



REPORT ON THE HYDROGEOLOGIC INVESTIGATION
OF THE MEADOW PARK LAKE AND DAM
CUMBERLAND COUNTY, TENNESSEE

Prepared for

Environmental and Civil Engineering Services, Inc.
702 Old Jamestown Road
Crossville, Tennessee 38555

Prepared by

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PELA Project #670101

September 6, 2005

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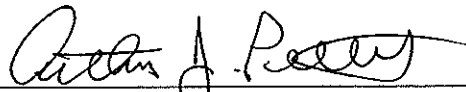
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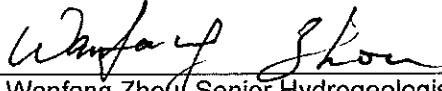
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I. INTRODUCTION

In a letter to Mr. Tim Begley, Engineering Assistant, City of Crossville, dated July 20, 2004, Mr. Scott Christian, Environmental and Civil Engineering Services, Inc. (ECE), described the current progress of the feasibility study for increasing the capacity of the Meadow Park Lake. In that letter he indicated that a thorough hydrogeologic study was necessary to assure that the current dam was not experiencing significant leakage, that the geology would support a larger dam structure and the loading caused by increasing the lake level. On August 27, 2004, P.E. LaMoreaux and Associates, Inc. (PELA), was contracted to perform the investigation.

The Meadow Park Lake is located approximately 5 miles southwest of the City of Crossville, TN. The lake is used as a reservoir for the City of Crossville as well as for limited recreational purposes. The purposes of PELA's investigation were:

- (1) To determine if the dam is currently leaking, and if so where, why, and the magnitude of the leaks.
- (2) To determine if the local geology would support the lake if it were raised by 20 feet.
- (3) To recommend remediation measures if the dam is significantly leaking or would significantly leak.

To answer these questions PELA proposed a multi-method approach. This included:

- (1) A review of published literature on the local geology, hydrology, topography and the hydrology of dams.
- (2) An evaluation of the six boreholes previously drilled by ECE as well as four new boreholes selected by PELA.
- (3) Monitoring of the accessible boreholes to determine the groundwater levels around the lake and the changes observed over two and a half months.
- (4) Pump testing the above boreholes to determine the current aquifer characteristics. Slug testing was also performed to determine if the lake could be raised by as much as twenty feet.
- (5) Geophysical investigations to determine the location of preferential flow paths in the bedrock for potential remediation.

II. GENERAL GEOLOGY AND TOPOGRAPHY

The Meadow Park Lake lies in the Cumberland Plateau physiographic province of East Central Tennessee (Figure 1). The plateau is described as a (relatively) flat-topped table land, rising 1000 feet above the adjacent provinces (Wilson, 1958). It is on average 35 miles wide and extends the entire width of the state from Kentucky to Alabama. The central portion of the plateau, where the site is located, is a rolling topography with generally low hills and a few deeply incised stream valleys.

The upper 600 feet of the plateau is comprised of Pennsylvanian age sedimentary rocks, a mixture of sandstones, conglomerates, shales, coals and minor limestones. Much of the plateau contains nearly horizontally bedded rocks with a very simple geologic structure. However the site area lies very near the Cumberland Plateau Overthrust which was created during the Allegheny Orogeny, 300 – 280 million years ago. The Cumberland Plateau Overthrust is a major thrust fault that displaced rock both horizontally and vertically. The site contains a number of smaller thrust faults that were probably formed at the same time as the Cumberland Plateau Overthrust. An overthrust fault is a break in the bedrock that is usually more horizontal than vertical. The overthrust fault has moved the upper bedrock from east to west. The amount of the displacement could not be determined. In the site area these overthrust faults have ramped to the surface.

In the site area the bedrock is composed of Pennsylvanian sandstones and conglomerates. Thin layers of shale and coal are also present. The faulting mentioned above usually occurs along a coal or shale

layer located at the base of the Sewanee Conglomerate (Ps). From the Geologic Map of the Crossville Quadrangle, (Moore 1981) (Figure II-2) formations outcropping at the site include, from oldest to youngest, the Sewanee Conglomerate (Ps), Whitwell Shale (Pw), Newton Sandstone (Pn), Vandever Formation (Pv), and the Rockcastle Conglomerate (Pr). Due to the thrust faults ramping to the surface across the site, the normal bedding of the formations has been altered which makes identification of subsurface formations difficult.

It is PELA's opinion that the local geology especially the faulting that occurs in the vicinity of the dam, created the unique topographic setting that made installing a dam at that location so attractive. Several faults cross in the vicinity of the current dam. The faulting weakened the bedrock in that area sufficiently that the local stream was able to erode a deep narrow valley rather than a broad flat valley as seen upstream of that location.

Physiographic Provinces of Tennessee

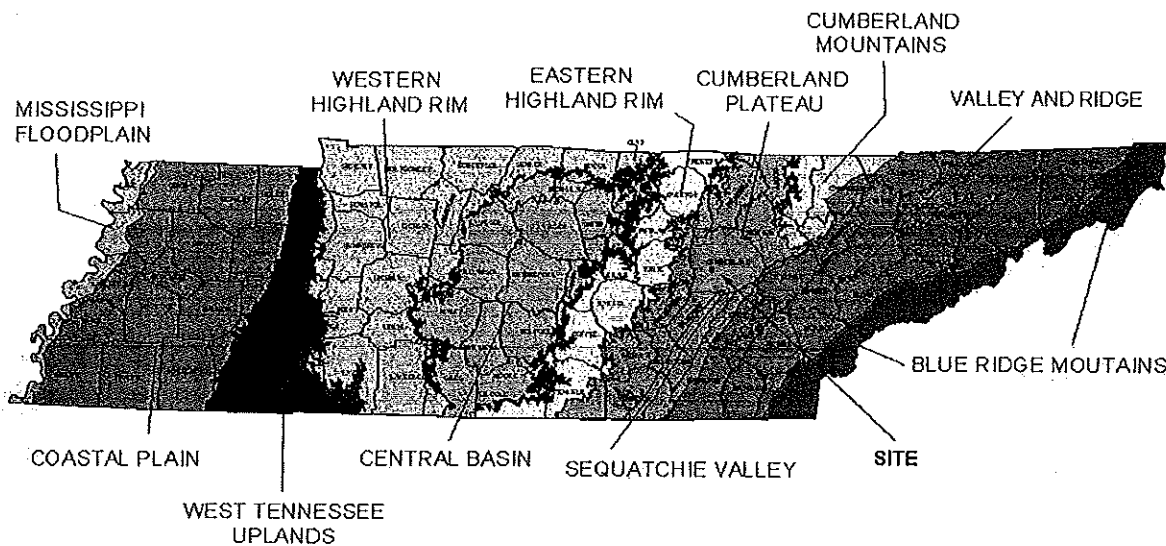


Figure II-1 - Tennessee Physiographic Provinces Map with approximate site location.
Adapted from Tennessee Ground Water 305b Water Quality Report November 2002.

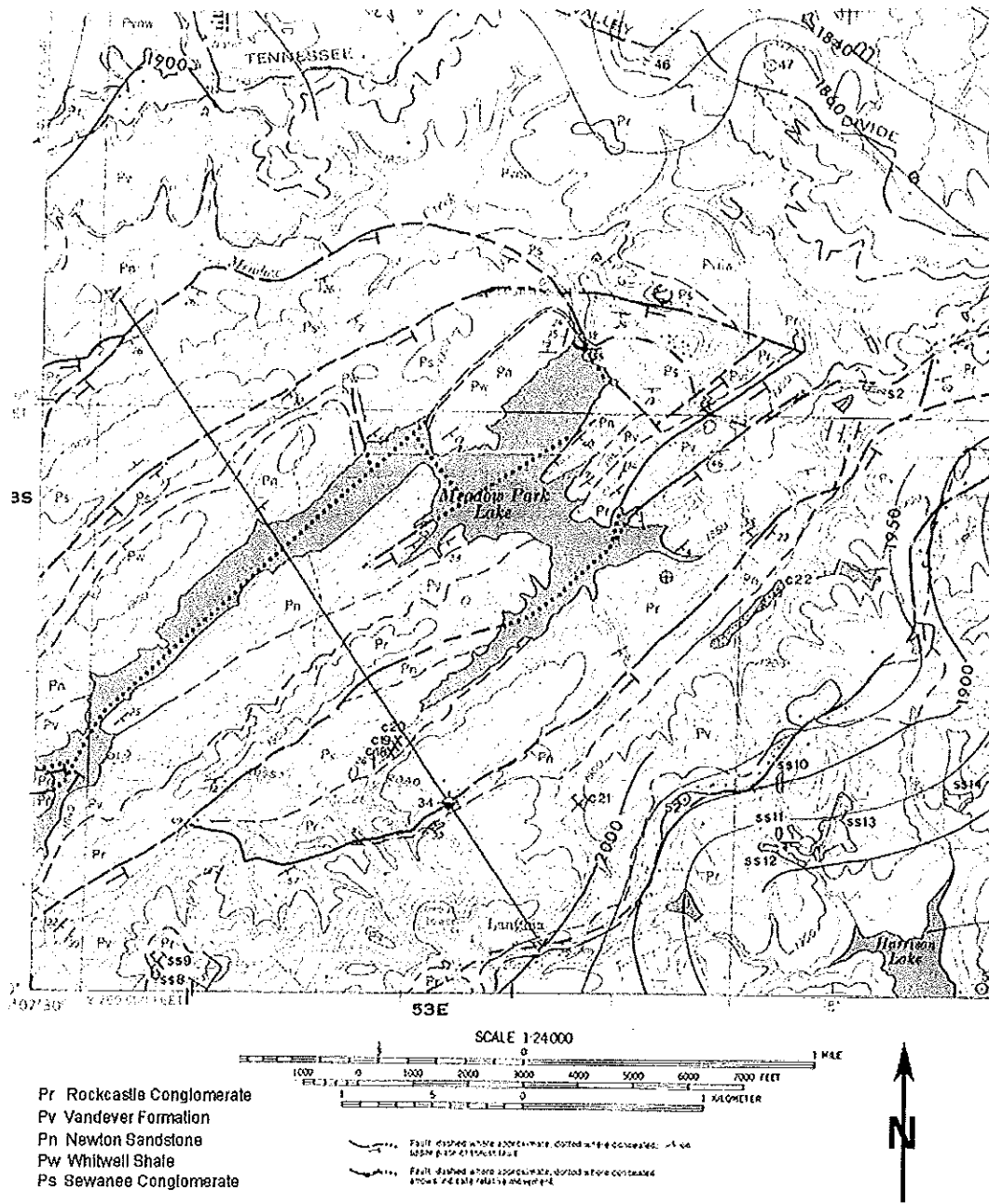


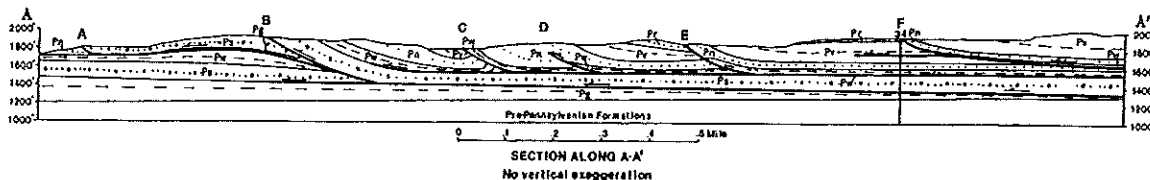
Figure II-2 - Geologic map of the site area.
 Adapted from the Geologic Map of the Crossville Quadrangle, Moore 1981

III. GENERAL HYDROLOGY

According to Brahana (1986), the Cumberland Plateau in general has shallow aquifers with recharge occurring from precipitation and discharging to streams. Due to the low primary porosity of the sandstones and conglomerates, well yields are generally low. Secondary porosity is derived from fractures. Shale layers where present, retard the downward movement of ground water. Where shale layers exist, there is very little movement of ground water between formations.

The faulting which has occurred across the site could have two potential impacts. If the faults are tight and do not allow groundwater to move along them, the faulting would tend to segment the site and

reduce the potential recharge areas to the lake. This is particularly true on the southeastern side of the lake where the faults cause the bedrock to dip away from the lake. Due to the faulting, shale layers are now almost vertical instead of the normal horizontal layering usually seen in the Cumberland Plateau. The cross section for the Geologic Map of the Crossville Quadrangle shows this very well. However the shallow nature of the aquifers should tend to reduce these impacts. If the faults are open and allow for movement of water along them then ground water may more readily move to the lake. Also due to the faulting it may be possible for water to move from the lake to areas of lower water level, notably below the dam, more rapidly than it would if the bedrock were undisturbed.



GEOLOGIC MAP OF THE CROSSVILLE QUADRANGLE, TENNESSEE

Figure II-3 Cross-section from the geologic map Figure II-2.

Ground water levels around a lake are normally at or above the lake level depending on the local topography. At this site the topography rises steeply around most of the lake, and ground water levels should also rise. In the vicinity of the dam structure and down stream, ground water levels should decrease rapidly until they are at or near the level of the stream below the dam.

IV. BACKGROUND INVESTIGATIONS

Initial investigations included a review of available maps and literature on the geology and hydrology of the Cumberland Plateau with emphasis on the Crossville area. The review also included a check for any literature on problems with dams in sandstone bedrock as well as structural problems due to faults. There was little written on the hydrology of the Crossville area specifically. There was however a very good report done on the entire Cumberland Plateau by Brahana (1986). Geologic data came from a number of sources including the Geologic Map of the Crossville Quadrangle and its associated Mineral Resources Bulletin (Moore 1981). Also Wilson (1958), provided important information on the nature of the Cumberland Plateau Thrust Fault system as well as the regional geology. A map by Wilson (1956), provided additional geologic information. General information on dam leaks and remediation measures came from Plata (2002), as well as Nuser (2002).

V. BOREHOLE CORE AND VIDEO LOGGING

A. CORE LOGGING

The site characterization conducted by ECE included augering and sampling of the overburden as well as coring of the bedrock to determine its structural characteristics. PELA used existing core samples from previous boreholes as well as core samples from several new boreholes to help characterize the nature of the bedrock at the dam site and around the lake. Borehole locations were selected to best characterize locations where leakage was most likely to occur as well as in one location that would be representative of areas that were relatively undisturbed.

Cores were received by PELA from ECE for boreholes 1B, 1C, 2, 3, 3C, 4, 4B, 5, 6 and 12 along with ECE's driller's logs. The purpose of this evaluation was to determine the number and type of fractures in the bedrock as well as to confirm the local geology. Based on this evaluation, borehole logs were

created to document the findings as well as to facilitate correlation between boreholes. A column is also provided on the borehole logs to include data from the video logging described in sub-section B. Both physical logging and video logging have limitations. The combination of the two methods can remove uncertainties in both methods and provide for a much more accurate subsurface interpretation.

In general the physical borehole logs agree with the video logs. The video logs are more accurate in determining the absolute depth to identifiable features such as coal seams or shale beds.

B. VIDEO LOGGING

Although traditional rock coring provides important information on the type of rock and the fractures present, it also requires interpretation by the drillers and the geologist. Because of the requirement for pressurized water and the mechanical motion of the drilling process, areas of weak or highly fractured rock often appear to be open voids to the driller. Under such conditions these materials are often converted to fine mud or sand that is washed out of the borehole, leaving gaps in the bedrock core recovered. This lost data is often important to the geologist. The exact position and size of these gaps is often difficult to determine if there are multiple weak points in a core section. Furthermore, it is not possible to determine the orientation of fractures in the bedrock from an unoriented core sample. Predominant fracture orientations are often important to the geologist in understanding the local geology and hydrology. For this reason PELA recommended that an examination of the boreholes using a down-hole video camera could make a valuable contribution to this investigation.

A GeoVision Jr. color video camera was used. This system includes a 2" diameter, color video camera head attached to a cable and winch system. The video camera is connected to a control box that decodes the video signal as well as powers the video head. The control box can also add an audio output signal. From the control box the video and audio signals are routed to a combination DC television and video recorder. The down-hole video could be viewed in real time and real time audio observations can be added to the tape. The recorded tapes were then returned to the office where they were reviewed, and the information was transferred to the borehole logs.

The borehole logs including descriptions from core and video logging are located in Appendix A. Note that areas of the core log marked as "TTU LAB" were selected and removed by ECE for testing and were therefore not available to PELA for description.

The video logs were very useful in understanding the subsurface geology. Many of the areas that were missing core or reported as voids by the driller were found to be areas of fractured and weakened rock that had been broken down by the drilling. However, based on video logging alone it would often not be possible to determine the type of rock or to distinguish between different rock layers with similar colors. For these tasks the physical core is necessary.

C. INTERPRETATIONS

Boreholes (BH) 1B and 1C are located on the eastern side of the dam approximately 50 feet apart (see figure V-1). The two boreholes showed similar lithologies. BH1B was drilled to a depth of 70 feet below the ground surface (BGS). BH1C was drilled to a depth of 130 feet BGS. According to the geologic quadrangle map these two boreholes should be located in the Sewanee Conglomerate (Ps). The Sewanee Conglomerate is reported to be 140 to 230 feet thick in this area. The samples observed from these boreholes confirmed that they are probably located within the Sewanee Conglomerate. Below the Sewanee Conglomerate is the Gizzard Group, which is predominantly shales. The logs indicate that only sandstones and conglomerates were encountered in the boreholes. The video log of BH3C did not indicate any enlarged fractures or openings. The video logs and core logs showed comparable lithologies.



Photo 1: Video logger set up at BH4B.

BH2 is located directly downstream of the dam at approximately its center point. According to the geologic map, a fault runs between BH2 and BH1. The fault could not be observed in the field due to soils and broken rock covering the bedrock. BH2 was drilled to a total depth of 100 feet BGS. According to the geologic map, BH2 should be located in the Newton Sandstone (Pn) and possibly the Whitwell Shale (Pw). Both these formations are 5 to 100 feet thick in this area. The video log and core log showed comparable lithologies. Since sandstones were encountered throughout the borehole with only minor shale beds it appears BH2 is located in the Pn. The core log indicates a 3 – 4" high void occurring at 68 feet BGS. When first drilled this void produced water at a substantial rate, but the discharge was not measured. This void corresponds to 2 – 3" high coal seam seen in the video log at 70 feet below the top of casing. This coal seam contained some small open tubes that may have been created by ground water flow. A slight flow of water appeared to be coming from the tubes in the video log. Flow rate from the borehole was less than a gallon per minute when the video logging was performed, several months after drilling.

BH3 and BH3C are located to the west of the dam. BH3 is located approximately 100 feet west of the west end of the dam. BH3C is located approximately 300 feet southwest of the west end of the dam and 200 feet south of BH3. BH3 was drilled to a depth of 42 feet BGS. BH3C was drilled to a depth of 127.5 feet BGS. The geologic map shows that a fault lies just north of BH3. Both boreholes should be located in the Newton Sandstone (Pn). The lithologies from the core logs vary slightly. BH3 tends to be predominantly reddish and medium gray sandstones. BH3C contains mostly light gray and bluish gray sandstones. There is no evidence of the Whitwell Shale (Pw) in either borehole. The rocks in the two boreholes are dipping at very different angles that may account for the varying lithologies. There is also

the potential for a small fault or fracture in the area that separates the two boreholes. During pump testing, no draw down occurred in BH3 while BH3C was being pumped which supports this hypothesis.

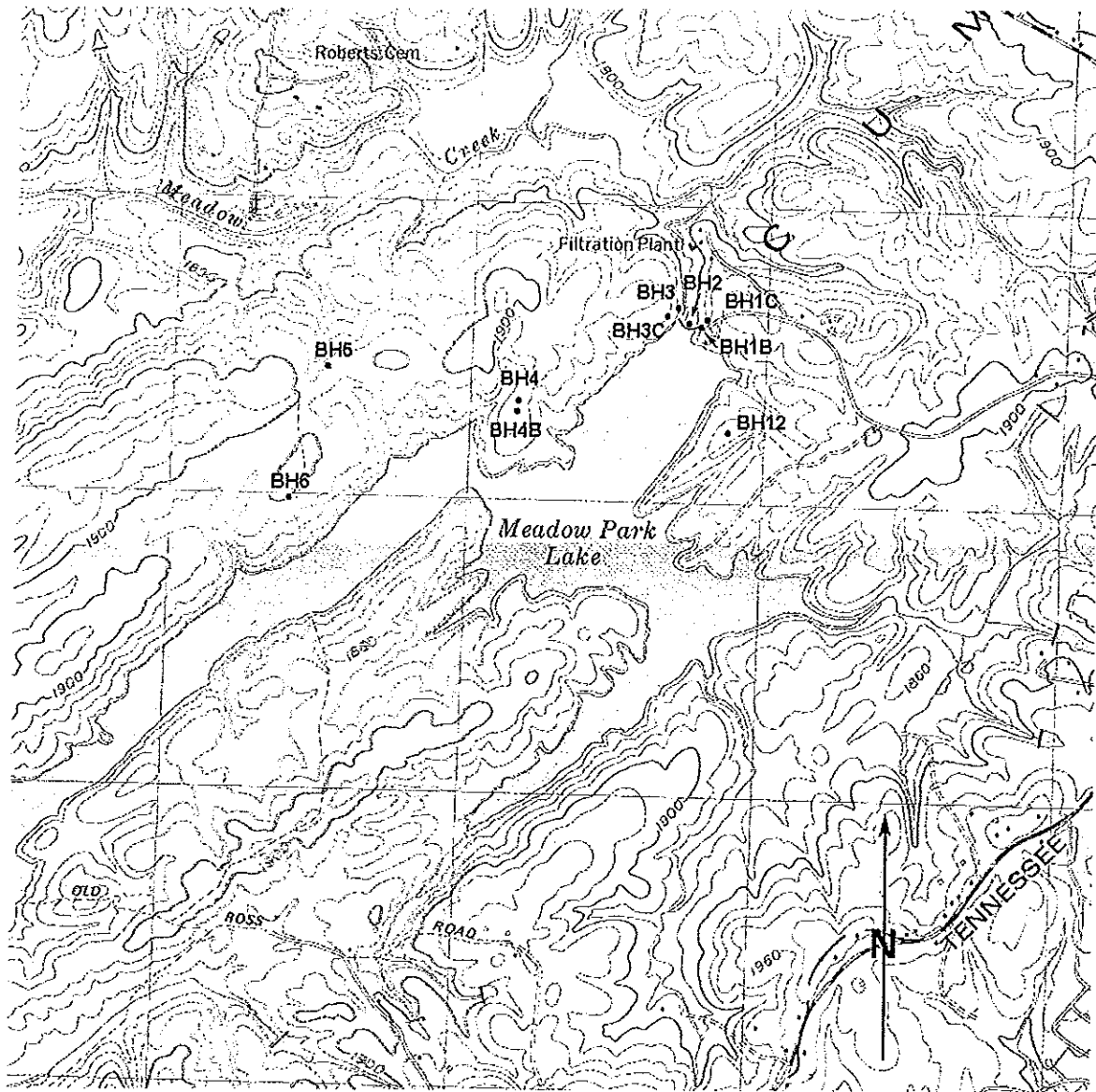


Figure V-1: Portion of the Crossville topographic map showing Meadow Park Lake and the approximate locations of the boreholes.

BH4 and BH4B are located on the west side of the lake approximately 1500 feet southwest of the dam. BH4B is located approximately 200 feet south of BH4. BH4 was drilled to a depth of 102 feet BGS. BH4B was drilled to a depth of 162.5 feet BGS. According to the geologic map both these boreholes are located in the Newton Sandstone (Pn). The lithologies were similar but not correlatable. This is probably due to the dip of the rocks caused by faulting in the area.

BH5 is located on the west side of the lake approximately 4000 feet southwest of the dam. BH5 was drilled to a depth of 178 feet BGS. According to the geologic map BH5 is located in the Sewanee Conglomerate (Ps). There are two major faults in the vicinity of BH5. One is a thrust fault that should surface just west of the borehole. The other is a strike-slip or vertical fault that should be located south

and east of the borehole. A review of the core and video logs did not indicate the presence of either of these faults. There was a 6 foot thick layer of coal located at approximately 153 feet BGS. This thick coal member is not mentioned in any of the geologic descriptions. It may represent the base of the thrust fault where the decollement occurred. Due to extremely turbid water, this area of the borehole could not be observed with the video camera.

BH6 is located on the west side of the lake approximately 4750 feet southwest of the dam. BH6 was drilled to a depth of 200 feet. According to the geologic quadrangle map BH6 was drilled in the Newton Sandstone (Pn). The core log indicated several areas with no samples, but no voids were located with the video camera. The lithology matches the description of the Newton Sandstone. The video log indicated that the borehole was filled with sediment from 176 feet to the bottom.

BH12 is located on the east side of the lake approximately 1200 feet southeast of the dam. The borehole is located approximately 100 feet in front of the water treatment plant. According to the geologic quadrangle map, BH12 is drilled in the Newton Sandstone very near a small thrust fault. Because of the unstable nature of BH12, a well casing had to be installed in the borehole to keep it open; therefore no video log was obtained. The core log indicates sandstones down to about 32 feet BGS. For the next ten feet, there was a layer of interbedded sandstone and shale. At 42 feet BGS the bedrock was mostly shale, and the bedding was at an angle of approximately 70% indicating that the thrust fault was present. This steeply dipping shale layer was present down to 82 feet BGS. After 82 feet BGS, the bedrock was composed of primarily sandstones with a much lower dip. This confirmed the fault in the area and the need to investigate it further.

VII. BOREHOLE WATER-LEVEL EVALUATION

The water levels in the boreholes were measured from October 12, 2004 until December 20, 2004. After drilling and completion of the boreholes by ECE, surveyors from the city of Crossville surveyed reference points near each well and to the top of the dam. PELA then performed a simple level survey to determine the exact elevation of a measuring point (MP) on all the wells and the crest of the dam spillway on the eastern side.

Depth to water measurements were taken with a water-level meter each time ECE or PELA personnel were on site. With this data PELA was able to derive an accurate water level in each borehole referenced to mean-sea-level elevation (MSL). Graphs of the water level elevations are located in Appendix B.

In a typical aquifer that has uniform rock properties, it is expected that the water level in the boreholes would rise and fall in response to precipitation events. Those boreholes lying up-stream of the dam should have water-level elevations at or above lake level. Those boreholes lying down-stream of the dam should have water-level elevations below the lake elevation but above the level of the stream. In evaluating the graphs of the borehole water elevation data, some anomalous elevations were observed.

BH1C is located approximately 100 feet northeast of the dam. It is located down stream of the dam, and the top of the borehole is 24.45 feet above the elevation of the spillway. The water level in BH1C averages approximately 20 feet below the level of the lake. The water level in BH1C responds to precipitation events in a predictable manner.

BH2 is located approximately 10' down stream and at the approximate vertical center line of the dam. The top of the borehole is 23.4 feet below the level of the spillway. Because of its location it has artesian flow. Its water level is based primarily on lake level and is not affected directly by precipitation.

BH3 is located approximately 100 feet northwest of the west end of the dam. It is located down stream of the dam and the top of the borehole is 26.55 feet above the elevation of the spillway. It would be anticipated that the water level in BH3 would be below lake level. BH3 is much shallower than other

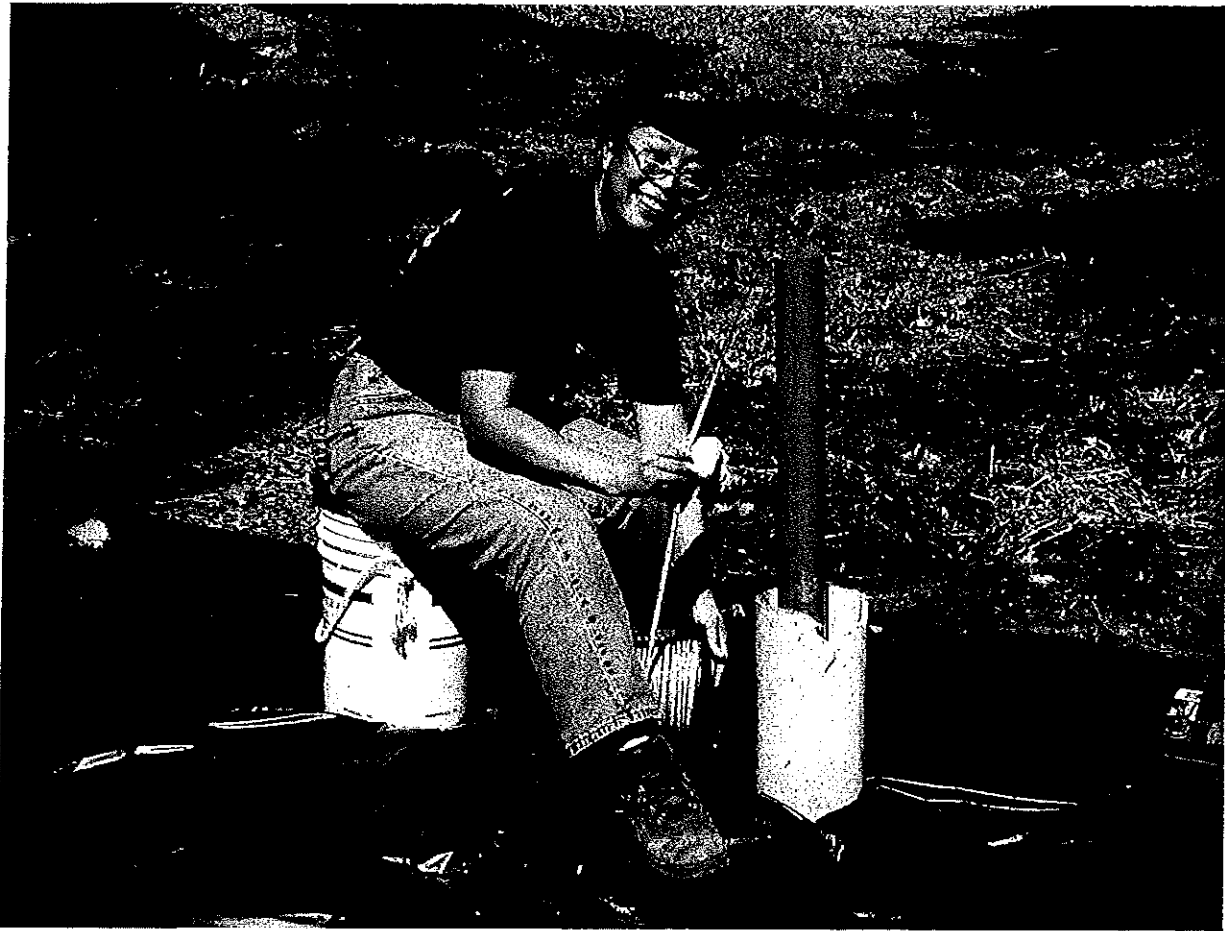


Photo 2: PELA geologist Jie Wang measuring the water level at BH3C.

boreholes having been drilled only 42 feet deep. The water level in BH3 ranged anywhere from approximately one foot above lake level to as much as 8 feet above lake level. Fluctuations of level

tended to lag behind precipitation events by several days and did not respond rapidly. The overall level appears to be cumulative. This data suggests an aquifer with very low permeability. The water level is probably being effected by the complicated geology of the area.

BH3C is located approximately 300 feet southwest of the west end of the dam. It is located upstream of the dam, and the top of the borehole is 30.57 feet above the elevation of the spillway. A review of the water-level data shows that the level of the water in the borehole was relatively stable during the time when data was collected. The water level was approximately 11 feet below lake level; although, it would be expected that the water level in the borehole would be at or above the level of the lake. The anomalous water level in this area indicates that the ground water is being discharged to a point below the dam faster than it can be recharged from the lake. It should also be noted that the level in BH3C is still approximately 13 feet above the level of the stream below the dam. The leakage at this point is not rapid enough to lower the ground water further. There are several faults located in the vicinity of BH3C. It is very possible that one or more of these faults is transmitting ground water to a point below the dam. The data also shows a noticeable lowering of the water level occurring on 12/15/04 and 12/16/04. At this time pump testing was being performed on BH2. This indicates some type of connection between these boreholes. Due to the dip of the rocks at this location, it is very possible that they share a more permeable rock layer or common bedding-plane fracture. The constant water level and the height of the water level, as well as the results of the pump and slug testing (see section VIII below), do not indicate significant leakage in this area. The bedrock in the area has an overall low permeability.

BH4 and BH4B are located on the west side of the lake approximately 1500 feet southwest (upstream) of the dam. BH4B is located approximately 200 feet south of BH4. The top of BH4 is 69.89 feet above the elevation of the spillway. The top of BH4B is located 62.25 feet above the elevation of the spillway. A review of the data from both boreholes shows that water levels in both are over 40 feet above lake level. They have similar hydrographs, with the water level in BH4A being approximately 5 feet higher than the water level in BH4B. These wells display a gradual response to precipitation events indicating a low permeability aquifer with gradual recharge.

BH5 is located on the west side of the lake approximately 4000 feet southwest (upstream) of the dam. The top of BH5 is 67.85 feet above the elevation of the dam spillway. An analysis of the water-level data at BH5 shows that it was generally 42 feet or more above lake level. An initial low reading was probably due to the water in the borehole not having fully equilibrated with the ground-water elevation after drilling. The water level showed only a very gradual change due to precipitation over an extended period of time. This is probably due to two factors. BH5 is located on the very top of a narrow ridge and, therefore, has a very limited recharge area. Secondly, the graph of the water level indicates the aquifer has very low permeability.

BH6 is located on the west side of the lake approximately 4750 feet southwest (upstream) of the dam. The top of BH6 is 81.85 feet above the elevation of the dam spillway. An analysis of the water-level data at BH6 shows that it was 46 feet or more above lake level. The water level showed only a very gradual change from precipitation over an extended period of time. This location is similar to that found at BH5, and their water-level graphs are very similar.

BH12 is located on the east side of the lake approximately 1200 feet southeast (upstream) of the dam. The top of BH12 is 47.92 feet above the elevation of the dam spillway. Initially, the groundwater-level data indicated that the water level averaged 30 feet above lake level. On 10/05/04, while attempting to video log BH12, it was discovered that the borehole had collapsed and was plugged at 17' below the top of the casing. The borehole was reopened and cased with slotted casing on 12/08/04. At that time, the water level dropped to approximately 10 feet below the level of the lake and remained there for the duration of the data collection period. The water level showed only minor fluctuations. BH12 is located on a major fault line. The water-level data suggests that the fault is draining water away faster than it is gaining water. The pump and slug testing indicated that leakage is minor, and this is not a very permeable fault.

In order to determine the relationship of the groundwater levels to the lake level, and in order to raise the slug tests to a sufficient level above lake level, it was necessary to obtain general measurements of the lake level. The lake level is relatively constant because of the dam, and it changed by no more than a foot over the period of the investigation. The initial water levels were obtained while the level of water flowing over the spillway was low. After these initial water levels were obtained, it was no longer necessary to monitor the lake, and elevated lake levels would have made those measurements very difficult.

Daily precipitation data was obtained from the National Weather Service web site at <http://www.srh.noaa.gov/ohx/climate.html>. This data is from a weather station located in the city of Crossville and gives a reasonable approximation of precipitation at the site.

VIII. PUMP AND SLUG TESTING

An integral part of characterization of the site involved pump and slug testing of boreholes at the site. Pump testing provided an estimate of the current leakage around the dam as well as the porosity of the rock around the dam and lake. The slug tests were performed to estimate leakage from the lake and around the dam if the water level were raised by approximately 20 feet. For this part of the characterization six wells were determined to be suitable for pump and slug testing. At three locations BH2, BH3 and BH4, due to the availability of pairs of boreholes, one well was used as the test while the other well was used as a monitoring well. The results of the pump and slug testing are reported in Section C.

A. PUMP TESTING

Pump tests were performed to determine aquifer characteristics below the current water table. These tests required pumping water from the borehole at a known rate until a steady state of draw down was achieved. At this point the aquifer supplies water to the well at a rate equal to the pumping rate. The amount of draw down achieved at a given pumping rate is used to determine the porosity and storage capacity of the bedrock that forms the aquifer. When the draw-down data is graphed over time, the form of the draw-down curve can be used to interpret other aquifer characteristics such as fractures, recharge boundaries, confining layers, etc.

The basic set-up for a pump test includes a submersible pump(s) to pump the water from the well and an In-Situ® Hermit® datalogger with pressure transducer(s) to automatically record water-level data. A member of PELA's staff was on site for the initial set up and testing of the borehole. They stayed until the appropriate pumping rate was attained. The pumping rate had to be high enough to draw the well down sufficiently enough to get a good curve but low enough not to pump the borehole dry. This usually meant several tests had to be performed with as much as 24 hours between tests to allow the water level in the borehole to recover and stabilize. During each pump test by PELA and/or ECE personnel, data was collected manually in order to back up the Hermit data logger and to allow for calibration if necessary.



Photo 3: Pump testing BH5.

Pump testing began at BH3C on November 9, 2004, and concluded at BH6 on January 6, 2005. Boreholes 1C, 2, 3C, 4B, 5, 6 and 12 were successfully tested. BH3A could not be tested due to a kink in the PVC well casing just below the ground surface. BH4A was not tested due to its proximity to BH4B and the draw down observed in BH4A in response to pump testing at BH4B. BH4B was drilled deeper

than BH4A and was, therefore, more appropriate for testing. It was determined that these two boreholes share a common aquifer and that additional data could not be attained by pumping BH4A.

At BH2 the pump testing methodology had to be modified slightly due to leakage around the well casing. The sampling pumps used to pump the other boreholes were not capable of pumping sufficient water to significantly lower the water level. A larger submersible pump was tried next. This was able to lower the water level to somewhere near the bottom of the casing. A piezometer (a shallow well in the gravel) had been installed near BH2 to check the amount of leakage between the dam and the bedrock. By monitoring the piezometer it was found that pumping BH2 caused draw down in the water level in the piezometer. This leakage could have been caused by several factors. One possible factor could have been the well casing not being fully sealed into the bedrock which would allow water from above the bedrock to be drawn into the borehole during pumping. Another possibility was an open fracture in the bedrock conducting water from the gravel through the bedrock into the well. To isolate the well casing from the deeper borehole a packer was installed. A packer is a large rubber doughnut that is inserted into the well; the pump and piping passes through the center to the surface. When the packer is inflated it seals and isolates the areas above and below the packer. The packer was installed approximately eight feet below the top of bedrock in the borehole. The video logging showed this area to be very smooth and free of cracks so that the packer would provide a good seal. The pump was installed below the packer and the water line run through the packer casing to the surface. With this configuration, BH2 was successfully pump tested and draw down was not observed in the gravel piezometer. That meant water was being drawn from the bedrock aquifer and was not leaking from the surface gravel.

When pump testing was complete at BH2, the packer was left in place, and a section of clear plastic tubing was attached to the top of the well casing to measure the bedrock water level above the well. The maximum water level recorded was 16.4 feet above the measuring point or approximately 17 feet above the ground surface. This level is below lake level but considerably above the ground surface. It indicates that the aquifer is being affected by the lake, as would be expected, but the low flow rates during testing indicate that there is no direct connection such as an enlarged fracture or joint.

B. SLUG TESTING

PELA performed a modified slug test on boreholes 1C, 3C and 12 in order to evaluate the aquifer above the current lake water level, which may be impacted if the lake level is raised. Borehole 2 was not slug tested since it is physically located below the level of the current dam and has water to the surface. BH4C, 5 and 6 were not slug tested because their natural water levels are high enough in elevation that raising the lake level even 20 feet would have no significant effect on the aquifer at these locations. Additionally, the pump testing at these boreholes indicated that these areas had bedrock with very low permeability.

Traditional slug testing involves quickly placing a large solid object, or slug, of known displacement below the water level of a borehole and measuring the actual displacement of the water level and it's subsequent fall or regression. Slug testing may also be done by quickly injecting a known quantity of water into a well and measuring the water level rise and regression. Both of these methods are usually used to evaluate the aquifer below the current water table as a pump test does. Due to the size of the boreholes and the increase in water level necessary to evaluate the upper bedrock, PELA did not feel that the traditional slug testing methods were appropriate. The physical slug test requires insertion into the well of a very large slug, custom made to each well, to achieve the proper water-level rise. The water-injection-slug test requires a large amount of water to be injected very quickly. After reviewing the necessary quantities PELA determined that this method was not feasible. Instead PELA decided to use a modified water-injection-slug test that is basically the reverse procedure of the pump tests. For this method water was injected into the borehole at a known flow rate. Over a series of test runs, this flow rate was adjusted to raise the water level in the borehole to a level that was at or slightly above the anticipated lake level if raised the maximum of 20 feet.

Slug testing began at BH12 on Dec. 17, 2004, and concluded at BH3C on Jan 10, 2005. To achieve a constant flow rate, a large tank filled with potable water was set up above the level of the borehole. Since the flow rate from this tank would vary as the level of the water decreased, water from this tank drained to a smaller tank located near the borehole. The water level in the smaller tank was kept level by allowing it to overflow the tank slightly. The water from this tank, now discharging at a constant flow rate, was injected into the borehole. BH12 used a slightly different set up. Potable water was available from a fire hydrant at this location. This was fed directly into the smaller tank and then injected into the borehole.



Photo 4: Slug testing BH12.

Water-level data was again collected using the Hermit® datalogger and pressure transducers. Due to the water being injected into the borehole, manual measurements with a water level indicator tape could not be taken. The datalogger was read in real time to determine when the proper water level was achieved.

C. DATA ANALYSIS

AQTESOLV software was used to determine the aquifer parameters, transmissivity T , Storage Coefficient S and Hydraulic Conductivity K . The unconfined aquifer model and Theis method were applied in calculating the parameters. Calculation of the aquifer parameters was based on the following assumptions:

- The aquifer has infinite areal extent;
- The aquifer is homogeneous, isotropic and of uniform thickness;
- The pumping well is fully penetrating;

- The flow to the well is horizontal;
- The flow is unsteady;
- The water is released instantaneously from storage with decline of hydraulic head;
- The diameter of the pumping well is very small so that the storage in the well can be neglected;
- There is no delayed-gravity response in the aquifer;
- The flow velocity is proportional to tangent of the hydraulic gradient;
- The flow is horizontal and uniform in a vertical section through the axis of the well;
- The displacement is relatively small - relative to the saturated thickness of the aquifer.

The data analysis considered the water-level measurements during both the pumping and recovery periods. Table 1 lists all of the results.

The amount of water that may leak from the lake depends on the aquifer parameters, the hydraulic gradient to the discharge point, and the flow-through area in the subsurface. The calculated transmissivity values indicate that the aquifer is heterogeneous overall. To utilize the assumption of an homogeneous aquifer, the site was divided into sections that were internally similar based on the transmissivity values. The area of possible leakage was divided into four sections beneath the existing lake level and three sections above the lake level. Within each section, the hydraulic gradient and the flow-through cross-section were estimated based on the local hydrogeology and the following assumptions:

- ◆ The aquifer is unconfined, homogeneous and isotropic.
- ◆ The leakage flow is laminar and follows Darcy's law.
- ◆ The leakage flow through the sandstone and shale layers can be treated as one composite layer for this calculation.
- ◆ The hydraulic gradient is consistent within in the calculation area.
- ◆ The leakage from the reservoir discharges into the adjacent local creek downstream.

In each section, the following equation was used to calculate the leakage. The total leakage is the summary of leakage from each section.

$$Q = - KAI = - K \Delta h^2 W / L \quad \text{where } K = T / H$$

where: Q = leakage rate (feet³/day)
 K = hydraulic conductivity (feet/day)
 A = flow-through area (feet²)
 I = hydraulic gradient
 Δh = water head loss from reservoir to creek (feet)
 W = width of section through which water leaks (feet)
 L = average length of leakage flow from reservoir to creek (feet)
 T = aquifer parameter, transmissivity (feet²/day)
 H = saturated thickness (feet).

The calculation processes are included in Appendix E of this report. Table A lists the data and results of calculations used to determine the leakage of the current aquifer. Table B lists the data and results of calculations used to determine the leakage if the lake level is raised 20 feet.

Pumping Well	Pumping Activities	Maximum Draw-down /Build-up (feet)	Saturated Thickness (feet)	T (feet ² /day)	S	K (feet/day)
BH 1C	Pumping 190 minutes, pumping rate stabilized at 0.3 gpm 20 minutes after pumping; recovery monitoring until 1260 minutes	31.15	49	0.9415	0.2094	0.019
BH 2	Pumping 1415 minutes at 18 gpm, no recovery monitoring	49.01	60.61	62.17	0.1126	1.026
BH 3C	Pumping 570 minutes at 5.6 gpm, recovery monitoring until 1330 minutes	10.15	57	96.44	0.2	1.692
BH 4B	Pumping 1095 minutes at 1.02 gpm, recovery monitoring until 1215 minutes	24.39	120	5.312	0.2	0.044
BH 5	Pumping 685 minutes at 2.5 gpm, recovery monitoring until 2510 minutes	12.25	115	30.84	0.2	0.268
BH 6	Pumping 1110 minutes at 3.4 gpm, no recovery monitoring	11.49	117	48.63	0.21	0.416
BH 12	Pumping 320 minutes at 3.03 gpm, recovery monitoring until 1235 minutes	14.99	60	34.71	0.1852	0.579
Slug Test Results						
BH 1C	Injection 30 minutes at 1.27 gpm, recovery monitoring until 87 minutes	28.07	77	2.184	0.32	0.04*
BH 3C	Injection 242 minutes at 15.46 gpm, recovery monitoring until 330 minutes	27.74	84	87.64	0.2	2.17*
BH 12	Injection 55 minutes at 7.7 gpm, recovery monitoring until 76 minutes	46.74	106	19.04	0.23	0.50*

* Weighted Hydraulic Conductivity was used for slug test analysis.

Table VIII-1. Summary of Parameters Calculated from Pumping and Slug Tests

Location of Water-level Measurement	BH 1C	BH 2	BH 3C	BH 4B	BH 5	BH 6	BH 12	Reservoir
Data (by pumping test)								
Average water level used for contour map (feet AMSL)	1798.9	1810.8	1807.6	1869.8	1862.4	1865.3	1809.5	1818.8
Saturated Thickness H (feet)	49.0	60.6	57.0	120.0	115.0	117.0	60.0	
Transmissivity T (feet ² /day)	0.9415	62.17	95.28	5.31	30.84	48.63	34.71	
Data (by slug test)								
Saturated Thickness H (feet)	77.0		84.0				106.0	
Transmissivity T (feet ² /day)	2.18		87.64				19.04	
Elevation after water level raising								1838.8

Table VIII-2. Calculation Data of Borehole and Reservoir

Based on the average water-level data in Table 2, a water-level contour map can be drawn. It is obvious that the ground water level is higher on the west side of the reservoir and lower on the north. Due to its topography the eastern side of the reservoir was not analyzed except in the vicinity of BH12. The possibility of leakage from this side of the reservoir is very low. Ground-water levels on the eastern side of the reservoir should also be above lake level. Therefore, groundwater flows down from the west hill to the reservoir and from the reservoir to the north, especially from the dam area to the creek basin. Depending on the calculation results (see the details of Attachment A), the total estimated leakage around the dam, from BH3C to BH12 is **24.7 gallon/minute** under existing conditions and **48.9 gallon/minute** after a 20 foot raise in the reservoir level.

This data represents the water flow through the bedrock around the dam based on the data from boreholes 1C, 2, 3C, and 12. It must be understood that these four boreholes represent only a few limited points for a much larger area. These points were chosen based on topography, geology and engineering purposes. The borehole logs, especially BH12, indicate that the geologic map is accurate. There is always the possibility that subsurface data is missing or that an undetected anomalous area exists. PELA has made a concerted effort to obtain the best data within the scope of the project.

It should also be noted that there is leakage occurring between the bottom of the dam and the top of the bedrock. The pumping at BH2 before the packer was installed, as well as visual observations of water welling up at the face of the dam, indicate there is some leakage. According to Plata, 2002 this type of leakage is common to most dams. During the course of the investigation, the dam was observed when no water was flowing over the spillways. At this time all the water flowing below the dam was due to the leakage occurring under the dam. The flow rate was approximately 100 gallons per minute or less. During these times there did not appear to be any leakage occurring around the dam abutments. Future construction will need to evaluate the cause and significance of this leakage and determine the best method of remediation, if necessary.

IX. GENERAL SITE INSPECTIONS

As part of the overall site evaluation, stream valleys that were determined to be potential discharge points for lake leakage beneath or around the dam were inspected by PELA personnel. PELA personnel looked for any springs that could be a potential discharge points for leakage. The main stream valley below the Meadow Park dam was checked for approximately ¼ mile downstream. At this point the stream enters a very narrow, deep, rock canyon which was not traversable at the bottom. However, at this point Meadow Creek is beyond the major faults shown on the topographic map so that leakage

beyond this point is unlikely. Only minor seep areas were noted during the inspection. These seeps are probably the result of localized ground-water discharge. They did not have any distinct discharge points and were of very low flow, less than 1 GPM.

A side valley just west of BH 5 was also investigated. This valley occurs at the narrowest point on a section of ridge surrounding the lake, and it drains to Meadow Creek downstream; so it is a potential point of leakage. This area was also of interest due to a normal fault located just north and southeast of BH5. The geologic map indicates that this fault does not penetrate through the ridge but extends from the lake to near the centerline of the ridge. After careful reconnaissance, no springs were found in this valley.

X. NATURAL POTENTIAL INVESTIGATION

Prior to the final analysis of the pump and slug tests, PELA performed a limited Natural Potential (NP) geophysical investigation to locate the cause for the anomalous water-level data at BH3 (thought to be a possible "leaking fault"). As a basis for comparison, NP data was also collected on the opposite side of the dam, in the vicinity of BH1C, where no anomalous data had been noted. Data from four NP transects of varying length were collected at the site, two on each side of the dam. Each side contained one transect parallel to the dam face and one transect perpendicular to the dam. This enabled maximum coverage of the bedrock around the dam.

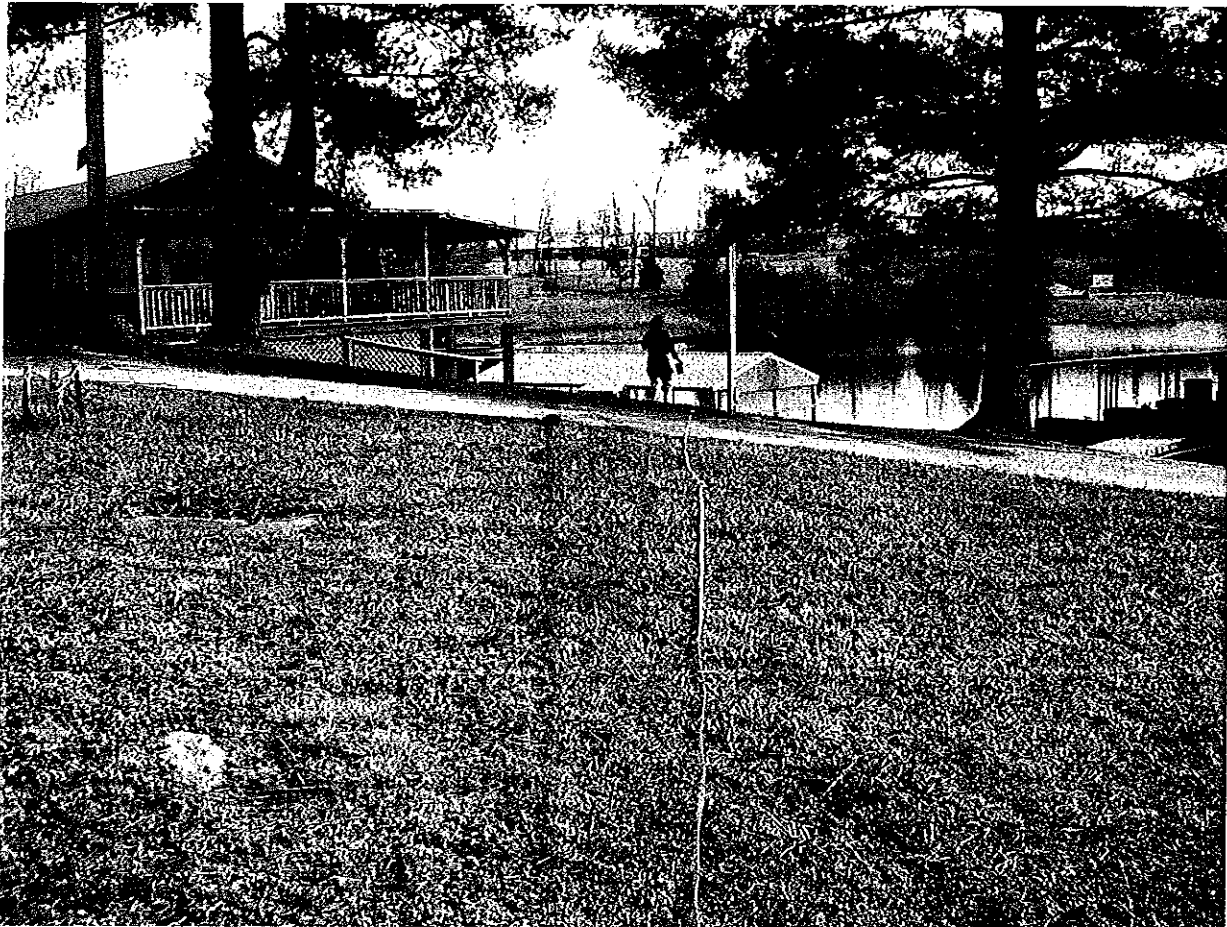


Photo 6: PELA geophysicist Angela Adams setting up NP line 1.

The natural potential (NP) method—also known as self potential, spontaneous potential, streaming potential, and SP—involves measurement at the ground surface of natural voltage developed by

ambient electrical currents in the earth. Such currents occur everywhere, but they do not arise from random processes. They result from a variety of discrete physical phenomena acting underground, including (a) redox reactions around a metallic conductor intersecting the saturated zone; (b) fluid diffusion across soil and lithologic contacts; (c) subterranean chemical and temperature gradients; and (d) most commonly, the water pressure gradient resulting from water flowing through fractures and openings in the ground, i.e. the electrokinetic effect. An electrical potential gradient is linearly proportional to the driving force of the water flow.

In saturated bedrock, groundwater flows preferentially through various joints, faults, and fractures. A potential gradient can develop along the flowpath. The upstream end of the channel can become negatively charged relative to the downstream end. The normal potential distribution is a positive anomaly transverse to the flowpath over the discharge point (such as a spring) and a negative expression over the point of water entry (such as a sinkhole or a swallet). If the flow is channeled along conduits or fractures, it can be detected by the asymmetrical potential pattern at the surface. Thus, from the ground surface, the NP method can help to locate discrete groundwater conduits and fracture pathways.

As with other electrical potential-field methods, the larger the target and the longer its strike length, the more readily detectable it will be. The response at the ground surface is attenuated by conductive materials such as clay; hence a "leaking fault" will be better defined over a bare, resistive rock than over clay-covered rock. The detection depth of the NP method depends on a number of factors, including (a) the electrical resistivity of the surrounding lithology; (b) the electrical and chemical properties of the electrolyte; (c) the rate of water movement; (d) the dimensions and definition of the targets; and (e) the physical mechanism causing the potential anomaly. Small stream conduits (caves with flowing streams) have been detected at depths as shallow as 3 m (10ft) and as deep as 46m (150 ft).

The NP measurement system consists of two non-polarizing copper/copper sulfate porous pot electrodes, a voltmeter and IP wire. Procedurally, one electrode was kept at a fixed base station, and the second (roving) electrode was moved along the traverse. At the base station, the electrode was buried to provide a stable environment. At each data point, the roving electrode was placed approximately 4-6" deep into the topsoil to ensure a good contact. NP data was collected every 5 feet along each transect. At each station, two readings were taken to ensure that the measurement was representative of that location. If the difference between the two readings was less than 2 mV under 100 mV and 5 mV over 100 mV, the readings were recorded and used to represent that data point. If the difference was greater, additional measurements were taken until the difference between two readings was less than the acceptable threshold. The base station was visited at the beginning of the transect, hourly, and at the end of the transect for the purpose of drift correction. Temperature, moisture, and chemical fluctuations in the soil and electrodes cause drift. Drift can be monitored by repeated measurements at the reference electrode, and this plot of the drift over time can be used to make the correction. Where necessary, residual profiles are then generated by removing any additional trends induced by artificial currents or topography. From the final residual profile, the position of anomalies of interest can be modeled and interpreted utilizing the principals described above.

The drift-corrected NP data represent the effect of local streaming potential, which is caused predominantly by groundwater flow (Ernstson, 1986). Infiltration of neutral water (pH of 7) causes a negative anomaly, and negative anomalies have been documented in the field in areas with active infiltration (Zhou 1999). The interpreted NP profiles are included in Appendix D.

NP transect 1 was located on the east side of the dam and roughly parallel to the dam face (see Figure X1 for map of transect locations). It began near the eastern end of the dam and continued to the waters edge near the boat dock on the lake. Anomalous data was expected and observed where the line crossed a concrete road leading to the boat ramp. The graphical representation of the data on this transect is a relatively smooth graph as opposed to the data obtained on the western side of the dam. The eastern side of the dam has a thicker layer of soil over the bedrock than the western side of the dam.

NP transect 2 was located on the western side of the dam perpendicular to the dam face. This line began near BH3 and extended approximately 60 feet past BH3C. The data for this transect is significantly more erratic than that observed at transect 1. This is probably due to the very thin sandy soil or bare bedrock often exposed. The data indicates a potential anomaly located between 60 and 90 feet with a center at approximately 75 feet. Due to its low magnitude and the erratic nature of the total data set, the data is inconclusive.

NP transect 3 was located on the western side of the dam parallel to the dam face. It began near the end of the dam and extended to a point just beyond BH3. The graph of the data indicates a drop in the voltage due to rise in the elevation from the beginning of the transect to the end. This data is also more erratic than the data from the NP transects on the eastern side of the dam for the reasons given above.

NP transect 4 was located on the east side of the dam and perpendicular to the dam face. It began approximately 230 feet north of the dam and continued to the lake shore, 70 feet south of the dam. The graph of the data indicates an anomalous, negatively charged area. However, with some surface observation, it was discovered the negative spike occurred where the transect passed near an iron water

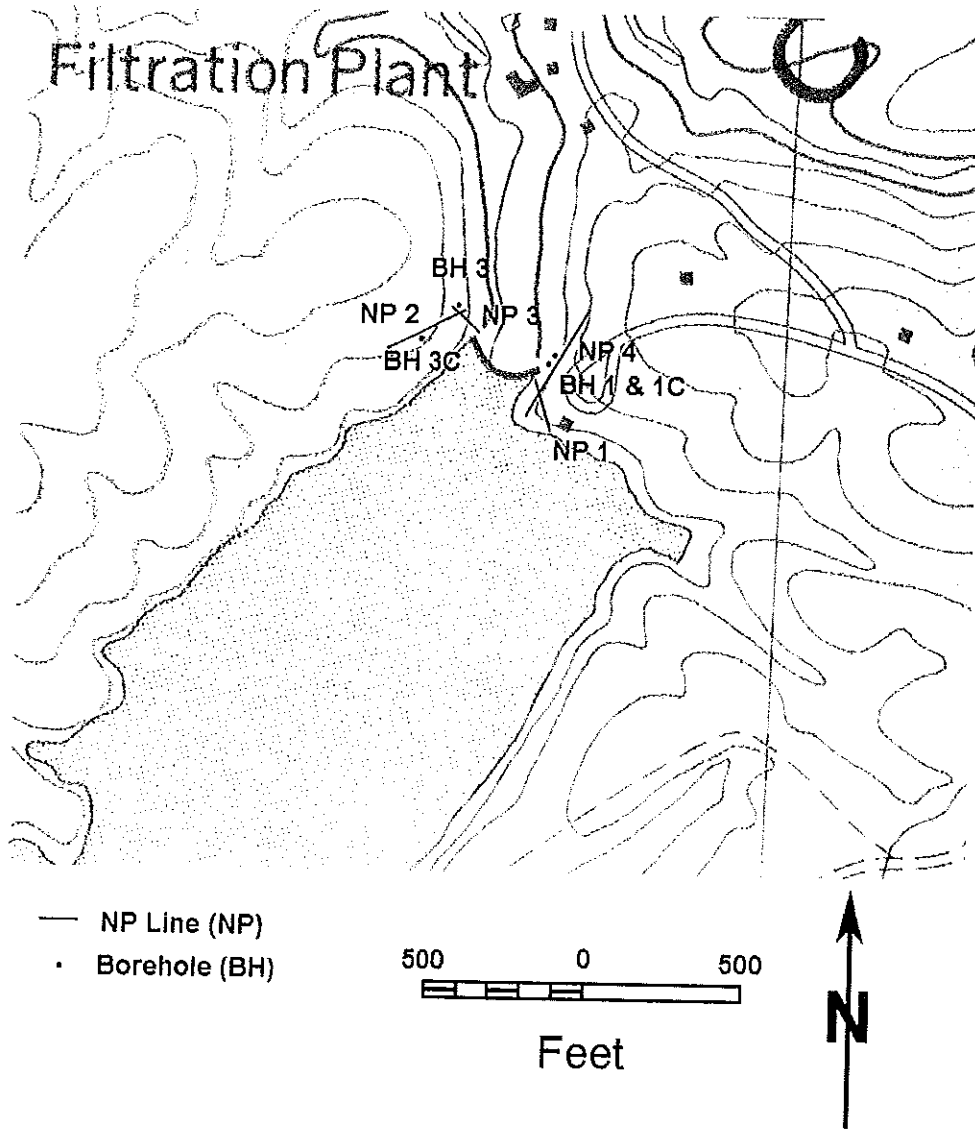


Figure X1: Location map of natural potential transects.

pipe. The iron pipe draws electrons away from the soil, creating the very negative spike in the graph.

The NP data did not indicate any significant leakage in the abutments to the dam. The data from the east side of the dam was significantly more stable than the data from the western side of the dam. This was probably due to the thicker soil cover in that area. A potential low level anomolous area was seen in the data from line 2. This could be evidence of a "leaking" fault, but due to it's low magnitude and the erratic data in general from this line, this can not be proven conclusively.

XI. CONCLUSIONS

The site area is located on an area of the Cumberland Plateau that has been significantly impacted by the Cumberland Plateau Thrust Fault and associated faults. The geology is complicated across the site due to fragmentation caused by the thrust faulting. Initial concerns about the water producing void located in BH2 and the possibility of the fractured bedrock causing preferential flow paths around the dam structure were reasonable.

The initial borehole logs indicated potential problems with the site, possibly void areas in the rock. This was also a concern with the water-level data obtained from these boreholes. However, video logging of the boreholes shows that the voids encountered in the drilling are primarily due to the removal of weak and fractured rock during the drilling process rather than the presence of open voids in the subsurface. Fractures, where present, appear to be tight and not conducive to the flow of a significant volume of water. The void in BH2 appears to be a coal layer that has been partially removed by groundwater. This created a pressurized-storage area that flowed appreciable water when first encountered but decreased to only a few gallons per minute several months later. If BH2 is properly grouted, there should be little to no water loss from the coal seam or BH2.

The water-level data indicates potential leakage problems at BH3C at the western abutment of the dam and at BH12 where a significant fault exists. Boreholes located in other areas around the lake show normal hydrologic patterns. No water levels observed in the boreholes indicate a direct, open connection between the borehole and the lake.

The natural potential data does not indicate leakage in the abutment areas around the current dam structure. The NP data from the western side of the dam is very erratic compared to data on the eastern side of the dam. This is caused by the very thin and very sandy soil covering the bedrock in this area. The land on the eastern side of the dam has thicker, more clayey soils that hold moisture and provide more stable data. The NP data supports PELA's conclusion that there is overall low leakage around the present dam structure.

Pump testing of the boreholes indicates that groundwater flow rates were very low and were primarily due to the porosity of the bedrock. Movement through fractures is minimal. PELA concludes that the low water levels seen in BH3C and BH12 are due to slightly enhanced groundwater flow associated with faults in these areas, but that the faults are not significant pathways for leakage. The recharge to these faults is through the surrounding bedrock and not directly from the lake. Slug testing indicates that the local geology and hydrology will be similar if the water level in the lake is raised by as much as 20 feet. Leakage should be only slightly greater than what it is now, and should not be a significant problem.

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APPENDIX A

**Well Logs of BH1B, BH1C, BH2, BH3, BH3C,
BH4, BH4B, BH5, BH6 and BH12.**

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/3/04

LOCATION: Adjacent to Dam

SURFACE ELEV.: 1840.22

LOG ID: BH-1B

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 4/5/04

DRILL CONTRACTOR: ECE

DRILLER: Floyd, Steve, Otis

DRILL RIG TYPE: Mobile B-30

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL DEPTH:

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
0				Auger Refusal @ 3.5 feet		Video log not made. Borehole closed prior to video logging.
5	ECE 103			FRACTURED SANDSTONE: Gray (N5.5), fine grained, many small (<1mm) coal seams, horiz. fractures along seams @ 3.7, 3.75, 4.25, 4.6, 4.9, 5.0, 5.15, 5.5		
				SANDSTONE: Gray (N5.5), fine grained, horiz. fracture w/ FeO2 clay residue @ 5.5, angular fractures w/coal @ 5.9, 6.2, 6.42, 6.75, horiz. fracture w/coal @ 6.25		
				SANDSTONE: Gray (N5.5), fine grained, significant FeO2 staining, angular fractures w/limonite @ 7.25, 7.45		
				SANDSTONE: Gray (N5.5), fine grained, angular fracture w/minor FeO2 stain @ 7.9, angular fractures w/coal and loose coarse grained material @ 8.1, 8.6, 8.9, 9.15		
10	ECE 103			TTU LAB		
				SANDSTONE: Gray (N5.5), fine grained, angular fractures w/coal @ 9.7, 10		
				FRACTURED SANDSTONE: Gray (N5.5), fine grained, many small (<1mm) coal seams, horiz. fractures along seams @ 10.05, 10.1, 10.3, 10.35, 10.4, 10.5, 10.6		
				SANDSTONE: Brown gray (5YR 4/1), fine grained, angular fracture w/ FeO2 staining @ 10.9, horiz. fractures w/ limonite @ 11, 11.03, 11.1		
				SANDSTONE: Med. gray (N6), fine grained, angular fractures w/hematite mud @ 11.17, 11.28, 11.35, horiz. fractures @ 11.5, 12, 12.15		
				SANDSTONE: Med. gray (N6.5), fine grained, heavy FeO2 staining, angular fractures w/ hematite mud @ 12.2, 12.4, 12.55, 12.8, 13.0		
				SANDSTONE: Med. gray (N6.5), angular fractures w/ heavy FeO2 @ 14.05, 14.27, angular fracture @ 13.67 w/ FeO2 stain very coarse grained weathered		
15	ECE 103	94.2%	29.7%	FRACTURED SANDSTONE: Med. gray (N6.5), fine grained, heavy FeO2 staining, horiz. fractures w/ hematite mud @ 14.4, 14.6, 14.7, 14.75, 14.83, 15		
				SANDSTONE: Gray (N5.5), fine grained, small (<1mm) coal seams, angular fracture w/ coal @ 15.7		
				INTERBEDDED SANDSTONE: Gray (N5.5), fine grained, many small (<1mm) coal seams, horiz. fractures along seams @ 15.86, 15.9, 15.95, 16.15, 16.25		
				SANDSTONE: Gray (N5.5), fine grained, small (<1mm) coal seams, angular fractures w/ coal @ 16.55, 16.75, 16.85, horiz. fracture w/ coal @ 16.65		
				FRACTURED SANDSTONE: Gray (N5.5), fine grained, heavily fractured areas w/ numerous coal seams, sub horiz. fractures w/ coal @ 16.9, 17,		



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BORING NO: 1B

Sheet 1 of 4

Hydrogeologists, Geologists:
Karst & Sinkhole Specialists

www.pela-tenn.com

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/3/04

LOCATION: Adjacent to Dam

SURFACE ELEV.: 1840.22

LOG ID: BH-1B

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 4/5/04

DRILL CONTRACTOR: ECE

DRILLER: Floyd, Steve, Otis

DRILL RIG TYPE: Mobile B-30

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL DEPTH:

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
20	ECE 105			17.05, 17.1, 17.15, 17.23, 17.25, 17.3, 17.4, 17.45 TTU LAB SANDSTONE: Med. gray (N6) fine grained, clean angular fracture w/olive mud @ 18.2, angular fracture w/bituminous coat @ 18.45, angular fracture w/ coal @ 18.65, 19, 19.3, horiz. fractures w/ coal @ 19.7, 20.15, 20.35, 21, 22		
25	ECE 105	95%	45.4%	COAL: Black (N1), dull, microcrystalline, many fractures @ 22.15, 22.18, 22.2, 22.24, 22.3, 22.4 SANDSTONE: Med. gray (N6) fine grained COAL: Black (N1), dull, microcrystalline, fractures @ 22.6, 22.65, 22.7 SANDSTONE: Med. gray (N6) fine grained, angular fractures @ 23.15, 23.35, 23.4 COAL: Black (N1), dull, microcrystalline, fracture @ 23.9 Missing		
30	ECE 105			TTU LAB SANDSTONE: Med. gray (N6) fine grained, angular fractures w/ coal @ 26.43, 26.75 COAL: Black (N1), dull, microcrystalline FRACTURED SANDSTONE: Gray (N5.5), fine grained, heavily fractured area, sub horiz. fractures w/ coal @ 27.15, 27.17, 27.2, 27.25, 27.3 INTERBEDDED SANDSTONE: Gray (N5.5), fine grained, many small (<1mm) coal seams, horiz. fractures along seams @ 27.7, 27.75, 27.8, 27.85, 28.1, 28.15, 28.2, 28.23, 28.4 COAL: Black (N1), dull, microcrystalline, fracture @ 28.5 SANDSTONE: Med. gray (N6) fine grained, horiz. fracture w/ coal @ 28.75 COAL: Black (N1), dull, microcrystalline INTERBEDDED SANDSTONE: Med. gray (N6), fine grained, many small (<1mm) coal seams, horiz. fractures along seams @ 29, 29.03, 29.1, 29.13, 29.15, 29.2, 29.25 SANDSTONE: Med. gray (N6) fine grained SANDSTONE: Gray (N5), med. fine grained, bounded by a pair of stylolites SANDSTONE: Med. gray (N6) fine grained, fractures w/ coal @ 29.55, 29.65, 29.9, 29.65 also has coarse pitting		
35	ECE 112	100%	57%	TTU LAB SANDSTONE: Med. gray (N6) fine grained, angular fracture w/moderate coarse pitting @ 31.5 Missing SANDSTONE: Med. gray (N6) fine grained, angular fractures w/coal @ 35.25,		



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BORING NO: 1B

Sheet 2 of 4

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/3/04

LOCATION: Adjacent to Dam

SURFACE ELEV.: 1840.22

LOG ID: BH-1B

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 4/5/04

DRILL CONTRACTOR: ECE

DRILLER: Floyd, Steve, Otis

DRILL RIG TYPE: Mobile B-30

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL DEPTH:

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
40	ECE 112			35.9, 36.3, 36.6, 36.65, 36.67, 36.7, 38.9, angular fractures w/ pitting @ 35.55, 37.07, 37.9, 38.1		
				SANDSTONE: Med. gray (N6), fine grained, angular fractures w/coal @ 39.13, 39.5, 39.6, 39.75, 40.75, large inclusions of 5YR4/1 @ 39		
45	ECE 112	100%	70.8%	FRACTURED SANDSTONE: Gray (N5.5), fine grained, many small (<1mm) coal seams, horiz. fractures along seams @ 41.05, 41.1, 41.2, 41.3, 41.35, 41.37, 41.4, 41.45, 41.6, 41.65, 41.7, 41.8		
				SANDSTONE: Med. gray (N6), fine grained, angular fractures w/coal @ 41.9, 42.7, angular fracture w/ slickenlines @ 42.1		
				INTERBEDDED SANDSTONE: Med. gray (N6), fine grained, interbeds of 5YR 4/4 along criss crossing fracture traces, vert. fracture from 42.8-43.1, angular fracture @ 43.3		
				SANDSTONE: Med. gray (N6), fine grained, pair of stylolites @ 43.35, angular fracture w/coal @ 43.65 coarse pitting obvious grains		
50	ECE 112			TTU LAB		
				Missing		
				SANDSTONE: Med. gray (N6), fine grained, angular fracture w/ coarse pitting @ 51, stylolites @ 51.16, 51.3, 51.45, 51.5, angular fracture w/ bituminous coal @ 51.6		
				SANDSTONE: Med. gray (N6), fine grained, angular fracture w/ coal @ 51.75, 51.95, 52.77, 53.77, 53.8, 55, stylolites @ 53.68, 53.73, 55.3, horiz. fracture w/ coal @ 55.3, clean horiz. fracture @ 55.9		



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BORING NO: 1B
 Sheet 3 of 4

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PROJECT NAME: Meadow Park Lake Dam
 LOCATION: Adjacent to southeast end of dam
 LOG ID: BH1C

PROJECT NO.: 670101
 SURFACE ELEV.: 1840.81
 MUNICIPALITY: Crossville, TN

DATE: 11/04

DATE STARTED/COMPLETED: 10/6/04
 DRILLER: DMR, VND
 LOGGED BY: Jie Wang

DRILL CONTRACTOR: ECE Services, Inc.
 DRILL RIG TYPE: Mobile - B80

DRILLING METHOD: Mud Rotary
 SAMPLER DIAM: 2 in

CASING DIAMETER [OD/ID]: 3" PVC
 WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1797.04

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
0	ECE 201	44%	24.5%	TOPSOIL: Auger refusal @ 0.5 feet		
				FRACTURED SANDSTONE: Very pale orange (10YR 8/4), lower angular and vertical fractures, iron stain visible		
				FRACTURED SANDSTONE: Very pale orange (10YR 8/4), lower angular and vertical fractures, iron stain fragment inclusion, weathered angular fractures with mud in lower part, iron stain visible		
5				FRACTURED SANDSTONE: Very pale orange (10YR 8/4), lower angular fractures, weathered with mud, pitting and iron staining		
				SANDSTONE: Light grayish orange pink (5YR 7/2), angular and vertical fractures with iron staining		0-9', 3" PVC casing
10	ECE 201	80.9%	37.4%	FRACTURED SANDSTONE: Light grayish orange pink (5YR 7/2), angular and few vertical fractures with shale and iron staining, few small pitting		Horiz. fractures w/ thin coal or shale layers, few thin variable angular dark shale layers to east
				FRACTURED SANDSTONE: Very light gray (N8), lower angular fractures with thin wavy coal or shale layers		Horiz. & low angle fractures w/ shale, few vertical fractures to N & W, iron stain visible
				SANDSTONE: Very light gray (N8), lower angular and horizontal fractures with thin and wavy coal and shale layers		Few angular fractures w/ dark shale layers, two high angle or vertical fractures to SW & NE
15				SANDSTONE: Very light gray (N8), a few angular fractures with shale and pitting		Lower angle interbedded shale layers
				SANDSTONE: Yellowish gray (5Y 8/1), lower angular fractures with coal or shale		Horiz. & angular fractures w/ coal seam in top part, lower part is massive sandstone, few thin variable fractures on NW & NE, iron stain visible
20	ECE 201	203%	149.6%	INTERBEDDED SANDSTONE: Yellowish gray (5Y 8/1), lower angular fractures; Coal seams, brownish black (5YR 2/1), microcrystalline, bituminous, horizontal fractures; shale blurs exist		15-17', Massive sandstone, few angular fractures
				SANDSTONE: Yellowish gray (5Y 8/1), lower angular fractures with thin coal layers		Angular fractures with shale layers in lower part
						Lower angle fractures w/ shale layers, a void in middle & coal seam visible
25	ECE 001					Angular fractures with interbedded shale layers, iron stain on the wall
						Few low angle fractures and shale layers
						Lower angular fractures with interbedded shale layers, iron stain on the wall
						A vertical fracture near top on NW side, horizontal and variable angular fractures w/ shale layers, iron stain visible
						24-26', Angular fractures with interbedded shale



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BORING NO: 1C
 Sheet 1 of 5

PROJECT NAME: Meadow Park Lake Dam
 LOCATION: Adjacent to southeast end of dam
 LOG ID: BH1C

PROJECT NO.: 670101
 SURFACE ELEV.: 1840.81
 MUNICIPALITY: Crossville, TN

DATE: 11/04

DATE STARTED/COMPLETED: 10/6/04
 DRILLER: DMR, VND
 LOGGED BY: Jie Wang

DRILL CONTRACTOR: ECE Services, Inc.
 DRILL RIG TYPE: Mobile - B80

DRILLING METHOD: Mud Rotary
 SAMPLER DIAM: 2 in

CASING DIAMETER [OD/ID]: 3" PVC
 WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1797.04

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
30	ECE 001	74.9%	44.9%	SANDSTONE: Yellowish gray (5Y 8/1), few angular fractures with coal		layers and coal seams Few high angle fractures in top part w/iron stain, 2 vertical fractures in base to the NE & NW
	ECE 034			SANDSTONE: Yellowish gray (5Y 8/1), few angular fractures with coal		28-29', Angular fractures with shale or coal layers
35	ECE 034	91.8%	65.1%	INTERBEDDED SANDSTONE: Yellowish gray (5Y 8/1), angular fractures with coal seams		30-31', Conglomeritic sandstone, few angular fractures with shale or coal layers in bottom
				SANDSTONE: Yellowish gray (5Y 8/1), few angular fractures		32-33', Variable angular fractures with shale layers, iron stain on the wall
40	ECE 034	91.8%	65.1%	SANDSTONE: Yellowish gray (5Y 8/1), few angular fractures		34-35', Angular fractures with shale layers and coal seam
				SANDSTONE: Very light gray (N8), few clean angular fractures		Angular fractures, highly fractured at bottom
45	ECE 034	90.1%	69%	SANDSTONE: Very light gray (N8), angular and horizontal fractures, a part iron stain visible		36-40' Massive, few angular fractures & shale layer Water table @ 40.5
				SANDSTONE: Very light gray (N8), variety angular fractures with coal or shale		41-42', Few angular fractures & shale layers, vertical fracture on south side of borehole, some pits visible on the wall
50	ECE 037	90.1%	69%	SANDSTONE: Very light gray (N8), angular fractures with coal or shale, higher angular ones with iron staining in lower part		43' Angular fractures, vertical fracture on west side of borehole
				FRACTURED SANDSTONE: Yellowish gray (5Y 8/1), angular and vertical fractures with iron staining and coal layer, few feldspars exist in coal layer		44-45', Variable angular fractures, iron stain visible
				SANDSTONE: Yellowish gray (5Y 8/1), angular fractures with shale or thin coal layers, shale pebbles or blurb visible		46-47' Highly fractured, pieces of shale removed, two vertical fractures in lower 47' area, E & NW
				SANDSTONE: Yellowish gray (5YR 8/1), few angular fractures with thin shale		48-52' Massive sandstone, few angular fractures w/ shale and coal seam



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BORING NO: 1C
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PROJECT NAME: Meadow Park Lake Dam
 LOCATION: Adjacent to southeast end of dam
 LOG ID: BH1C

PROJECT NO.: 670101
 SURFACE ELEV.: 1840.81
 MUNICIPALITY: Crossville, TN

DATE: 11/04

DATE STARTED/COMPLETED: 10/6/04
 DRILLER: DMR, VND
 LOGGED BY: Jie Wang

DRILL CONTRACTOR: ECE Services, Inc.
 DRILL RIG TYPE: Mobile - B80

DRILLING METHOD: Mud Rotary
 SAMPLER DIAM: 2 in

CASING DIAMETER [OD/ID]: 3" PVC
 WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1797.04

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
55	ECE 037	82.3%	75.9%	and coal, fine quartz visible		Few horizontal fractures with coal layers
SANDSTONE: Yellowish gray (5Y 8/1), few angular and horizontal fractures with shale				54-56', Massive sandstone		
SANDSTONE: Yellowish gray (5Y 8/1), angular fractures with shale and coal layers				57-58', Angular fractures with shale layers		
60	ECE 2026	87.5%	80.4%	SANDSTONE: Yellowish gray (5Y 8/1), angular fractures with shale and little coal		Between 58' and 59', two vertical fractures in N & SE, few angular fractures visible
SANDSTONE: Yellowish gray (5Y 8/1), a few angular fractures with shale				A vertical fracture in south, few angular fractures exist		
SANDSTONE: Yellowish gray (5Y 8/1), angular and vertical fractures with coal or shale layers				Angular fractures and two vertical fractures on S & NW in lower part		
SANDSTONE: Yellowish gray (5Y 8/1), horizontal and lower angular fractures with thin coal layers				Interbedded shale layers and coal seam		
65	ECE 2026	117.8%	93.6%	SANDSTONE: Yellowish gray (5Y 8/1), angular and horizontal fractures with shale and coal layers		64-67', Few angular fractures and shale or coal layers
SANDSTONE: Yellowish gray (5Y 8/1), a few lower angular fractures with shale or coal, and fine quartz visible				68-69', Few angular fractures and shale layer		
SANDSTONE: Yellowish gray (5Y 8/1), angular and horizontal fractures with shale and coal layers				70-74', Massive sandstone with few angular fractures and shale layers		
70	ECE 2026	117.8%	93.6%	FRACTURED SANDSTONE: Yellowish gray (5Y 8/1), angular and horizontal fractures with shale and coal layers		
75				ECE 2026		SANDSTONE: Yellowish gray (5Y 8/1), angular fractures with thin coal layers, shale pebbles and quartz exist
75	ECE 046			SANDSTONE: Yellowish gray (5Y 8/1), angular and horizontal fractures with shale and thin bituminous coal layers		75-78', Interbedded shale layers on top, massive sandstone Horizontal and angular fractures with shale layers



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BORING NO: 1C
 Sheet 3 of 5

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PROJECT NAME: Meadow Park Lake Dam
 LOCATION: Adjacent to southeast end of dam
 LOG ID: BH1C

PROJECT NO.: 670101
 SURFACE ELEV.: 1840.81
 MUNICIPALITY: Crossville, TN

DATE: 11/04

DATE STARTED/COMPLETED: 10/6/04
 DRILLER: DMR, VND
 LOGGED BY: Jie Wang

DRILL CONTRACTOR: ECE Services, Inc.
 DRILL RIG TYPE: Mobile - B80

DRILLING METHOD: Mud Rotary
 SAMPLER DIAM: 2 in

CASING DIAMETER [OD/ID]: 3" PVC
 WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1797.04

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
80	ECE 046	67.3%	58.2%	SANDSTONE: Yellowish gray (5Y 8/1), lower angular fractures with shale and coal		80-83', Massive sandstone, few shale or coal layers
				FRACTURED SANDSTONE: Yellowish gray (5Y 8/1), angular fractures with shale and thin coal layers		
85	ECE 016	81.5%	70.7%	SANDSTONE: Yellowish gray (5Y 8/1), few horizontal and angular fractures with shale or coal		84-85', Massive sandstone, a vertical fracture on West of 85' lower part Vertical fracture to NW
				SANDSTONE: Yellowish gray (5Y 8/1), angular fractures with shale and bituminous coal		
				SANDSTONE: Yellowish gray (5Y 8/1), conglomerate, an angular fracture with coal		
90	ECE 016	81.5%	70.7%	FRACTURED SANDSTONE: Yellowish gray (5Y 8/1), various angular fractures with coal and shale layers		87-88', Massive sandstone, lower visibility
				SANDSTONE: Yellowish gray (5Y 8/1), angular fractures with coal or shale layers, thin coal seam in lower part		
95	ECE 016	117.5%	89.5%	SANDSTONE: Yellowish gray (5Y 8/1), conglomerate, angular fracture in higher part		89-90', Massive sandstone with coal seam Coal seam and layers, about 2-4" thick, few angular fractures
				SANDSTONE: Light greenish gray (5GY 8/1), clean angular fractures		
100	ECE 016	117.5%	89.5%	SANDSTONE: Light greenish gray (5GY 8/1), clean angular and a few horizontal fractures		92-93', Massive sandstone with few angular fractures Several shale layers and coal seams, bacteria increases in water
				SANDSTONE: Light greenish gray (5GY 8/1), clean angular and a few horizontal fractures		
105	ECE 016	117.5%	89.5%	INTERBEDDED SANDSTONE: Light greenish gray (5GY 8/1), angular and vertical fractures with coal, about 1 foot thick coal or shale seam with angular fractures in lower part		95-98', Massive sandstone, few angular fractures
						99-102', Massive sandstone
						103-104', Massive sandstone with few horizontal fractures and shale layers
						105-106', Massive sandstone, bacteria on the wall,



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BORING NO: 1C
 Sheet 4 of 5

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PROJECT NAME: Meadow Park Lake Dam
 LOCATION: Adjacent to southeast end of dam
 LOG ID: BH1C

PROJECT NO.: 670101
 SURFACE ELEV.: 1840.81
 MUNICIPALITY: Crossville, TN

DATE: 11/04

DATE STARTED/COMPLETED: 10/6/04
 DRILLER: DMR, VND
 LOGGED BY: Jie Wang

DRILL CONTRACTOR: ECE Services, Inc.
 DRILL RIG TYPE: Mobile - B80

DRILLING METHOD: Mud Rotary
 SAMPLER DIAM: 2 in

CASING DIAMETER [OD/ID]: 3" PVC
 WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1797.04

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
110	ECE 032	52.6%	40%	SANDSTONE: Very light gray (N8), conglomerate and medium crystalline sandstone		lower visibility
	SANDSTONE: Very light gray (N8), angular fractures with shale or coal layers, pilling or blurbs visible					107-109', Massive sandstone with few angular fractures and shale or coal layers
	SANDSTONE: Yellowish gray (5Y 8/1), angular fractures with shale and coal layers and pebbles packaged					110-111', Some interbedded shale layers and pebbles
115	ECE 032			SANDSTONE: Yellowish gray (5Y 8/1), few angular fractures with shale and coal, shale pebbles visible		
	ECE 033			SANDSTONE: Yellowish gray (5Y 8/1), conglomerate and medium crystalline sandstone with some small shale blurbs		
120	ECE 033			SANDSTONE: Yellowish gray (5Y 8/1), horizontal and lower angular fractures with shale pebbles or fragments		
				SANDSTONE: Yellowish gray (5Y 8/1), horizontal and lower angular fractures with shale pebbles or fragments		
125				SANDSTONE: Yellowish gray (5Y 8/1), horizontal and lower angular fractures with shale pebbles or fragments		
	ECE 033	SANDSTONE: Yellowish gray (5Y 8/1), horizontal and lower angular fractures with shale pebbles or fragments		Angular fractures visible, bottom sediments		
130						



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BORING NO: 1C
 Sheet 5 of 5

PROJECT NAME: Meadow Park Lake Dam
 LOCATION: Below the Dam
 LOG ID: BH2
 DATE STARTED/COMPLETED: 4/6/04
 DRILLER: Floyd, Steve, Otis
 LOGGED BY: Angela Adams

PROJECT NO.: 670101
 SURFACE ELEV.: 1793.61
 MUNICIPALITY: Crossville, TN
 DRILL CONTRACTOR: ECE
 DRILL RIG TYPE: Mobile B-30

DATE: 9/3/04

DRILLING METHOD: Mud Rotary
 SAMPLER DIAM: 2 in

CASING DIAMETER [OD/ID]: 3.25 IN

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1793.83

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
0				Auger Refusal @ 8 feet		
5						0-10.5 ft Steel casing
10	ECE 086	95.8%	70.8%	SANDSTONE: Med. gray (N6.5), fine grained, generally free from coal seams, clean horiz. fractures @ 8.2, 8.3, 8.65 FRACTURED SANDSTONE: Med. gray (N6.5), vert. fracture 8.65-9, clean horiz. fractures @ 9, 9.2, 9.3, horiz. fracture w/ FeO2 staining @ 9.15 SANDSTONE: Med. gray (N6.5), clean angular fracture @ 9.75, angular fractures w/ moderate pitting & coal @ 10.25, 10.8, 10.9, 11.55, horiz. fracture w/ a .5" qtz pbl @ 10.35, horiz. fracture w/ mud @ 11.3		
15	ECE 086			SANDSTONE: Med. gray (N6.5), clean angular fracture @ 11.9, sub-horiz. fractures w/ moderate pitting & coal @ 14.05, 15.29 horiz. fractures w/ mud @ 13.1, 13.53, clean horiz. fracture @ 15		10+ ft Clean, light colored sandstone
				TTU LAB		Horizontal fracture with coal
				SANDSTONE: Med. gray (N6.5), angular fracture w/ pitting and minor coal @ 17.14, 18.65, clean sub-horiz. fracture @ 17.68		Horizontal fracture with coal
20	ECE 086			SANDSTONE: Med. gray (N6), horiz. fracture w/ coal <25% @ 18.85, 19.05 SANDSTONE: Med. gray (N6.5), angular fracture w/ pitting @ 19.42 SANDSTONE: Med. gray (N6), fine grained SANDSTONE: Med. gray (N6.5), fine grained, sub-horiz. fractures w/ coal @ 20, 20.75, 25, an interbed of 5YR 4/4 @ 20.5		Low angle fracture with coal Horizontal fracture with coal
						Fracture with coal
25	ECE 079	100%	83.3%	SANDSTONE: Med. gray (N6), clean horiz. fractures @ 25.5, 25.9, vert. fracture from 25.5-25.8		1" coal seam
						25.5-26 ft thin horizontal fractures with coal



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BORING NO: 2
 Sheet 1 of 4

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/3/04

LOCATION: Below the Dam

SURFACE ELEV.: 1793.61

LOG ID: BH2

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 4/6/04

DRILL CONTRACTOR: ECE

DRILLER: Floyd, Steve, Otis

DRILL RIG TYPE: Mobile B-30

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1793.83

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
30	ECE 079	96.6%	85.8%	TTU LAB		Vertical fractures, thin
				SANDSTONE: Med. gray (N6), fine grained		
				FRACTURED SANDSTONE: Med. gray (N6), fine grained, angular fractures w/ coal @ 28.2, 28.4, 28.65, 29, 30.14, 30.71, 30.75		
35	ECE 079	96.6%	85.8%	SANDSTONE: Med. gray (N6), fine grained, sub. horiz. fracture w/ moderate pitting @ 31.2, horiz. fracture @ 31.61		Horizontal coal or shale seam
				SANDSTONE: Med. gray (N6.5), angular fracture w/ pitting and coal @ 31.68, 33.4, 33.71, clean angular fracture @ 32.56, horiz. fracture w/ <25% coal @ 33.1		
				SANDSTONE: Med. gray (N6.5), angular fracture w/ rounded pieces of coal @ 35, 35.33, 35.9, horiz. fracture w/ minor pitting and mica @ 36.1, horiz. fracture w/ minor pitting, mica and mud @ 36.35, 36.45, 37.13		
40	ECE 079	96.6%	85.8%	INTERBEDDED SANDSTONE: Gray (N5.5), many small (< 1mm) coal interbeds, sub-horiz. fracture with sandy mud @ 38.46, sub-horiz. fractures w/ <25% coal @ 38.64, 38.8, 39.03, 39.1		Horizontal fracture with coal Begin interbedded shale or coal Shale or coal Partial layer coal or shale
				SANDSTONE: Med. gray (N6.5), fine grained, large (> .5") coal inclusions @ 39.15, 39.3, clean horiz. fractures @ 40.2, 40.5, 40.87		
45	ECE 012	100%	88.8%	SANDSTONE: Med. gray (N6), fine grained, angular fracture w/ pitting and coal @ 45.25, sub-horiz. fracture w/ coal @ 45.85		Thin coal layers Shale layer 44-45 ft horizontal fractures with coal
				SANDSTONE: Med. gray (N6.5), fine grained		
				SANDSTONE: Med. gray (N6), fine grained, sub-horiz. fracture w/ coal @ 47.1, horiz. fractures w/ coal @ 47.34, 47.4, 47.5		
				INTERBEDDED SANDSTONE: Med. gray (N6), fine grained, sub-horiz. fractures @ 47.88, 47.96, 48.07		
50	ECE 012	100%	88.8%	TTU LAB		horizontal fractures with coal and shale fracture zone with coal layers Horizontal fracture with coal and shale layer Sub horizontal and thin vertical fractures 52-53 ft horizontal fractures with coal
				SANDSTONE: Med. gray (N6), fine grained, sub-horiz. fractures w/ minor pitting and mica @ 51.16, 51.34, sub-horiz. fractures w/ coal @ 51.88, 51.97, 52.23, 52.62, horiz. fractures w/ coal @ 53.2, 53.4, angular fracture w/ coal @ 53.1		



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BORING NO: 2
 Sheet 2 of 4

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/3/04

LOCATION: Below the Dam

SURFACE ELEV.: 1793.61

LOG ID: BH2

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 4/6/04

DRILL CONTRACTOR: ECE

DRILLER: Floyd, Steve, Otis

DRILL RIG TYPE: Mobile B-30

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

AMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1793.83

DEPTH (FT.)	SAMPLE #	REC (%)	RAD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
55	ECE 012	100%	88.8%	INTERBEDDED SANDSTONE: Med. gray (N6), fine grained, sub-horiz. fractures w/bituminous coal @ 53.85, 54.3, 54.4, 54.5, 54.7, 54.9, 55, 55.25, 55.5		Thin NE oriented vertical fractures with coal
				SANDSTONE: Med. gray (N6.5), fine grained, sub-horiz. fracture w/pitting @ 55.55, clean sub-horiz. fracture @ 55.65		Horizontal fracture
				TTU LAB		
				SANDSTONE: Med. gray (N6), fine grained, vert. fracture from 57.2-57.5, clean horiz. fractures @ 57.5, 58, 58.6		
60	ECE 154			SANDSTONE: Med. gray (N6.5), fine grained, angular fractures @ 58.82, 59.05		Horizontal fractures
				SANDSTONE: Med. gray (N6), fine grained, horiz. fractures w/ coal @ 59.2, 59.25, 59.6 (bituminous)		
				SANDSTONE: Med. gray (N6), fine grained, angular. fracture w/ coal @ 60.7		
				FRACTURED SANDSTONE: Gray (N5.5), fine grained, fracture zone w/ coal		
				SANDSTONE: Grayish red (5R 4/2), fine grained, light and spotty FeO2 stain throughout, horiz. fracture @ 62.87, horiz. fracture w/pitting @ 63.57, 64.8, 64.9, 65, angular fractures w/pitting @ 65.78, 65.95, 66.28		63-64 ft fracture zone with shale and coal layers
65	ECE 154	100%	85.4%			
				TTU LAB		
				FRACTURED SANDSTONE: Med. gray (N6), fine grained, vert. fracture from 67.15-66.58 w/ many cross cutting horiz. fractures		67-69 ft thin horizontal fractures
70	ECE 156			SANDSTONE: Med. gray (N6), fine grained, horiz. fractures w/pitting @ 68.8, 69, angular fracture w/pitting @ 69.43		
				FRACTURED SANDSTONE: Med. gray (N6), fine grained, angular fractures @ 69.6, 70, 70.2		
				FRACTURED SANDSTONE: Med. gray (N6), fine grained, angular fractures @ 70.75, 72.65, 73.04		3" drop while drilling, free flowing water, void area. 2-3 inch coal seam w/ holes, vertical fractures with coal and shale
75	ECE 156	98.8%	69.6%	COAL: Glossy, vitreous black bituminous coal		
				SANDSTONE: Med. gray (N6), fine grained, angular fractures w/coal @ 75		
				FRACTURED SANDSTONE: Med. gray (N6), fine grained with much interbedded coal, sub-horiz. fractures w/ coal @ 75.45, 75.55, angular fractures w/coal @ 75.8, 76.2, horiz. fractures @ 76.45		77-78 ft fracture zone with coal and shale layer
				SANDSTONE: Grayish red (5R 4/2), fine grained, light and spotty FeO2 stain throughout, angular fractures w/coal @ 77.5, 77.87, 78		
				SANDSTONE: Gray (N5.5), fine grained, sub-horiz. fracture @ 78.3		
				INTERBEDDED SANDSTONE: Gray (N5), fine grained, intense area of interbedded matte coal, angular fractures w/coal @ 79.18, 79.37, 79.65		



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BORING NO: 2

Sheet 3 of 4

Hydrogeologists, Geologists:
Earth & Sinkhole Specialists

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/3/04

LOCATION: Below the Dam

SURFACE ELEV.: 1793.61

LOG ID: BH2

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 4/6/04

DRILL CONTRACTOR: ECE

DRILLER: Floyd, Steve, Otis

DRILL RIG TYPE: Mobile B-30

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1793.83

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
80	ECE 000	98.8%	59.6%	Interbedded med. coal, angular fractures w/coal @ 79.18, 79.37, 79.65 SANDSTONE: Med. gray (N6), fine grained, angular fractures w/coal @ 80.45, 80.68, 81.15, 81.95		Shale seam, horizontal fracture 81-82 ft. fracture zone with coal layer
				INTERBEDDED SANDSTONE: Med. gray (N6), fine grained, horiz. fractures w/coal @ 82, 82.05, 82.35, 82.5, vert. fracture from 82.1-82.35		Horizontal fracture
				SANDSTONE: Med. gray (N6), fine grained, angular, fractures w/coal @ 83.2, 83.5, 83.9		
85	ECE 000			SANDSTONE: Brownish gray (5YR 5/1), fine grained, microlaminations throughout, pitted sub horiz. fracture w/mica @ 85.62, clean horiz. fracture @ 86.4		Horizontal fracture with coal
				SANDSTONE: Light bluish gray (5B 7/1), fine grained, sub horiz. fracture @ 87.48, sub horiz. fracture w/coal @ 88.4		
				SANDSTONE: Brownish gray (5YR 5/1), fine grained, microlaminations throughout, pitted sub horiz. fractures w/mica @ 90.1, 90.38		
90	ECE 024			SANDSTONE: Light bluish gray (5B 7/1), fine grained, sub horiz. fracture w/coal @ 91.25, angular fracture w/ slickenlines @ 91.55, angular fracture along stylolites w/coal @ 92.03		Fracture zone
				INTERBEDDED SANDSTONE: Brownish gray (5YR 5/1), fine grained, heavy interbedded wavy sub parallel coal seams, sub horiz. fractures w/coal @ 92.36, 92.61, 93.2, fracture @ 92.81 had brown fine sand on the face (void?)		
				SANDSTONE: Light bluish gray (5B 7/1), fine grained, angular fracture w/ FeO2 stains @ 94.05, horiz. fractures @ 94.78, 94.88, 95.07		Horizontal fractures
95	ECE 024					95-96 ft fracture zone with coal and shale layers
		Air Rotary	Angular fractures			
			Horizontal fractures			
100						



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BORING NO: 2
 Sheet 4 of 4

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/1/04

LOCATION: West side of lake

SURFACE ELEV.: 1841.91

LOG ID: BH-3

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 7/13/04

DRILL CONTRACTOR: ECE

DRILLER: SJL, ACG, JEB

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL DEPTH: 1822.59

DEPTH (FT.)	SAMPLE #	REC (%)	RAD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
0				Auger Refusal @ 2 feet		Video log not made. Well cased prior to video logging.
	ECE 117			SANDSTONE: Med. gray (N6), fine grained generally free from coal seams, horiz. fracture that is weakly cemented @ 2.5		
				FRACTURED SANDSTONE: Med. gray (N6), horiz. fracture w/ FeO2 staining @ 2.85, 2.9, 2.95, 3		
				SANDSTONE: Reddish gray (10R 5/6), fine grained, heavy FeO2 staining, horiz. fracture w/ FeO2 @ 3.4		
				SANDSTONE: Med. gray (N6), horiz. fracture w/ FeO2 staining @ 3.85, 4		
				FRACTURED SANDSTONE: Heavy fracturing low recovery, estimated length based on pieces (10R 5/6), weakly cemented		
5	ECE 117			SANDSTONE: Med. gray (N6), horiz. fracture w/ FeO2 staining (Limonite) @ 5.3, sub-horiz. fracture w/ Limonite @ 6		
		61.6%	19%	FRACTURED SANDSTONE: Heavy fracturing low recovery, estimated length based on pieces (10R 5/6), weakly cemented, FeO2 staining		
				SANDSTONE: Med. gray (N6), horiz. fracture, clean @ 8.17		
				SANDSTONE: Estimated reddish gray (10R 5/6), fine grained, heavy FeO2 staining, angular fracture w/ FeO2 stains		
10	ECE 117			INTERBEDDED SANDSTONE: Med. gray (N6), fine grained w/ interbedded coal seams fractures @ 10.7, 10.9		
				SANDSTONE: Med. gray (N6), horiz. fracture w/ coal <25% @ 11.15, 11.24		
				SANDSTONE: Reddish gray (10R 5/6), fine grained, horiz. fracture w/ FeO2 @ 11.33		
				SANDSTONE: Med. gray (N6), fine grained, between 11.74 to 11.8 a weaker cement, sub-horiz. fracture w/ FeO2 stain @ 12		
				SANDSTONE: Reddish gray (10R 5/6), fine grained, horiz. fracture w/ FeO2 and coal @ 12.5, stylolite @ 13.06 w/ recrystallization along plane, matrix less cemented		
				FRACTURED SANDSTONE: Heavy fracturing, estimated length based on pieces (10R 5/6), all fractures have hematite mud on them. Vert. fracture from 13.35-13.6		



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BORING NO: 3

Sheet 1 of 3

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/1/04

LOCATION: West side of lake

SURFACE ELEV.: 1841.91

LOG ID: BH-3

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 7/13/04

DRILL CONTRACTOR: ECE

DRILLER: SJL, ACG, JEB

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL DEPTH: 1822.59

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
15	ECE 117	80.8%	32.5%	SANDSTONE: Med. gray (N6), sub-horiz. fracture w/ FeO2 stain @ 14.2 SANDSTONE: Reddish gray (10R 5/6), fine grained, horiz. fracture w/ FeO2 @ 14.35 FRACTURED SANDSTONE: Med. gray (N6), horiz. fractures @ 14.58, 14.64, 14.65, 14.75, 15 all clean SANDSTONE: Reddish gray (10R 5/6), fine grained, weakly cemented FeO2 stained, horiz. fracture w/ FeO2 @ 15.23, 15.4 SANDSTONE: Med. gray (N6), fine grained, horiz. fracture w/ FeO2 stain @ 15.73, angular fracture w/ FeO2 stain @ 16.05, horiz. fract @ 16.1 clean SANDSTONE: Reddish gray (10R 5/6), fine grained, vert. fracture w/ FeO2 from 16.1-16.4 SANDSTONE: Med. gray (N6), horiz. fracture w/ FeO2 stain @ 16.55 SANDSTONE: Reddish gray (10R 5/6), fine grained, horiz. fracture w/ FeO2 @ 16.8 FRACTURED SANDSTONE: Med. gray (N6), horiz. fractures w/ FeO2 and mud @ 16.9, 17, 17.23, 17.55, 17.7 FRACTURED SANDSTONE: Gray (N5), fractured piece w/ stylolites and gray mud SANDSTONE: Reddish gray (10R 5/6), fine grained, heavily FeO2 stained, 0.5 inch vugs @ 18.35, ang. fractures w/ FeO2 @ 18.55, 18.7, 18.85 SANDSTONE: Gray (N5.5), stylolites from 19.55-19.65 SANDSTONE: Reddish gray (10R 5/6), fine grained, tightly cemented SANDSTONE: Med. gray (N6), fine grained		
20	ECE 077	90%	35.8%	SANDSTONE: Reddish gray (10R 5/6), fine grained, weathered zone, sub-horiz. fractures w/ FeO2 @ 20.9, 20.95, zone of stylolites from 20.5-20.9, horiz. fractures w/ FeO2 staining and large coarse grained qtz crystals on face @ 21.2, 21.6, 22.1, horiz. fracture w/ FeO2 @ 22.4. Vert. fracture from 22.15-22.37 SANDSTONE: Med. gray (N6), fine grained, clean horiz. fracture 22.85, horiz. fracture w/ coal @ 23. Coal stylolites from 23-23.2 FRACTURED SANDSTONE: Gray (N5.5), fractures along coal seams @ 23.3, 23.4, 23.45, 23.5, 23.6, 23.65, 23.7, 23.8, 23.9 SANDSTONE: Gray (N5.5), fine grained SANDSTONE: Med. gray (N6), fine grained, sub-horiz. fracture @ 24.45 minor coal <15% FRACTURED SANDSTONE: Med. gray (N6), fine grained, angular fracture w/ slickenlines @ 24.55, sub-horiz. fracture @ 24.75 w/mud, sub-horiz. fractures @ 24.9, 25, 25.13, 25.25, 25.45, 25.5, 25.6 w/coal SANDSTONE: Reddish gray (10R 5/6), fine grained, vugs @ 26.05, horiz. fractures w/ FeO2 @ 26.15, 26.32 (Limonite), horiz. fracture @ 26.7 clean FRACTURED SANDSTONE: Med. gray (N6), fine grained, angular fractures w/ FeO2 @ 27.1, 27.5, angular fracture @ 27.6 clean, angular fractures w/coal @ 28.85 (pitted), 29.15, 29.25, 29.7 (pitted), 30.1, clean angular fracture @ 29.9		
25	ECE 077					



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BORING NO: 3
 Sheet 2 of 3

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/1/04

LOCATION: West side of lake

SURFACE ELEV.: 1841.91

LOG ID: BH-3

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 7/13/04

DRILL CONTRACTOR: ECE

DRILLER: SJL, ACG, JEB

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL DEPTH: 1822.59

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
30	ECE 077	92.5%	62.5%	SANDSTONE: Reddish gray (10R 5/6), fine grained, horiz. fracture w/ FeO2 @ 30.2, horiz. fracture w/ FeO2 and mud @ 30.35 FRACTURED SANDSTONE: Heavy fracturing, estimated length based on pieces (N6), angular fractures w/ bituminous coal @ 30.5, 31. Below 31 only pieces.		
				SANDSTONE: Reddish gray (10R 5/6), fine grained, angular fracture w/ FeO2 @ 32.9, vert. fracture w/ FeO2 from 32.7-33, angular fracture w/ coal @ 33.5		
35	ECE 109			SANDSTONE: Med. gray (N6), fine grained, angular fractures w/ coal (<30%) @ 33.7, 34.1, 34.2, 34.95, vugs @ 35.4		
				SANDSTONE: Reddish gray (10R 5/6), med. fine grained, angular fracture w/ FeO2 @ 39.35 weathering zone		
				SANDSTONE: Med. gray (N6), fine grained, sub-horiz. irregular fracture w/ coal @ 37.3		
				SANDSTONE: Gray (N5.5), fine grained, sub-horiz. irregular fracture w/ coal @ 37.8, stylolites @ 38.06, clean horiz. fracture @ 39.05, horiz. fracture w/ coal (<10%) @ 39.8		
40	ECE 109			FRACTURED SANDSTONE: Gray (N5.5), fine grained, horiz. fractures w/ coal (<10%) @ 39.87, 39.91, 40.2, 40.25, 40.4, 40.45, 40.55, 40.7		
				SANDSTONE: Med. gray (N6), fine grained, FeO2 staining from 41-41.2, clean horiz. fractures @ 41.2, 42		



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BORING NO: 3

Sheet 3 of 3

Hydrogeologists, Geologists:
Karst & Sinkhole Specialists

PROJECT NAME: Meadow Park Lake Dam
 LOCATION: Adjacent to northwest end of dam
 LOG ID: BH3C

PROJECT NO.: 670101
 SURFACE ELEV.: 1818.85 ft
 MUNICIPALITY: Crossville, TN

DATE: 9/1/04

DATE STARTED/COMPLETED: 7/13/04
 DRILLER: SJL, ACG, JEB
 LOGGED BY: Angela Adams

DRILL CONTRACTOR: ECE
 DRILL RIG TYPE: Mobile B-80

DRILLING METHOD: Mud Rotary
 SAMPLER DIAM: 2 in

CASING DIAMETER [OD/ID]: 3.25 IN
 WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION:

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
0				TOPSOIL: Auger refusal @ 2 feet		
5	ECE 076	61.6%	19%	SANDSTONE: Light grayish orange (5YR 7/2), fine grained, clean quartz sandstone, horiz. fractures @ 2.2, 2.3, 4.1, 4.2, 5.5, 6.67, 6.75, 7.84, 7.95, 8 all of these horiz. fractures on the fracture plane weather to fine sand, angular fractures @ 2.78, 3.1, 3.7, FeO2 zones @ 4.95, between 6.87-7.08, 7.95-8.0, vug @ 6.8		
10	ECE 076			FRACTURED SANDSTONE: Light grayish orange (5YR 7/2), fine grained, numerous horiz. fractures w/ hematite mud @ 8.1, 8.15, 8.27, 8.49, 8.72, 8.86, 9.21, 9.3, 9.57, 10.13, 10.25, 10.36, 10.6, 10.75, 10.98, 11.05, between 11.27-11.8, 12, 12.05, 12.15, 12.2, 12.3, 12.4		
15	ECE 076	80.8%	32.5%	FRACTURED SANDSTONE: Light bluish gray (5B7/1), fine grained, horiz. Fractures w/ coal @ 12.49, 12.57, 12.75, 13, 14.3, 14.8, 15.02, 15.3, 15.8, 15.95, 16.15		0-13', 3" PVC casing 13'-14', weathered sandstone, horizontal bedding 14'-15', fracture zone with coal, shale layers and rich iron stain
20	ECE 076			FRACTURED SANDSTONE: Light bluish gray (5B 7/1), med. fine grained, (weathered) indiv. grains visible, weathering into sand not well cemented limonite staining on core in amorphous patterns, angular fracture w/ FeO2 stained sand @ 16.6, 16.65, 17.04 most of this section is missing.		16'-17', horizontal fractures with coal layers, iron stain visible Horizontal fractures with shale, coal layers, a vertical fracture E to W orientation Coal layers, vertical fracture E to W orientation
25		90%	35.8%			20'-21', massive sandstone with shale and coal layers Shale, coal layers with iron stain
30	ECE 009			FRACTURED SANDSTONE: Light gray (N6.5), fine grained, horiz. fractures @ 27.1, 27.32, 27.39, 27.46, 27.65		24-25 ft, Sandstone, horizontal fractures 26-27 ft, Shale and coal layers, iron stain visible
				SANDSTONE: Light gray (N6.5), fine grained, angular fracture @ 28.07, coal stylolites between 28.25-28.4, vug w/ very soft coal @ 28.53		Horizontal fractures, vertical fracture to NW
		92.5%	62.5%	FRACTURED SANDSTONE: Light gray (N6.5), fine grained, horiz. fractures w/ bituminous coal @ 28.75, 28.87, 28.9, 29.2, 29.25, 29.4, 29.6, 29.7, 29.85, 30.06, 30.15, 30.2, 30.25, 30.3, 30.37, 30.55, some wavy parallel interbeds of coal, vug w/ very soft coal @ 29		Shale layers with iron stain 30-31 ft, Shale layers, iron stain visible 31-32 ft, vertical fractures, oriented W to E and NW



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BORING NO: 3C
 Sheet 1 of 4

PROJECT NAME: Meadow Park Lake Dam
 LOCATION: Adjacent to northwest end of dam
 LOG ID: BH3C

PROJECT NO.: 670101
 SURFACE ELEV.: 1818.85 ft
 MUNICIPALITY: Crossville, TN

DATE: 9/1/04

DATE STARTED/COMPLETED: 7/13/04
 DRILLER: SJL, ACG, JEB
 LOGGED BY: Angela Adams

DRILL CONTRACTOR: ECE
 DRILL RIG TYPE: Mobile B-80

DRILLING METHOD: Mud Rotary
 SAMPLER DIAM: 2 in

CASING DIAMETER [OD/ID]: 3.25 IN
 WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION:

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
35	ECE 009			SANDSTONE: Light gray (N6.5), fine grained, horiz. fractures w/bituminous coal @ 34.62, 34.73, 34.75, 34.9, some wavy parallel interbeds of coal		Angular fractures, horizontal bedding fractures Horizontal fractures with coal Vertical fractures NE and W
40	ECE 009			INTERBEDDED SANDSTONE: Light gray (N6), fine grained, horiz. fractures along numerous continuous wavy parallel interbeds of coal @ 36.86, 36.94, 37.1, 37.2, 37.3 SANDSTONE: Light gray (N7), fine grained, sub horiz. fractures w/bituminous coal @ 37.6, horiz. fractures w/moderate pitting & coal @ 38.47, 38.61, 39.62, 39.65, 39.84, 39.9, 41.28, 41.5, 41.67, 42.05, 42.2, 42.46, 42.75, 46.2, 46.3, 46.45, 47.35, angular fractures @ 39, 39.45, 40.2, 40.6, 47.55, vert. fracture from 40.74-41,		36-37 ft, Horizontal fractures with iron stain, few thin vertical fractures on W Vertical fractures, E to W, iron stain; horizontal fractures with coal layer Water table Horizontal fracture
45	ECE 014			SANDSTONE: Light bluish gray (5B 7/1), med. fine grained, (weathered) indiv. grains visible, weathering into sand limonite staining on core in amorphous patterns, angular fracture w/FeO2 stained sand @ 45.2		
	ECE 014			SANDSTONE: Light bluish gray (5B7/1), fine grained, horiz. fractures w/coal @ 46, 46.6, 47.4, 47.7, vert. fracture from 47.4-47.7		46-47 ft, Few thin horizontal fractures
50	ECE 014			SANDSTONE: Light bluish gray (5B7/1), fine grained, horiz. fractures w/coal @ 47.48, 48, 48.3, vert. Fracture trace from 48.3-48.9, vug w/coal @ 48.85, clean horiz. Fractures @ 49.32, 49.37, 49.95		A shale or coal layer Horizontal bedding and fractures with thin coal layer
55	ECE 014			SANDSTONE: Pale red (5R 5/2) fine grained, horiz. fractures w/FeO2 stains & pilling @ 50.53, 51.54, 52.07, 52.24, 52.93, 53.95, 54.16, angular fracture w/ FeO2 staining @ 52.65, vug @ 52.53		Few horizontal fractures
60				SANDSTONE: Light bluish gray (5B7/1), fine grained, clean horiz. fractures @ 58, 58.12, 58.25, 58.36, 58.53, 58.7, 59.62, 59.95, 60.03, 60.13		Few horizontal and angular fractures Shale or coal layers Horizontal fracture
				SANDSTONE: Light bluish gray (5B7/1), fine grained, horiz. fractures w/coal @ 60.9, 61.11, 61.63, 62.33, 62.55, 62.7, 62.9, 63.1, 63.2, 63.25, 63.45, vug @ 63.5, moderate discontinuous wavy layers of coal throughout although conc. blw 61.6-62.14		Vertical fracture to S or S to E orientation
65				SANDSTONE: Light gray (N7), fine grained, clean horiz. fractures @ 64.3, 65.15, 66, 67.2, 67.7, 68.3, 68.58, 70.35, 70.84, 71.58, angular fractures @ 64.4, 65.25, vert. Fracture from 70.9-71.48		



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BORING NO: 3C
 Sheet 2 of 4

Hydrogeologists, Geologists:
 Karst & Sinkhole Specialists

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/1/04

LOCATION: Adjacent to northwest end of dam

SURFACE ELEV.: 1818.85 ft

LOG ID: BH3C

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 7/13/04

DRILL CONTRACTOR: ECE

DRILLER: SJL, ACG, JEB

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION:

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
70						Coal interbedded on top Horizontal fractures Horizontal fracture with coal interbedded
				INTERBEDDED SANDSTONE: Light gray (N7), fine grained, many thin beds of coal visible, angular fracture @ 71.9		
				SANDSTONE: Light gray (N7), fine grained		
75				INTERBEDDED SANDSTONE: Light gray (N7), fine grained, many thin beds of coal visible, clean horiz. fractures @ 73.08, 73.4, 73.52		
				SANDSTONE: Light gray (N7), fine grained		
				INTERBEDDED SANDSTONE: Light gray (N7), fine grained, many thin beds of coal visible, clean horiz. fracture @ 74.9		
				FRACTURED SANDSTONE: Light gray (N7), fine grained, not much sample retained blocky fracture		76-77 ft, Horizontal bedding fracture with shale
80				SANDSTONE: Light gray (N7), fine grained, clean sub horiz. fractures @ 78.26, 78.83, 79.34, 79.75, 81.27, 82.7 horiz. fractures w/pitting @ 80.4, 80.66, 82.1, rounded to elongate inclusions of coal @ 76.85, 77.9, 78.59, 81.69, 82.4, stylolites @ 82.14, 82.58, 82.61		Few thin horizontal fractures with coal
85				SANDSTONE: Light brownish gray (5YR 7/1), med. fine grained, not as compact as previous, horiz. fractures w/pitting @ coal @ 83.46, 84.93, 85.85, 88.2, 87.6, 87.7, clean horiz. fracture @ 86.4, stylolites @ 82.78, 82.82, 83, 83.1, 83.6, 84.97, 86.32, 86.4, 87.47, 87.7, vug w/missing coal @ 86.6		Few thin horizontal fractures with coal Horizontal fracture, vertical fractures E to W orientation
90				SANDSTONE: Light brownish gray (5YR 7/1) fine grained, horiz. fractures w/pitting @ coal @ 88.69, 88.85, 89.2, 90.35, 90.59, 91.08, 91.65, 92.05, horiz. fracture w/bituminous coal @ 91.33, 92.12, 92.4, stylolites @ 87.85, 88, 88.7, 88.77, 90.3, 90.6, 90.7, 90.72, 90.75, 90.88, 91, 91.25, 91.55, 91.83		Angular fractures, vertical fractures on SW Horizontal bedding fractures
95				SANDSTONE: Light gray (N7), fine grained, angular fracture @ 92.6, horiz. fracture w/pitting & coal @ 93.85		Horizontal fractures, vertical fractures NE and W
				SANDSTONE: Light brownish gray (5YR 7/1), fine grained, horiz. fractures w/pitting & coal @ 95.4, 97.16, 97.7, stylolites @ 95.2, 95.24, 96.03, 96.06, 96.35, 97.19, 97.45, 97.67		94-95 ft, Angular fractures with shale layer Small fracture zone Small fracture zone in middle
				SANDSTONE: Light gray (N7), fine grained, horiz. fracture w/pitting & coal @ 98.2, 100, 100.42, 100.52, angular fractures w/coal @ 99.99, 77, near vert. fracture @ 101, stylolites @ 97.73, 97.8, 97.86, 98.98, 99.7, 100.05, 100.1		



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BORING NO: 3C

Sheet 3 of 4

PROJECT NAME: Meadow Park Lake Dam
 LOCATION: Adjacent to northwest end of dam
 LOG ID: BH3C

PROJECT NO.: 670101
 SURFACE ELEV.: 1818.85 ft
 MUNICIPALITY: Crossville, TN

DATE: 9/1/04

DATE STARTED/COMPLETED: 7/13/04
 DRILLER: SJL, ACG, JEB
 LOGGED BY: Angela Adams

DRILL CONTRACTOR: ECE
 DRILL RIG TYPE: Mobile B-80

DRILLING METHOD: Mud Rotary
 SAMPLER DIAM: 2 in

CASING DIAMETER [OD/ID]: 3.25 IN
 WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION:

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
100				100.45, 101.6		99-100 ft Horizontal fractures
				SANDSTONE: Light gray (N7), fine grained, horiz. fracture w/pitting&coal @ 102.38, 103.2, stylolites @ 102.7		Thin fractures
105				SANDSTONE: Light bluish gray (5B7/1), fine grained, horiz. fractures w/coal @ 103.52, 104.45, 107.33, 108, 108.34, 109.2, angular fracture w/pitting & coal @ 105.25, 109.86, clean angular fracture @ 107.7		Coal seam Vertical fractures on SE and SW
						105-107 ft, Horizontal fractures with coal and shale layers
110				SANDSTONE: Brownish gray (5YR 4/1), med. fine grained, (weathered) ind. grains visible, angular fracture @ 110, horiz. fractures @ 110.32, 110.42		Horizontal fractures
				SANDSTONE: Light gray (N6) w/ slight brown overtones along bedding, fine grained, numerous discontinuous wavy coal seams, sub horiz. fractures along coal seams @ 111.2, 111.25, 111.37, 111.54		Several angular fractures
				COAL: Brownish black (5YR 2/1), microcrystalline, bituminous, horiz. fracture @ 111.8		Turbidity increasing, low visibility zone
115				SANDSTONE: Light gray (N6) w/ slight brown overtones along bedding, fine grained, numerous discontinuous wavy coal seams, sub horiz. fractures along coal seams @ 112.03		
				SANDSTONE: Light bluish gray (5B7/1), fine grained		
				COAL: Brownish black (5YR 2/1), microcrystalline, bituminous, concoidal fract., horiz. fractures @ 113.8, 113.9		
				SANDSTONE: Light gray (N6) w/ slight brown overtones along bedding, fine grained, numerous discontinuous wavy coal seams, angular fracture along coal seams @ 114.45, horiz. fractures along coal seams @ 115.32, 116.1		
120				COAL: Brownish black (5YR 2/1), microcrystalline, bituminous		Mud, video end
				SANDSTONE: Light gray (N6) w/ slight brown overtones along bedding, fine grained, numerous discontinuous wavy coal seams, horiz. fracture w/ coal @ 116.47		
				INTERBEDDED SANDSTONE: Gray (N5), fine grained, rhythmically bedded parallel layers of shale, horiz. fractures @ 116.5, 115.5, 116.6, 116.65		
				SANDSTONE: Light gray (N7) fine grained, angular fracture w/coal @ 117		
125				SANDSTONE: Light gray (N6) fine grained, horiz. fractures @ 117.7, 118.53, 118.78, 118.82, 119, angular fracture @ 119.9, discontinuous wavy shale beds between 120-120.3		
				INTERBEDDED SANDSTONE: Light gray (N6) fine grained, wavy discontinuous shale interbeds throughout, sub horiz. fractures w/ shale @ 120.55, 120.6, 120.66, 120.78, 120.9, 121.4, 121.44, 121.6, 122.1, 122.48, 122.8, 122.85, 123.76, 124.45		
				INTERBEDDED SANDSTONE: Gray (N5), fine grained, rhythmically bedded parallel layers of shale, horiz. fractures @ 125, 125.11, 125.28, 125.41, 125.46, 125.82, 126.03, 126.32, 126.44, 126.55, 126.6, 126.68, 126.87, 127.18, 127.35, 127.7		



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BORING NO: 3C
 Sheet 4 of 4

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/17/04

LOCATION: West of the lake

SURFACE ELEV.: 1885.25

LOG ID: BH-4

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 7/15/04

DRILL CONTRACTOR: ECE

DRILLER: SJL, ACG, JEB

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL DEPTH: 1873.80

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
0				TOPSOIL CLAY: Tan		Video log not made. Borehole fully cased prior to video logging.
5		100%	86%	Missing (core was not provided by drillers) 4.1 feet to 18 feet.		
10	ECE 099	97.5%	63%			
15						
20	ECE 060	84%	47%	SANDSTONE: Light brownish gray (5YR 7/1), fine grained, polished, dense, visible bedding/cross bedding from 19.65-20.45, clean sub horiz. fractures @ 18.6, 19.4, vug @ 19, horiz. fracture w/FeO2 stain @ 19.9		
				FRACTURED SANDSTONE: Light brownish gray (5YR 7/1), fine grained, FeO2 staining along all fractures both vert. and horiz.		
				SANDSTONE: Grayish pink (5YR 7/2), med. fine grained, clean sub		



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BORING NO: 4
 Sheet 1 of 5

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PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/17/04

LOCATION: West of the lake

SURFACE ELEV.: 1885.25

LOG ID: BH-4

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 7/15/04

DRILL CONTRACTOR: ECE

DRILLER: SJL, ACG, JEB

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL DEPTH: 1873.80

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
25	ECE 060	100%	92%	horiz fractures @ 22.45, 22.6		
				FRACTURED SANDSTONE: Grayish pink (5YR 7/2), med fine grained, FeO2 staining along all fractures, vert. fracture entire length		
30	ECE 060	100%	92%	SANDSTONE: Grayish red (5R 4/2), fine grained, area of heavy FeO2 staining		
				SANDSTONE: Grayish pink (5YR 7/2), fine grained, noticeable dissolution along bedding planes, clean angular fracture @ 23.6, sub horiz. Fracture w/ FeO2 staining @ 24.45		
				SANDSTONE: Light brownish gray (5YR 7/1), fine grained, polished, dense, clean sub horiz. Fractures @ 25.5, 25.8		
				SANDSTONE: Light brownish gray (5YR 7/1), fine grained, polished, dense, visible bedding/cross bedding		
				FRACTURED SANDSTONE: Light brownish gray (5YR 7/1), fine grained, FeO2 staining along horiz. Fractures		
35	ECE 058	100%	74%	FRACTURED SANDSTONE: Grayish red (5R 4/2), fine grained, horiz. fractures w/ FeO2 @ 30, 30.45, 31.1, vert. fracture w/ FeO2 staining and limonite from 30.45-31		
				FRACTURED SANDSTONE: Grayish red (5R 4/2), fine grained, light brown mud seam, w/ shale partings, FeO2 on fractures		
				SANDSTONE: Light brownish gray (5YR 7/1), fine grained, vert. fracture w/ FeO2 stain from 32.05-32.3, clean horiz. Fracture @ 32.68, angular fracture w/ pinkish mud @ 33.25		
				FRACTURED SANDSTONE: Light brownish gray (5YR 7/1), fine grained, pinkish mud		
40	ECE 058	100%	74%	SANDSTONE: Light bluish gray (5B 8/1), fine grained		
				SANDSTONE: Light bluish gray (5B 8/1), fine grained		
				SANDSTONE: Light bluish gray (5B 7/1), fine grained w/ abundant coal stringers, angular fracture w/ slickenlines @ 35.55, irregular angular fractures @ 37.1, 37.7, 37.4		
				SANDSTONE: Light bluish gray (5B 8/1), fine grained, clean angular fractures @ 38, 38.8, clean horiz. fractures @ 39.8, 40		
44				SANDSTONE: Light bluish gray (5B 8/1), fine grained, irregular angular fracture w/ minor coal @ 42, clean angular fracture @ 43.8, clean horiz. fractures @ 44.4, 44.6		



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BORING NO: 4
 Sheet 2 of 5

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/17/04

LOCATION: West of the lake

SURFACE ELEV.: 1885.25

LOG ID: BH-4

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 7/15/04

DRILL CONTRACTOR: ECE

DRILLER: SJL, ACG, JEB

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL DEPTH: 1873.80

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
40	ECE 058	90%	80%	SANDSTONE: Light bluish gray (5B 8/1), fine grained, clean angular fractures @ 46.2, 47.25, 47.85 horiz. fracture w/FeO2 stain @ 48		
				SANDSTONE: Grayish red (5R 4/2), fine grained, area of heavy FeO2 staining, horiz. fracture w/ FeO2 @ 48.13		
50				SANDSTONE: Light bluish gray (5B 8/1), fine grained, clean angular fracture @ 50, matrix is such that you can see individual grains		
				Missing (core was not provided by drillers) 50-70 feet		
55		87%	83%			
60		100%	84%			
65				COAL: According to drillers log (no rock core sample provided by driller) Missing (core was not provided by drillers) 50-70 feet.		



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BORING NO: 4
 Sheet 3 of 5

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/17/04

LOCATION: West of the lake

SURFACE ELEV.: 1885.25

LOG ID: BH-4

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 7/15/04

DRILL CONTRACTOR: ECE

DRILLER: SJL, ACG, JEB

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL DEPTH: 1873.80

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
70	ECE 030	100%	94%	SANDSTONE: Light gray (N7), fine grained, dense, polished, clean angular fractures @ 70.1, 72.93, clean horiz. fractures @ 70.65, 71.7, 71.86, 72.7, 73.45		
75	ECE 030			CONGLOMERATE: Light gray (N7), sub rounded milky white qtz pbis > 1/4", moderate brown pbis also SANDSTONE: Light gray (N7), fine grained CONGLOMERATE: Light gray (N7), sub rounded milky white qtz pbis > 1/4", moderate brown pbis also SANDSTONE: Light gray (N7), fine grained, clear angular fractures @ 75.4, 76.5, 77.05 SANDSTONE: Light gray (N7), fine grained, dense, polished, angular fracture w/coal @ 77.1, angular fracture w/pitting @ 78.1, 78.55		
80	ECE 030			FRACTURED SANDSTONE: Light gray (N7), fine grained, dense, polished, angular fracture w/bituminous coal @ 78.8, 78.9, 79.3 CONGLOMERATE: Light gray (N7), sub rounded milky white qtz pbis > 1/4", moderate brown pbis also FRACTURED SANDSTONE: Light gray (N7), fine grained, dense, polished, angular fracture w/slickenlines @ 79.8 FRACTURED SANDSTONE: Light gray (N7), fine grained, dense, polished SANDSTONE: Light gray (N7), fine grained, clean sub horiz. fracture @ 86		
85	ECE 1028	100%	79%	FRACTURED SANDSTONE: Light gray (N7), fine grained, angular fractures stained w/FeO2 & many coal inclusions SANDSTONE: Light gray (N7), fine grained, angular fracture w/coal @ 86.9 SANDSTONE: Grayish red (5R 4/2), fine grained, area of heavy FeO2 staining, angular fracture w/ FeO2 @ 87.15 SANDSTONE: Light gray (N7), fine grained, clean angular fracture @ 87.85 FRACTURED SANDSTONE: Medium gray (N6), fine grained, many angular fractures w/ bituminous coal 88.7, the rest are too highly fractured to recreate exact location		



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BORING NO: 4
 Sheet 4 of 5

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/17/04

LOCATION: West of the lake

SURFACE ELEV.: 1885.25

LOG ID: BH-4

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 7/15/04

DRILL CONTRACTOR: ECE

DRILLER: SJL, ACG, JEB

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

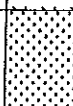



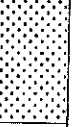
CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL DEPTH: 1873.80

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
90	ECE 1028			SANDSTONE: Light gray (N7), fine grained, clean horiz. fracture @ 91.03, clean angular fracture @ 91.77, angular fracture w/coal @ 92		
				FRACTURED SANDSTONE: Medium gray (N6), fine grained, many horiz. fractures w/ bituminous coal too highly fractured to recreate exact location		
				FRACTURED SANDSTONE: Grayish red (5R 4/2), fine grained, area of heavy FeO2 staining, horiz. fractures w/ FeO2 @ 92.43, 92.55, 92.7		
95	ECE 1027	88%	71%	SANDSTONE: Light gray (N7), fine grained, clean sub horiz. fractures @ 92.93, 93.3, 98.5, 98.7, 99.25, sub horiz. fracture w/FeO2 stain @ 94.25, pitted angular fractures w/coal @ 94.65, 95.6, 98.8		
100	ECE 1027	100%	100%	SANDSTONE: Light gray (N7), fine grained, dense, polished, sub horiz. fracture w/FeO2 stain @ 100, clean horiz. fracture @ 101.8, single line of FeO2 stain from 100.35-101.8		



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BORING NO: 4
 Sheet 5 of 5

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 10/29/04

LOCATION: West of the lake

SURFACE ELEV.: 1877.83

LOG ID: BH-4B

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 9/22/04

DRILL CONTRACTOR: ECE

DRILLER: DMR, VND

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1869.78

DEPTH (FT.)	SAMPLE #	REC (%)	RAD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
0				CLAY		Water table
5				CLAY: Auger refusal @ 7.1 feet		0-9.25' PVC casing
				No recovery		
10	ECE 015			FRACTURED SANDSTONE: Moderate reddish gray (5R 5/4), med. fine grained highly weathered sugary arkosic sandstone, weathering to quartz sand		9'+ Light gray sandstone, horizontal bedding
				SANDSTONE: Moderate reddish gray (5R 5/4), med. fine grained, competent arkosic sandstone		
				FRACTURED SANDSTONE: Moderate reddish gray (5R 5/4), med. fine grained highly weathered sugary arkosic sandstone, weathering to quartz sand		
15	ECE 015			FRACTURED SANDSTONE: Pinkish gray (5YR 8/1), fine grained, angular fractures w/ pitting @ 12.4, 12.5, horiz. fractures w/ pitting @ 12.8, 13.1, 13.3, 13.7 sugary texture where weathered		13'-14' Angular fractures, EW orientation, iron staining visible
				SANDSTONE: Pinkish gray (5YR 8/1), fine grained, horiz. fractures w/ heavy FeO2 stains as well as hematite and limonite recrystallization @ 14.6, 15		
				SANDSTONE: Very light gray (N7.5), fine grained, clean sub horiz. fracture @ 16.63, angular fractures w/ pitting & limonite staining @ 16.73, 16.94		
20	ECE 015			SANDSTONE: Pale red (10R 6/2), fine grained, horiz. fractures w/ light FeO2 stains @ 17.9, 18.03, angular fractures w/ pitting & light FeO2 stains @ 18.1, 18.25		17'-18' Horizontal and angular fractures
				SANDSTONE: Grayish red (5R 5/2), fine grained, darker red along bedding, angular fracture w/ FeO2 stain @ 20.03		Angular fractures and horizontal shale layer
				FRACTURED SANDSTONE: Moderate reddish brown (5YR 4/4), fine grained, darker red along bedding, healed fracture lines throughout		
				SANDSTONE: Light gray (N7), fine grained, angular fractures w/ pitting & FeO2 staining @ 21.45, 21.84, 22.05, 22.55, 22.9, 23.5, clean horiz. Fractures @ 25.6, 26		21'-23' Angular fractures
25	ECE 010			SANDSTONE: Pale red (10R 6/2), fine grained, angular fractures w/ pitting & light FeO2 stains (limonite) @ 26.45, near vert. fracture trace @ 26.9		25'-26' Angular fractures
	ECE 010					



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BORING NO: 4B

Sheet 1 of 6

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PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 10/29/04

LOCATION: West of the lake

SURFACE ELEV.: 1877.83

LOG ID: BH-4B

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 9/22/04

DRILL CONTRACTOR: ECE

DRILLER: DMR, VND

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1869.78

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
30	ECE 013			SANDSTONE: Light gray (N7), fine grained, sub horiz. fractures @ 27.05, 27.1, 27.25, 28, 28.2, 28.3, 31, 32, 32.64, 33.26, 34, 34.4, 34.7, angular fracture @ 30.4, angular fracture w/pitting @ 35.6		28'-30' Horizontal fractures, few vertical fractures, oriented E - W
35				32'-33' Horizontal fractures		
40	ECE 013			FRACTURED SANDSTONE: Light gray (N7), fine grained, horiz. fractures @ 36.35, 36.55, 36.63, 36.68, 38.82, 37		35'-36' Few horizontal fractures
45				SANDSTONE: Light gray (N7), fine grained, horiz. fractures w/FeO2 staining @ 37.7, 39, angular fractures w/pitting @ 37.85, 39.7, 41.8, 41.9, 42.18, angular fracture w/FeO2 staining @ 40.65		Angular fractures, iron staining visible
50	ECE 013			SANDSTONE: Moderate reddish brown (5YR 4/4), fine grained, darker red along bedding, healed fracture lines throughout, highly weathered		40'-41' SW striking vertical fractures
55				SANDSTONE: Faintly mottled light gray (N7), fine grained, horiz. fractures @ 44.85, horiz. fractures w/FeO2 stains @ 45.5, 45.6, 45.7, angular fracture w/FeO2 staining @ 48. The fracture @ 45.7 exhibits a cavity filled w/ limonitic mud in place.		SW striking angular fractures
	ECE 013			FRACTURED SANDSTONE: Light gray (N7), fine grained, angular fracture @ 46 has limonitic mud in place, vertical fracture from 46.1-47.2		Angular fractures with iron staining
				SANDSTONE: Mottled light gray (N7), fine grained, discontinuous wavy lenses of shale throughout, angular fractures @ 48.07, 48.4		SW striking vertical fractures, angular fractures with iron staining
	ECE 024B			SANDSTONE: Light gray (N7), fine grained, angular fracture w/FeO2 staining @ 49.53, horiz. fractures @ 50.2, 50.8, 51.55, angular fracture @ 51.16		Larger bedding fracture with shale
				FRACTURED SANDSTONE: Grayish orange pink (10R 8/2), fine grained, intensely fractured between 51.55-52, horiz. fractures w/pitting & FeO2 staining @ 52, 52.95, 53.3, 3.8, 54.3, vertical fractures from 52-52.68 53.3-54.3		Horizontal fractures
				SANDSTONE: Light gray (N7), fine grained		Vertical fractures, orientation SE to NW; horizontal bedding fractures
						Highly fractured area with missing rock fragments, 2-3", iron staining below it



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BORING NO: 4B
 Sheet 2 of 6

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 10/29/04

LOCATION: West of the lake

SURFACE ELEV.: 1877.83

LOG ID: BH-4B

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 9/22/04

DRILL CONTRACTOR: ECE

DRILLER: DMR, VND

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1869.78

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
60	ECE 024B			SANDSTONE: Pale reddish brown (10R 5/4), fine grained, numerous horiz./sub horiz. fractures @ 56.25, 56.4, 56.45, 56.5, 56.6, 56.65, 56.75 SANDSTONE: Light gray (N6) fine grained, horiz. fractures @ 56.95, 57.2, 58.46, 58.5, 59.4, 59.45, 59.6 along stylolitic coal seams	[Dotted pattern]	57'-58' Horizontal fractures Bedding fractures with shale
				SANDSTONE: Light gray (N6) med. fine grained, indiv. white grains visible, horiz. fracture w/trace coal @60.53, horiz. fracture w/heavy pitting @ 61.2		Angular fractures 61'-62' Angular fractures
65	ECE 024B			SANDSTONE: Pale reddish brown (10R 5/4), fine grained, horiz. fracture @ 62.1	[Dotted pattern]	2 Larger horizontal fractures with mud, iron staining visible
				SANDSTONE: Light gray almost buff (N7), fine grained, jagged sub horiz. fracture @82.2, solution vug @ 62.5		
	ECE 200			CONGLOMERATE: Pale reddish brown (10R 5/4), fine grained, horiz. fracture @ 62.75 w/ visible grains and pebbles SANDSTONE: Grayish orange pink (10R 8/2), fine grained, weathering/depositional/diagenetic cavity from 65.1-65.2 w/ visible >.25" quartz pebbles encompasses ~90% of core diameter SANDSTONE: Light gray (N6) med. fine grained, indiv. white grains visible, horiz. fracture w/coal @ 66.02		
70				SANDSTONE: Light gray (N6) fine grained, vert. fracture trace w/ FeO2 staining from 67.3-68.8, horiz. fractures pitted&weathered @67.2, 67.3, horiz. Fracture w/pitting&FeO2 stains @ 70, 71.4, 72, 72.4, 72.8	[Dotted pattern]	Vertical fractures oriented NW and SE, iron staining visible 69'-70' Two vertical fractures oriented to the W and S respectively, iron staining
						Horizontal fractures, iron staining 72'-73' Angular fractures
75	ECE 200			SANDSTONE: Light gray (N7.5) fine grained, horiz. fractures pitted&weathered @ 73.67, 74.3, 81.86, 82.27, angular fracture @ 83.4 w/ FeO2 staining	[Dotted pattern]	74'-75' Vertical fractures, oriented N - S
						Thin vertical and horizontal fractures 2 vertical fractures, oriented N - S, horizontal fractures with shale Angular fractures Vertical fractures to S and SW
80					[Dotted pattern]	



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BORING NO: 4B
 Sheet 3 of 6

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 10/29/04

LOCATION: West of the lake

SURFACE ELEV.: 1877.83

LOG ID: BH-4B

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 9/22/04

DRILL CONTRACTOR: ECE

DRILLER: DMR, VND

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1869.78

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
85	ECE 081			SANDSTONE: Light gray (N7.5) fine grained, fractures along coal seams @ 84.55, 84.93, vug @ 85.82, angular fractures w/ pitting and sand @ 85.25, vertical fracture w/ FeO2 staining from 85.1-85.8		Vertical and angular fractures to SW, iron staining, water flow possible 2 vertical fractures to N and W Fracture zone
90	ECE 020			FRACTURED SANDSTONE: Light gray (N7.5) fine grained, high fracture zone w/ residual sand, Fe staining along fractures SANDSTONE: Light bluish gray (5B 8/1) fine grained, denser than previous in that indiv. grains not apparent, vert. fracture traces from 88.25-88.56, sub. horiz. fracture w/ coarse pitting @ 89.5, angular fracture w/ fine pitting and limonite staining @ 90.1		88'-89' Vertical fractures, oriented E- W, iron staining visible
95	ECE 020			SANDSTONE: Light bluish gray (5B 8/1) fine grained, dense/polished, vert. fracture trace / FeO2 stain from 90.65-91.75, angular fracture @ 90.6, sub horiz. fracture @ 92.48 w/ white silty clay material FRACTURED SANDSTONE: Light bluish gray (5B 8/1) fine grained, dense/polished, vert. fracture for entire length w/ white silty clay material, sub horiz. fracture @ 92.74 w/ white silty clay material		Thin vertical and horizontal fractures A vertical fracture to NW
100	ECE 020			SANDSTONE: Light bluish gray (5B 8/1) fine grained, dense/polished, angular fracture @ 93.6 w/ white silty clay material, horiz. Fracture w/ minor pitting and white silty clay material @ 96, SANDSTONE: Grayish red (5R 4/2), fine grained, angular fracture w/ FeO2 stain @ 96.03 SANDSTONE: Light bluish gray (5B 8/1) fine grained, dense/polished, horiz. fracture w/ pitting @ 97.05, stylolites between 97.4-97.76, horiz. fracture w/ pitting and 25% coal @ 97.85		94'-95' Vertical fractures, oriented N - S; horizontal fractures with iron staining 97'-98' Horizontal fractures, 2 vertical fractures to S and NW
105	ECE 011			SANDSTONE: Light bluish gray (5B 7/1) fine grained, horiz. fractures w/ pitting and coal @ 98.85, 99.6, 100.95, angular fractures w/ pitting and coal @ 101.3, 103.7, 104.98, clean horiz. fractures @ 105.75, 106.26, 106.4, 106.7		Horizontal fractures, 2 vertical fractures to S and N 102'-104' Few thin angular fractures
110				FRACTURED SANDSTONE: Light bluish gray (5B 7/1) fine grained numerous clean fractures SANDSTONE: Light bluish gray (5B 7/1) fine grained, angular fracture w/ slickenlines @ 108.1 SANDSTONE: Light bluish gray (5B 8/1) fine grained		Few angular and vertical fractures 108'-109' 2 vertical fractures oriented S and E respectively, horizontal fractures



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BORING NO: 4B
 Sheet 4 of 6

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 10/29/04

LOCATION: West of the lake

SURFACE ELEV.: 1877.83

LOG ID: BH-4B

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 9/22/04

DRILL CONTRACTOR: ECE

DRILLER: DMR, VND

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1869.78

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
115	ECE 011			SANDSTONE: Light bluish gray (5B 8/1) fine grained, horiz. fracture @ 111.1, 112.75, 113.33, 114.05, 115, 116.87, clean angular fracture @ 111.85, brown inclusion @ 112.6, conglomeritic zone @ 113.7-113.85	[Dotted pattern]	Vertical and angular fractures to the NW and E, iron staining visible Shale or coal layers 115'-117' Vertical and angular fractures
120	ECE 005			SANDSTONE: Light bluish gray (5B 7/1) fine grained, sub horiz. fractures w/pitting&coal @ 117.77, 118.81, 120.26, 120.87, 121.58, vert. fracture from 121.8-122.1		118'-119' Horizontal and angular fractures Horizontal fractures; vertical fractures oriented to E 123'-124' Thin angular fractures
125	ECE 005			SANDSTONE: Med. Brown (5YR 4/4), fine grained SANDSTONE: Light bluish gray (5B 7/1) fine grained, sub horiz. fractures w/pitting&coal @ 125.1, 125.43 INTERBEDDED SANDSTONE: Light gray (N6) fine grained, many wavy interbeds of coal w/ angular fracturing along seams SANDSTONE: Light gray (N6) fine grained, angular fracturing along coal seams @ 127.77, 128.17, 128.4, 129.15	[Dotted pattern]	125'-127' Horizontal fractures with iron stain, angular fractures Horizontal fractures with shale or coal layers 129'-130' Thin horizontal and angular fractures
130	ECE 005			INTERBEDDED SANDSTONE: Light gray (N6) fine grained, many wavy interbeds of coal w/ angular fracturing along seams SANDSTONE: Light gray (N6) fine grained, INTERBEDDED SANDSTONE: Brownish gray (10YR 4/2) fine grained, many wavy parallel interbedded coal micro-seams SANDSTONE: Light gray (N6) fine grained, sub horiz. Fracture w/pitting&coal @ 137.15, 137.35, 137.8, 138.4, 138.9, 139.1, 139.5, 141.87		[Dotted pattern]
135						



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BORING NO: 4B
 Sheet 5 of 6

Hydrogeologists, Geologists:
 Karst & Sinkhole Specialists

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 10/29/04

LOCATION: West of the lake

SURFACE ELEV.: 1877.83

LOG ID: BH-4B

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 9/22/04

DRILL CONTRACTOR: ECE

DRILLER: DMR, VND

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1869.78

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
140						Horizontal fractures
						Horizontal and angular fractures
				INTERBEDDED SANDSTONE: Light gray (N6) fine grained, wavy non parallel discontinuous stringers of coal w/ angular fracturing along seams		
145						145'-146' horizontal and angular fractures
						147'-148' angular fractures
150				No recovery		Horizontal and angular fractures
						Horizontal bedding fractures, rock color becoming dark
						153'-154' Angular fractures
155						155'-156' Horizontal fractures
						Angular fractures
						Angular fractures
160						Bottom sediment



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BORING NO: 4B
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PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/21/04

LOCATION: West of the lake

SURFACE ELEV.: 1884.11

LOG ID: BH5

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/20/04

DRILL CONTRACTOR: ECE

DRILLER: JEB, MWR, DMR

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1862.40

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
0				TOPSOIL		
0-5	ECE 022	16.6%	0%	CLAY: Red, auger refusal @ 5 feet		0-5.25' PVC Casing
5-7				SANDSTONE: Light brown reddish gray (5YR 6/2), weathered to sand & clay, not competent		5'+ Weathered sandstone
7-8				CLAY: Red		Void area with mud or clay
8-11				FRACTURED SANDSTONE: Light brown reddish gray (5YR 6/2), fine grained, weathered to sand & clay, not competent		7-8' Fracture zone with mud or clay, horizontal bedding
11-13						NW oriented vertical and angular fractures
13-15						Void area with mud or clay
15-16	ECE 022	105%	68.7%	SANDSTONE: Light gray (N7), fine grained, sub horiz. fractures w/ reddish brown mud @ 11.45, 11.56, 11.62, 11.75		11-13' Sandstone, partial horizontal fractures
16-18				FRACTURED SANDSTONE: Light brown reddish gray (5YR 6/2), fine grained, weathered to sand & clay, not competent		Variety of angular fractures oriented West and Southeast
18-20				SANDSTONE: Light gray (N7), fine grained, sub horiz. fractures w/ reddish brown mud @ 12.5, 12.65, 13.1, 13.3, 13.45, 14.3, angular fractures w/ reddish brown mud @ 13.9, 14.6, 15.92		15-16' Fracture zone with mud
20-22				FRACTURED SANDSTONE: Pale reddish gray (10R 4/4), fine grained, angular fracture w/ reddish brown mud @ 15.6, 15.93, 16.08, 16.13, 16.24, 16.45		Water table
22-24		70%	48%	SANDSTONE: Light gray (N7), fine grained, pitted angular fracture w/ reddish brown mud @ 17.2		Massive sandstone, thin partial angular fractures
24-26	ECE 022			FRACTURED SANDSTONE: Pale red (5R 6/2), fine grained, highly fractured w/ many healed traces, some very red areas surfaces, hematite rich clay		
26-28				SANDSTONE: Light gray (N7), med. fine grained, (weathered) indiv grains visible, angular fractures w/ sand & FeO2 @ 21.1, 21.65, 22.1, 22.45, 22.8, 23.2, 23.5, 23.6		Horizontal or bedding fractures with iron stain and clay layer
28-30				FRACTURED SANDSTONE: Pale red (5R 6/2), fine grained, highly fractured, hematite rich clay seam		Few clean angular fractures
30-32				SANDSTONE: Light gray (N7), fine grained, horiz. fractures w/ tan vf. sand @ 24.71, 25.2, 25.45, 26.2, 26.9, 27		
32-34	ECE 017	43.9%	24.5%	SANDSTONE: Light gray (N6.5), fine grained, dense, polished, pitted angular fractures @ 27.5, 27.6, 27.9		Few horizontal fractures
34-36				SANDSTONE: Light gray (N7), fine grained, dense, polished, pitted sub horiz. fractures w/ vf. sand @ 28.75, 29.5, 29.8, 3.1, 30.63, >1/4" vug @ 29.65, pitted angular fractures w/ vf. sand @ 30.25, 31.35, vert. fracture trace from 32.3-33.83, clean angular fracture @ 33.5		28-29' Vertical or high angle fracture oriented NW
36-38						Few horizontal fractures, minor water flow



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BORING NO: 5
 Sheet 1 of 6

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/21/04

LOCATION: West of the lake

SURFACE ELEV.: 1884.11

LOG ID: BH5

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/20/04

DRILL CONTRACTOR: ECE

DRILLER: JEB, MWR, DMR

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1862.40

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
35	ECE 017	97%	72.5%	SANDSTONE: Pale red (5R 6/2), fine grained, angular fracture w/FeO2 stains @ 33.9		36-37' Clean thin angular fractures Horizontal fractures with iron stain 40-41' Few angular fractures 42-44' Variety of angular fractures, iron stain visible Angular fractures, horizontal fracture with iron stain Horizontal fractures with iron stain Horizontal fracture with iron stain 53-54' NE oriented angular fractures, iron stain visible Horizontal fractures with iron stain Few angular fractures Angular fractures with iron stain
				SANDSTONE: Light gray (N7), fine grained, irregular fracture w/ FeO2 stains @ 34.5, solution vug @ 34.91, angular fracture w/light pitting @ 34.95		
				SANDSTONE: Pale reddish gray (10R 4/4), fine grained		
		100%	90.4%	SANDSTONE: Light gray (N7), fine grained, horiz. fractures w/ light pitting & vf. sand @ 35.67, 36.7, 37, clean angular fracture @ 35.8, angular fracture w/light pitting & vf. sand @ 36.5		
40				FRACTURED SANDSTONE: Light gray (N7), fine grained, angular fractures w/light pitting & vf. sand @ 37.1, 37.15, 37.25		
				SANDSTONE: Light gray (N7), fine grained, horiz. fractures w/ light pitting & vf. sand @ 38.1, 39, 41, 41.35, 41.75, clean angular fracture @ 40, angular fractures w/light pitting & vf. sand @ 37.8, 41.4		
45	ECE 089	38%	17%	SANDSTONE: Light gray (N7), fine grained, clean angular fracture @ 45.15		
				FRACTURED SANDSTONE: Light gray (N7), fine grained, too fractured to reconstruct indiv. fracture locations, fracture faces clean w/ one showing moderate light pitting and one angular fracture w/FeO2 staining		
	ECE 089	72%	68%	SANDSTONE: Light gray (N7), fine grained, clean horiz. fractures @ 47.9, 47.95, angular fractures w/pitting @ 46.5, 49		
50		90%	41%			
		97.5%	73.7%	SANDSTONE: Reddish brown gray (5R 5/2), fine grained, horiz. fracture w/ light pitting @ 49.7, angular fractures w/ pitting @ 50.2, 50.3 w/in a fracture zone between 49.9-50.3		
				SANDSTONE: Light gray (N7), fine grained, clean horiz. fracture @ 51.13, horiz. fracture w/ pitting @ 51.23, vertical fracture from 51.13-51.5 w/ FeO2 staining		
		62%	57.9%	SANDSTONE: Reddish brown gray (5R 5/2), fine grained, horiz. fracture w/ pitting @ 51.7		
55	ECE 089			SANDSTONE: Grayish red (5R 4/2), fine grained, visible bedding or crossbedding, angular fracture w/FeO2 staining & light pitting @ 51.85		
				SANDSTONE: Reddish brown gray (5R 5/2), fine grained, sub horiz. fracture w/ pitting @ 52.6		
				SANDSTONE: Light gray (N7), fine grained, angular fracture w/pitting @ 53.7, 60.5, clean irregular fracture @ 54.2, stylolites @ 54.25, 54.4, 54.5, 54.65, 54.68, 54.74, 54.83, 54.88, 54.91, 54.98, 55, 59.42, 59.65, 59.98, 60.05, 60.55, horiz. fracture @ 59.5, angular fracture w/minor coal @ 60.76, clean horiz. fractures @ 60.85, 60.96, 61, 61.95		
60	ECE 089					



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BORING NO: 5
 Sheet 2 of 6

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/21/04

LOCATION: West of the lake

SURFACE ELEV.: 1884.11

LOG ID: BH5

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/20/04

DRILL CONTRACTOR: ECE

DRILLER: JEB, MWR, DMR

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1862.40

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
65	ECE 007	91.6%	80.3%	SANDSTONE: Pale reddish brown (10R 5/4), fine grained, visible bedding or crossbedding, angular fracture w/FeO2 staining @ 61.9		62-63' Few angular fractures, iron stain visible
		90%	88.2%	SANDSTONE: Light gray (N7), fine grained, sub horiz. fractures @ 63.4, 64.5, vert. fracture from 63.5-64.5 w/ minor FeO2 precipitation more like xlt growth than staining		65-66' Variety of angular fractures
70	ECE 007	95%	92%	FRACTURED SANDSTONE: Grayish red (5R 4/2), fine grained, visible bedding or crossbedding, angular fracture w/FeO2 staining @ 64.9, 65.35, vert. fractures from 64.9-65.4 and 65.6-67		Horizontal fractures
				SANDSTONE: Reddish brown gray (5R 6/2), fine grained		
75	ECE 007	87%	85%	SANDSTONE: Grayish red (5R 4/2), fine grained		73-74' Horizontal and angular fractures
				FRACTURED SANDSTONE: Pale reddish brown (10R 5/4), fine grained, horiz. fracture w/ FeO2 stains @ 69.9, angular fracture w/FeO2 stains @ 70.6, zone of intense fracturing w/healed fractures between 69.45-70 all FeO2 stained		
80	ECE 008	95.3%	73.3%	SANDSTONE: Light gray (N7), fine grained, sub horiz. fracture w/coal @ 71.2, sub horiz. fracture w/pitting @ 71.72, clean angular fracture @ 71.85, vugs @ 71.95, 72.4, fracture traces @ 72, 72.15, 72.6, angular fractures w/pitting @ 73.13, 73.9		Horizontal fractures, iron stain visible
				SANDSTONE: Grayish red (5R 4/2), fine grained		
85	ECE 008	93%	84.5%	SANDSTONE: Light gray (N7), fine grained, clean sub horiz. fractures @ 75.06, 75.8, 77.16		Horizontal fractures with iron staining
				SANDSTONE: Pinkish gray (5YR 7/1), fine grained, angular fracture w/FeO2 @ 77.16, clean horiz. fracture @ 77.74		
90	ECE 008			SANDSTONE: Light gray (N7), fine grained, clean irregular fracture @ 78.35, sub horiz. fractures w/ pitting @ 79, 80, angular fracture w/ FeO2 staining @ 80.55		82-83' Horizontal fractures
				FRACTURED SANDSTONE: Light gray (N7), fine grained, angular fractures w/ FeO2 staining, sub horiz. & irregular fractures w/ pitting		
				SANDSTONE: Light gray (N7), fine grained, dense, polished, clean irregular fracture @ 83.4		NW and SW oriented vertical and angular fractures
				SANDSTONE: Light gray (N7), fine grained, angular fractures w/pitting & coal @ 84, 84.3, 85, 86.23, clean angular fracture @ 86.8, sub horiz. fracture w/ coarse pitting @ 87.4, 89.52, 89.79, 89.85, 89.9, 90.45 clean horiz. fracture @ 85.4, horiz. fracture w/ coal @ 87.66, angular fracture traces (3) from 88.9-89.08		87-88' Few horizontal fractures with iron stain and coal
				SANDSTONE: Grayish red (5R 4/2), fine grained		89-90' Angular fractures
				SANDSTONE: Pale reddish brown (10R 5/4), fine grained, angular fracture		



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BORING NO: 5
 Sheet 3 of 6

Hydrogeologists, Geologists:
 Karst & Sinkhole Specialists

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/21/04

LOCATION: West of the lake

SURFACE ELEV.: 1884.11

LOG ID: BH5

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/20/04

DRILL CONTRACTOR: ECE

DRILLER: JEB, MWR, DMR

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1862.40

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
95	ECE 1012	92%	70%	w/pitting @ 91.05, sub horiz. fractures w/coal @ 92, 92.14		92-93' Horizontal fractures
				SANDSTONE: Light gray (N6), fine grained, angular fracture @ 93.75, weathered matrix from 93.85-94.4, sub horiz. fractures w/vf. sand @ 94.45, 94.52, 94.6, 95.05, 95.3		Angular fractures
100	ECE 1012	91%	54.5%	SANDSTONE: Light gray (N6), fine grained, vug from 95.66-95.73, pitted sub horiz. fracture w/ mud & coal @ 96.2, angular fractures w/minor coal @ 96.67, 97, many coal stringers from 96.4-97		98-99' Angular and horizontal fractures, iron stain visible
				FRACTURED SANDSTONE: Gray (N5), fine grained, many interbedded coal seams, horiz fractures w/ coal @ 97.15, 97.3, 97.38, 97.53, 97.8		
				SANDSTONE: Grayish red (5R 4/2), fine grained		
				SANDSTONE: Light gray (N6), fine grained, sub horiz. fractures w/pitting @ 98.22, 98.35, 98.55, 98.75, vert. fracture from 98.55-98.75		
				SANDSTONE: Grayish red (5R 4/2), fine grained, angular fracture w/FeO2 staining @ 98.92		
				SANDSTONE: Light gray (N6), fine grained, angular fracture @ 99.15 w/ FeO2 stain, vert. fracture w/ FeO2 staining from 98.92-99.15		
				SANDSTONE: Grayish red (5R 4/2), fine grained, angular fracture w/pitting @ minor coal @ 99.67		
				SANDSTONE: Light gray (N6), fine grained, sub horiz. fractures w/coal @ 100.8, 101.75		
105	ECE 026	65.8%	70.8%	SANDSTONE: Light gray (N6) w/ slight brown overtones, fine grained, pitted angular fractures w/vf. sand @ 102, 102.67, 102.88, 103.6, sub horiz. Fractures w/coal @ 104.22, 104.28, 104.37, 104.5, 105.13, 105.4, 105.5, 105.75, 106.1, clean angular fractures @ 107.55, 108, 109.6, pitted angular fractures w/coal @ 107.8, 108.85, 109, 110.1		Horizontal fractures with dark staining
				Horizontal fractures		
110	ECE 026	75%	70.5%	FRACTURED SANDSTONE: Light gray (N6) fine grained, many criss crossing fracture traces w/coarsely pitted angular fractures @ 110.9 and 111		West or NW striking horizontal fractures, vertical fractures
				SANDSTONE: Light gray (N6) w/ slight brown overtones, fine grained, sub horiz. fractures w/pitting @ 111.1, 112.32, 112.5, 113.67, 14.25, clean horiz. fracture @ 111.23, sub horiz fracture w/coal @ 111.73, clean angular fracture @ 12.9, many stylolites between 111.45-112.03		106-107' Few horizontal fractures
115	ECE 026			SANDSTONE: Light gray (N6) fine grained, angular fractures w/ pitting @ 117.9, 118.4, 118.6, 118.75, 119		109-110' Few horizontal and angular fractures
				SANDSTONE: Light gray (N6) w/ slight brown overtones along bedding, fine grained, 40% H2O loss between 119.8-120, vert. fracture from 119-119.6, sub horiz. fractures @ 119.6, 119.7, 120.1, 121		Horizontal fractures with shale layer
120	ECE 026			SANDSTONE: Light gray (N6) w/ slight brown overtones along bedding, fine grained, vert. fracture from 121-121.3, angular fracture w/pitting @ 121.95, sub horiz. fractures w/pitting & gray silty sand @ 122.36, 122.65, 123.07		114-115' Few horizontal and angular fractures, iron stain visible
						Horizontal fractures, few angular ones Bedding fractures
						119-120' Horizontal and angular fractures



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BORING NO: 5
 Sheet 4 of 6

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PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/21/04

LOCATION: West of the lake

SURFACE ELEV.: 1884.11

LOG ID: BH5

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/20/04

DRILL CONTRACTOR: ECE

DRILLER: JEB, MWR, DMR

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1862.40

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
125	ECE 026			COAL: Brownish black (5YR 2/1), microcrystalline, horiz. fracture @ 123.22 SANDSTONE: Light gray (N6) w/ slight brown overtones along bedding, fine grained, angular fractures w/gray silty sand @ 123.83, 128.6, horiz. fracture w/ gray silty sand @ 124.96		Clean horizontal fractures 125-126' Horizontal fractures NW striking vertical and angular fractures
130	ECE 025A			FRACTURED SANDSTONE: Light gray (N6) fine grained, vert. fracture from 128.6-129 otherwise too fractured to recreate SANDSTONE: Light gray (N6) fine grained, clean horiz. fracture @ 129.47, angular fracture w/coal @ 130.4		Horizontal and angular fractures Horizontal or bedding fractures
135	ECE 025A	101.5%	93%	FRACTURED SANDSTONE: Light gray (N6) w/ slight brown overtones along bedding, fine grained, clean vert. fracture from 130.4-131.9, clean sub horiz. fractures @ 131, 131.15, 131.63, angular fracture w/ pitting @ 131.9 SANDSTONE: Light gray (N6) w/ slight brown overtones along bedding, fine grained SANDSTONE: Light gray (N6) w/ slight brown overtones along bedding, fine grained, angular fracture @ 136.25		Higher turbidity water
140	ECE 025A			COAL: Brownish black (5YR 2/1), microcrystalline, horiz. fracture @ 136.62 SANDSTONE: Light gray (N6) fine grained, sub horiz. fracture w/coal @ 137.15, vert. fracture from 137.15-137.55 COAL: Brownish black (5YR 2/1), microcrystalline, horiz. fracture @ 137.75 SANDSTONE: Light gray (N6) fine grained, sub horiz. fracture w/coal @ 138.43, vert. fracture from 138-138.38, angular fracture @ 139		High turbidity, no visibility
145	ECE 025A	68.5%	61.4%	FRACTURED SANDSTONE: Light gray (N6) w/ slight brown overtones along bedding, fine grained, many stylolites, angular fracture @ 139.1, horiz. fractures w/ coal @ 139.2, 139.25, 139.35, 139.5 SANDSTONE: Light gray (N6.5) w/ slight brown overtones along bedding, fine grained, sub horiz. fracture w/coal @ 139.77, 140.02, 141, 142, vert. fracture trace from 140.48-141 FRACTURED SANDSTONE: Light gray (N7) fine grained, white banding, deformed core, 100% H2O loss from 148-148.7, clean irregular fractures @ 148.5, 148.68, 149.04, 149.4		
150	ECE 006	98.8%	61.3%	SANDSTONE: Light gray (N6.5) fine grained, sub horiz. fractures @ 150, 150.35 SANDSTONE: Light gray (N6) fine grained, angular fractures @ 150.9, 151.1, horiz. fracture w/pitting @ 151.43 SANDSTONE: Light gray (N6) fine grained, pitted sub horiz. fractures w/ coal @ 151.54, 151.58, 152.23, 152.42, 153 COAL: Olive brown (5Y 4/4), conchoidal fracture, too fractured to reconstruct		High turbidity water



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BORING NO: 5
 Sheet 5 of 6

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670101

DATE: 9/21/04

LOCATION: West of the lake

SURFACE ELEV.: 1884.11

LOG ID: BH5

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/20/04

DRILL CONTRACTOR: ECE

DRILLER: JEB, MWR, DMR

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1862.40

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
155		71.2%	37.8%			
160	ECE 006			SANDSTONE: Light gray (N7.5) fine grained, clean angular fracture @ 159.45, vert. fracture trace from 159.45-160, angular fractures w/ black bituminous coal @ 160.52, 161.25, 161.67, 162.04, 162.2, 163.5		
165		65.6%	54.4%	FRACTURED SANDSTONE: Light gray (N7.5) fine grained, sub horiz. fractures w/ black bituminous coal @ 163.55, 163.67, 163.78, 164 SANDSTONE: Light gray (N7.5) fine grained, angular fractures w/ black bituminous coal @ 164.35, 164.57, 165.36, 165.59, 165.85, 165.95, clean irregular fractures @ 166.13, 168, vert. fracture trace from 164.75-165 and 70.1-170.45, angular fracture w/ coal @ 169, clean vert. fracture from 168.78-169		Video end
170	ECE 006					
175	ECE 098	78%	72%	SANDSTONE: Light gray (N7.5) fine grained, angular fractures w/pitting @ 173.65, 174.75, 174.95, 178		
180						



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BORING NO: 5

Sheet 6 of 6

Hydrogeologists, Geologists:
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PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670100

DATE: 8/30/04

LOCATION: West of the lake

SURFACE ELEV.: 1898.48

LOG ID: BH6

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/9/04

DRILL CONTRACTOR: ECE

DRILLER: JCB, SJL, ACG

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25"

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1865.32

DEPTH (FT.)	SAMPLE #	REC (%)	RAD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
0				TOPSOIL		
				Auger Refusal @ 5.0 ft		0-5.25' PVC Casing
5				SANDSTONE: Light gray (N7), fine grained, light FeO2 staining, abundant mica, <5% pebbles, a weathered weakly cemented zone from 5-5.17, angular fractures w/ FeO2 @ 5.2, 5.8, sub horiz. fracture along stylolite @ 5.5		5+ Sandstone with iron staining Horizontal fractures, angular fractures, S to W
	ECE #027	89%	34%	SANDSTONE: Grayish orange pink (5YR 7/2), fine grained, at 7.3, 8.3 and 9.3 a 4, 5 and 10 mm respectively dark reddish brown layer (10R4/2), horiz. fractures @ 7.66, 8.08, 8.6, crossbedded from 9.4-9.5, weakly cemented weathered zone from 8.7-10		7'-10' Weathered zone with iron staining, horizontal bedding
10				SANDSTONE: Light gray (N7), fine grained, horiz. fractures w/pitting @ 10.8, 11.1, 13, vugs @ 11.5, 12, weathered zone from 12.25-12.5		11'-12' Bedding or horizontal fractures, some angular fractures
				Missing		13'-14' Weathered fracture zone, iron staining
15	ECE #027	44%	23.5%	SANDSTONE: Light brown (5YR 6/4), fine grained, fractures @ 15.25, 15.6, 15.75, 16.1, 16.75, vert. fracture from 16.5-16.75		15'-16' Massive Sandstone, iron staining, few horizontal fractures



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BORING NO: 6

Sheet 1 of 12

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670100

DATE: 8/30/04

LOCATION: West of the lake

SURFACE ELEV.: 1898.48

LOG ID: BH6

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/9/04

DRILL CONTRACTOR: ECE

DRILLER: JCB, SJL, ACG

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25"

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1865.32

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
20	ECE #151					18'-19' Horizontal or bedding fractures, iron staining
				SANDSTONE: Light gray (N7), fine grained		Vertical fractures striking W & S and lower ones to E & W
25	ECE #151	47.25%	26.5%	SANDSTONE: Pinkish gray (5YR 8/1), fine grained, pitted angular fracture w/ FeO2 stain @ 21.2, sub horiz. fractures very coarsely pitted w/ FeO2 staining @ 21.45, 22.3, clean horiz. fractures @ 21.65, 22.22.1, cavity no crystals @ 21.9, 22, stylolites @ 22.2, 22.25		22'-23' Fracture zone with iron staining, coal or shale
				SANDSTONE: Light gray (N8), fine grained, vert. fracture from 22.7-23.6, horiz. fractures w/ pitting and FeO2 stain @ 24, 24.8, healed vert. seams from 24-24.8, vugs @ 23.8, offset fracture possible fault trace offset to right @ 24.6 and at 24.7 vert. fracture terminates		NW oriented angular fracture
				SANDSTONE: Med. brown (5YR 4/4), fine grained, sub horiz. fracture @ 24.85, angular fractures w/ FeO2 stain and slickenlines @ 25, 25.3, horiz. fracture w/ FeO2 stain and slickenlines @ 25.1		25'-26' Fracture zone with iron staining
				INTERBEDDED SANDSTONE: Light gray (N6.5), fine grained, fracture w/ coal @ 25.55		
				FRACTURED SANDSTONE: Light gray (N7), med. fine grained, vert. fracture from 25.8-26.1, visible angular coarse grains		
				SANDSTONE: Light gray (N7), fine grained, horiz. fracture @ 26.15		
30	ECE #151			SANDSTONE: Light gray (N7), med. fine grained, >1/4" milky white qtz pbls		Few horizontal and angular fractures
				SANDSTONE: Light gray (N7), fine grained, horiz. fracture @ 26.8, angular fractures w/ pitting & coal @ 26.95, 27.2		
				INTERBEDDED SANDSTONE: Yellowish brown (10YR 6/2), fine grained, many <1mm coal seams, angular. fracture/ pitting @ 27.2, 28, 28.3, 28.8, sub horiz. fracture pitted w/ coal @ 30.05, stylolite @ 29.95		
				SANDSTONE: Light gray (N7), med. fine grained, stylolites		
				SANDSTONE: Yellowish brown (10YR 6/2), fine grained		
35	ECE #080			SANDSTONE: Light gray (N7), fine grained		Horizontal or bedding fractures
				SANDSTONE: Med. brown (5YR 4/4), fine grained		
				SANDSTONE: Light gray (N7), fine grained		
				SANDSTONE: Light gray (N7), fine grained, horiz. fractures w/ coal @ 31.65, 32, 32.75, 33, 33.9, 34.85, 35.2, 35.5, 35.7, angular fractures pitted w/ coal @ 37.8, 38.55, 39.2		
		103.25%	43.7%			Water table Lower visibility
						Few horizontal fractures



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BORING NO: 6

Sheet 2 of 12

PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670100

DATE: 8/30/04

LOCATION: West of the lake

SURFACE ELEV.: 1898.48

LOG ID: BH6

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/9/04

DRILL CONTRACTOR: ECE

DRILLER: JCB, SJL, ACG

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25"

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1865.32

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
40	ECE #080	61.25%	35.9%	INTERBEDDED SANDSTONE: Yellowish brown (10YR 6/2), fine grained, horiz. fractures w/ coal & pitting @ 39.7, 40, 40.55, 42.6, many <1mm coal seams, angular fracture w/ slickenlines @ 42.45		Horizontal fractures
						Horizontal fractures with coal layers, conglomerate sandstone
45	ECE #080	54%	34.2%	SANDSTONE: Light gray (N6), fine grained, horiz. fracture w/ coal @ 43, angular fracture w/ coal @ 43.5, vert. fracture entire length		Horizontal fractures, heavy bacteria in water and on the wall
				SANDSTONE: Light gray (N6), med. fine grained, sub horiz. fracture w/ mica & <25% coal @ 43.9		Horizontal fractures, heavy bacteria in water and on the wall
				SANDSTONE: Light gray (N6), fine grained, angular fracture w/ coal & mud @ 44.4, vert. fracture from 43.9-44.2		Horizontal fractures, heavy bacteria in water and on the wall
				SANDSTONE: Light gray (N6.5), fine grained, horiz. fracture w/ coal @ 45, vert. fracture trace from 45-45.6, zone of large >1/4" milky white qtz pbis between 45.7-45.75		Horizontal and angular fractures
50	ECE #042	54%	34.2%	FRACTURED SANDSTONE: Light gray (N6.5), fine grained, sub horiz. fracture w/ mica & <25% coal @ 45.9, stylolites @ 46.1, 48.25, 48.37, vert. fracture trace from 46.65-47, vert. fracture from 47-47.5, sub horiz. fracture @ 47.85, angular fracture w/ minor coal @ 48.1, 48.7, clean angular fracture @ 48.9, sub horiz. fracture w/ coal @ 49.15		Horizontal and angular fractures
				SANDSTONE: Light gray (N7), med. fine grained, sub horiz. fracture w/ minor coal @ 49.3		49'-50' Few horizontal fractures with coal or shale
				SANDSTONE: Light gray (N6.5), fine grained, sub horiz. fractures w/ minor coal @ 50.4, 50.8		Few thin horizontal fractures
				SANDSTONE: Light gray (N6), fine grained, horiz. fracture @ 50.95		Few thin horizontal fractures
				SANDSTONE: Light gray (N6), med. fine grained		Horizontal fractures
				SANDSTONE: Light gray (N6), fine grained, pitted sub horiz. fracture-minor coal @ 51.2, 51.55, 51.8, clean horiz. fracture @ 51.3, angular fracture w/ coal @ 51.4, fracture trace no separation @ 51.7, large milky white qtz pbis from 51.65-51.7		
				SANDSTONE: Light gray (N6.5), fine grained, angular fracture w/ coal & sand		



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BORING NO: 6

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PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670100

DATE: 8/30/04

LOCATION: West of the lake

SURFACE ELEV.: 1898.48

LOG ID: BH6

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/9/04

DRILL CONTRACTOR: ECE

DRILLER: JCB, SJL, ACG

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25"

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1865.32

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
55	ECE #042	96%	40.7%	<p>@ 52.1, large inclusion of 10YR 4/2 from 52.15-52.2, horiz. fracture w/ coal & sand @ 52.35, sub. horiz. fracture w/ coal (faint slickenlines) @ 52.0</p> <p>SANDSTONE: Very light gray (N8), med. fine grained</p> <p>SANDSTONE: Light gray (N7), fine grained, sub. horiz. fracture w/ coal @ 52.7, vert. fracture trace from 53.1-53.3, horiz. fracture w/ coal @ 53.1, 53.5, stylolites @ 52.84, 52.9, 53.05</p> <p>SANDSTONE: Light gray (N6.5), fine grained, horiz. fracture w/ mica @ 53.7, fracture w/ minor pitting @ 54</p> <p>SANDSTONE: Pale brown (5YR 5/2), fine grained</p> <p>SANDSTONE: Light gray (N6.5), fine grained, stylolite @ 54.83</p> <p>SANDSTONE: Pale brown (5YR 5/2), fine grained</p> <p>SANDSTONE: Very light gray (N8), med. fine grained, horiz. fracture w/ coal @ 54.9</p> <p>FRACTURED SANDSTONE: Light gray (N6.5), fine grained, horiz. fracture w/ coal @ 55.32, 55.45, 55.5, 55.6, 55.7</p> <p>Missing</p> <p>SANDSTONE: Light gray (N6.5), fine grained, vert. fracture trace from 55.9-59.1, stylolite @ 58.15, angular fracture w/ slickenlines @ 57.15, sub horiz. fracture @ 57.8, 57.85</p> <p>SANDSTONE: Med. gray (N4), fine grained, horiz. fracture w/ coal @ 58.42</p> <p>SANDSTONE: Light gray (N6.5), fine grained, horiz. fractures w/ coal @ 58.6, 58.85</p> <p>SANDSTONE: Pale brown (5YR 5/2), fine grained, stylolites @ 59.42, 59.65, sub horiz. fracture w/ coal @ 59.45, vert. fracture trace offset by stylolite @ 59.65 from 59.58-59.7</p> <p>SANDSTONE: Brownish gray (5YR 4/1), fine grained, stylolite @ 59.7, sub horiz. fracture w/ coal @ 59.75</p> <p>SANDSTONE: Pale brown (5YR 5/2), fine grained, fractures w/ coal @ 59.92, 60.15</p> <p>FRACTURED SANDSTONE: Light gray (N6.5), fine grained, vert. fracture from 60.15-60.4, horiz. fractures w/ coal @ 60.4, 61.81, 61.15, 61.4, 61.8, stylolites @ 60.45, 60.95</p> <p>Missing</p> <p>SANDSTONE: Light gray (N6.5), fine grained, vert. fracture from 62-62.2</p> <p>SANDSTONE: Light gray (N7), med. fine grained, sub horiz. fracture w/ minor coal @ 63.1</p> <p>SANDSTONE: Light gray (N6.5), fine grained</p> <p>SANDSTONE: Light gray (N6.5), med. fine grained, sub horiz. fracture @ 63.65, small minor pitting</p> <p>SANDSTONE: Light gray (N6.5), fine grained, stylolite @ 64.05, vert. fracture trace from 63.7-63.9</p> <p>SANDSTONE: Pale brown (5YR 4/1), fine grained, stylolite @ 64.65</p> <p>SANDSTONE: Light gray (N6.5), fine grained, stylolites @ 64.85, 65.48, 65.52, 65.6</p> <p>SANDSTONE: Pale brownish gray (5YR 5/1), fine grained, horiz. fracture w/ coal</p> <p>SANDSTONE: Light gray (N6), fine grained, vert. fracture trace from 66.37-66.65</p> <p>SANDSTONE: Light gray (N6.5), fine grained, horiz. fracture @ 67.45, slightly pitted w/ coal</p> <p>SANDSTONE: Light gray (N6.5), fine grained, horiz. fracture @ 67.7 w/ coal, stylolites @ 67.75, 67.85, 67.9</p> <p>No Sample</p> <p>SANDSTONE: Light gray (N8), fine grained, horiz. fracture @ 70.3, pitted w/ coal, stylolites @ 70.35, 70.88, 70.9, fracture @ 71, minor pitting, horiz.</p>		<p>Horizontal fractures, heavy bacteria on SE wall</p> <p>A vertical fracture oriented W</p> <p>Few horizontal fractures</p> <p>66'-67' Few horizontal fractures</p> <p>Few horizontal fractures</p> <p>70'-71' Few horizontal fractures</p>
60	ECE #029					
65		107.25%	50%			
70	ECE #029					



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BORING NO: 6

Sheet 4 of 12

Hydrogeologists, Geologists,
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PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670100

DATE: 8/30/04

LOCATION: West of the lake

SURFACE ELEV.: 1898.48

LOG ID: BH6

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/9/04

DRILL CONTRACTOR: ECE

DRILLER: JCB, SJL, ACG

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25"

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1865.32

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
75	ECE #029	83.75%	45.3%	w/coal, stylolites @ 70.35, 70.86, 70.9, fracture @ 71, minor pitting, horiz. fracture @ 71.35		
				SANDSTONE: Light brown reddish gray (5YR 6/1), fine grained, vert. fracture trace @ 71.35-71.55, clean horiz. fracture @ 71.55 (false?), fracture @ 72 w/coal		
				No Sample		
80	ECE #040	33.3%	30.2%	FRACTURED SANDSTONE: Light gray (N6.5), fine grained, angular fracture w/ coal @ 72.8, 76.15, vert. fracture @ 72.8-72.9, vert. fracture from 73.55-74.1, and 74.3-75.05, heavily pitted horiz. fracture @ 74.1, large inclusion (5YR 4/4) from 74.15-74.2, horiz. fracture @ 74.3, stylolites @ 75.18, 75.7, 75.8, 75.85, fracture @ 76 w/light pitting		Horizontal fracture with dark layer, lower visibility
				Missing		Horizontal fractures, a vertical fracture oriented S
				SANDSTONE: Light gray (N6.5), fine grained, many stylolites throughout section, sub horiz. fracture w/coal @ 77, stylolites @ 77.6, 77.78, 77.9, 77.94, 77.97, 77.99, 78.0, 78.93, horiz. fracture w/coal @ 78.1, clay inclusions @ 78.15-78.20, vert. fracture from 78.52-79		78'-79' Few thin horizontal fractures
85	ECE #040	36.4%	31.2%	Missing		82'-83' Few horizontal fractures
				SANDSTONE: Light gray (N6.5), fine grained, coal fracture @ 79.23, beginning of vert. fracture from 79.5-80		
				SANDSTONE: Light gray (N7), med. fine grained, coarser zone, continuation of vert. fracture from 79.5-80		
85	ECE #040	36.4%	31.2%	SANDSTONE: Light gray (N6.5), fine grained, end of vert. fracture from 79.5-80, minor coal		84'-85' Horizontal or bedding fractures
				SANDSTONE: Light gray (N6), fine grained, vert. fracture from 80-80.35, very "dirty" discontinuous coal seams 80.35-82.75, horiz. fractures @ 82.75, 82.83, 82.87, 82.95, angular fracture @ 83, horiz. fractures @ 83.15, 83.55, 84.2, 84.55, 84.75, angular fracture w/coal @ 85		
				SANDSTONE: Pale brown (5YR 5/2), fine grained, facies change		
85	ECE #040	36.4%	31.2%	SANDSTONE: Light gray (N6), fine grained, fracture @ 85.75, small pitting, fracture @ 85.9 w/clay		Few horizontal fractures with coal
				FRACTURED SANDSTONE: Light gray (N6.5), fine grained, horiz. fracture w/coal @ 86.1, 86.4, 87.1, vug @ 87.26-87.29, horiz. fracture @ 87.35, 87.9, 89, sub horiz. fracture w/coal @ 88.8, 89.5, 90, stylolite @ 89.43, 89.8		



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BORING NO: 6

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PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670100

DATE: 8/30/04

LOCATION: West of the lake

SURFACE ELEV.: 1898.48

LOG ID: BH6

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/9/04

DRILL CONTRACTOR: ECE

DRILLER: JCB, SJL, ACG

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25"

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1865.32

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
90	ECE #041			SANDSTONE: Light brown reddish gray (5YR 6/1), fine grained,		Few horizontal fractures
						Few horizontal fractures
95		64.9%	51.59%	FRACTURED SANDSTONE: Light brown reddish gray (5YR 6/1), fine grained, fracture w/minor pitting @ 91.2, angular fracture w/minor pitting @ 92.5, fracture w/minor pitting w/ 20% coal @ 92.7, horiz. fracture @ 92.95, 93.15, 93.9, 94.55 - all have minor traces of coal and no pitting, horiz. fracture @ 94.8 has 50% coal, 95.1 has 50% coal on horiz. fracture, horiz. fracture @ 95.65, sub horiz. fracture w/coal @ 95.8, angular fracture w/coal @ 96.4, vert. fracture 96.6-96.8		Few horizontal fractures with coal 95'-96' Horizontal fractures with coal or shale layers
	ECE #041			SANDSTONE: Light brown reddish gray (5YR 6/1), fine grained, stylolite @ 96.97, horiz fracture w/coal and a light gray mud @ 97.0, stylolite @ 97.38, sub horiz. fracture w/coal and mud @ 97.65, sub horiz fracture w/coal @ 97.9		97'-98' Vertical fractures oriented N and SW
				SANDSTONE: Dark gray (N3), fine grained, mottled, significantly darker horizon, significantly more coal present, fracture w/coal @ 98.3, fracture w/coal @ 98.9		
100	ECE #031			SANDSTONE: Light gray (N6.5), fine grained, vert. fracture from 98.9-99.1, light FeO2 staining throughout section		Few angular fractures oriented N to S
				SANDSTONE: Light gray (N6), fine grained		
				SANDSTONE: Brownish gray (5YR 4/1), fine grained, mottled angular fracture zone from 101-101.25, sub horiz. fracture @ 102.25, vert. fracture from 102.25-102.7 w/bifurcating horiz. fractures @ 102.38 and 102.53, angular fracture w/coal @ 102.7 (probably a seam)		Coal seam or layers
				SANDSTONE: Light gray (N6), fine grained, angular fracture w/coal @ 103, fractures @ 103.3, 103.6, 104, fracture @ 104 w/ coal		Coal seam
105		74.7%	55.3%	SANDSTONE: Medium gray (N5), fine grained, coal seams becoming more pervasive, stylolites @ 104.5, 104.8, sub horiz. fracture w/coal @ 105.05		An angular fracture oriented NW Few angular fractures and coal or shale layer
	ECE #031			SANDSTONE: Brownish gray (5YR 4/1), fine grained		
				SANDSTONE: Medium gray (N5), fine grained, stylolite @ 105.45		
				SANDSTONE: Dark gray (N3), fine grained, fracture w/coal @ 105.55, area of		



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BORING NO: 6
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PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670100

DATE: 8/30/04

LOCATION: West of the lake

SURFACE ELEV.: 1898.48

LOG ID: BH6

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/9/04

DRILL CONTRACTOR: ECE

DRILLER: JCB, SJL, ACG

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25"

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1865.32

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG		
110	ECE #028			concentrated coal seams		106'-109' Thin fracture zone with coal or shale		
				SANDSTONE: Medium gray (N5), fine grained				
				SANDSTONE: Med. dark gray (N4), fine grained, thinly laminated coal seams, fracture w/coal @ 107.8				
				SANDSTONE: Dark yellowish brown (10YR 4/2), fine grained, fractures @ 106.15, 106.2				
115	ECE #028	102%	89%	SANDSTONE: Brownish gray (5YR 4/1), fine grained, vert. fracture from 107.55-108, sub horiz. fracture w/coal @ 108, mottled brown gray, angular fracture @ 108.2, 108.35		111'-113' Angular and horizontal fractures with coal layers		
				SANDSTONE: Medium gray (N5), fine grained, numerous small coal seams, sub horiz. fracture w/coal and one sm <1cm area of pyrite fracture @ 109.1, fracture w/coal w/minor trace of pyrite @ 110, sub horiz. fracture w/bituminous coal @ 110.5				
				SANDSTONE: Light gray (N6.5), med. fine grained, concentrated area of buffers w/coal seam stylolites, angular fracture w/highly bituminous coal @ 111.5				
				SANDSTONE: Moderate brown (5YR 3.5/4), fine grained, sharp facies change below an area of concentrated stylolites				
				SANDSTONE: Pale brownish gray (5YR 5/1), fine grained, concentrated area of stylolites, gradational color change, horiz. fractures @ 113.28, 113.4, 113.7 all w/coal				
				SANDSTONE: Light gray (N6), fine grained, sub horiz. fracture w/minor coal @ 114, many small coal stylolites, angular fracture w/lots of bituminous coal @ 114.45-114.7				
				COAL: Coal (N1), coal seam per ECE				Angular and horizontal fractures, vertical fractures oriented S
				SANDSTONE: Light gray (N6), very fractured w/numerous small coal stylolites concentrated between 118-119.4, horiz. fracture w/heavily bituminous coal @ 119.4				
120	ECE #028	64.5%	48.7%	SANDSTONE: Light brown reddish gray (5YR 6/1), fine grained, more compact than above, minor coal stylolites, definite change, angular fracture w/minor coal @ 120		Bedding or horizontal fractures		
				FRACTURED SANDSTONE: Pale grayish brown (5YR 4/2), fine grained, numerous healed fractures w/quartz replacement, clay included				
				SANDSTONE: Light gray (N6), fine grained, gradational transition from above, almost no clay inclusions or fractures, very competent				
				SANDSTONE: Light gray (N6.5), fine grained, many pieces missing, appears to be fracture zone				
				Core barrel jammed, no recovery		Horizontal fractures with coal layer, vertical fracture oriented E		



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BORING NO: 6

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PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670100

DATE: 8/30/04

LOCATION: West of the lake

SURFACE ELEV.: 1898.48

LOG ID: BH6

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/9/04

DRILL CONTRACTOR: ECE

DRILLER: JCB, SJL, ACG

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25"

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1865.32

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
125	ECE #028	55.4%	43.1%	SANDSTONE: Light gray (N7), fine grained, angular fracture w/small crystal pyrite @ 125, 125.44, 126.91, stylolite @ 126.25, angular fracture @ 126.4, horiz fracture @ 126.55, vert. fracture trace from 126.55-126.75		Few horizontal fractures, a lot of bacteria in water
				FRACTURED SANDSTONE: Light gray (N7), fine grained, fracture zone, angular fracture w/minor coal @ 127, 127.3		Few horizontal fractures, a lot of bacteria in water
130	ECE #028	55.4%	43.1%	SANDSTONE: Light gray (N7), fine grained, angular fracture w/coal @ 127.5, very angular fracture @ 127.7-128, horiz. fracture @ 128.3, solid w/no stylolites (clean/competent) from 127.5-131, horiz. fractures @ 130.2, 130.5, 130.85, 131, 132.6, fracture @ 130.2 has some pitting as does 130.85 and 131, horiz. fracture w/coal @ 131.45 and 131.53, 132.34, angular fracture @ 131.9, stylolites @ 132.4, 132.43,		129'-130' Few horizontal fractures with coal or shale, and angular fractures
				SANDSTONE: Light gray (N6), fine grained, horiz. fracture w/some mud present @ 132.7, horiz. fracture (man-made?) @ 132.9		Horizontal and angular fractures, dark stain on North
				SANDSTONE: Light gray (N7), fine grained, fracture @ 133.73, grad. color change from above		134'-135' Horizontal fractures, lot of bacteria in water
135	ECE #028	55.4%	43.1%	SANDSTONE: Light gray (N7), fine grained, horiz. fractures @ 135.25, 136.1, 136.5, 140.25, 141.7 w/mod. pitting, 135.7 w/heavy pitting, 137.2 w/minor pitting, smooth horiz. fracture @ 142		Vertical fractures, E - W orientation; and horizontal fractures
						138'-139' Few horizontal fractures, lot of bacteria in water
140	ECE #044					



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PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670100

DATE: 8/30/04

LOCATION: West of the lake

SURFACE ELEV.: 1898.48

LOG ID: BH6

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/9/04

DRILL CONTRACTOR: ECE

DRILLER: JCB, SJL, ACG

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25"

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1865.32

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG	
145	ECE #155	102%	82%	SANDSTONE: Light brown reddish gray (5YR 6/1), fine grained, angular fracture w/coal @ 143 occurring in the middle of stylolite area, stylolites @ 142.94, 143.05, 143.13, horiz. fracture w/coal @ 144.35		142'-143' Horizontal fractures with coal	
				SANDSTONE: Grayish brown (5YR 3/2), fine grained, browner area w/thinly laminated coal seams between 144.65-144.7, horiz. fracture @ w/minor coal @ 144.7		144'-145' Horizontal fractures with coal	
150	ECE #155	79%	77%	SANDSTONE: Light gray (N6.5), fine grained, sub horiz. fractures w/mod. pitting @ 146.25 and 146.43		Horizontal fractures with shale and coal layer	
				SANDSTONE: Medium gray (N5.5), fine grained, sub horiz. fractures w/fine pitting and some residual clay @ 147.75, 148.55, 148.67, 150.4, sub horiz. fractures @ 151, 151.3, 151.9, all smooth		Vertical fractures oriented NE and SW	
				INTERBEDDED SANDSTONE: Medium gray (N5), fine grained, with a much higher component of thinly bedded coal seams, has tints of 5YR 4/1, sharp and smooth horiz. fractures @ 152.3, 152.4, 152.7, 153.16		Thin vertical fractures oriented E and S, some angular fractures	
155	ECE #155	87.7%	73.5%	SANDSTONE: Medium gray (N5.5), fine grained, sub horiz. fractures w/coal and minor pitting @ 153.45, sub horiz. fracture @ 154, 50% coal thin layer, minor pitting		Few angular fractures oriented N and S, some horizontal fractures	
				SANDSTONE: Light gray (N6.5), fine grained, sub horiz. fractures w/coal @ 154.5, 154.8, 155.1, coal is 50% not well developed		156'-157' Horizontal fractures	
				SANDSTONE: Brownish gray (5YR 4/1), fine grained, mottled brown gray w/ some cross grain of quartz visible, vert. fracture trace the whole length			Horizontal fractures, vertical one oriented E
				SANDSTONE: Yellowish brown (10YR 6/2), med. fine grained, larger grain, mottled brownish gray w/large <1/4" subrounded pieces of milky white quartz, similar in size to small pebbles >25% from 155.93-156.7 not as concentrated as above but 7-10% milky white quartz pebbles			
				COAL: Coal (N1), dull, soft, not bituminous			
SANDSTONE: Yellowish brown (10YR 6/2), med. fine grained, mottled brownish gray							
				SANDSTONE: Light gray (N6), fine grained, vert. fracture from 158.37-158.83, vert. fracture from 159.84-160, sub horiz. fracture @ 159.55			



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PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670100

DATE: 8/30/04

LOCATION: West of the lake

SURFACE ELEV.: 1898.48

LOG ID: BH6

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/9/04

DRILL CONTRACTOR: ECE

DRILLER: JCB, SJL, ACG

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25"

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1865.32

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
160	ECE #071	101.6%	87.6%	Missing		
				SANDSTONE: Light gray (N6.5), fine grained, sub horiz. fracture w/mod. pitting @ 161.31, sub horiz. fracture w/minor pitting @ 162.88, vert. fracture from 163.1-163.35, clear horiz. fracture @ 163.35		Few horizontal fractures Horizontal fractures with coal or shale layers
				SANDSTONE: Light gray (N6), fine grained, vert. fracture from 163.35-163.73, clean horiz. fracture @ 163.55 and 164.1		163'-164' Few angular fractures and horizontal ones
165	ECE #071			SANDSTONE: Light gray (N6.5), fine grained, angular fracture w/ minor pitting @ 165		
				FRACTURED SANDSTONE: Light gray (N6), fine grained, thin beds of brown 5YR 4/1, more stylolites, angular fractures @ 165.34, 166.85, 166.35, 166.65, 166.8, 167.3, 167.4, all except 166.35 have moderately fine pitting		Vertical fractures, W and SE orientation
				FRACTURED SANDSTONE: Light gray (N6.5), med. fine grained, angular fractures with moderately fine pitting @ 168.4, 169.85, 169.6, 170, 170-170.15 large milky quartz crystals		Angular fractures, coal or shale layer Vertical fracture oriented N
170	ECE #071			FRACTURED SANDSTONE: Light gray (N6), fine grained, horiz. fractures @ 170.6, 170.9, 171.3, 171.4, 171.8, the fractures @ 171.4 and 171.8 have moderately fine pitting		Fracture area with coal and shale layer Horizontal fracture with coal or shale
				SANDSTONE: Light gray (N6), fine grained, sub horiz. fracture w/heavy pitting and coal @ 172.45, horiz. fracture w/moderately fine pitting @ 172.63, angular fracture w/fine pitting @ 180.05, angular fracture w/coarse pitting @ 180.4 and 181.2, sub horiz. fracture (man made?) @ 181.9		Angular and horizontal fractures 174'-175' Few angular fractures
175	ECE #071					Bottom sediment



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PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670100

DATE: 8/30/04

LOCATION: West of the lake

SURFACE ELEV.: 1898.48

LOG ID: BH6

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/9/04

DRILL CONTRACTOR: ECE

DRILLER: JCB, SJL, ACG

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25"

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1865.32

DEPTH (FT.)	SAMPLE #	REC (%)	RAD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
180	ECE #099					
				SANDSTONE: Light gray (N6), fine grained, angular fractures @ 183.15 and 183.34, both have heavy coarse pitting w/a man-made vert. fracture between them		
				FRACTURED SANDSTONE: Brownish gray (5YR 4/1), fine grained, vert. fracture from 183.34-184.1, more coarse grained white quartz possibly crossbedded, fractures @ 183.9, 184.25, 184.45, 184.5, 184.6		
185	ECE #099			SANDSTONE: Light gray (N6), fine grained, bituminous coal on jagged fracture @ 185.7, angular fracture w/ minor fine pitting @ 186.17		
				Missing		
190	ECE #099			SANDSTONE: Light gray (N6), fine grained, vert. fracture from 190-190.55, angular fracture w/ minor fine pitting @ 190.95, angular fracture w/ deep heavy pitting and coal @ 191.35, angular fracture w/ deep heavy pitting @ 192, sub horiz. fracture w/ minor med. pitting, angular fractures w/ moderately fine pitting @ 194.7 and 194.8, 195.15, 196, 196.9 and 197.55, sub horiz. fracture @ 198.4		
195						



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Hydrogeologists, Geologists:
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PROJECT NAME: Meadow Park Lake Dam

PROJECT NO.: 670100

DATE: 8/30/04

LOCATION: West of the lake

SURFACE ELEV.: 1898.48

LOG ID: BH6

MUNICIPALITY: Crossville, TN

DATE STARTED/COMPLETED: 8/9/04

DRILL CONTRACTOR: ECE

DRILLER: JCB, SJL, ACG

DRILL RIG TYPE: Mobile B-80

LOGGED BY: Angela Adams

CASING DIAMETER [OD/ID]: 3.25"

DRILLING METHOD: Mud Rotary

SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL ELEVATION: 1865.32

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
	ECE #099					
200	ECE #099			SANDSTONE: Light gray (N6.5), fine grained, sub horiz. fracture @ 199.35 w/a minor piece of coal; sharp contact w/ below		
				SANDSTONE: Light gray (N7), coarse grained, vert. fracture runs from 199.35-199.8, visible quartz crystals		



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BORING NO: 6

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PROJECT NAME: Meadow Park Lake Dam
 LOCATION: Adjacent to Water Treatment Plant
 LOG ID: BH-12

PROJECT NO.: 670101
 SURFACE ELEV.: 1863.52
 MUNICIPALITY: Crossville, TN

DATE: 9/29/04

DATE STARTED/COMPLETED: 9/09/04
 DRILLER: JEB, MWR, DMR
 LOGGED BY: Angela Adams

DRILL CONTRACTOR: ECE
 DRILL RIG TYPE: Mobile B-80

DRILLING METHOD: Mud Rotary
 SAMPLER DIAM: 2 in

CASING DIAMETER [OD/ID]: 3.25 IN
 WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL DEPTH: 1837.03

DEPTH (FT.)	SAMPLE #	REC (%)	RAD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
0				FILL: Limestone fill (ECE notes)		Could not video log borehole due to instability requiring installation of casing.
				WEATHERED SANDSTONE: Weathered red/tan sandstone, auger refusal @10 feet (ECE notes)		
5						
10	ECE 048	12.5%	0%	FRACTURED SANDSTONE: Light brown reddish gray (5R 6/2), fine grained, fractured and weathered extensively		
15						
	ECE 048	22.5%	3.5%	FRACTURED SANDSTONE: Light gray (N7), fine grained		
20						
	ECE 048			INTERBEDDED SANDSTONE: Med. dark gray (N4.5), fine grained, interbedded shale and sandstone, angular and vert. fractures w/ micaceous shale		
				SANDSTONE: Gray (N6), fine grained, sub horiz. fractures w/gray mud @ 21.75, 22		
25						
		29%	4.5%	SANDSTONE: Light gray (N7), fine grained, sub horiz. fractures w/FeO2 staining @ 22, angular fractures w/FeO2 staining @ 22.8, 23.2, 30.4, 30.5,		



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BORING NO: 12
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PROJECT NAME: Meadow Park Lake Dam
 LOCATION: Adjacent to Water Treatment Plant
 LOG ID: BH-12

PROJECT NO.: 670101
 SURFACE ELEV.: 1863.52
 MUNICIPALITY: Crossville, TN

DATE: 9/29/04


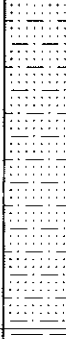

DATE STARTED/COMPLETED: 9/09/04
 DRILLER: JEB, MWR, DMR
 LOGGED BY: Angela Adams

DRILL CONTRACTOR: ECE
 DRILL RIG TYPE: Mobile B-80

DRILLING METHOD: Mud Rotary
 SAMPLER DIAM: 2 in

CASING DIAMETER [OD/ID]: 3.25 IN
 WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL DEPTH: 1837.03

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
30	ECE 048	26%	0%	SHALE: Med. dark gray (N4), fine grained, extensively fractured shale micaceous		
				SANDSTONE: Gray (N6), fine grained, sub horiz. fractures w/gray mud @ 31.55, 31.65, 31.8, 32		
35				INTERBEDDED SANDSTONE: Gray (N6), fine grained, horizontal wavy subparallel shale laminations, fractured into ~1inch pieces		
40	ECE 048			SHALE: Dark gray (N3), fine grained, micaceous, extensively fractured chips < 1 inch		
45	ECE 048	16%	4%	INTERBEDDED SHALE: Dark gray (N3), micaceous, near vertically bedded (+/- 70%), parallel lenticular interbeds of fine grained gray (N6) sandstone, fractured into ~1inch pieces SHALE: Dark gray (N3), fine grained, micaceous, extensively fractured chips < 1 inch		
50				INTERBEDDED SHALE: Dark gray (N3), near vertically bedded (+/- 70%), 40% parallel lenticular interbeds of gray N6 sandstone, fractured near vertical along shale beds		
55	ECE 048	38.5%	13.5%	SHALE: Dark gray (N3), fine grained, micaceous, extensively fractured shards-1 inch		



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BORING NO: 12
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Hydrogeologists, Geologists:
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PROJECT NAME: Meadow Park Lake Dam
 LOCATION: Adjacent to Water Treatment Plant
 LOG ID: BH-12

PROJECT NO.: 670101
 SURFACE ELEV.: 1863.52
 MUNICIPALITY: Crossville, TN

DATE: 9/29/04

DATE STARTED/COMPLETED: 9/09/04
 DRILLER: JEB, MWR, DMR
 LOGGED BY: Angela Adams

DRILL CONTRACTOR: ECE
 DRILL RIG TYPE: Mobile B-80

DRILLING METHOD: Mud Rotary
 SAMPLER DIAM: 2 in

CASING DIAMETER [OD/ID]: 3.25 IN
 WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL DEPTH: 1837.03

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
60	ECE 045	26%	19%	INTERBEDDED SHALE: Dark gray (N3), near vertically bedded (+/- 70%), 20% parallel interbeds of gray N6 sandstone, fractured near vertical along shale beds some fracture planes exhibit slickenlines		
65				INTERBEDDED SANDSTONE: Gray (N6), fine grained, horizontal wavy subparallel shale laminations, fractured into ~1 inch pieces		
65				INTERBEDDED SHALE: Dark gray (N3), near vertically bedded (+/- 70%), 20% parallel interbeds of gray N6 sandstone, fractured near vertical along shale beds some fracture planes exhibit slickenlines		
70	ECE 045	21.25%	0%	SHALE: Dark gray (N3), appears massively bedded and relatively solid		
75	INTERBEDDED SHALE: Dark gray (N3), near vertically bedded (+/- 70%), 20% parallel interbeds of gray N6 sandstone, fractured near vertical along shale beds some fracture planes exhibit slickenlines					
80	ECE 045	60%	0%	INTERBEDDED SANDSTONE: Gray (N6), fine grained, shale laminations, fractured into ~1 inch pieces		
85	ECE 045			SHALE: Dark gray (N3), fine grained silty, micaceous, extensively fractured chips < 1 inch		
	ECE 045	40%	6.4%	INTERBEDDED SANDSTONE: Gray (N6), fine grained, angular fractures w/shale @ 85, 85.2, 85.55 w/ plastic deformation of lenticular shale bedding		
	ECE 045			SANDSTONE: Light gray (N7), fine grained, numerous discontinuous shale laminae, angular fractures along wavy shale laminations @ 86, 86.2, 86.33, 86.5, 86.8, 86.9		
				SHALE: Dark gray (N3), fine grained, micaceous, extensively fractured shards ~1 inch		



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BORING NO: 12
 Sheet 3 of 5

Hydrogeologists, Geologists:
 Karst & Sinkhole Specialists

PROJECT NAME: Meadow Park Lake Dam
 LOCATION: Adjacent to Water Treatment Plant
 LOG ID: BH-12

PROJECT NO.: 670101
 SURFACE ELEV.: 1863.52
 MUNICIPALITY: Crossville, TN

DATE: 9/29/04

DATE STARTED/COMPLETED: 9/09/04
 DRILLER: JEB, MWR, DMR
 LOGGED BY: Angela Adams

DRILL CONTRACTOR: ECE
 DRILL RIG TYPE: Mobile B-80

CASING DIAMETER [OD/ID]: 3.25 IN

DRILLING METHOD: Mud Rotary
 SAMPLER DIAM: 2 in

WEIGHT: 140 lbs DROP: 30 in

WATER LEVEL DEPTH: 1837.03

DEPTH (FT.)	SAMPLE #	REC (%)	RQD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
90	ECE 045	94%	50%	SANDSTONE: Light gray (N7), fine grained, sub horiz. fractures along shale laminations @ 91.6, 91.65, 92		
				SANDSTONE: Light gray (N7), fine grained, numerous discontinuous shale laminae, irregular fractures along lenticular shale laminations @ 92.2, 92.75, 93.9, angular fractures along shale laminations @ 93.8, 94.35, 94.45, 94.5, 94.75, 94.9, clean angular fractures @ 92.55, 92.95, 93.4		
95	ECE 045	76%	45%	SHALE: Dark gray (N3), fine grained silty, micaceous, begins from 94.9-95.1 as an wavy subparallel interbedded shale becoming extensively fractured		
	ECE 045			SANDSTONE: Gray (N6), fine grained, angular fractures w/shale @ 95.9, 96.5, 97		
	ECE 021			SANDSTONE: Light gray (N7), fine grained, numerous near vertical discontinuous non parallel shale laminae, angular fractures along shale laminations @ 97.2, 97.6, 98, 98.3, 98.6, 98.7, clean horiz. fracture @ 98.9		
100	ECE 021			SANDSTONE: Light gray (N7), fine grained, a few discontinuous near vertical shale laminae, clean irregular fracture @ 101.1		
	ECE 021	52.5%	23.5%	FRACTURED SANDSTONE: Light gray (N7), fine grained, some near vertical discontinuous near vertical shale laminae		
	ECE 021			FRACTURED SANDSTONE: Gray (N6), fine grained, intense near vertical fracturing along nearly vertical shale interbeds, some fractures exhibit slickenlines		
	ECE 021			SANDSTONE: Light gray (N7), fine grained, a few discontinuous near vertical shale laminae, clean irregular fracture @ 103.75		
105	ECE 021			FRACTURED SANDSTONE: Gray (N6), fine grained, intense near vertical fracturing along nearly vertical shale interbeds, some fractures exhibit slickenlines		
	ECE 021			SANDSTONE: Light gray (N7), fine grained, a few discontinuous near vertical shale laminae, clean irregular fracture @ 103.75		
	ECE 021			FRACTURED SANDSTONE: Gray (N6), fine grained		
110	ECE 021	40%	13.75%	SANDSTONE: Light gray (N7), fine grained, a few discontinuous near vertical shale laminae, angular fracture w/ shale @ 112.1		
	ECE 021			FRACTURED SANDSTONE: Gray (N6), fine grained, intense near vertical fracturing along nearly vertical shale interbeds, some fractures exhibit slickenlines		
	ECE 021			SANDSTONE: Light gray (N7), fine grained, a few discontinuous near vertical shale laminae, angular fracture w/shale @ 113.3, angular fracture w/slickenlines @ 113.5, irregular fracture w/ shale @ 113.8		
115	ECE 021			FRACTURED SANDSTONE: Gray (N6), fine grained, intense near vertical fracturing along nearly vertical shale interbeds, some fractures exhibit slickenlines		



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BORING NO: 12
 Sheet 4 of 5

PROJECT NAME: Meadow Park Lake Dam
LOCATION: Adjacent to Water Treatment Plant
LOG ID: BH-12

PROJECT NO.: 670101
SURFACE ELEV.: 1863.52
MUNICIPALITY: Crossville, TN

DATE: 9/29/04

DATE STARTED/COMPLETED: 9/09/04
DRILLER: JEB, MWR, DMR
LOGGED BY: Angela Adams




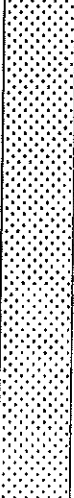
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DRILL RIG TYPE: Mobile B-80

DRILLING METHOD: Mud Rotary
SAMPLER DIAM: 2 in

CASING DIAMETER [OD/ID]: 3.25 IN

WEIGHT: 140 lbs **DROP:** 30 in

WATER LEVEL DEPTH: 1837.03

DEPTH (FT.)	SAMPLE #	REC (%)	ROD (%)	DESCRIPTION (COLOR, TYPE, MOISTURE)	LITHOLOGY	DESCRIPTION OF VIDEO LOG
120	ECE 021			SANDSTONE: Light gray (N7), fine grained, trace angular shale laminae, clean angular fracture @ 120.8		
	ECE 106			SANDSTONE: Light gray (N7), fine grained, clean irregular fracture @ 122.25, clean angular fractures @ 122.45, 123.1 clean horiz. fractures @ 122.65, 122.83		
125		55.4%	40.6%	FRACTURED SANDSTONE: Gray (N6), fine grained, intense near vertical fracturing along nearly vertical shale interbeds, some fractures exhibit slickenlines		
	ECE 106			SANDSTONE: Light gray (N7), fine grained, many near vertical shale laminae, angular fractures w/ shale @ 124.15, 124.7, 124.9, 125.15, 125.4, clean horiz. Fractures @ 125.67, 125.9		
130		40.5%	24.75%			
135		75.7%	74.3%			



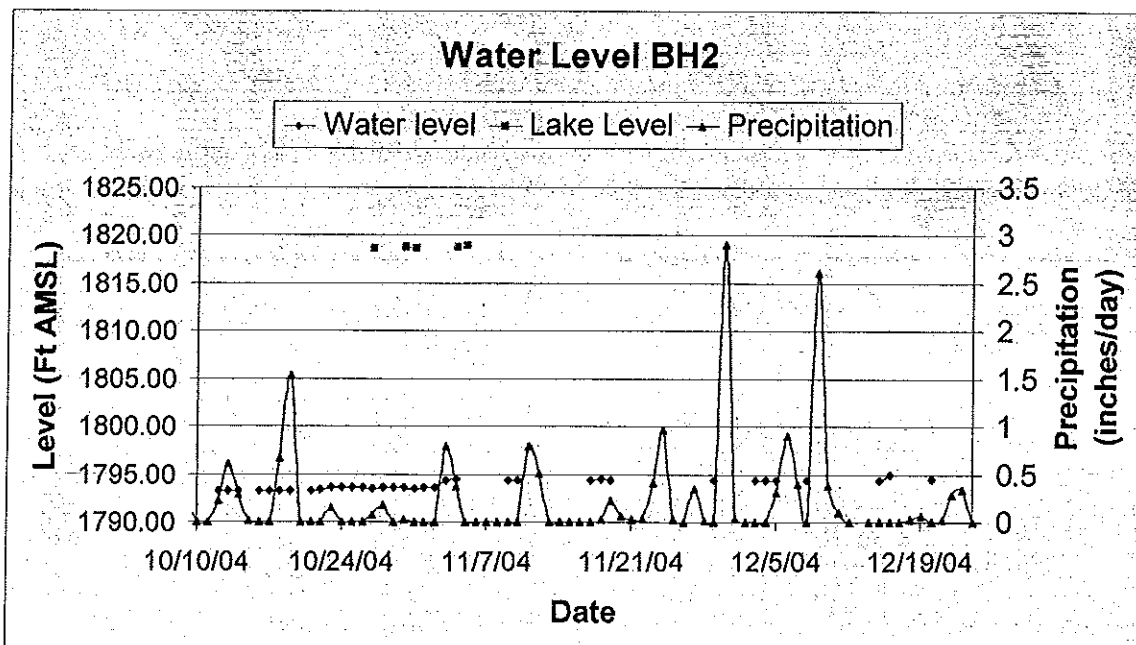
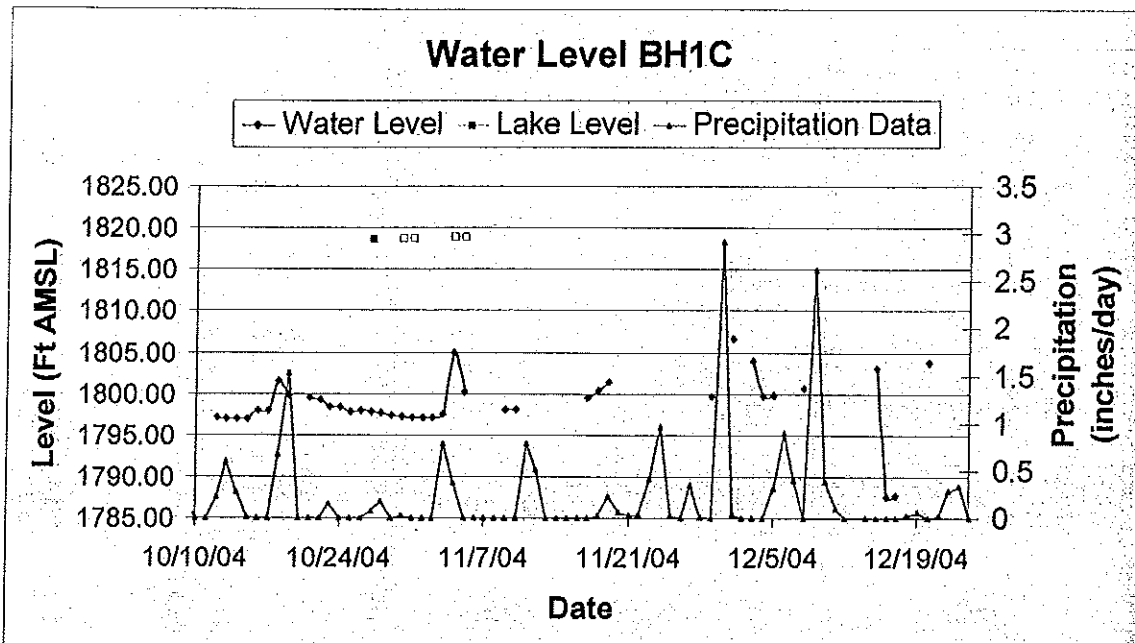
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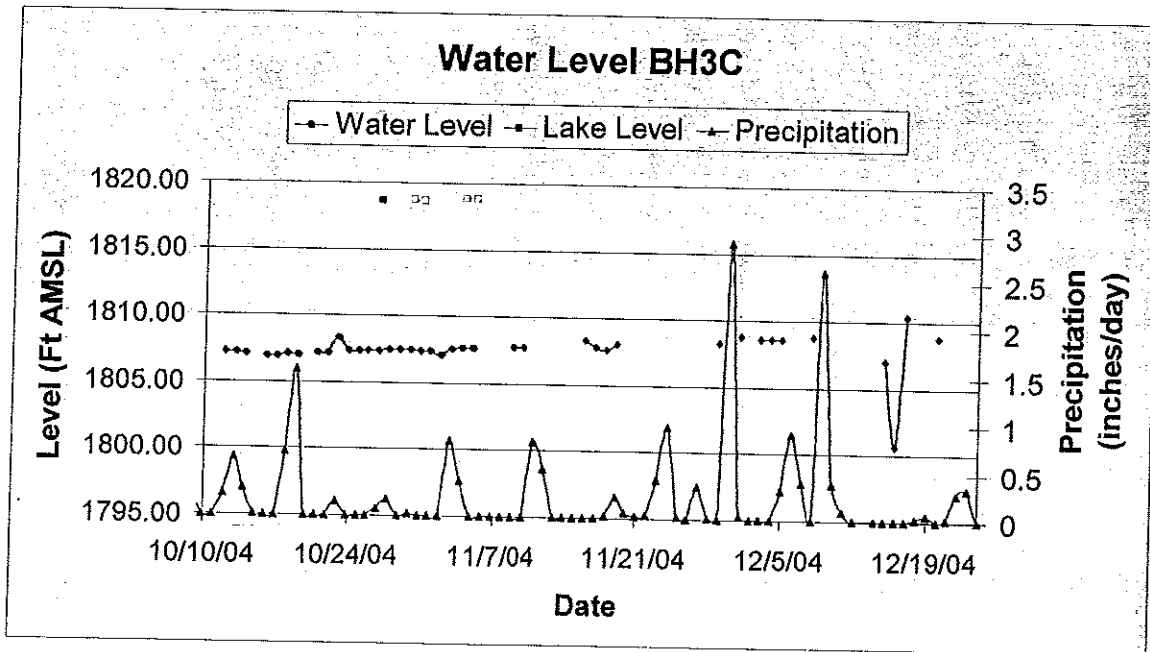
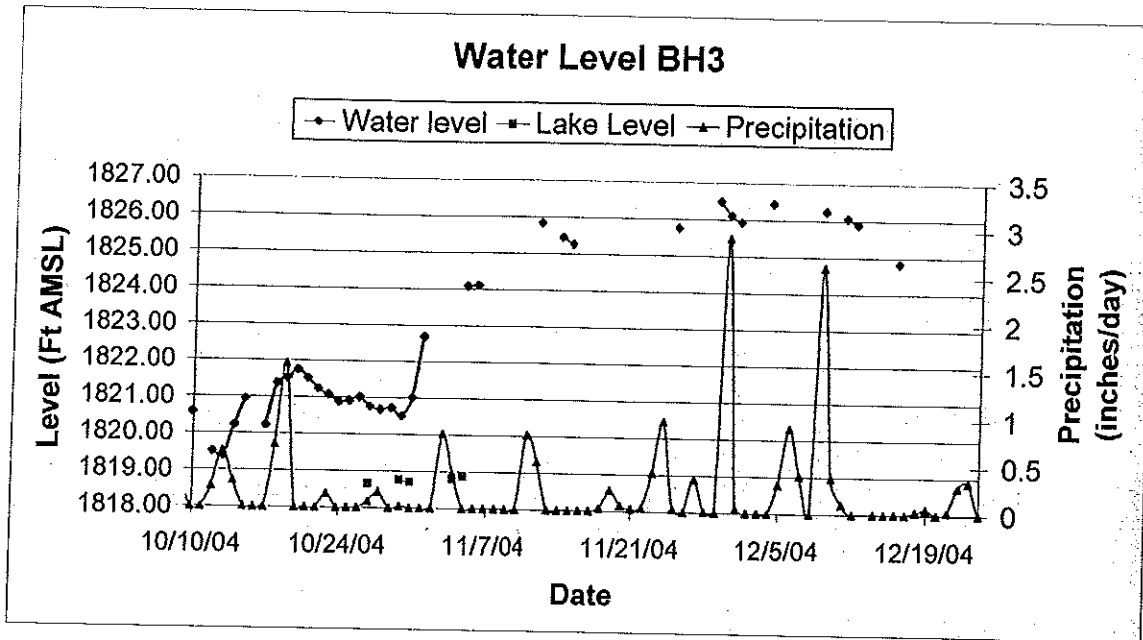
BORING NO: 12
 Sheet 5 of 5

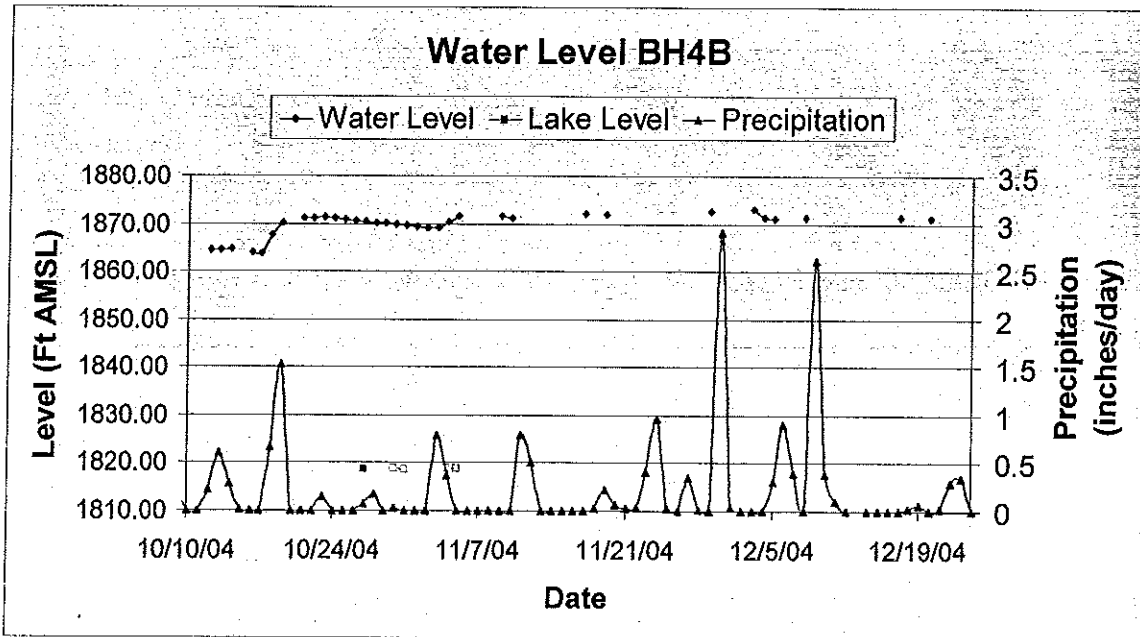
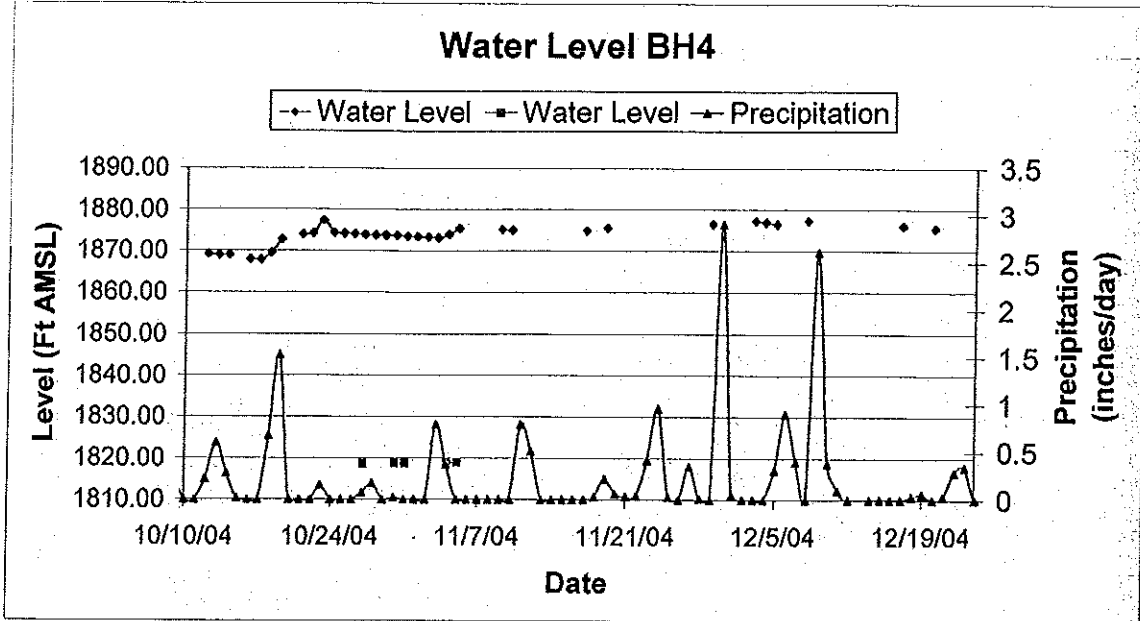
Hydrogeologists, Geologists:
 Karst & Sinkhole Specialists

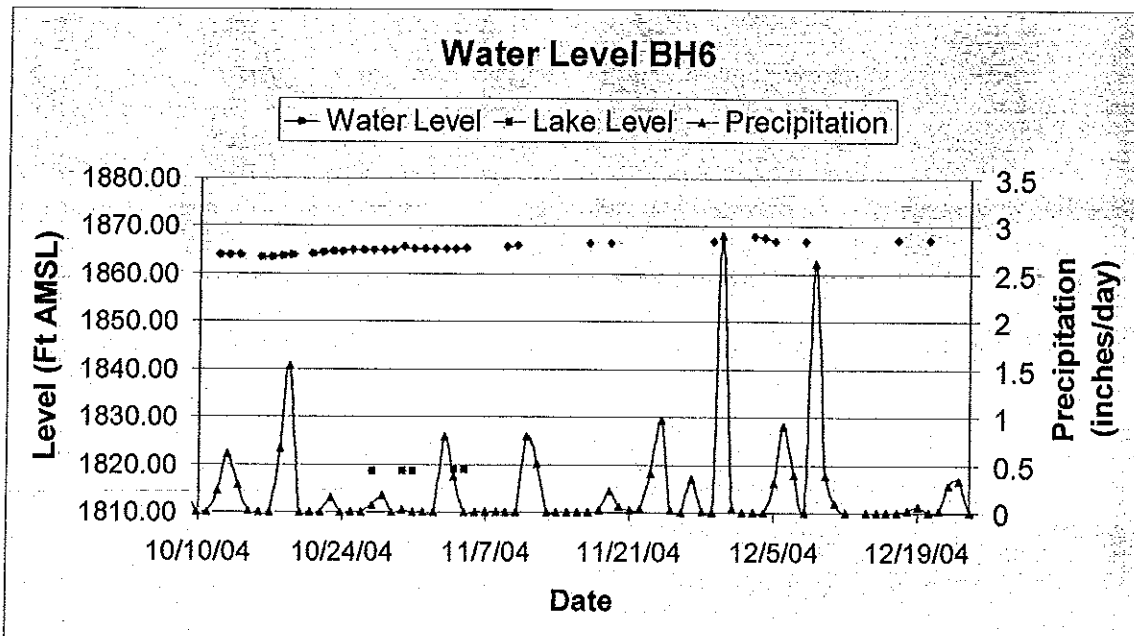
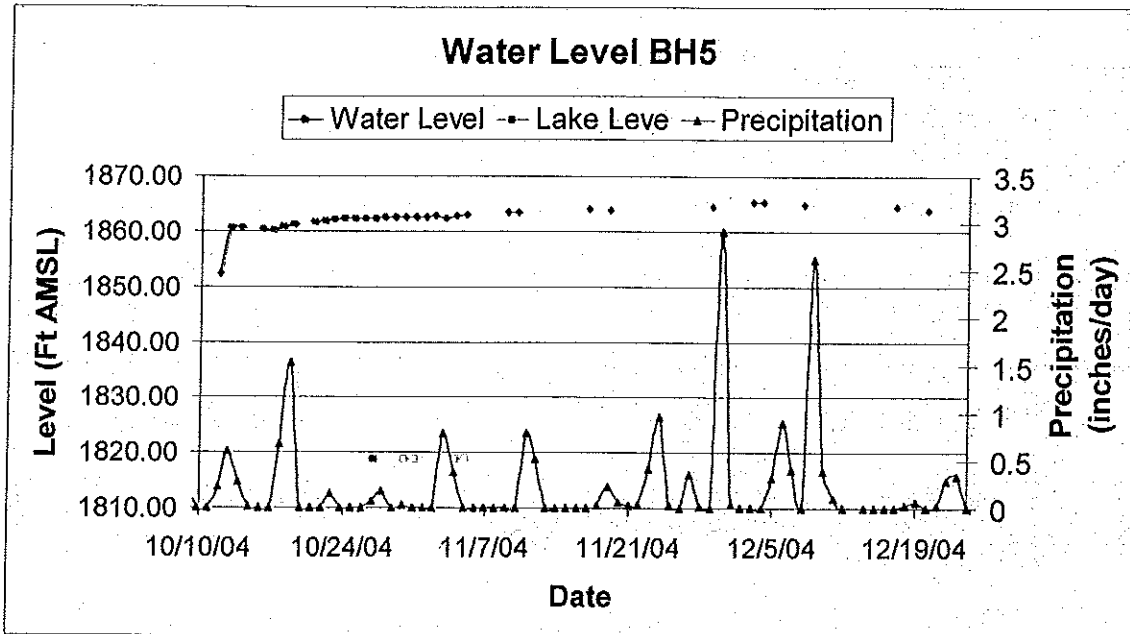
APPENDIX B

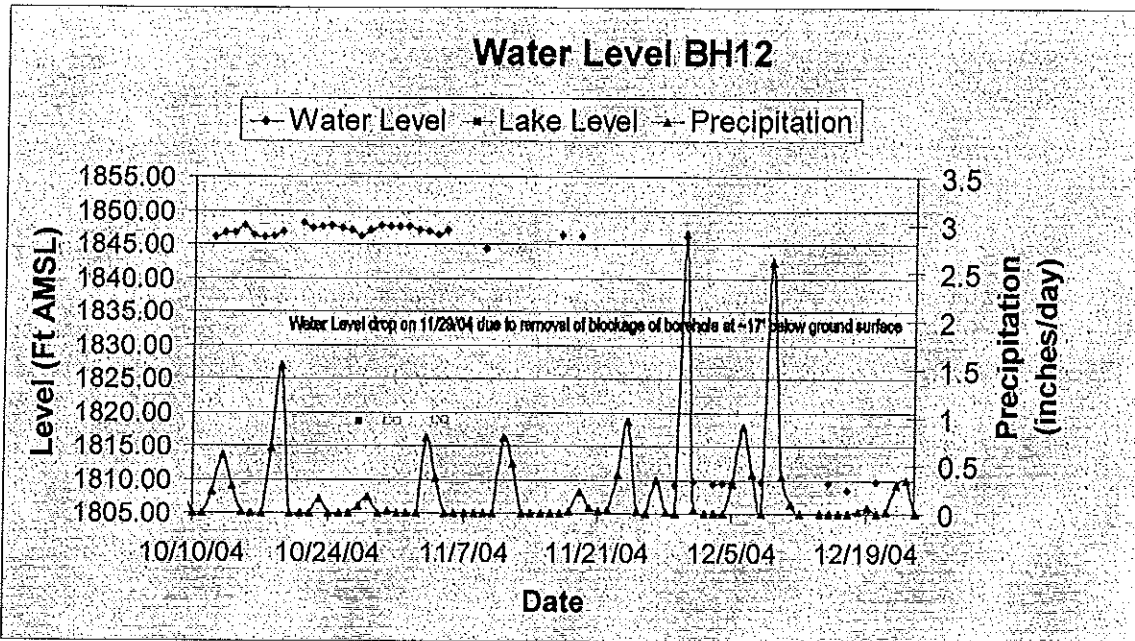
Borehole Water-level Graphs







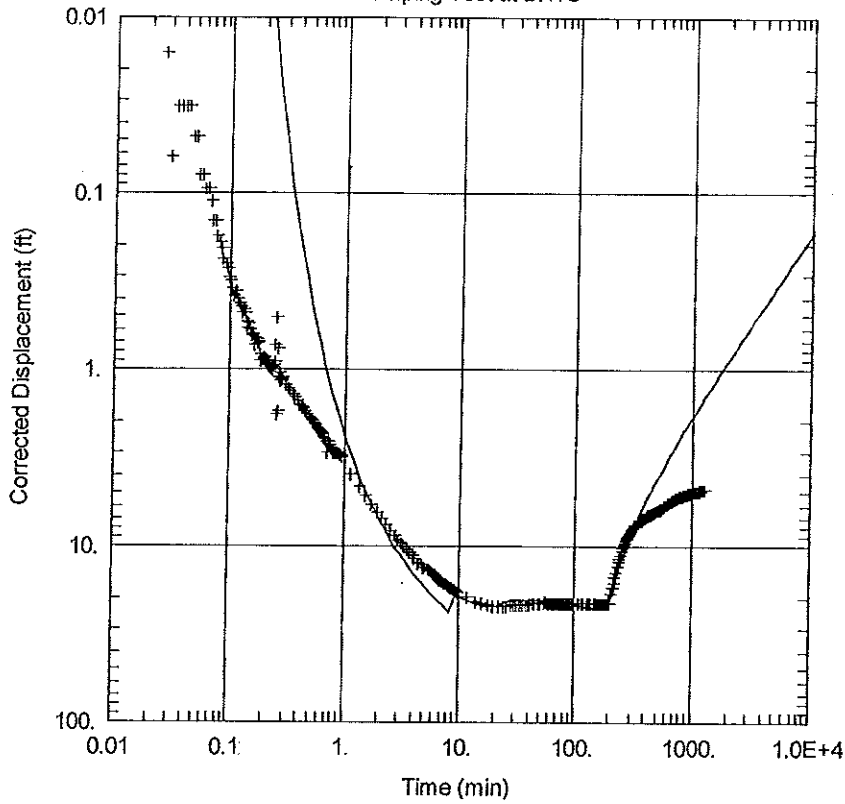




APPENDIX C

Pump and Slug Test Graphs

Pumping Test at BH1C



Obs. Wells

+ BH1C

Aquifer Model

Unconfined

Solution

Theis

Parameters

T = 0.9415 ft²/day

S = 0.2094

Kz/Kr = 1.

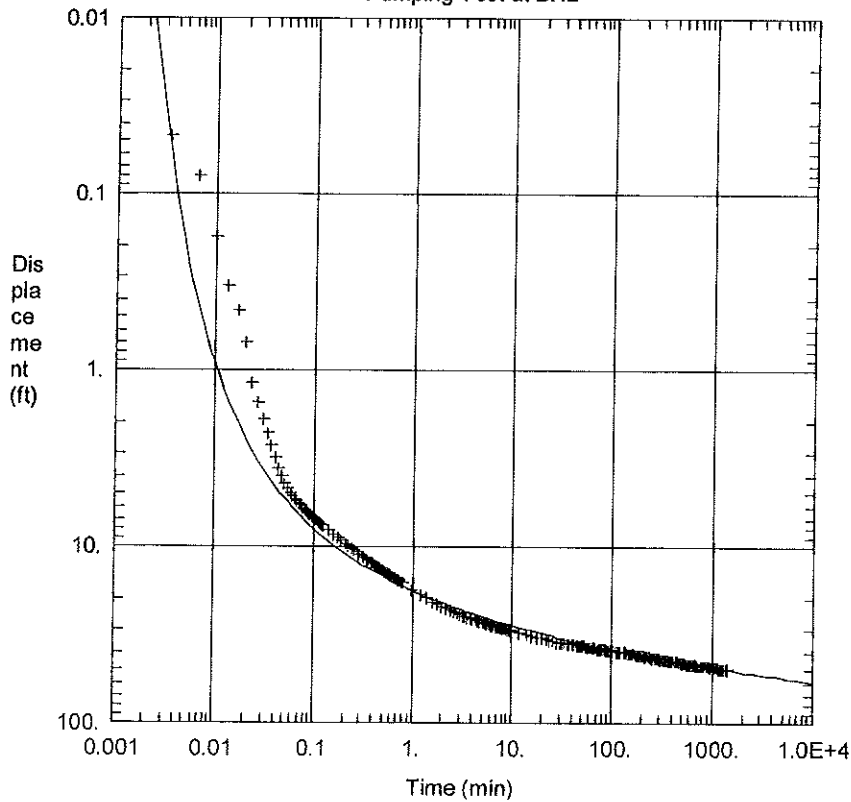
b = 49. ft

Kz/Kr Curves

Upper: 0.5

Lower: 2.

Pumping Test at BH2



Obs. Wells

+ BH2

Aquifer Model

Confined

Solution

Theis

Parameters

T = 62.17 ft²/day

S = 0.1126

Kz/Kr = 1.

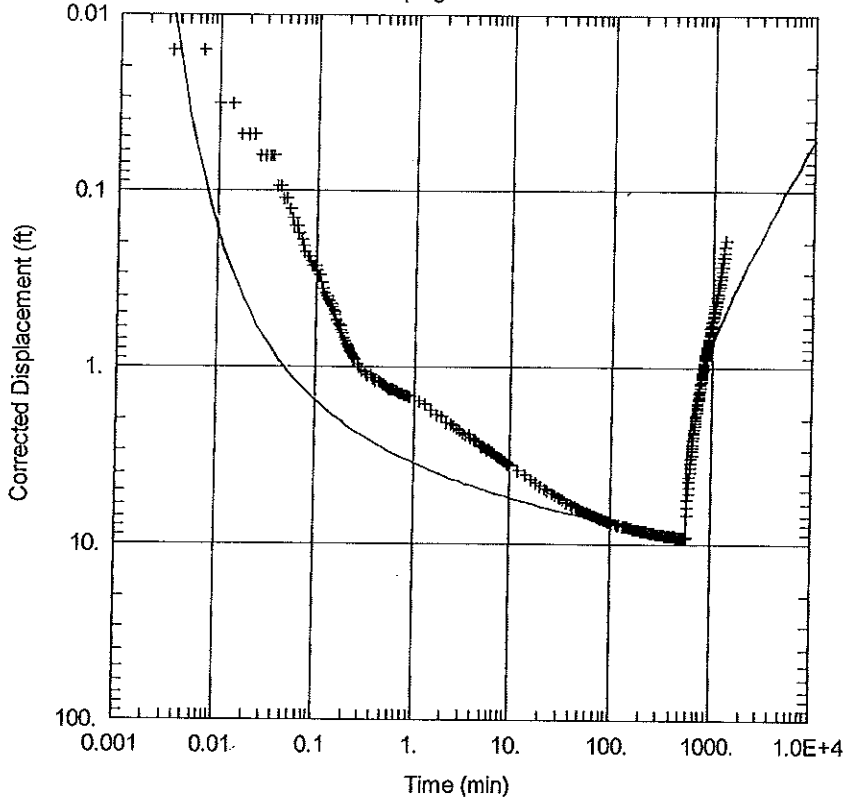
b = 60.61 ft

Kz/Kr Curves

Upper: 0.5

Lower: 2.

Pumping Test at BH3C



Obs. Wells
+ BH3C

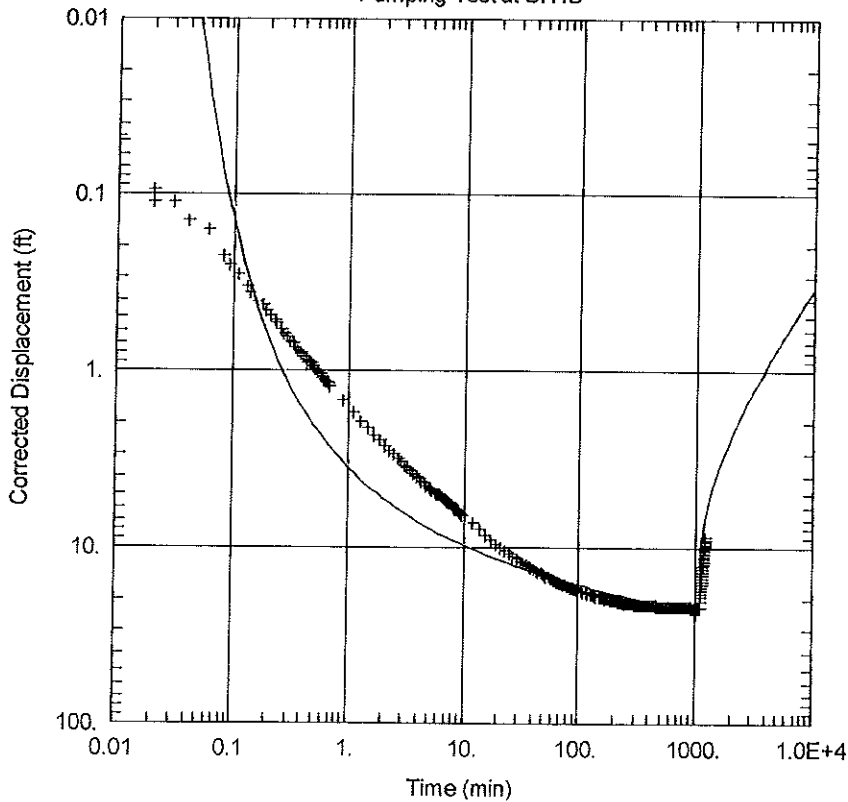
Aquifer Model
Unconfined

Solution
Theis

Parameters
T = 95.28 ft²/day
S = 0.2
Kz/Kr = 1.
b = 57. ft

Kz/Kr Curves
Upper: 0.5
Lower: 2.

Pumping Test at BH4B



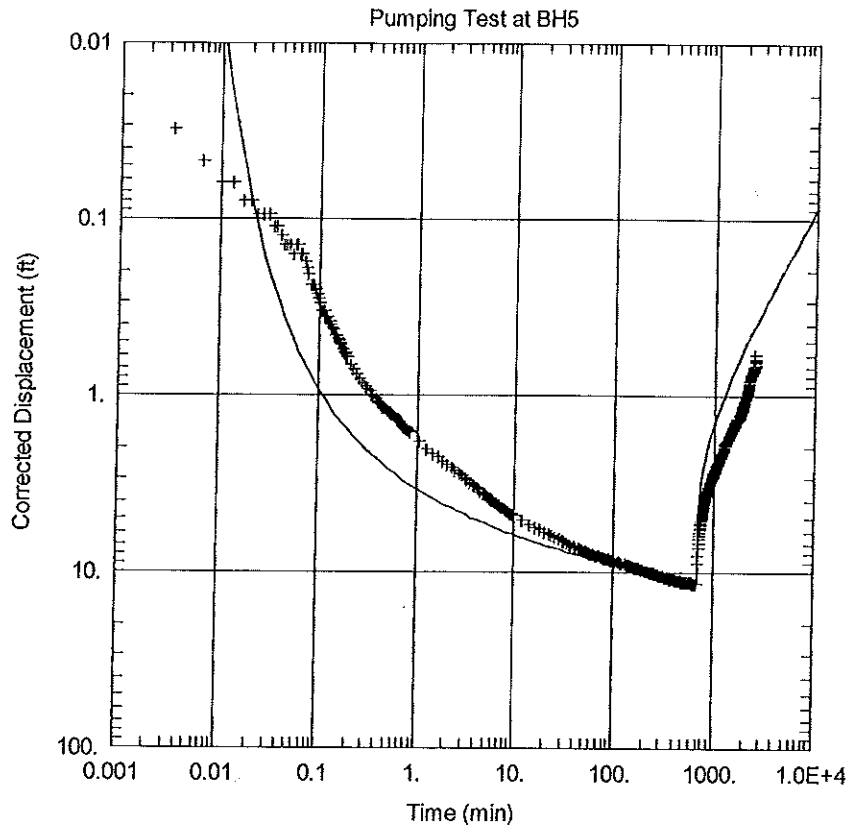
Obs. Wells
+ BH4B

Aquifer Model
Unconfined

Solution
Theis

Parameters
T = 5,312 ft²/day
S = 0.2
Kz/Kr = 1.
b = 120. ft

Kz/Kr Curves
Upper: 0.5
Lower: 2.



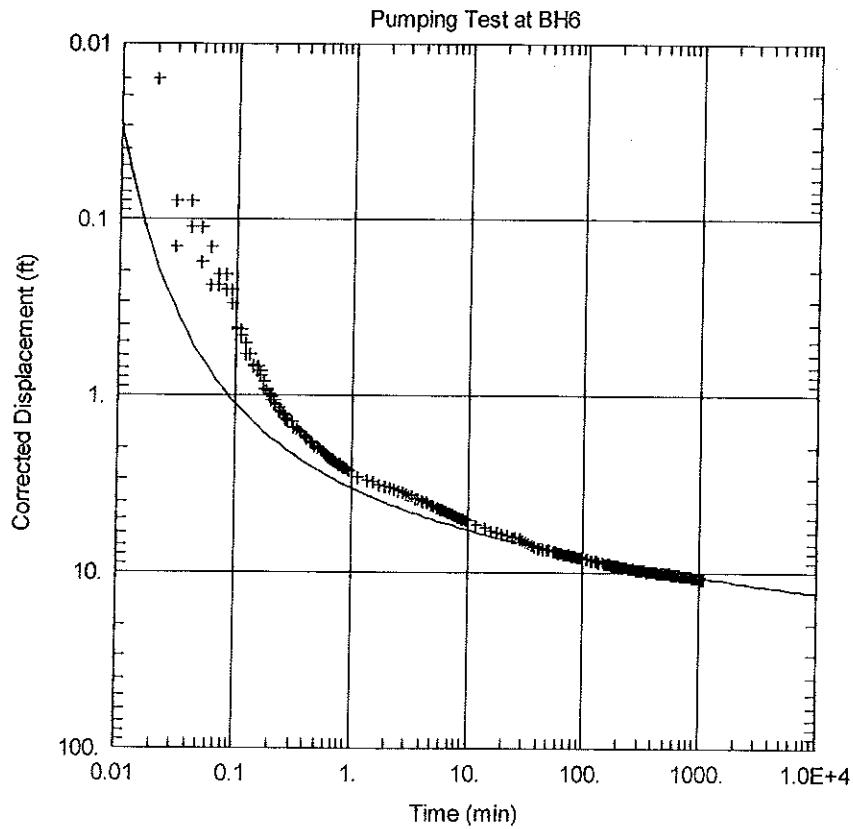
Obs. Wells
+ BH5

Aquifer Model
Unconfined

Solution
Theis

Parameters
 $T = 30.84 \text{ ft}^2/\text{day}$
 $S = 0.2$
 $Kz/Kr = 1.$
 $b = 115. \text{ ft}$

Kz/Kr Curves
 Upper: 0.5
 Lower: 2.



Obs. Wells
+ BH6

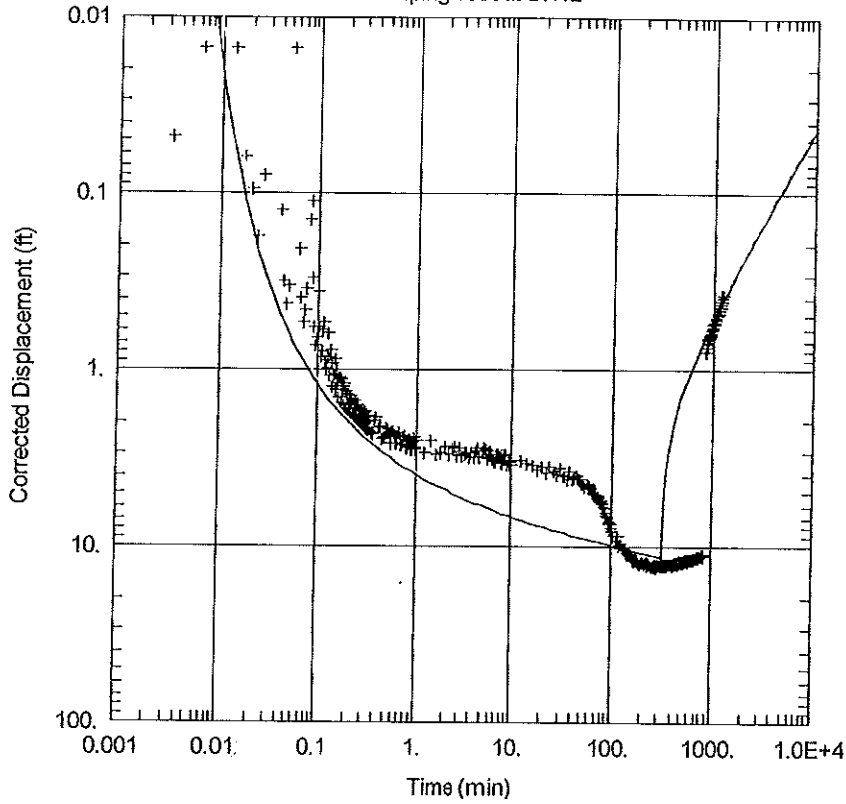
Aquifer Model
Unconfined

Solution
Theis

Parameters
 $T = 48.63 \text{ ft}^2/\text{day}$
 $S = 0.21$
 $Kz/Kr = 1.$
 $b = 117. \text{ ft}$

Kz/Kr Curves
 Upper: 0.5
 Lower: 2.

Pumping Test at BH12



Obs. Wells

+ BH12

Aquifer Model

Unconfined

Solution

Theis

Parameters

T = 34.71 ft²/day

S = 0.2

Kz/Kr = 1.

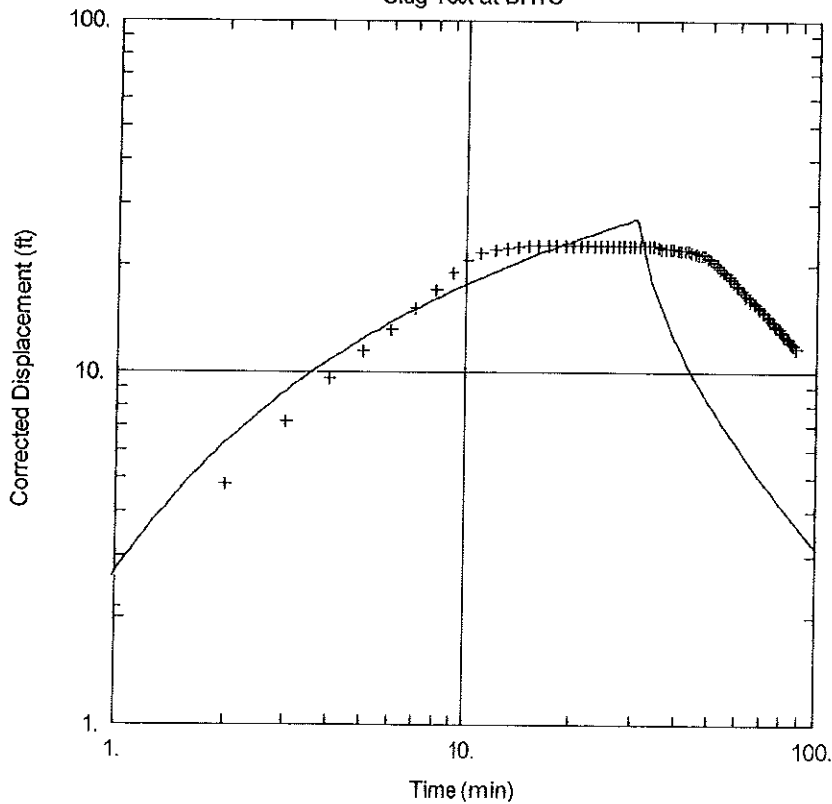
b = 60. ft

Kz/Kr Curves

Upper: 0.5

Lower: 2.

Slug Test at BH1C



Obs. Wells

+ BH1C_SLUG

Aquifer Model

Unconfined

Solution

Theis

Parameters

T = 2.184 ft²/day

S = 0.3224

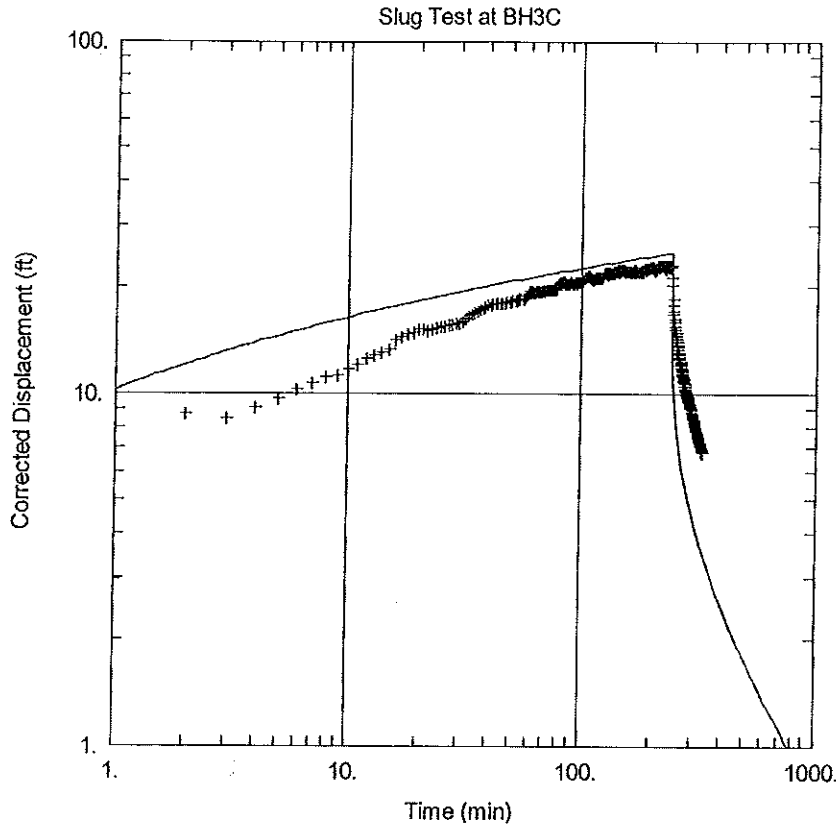
Kz/Kr = 1.

b = 77. ft

Kz/Kr Curves

Upper: 0.5

Lower: 2.



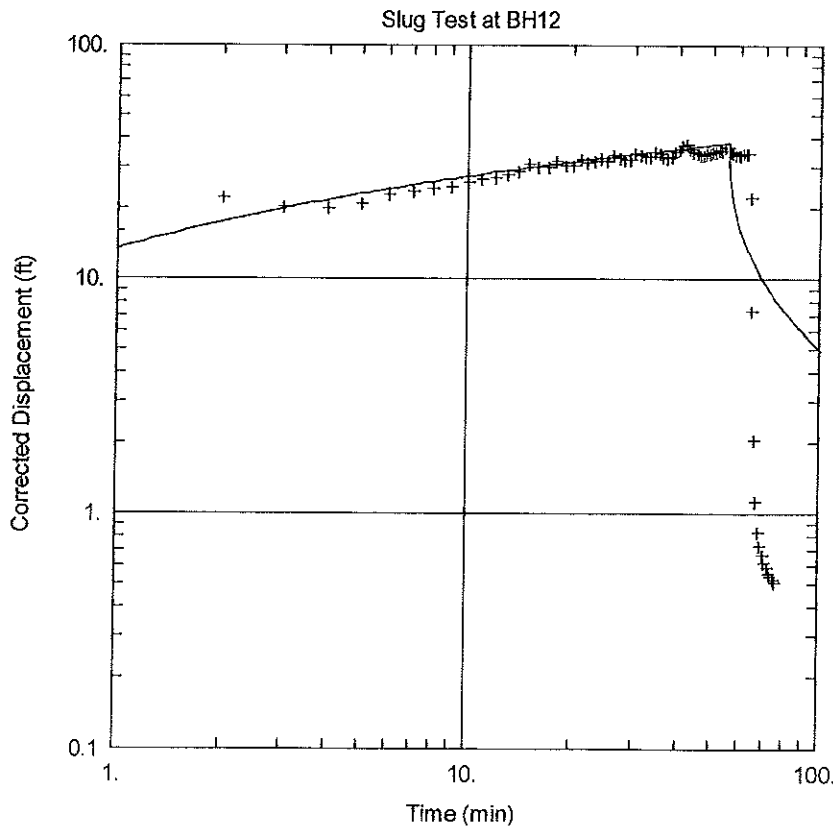
Obs. Wells
+ BH3C_SLUG

Aquifer Model
Unconfined

Solution
Theis

Parameters
 $T = 87.64 \text{ ft}^2/\text{day}$
 $S = 0.2$
 $Kz/Kr = 1.$
 $b = 84. \text{ ft}$

Kz/Kr Curves
 Upper: 0.5
 Lower: 2.



Obs. Wells
+ BH12_SLUG

Aquifer Model
Unconfined

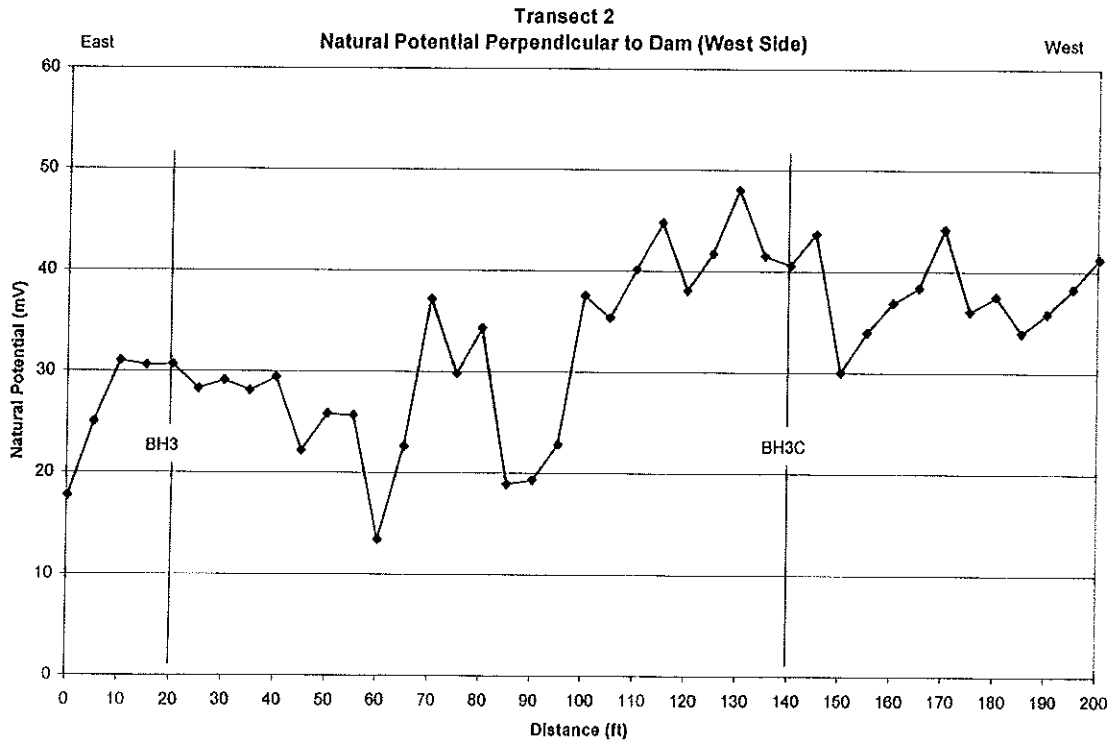
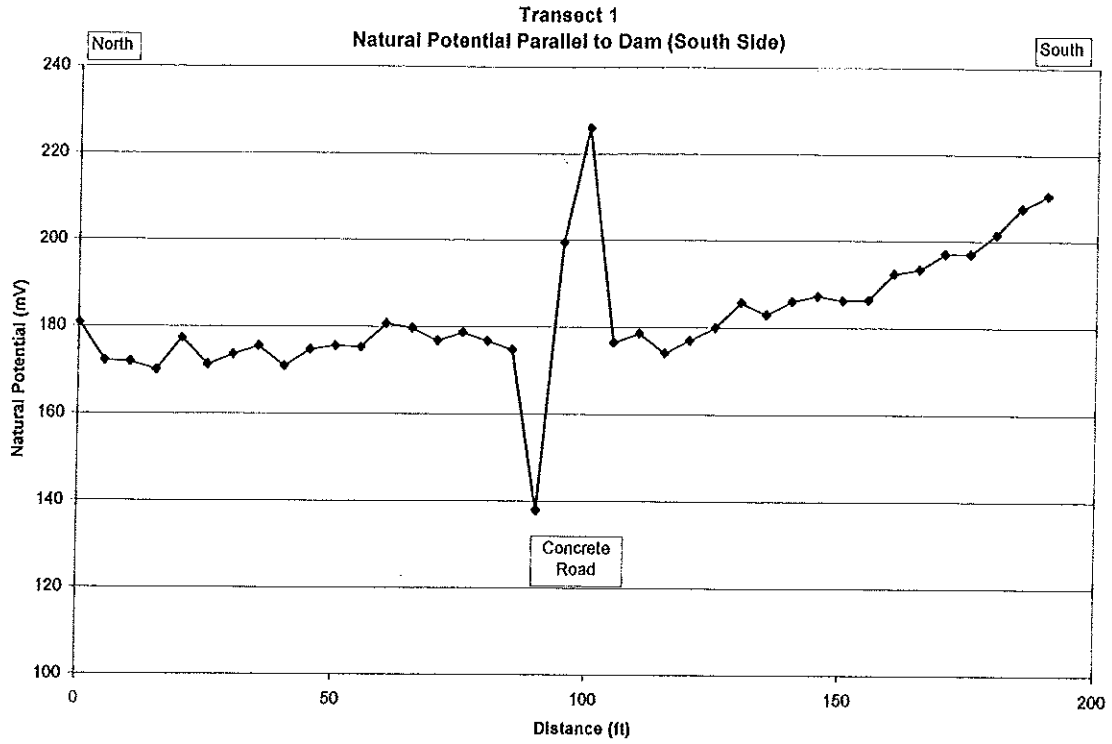
Solution
Theis

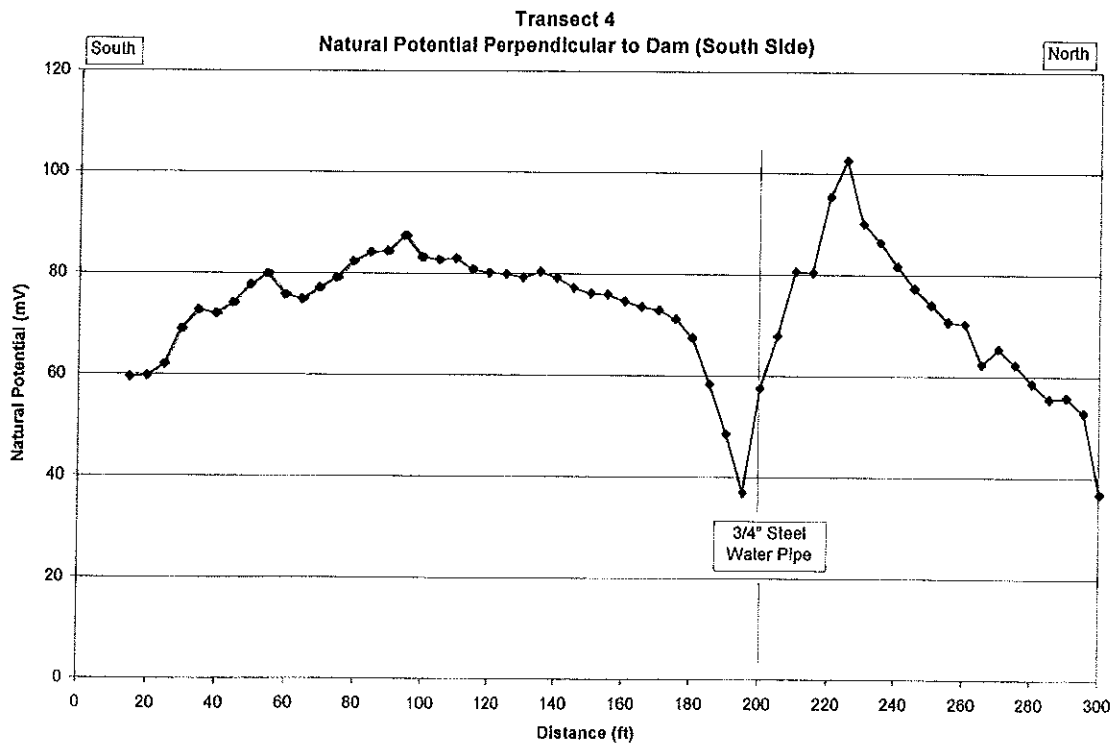
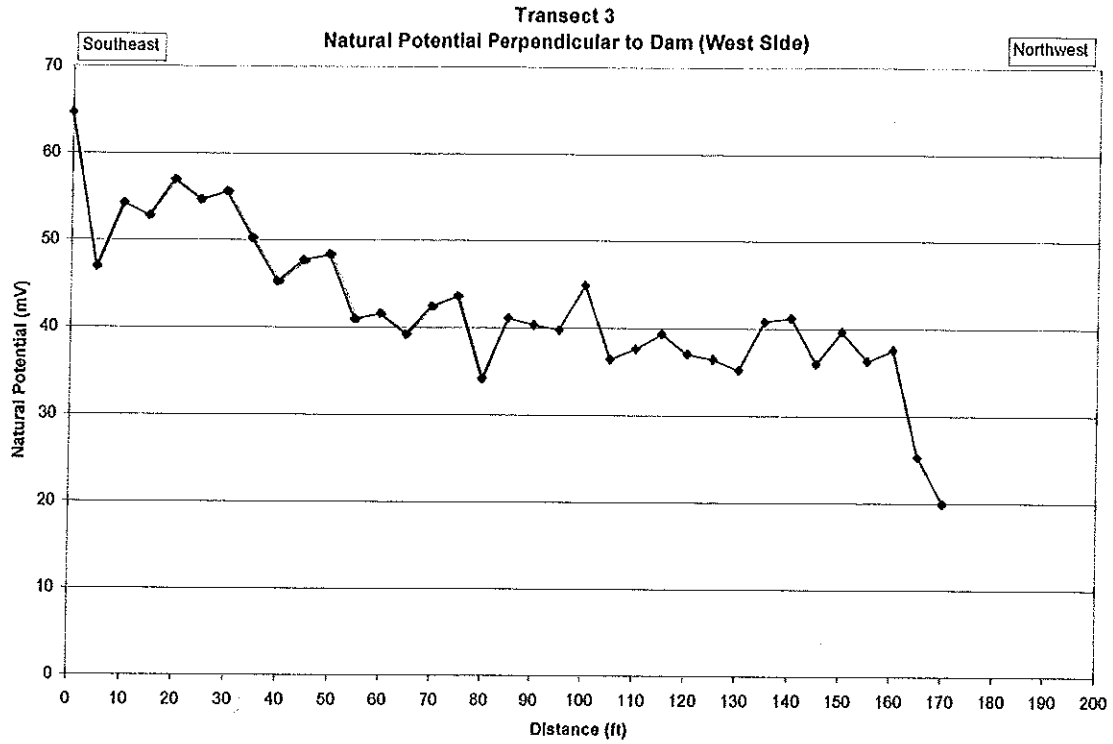
Parameters
 $T = 19.04 \text{ ft}^2/\text{day}$
 $S = 0.2332$
 $Kz/Kr = 1.$
 $b = 106. \text{ ft}$

Kz/Kr Curves
 Upper: 0.5
 Lower: 2.

APPENDIX D

Natural Potential Graphs





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APPENDIX E

Leakage Calculation Tables

Table A. Leakage Estimation Under Existing Conditions

I. Data (Pumping Test)

WL Measured Location	BH 1	BH 2	BH 3C	BH 4B	BH 5	BH 6	BH 12	LAKE
Average Water Level Elevation (feet) (AMSL)	1798.9	1793.8	1807.6	1869.8	1862.4	1865.3	1809.5	1818.8
Adjustment (feet)		17.0						
Elev. Used for WL contour map	1798.9	1810.8	1807.6	1869.8	1862.4	1865.3	1809.5	1818.8
Saturated Thickness H (feet)	49.0	60.6	57.0	120.0			60.0	
Transmissivity T (feet ² /day)	0.9415	62.17	95.28	5.31			32.14	

II. Calculation

Width of section 1 MC1	644.5	the distance between two middle points of BH1 - BH2 and BH1 - BH12
Width of section 2 MC2	270.7	the distance between two middle points of BH1 - BH2 and BH2 - BH3C
Width of section 3 MC3	640.2	the distance from middle points of BH2 - BH3C to the point where lake discharge groundwater
Width of section 4 MC4	644.5	the distance from middle point of BH1 - BH12 to BH12
Meadow Creek basin level	1750	
Scale rate b = 1:2000		
Section 1 to M Creek L1	1380	} (along groundwater flow direction, the distance from the middle point of each section to Meadow Creek basin)
Section 2 to M Creek L2	1620	
Section 3 to M Creek L3	1620	
Section 4 to M Creek L4	2120	
Water head loss from lake to creek Δh	$1818.8 - 1750 =$	68.8
$4h^2$	$=$	4728.8
Hydraulic Conductivity K1	$T1/H1 =$	0.02
Hydraulic Conductivity K2	$T2/H2 =$	1.03
Hydraulic Conductivity K3	$T3c/H3c =$	1.67
Hydraulic Conductivity K4	$T12/H12 =$	0.54
		Calculation Fomular : $Q = K\Delta h^2 W / L$
Discharge Q1	$K1\Delta h^2 W1/L1 =$	0.2 gpm
Discharge Q2	$K2\Delta h^2 W2/L2 =$	4.2 gpm
Discharge Q3	$K3\Delta h^2 W3/L3 =$	16.2 gpm
Discharge Q4	$K4\Delta h^2 W4/L4 =$	4.0 gpm
Total		24.7 gpm

Table B. Leakage Estimation After 20-foot Rise in Lake Level

I. Data (Slug test)

Water Level Measured Location	BH 1	BH 2	BH 3C	BH 4B	BH 5	BH 6	BH 12	LAKE
Average Water Level	1798.9	1793.8	1807.6	1869.8	1862.4	1865.3	1809.5	1818.8
Elevation (feet) (AMSL)								
Adjustment (feet)		17.0						20.0
Elevation after adjustment (feet)		1810.8						1838.8
Saturated Thickness H (feet)	77.0		84.0				106.0	
Transmissivity T (ft ² /day)	2.20		87.64				19.04	
Peak Water Mound (feet)	29.00		28.00				47.00	

II. Calculation

Width of section 1 W1 644.5 the distance from middle point of BH1 - BH12 to BH12
 Width of section 2 W2 777.7 the distance between two middle points of BH1 - BH3C and BH1 - BH12
 Width of section 3 W3 1800.4 the distance from middle points of BH1 - BH3C to the point where lake discharge groundwater after lake level raising 20 feet

Meadow Creek base level 1750

Section 1 to M Creek L1 3000
 Section 2 to M Creek L2 3620
 Section 3 to M Creek L3 3620 } along groundwater flow direction, the distance from the middle point of each section to Meadow Creek

Water head loss from lake to creek Δh 1838.8 - 1750 = 88.8
 $(\Delta h)^2 = 7879.4$

Weighted Hydraulic Conductivity K1 ⁽¹⁾ 0.48
 Weighted Hydraulic Conductivity K2 0.04
 Weighted Hydraulic Conductivity K3 2.15

Calculation equation: $Q = K \Delta h^2 W / L$

Discharge Q1 (gpm) $K1 \cdot \Delta h^2 \cdot W1 / L1 = 4.2$
 Discharge Q2 (gpm) $K2 \cdot \Delta h^2 \cdot W2 / L2 = 0.4$
 Discharge Q3 (gpm) $K3 \cdot \Delta h^2 \cdot W3 / L3 = 43.8$
 Total (gpm) 48

(1) Weighted Hydraulic Conductivity = (transmissivity from pumping test + transmissivity from slug test) / (saturated thickness in pumping test + partial penetration in slug test)

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