRUCTUR	8,190	J. Lowe STA 169 + 00, S&E OF SHOT		BACKFILL	1.0

Use ZAP and LP-48s

125ms Surface Delay — Holes/8 ms Delay

HOLE DEPTH	BACKFILL	COLUMN LOAD	TOP LOAD	TOTAL P.F.	TOTAL POUNDS	HOLES / DELAY	STEM HEIGHT (Max Stem Ht: 18.0)	EN Facto aws 830	RC Factor De 1.17
5.0	1.0	58	0	0.39	58	272.5	2.5	91	0.301
6.0	1.0	78	0	0.43	78	204.3	3.0	102	0.332
7.0	1.0	97	0	0.46	97	163.5	3.5	109	0.363
8.0	1.0	117	0	0.49	117	136.2	4.0	114	0.394
9.0	1.0	136	0	0.50	136	116.8	4.5	119	0.426
10.0	1.0	155	0	0.52	155	102.2	5.0	122	0.457
11.0	1.0	175	0	0.53	175	90.8	5.5	125	0.488
12.0	1.0	194	0	0.54	194	81.7	6.0	127	0.520
13.0	1.0	214	0	0.55	214	74.3	6.5	129	0.551
14.0	1.0	233	0	0.55	233	68.1	7.0	131	0.582
15.0	1.0	253	0	0.56	253	62.9	7.5	132	0.613
16.0	1.0	272	0	0.57	272	58.4	8.0	133	0.645
17.0	1.0	291	0	0.57	291	54.5	8.5	135	0.676
18.0	1.0	311	0	0.58	311	51.1	9.0	136	0.707
19.0	1.0	330	0	0.58	330	48.1	9.5	136	0.739
20.0	1.0	350	0	0.58	350	45.4	10.0	137	0.770
21.0	1.0	369	0	0.59	369	43.0	10.5	138	0.801
22.0	1.0	388	0	0.59	388	40.9	11.0	139	0.832
23.0	1.0	408	0	0.59	408	38.9	11.5	139	0.864
24.0	1.0	427	0	0.59	427	37.2	12.0	140	0.895
25.0	1.0	447	0	0.60	447	35.5	12.5	140	0.926
26.0	1.0	466	0	0.60	466	34.1	13.0	141	0.958
27.0	1.0	486	0	0.60	486	32.7	13.5	141	0.989
28.0	1.0	505	0	0.60	505	31.4	14.0	142	1.020
29.0	1.0	524	0	0.60	524	30.3	14.5	142	1.051
30.0	1.0	544	0	0.60	544	29.2	15.0	142	1.083
31.0	1.0	563	0	0.61	563	28.2	15.5	143	1.114
32.0	1.0	583	0	0.61	583	27.2	16.0	143	1.145
33.0	1.0	602	0	0.61	602	26.4	16.5	143	1.177
34.0	1.0	622	0	0.81	622	25.5	17.0	144	1.208
35.0	1.0	641	0	0.61	641	24.8	17.5	144	1.239
36.0	1.0	660	0	0.61	660	24.0	18.0	144	1.270
37.0	1.0	699	0	0.63	699	22.7	18.0	148	1.270
38.0	1.0	738	0	0.65	738	21.5	18.0	152	1.270
39.0	1.0	777	0	0.66	777	20.4	18.0	156	1.270
40.0	1.0	816	0	0.68	816	19.5	18.0	160	1.270
41.0	1.0	855	0	0.69	855	18.6	18.0	164	1.270
42.0	1.0	894	0	0.71	894	17.8	18.0	167	1.270
43.0	1.0	932	0	0.72	932	17.0	18.0	170	1.270
44.0	1.0	971	0	0.74	971	16.3	18.0	173	1.270
45.0	1.0	1010	0	0.75	1,010	15.7	18.0	176	1.270
46.0	1.0	1049	0	0.76	1,049	15.1	18.0	179	1.270
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18.0	182	1.270
48.0	1.0	1127	0	0.78	1,127	14.1	18.0	184	1.270
49.0	1.0	1165	0	0.79	1,165	13.6	18.0	187	1.270
50.0	1.0	1204	0	0.80	1,204	13.2	18.0	189	1.270
51.0	1.0	1243	0	0.81	1,243	12.8	18.0	191	1.270
52.0	1.0	1282	0	0.82	1,282	12.4	18.0	194	1.270
53.0	1.0	1321	0	0.83	1,321	12.0	18.0	196	1.270
54.0	1.0	1360	0	0.84	1,360	11.7	18.0	198	1.270
55.0	1.0	1399	0	0.85	1,399	11.4	18.0	200	1.270
56.0	1.0	1437	0	0.86	1,437	11.0	18.0	202	1.270
57.0	1.0	1476	0	0.86	1,476	10.8	18.0	203	1.270
58.0	1.0	1515	0	0.87	1,515	10.5	18.0	205	1.270
59.0	1.0	1554	0	0.88	1,554	10.2	18.0	207	1.270
60.0	1.0	1593	0	0.88	1,593	10.0	18.0	208	1.270
61.0	1.0	1632	0	0.89	1,632	9.7	18.0	210	1.270
62.0	1.0	1670	0	0.90	1,670	9.5	18.0	212	1.270
63.0	1.0	1709	0	0.90	1,709	9.3	18.0	213	1.270
64.0	1.0	1748	0	0.91	1,748	9.1	18.0	214	1.270
65.0	1.0	1787	0	0.92	1,787	8.9	18.0	216	1.270
66.0	1.0	1826	0	0.92	1,826	8.7	18.0	217	1.270
67.0	1.0	1865	0	0.93	1,865	8.5	18.0	218	1.270
68.0	1.0	1904	0	0.93	1,904	8.3	18.0	220	1.270
69.0	1.0	1942	0	0.94	1,942	8.2	18.0	221	1.270
70.0	1.0	1981	0	0.94	1,981	8.0	18.0	222	1.270
71.0	1.0	2020	0	0.95	2,020	7.9	18.0	223	1.270
72.0	1.0	2059	0	0.95	2,059	7.7	18.0	224	1.270
73.0	1.0	2098	0	0.96	2,098	7.6	18.0	226	1.270
74.0	1.0	2137	0	0.96	2,137	7.4	18.0	227	1.270
75.0	1.0	2176	0	0.97	2,176	7.3	18.0	228	1.270
76.0	1.0	2214	0	0.97	2,214	7.2	18.0	229	1.270
77.0	1.0	2253	0	0.98	2,253	7.0	18.0	230	1.270
78.0	1.0	2292	0	0.98	2,292	6.9	18.0	231	1.270
79.0	1.0	2331	0	0.98	2,331	6.8	18.0	232	1.270
80.0	1.0	2370	0	0.99	2,370	6.7	18.0	233	1.270
81.0	1.0	2409	0	0.99	2,409	6.6	18.0	233	1.270
82.0	1.0	2447	0	0.99	2,447	6.5	18.0	234	1.270
83.0	1.0	2486	0	1.00	2,486	6.4	18.0	235	1.270
84.0	1.0	2525	0	1.00	2,525	6.3	18.0	236	1.270
85.0	1.0	2564	0	1.01	2,564	6.2	18.0	237	1.270

EXHIBIT 1

DISTANCE TO BUILDING			
LOCATION	NORTHING	EASTING	DISTANCE
C. Dixon	2,019,247	309,331	
STA 101+00	2,016,400	302,870	7,060
	2,847	6,461	N&E
M. Yazzie	2,013,083	293,047	
STA 152+00	2,011,300	302,870	9,984
	1,783	(9,823)	N&W
	Nearest:	C. Dixon	
	STA:	STA 101+00	
	Dir:	N&E	

Legal Weight: 11,799 pounds

Resident	Northing	Easting
E Yazzie	2,066,240	313,395
J. Allen	2,064,299	312,151
D. Harris	2,058,691	326,525
Qstar-Pt3	2,054,765	315,640
Qstar-Pt5	2,053,538	321,606
Qstar-Pt4	2,053,301	320,481
H. Barber	2,052,300	305,675
Qstar-Pt1	2,051,701	309,494
Qstar-Pt2	2,051,435	312,152
A. Mason	2,040,620	322,409
John Mason	2,039,591	321,431
P. White	2,034,347	286,250
AIII	2,033,820	300,603
A. Barber	2,028,053	305,911
J. Lowe	2,026,622	302,417
J. Mason 1	2,022,171	310,570
J. Mason 2	2,020,959	310,302
K. Joe	2,020,555	308,939
K. Dobey	2,019,750	294,800
C. Dixon	2,019,247	309,331
M. Yazzie	2,013,083	293,047
A. Gilmore 2	2,003,500	296,500
R. Mason	2,022,434	309,701

EXHIBIT 2

S. Barber Pit Scaled Distances

Strip #: 60

STATIONS	Relative Direction from Pit: N of Pit	S of Pit	NW of Pit	SE of Pit	E of Pit	SB COAL LINE N	E
	Distance To: 4CPL	K. Dobey	H. Barber	J. Lowe	AJJ	(INTERPOLED FROM BY CBN)	
79+0	10,599	20,869	13,885	11,999	5,751	2,038,528	303,905
80+0	10,694	20,786	13,946	11,939	5,660	2,038,478	303,818
81+0	10,790	20,704	14,007	11,879	5,570	2,038,428	303,732
82+0	10,886	20,622	14,069	11,821	5,480	2,038,379	303,645
83+0	10,981	20,540	14,131	11,762	5,391	2,038,329	303,558
84+0	11,077	20,458	14,193	11,705	5,302	2,038,279	303,471
85+0	11,173	20,376	14,256	11,648	5,213	2,038,229	303,385
86+0	11,269	20,294	14,319	11,591	5,125	2,038,180	303,298
87+0	11,365	20,213	14,383	11,535	5,038	2,038,130	303,211
88+0	11,461	20,132	14,447	11,480	4,950	2,038,080	303,124
89+0	11,557	20,051	14,511	11,425	4,864	2,038,030	303,038
90+0	11,653	19,970	14,576	11,371	4,777	2,037,980	302,951
91+0	11,749	19,889	14,642	11,318	4,692	2,037,931	302,864
92+0	11,845	19,808	14,707	11,265	4,606	2,037,881	302,777
93+0	11,942	19,728	14,773	11,213	4,522	2,037,831	302,691
94+0	12,038	19,648	14,840	11,161	4,438	2,037,781	302,604
95+0	12,135	19,568	14,907	11,110	4,355	2,037,732	302,517
96+0	12,231	19,488	14,974	11,060	4,272	2,037,682	302,431
97+0	12,328	19,408	15,041	11,010	4,191	2,037,632	302,344
98+0	12,424	19,329	15,109	10,961	4,110	2,037,582	302,257
99+0	12,521	19,249	15,178	10,913	4,030	2,037,533	302,170
100+0	12,618	19,170	15,246	10,866	3,951	2,037,483	302,084
101+0	12,715	19,091	15,315	10,819	3,873	2,037,433	301,997
102+0	12,812	19,013	15,385	10,773	3,795	2,037,383	301,910
103+0	12,908	18,934	15,454	10,728	3,719	2,037,333	301,823
104+0	13,005	18,856	15,524	10,683	3,644	2,037,284	301,737
105+0	13,102	18,778	15,595	10,640	3,571	2,037,234	301,650
106+0	13,199	18,700	15,665	10,597	3,498	2,037,184	301,563
107+0	13,296	18,622	15,736	10,554	3,428	2,037,134	301,476
108+0	13,394	18,545	15,807	10,513	3,358	2,037,085	301,390
109+0	13,491	18,468	15,879	10,472	3,290	2,037,035	301,303
110+0	13,588	18,391	15,951	10,432	3,224	2,036,985	301,216
111+0	13,685	18,314	16,023	10,393	3,159	2,036,935	301,130
112+0	13,782	18,237	16,096	10,354	3,095	2,036,886	301,043
113+0	13,880	18,161	16,168	10,318	3,036	2,036,836	300,956
114+0	13,977	18,085	16,241	10,281	2,978	2,036,786	300,869
115+0	14,075	18,009	16,315	10,245	2,922	2,036,736	300,783
116+0	14,172	18,033	16,388	10,208	2,866	2,036,686	300,696
117+0	14,042	18,019	16,306	10,231	2,919	2,036,730	300,833
118+0	14,142	17,928	16,396	10,170	2,842	2,036,657	300,764
119+0	14,242	17,837	16,486	10,110	2,766	2,036,585	300,695
120+0	14,342	17,746	16,575	10,051	2,692	2,036,512	300,626
121+0	14,441	17,655	16,666	9,992	2,620	2,036,440	300,558
122+0	14,541	17,564	16,756	9,934	2,550	2,036,367	300,489
123+0	14,641	17,473	16,846	9,877	2,481	2,036,295	300,420
124+0	14,741	17,382	16,936	9,820	2,415	2,036,222	300,351
125+0	14,841	17,292	17,027	9,764	2,352	2,036,150	300,282
126+0	14,941	17,201	17,118	9,709	2,291	2,036,077	300,213
127+0	15,041	17,111	17,208	9,654	2,232	2,036,005	300,144
128+0	15,140	17,020	17,299	9,600	2,177	2,035,932	300,075
129+0	15,240	16,930	17,390	9,547	2,123	2,035,860	300,006
130+0	15,340	16,840	17,481	9,495	2,077	2,035,787	299,938
131+0	15,440	16,750	17,572	9,443	2,032	2,035,715	299,869
132+0	15,540	16,660	17,663	9,392	1,991	2,035,642	299,800
133+0	15,640	16,570	17,755	9,342	1,955	2,035,570	299,731
134+0	15,739	16,481	17,846	9,293	1,923	2,035,497	299,662
135+0	15,839	16,391	17,938	9,245	1,896	2,035,425	299,593
136+0	15,939	16,302	18,029	9,197	1,874	2,035,352	299,524
137+0	16,039	16,213	18,121	9,150	1,857	2,035,280	299,455
138+0	16,139	16,123	18,213	9,105	1,845	2,035,207	299,386
139+0	16,239	16,034	18,305	9,060	1,839	2,035,135	299,317
140+0	16,339	15,946	18,397	9,015	1,838	2,035,062	299,249
141+0	16,439	15,857	18,489	8,972	1,842	2,034,990	299,180
142+0	16,538	15,768	18,581	8,930	1,852	2,034,917	299,111
143+0	16,638	15,680	18,673	8,889	1,867	2,034,845	299,042
144+0	16,738	15,591	18,763	8,848	1,888	2,034,772	298,973
145+0	16,838	15,503	18,858	8,809	1,913	2,034,700	298,904
146+0	16,938	15,415	18,950	8,770	1,943	2,034,627	298,835
147+0	17,038	15,327	19,042	8,733	1,978	2,034,555	298,766
148+0	17,138	15,239	19,135	8,696	2,017	2,034,483	298,697
149+0	17,238	15,152	19,228	8,661	2,061	2,034,410	298,629
150+0	17,337	15,064	19,320	8,626	2,108	2,034,338	298,560
151+0	17,437	14,977	19,413	8,593	2,159	2,034,265	298,491
152+0	17,537	14,890	19,506	8,560	2,213	2,034,193	298,422
153+0	17,637	14,803	19,599	8,529	2,270	2,034,120	298,353
154+0	17,737	14,716	19,692	8,498	2,330	2,034,048	298,284
155+0	17,837	14,629	19,785	8,469	2,393	2,033,975	298,215
156+0	17,937	14,543	19,878	8,441	2,458	2,033,903	298,146
157+0	18,037	14,457	19,971	8,414	2,526	2,033,830	298,077
158+0	18,137	14,370	20,065	8,388	2,595	2,033,758	298,009
159+0	18,237	14,285	20,158	8,363	2,667	2,033,685	297,940
160+0	18,336	14,199	20,251	8,339	2,740	2,033,613	297,871
161+0	18,436	14,113	20,345	8,316	2,815	2,033,540	297,802
162+0	18,536	14,028	20,438	8,295	2,892	2,033,468	297,733
163+0	18,636	13,943	20,532	8,275	2,969	2,033,395	297,664
164+0	18,736	13,858	20,626	8,255	3,049	2,033,323	297,595
165+0	18,836	13,773	20,719	8,237	3,129	2,033,250	297,526
166+0	18,936	13,688	20,813	8,221	3,210	2,033,178	297,457
167+0	19,036	13,604	20,907	8,203	3,293	2,033,105	297,388
168+0	19,136	13,520	21,001	8,190	3,376	2,033,033	297,320

EXHIBIT 3

Shot Monitoring and Reporting

Shot Monitoring

BNCC monitors all shots that meet the following criteria:

- All Cast Shots.
- All blasts that exceed the scale distance requirement.
- Shots utilizing new designs or products.

BNCC will also monitor shots for our own analysis on a regular basis. Any shots that are monitored for compliance purposes will have the seismograph tape attached to the Blast Report.

BNCC uses a White - Mini Seis II seismograph for the monitoring activities.

Blast Reporting

Included in this appendix are examples of Coal and Overburden Blast Reports. These reports were generated using BlastMan Pro software. The reports contain the following information:

Page 1

- Shot Date, Time, Location, Material Type, and the Name of Blaster of Record.
- Summary of Pattern Dimensions, Average Hole Depth, Number of Holes, Volume Shot, and Average Stem Height.
- Summary of Bulk Explosives Used.
- Summary of Primers Used.
- Compliance information including Nearest Structure, Distance to Structure, Scaled Distance Factor, Actual Holes per 8ms Period, Maximum Charge per 8ms Period, and Calculated Legal Minimum Distance to Structure.

It should be noted that when calculating the maximum charge per 8ms period, the BlastMan Pro software will go to the load information for the block and pull the maximum load that exists in any one hole in the block. Maximum charge per 8 ms period for coal shots also uses the maximum load in any one hole located within the block. This maximum hole load is then multiplied by the number of holes per 8 ms delay that is input by the blaster to determine the reported maximum charge per 8 ms period. BNCC believes that this is an extremely conservative approach to determining and reporting compliance values for ground vibration. In conjunction with the safety factor incorporated into the design, BNCC believes that it would be exceedingly unlikely for Navajo Mine to be out of compliance on any of these shots.

Page 2

- For Overburden/Parting Shots - Summary of B1asting Accessories Used
- For Coal Shots - Blast Diagram and Seismograph Information (if monitored)

Page 3

- For Overburden/Parting Shots - Blast Diagram and Seismograph Information (if monitored).
- For Coal Shots – Blast hole data sheet(s)

Page 4 - End

- Hole Loading Information by Block/Row/Hole. Type and amount of explosive used in each hole is shown. This portion of the blast report also indicates wet or dry holes and lost holes.

The only area of appreciable difference between design loads and actual loads will be in deep overburden holes such as on cast shots. In these areas, BNCC loads more to a design stem height than to a design load. Generally, the actual 1oads in casts will exceed the design by about 200 pounds per hole (about 5%).

Actual Hole Locations

Due to the magnitude of our operations, surveying and reporting each individual hole location becomes impractical. Instead, Navajo Mine surveys and reports the four comers of the shot block (for accuracy) and uses these coordinate sets to determine scaled distance for reporting purposes. A shot block is determined by load sheet changes or by drill pattern changes and a blast may contain multiple blocks. Since shot block coordinates are known, the user will then be able to calculate coordinates for subsequent hole locations, since pattern dimensions are reported.

Actual Hole Loads

Blasts with varying hole weights will be reported with actual load per hole in the pattern. Navajo Mine will continue to report the worst case (maximum potential explosives detonated in 8 ms) on blast reports for calculation of scaled distances. Blasts with holes that are loaded with the same amount of explosive will be reported using this hole load weight for the entire blast pattern.

Navajo Mine uses *"worst-case-maximum-weight"* to determine maximum weight per eight (8) millisecond delay period. After the maximum weight of the pattern(s) is determined, that weight is used to calculate allowable weight/8ms and the minimum shot distance (ft) from protected structures. The worst case-maximum-weight is a conservative scenario in which it is assumed that every blast hole in the pattern was loaded with that weight. Pattern corners are surveyed for actual distance determination to the nearest protected structure(s). Thus from each pattern corner, scaled distance calculations are made to the nearest structure(s) using the "worst-case-maximum-weight" previously determined. Depending upon the number of surrounding protected structures, numerous repetitive calculations are performed at each pattern corner to determine the legal shot weight and distance to the nearest protected structure.

Blast Diagrams

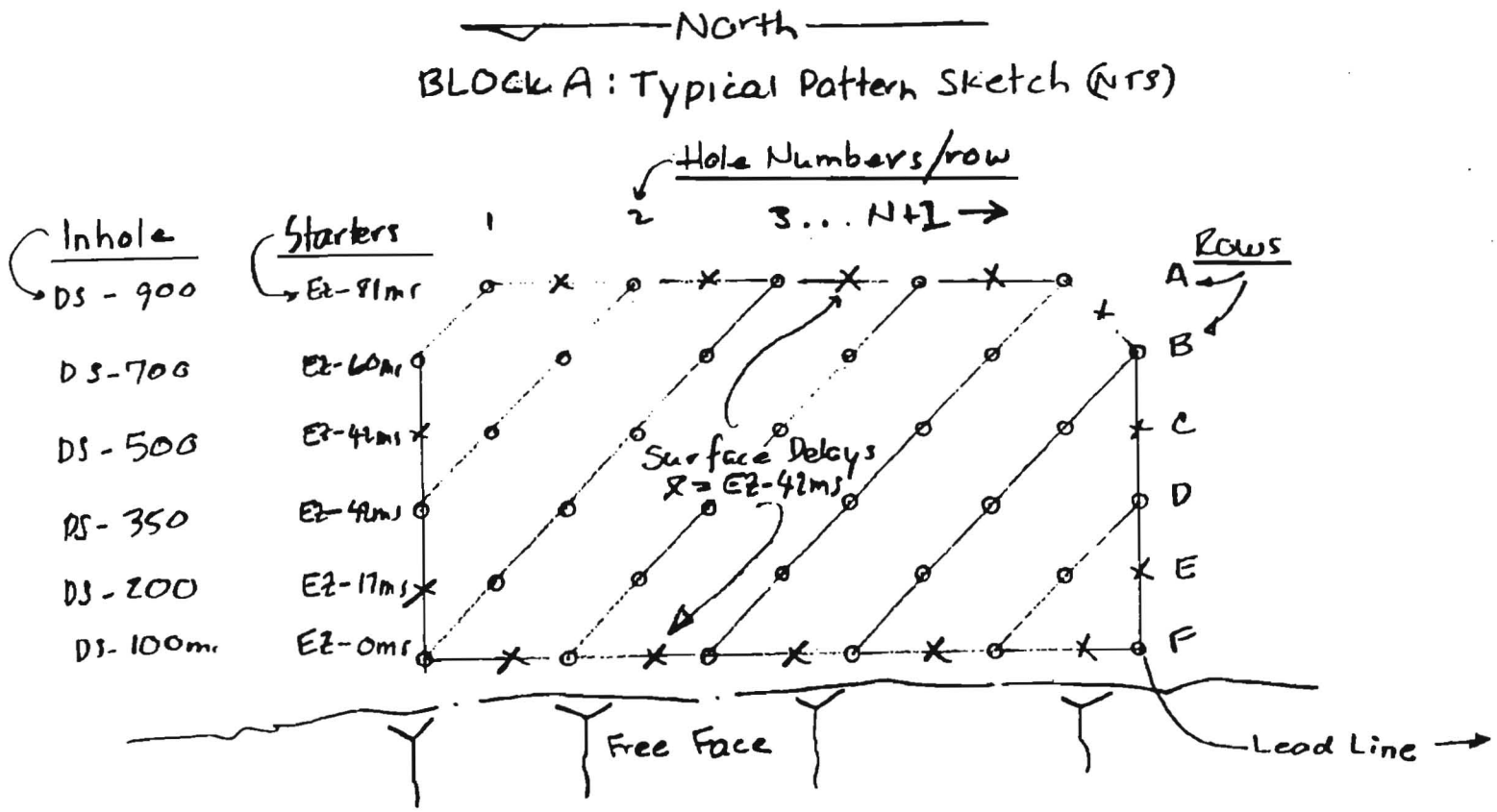
With the exception of large, complex blocks such as those found on cast shots, Navajo Mine will provide a blast diagram for the following shot types:

- Overburden/Parting shots using In-Hole Delays System (Exhibit 5)
- Overburden/Parting shots using Detonating Cord/Surface Connectors (Exhibit 6)
- Coal Shots tied in Row-by-Row (Exhibit 7)
- Coal Shots tied in en Echelon (Exhibit 8)

Navajo Mine will also provide a note on the diagram when electronic detonators are used as a form of initiation. In all of these typical diagrams, the following information will be explicitly defined in the drawing:

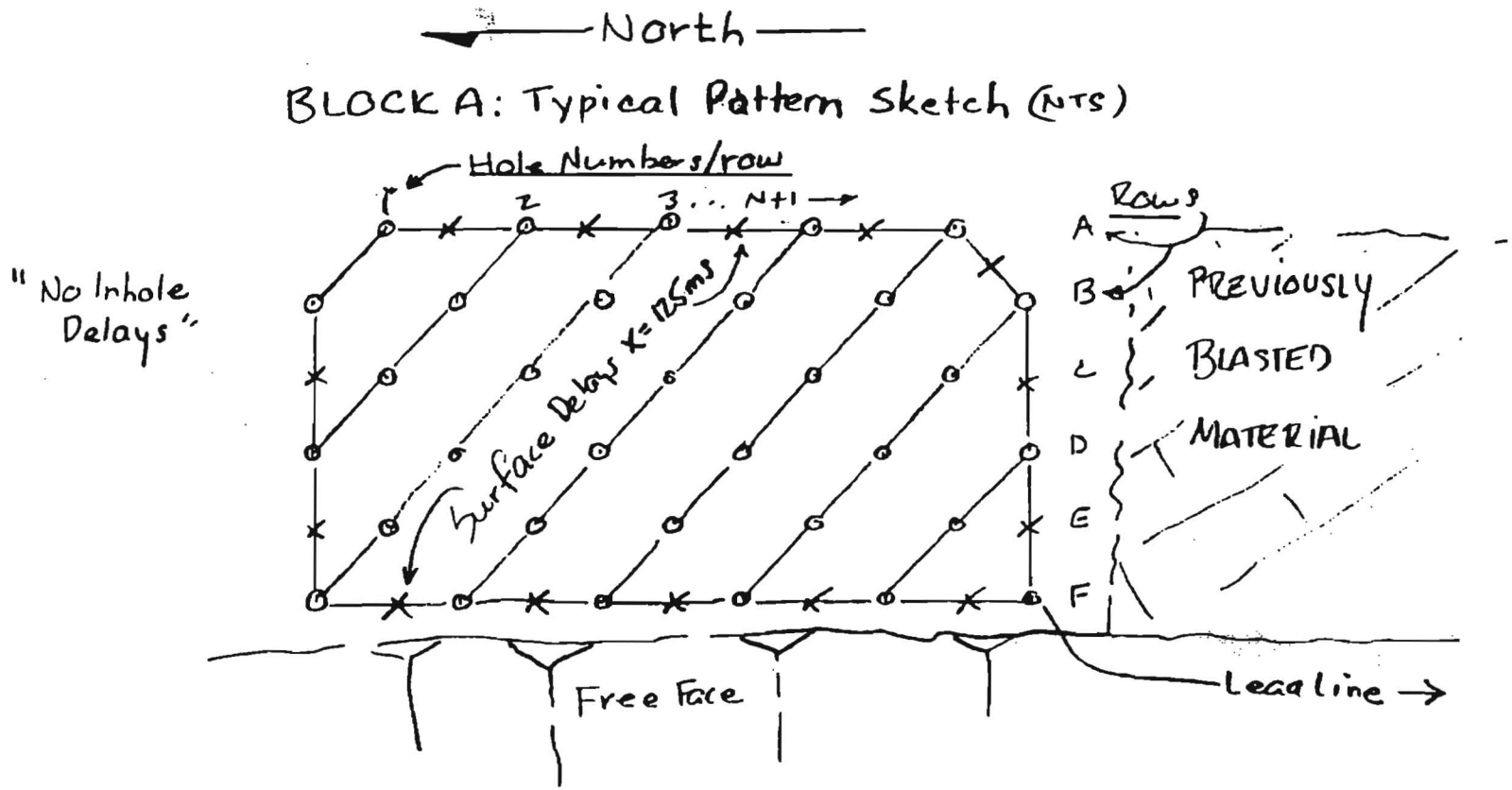
- North Arrow.
- Row Letter.
- Hole Number – diagram will not show the total holes in a row, but a number sufficient to determine the initiation sequence.
- Relative Hole Locations – diagram will show terminal ends of the shot pattern to include lead-in and termination. General or repetitive data for the body of the shot will be excluded.
- Relative locations of Free Face, Highwall, Empty Pit, etc.
- Location and period of all surface delays. Top-of-hole delays will be specified in tabular format above or alongside the drawing. Generally, all holes in a row will have the same top-of-hole delay period. Circuit delays will be shown symbolically on the drawing then detailed in a legend below the diagram.
- Period of In-Hole delays. Again provided in tabular format. Generally, all holes in a row will have the same in-hole delay period.
- Type of material bounding the shot. (i.e. Prime, Previously Shot).

In areas where conditions require the addition of more holes than planned (double drilling around failures, added row of holes for a short length of pit), this information will be shown in detail in addition to the diagrams currently drawn. All diagrams will have sufficient detail to allow the user to accurately reconstruct the initiation sequence of the shot.



In – Hole Delay System

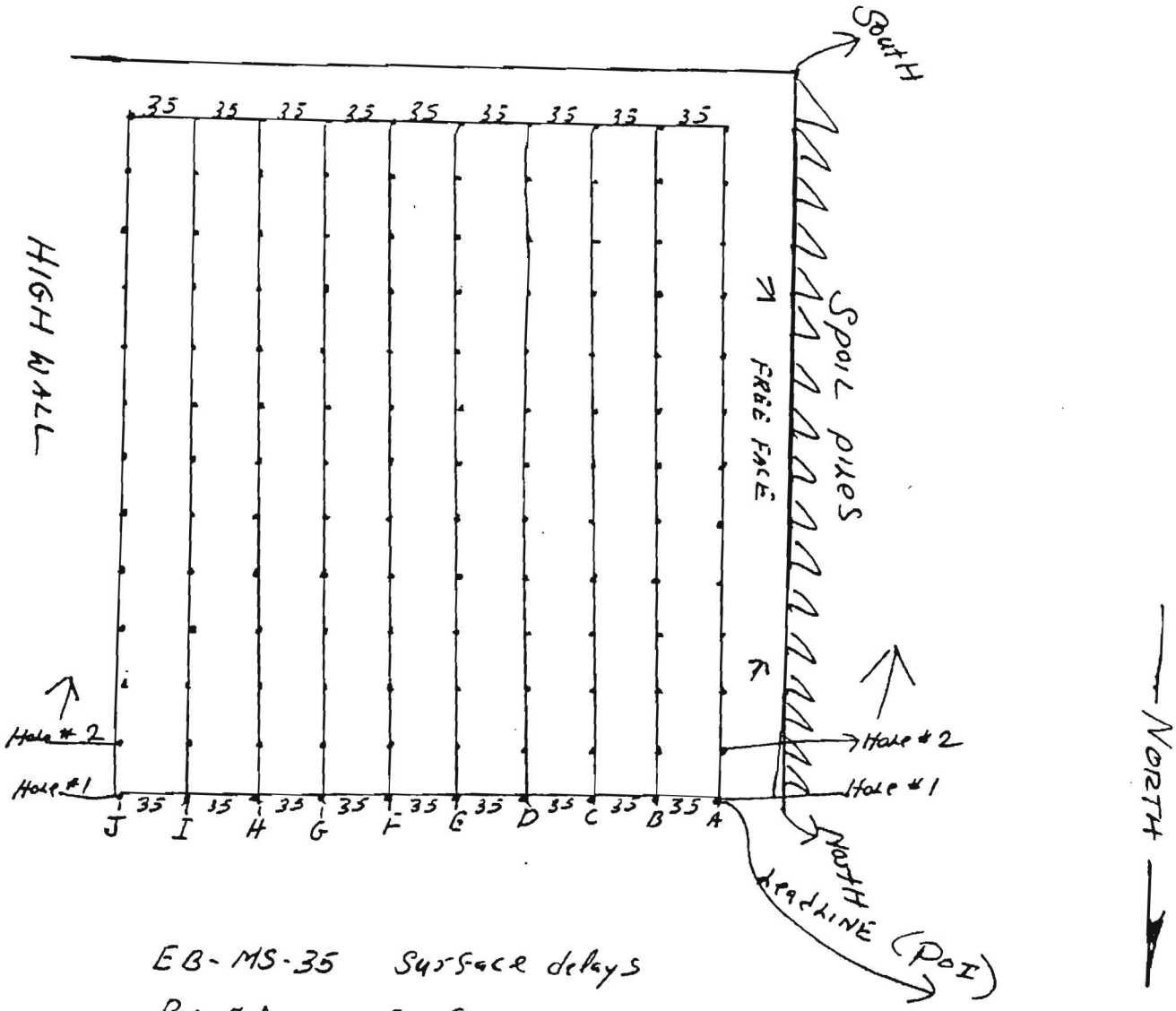
EXHIBIT 5



Instantaneous Blasting or
Surface Delay System

EXHIBIT 6

Coal Blast Diagram #1

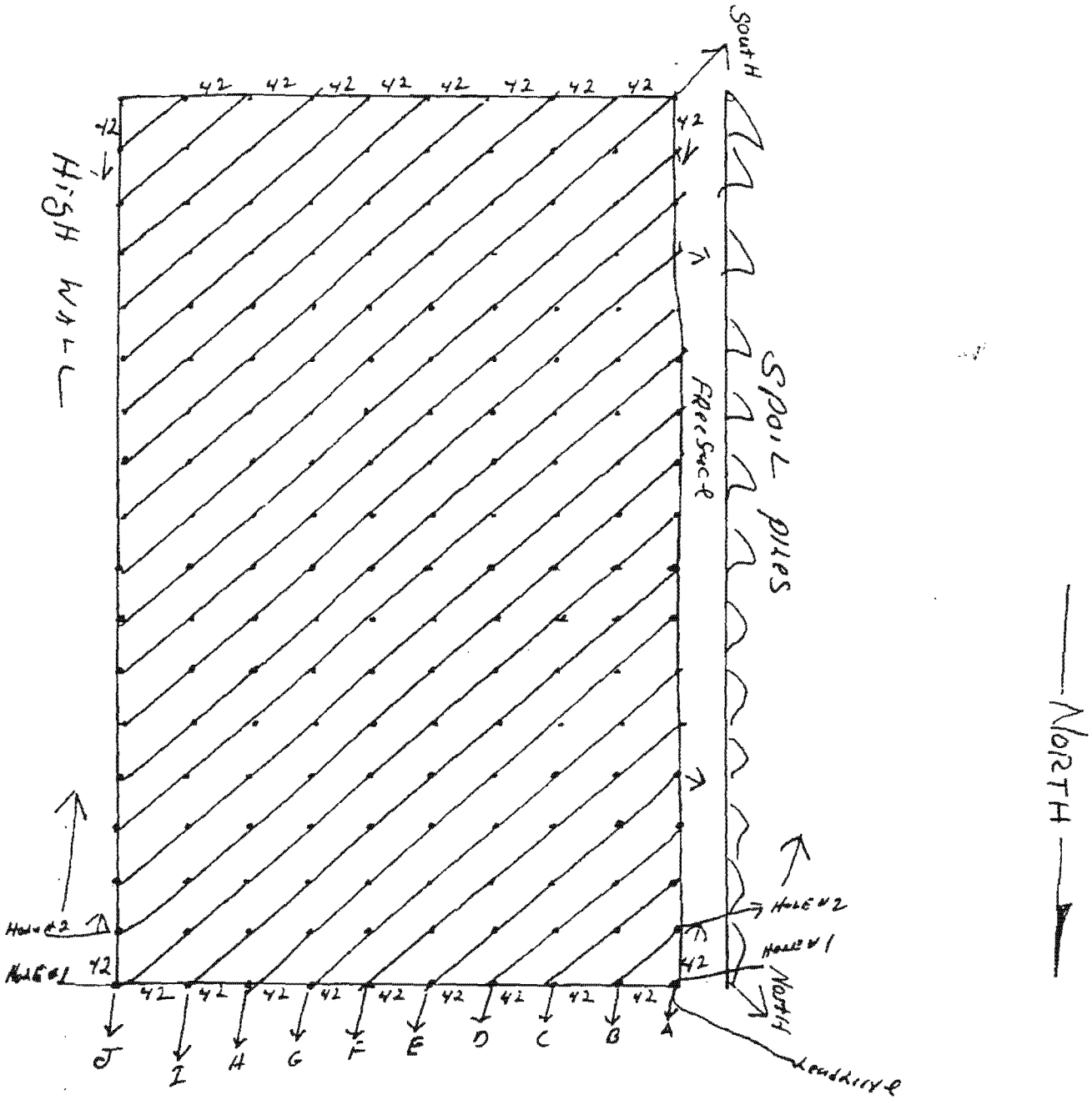


EB-MS-35 Surface delays

Row # A on Free face

EXHIBIT 7

Coal Blast Diagram #2



EB-MS-42 Surface delays
Row # A on FREE face

EXHIBIT 8