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Second Revision

Engineering Evaluation/Cost Analysis Report
Elvins/Rivermines Mine Tailings Site
Park Hills, Missouri

Prepared for
The Doe Run Company

June 2003

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SUPERFUND RECORDS

BARR

ED_000859_00001631-00001

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6-30-03

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Executive Summary

The Elvins/Rivermines Mine Tailings Site located in the Old Lead Belt of St Francois County in southeastern Missouri is the result of mining operations and stockpiling of milling wastes from about 1890 until the mill was permanently closed in approximately 1940 The U S Environmental Protection Agency (USEPA) has determined that a non time critical removal action is required for the Elvins/Rivermines Site because lead in the tailings at the Site presents a threat of actual or potential exposure to nearby human populations This engineering evaluation/cost analysis (EE/CA) is the last submittal required by the Administrative Order on Consent (AOC) issued by the USEPA Region VII to The Doe Run Resources Corporation which became effective on June 7 2000 The purpose of the EE/CA is to identify and evaluate alternatives for the removal action to prevent mitigate or otherwise respond to or remedy the release or threatened release of hazardous substances pollutants or contaminants at the Rivermines Site

The entire Site including the remaining buildings the chat pile and the tailings area is leased from The Doe Run Company to the Lead Belt Materials Company (LBM Co) Currently LBM Co operates a limestone quarry and a bituminous pavement mix production facility LBM Co uses chat from the chat pile at the Site as an aggregate component in the production of bituminous mix LBM Co also excavates and sells significant quantities of material from the Tailings Area for use as agricultural lime Sales of agricultural lime will end on August 1 2003 Areas surrounding the Site are largely residential or forested

The Site comprises four discrete areas as shown on Figure 2 Alternative removal actions were analyzed in terms of effectiveness and cost and certain actions were recommended for implementation as summarized below Estimated costs for the alternatives are summarized in Table 5 The recommended removal actions protect human health and the environment are consistent with intended use of the Site allow recreational development on portions of the Site if desired, and have reasonable costs

The recommended removal action is summarized below

Chat Pile The Chat Pile will be regraded to provide side slopes of three horizontal to 1 vertical The top elevation will be reduced to approximately Elev 930 A minimum of 12 inches of rock will be applied to the slopes and the regraded top to control wind erosion

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2 **Spillway** All of the tailings will be excavated from the spillway upstream of Old Highway 32 to create sedimentation ponds and aquatic plants will be established The drainage route from Old Highway 32 to the Flat River will be excavated to remove tailings deposits Trackside tailings between Old Highway 32 and the existing railroad will be excavated and returned to the site The old railroad grade crossing the spillway will be removed

3 **Tailings Area** The eastern and western slopes of the tailings area will be stabilized by adding a chat fill with a three horizontal to one vertical slope against the existing slope A minimum of 12 inches of rock will be applied to the slopes

The northern portion of top of the tailings area will be regraded to drain to the existing tailings pond The pond will discharge through the adjacent decant tower and buried pipeline to an open channel around the western and southern sides of the site The southern portion will be regraded to drain to a new detention basin near the second existing decant tower The southern portion will be approximately 15 feet lower than the northern portion due to the previous removal of tailings for agricultural lime

If the City of Park Hills and Doe Run come to an agreement for such use of the property the top of the tailings field will be finish graded for athletic fields It will be covered with 12 inches of cover soil likely obtained from strippings from the adjacent quarry and 6 inches of vegetative soil from off site and then vegetated If an agreement for athletic fields is not reached the top of the tailings field will be covered with a minimum of 6 inches of clay cover soil from on site and vegetated However if The Doe Run Company prepares a vegetation plan and demonstrates that directly seeding the tailings will meet the applicable relevant and appropriate standards (ARARs) the EPA will approve this plan and no cover soil will be required If athletic fields are not developed the second existing decant tower will be abandoned and an infiltration/evaporation pond will be established in the area of the existing excavation for agricultural lime

4 **Lead Belt Materials Operation Area** The portion of this area adjacent to the Tailings Area will be regraded to a slope of four (or more) horizontal to one vertical A minimum of 12 inches of rock will be applied to the slope and to any flat or gently sloping areas north of the quarry entrance road The area south of the quarry entrance road will be stripped to natural ground and revegetated The remains of the old mill and associated buildings and other debris will be buried in the fill area north of the entrance road

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1 0 Introduction

An engineering evaluation/cost analysis (EE/CA) was performed on the Elvins/Rivermines Mines Tailings Site located in the Old Lead Belt of St Francois County in southeastern Missouri This EE/CA report is the last submittal required by the Administrative Order on Consent (AOC) issued by the USEPA Region VII effective June 7 2000 to the potentially responsible party (PRP) The Doe Run Resources Corporation

The Rivermines Site is the result of mining operations and stockpiling of milling wastes from the early 1890 s until the mill was permanently closed in approximately 1940 The Lead Belt Materials Company (LBM Co) currently leases the Site and owns an adjacent quarry expansion LBM Co uses chat from the Site as aggregate in bituminous mix and also sells tailings as agricultural lime Sales of agricultural lime will end on August 1 2003 The purpose of the EE/CA is to screen and evaluate non time critical removal action alternatives for controlling erosion from wind and storm water runoff and providing slope stability Groundwater and surface water were not addressed under this EE/CA because they are being addressed under an area wide remedial investigation currently being conducted for The Doe Run Company (Doe Run)

The U S Environmental Protection Agency (USEPA) has determined that a non time critical removal action is required for this area because the lead in the tailings at the Site presents a threat of actual or potential exposure to nearby human populations There are several residences in close proximity to the Site and the potential for off-site migration of lead contaminated particles exists through wind transport mechanisms Also lead contaminated tailings may migrate to surface water including the Flat River The surface of the tailings pile is dry with limited vegetation and the tailings are susceptible to erosion from wind and storm water runoff

The Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and the National Contingency Plan (NCP) define removal actions to include *the cleanup or removal of released hazardous substances from the environment such actions as may necessarily be taken in the event of the threat of release of hazardous substances into the environment such actions as may be necessary to monitor assess and evaluate the release or threat of release of hazardous substances the disposal of removed material or the taking of such other actions as may be necessary to prevent minimize or mitigate damage to the public health or welfare or to the environment which may otherwise result from a release or threat of release* An EE/CA must be completed for all non time critical removal actions under CERCLA as required by section 300 415(b)(4)(I) of the NCP The

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goals of the EE/CA are to identify the objectives of the removal action to analyze the effectiveness implementability and cost of various alternatives that may satisfy these objectives and to recommend a removal action alternative (USEPA 1993a)

An August 2000 letter report on conceptual removal action alternatives) (Barr 2000a) was the first step in satisfying the requirements of the Statement of Work (SOW) included as part of the AOC The letter report described conceptual alternatives that were to be evaluated in the EE/CA The letter report was shared with the local community and landowners to provide them an opportunity to comment on the concepts early in the planning process Based on those comments and comments received from the USEPA a Work Plan and Field Sampling Plan were developed for the Site by Doe Run and submitted to the USEPA on February 15 2001 (Barr 2001) This report summarized previous investigations at the Site and outlined additional data gathering activities to take place prior to drafting of the EE/CA

This EE/CA report is organized as follows

Chapter 1—Introduction

Chapter 2—Site Characterization

Chapter 3—Identification of Removal Action Objectives

Chapter 4—Identification and Analysis of Removal Action Alternatives

Chapter 5—Comparative Analysis of Removal Action Alternatives

Chapter 6—Recommended Removal Action Alternative

2 0 Site Characterization

This chapter provides background information on Site location history past investigations physical and chemical characteristics and analytical data It also presents a streamlined risk evaluation

2 1 Site Description

The Elvins/Rivermines Tailings Site is located in an area known as the Old Lead Belt The Old Lead Belt is located in St Francois County in southeastern Missouri and covers an area of approximately 110 square miles The Site can be located on the Flat River 7 ½ minute USGS quadrangle map in the East 1/2 Section 12, Township 36 North Range 4 East and the South half Section 7 Township 36 North Range 5 East The Site is located approximately at latitude 37° 50 30 and longitude 90° 32 (see Figure 1) The facility occupies approximately 300 acres and is located west of State Highway 32 between the communities of Elvins and Rivermines Missouri These communities are now part of the City of Park Hills Missouri Tailings and chat cover approximately 130 acres of the Site The remaining area is wooded or part of the Lead Belt Material Company s (LBM Co) quarry and bituminous mix operations The Site comprises four areas as shown on Figure 2 and as defined below

Figure 3 presents a map showing property boundaries and identifying ownership Properties identified on Figure 3 are numbered to allow identification of ownership Table 1 lists the names and addresses of the property owners associated with each of the numbered properties The site includes only the property owned by The Doe Run Company and property owned by Union Pacific Corporation[1] in the trackside tailings area (see Figure 2) All the other property owners identified on Figure 3 and Table 1 are included only to identify those whose property is adjacent to or near the Doe Run property on which the site is located If during removal action waste is identified on the adjacent properties Doe Run will negotiate an access agreement with the owner to remove or cover the waste

[1] Two properties are identified by the St Francois County registrar s records in the trackside tailings area They are identified as being owned by the Missouri Pacific Railroad and the Missouri Illinois Railroad It is believed these are both now part of Union Pacific Corporation

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2 1 1 Chat Pile

The Chat Pile Area covers approximately 13 acres and is approximately 170 feet high Chat is the waste material generated through the gravity settling process used to separate the valuable metallic ore from the host dolomite rock It was piled using a conveyor system The result is a steep sided barren mound of sand to fine gravel Surface water from the Site percolates through the chat and discharges from the toe of this main pile The east side of this pile is bordered by woods The entrance road to the facility separates the south side of the pile from several homes The northwest side of the pile adjoins the Tailings Area The 1954 aerial photograph (Figure 5) indicates that the Chat Pile Area originally extended west of its current location into the large excavation created by LBM Co The Chat Pile Area apparently served as a dike to retain the Tailings Area while it was deposited

2 1 2 Tailings Area

The Tailings Area is relatively flat and composed of primarily tailings with some areas of slimes The area is approximately 50 feet lower than the top of the Chat Pile Area which borders it to the southeast This area is surrounded by woods on the north east and west sides and by LBM Co s Operation Area to the south The community of Elvins is located just south of LBM Co 's operation

Surface water collects in a pond located in the northern portion of this area This pond likely served as a settling pond during the active tailings disposal It over flows through decant tower 1 located on the edge of the pond Decant tower 1 discharges through an approximately 1200-foot long 12 inch diameter steel pipe which outlets at the toe of the tailings slope in the northwest corner of the site The water currently flows to a landlocked on site pond which is part of LBM Co operations Decant tower 2 is located in the southwest corner of this area adjacent to the main chat pile Decant tower 2 now serves a drainage area of a few acres Decant tower 2 probably functioned in earlier stages of the tailings disposal It may be functional again as a part of a removal action regrading plan The water from decant tower 2 travels through a concrete culvert to a discharge point on the east side of the main chat pile at the toe To a lesser extent surface water may run off from the eastern slope of the Tailings Area to a small unnamed creek which discharges to the Flat River

2 1 3 Spillway Area

Water flowing from the decant tower 2 outlet and the toe of the pile flows through the spillway before discharging through Outfall 1 (Figure 2) The discharge from Outfall 1 flows through a ditch and unnamed creek to the Flat River approximately one quarter mile to the east The ditch and creek

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contain tailings and chat washed from the storage areas Portions of the creek have been dredged to remove the tailings The tailings from the creek were placed in piles adjacent to the creek

In addition surface water runoff from a small portion of the Tailings Area discharges through Outfall 2 This flow passes through a heavily vegetated area between the toe of the tailings slope and the beginning of the well defined channel This vegetation effectively filters the runoff As a result very little quantity of sediment was observed in the small creek that discharges through Outfall 2 to the Flat River

2 1 4 Lead Belt Materials Co Operation Area

All of the chat pile and tailings area and the original quarry are leased from The Doe Run Company to the LBM Co In addition LBM Co owns the quarry expansion area to the west LBM Co operates a limestone quarry and a bituminous pavement facility at the Site Their office and maintenance facilities are located on the southwest side of the Site The limestone quarry occupies most of the southwest and western portion of the Site and the bituminous facility is located in the south central portion of the Site The quarry operations recently moved from the southwest portion of the Site to a new area west of the Site Surface water from the quarry operation collects in a series of ponds that do not have a discharge In addition materials from the Tailings Area are excavated and sold as agricultural lime at an estimated rate of 20 000 cubic yards per year Sale of tailings as agricultural lime will end on August 1 2003

The bituminous facility uses chat and rock from the quarry operations to produce bituminous pavement mix for road construction consuming approximately 35 000 cubic yards of chat per year Water from the main quarry pond is used as cooling water for the bituminous operation and then returned to the pond Asphalt products used to manufacture the bituminous mix are delivered to the Site by bulk transports and stored in several large above ground storage tanks

2 2 Site Background

Lead was discovered in near surface deposits in the area in the early 1700s Until the 1860s mining in the area was restricted to shallow workings from pits and trenches Diamond bit core drilling of the area began in 1869 and led to the discovery of lead-rich ore deposits and underground mining operations under the Missouri towns of Bonne Terre Desloge Flat River Leadwood and Elvins As many as 15 lead companies operated in the area from the late 1800s to 1900s However by 1933 all of the properties in the area had been acquired by the St Joseph Lead Company which later became

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the St Joe Minerals Corporation Mining activity in the area decreased in the 1950s and 1960s as the ore deposits were depleted and with the discovery of the Viburnum Trend (New Lead Belt) which had higher grade ore (USEPA 1993b)

Mining activities commenced at and near the Rivermines site about 1890 Early operations included mining milling at numerous locations roasting and smelting Ownership consolidation occurred and by approximately 1909 milling in the Elvins/Rivermines area had been consolidated to one site Ore fed to the Rivermines mill was from multiple mine shafts or mines in nearby areas Ore was hauled to the mill from remote locations by rail above ground (early) and under ground (later) The Rivermines mill was modernized and enlarged on occasion until it was permanently closed about 1940

A limited amount of historic Site information is available The USGS prepared a 15 minute quadrangle map of the area based on surveys completed in 1905 Contours from the 1905 quadrangle were digitized into the Site base map and are shown in Figure 4 An aerial photograph taken in 1954 showing Site conditions prior to more recent development has been provided by the US EPA (see Figure 5)

The mill was located near the south boundary of the Site Partially demolished portions of the mill and related facilities remain at the Site

2 3 Site Topography and Geology

Topography in the Old Lead Belt is characterized by rolling hills dissected by narrow floodplain creek and river valleys Hills and ridges are generally steep sided with flat tops consisting of thin mantles of clayey soils The area is drained primarily by the Big River and its tributaries Due to local geology these tributaries frequently gain or lose flow through bedrock and can be intermittent or perennial depending on the specific location of the observer Stream hydrographs typically react quickly to major precipitation events (Fluor Daniel 1995)

2 3 1 Topography and Drainage

The Site is located in a small valley Storm water runoff from the adjacent properties up to the ridgeline flows onto the Site Prior to mining activities this storm water would have collected in a stream running along the valley floor discharging to the Big River A significant portion of the valley has been filled with tailings and chat (see Figure 4) Precipitation that falls on the chat

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percolates into the chat and does not generate surface runoff Precipitation on the tailings will produce runoff to varying degrees in proportion to how fine the tailings are Storm water runoff is discharged from the Site through either the spillway or a tributary of the Flat River extending along the east side of the property (see Figure 2)

Two decant towers and a concrete culvert collect overflow from the northern tailings pond and runoff from a small area of tailings near the chat pile Decant tower 1 drains the northern tailings pond through a 12 inch diameter steel pipe exiting near the north end of the west slope of the tailings Decant tower 2 located near the chat pile drains through a large concrete culvert discharging to the spillway The culvert extends from the toe of the tailings pile on the southeast side of the facility In addition the concrete culvert appears to provide a drainage conveyance for ground water collected within the tailings and chat Due to the large groundwater storage capacity within the chat and tailings the discharge of groundwater through the concrete culvert and the toe of the chat pile is spread throughout all or most of the year

It appears that to a lesser extent storm water runoff from the south side of the facility may flow along the entrance road and enter the drainage system associated with adjacent residential properties to the south This storm water would also discharge to the Flat River

Several holding ponds were created by the LBM Co to control surface water in their quarry and asphalt production area Discharge from the cooling pond for the asphalt operation is under an NPDES discharge permit The remaining ponds have no surface water discharge The discharge from decant tower 1 apparently eventually reaches the ponds in the LBM Co Operations Area

2 3 2 Geology

The lead producing area of Missouri is located on the flank of a somewhat circular shaped positive structure known as the St Francois Mountains, the northeastern part of the Ozark dome The core of this structure is formed by Precambrian igneous rocks mainly rhyolitic porphyries intruded by granite and diabase rock Many of the erosion formed igneous knobs are exposed at the surface and others remain buried by Cambrian and Ordovician sedimentary formations

The sedimentary formations in order of deposition are Lamotte sandstone Bonne Terre formation Davis shale Derby-Doe Run dolomite Potosi dolomite Eminence dolomite Gasconade dolomite Roubidoux formation and Jefferson City dolomite The Cambrian-Ordovician division is considered to be at the top of the Eminence dolomite

At the Rivermines Site bedrock is typically overlain by shallow clay soils (0 to 10 feet) Surface topography is therefore a close reflection of bedrock topography in areas outside of the tailings deposits Clay thickness may be greater on the ridges as seen in stripping for the quarry to the west

2 4 Previous Removal Action Activities

Although no interim removal action activities have taken place at the Site tailings have been excavated from the Tailings Area and the Chat Pile by LBM Co since approximately 1975 Chat is currently used as an aggregate in production of bituminous pavement Tailings are currently being used as a source of agricultural lime Sales of tailings as agricultural lime will end on August 1 2003 The 1954 aerial photo (Figure 5) also shows evidence of chat removal

2 5 Source, Nature, and Extent of Contamination

The tailings and chat are the waste products of the milling of lead ores By their nature the tailings and chat contain measurable concentrations of lead zinc cadmium and other metals They range in size fraction from sand (chat) to clay (tailings slimes) Essentially devoid of organic materials or nutrients most of the chat and tailings remain unvegetated except where special efforts have been made

Early ore concentrating technology produced chat as a waste material Chat was disposed of in large piles using a conveyor Fine wastes (slimes) unable to be carried up the conveyor were typically disposed of in areas adjacent to the chat piles As the concentrating technology improved the grind size of the lead bearing ore was reduced and water was used to carry the total waste (tailings) including coarse and fine fractions to a tailings pond

At the Rivermines Site chat was piled in the lower part of the valley Later tailings appear to have been deposited in a settling pond area created by the chat pile on the south and spigotted tailings dikes in the east and west The depth of the chat pile varies from 0 to 180 feet and it occupies approximately 13 acres The depth of the tailings deposit vary from 0 to 100 feet and it covers approximately 55 acres

Slimes have been observed at this Site in the lower half of the western slope of the Tailings Area These slimes may be associated with the early disposal of chat at the Site Slimes have also been observed in the upper half of the eastern slope of the Tailings Area These slimes are more likely to be associated with ponding areas during later tailings disposal

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2 5 1 Previous Investigations of Tailings

In response to questions from the public and the mining industry the Missouri Department of Natural Resources funded a study to determine the feasibility of using chat and tailings from the Old Lead Belt for agricultural limestone The study was performed by a team from the University of Missouri – Rolla headed by Bobby Wixson (Wixson 1983) The goal was to determine whether bioconcentration of heavy metals in the plant system might be of concern to public health The first step in the study was to characterize the chemical composition of tailings in the Old Lead Belt including the Rivermines Site The Rivermines Site is referenced as the Elvins Tailings Pile in the Wixson report

Text in the Wixson report indicated ninety one (91) near surface unweathered samples were collected from the Rivermines Site However Table 11 of the Wixson report contained 93 sample results and the sample location map Figure 9 of the Wixson report identified 95 sample points Only those sample data that appeared both on the location map and in Table 11 were used in this report resulting in a total of 93 samples Sample numbers E209 and E243 were marked on the map but not reported in Table 11 The sample location map Figure 9 of the Wixson report (see Appendix B of this report) was not drawn to scale so sample locations are approximate

The Wixson report concluded that dolomitic limestone tailings in Southeast Missouri could be used as a cheap and convenient substitute for agricultural limestone with resultant environmental benefits but the materials selected for such use should not contain elevated metals levels found in some of the older chat and tailings locations characterized in the study Data provided in the report demonstrated that the material sampled at the Elvins Tailings Pile was found to contain the highest mean values of lead and zinc as compared to the four other tailings areas researched in the study

The Wixson study evaluated only plant uptake of metals using tailings and chat as an amendment for acidic soils and did not consider other impacts to the environment or public health EPA believes that the disadvantages of using lead mine tailings as a source of agricultural lime far outweigh the convenience this material provides as a soil amendment Wixson s study did not consider or effectively research the potential for adverse impacts on stream ecosystems future land use and the potential for mishandling and misusing the material prior to being applied to agricultural fields

2 5 1 1 Chat Pile

Forty eight near surface samples collected from the Chat Pile Area were analyzed for lead cadmium and zinc according to U S EPA Method 6010 A figure showing the sample locations and a table

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presenting the analytical results are shown in Appendix B The samples were collected from approximately 20 to 40 centimeters (cm) below the surface Wixson intended to obtain unweathered material The sample was air dried and sieved with the less than 40 mesh fine fraction being dissolved in nitric acid and analyzed for lead cadmium and zinc by atomic absorption (AAS) or the inductively coupled argon plasma (ICAP) method (Wixson 1983) Table 2 summarizes the analytical results For the most part the samples were collected in four lines that began at the top of the pile and ended at the toe These lines were located primarily on the north and south sides of the chat pile Samples were also collected on the west side of the pile that faces the LBM Co operations

2 5 1 2 Tailings Area

Eighteen (18) near surface samples collected from the Tailings Area were analyzed for lead cadmium and zinc according to U S EPA Method 6010 The samples were collected and analyzed as discussed above (Section 2 5 1 1) A figure showing the sample locations and a table presenting the results are shown in Appendix B Table 2 summarizes these results Samples were collected in a line extending from the edge of the chat pile that roughly followed the line made by connecting the two decant structures Two additional samples were collected on the eastern edge of the Tailings Area

2 5 1 3 Spillway Area

Previous investigative soils samples were not collected from this area

2 5 1 4 Lead Belt Materials Co Operations Area

Twenty seven (27) near surface samples collected from the chat excavation area portion of the LBM Co Operations Area were analyzed for lead cadmium and zinc according to U S EPA Method 6010 The samples collected from the LBM Co Operations Area were primarily collected along a line which appears to have been on the north side of the entrance road and another line along the scarp between the Tailings Area and the LBM Co Operations Area The materials represented by these samples may have subsequently been removed by LBM Co activities

2 5 2 Previous Investigations of Surface Water

The University of Missouri conducted several investigations on the impact of lead on surface water fish and sediments in the Big River Results from a 1985 study which built upon these previous studies are summarized in Continued Studies on Vagrant Lead in Fish, Molluscs and Sediments of

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the Big River of Southeastern Missouri (Wixson 1986) This study included limited sampling of the Flat River Creek The data from the Big River is likely to be generally representative of the conditions found in the Flat River and is therefore included in this report Portions of the previous investigation results are included in this report as appropriate

A figure showing sampling locations and graphs showing concentrations of lead in fish and sediments from the study are shown in Appendix B The conclusions from the study are also shown in Appendix B

The 1986 report listed one fish sampling site number 8 relevant to the Rivermines Site Sample Site 8 was located immediately down stream from the National Mine Tailings Site where the Flat River passes under Highway 67 Samples were not collected upstream from the National Site Site 8 is likely more influenced by the National Site than the Rivermines Site and is also downstream of the Federal Site Fish collected from sample site 8 showed 0 392 ppm lead in Sunfish 0 728 ppm lead in Northern hogsuckers and 0 254 ppm lead in catfish Lead levels in two sediment samples collected from sample point 8 in 1985 were 1 060 and 1 200 ppm Sediment cadmium levels were 6 5 and 6 ppm and zinc was 378 and 289 ppm

According to the 1986 study the World Health Organization (WHO) recommended concentrations of lead in fish less than 0 3 ppm to be considered safe for human consumption This is the same action limit currently used by the Missouri Department of Health The Missouri Department of Health was contacted on August 28 2000 to determine the current fish advisories for Missouri Their report is contained in the following paragraph The fish advisories are updated every year and there have been no significant changes in the advisory for the Old Lead Belt region since at least 1997

> *The Missouri Department of Health is continuing its advisory for sunfish carp Redhorse and other suckers found in the Big River in St Francois and Jefferson Counties the Flat River in St Francois County from Highway B six miles downstream to where it enters the Big River These fish in both rivers have been found to contain lead at levels of significant health concern and should not be eaten Lead mine waste piles in the area have contaminated the rivers with Lead at levels of health concern Since 1980 the Department of Health has recommended people not eat carp redhorse or suckers from the Big River downstream from Desloge to the mouth of the river where it enters the Meramec River For a few years in the late 1980s catfish were also found to be contaminated with lead at levels of health concern Sampling since 1992 however indicates that catfish no longer poses a health risk Sunfish were captured and analyzed for the*

first time in 1993 and were also found to be contaminated The Missouri Department of Conservation sampled more fish in 1996 and 1997 in the Big River as well as in the Flat River because of an increased concern about lead contamination That sampling indicates that sunfish carp redhorse and other suckers in the Big River and Flat River are still contained with lead at levels of health concern (Missouri Department of Health 2000)

The 1985 sampling report conclusions included

Analyses of sunfish collected during 1985 indicated that specimens from one of the eleven Old Lead Belt locations tested had concentrations of lead above the 0 3 ppm limit recommended by the World Health Organization A mean lead concentration of 0 392 ppm was observed in sunfish collected from Flat River Creek near the old National Tailings Pile Therefore sunfish from most sites throughout the Old Lead Belt could be considered safe for human consumption even by the most stringent WHO guidelines

Concentrations of lead in filets of Northern Hogsucker were above the 0 3 ppm limit recommended by the WHO in six of the 9 sampling locations for which data were available in 1985 Mean lead concentrations were however well below the 1 0 ppm limit established for commercial food within the United Kingdom Highest absolute lead concentrations (0 887 ppm) were observed in a specimen caught at site number 8 (Flat River Creek near National Tailings Pile)

Lead concentrations in suckers were generally high throughout the entire Old Lead Belt area Highest mean concentrations were observed in the vicinity of the National Tailings Pile gradually decreasing with distance downstream in the Big River

Two other relevant studies have been contracted to the University of Missouri Rolla by The Doe Run Company and previously submitted to USEPA and MoDNR The reports provide more recent data on heavy metals concentrations in fish surface water and sediments in the Old Lead Belt These studies included samples from the Flat River up-stream and down stream from the confluence with the spillway discharge from the Rivermines Site

The United States Geological Survey also conducted a study of water chemistry and sediment in the Old Lead Belt (USGS 1991) It included water and sediment sampling in the Spillway Area of the Rivermines Site both at the toe of the chat pile and at Old Highway 32 Data from soil and water samples collected under this Work Plan are compared with USGS data in sections 2 7 1 3 and 2 7 2 3 respectively

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2 6 Work Plan Implementation

The *Work Plan and Field Sampling Plan Rev 1* (Barr February 15 2001) defined the scope of activities needed at the Site to better define the nature and extent of contamination on Site and to gather data needed for development and evaluation of removal action alternatives All activities listed in the field sampling plan were completed during the field investigation performed in August 2001 with the exception of wet weather water sampling This included walking the toe of all the tailings and chat slopes to identify and sample seeps

2 6 1 Wetlands

An off site wetland evaluation was conducted using a 1998 color aerial photograph the 1954 black and white aerial photograph (Figure 5) the 2 foot site topography the 7 5 minute quadrangle map the St Francois County Soil Survey prepared by the SCS and site photographs taken on April 13 2000

The off site wetland determination was conducted according to the Routine Off Site Determination Method specified in the *U S Army Corps of Engineers Wetlands Delineation Manual* (1987 Edition) All of the data listed above were reviewed to determine the likelihood of wetlands to be present in the area surrounding the tailings No specific vegetation data was reviewed and the wetland determination was based primarily on hydrologic characteristics evident from the topography and indicators on the color aerial photograph The wetlands were mapped on the May 11 1998 aerial photograph

Two apparent wetland areas were identified within the Tailings Area (See Figure 6) The north pond (Wetland 1) appears to be Type 4 deep marsh in accordance with the U S Fish and Wildlife Service Circular 39 Wetland Classification System and a palustrine emergent intermittently exposed wetland (PEMG) in accordance with the U S Fish and Wildlife Service Cowardin Wetland Classification System The wetland is approximately 4 4 acres in size There is a ring of emergent vegetation present around the perimeter and submergent vegetation in the majority of the pond

There is an area about 3 7 acres in size located south of the pond (Wetland 2) which appears to be saturated or ponded for long enough duration to meet the mandatory wetland hydrology criteria Tailings deposition in this area is estimated to be 30 to 50 feet thick but surface soils are frequently saturated and vegetation has become established The topography indicates that Wetland 2 is less than 0 5 foot above the elevation of Wetland 1 which provides strong evidence of extended saturation assuming the surficial substrate/soils between the two basins are permeable The area also

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contains vegetative cover that appears to be similar to the vegetation surrounding the larger pond to the north

Both areas are created wetlands as a result of the tailings disposal operation Since this Site is a CERCLA site any activities approved or required by EPA within wetlands on this site will not require a permit under Section 404 of the Clean Water Act as stated in the December 10 1996 Decision Document for Nationwide Permit No 38 Appendix I includes a copy of the text of Nationwide Permit No 38 and the Internet address for the 25-page long decision document All of the Nationwide Permits were reissued effective March 18 2002 as reported in the Tuesday January 15 2002 Federal Register No alteration of the pond (Wetland 1) is anticipated Wetland 2 will likely be filled if athletic fields are developed at the Site otherwise it will be undisturbed

2 6 2 Decant System Inspection

The drainage culvert that connects decant tower 2 to the outlet at the toe of the chat pile was inspected as part of the physical feature investigation The purpose of the inspection was to determine whether the culvert was in satisfactory condition to continue to serve as a drain for a portion of the Site following the removal action

Two engineers from Barr traveled the length of the culvert from the outlet at its east end to decant tower 2 At the time of the inspection it was presumed that the culvert continued to decant tower 1 near the tailings pond No such continuation was observed However a blockage exists in decant tower 2 just above its base The blockage apparently consists of materials dropped from the top of the tower The potential for debris to fall made it unsafe to enter the base of decant tower 2 from the culvert The base of decant tower 2 is approximately 100 feet below the tailings surface based on a nearby boring (B 6 Figure 6) and the 1905 topography (Figure 4) Both decant towers were also inspected with a mirror from the surface in October 2001 Blockages in both towers prevented observance of the culvert or pipe exiting the base of the tower The depth of the bottom of decant tower 1 is estimated to be approximately 40-feet below the surface based on the 1905 topography

The culvert is a rectangular reinforced concrete box with inside dimensions of 3 0 feet wide by 4 67 feet high with a slightly rounded inside top shape Approximately 150 feet of the culvert s downstream end is exposed beyond the toe of the chat pile The visible portion of the culvert has a wide foundation base and is supported with buttresses It is assumed that the culvert section is similar throughout its length

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Considerable scouring has occurred along the culvert floor from the outlet to approximately 150 feet upstream Several holes have eroded through the culvert wall in this reach The culvert exhibits very little scouring upstream from this reach to decant tower number two with only occasional isolated areas where concrete has eroded or degraded There is no evidence of structural cracking in the culvert walls There is very little debris or trash in the culvert outside the decant tower

Following the field investigation and publication of the draft EE/CA there was suspicion that the two decant towers were not connected This was due both to the absence of a culvert extension at the base of decant tower 2 and the discovery of a 12-inch diameter steel pipe exiting the northwest toe of the tailings slope at the location of sample W 11 on Figure 6 On March 6 2002 dye was added to the overflow occurring from the tailings pond into decant tower 1 The discharge was found to be from the 12-inch pipe The outlet end of the pipe was surveyed to have an invert elevation of 904 03 Considering the tailings elevation of approximately 936 at the decant tower the bottom of decant tower 1 was re estimated to be 30 feet or less below the surface The text and Appendix F Hydrology of the EE/CA have been revised to reflect the separate discharge points of the two decant towers

2 6 3 Mine Shaft Location

The location of one production shaft was identified in the field as shown on Figure 2 Standing water was observed at the entrance to the mine shaft however the mine is reportedly sealed with concrete below the water line All that remains of the old mill facilities are footings two large two story concrete structures and broken up concrete slabs This area is within the site boundaries However access is not restricted and the local residents use the area to dispose of large debris garbage tires etc

Details of demolition of surface facilities and shaft plugging, if necessary will be included in the plans and specifications for the removal action Identification of shafts in the region is an ongoing activity by Doe Run If any additional shafts are identified on the Site they will be added to Figure 2

2 6 4 Geotechnical Sampling and Analysis

Geotechnical samples were collected at the locations shown on Figure 6 to assist in characterizing the Site and in completing a slope stability analysis Results of geotechnical analyses are provided in Appendix D Laboratory analysis of samples was performed by Soil Engineering Testing of

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Minneapolis Minnesota Laboratory testing included sieve and hydrometer analyses Atterberg limits determination and soil classification

2 6 5 Slope Stability Analysis

A stability analysis of the proposed regraded slopes was performed to determine whether the slopes would be stable Appendix E provides a description of the analysis Two cross sections were analyzed one on the east slope of the tailings field and one on the west slope They were identified as critical based on the presence of slime layers in the cross-section The slime layers are observed as outcroppings in the slopes and in the machine boring and cone penetrometer investigations

The factor of safety for static stability at both locations was computed to be approximately 1 6 which exceeds the normally accepted factor of safety under static conditions (1 5)

The results of the seismic stability analysis show that the computed permanent displacement of the slopes can be kept to less than 20 cm which is acceptable For a small area in the vicinity of the critical cross section on the east slope limiting the displacement requires a minor modification to the proposed slope The width of the chat fill must be increased by 15 feet or additional borings be made to clarify the limits of the slimes Liquefaction is not a concern because the slimes layers identified in the borings are too fine to be subject to liquefaction The fine tailings/slimes layer identified in another CPT sounding was not saturated

The above analysis indicates that slumping will not be a problem on the regraded site Evidence of piping is not found on the existing tailing deposits Piping is not a concern after completion of the removal action because the existing tailing pond is the only permanent pond proposed for the Site and it is located well away from the outer slopes of the Site

2 6 6 Hydrology

A conceptual level hydrologic analysis was completed for the Site and tributary upstream areas Conditions were modeled for the primary discharge route across the Site A description of the model procedure and summary of results are provided in Appendix F along with model printouts for the 10 and 100-year 24 hour events The proposed drainage divides are shown on Figure F 1 in Appendix F It was assumed that the upper and lower tailings field flats have a soil cover with established vegetation which would be the most critical case The old stockpile area south of the entrance road is also assumed to have a soil cover because it would be stripped to natural ground

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These three areas along with the spillway watershed were the subject of a hydrologic routing analysis

It was assumed that the regraded outer slopes which will consist of chat and have rock slope protection applied to their surface will generate no runoff based on infiltration test results at the National Site The grain size analyses for the National and Rivermines chat pile samples are similar The drainage area to the quarry was assumed to be landlocked However, the discharge from decant tower 1 was assumed to be routed through the east edge of the quarry and eventually to the sedimentation pond in the spillway The tributary area to Outfall 2 is not modeled because no changes are proposed except for the elimination of runoff from the east tailings field slope by covering it with chat

The routing model includes three detention basins The first is the existing tailings pond in the upper tailings flats which overflows through decant tower 1 A similar detention basin was assumed to be developed for decant tower 2 although it may be normally dry For preliminary design purposes the same size of pond with the same overflow weir length was also assumed to be excavated in the spillway upstream of Outfall 1 For the 10 and 100 year 24 hour storms the pond level bounce for the three detention basins ranged from 1 3 to 5 4 feet and the detention times ranged from approximately 2 7 to 5 9 hours This indicates that the assumed basin sizes are a good starting point for final design

Channels and other drainage features will be designed as part of the final design process to accommodate the modeled discharges Such accommodation may include additional detention basin storage to reduce the peak discharges and allow installation of smaller pipes or channels

2 6 7 Flood Plain

The 100 year flood elevations for the Site are available on the Federal Flood Insurance Rate Map for the City of Park Hills (FEMA 1998) The map indicates that approximately the last 600 feet of the creek connecting the spillway to the Flat River are in the Flat River 100-year floodplain The settling pond on the northwest side of the tailings area is also indicated as a 100-year floodplain The approximate 100 year flood boundary line is shown on the detailed topographic map on Figure 2 of this report

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2 7 Analytical Data

The *Work Plan and Field Sampling Plan Rev 1* (Barr February 15 2001) identified gaps in data available from previous investigations In accordance with the field sampling plan prepared additional samples were collected from the Site in August 2001 A quality control review of the data was completed upon receipt of results This section first describes the analytical sampling completed during the field work and then summarizes the quality control review

2 7 1 Soil Sample Analysis

Twenty-nine soil samples were collected as part of the field investigation and analyzed for total cadmium lead and zinc distributed across the Site as identified below and as shown on Figure 6 Table 3 summarizes analytical data obtained from the samples Laboratory data is included in Appendix C

2 7 1 1 Chat Pile

Samples from this area A-23

A majority of the samples collected in previous studies were collected from the chat pile As a result additional samples from the chat pile were not required under the Work Plan and Field Sampling Plan During the physical feature investigation a small out cropping of gravel and rock material was noted on the southeast corner of the chat pile A sample was collected from the material in the out cropping and is identified as sample A 23 Analytical results from A 23 showed a lead concentration of 5740 ppm cadmium at 17 1 ppm and zinc at 934 ppm The results from this sampling event were consistent with previous sample results reported by Wixson

2 7 1 2 Tailings Area

Samples collected from this area A 11 11s 12, 13 13s 24, 25

Seven samples were collected from the tailings area Two of the seven samples were surface samples Samples 11 through 13 all looked like tailings Analytical results for these samples revealed levels of metals consistent with previous investigations Lead was in the range of 638 to 2 330 ppm cadmium ranged from 29 1 to 38 8 and zinc ranged from 915 to 1 760 ppm Samples 24 and 25 were additional samples collected as a result of the field investigation Sample 24 was collected from the discharge area associated with an approximately 12 inch diameter steel pipe that appears to discharge water from the tailings area into the adjacent wooded area to the west

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Sample 24 appeared to consist mostly of soil with little tailings Sample A 24 contained lead at 735 ppm cadmium at 24 2 ppm and zinc at 1 800 ppm Sample A 25 was collected from what appeared to be grey slimes on the southwest side of the tailings between the tailings area and the LBMOA Sample 25 contained lead at 3 190 ppm cadmium at 63 7 ppm and zinc at 3 020 ppm The results from this sampling event were consistent with previous sample results reported by Wixson

2 7 1 3 Spillway Area

Samples collected from this area A 1 2 3 4 5 6 7 8 9 10 22

Soil samples collected from the spillway were when possible co-located with water samples The spillway was not previously sampled All these samples appeared to be a combination of chat and tailings The sample with the highest lead concentration in the spillway was taken from the toe of the chat pile (A 1) The sample collected from the discharge culvert at the end of the spillway contained the highest levels of cadmium and zinc at 57 7 ppm and 13 600 ppm respectively The remaining sample results had levels of metals consistent with the concentrations found in other samples at this Site The results from this sampling event were consistent with previous sample results reported by Wixson

The following table compares the most recent sample results with results found in the U S Geological Survey report titled Hydrochemical and Sediment Data for the Old Lead Belt Southeastern Missouri 1988 89 (USGS 1991) Samples A-1 and A 6 correspond to USGS sample points 8 and 9 respectively

Sample	Metal	2001 Results	1988 89 USGS Results*
A 1 USGS 8	Lead	10 800 mg/kg	11 067 mg/kg
Toe of the Chat Pile	Cadmium	22 3 mg/kg	84 7 mg/kg
	Zinc	820 mg/kg	30 178 mg/kg
A 6 USGS 9	Lead	3 710 mg/kg	6467 mg/kg
Discharge Culvert	Cadmium	57 7 mg/kg	52 2 mg/kg
	Zinc	13 600 mg/kg	49 000 mg/kg

The number reported in this table is an average of the data collected by the USGS between 1988 and 89

2 7 1 4 Lead Belt Materials Co Operation Area

Samples collected from this area A 14 15 16 17

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Samples were collected from the Lead Belt Materials Co Operation Area Samples A16 and A17 were collected from the area where the old mill was located Sample A16 was composed of fine gravel and soil taken from an area that was backfilled with gravel The sample was the fine materials left after removing the rocks Sample A17 looked like it was a combination of soil chat and cement chips These samples contained lead at 2 470 ppm and 2 020 ppm cadmium at 39 4 and 7 5 ppm and zinc at 1 910 and 399 ppm respectively Samples A14 and A15 were collected from the floor of the chat borrow area These samples contained lead at 5 080 and 6 870 ppm cadmium at 130 ppm and 14 4 ppm and zinc at 2 030 ppm and 590 ppm respectively The results from this sampling event were consistent with previous sample results

2 7 1 5 Other Samples

Samples collected from this area A 21 21s 20 19 18 26

Samples A21 and A21s were collected from the old railroad grade where it exits the property on the southeast corner of the LBMOA This portion of railroad grade was cut into the ground varying from grade to 6 feet in depth The sub surface sample A 21s contained the highest level of lead found on site during this sampling event at 19 300 ppm The corresponding surface sample contained 4 590 ppm lead The sub surface sample was composed of a chat like material The surface sample was composed of soil decayed vegetation and sediment

Sample A20 was collected from the old railroad grade near the southern entrance road to the property This sample had the same texture and size of chat as sample A21s however the color was slightly darker Sample A20 contained lead at 7 420 ppm cadmium at 59 4 ppm and zinc at 2 760 ppm

Sample A19 was taken 20 feet east of the base of the railroad grade where A20 was collected This sample was co located with water sample W10 Sample A19 looked like the chat collected in A20 Samples A19 and 20 contained lead at 8 920 ppm and 7 420 ppm cadmium at 21 1 ppm and 59 4 ppm and zinc at 1 860 ppm and 2 760 ppm respectively

Sample A26 was collected from a seep located on the northeast side of the property east of the tailings area This sample was co located with water sample W13 This sample was collected near the surface due to a rock ledge approximately 4 inches below the surface The sample was composed of a silty clay topsoil mix Sample A26 contained lead at 1 910 ppm cadmium at 34 2 ppm and zinc at 1 570 ppm

Sample A18 was co-located with water sample W09 This sample was collected from a sand bar located in an un named tributary of the Flat River The sample point was located approximately 50 yards west of Old Highway 32 The sample was composed of sand small gravel and soil and contained lead at 1770 ppm cadmium at 7 7 ppm and zinc at 812 ppm

2 7 2 Water Sample Analysis

Thirteen surface water samples were collected Sample locations are shown on Figure 6 Results of water sample analysis are summarized in Table 4 Laboratory data is included in Appendix C All water samples were tested both filtered and unfiltered Samples were filtered in the field using a 40 micron filter The water samples were marked with a U (unfiltered) and F (filtered) suffix

2 7 2 1 Chat Pile

No water samples were collected from the Chat pile

2 7 2 2 Tailings Area

Samples collected from this area W 6 11

The water level of the upper tailings pond was up at the time of the sampling event The edge of the water stopped just past the northern most decant structure Sample W6 was collected from inside the pond s normal level area The water was clear

Sample W11 was collected from a small pool just inside the wooded area fed by a steel discharge pipe on the west side of the tailings area The flow from the pipe at the time of the sampling consisted of a steady drip but due to the depth of the pool and flow channel it is expected to have a higher flow rate during wet conditions

2 7 2 3 Spillway Area

Samples collected from this area W 1 2, 3 4, 5 8

All of the samples collected from the spillway area appeared clear and free of sediment

Sample W1 was collected from the discharge of the decant outlet structure W2 was collected from the spillway discharge culvert that passes underneath the old railroad grade W3 was collected from just upstream of where the spillway creek discharges to the Flat River W4 was collected from the seep in the center of the spillway at the toe of chat pile W5 was collected from the flow on the north

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side of the decant outlet structure This flow was fed by a seep from the toe of the chat pile near the north side of the decant outlet W8 was collected from the flow from a seep in natural ground near the toe of the south side of the chat pile All of these samples contained elevated levels of lead cadmium and zinc The filtered samples showed a very slight reduction in metals concentration

The following table compares the most recent sample results with results found in the U S Geological Survey report titled Hydrochemical and Sediment Data for the Old Lead Belt Southeastern Missouri 1988 89' (USGS 1991) Samples W 2 and W 4 were co-located with USGS sample points 8 and 9

Sample	Metal	2001 Result	1988 89 USGS Results*
W 2 USGS 9 Spillway discharge	Lead	0 081 Mg/L	0 034 Mg/L
	Cadmium	0 027 Mg/L	0 017 Mg/L
	Zinc	8 1 Mg/L	4 9 Mg/L
W 4 USGS 8 Toe of Chat Pile	Lead	0 113 Mg/L	0 058 Mg/L
	Cadmium	0 033 Mg/L	0 021 Mg/L
	Zinc	23 4 Mg/L	15 Mg/L

The number reported in this table is an average of the data collected by the USGS between 1988 and 89

2 7 2 4 Lead Belt Materials Co Operations Area

Samples collected from this area W 7, 12

Sample W7 and W12 were collected from the two ponds within the LBMOA that are closest to the tailings Sample W7 was collected from the pond used for cooling water in the asphalt operation Water from this pond may be discharged under an NPDES permit Sample W12 was collected from another pond that receives runoff from a portion of the tailings slope which include slimes These samples had elevated metals Filtering slightly reduced the concentration of metals

2 7 2 5 Other Samples

Samples collected from this area W-9 10 13

Samples W9 10 and 13 were collected near the boundaries of the property W9 and W13 were collected from the unnamed tributary that collects surface flow from the northern portion of the property W9 was collected from a large standing pool of clear water approximately 50 yards upstream from Old Highway 32 Water at this point of the tributary appeared to be flowing at no more than a trickle W13 was collected from an upstream seep feeding the tributary The seep

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generated a steady flow of clear water The flow was approximately 1 5 to 2 feet wide and 1 to 2 inches in depth

Sample W10 was collected from a seep on the southeast side of the old railroad grade in the southeast corner of the property near the facility entrance road The source of the seep appeared to be a large area of standing water on the north side of the railroad grade

2 7 3 Quality Control Review

A review of the quality control data was conducted to assess the integrity of the sampling procedures and the validity of the analytical results for the Rivermines Site The quality control practices and procedures both field and laboratory are detailed in the *Quality Assurance Project Plan* (QAPP) (Barr 2000) Samples collected at the Site were analyzed by Southwest Laboratory of Oklahoma Inc located in Broken Arrow Oklahoma using U S EPA Method SW846 3010A/6010B for cadmium lead and zinc

This section contains reviews of the field sampling procedures and laboratory performance The analytical data was evaluated according to the procedures outlined in the *Barr Engineering Standard Operating Procedures For Routine Level Inorganic Data Validation* (Barr 1997)

2 7 3 1 Field Sampling Quality Control

Field blanks were collected and analyzed to monitor potential contamination from incomplete decontamination of sampling equipment sample transport contamination and laboratory procedures Low levels of zinc were present in the field blank The most likely source is from incomplete decontamination procedures or laboratory contamination All data within five times the blank value was qualified as a potential false positive

2 7 3 2 Laboratory Performance

The laboratory quality control review was assessed by reviewing the holding times and method blanks masked duplicates and laboratory control spike analysis All holding times were met for the project samples The laboratory preparation blanks contained low level detections of zinc All data within five times the blank value was qualified as a potential false positive All analysis procedures were determined to be appropriate and did not adversely affect the quality of the project data

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2 7 3 3 Precision

Laboratory control and matrix spikes were analyzed with the sample batches and one field duplicate was collected and used to determine the overall precision of the sampling and analysis procedures The precision was determined by calculating the Relative Percent Difference (RPD) for the data pairs where both values were above the detection limit

The laboratory spikes all displayed RPDs at 30 or less except for the duplicate for lead associated with some of the samples collected on August 13 and 14 2001 All lead results associated with this sample duplicate were qualified The masked duplicates displayed RPDs of less than 30% indicating relatively good precision

2 7 3 4 Accuracy

All laboratory control spikes displayed accuracy within laboratory acceptance limits with the exception of the ICP serial dilution associated with some of the samples collected on August 13 14 and 15 2001 This serial dilution exceeded laboratory control criteria for all the elements present indicating some potential interference present in the sample This is most likely the result of high levels of the target compounds being present in the samples All associated results have been qualified to indicate QC criteria not met

2 7 3 5 Conclusions

The project data quality objectives were met by the sample collection and analysis activities All data is determined acceptable with above mentioned qualifications

2 8 Streamlined Risk Evaluation

Exposure of humans and other organisms to lead and its compounds may occur by inhalation or ingestion This results in lead accumulation in living tissues including blood Human exposure may result in toxic effects to the brain and central nervous system resulting in lead encephalopathy permanent brain damage peripheral neuropathy, and in children permanent learning disabilities Kidney damage may occur which may be reversible following short-term exposure but is permanent if exposure is prolonged Exposure may inhibit hemoglobin synthesis, resulting in anemia and shortened life span of red blood cells Lead exerts a toxic effect following conception and may injure fetuses The International Agency for Research on Cancer has determined that lead is carcinogenic in laboratory animals, it is a suspected human carcinogen Arsenic and cadmium are classified as A and B1 inhalation carcinogens respectively (USEPA 1993b)

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A significant exposure route associated with the Rivermines Site is the air pathway The tailings material at the Site is easily suspended in the air and carried off site by winds where it can accumulate in nearby residential soils Airborne concentrations of lead may also occur through circulation of lead contaminated dust by on-site activities such as off road vehicle use It is possible contamination may be carried into homes by foot tracking placing young children and other family members at increased risk of exposure to lead The lead levels on-site could pose a specific threat to females who are pregnant because developing fetuses are particularly vulnerable to the toxic effects of lead Site access is currently not restricted and it has been reported that many people have used the tailings piles for recreational purposes such as riding all terrain vehicles These activities promote airborne release of contaminants (USEPA 1993b)

Children may use the area as a playground Young children are the most likely to play in soil and to place their hands and other objects in their mouths increasing the opportunity for ingesting lead contaminated soil (USEPA 1993b)

The levels of lead in the on site tailings pose a potential threat to animal life coming into contact with the soil and to freshwater aquatic life encountering runoff from the Site Lead has the potential to bioaccumulate in the food chain Lead is toxic to mammals fishes, and birds especially waterfowl and it can reduce or eliminate various bacteria or fungi that assist in decomposing organic matter (USEPA 1993b)

The potential for contamination of the St Francois aquifer system (Bonne Terre and Lamotte formations) by the tailings appears to be minimal The groundwater study is addressed in the Area Wide Remedial Investigation/Feasibility Study being submitted in January of 2002

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3 0 Identification of Removal Action Objectives

3 1 Statutory Limits on Removal Actions

Guidance provided in *Guidance on Conducting Non Time Critical Removal Actions Under CERCLA* (USEPA 1993a) indicates that this Site is not subject to the statutory limits on schedule (12 months) and cost ($2 million) These limits apply only to Superfund financed removal actions

3 2 Determination of Removal Action Scope

The overall scope of the removal action will seek to reduce the erodibility of the tailings (and the related potential for off site transport via wind or water) as well as stabilize the tailings slopes to minimize future exposure of human or ecological receptors

3 3 Determination of Removal Action Schedule

It is expected that the recommended removal action will be implemented at the Site in phases defined by the Site areas The grading plan is shown on Figure 7 The Tailings Area will be worked on first The eastern and western slopes will be supported by placement of chat borrowed from the Chat Pile The surface of the Tailings Area will be graded to its final contours If athletic field use is not anticipated, the Tailings Area will be vegetated after grading is complete subject to seasonal considerations Prior to vegetation a minimum of 6 inches of clay cover soil from on site will be placed However if The Doe Run Company prepares a vegetation plan and demonstrates that directly seeding the tailings will meet ARARs the EPA will approve the plan and no soil will be required The Chat Pile will then be regraded beginning on its northeast side where it adjoins the Tailings Area eastern slope and working around the south side of the Chat Pile The excavation of the Spillway and stripping and demolition in the former stockpile area south of the entrance road will be ongoing during the first tasks and will be completed at this point The final grading activity will be the grading of the south slope of the Tailings Area and the east slope of the Chat Pile These slopes will be adjusted as necessary to result in a material balance for the Site

Slope Areas requiring rock slope protection will be covered as construction proceeds If athletic field use is planned soil cover for the Tailings Area will be placed near the end of the overall Site grading process to minimize contamination due to dust blown from unreclaimed parts of the Site It is assumed that most of the facility development for any athletic facilities will take place after the

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removal action is complete The overall work is expected to begin in the summer of 2004 and be finished within about 2 years

3 4 Planned Removal Activities

Removal activities are expected to include

- Excavation and consolidation of applicable tailings and chat materials to reduce the quantity of cover materials required
- Regrading to stabilize steep slopes
- Application of rock cover to slopes
- Revegetation including possible use of soils to reduce exposure of the public and minimize erosion
- Implement administrative controls including deed restrictions to prevent the public access to some areas and restrict land use at the Site

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4 0 Identification and Analysis of Removal Action Alternatives

As outlined in the work plan (Barr February 15 2001) there are several technologies that may be incorporated into a final remedy for the Site They are

- Slope stabilization
- Surface stabilization
- Drainage and sediment controls
- Grading
- Administrative controls

Each technology has advantages and disadvantages and it is likely that a combination of these technologies will be needed to meet the removal action objectives for entire Site Considering this information the following removal action alternatives have been developed

- Alternative 1 No Action
- Alternative 2 Administrative Controls Only
- Alternative 3 Storm Water Pollution Prevention Plan (SWP3) Control of Wind Erosion and Slope Stability Considerations
- Alternative 4 Other alternatives specific to sub areas of the Site

The alternatives were evaluated for their applicability for implementation The following sections describe the alternatives as they may be implemented at each of the site sub areas Total costs for Alternatives 2 3 and 4 are compared in Table 5 The Alternative 3 grading plan is shown on Figure 7 The recommended alternative which combines Alternatives 3 and 4 is shown on Figure 8

4 1 Alternative 1—No Action

Alternative 1 is the no action alternative required for analysis as stated in the U S EPA Guidance on conducting non time critical removal actions Under CERCLA August 1993 The purpose of the no action alternative is to act as a baseline condition for comparing the effectiveness of the various other alternatives There are no issues with implementability and there are no capital or operation and

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maintenance (O&M) costs to consider The no-action alternative would not provide any additional protection of public health and the environment and the risk would be the same as the existing conditions The no action alternative would not prevent wind erosion Suspended particulate and contaminants in the surface water runoff would continue to drain towards the Flat River

Because this alternative would not meet removal action objectives and would not be protective of human health and the environment Alternative 1 was eliminated from further consideration

4 2 Alternative 2—Administrative Controls

Alternative 2 is the implementation of administrative controls for the Site Administrative controls may include some or all of the following deed restrictions on the property warning signs and barrier fences and gates to inhibit trespassing full or part time surveillance to prevent trespassing and air and surface water monitoring

Administrative controls are also included as part of the various action alternatives Administrative controls only (Alternative 2) includes a minimum of a 6-foot chain link fence around the Site The various action alternatives do not include this fence because the surfaces will have been remediated Both the administrative controls only and the action alternatives include the cost of long term air and water monitoring

4 3 Alternative 3—Stormwater Pollution Prevention Plan (SWP3), Control of Wind Erosion, And Slope Stability Considerations

Alternative 3 includes implementation of the stormwater pollution prevention plan Appendix A for the Site The goal of the SWP3 is to reduce the amount of material migrating off site through soil erosion utilizing a minimal amount of material movement and construction Wind erosion must also be controlled since dust from the site reaching adjacent areas can be carried in runoff from those areas Geotechnical investigations performed after the SWP3 was prepared have indicated that the east and west slopes of the Tailings Area require placement of additional fill to support slimes materials Because an SWP3 alternative that did not also meet stability requirements would be unacceptable grading to meet stability requirements is also included in Alternative 3

The main chat pile (Figure 7) currently has slopes as steep as 1 5 horizontal to 1 vertical This alternative reduces the outer slopes of the pile to 3 horizontal to 1 vertical to allow the placement of 12 inches of rock slope protection for wind erosion control The rock protection will also be placed

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on top of the pile The rock used for slope protection will be selected for limited amounts of fine fractions in an effort to discourage weed growth and promote vertical infiltration Runoff from the chat pile is assumed not to occur because of the high infiltration capacity of the relatively coarse chat material

Gullies and the depression in the center of the Tailings Area (Figure 7) will be sloped and filled in as necessary to reduce the potential for erosion The top surfaces of the Tailings Area will be vegetated Prior to vegetation a minimum of 6 inches of clay cover soil from on site will be placed However if The Doe Run Company prepares a vegetation plan and demonstrates that directly seeding the tailings will meet ARARs the EPA will approve the plan and no soil will be required Runoff will be routed to the existing settling basin to the extent possible (Figure 7) The existing settling basin drains through decant tower 1 during high water levels Diversion of runon from the natural slopes north of the existing settling basin was considered However it is relatively impractical due to the steep slopes (5H 1V) shallow bedrock and heavy woods Due to the expense of repairing the culvert carrying the discharge from the decant tower 2 it will be sealed and abandoned (Figure 7) The portion of the tailings area not tributary to decant tower 1 will be routed to an infiltration/evaporation pond developed in the existing depression where agricultural lime has been removed (Figure 7)

The stormwater pollution prevention plan calls for a series of berms in the Spillway identifying them as Structure A (Figure 7) The existing spillway berms are breached reportedly by local off road enthusiasts Prior to the breach vegetation in the ponds created by the berms significantly reduced the amount of metals in the discharge with the exception of zinc The berms will be restored and some of the existing tailings material trapped behind the berms in the Spillway will be excavated and placed back on the remainder of the Site as fill Aquatic plants will be established in the ponds by placing excavated material from other ponds in the vicinity in the new ponds (Figure 8)

Tailings material deposited downstream of Old Highway 32 along the channel to the Flat River will also be excavated and returned to the Site (Figure 8) The old railroad grade crossing the Spillway will be removed and disposed on site (Figure 8) Tailings have been visually identified in an area approximately 1500 feet long and up to 200 feet wide between Old Highway 32 and the existing railroad This area will be referred to as trackside tailings (Figure 2) Tailings in this area will be excavated and returned to the site The area will then be revegetated (Figure 8)

A grading plan has been developed to meet the requirements of Alternative 3 with a minimum amount of material movement It is also designed to be compatible with the other sub area specific

alternatives under Alternative 4 The plan is shown on Figure 7 Details of the plan are discussed below

The chat pile slope will be reduced to 3 horizontal to 1 vertical to allow installation of rock slope protection To obtain fill for use elsewhere the top elevation will be lowered approximately 50 feet This will bring the Chat Pile Area level with the Tailings Area at approximately Elevation 930 making the Chat Pile visually indistinguishable from the Tailings Area following construction To minimize excavation of the pile when cutting back the slope the eastern toe of the pile will be extended eastward approximately 75 feet Existing material beneath the new toe in the spillway will be excavated and replaced as necessary The final height of the chat pile from the toe in the spillway will be approximately 150 feet

Surplus material excavated from the chat pile will be used to provide a compacted fill at a 3 horizontal to 1 vertical slope against the eastern and western slopes of the Tailings Area This is necessary to meet slope stability requirements by providing support to the existing slopes which include slimes layers This is discussed further in Section 2 6 5 The contours on Figure 7 for these slopes are conservative in terms of slope stability More detailed analysis of these slopes during final design may reduce the horizontal distance between the existing and proposed slopes and therefore the required fill Otherwise the proposed contours on these slopes are relatively fixed Like the Chat Pile slopes these slopes will be covered with rock slope protection

The stormwater pollution prevention plan (Appendix A) includes what is identified in the plan as Structure C This consists of regrading and riprapping the portion of the slope on the east side of the Tailings Area which is tributary to Outfall 2 (Figures 2 and 7) This is included in the regrading work for slope stability as described in the paragraph above The defined channel leading to Outfall 2 begins approximately 400 feet downhill from the toe of the regraded slope Special attention will be given to establishing a vegetative buffer in the non wooded portions of the area between the toe and the defined channel

The south slope of the Tailings Area (which will actually be constructed in what has been identified as the LBM Co Operating Area (Figure 2) will be constructed to provide stability while minimizing the fill which must be imported from elsewhere such as the Chat Pile Unlike the eastern and western slopes the location of the slope crest and toe in this area are relatively unrestricted by slope stability considerations or adjacent wooded natural areas Therefore an outer slope of 4 horizontal to 1 vertical has been proposed This may also reduce total material movement by better matching

existing slopes The location of this slope may be adjusted to correct for any material imbalances which occur during final design or which are discovered during construction Like the Chat Pile slopes these slopes will be covered with rock slope protection

The relatively flat area between the toe of this slope and the entrance road (Power Street) will likely be used for disposal of excavated materials from the Spillway Area stripping from the area south of the entrance road demolition debris from the Mine Shaft Area and similar materials (Figure 7) This area will also be covered with rock Rock cover is necessary because the disposed materials mentioned above will be overlain with surplus chat from regrading the chat pile Chat is more difficult to vegetate than tailings

The portion of the LBM Co Operations Area south of the entrance road will be stripped to natural ground and graded to drain to a ditch on the south side of the entrance road (Figure 8) A new culvert (Structure B of the Stormwater Pollution Prevention Plan) will be installed at the east end of the ditch to carry the discharge under the entrance road and thence to the new detention ponds in the Spillway (Figure 8)

The approximate boundary between the tailing contaminated portions of the site and the quarry is the west boundary line of the Lead Belt Materials Operations Area as shown on Figure 2 This boundary is our best estimate of the limits of tailings on the surface, based on aerial photographs and field observations During the removal action visual observation test pitting and XRF sampling and testing will be used to identify the precise limits of contamination Then stripping rock cover or vegetation will be used as appropriate Demolition and removal of all remains of mill buildings to the disposal area identified above is included in Alternative 4 5 Section 4 4 5 (Figure 8)

A depressed section of the old railroad grade into the site was sampled at A21 and A21S (Figure 6) and found to be contaminated The bottom of the depressed area will be stripped from the end of the depression approximately 50 feet south of the sampling point to the entrance road approximately 250 feet north of the sampling point This work will require significant tree removal Between the depressed area to be stripped and the fill portion of grade to be removed as part of the Spillway work the old railroad alignment is occupied by two parcels of residential private property (Figure 3) The grade has been obliterated in this area The two parcels are included for soil sampling as part of the Interim Action St Francois County Missouri

The top of the regraded Tailings Area has two levels to accommodate the existing ground elevations (Figure 7) For the purpose of estimating excavation volumes, they have been assumed to be level at

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Elevation 930 and Elevation 915 respectively During final design they will be sloped to provide drainage Raising the 23-acre lower area by 15 feet to match the elevation of the upper area would require over one half million cubic yards of fill Since leveling the entire area has no obvious benefits such an alternative was not considered The regraded Tailings Area will be vegetated Prior to vegetation a minimum of 6 inches of clay cover soil from on site will be placed However if The Doe Run Company prepares a vegetation plan and demonstrates that directly seeding the tailings will meet ARARs the EPA will approve the plan and no soil will be required

The Alternative 3 grading plan is designed to have a material balance It assumes that LBM Co s removal of agricultural lime and chat continues until the Spring of 2004 or four years after the date of the aerial photography on which the existing topographic map is based After adjusting for this removal (220 000 cubic yards) the total volume of cut remaining during the removal action is 830 000 cubic yards The required volume of fill in the Alternative 3 grading plan is 700 00 cubic yards allowing for 15 percent shrinkage from cut to fill If the material quantity removed by LBM Co is less the grading plan can be modified slightly to maintain approximately the same volume of cut and fill during the removal action

As noted previously the relatively flat area between the toe of the southern slope and the entrance road (Power Street) will likely be used for disposal of excavated materials from the Spillway Area stripping and demolition debris from the area south of the entrance road and similar materials (Figure 7) The contours in the Alternative 3 grading plan do not reflect this Disposing of this material would result in an average increase in elevation in that area of only 10 to 15 feet resulting in a negligible impact on the overall appearance of the Site The approximate shape of the filled disposal area is shown on Figure 8

4 4 Other Alternatives

These alternatives are relevant to specific portions of the Site and could be added to or subtracted from Alternative 3 as appropriate

4 4 1 Alternative 4 1—Re-Use/Recycle

As noted in Section 2 1 4 Lead Belt Materials Co (LBM Co) is removing approximately 20 000 cubic yards per year from the Tailings Area for sale as agricultural lime (Figure 2) They are also removing approximately 35 000 cubic yards per year from the Chat Pile for use as aggregate in their bituminous mix operation The grading case presented under Alternative 3 assumes that this will

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continue until the Spring of 2004 drawing to a close as removal action construction is about to begin During preparation of the Second Revision EE/CA it was agreed that sale of agricultural lime will cease as of August 1 2003 This will not significantly affect the grading plan

Under Alternative 4 1 portions of the Chat Pile will be set aside for continued use in their operation Requirements and restrictions for controlling LBM Co s use of the chat will be added to their lease from Doe Run LBM Co will be allowed to continue their operations at the Site as long as controls are effective in preventing the off site migration of chat All handling of chat at the site is already covered by an Air Operating Permit A low point will be maintained in the chat excavation area to collect any sediment due to water erosion

In addition plans will be established outlining how much of the chat will be removed where it will be excavated and what final contours will look like Final contours will be established based on slope stability requirements and LBM Co will not be allowed to excavate beyond those contours The chat available for removal will be limited to what is left after all material needed elsewhere for the removal action is removed and will exclude what must be left in place to provide a stable slope and buttress for the finer tailing in the Tailings Area It may be necessary to stockpile some of the desired materials elsewhere than their existing location in order to facilitate closure of as much of the site as possible during the removal action The removal action and subsequent LBM Co operations would likely include placement of a temporary rock cover for areas which are inactive but subject to future excavations

It is estimated that more than 30 years of chat can be removed from the Site at the current rates before the supply of material not needed to maintain slope stability is exhausted Only a relatively small portion of the Site (the western face of the Chat Pile) would need to be left open to allow continued use of the chat Because only the timing of application of a portion of the final cover is changed and not the total amount of cover applied the incremental cost estimate to implement this alternative is zero Additional detail regarding potential continued LBM Co operations using chat is included in Appendix J and Figures J-1 J 2 and J 3

LBM Co will be required to comply with all EPA regulations including the implementation of a Stormwater Pollution Prevention Plan

If Alternative 4 1 is not selected the LBM Co s lease on the portion of Doe Run property containing tailings and chat will be canceled Whether LBM Co remains active on the quarry portion of Doe

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Run property would be at the discretion of Doe Run A schedule will be prepared for mobilizing off site including any clean up required to remove any contamination from LBM Co s operation

4 4 2 Alternative 4 2—Grading and Cover for Athletic Complex

The Tailings Area may be developed into an athletic complex The potential athletic area has upper and lower levels (Figure 8) The upper tailings field will drain to the existing surface water pond and decant tower 1 The lower level will be created by regrading the existing large depression to drain to a lowered inlet on decant tower 2 Areas intended for active athletic use will first be covered with 12 inches of cover soil from on site and 6 inches of vegetative soil from off site and eventually be vegetated with a mix of athletic field grass Any unused areas will be vegetated after placing a minimum of 6 inches of cover soil on the tailing

Development of an athletic area will require a lease agreement with the City of Park Hills covering liability operations and maintenance and development costs The potential area of development is as much as 70 acres Athletic field development will require more detailed grading than Alternative 3 This is necessary to provide crowns on the fields swales between the fields parking areas etc The additional grading has been estimated at approximately one foot over the entire area or approximately 100 000 cubic yards

A general site layout for potential athletic fields was previously prepared for Doe Run at the request of the City of Park Hills That layout is included in Appendix H That conceptual layout was used to prepare the recommended alternative schematic plan shown on Figure 8

4 4 3 Alternative 4 3—Retaining Decant Tower 2

The culvert conveying the discharge from decant tower 2 was inspected during the EE/CA field work The purpose was to determine if it may convey surface water overflow from a potential additional detention basin at decant tower 2 and what the nature of the necessary repairs might be

Alternative 3 assumes that decant tower 2 is abandoned and that an evaporation/infiltration pond is established in the area of the agricultural lime excavation (Figure 7) Maintaining decant tower 2 and developing the associated normally dry ponding area (Figure 8) is only necessary if the Tailings Area is developed for athletic fields The soil cover will create increased runoff and it will be necessary to control pond levels to avoid flooding the fields Therefore Alternative 4 3 will be implemented only in conjunction with Alternative 4 2

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The cost estimate for decant culvert repair includes the entire length from the tower to the end of the culvert extension at the toe Costs are also estimated for reworking the tower inlets

4 4 4 Alternative 4 4—Treatment Ponds in Spillway

This alternative expands the detention ponds in Alternative 3 into treatment ponds (Figure 8) The treatment ponds will be designed specifically to lower the concentrations of metals including zinc in the discharge water Treatment technologies may include biological physical and chemical means If biological means are used plants known to aid in the removal of metals and particulate will be planted in the ponds The treatment ponds will be more complex than detention ponds and therefore require more engineering grading and construction work Treatment ponds are assumed to include excavation of the spillway to natural ground or an additional 50 000 cubic yards of excavation beyond Alternative 3

This alternative includes two sub alternatives Under Alternative 4 4A the spillway will be excavated to natural ground but further steps will not be taken pending operating experience with the enlarged ponds Alternative 4 4B includes the addition of advanced treatment methods The cost estimate for Alternative 4 4B assumes passive biological treatment The system assumed for the cost estimate is sized based on the removal of zinc It consists of a constructed wetland with an organic substrate Zinc is removed by sulfate reduction under anaerobic conditions resulting in the precipitation of insoluble metal sulfide

4 4 5 Alternative 4 5—Close Mine Shaft

The original mine shaft is located in the area where LBM Co currently operates (Figure 2) Field work performed during EE/CA preparation indicates that the shaft has been sealed Further field work including dewatering above the assumed shaft seal for a closer inspection will be performed during the removal action phase Additional demolition, debris cleanup and regrading in the mine shaft area may also be appropriate The cost estimate for Alternative 3 already includes 50 000 cubic yards of excavation in the area south of the entrance road including the Mine Shaft Area This is based on the surface area and an assumed stripping depth of five feet Alternative 4 5 adds the additional work of demolition of all of the old mine buildings on site (except those in active use by LBM Co) and disposal in the area just north of the entrance road (Figure 8)

5 0 Comparative Analysis of Removal Action Alternatives

Based on the identification of the removal action alternatives presented in Chapter 4 a comparative analysis of the alternatives was made The purpose of this comparative analysis was to identify the advantages and disadvantages of each alternative relative to the others as well as ensure that the recommended alternative would best address the criteria listed below

- Overall Protection of Public Health and the Environment
- Compliance with ARARs and other Criteria Advisories and Guidance
- Short Term Effectiveness
- Long Term Effectiveness and Permanence
- Reduction of Toxicity Mobility or Volume Through Treatment
- Technical Feasibility
- Administrative Feasibility
- Availability of Services and Materials
- Regulatory Acceptance
- Community Acceptance
- Cost

The recommended alternative will be presented in Chapter 6

Table 5 summarizes costs for the removal action alternatives

5 1 Effectiveness

Effectiveness is evaluated in terms of protection of public health and the environment compliance with ARARs and other criteria, advisories and guidance short-term effectiveness long term effectiveness and permanence and reduction of toxicity mobility or volume through treatment

5 1 1 Overall Protection of Public Health and the Environment

The no action and administrative control alternatives are inferior to the more proactive alternatives under this criterion Administrative Controls would restrict access to the tailings and chat areas and thus reduce direct human exposure However human exposure through windblown tailings and

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erosion of tailings into Flat River would continue Likewise wildlife would still be subject to direct exposure on the Site and aquatic life would still be exposed in Flat River Therefore administrative controls as a stand alone alternative will not be given further consideration however some administrative controls will be incorporated into the selected alternatives as appropriate

The remaining alternatives are considered satisfactory in terms of overall protection of public health and the environment and can meet ARARs and other criteria

5 1 2 Compliance with ARARs and Other Criteria, Advisories, and Guidance

The following applicable or relevant and appropriate requirements (ARARs) for the Elvins/Rivermines Mine Tailings Site were identified in the *Work Plan and Field Sampling Plan Rev-1* (Barr February 15 2001)

5 1 2 1 National Ambient Air Quality Standards (NAAQS)

The NAAQSs under the Clean Air Act 42 U S C §7401 et seq 40 CFR Part 250 and 10 CSR 10 6 010 establish ambient air quality standards for emissions of lead and particulate matter The removal action may involve regrading and movement of tailings and chat which could cause the airborne release of both lead and particulate matter Because the Site is not considered a ' major source" under the Clean Air Act the NAAQSs are not applicable However they are relevant and appropriate during on site construction activities Air monitoring and controls such as dust suppression will be implemented as necessary during removal activities to ensure that airborne emissions of particulates and lead during removal actions are below the following NAAQSs (a) for particulate matter less than 10 microns 150 µg/m3 24-hour concentration or 50 µg/m3 annual arithmetic mean (b) for lead 1 5 µg/m3 quarterly average

5 1 2 2 Fugitive Particulate Matter Regulations

The Fugitive Particulate Matter Regulations 10 CSR 10 6 170 provide restrictions on releases of particulate matter to ambient air These regulations will be applicable to any fugitive emissions of particulate matter which occur as a result of on-site construction activities

5 1 2 3 Surface Mining Control and Reclamation Act (SMCRA)

SMCRA governs activities associated with coal exploration and mining Because the standards and regulations promulgated under SMCRA are intended for active coal mines they are not applicable to actions at the Elvins/Rivermines Mine Tailings Site However some of the surface mining standards

found in 30 CFR Part 816 are relevant and appropriate because they address circumstances that are similar to those found at the Elvins/Rivermines Mine Tailings Site

Sediment Control Measures (§816 45)

SMCRA requires that sediment control measures be designed constructed and maintained to minimize erosion and prevent additional sediment from entering the stream flow of adjacent watercourses

Siltation Structures (§816 46)

SMCRA requires that when siltation structures such as sedimentation ponds are used they must contain spillways and be designed to (1) provide adequate sediment storage volume (2) contain or treat 10 year 24 hour precipitation events and (3) provide a non clogging dewatering device adequate to maintain detention time

Grading Requirements (§816 102)

SMCRA requires that disturbed mining areas be graded to minimize water pollution and erosion eliminate high walls and depressions prevent slides and achieve original contour

Revegetation (§816 111)

SMCRA requires that on regraded areas and all mining disturbed areas a vegetative cover must be established which is comprised of native species capable of stabilizing surface soil from erosion permanent and capable of self-regeneration

5 1 2 4 Clean Water Act (CWA) Direct Discharge Requirements

On site discharges from a CERCLA Site to surface waters must meet the substantive requirements of the National Pollutant Discharge Elimination System (NPDES) program These include use of best available technology economically achievable pursuant to Section 301(b) of the CWA and compliance with state effluent limitations and water quality standards pursuant to 10 CSR 20-7 015 and 10 CSR 20 7 031

Section 404 of the CWA regulates the placement of fill in waterways dredging of materials from waterways and wetlands impact mitigation The substantive requirements of a Section 404 permit, issued by the U S Army Corps of Engineers may need to be met depending on the final design

5 1 2 5 Storm Water Requirements (10 CSR 20 6 200)

The State of Missouri has promulgated regulations that are applicable to storm water discharges associated with areas where industrial activity including mining has taken place in the past and significant materials remain and are exposed to storm water The substantive requirements of the

storm water program must be complied with at the Site so long as runoff from the Site comes into contact with the tailings Detailed requirements for the Rivermines Site are in the Stormwater Pollution Prevention Plan in Appendix A

5 1 2 6 Protection of Flood Plains

As required by Executive Order 11990 and 40 CFR 6 Appendix A, if a proposed federal government action is located in or affects a 100 year floodplain the action must be designed and carried out so as to avoid adversely impacting the floodplain wherever possible In addition the actions' planning must reflect consideration of flood hazards A flood insurance study exists for the City of Park Hills (FEMA 1998)

5 1 2 7 RCRA Subtitle D Solid Waste Disposal Regulations

The RCRA Subtitle D program (40 CFR Part 257) as well as the State of Missouri Solid Waste Management Law and Regulation regulates the management of non hazardous solid waste 40 CFR Part 257 establishes requirements for maintenance of a facility at which solid wastes are disposed These regulations are relevant and appropriate for the removal action The regulations require that the facility be maintained so as to prevent a wash out of solid waste and that the public not be allowed uncontrolled access to the facility

5 1 2 8 Other Criteria to be Considered

In addition to applicable or relevant and appropriate requirements EPA and the state may identify other advisories criteria, or guidance "to be considered' for a particular release or response action Following are the "to be considered" criteria and guidance for this removal action

5 1 2 8 1 State of Missouri Metallic Minerals Act

This law only regulates closure of active metallic minerals mining operations Thus it is not an ARAR for closure of abandoned mine lands such as the Site However the closure standards and criteria under the Metallic Minerals Act will be reviewed and considered during design of the removal action

5 1 2 8 2 EPA/OSWER Interim Guidance on Soil Cleanup Levels

EPA/OSWER Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities OSWER Directive #9355 4 12 July 14 1994 and EPA/OSWER Clarification to the 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities

OSWER Directive #9200 4 27 August 1998 sets an interim soil cleanup level for residential settings of 400 ppm total lead At the Rivermines Mine Tailings Site a number of residences are located in the vicinity of the site and thus it is likely that children have and will play on or near the tailings pile Residential areas surrounding or adjacent to the site will not be addressed in the EE/CA for the site However the interim soil cleanup levels will be important for the evaluation of institutional controls at the site

5 1 2 9 Discussion of Compliance with ARARs and other Criteria, Advisories and Guidance

Alternatives that involve surface grading or moving of tailings and chat can be designed and implemented in accordance with the ARARs All proactive alternatives will provide grading to minimize erosion and improve slope stability followed by a protective surface cover of either rock soil and/or vegetation

All ponding areas will be designed to handle 10-year 24 hour precipitation events Work at the Site will include implementation of a Stormwater Pollution Prevention Plan A treatment system will be developed as necessary in the spillway to meet CWA discharge requirements Work in the floodplain of the Flat River will be limited to removal of tailings

5 1 3 Short-term Effectiveness

Alternative 3 provides short-term effectiveness The vegetative cover can be seeded shortly after grading in individual areas is complete Areas such as the Spillway and the eastern slope of the Tailings Area which have the greatest potential for water erosion can be worked on first Temporary erosion control measures will be applied as appropriate Dust control measures will be taken as necessary to meet air quality standards

Alternatives 4 1 through 4 5 have little influence on short term effectiveness with the exception of Alternative 4 2 Grading and Cover for Athletic Complex That alternative is somewhat less effective for dust control in the Tailings Area in the short term That is because the placement of soil cover will be delayed until most of the Site work is complete to prevent the soil from being contaminated by wind born tailings from elsewhere on the Site Alternatives 4 1 through 4 5 have little effect on the duration of construction Therefore with the exception of Alternative 4 2 there is no significant difference in environmental impact and worker or public exposure among the alternatives

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5 1 4 Long-term Effectiveness and Permanence

The primary risks to long term effectiveness and permanence are failure of the rock vegetative or soil and vegetative cover resulting in erosion of tailings and uncontrolled future human intrusions into the closed tailings deposit The risk of erosion will be controlled by regular inspection of the Site and patching and revegetation as needed under Alternatives 3 and 4 2 The risk of human intrusion will be controlled by deed restrictions public education the vigilance of law enforcement staff and observations made during inspection and maintenance of the cover

Alternative 3 has excellent long term effectiveness provided that the vegetated tailings areas are maintained Runoff from the Tailings Area flows to either a permanent pond or to a closed depression trapping sediment on the Site Alternative 4 1 Re Use/Recycle has less long term effectiveness because it will leave a small portion of the Site vulnerable to off-site migration of chat for an extended period

Alternative 4 2 Grading and Cover for Athletic Complex has both pluses and minuses in the long term Use as an athletic field subjects the Tailings Area to frequent observation and regular maintenance in the form of mowing fertilizing and reseeding Use as athletic fields also provides much greater public access and potential for intrusion However this is offset by much more frequent observation by city staff and law enforcement to safeguard their investment in the facilities

Alternative 4 3 Retaining Decant Tower 2 must be included if the complete athletic fields complex is constructed In general the concrete underground decant culvert is a long term liability Concrete eventually deteriorates and the buried nature of most of the culvert creates the potential for long-term observation and repairs to be inadequate However despite being abandoned for 60 years and likely being at least 20 years older than that, it is still structurally sound Repairs to wall cracks and portions of the floor and lower walls are proposed to bring the culvert back to good condition and maximize its remaining life These steps will minimize the long term risks associated with keeping decant tower 2 in operation

Alternative 4 4 Treatment Ponds in Spillway enhances the long-term potential for the discharge from the Site to meet water quality standards Sub-alternative 4 4A improves long term effectiveness by removing tailings from the spillway to minimize leaching Alternative 4 4B advanced treatment provides a method to meet water quality standards if the monitoring record after implementation of Sub-alternative 4 4A does not successfully meet water quality standards

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Alternative 4 5 Close Mine Shaft, increases long term effectiveness by eliminating building remains which could attract trespassers and create a physical hazard

5 1 5 Reduction of Toxicity, Mobility, or Volume Through Treatment

None of the alternatives include treatment of the tailings or chat The massive volume of tailings makes the application of any chemical stabilization or fixation approaches impractical Likewise the remaining metals content in the tailings cannot be economically removed by reprocessing

Alternative 4 4 includes treatment of the main site discharge to the degree necessary to meet water quality standards

5 2 Implementability

Implementability is evaluated in terms of technical feasibility administrative feasibility availability of services and materials, regulatory acceptance and community acceptance

5 2 1 Technical Feasibility

All of the alternatives rely upon standard earthmoving equipment and procedures

Passive biological treatment as included in Alternative 4 4B is an established water treatment technique at other mining sites However due to the many variables involved its effectiveness at individual sites is somewhat unpredictable A pilot treatment system may be appropriate if Alternative 4 4B is selected

5 2 2 Administrative Feasibility

None of the alternatives are expected to experience difficulty with administrative feasibility Cooperation from the City of Park Hills will be necessary to deal with issues such as zoning and the potential of athletic field development

5 2 3 Availability of Services and Materials

Because all the alternatives use straightforward earthmoving technology the availability of services and materials is good for all alternatives The Doe Run Company's crew working in the Old Lead Belt has demonstrated an ability to perform such work There are no off site treatment or disposal

requirements and the testing services required during construction are relatively minor and readily available

Quarried material for covering the slopes and other selected areas with rock is readily available in the quarry adjacent to the Site Cover soils are available as strippings from the quarry Higher quality vegetative soils for the athletic fields may have to be obtained from off site but are available in the area

5 2 4 Regulatory Acceptance

Alternative 3 and Alternatives 4 2 through 4 5 are all anticipated to be regulatorily acceptable Alternative 4 1 Re-Use/Recycle delays 100 percent final closure of the Site but meets the environmental goals of minimizing waste volume and recycling of waste materials

5 2 5 Community Acceptance

The Site is relatively isolated from most of the city Most interest will likely come from the residents of the former community of Elvins located immediately south of the Site Alternative 3 which will close the Site without any active use is not anticipated to draw opposition Alternative 4 2 Grading and Cover for Athletic Complex is dependent upon the needs and cooperation of the City of Park Hills Selection of this alternative is likely dependent upon factors not directly related to the Site such as the availability of alternative locations for the fields and city finances Reduce/recycle will have community support because it maintains an important local source of bituminous pavement mix The other Sub-alternatives are not anticipated to create significant community issues

5 3 Cost

The costs for the alternatives are summarized in Table 5 and set forth in detail in Tables G 1 through G 8 in Appendix G The costs given for Alternatives 4 1 through 4 5 in the tables are differential costs relative to Alternative 3 Alternative 3 provides a minimum cost to regrade and stabilize the Site The Alternative 3 cost includes a clay cover soil with a minimum thickness of 6 inches Alternatives 4 1 through 4 5 have costs associated with them which can be considered as part of the decision process for including them in the recommended alternative Alternative 4 1 Re Use/Recycle has no incremental cost although a portion of the cover cost will be delayed

Alternatives 4 2 Grading and Cover for Athletic Complex and 4 3 Retaining Decant Tower 2 are linked as explained in Section 4 4 3 They have a combined additional cost of $1 013 438 primarily

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due to the significant cost for additional soil cover in Alternative 4 2 Alternative 4 3 includes a cost of $413 000 for the present worth of 30 years of turf maintenance Since the cost of maintenance of athletic fields is incurred wherever they are located this maintenance cost could be considered as a non removal action cost if athletic fields are constructed Final acceptance of Alternative 4 2 will likely depend upon who will accept the responsibility for the additional soil cover costs and/or turf maintenance

It must be emphasized that the total grading volume estimate of 1 1 million cubic yards for the recommended alternative is approximate An effort to reduce the grading volume will be made during final design within the general grading plan established in Alternative 3 Also the actual volume of excavation in the Spillway from stripping south of the entrance road and from tailings removal in the trackside tailings area may increase or decrease depending on the actual tailing depths encountered during construction

6 0 Recommended Removal Action Alternative

The recommended removal action alternative for this Site is Alternative 3 with the addition of sub area specific Alternatives 4 1 4 2 4 3 4 4A and 4 5 This removal action was selected based on the information in Chapter 5 0 Comparative Analysis of Removal Action Alternatives This proposed removal action includes the administrative controls identified as Alternative 2 as well as the recommended removal action for each of the sub areas of the Site described below The detailed grading plan for Alternative 3 is as shown on Figure 7 except that the elevation of the flat area north of the entrance road will be increased by 10 to 15 feet This is necessary to allow for the disposal of materials from the Spillway Area stripping from the area south of the entrance road demolition debris from the Mine Shaft Area and similar materials The recommended removal action is shown on Figure 8 including Alternatives 4 1 4 2 4 3 4 4A and 4 5

6 1 Chat Pile Area

The Main Chat Pile will be lowered approximately 50 feet have its eastern toe extended approximately 75 feet regraded with slopes 3 horizontal to 1 vertical and the slopes and top covered with 12 inches of rock Its color will be similar to the chat and may appear similar from a distance The rock used for slope protection will be selected for limited amounts of fine fractions in an effort to discourage weed growth and promote vertical infiltration The chat pile will be partially removed regraded and rerocked over time as part of ongoing use of chat in bituminous mix by LBM Co The effect of this removal is included in the final chat pile slopes shown on Figure 8 The final chat pile slopes after chat removal will be established based upon stability requirements The life of the chat removal activity will be a function of the rate of use and the amount of chat available after all removal action and slope stability chat needs are satisfied

6 2 Tailings Area

This area has been considered for development as an athletic field by the City of Park Hills (Alternative 4 2) Development of an athletic area will require a lease agreement with the City of Park Hills covering liability operations and maintenance and development costs Inclusion of athletic field development in the recommended alternative assumes that an acceptable lease can be negotiated The potential area of athletic development is as much as 70 acres A general Site layout for potential athletic fields was previously prepared for Doe Run at the request of the City of Park Hills That layout is included in Appendix H

The potential athletic area has upper and lower levels (Figure 8) The upper athletic area will drain to the existing surface water pond and decant tower 1 The lower level will be created by regrading the existing large depression to drain to a lowered inlet on decant tower 2 Decant tower 2 and the culvert from the tower to the toe of the Chat Pile will be repaired for use as an outlet for a normally dry ponding area to be created in the lower Tailings Area (Figure 8) As shown on Figure 8 the culvert from decant tower 2 discharges directly into the treatment ponds The outlet pipe from decant tower 1 discharges near the northwest corner of the Tailings Area The tower 1 discharge then travels along the west side of the site through a ditch to be constructed along the south side of the entrance road through a culvert to the north side of the road and into the treatment ponds The treatment ponds are the permanent structures to retain and then discharge the water from both decant towers 1 and 2 The discharge from decant tower 1 also will pass through a pond which is part of LBM Co s water system as it flows along the west side of the site This pond may be made a permanent part of the system for discharge from decant tower 1 but it is not a necessary part of the decant tower 1 system Whether it becomes part of the final design will depend partly on the changes LBM Co may make in the pond prior to final closure of the site

Areas intended for active athletic use will first be covered with 12 inches of on site cover soil and 6 inches of vegetative soil from off site and eventually be vegetated with a mix of athletic field grass Vegetative soil is defined as soil which is capable of supporting vegetation with appropriate seed choices and fertilization It was not necessarily topsoil in its location of origin Vegetative soil will be tested to verify that it contains less than 400 ppm lead Because the Tailings Area may be developed for athletic use over an extended period of time Doe run will provide an initial planting of KY31 tall fescue applied at a rate of 100 pounds per acre Proposed fertilizer is 500 pounds per acre of 13 13 13 equivalent Methods of application and possible use of soil amendments will be developed as part of plans and specifications It is assumed that portions of the area will be reseeded into athletic field grass as the area is developed

For areas awaiting athletic development the vegetation will be fertilized reseeded and mowed as necessary until a self sustaining vegetative cover is established A walk through will be performed following spring green up to identify areas requiring reseeding and/or refertilization This will continue for 5 years or until deficient areas are no longer identified Reseeding and fertilization will be performed on bare or sparse areas discovered during the walk through Fertilization of other areas will be based on the general appearance of the vegetation and may be performed in spring or fall

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If the Tailings Area is not developed for athletic fields the same vegetation and maintenance program will be followed except that, prior to vegetation a minimum of 6 inches of clay cover soil from on site will be placed However if The Doe Run Company prepares a vegetation plan and demonstrates that directly seeding the tailings will meet ARARs, the EPA will approve the plan and no soil will be required

The east and west sides of the Tailings Area will be supported with a chat fill placed at a 3 horizontal to 1 vertical slope The south side of the Tailings Area will be bordered by a 4 horizontal to 1 vertical slope which will actually be constructed by regrading material within the LBMOA The new slopes will be covered with a minimum of 12 inches of rock slope protection the same as the chat pile (Figure 8)

6 3 Spillway Area

Tailings will be completely excavated from the toe of the chat pile to Old Highway 32 in accordance with Alternative 4 4A This will eliminate the potential for leaching of discharge waters through tailings in the spillway bottom Dikes will be used to create multiple ponding and sedimentation areas in the spillway (Figure 8) The dikes will be constructed of clay Aquatic plants will be established in the ponds by placing excavated material from other ponds in the vicinity in the new ponds The effluent from the ponds will be monitored after the removal action is complete to determine whether additional treatment methods need to be added

The tailings in and along the creek channel from downstream of Old Highway 32 to the Flat River will be excavated and returned to the Site (Figure 8) The trackside tailings in the area between Old Highway 32 and the existing railroad will also be excavated and returned to the site (Figure 8) The areas where tailings were removed will be vegetated on natural ground The old railroad grade crossing the spillway will also be removed and disposed on site (Figure 8)

6 4 Lead Belt Materials Co Operations Area

As noted above this area will be regraded to form the southern perimeter slope of the Tailings Area The former stockpile area south of the entrance road will be stripped to natural ground and vegetated (Figure 8) Demolition of all of the old mine buildings on site is also included (Alternative 4 5) except buildings in active use by LBM Co (Figure 8) The relatively flat area just north of the entrance road in the Alternative 3 grading plan will be used for disposal of this stripping and

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demolition debris and also materials excavated from the Spillway Area (Figure 8) The new slope and the relatively flat area will all be covered with rock as used on the chat pile

The former stockpile area stripped to natural ground and other miscellaneous areas stripped to natural ground will be directly vegetated These areas where the vegetation is anticipated to be permanent will be vegetated with a diverse seed mixture that will provide a self sustaining vegetative cover that is resistant to climatic extremes

6 5 Administrative Controls

LBM Co will remain in operation to use on site chat for the production of bituminous mix Chat may also be sold as fill with site specific written approval of the USEPA Details of the LBM Co operation are found in Appendix J

Administrative controls will be included as part of the removal action and included in the Post Removal Site Control Plan which will be submitted following completion of the removal action The types of controls are summarized below

Physical barriers and signage will be used to prevent vehicle access Former access roads to the site will be blocked or gated as appropriate Fences or other physical barriers will be constructed to prevent driving around gates or roadblocks Signage will be posted banning trespassing and removal of materials The purpose of these activities is to make it impossible for unauthorized persons to remove materials from the site without being aware that it is illegal

Doe Run owns the site and will place deed restrictions on it These restrictions will not allow removal of tailing materials without EPA approval Doe Run will also cooperate with the EPA in obtaining deed restrictions on adjacent properties as necessary

The cooperation of local law enforcement will be essential Doe Run will work with the City of Park Hills and request periodic checks of gates and vigilance for signs of trespassing Doe Run will cooperate in prosecuting anyone found to be illegally removing material

Public education will play a key role Doe Run will communicate with city staff (city manager law enforcement public works, and building officials) to verify that they understand that chat and tailings from the Rivermines site should not be appearing in public or private construction projects unless site specific written approval of the USEPA has been obtained Contact will be made with local truckers and excavation and grading contractors with the same emphasis Opportunities to

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contact the general public through the media such as press releases regarding removal action completion will also be used to emphasize the remaining allowable uses of the site and discourage trespassing

The site will be inspected by Doe Run on a regular basis to check the condition of the vegetation look for areas of erosion etc Checking for signs of material removal will also be included in these inspections The EPA will be notified if signs of unauthorized material removal are found either by Doe Run or by local law enforcement

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7 0 References

Barr 1997 *Standard Operating Procedures For Routine Level Inorganic Data Validation* 1997

Barr 1998 Stormwater Pollution Prevention Plan Rivermines Mine Tailings Site Park Hills Missouri Prepared for The Doe Run Company December 18 1998

Barr 2000a Letter Report on Conceptual Alternatives for the Engineering Evaluation/Cost Analysis Elvins/Rivermines Mine Tailings Site Park Hills MO Prepared for The Doe Run Company August 2000

Barr 2000b Quality Assurance Project Plan for the Engineering Evaluation/Cost Analysis Elvins/Rivermines Mine Tailings Site Park Hills MO Prepared for The Doe Run Company October 2000

Barr 2001 Work Plan and Field Sampling Plan for the Engineering Evaluation/Cost Analysis Elvins/Rivermines Mine Tailings Site Park Hills, MO Rev 1 Prepared for The Doe Run Company February 15 2001

Dames & Moore 1997a Draft Big River Mine Tailings Site Revegetation Memorandum Prepared for The Doe Run Company January 15 1997

Dames & Moore 1997b Letter to John Carter of The Doe Run Company from Laura Backus of Dames and Moore updating the recommendations section with observations from a successful 1985 test plot February 14 1997

Fluor Daniel 1995 Draft Initial Remedial Investigation Big River Mine Tailings Sites Old Lead Belt St Francois County, Missouri Prepared for Doe Run Company April 1995

FEMA 1998 Flood Insurance Rate Map City of Park Hills Missouri St Francois County Federal Emergency Management Agency February 18 1998

Missouri Department of Health 2000 Fish Advisory

USEPA 1993a Guidance on Conducting Non Time Critical Removal Actions Under CERCLA Office of Solid Waste and Emergency Response EPA 540-R 93 057 August 1993

USEPA 1993b Engineering Evaluation/Cost Analysis for the Big River Mine Tailings Site Desloge Missouri A Non Time Critical Removal Action for Dust Control Bank Stabilization and Storm Water Runoff Control, U S Environmental Protection Agency Region VII December 1993

USEPA 1995 Mine Waste Fact Sheet U S EPA Region VII July 1995

USEPA 1998 Elvins Mine Tailings Site Administrative Order on Consent (AOC) between The Doe Run Resources Corporation and the U S EPA Region VII June 7 2000

U S G S 1991 Hydrochemical and Sediment Data for the Old Lead Belt Southeastern Missouri—1988 89 U S Geological Survey Open File Report 91 211 Rolla Missouri 1991

Wixson 1983a A Study on the Possible Use of Chat and Tailings from the Old Lead Belt of Missouri for Agricultural Limestone A research report submitted to the Missouri Department of Natural Resources by Bobby G Wixson and Nord L Gale of University of Missouri Rolla and Brian E Davies of University College of Wales Aberystwyth

Wixson 1983b Possible Uses of Lead Zinc Mill Tailings as Agricultural Limestone A paper by Bobby G Wixson and Nord L Gale of University of Missouri-Rolla and Brian E Davies and Nicholas J Houghton of University College of Wales Aberystwyth Wales U K Trace Substances in Environmental Health XVII D D Hemphill Editor University of Missouri Columbia Columbia MO 1983

Wixson 1986 Continued Studies on Vagrant Lead in Fish Molluscs and Sediments of the Big River of Southeastern Missouri A research report submitted to St Joe Minerals Corporation Clayton Missouri by Nord L Gale Michael J Haas and Bobby G Wixson of University of Missouri Rolla March 1986

Table 1
Property Owners List
Elvins/Rivermines Mine Tailings Site

Property ID No	Book	Page	Owner*	Address	City	State	Zip
1	1314	406	Leadbelt Material	110 Mill Street	Park Hills	Mo	63601
2	1398	907	David M King	1200 Olive Rd	Park Hills	Mo	63601
3	1192	704	Carlene R Daugherty	1220 Olive Rd	Park Hills	Mo	63601
4	941	238	Melvin Daugherty	547 PO Box	Park Hills	Mo	63601
5	809	694	Pleasantview Apartments INC	110 Hampton St	Park Hills	Mo	63601
6	657	656	Pleasantview Apartments INC	110 Hampton St	Park Hills	Mo	63601
7	1389	1356	Carolyn S Whaley	191 McGlashon St	Park Hills	Mo	63601
8	1381	130	Vernon R Sibole	1390 Olive Rd	Park Hills	Mo	63601
9	1408	2382	Michele Dixon	518 Hampton St	Park Hills	Mo	63601
10	1408	2382	Michele Dixon	518 Hampton St	Park Hills	Mo	63601
11	945	275	Larry E Walker	516 Hampton St	Park Hills	Mo	63601
12	1253	1	Ray Nelson	514 Hampton St	Park Hills	Mo	63601
13	1339	396	Timothy W O Dell	512 Hampton St	Park Hills	Mo	63601
14	1378	1535	Jason M Lappe	519 Mill St	Park Hills	Mo	63601
15	1226	228		Mill St	Park Hills	Mo	63601
16	1397	928	Kevin L Moore	953 PO Box	Park Hills	Mo	63601
17	1397	1058	Richard E Asbridge	518 Mill St	Park Hills	Mo	63601
18					Park Hills	Mo	63601
19	920	491	Jeffrey L Fingers	510 Mill St	Park Hills	Mo	63601
20					Park Hills	Mo	63601
21	1161	71	Harold R Nelson	506 Mill St	Park Hills	Mo	63601

* From information available in the County Recorder s Office as of June 2000

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Table [illegible]ont)
Property Owners List
Elvins/Rivermines Mine Tailings Site

Property ID No	Book	Page	Owner*	Address	City	State	Zip
22	1045	674	Mikeal L Wilkinson	504 Mill St	Park Hills	Mo	63601
23	1221	110	Harry D Jr Gibbs	502 Mill St	Park Hills	Mo	63601
24	816	495	Earl L Bable	418 Mill St	Park Hills	Mo	63601
25	834	495	James E Dalton	414 Mill St	Park Hills	Mo	63601
26	1390	1648	Wilburn J Jr Boesch	Mill St	Park Hills	Mo	63601
27	1129	240	Harry L Jennings	537 Sequoia Ct	Farmington	Mo	63640
28	1414	1477	Raymond Ruby	400 Mill St	Park Hills	Mo	63601
29	0	0	Doe Run Company		Park Hills	Mo	63601
30	863	516	Marisa K Richardson	316 Mill St	Park Hills	Mo	63601
31	0	0			Park Hills	Mo	63601
32	890	414	Joseph W Allen	312 Mill St	Park Hills	Mo	63601
33	1153	660	Henry Radford	1506 Pine Ridge Tr	Park Hills	Mo	63601
34	877	569	Alfred H Stephens	3572 Hwy BB	Bismarck	Mo	63624
35	790	104	Reva C Mueller	Mill St			
36	0	0					
37	1411	511	Anna G O Connor	409 Dettmer St	Park Hills	Mo	63601
38	0	0					
39	1281	390	Charles E Jr Wolfe	413 Dettmer St	Park Hills	Mo	63601
40	1026	542	Jason Bridges	410 Dettmer St	Park Hills	Mo	63601
41	0	0		Dettmer St	Park Hills	Mo	63601
42	905	248	Delbert O Henson	Dettmer St	Park Hills	Mo	63601
43	1104	537	Danny R Kennedy	210 Mill St	Park Hills	Mo	63601
44	1293	642	Arthur W Holmes	206 Mill St	Park Hills	Mo	63601
45	880	690	Robert L Conway	114 Mill St	Park Hills	Mo	63601
46	575	433	James H Roper	312 Camilla St	Park Hills	Mo	63601
47	0	0	Doe Run Company				

* From information available in the County Recorder s Office as of June 2000

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Table [illegible]ont)
Property Owners List
Elvins/Rivermines Mine Tailings Site

Property ID No	Book	Page	Owner*	Address	City	State	Zip
48	1392	2360	Mickey T Fincher	7928 Hwy D	Bonne Terre	Mo	63628
49	1343	680	Tina M Camden	104 Front St	Park Hills	Mo	63601
50	840	61	Billy R Canada	405 Front St	Park Hills	Mo	63601
51	1070	630	Michael B Barton	409 Front St	Park Hills	Mo	63601
52	1233	190	Herald D Warren	Front St	Park Hills	Mo	63601
53	1310	363	P A T H Inc	671 PO Box	Farmington	Mo	63640
54	1198	21	Joseph Knowles	34 McMullin Pk	Park Hills	Mo	63601
55	1407	1604	Norman W Lucas	38 McMullin Pk	Park Hills	Mo	63601
56	785	458	Town & Country Grocers		Fredencktown	Mo	63645
57	1414	1147	Stephan W Lewis	18 W Church	Park Hills	Mo	63601
58	1146	710	Harold F Scott	17 Hill St	Park Hills	Mo	63601
59	0	0					
60	781	141	Lewis L Penberthy	21 Hill St	Park Hills	Mo	63601
61	816	137	James Vandiver	27 Wood St	Park Hills	Mo	63601
62	1240	656	Eugene Fritche	32 Hill St	Park Hills	Mo	63601
63	1359	366	Richard Barlow	27 Hill St	Park Hills	Mo	63601
64	1228	707	Richard Honbeck	524 PO Box	Farmington	MO	63640
65	1215	215	Eugene Fritche	32 Hill St	Park Hills	Mo	63601
66	1023	660	Percy Gammon	33 Hill St	Park Hills	Mo	63601
67	1071	657	Eugene Fritche	32 Hill St	Park Hills	Mo	63601
68	799	219	Leman R Kaiser	13 Pine St	Park Hills	Mo	63601
69	694	596	Keith W Wilkinson	18 Pine St	Park Hills	Mo	63601
70	361	415	Byron L Upchurch	310 W First St	Farmington	Mo	63640
71			Clarence R Rhodes	12 Pine St	Park Hills	Mo	63601
72	445	415	Lloyd C Dunn	10 Pine St	Park Hills	Mo	63601
73	584	760	James H Francis	14 Pine St	Park Hills	Mo	63601

* From information available in the County Recorder s Office as of June 2000
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Table (Cont)
Property Owners List
Elvins/Rivermines Mine Tailings Site

Property ID No	Book	Page	Owner*	Address	City	State	Zip
74			Jack R Bridges	18 Wood St	Park Hills	Mo	63601
75	1046	348	Bryan L Vandiver	27 Wood St	Park Hills	Mo	63601
76	1416	1035	Tina L Ramsey	28 Wood St	Park Hills	Mo	63601
77	1062	318	Ellis A Hutto	5 Barton St	Park Hills	Mo	63601
78	701	223	Dave Clark	7 Barton St	Park Hills	Mo	63601
79	838	385	Rudolph H Dalton	14 Barton St	Park Hills	Mo	63601
80	1362	265	Karen E Dalton	14 Barton St	Park Hills	Mo	63601
81	926	579	Randall M Haegele	236 Rt 1	Farmington	Mo	63640
82	621	328	Gladys V Pyatt	8 Barton St	Park Hills	Mo	63601
83	1401	1354	Calvin D Gunder	414 Elm St	Desloge	Mo	63601
84			John R Polete				
85			Richard E Dalton	5525 Tulsa Wy	Denver	Co	80239
86	1339	39	Lillie Mae Dalton	9 Cottonwood	Park Hills	Mo	63601
87	1082	242	William L Spradling	708 Briarwood	Desloge	Mo	63601
88	1292	514	Lambert Grandchildren Trust	728 Cleveland Ave	Kirkwood	Mo	63122
89			Richard E Dalton	5525 Tulsa Wy	Denver	Co	80239
90	1345	295	Edward Harrington	60 Wood St	Park Hills	Mo	63601
91	1287	222	Randall L Hulsey	410 Shaw St	Park Hills	Mo	63601
92	1177	571	Bob Vinyard	6 Davis St	Park Hills	Mo	63601
93	733	130	Southwestern Bell	1010 Pine St	St Louis	Mo	63129
94	1211	633	Terence J O Brien	1921 S Brentwood Blvd	St Louis	Mo	63144
95	1207	378	Keith W Wilkinson	16 Pine St	Park Hills	Mo	63601

* From information available in the County Recorder s Office as of June 2000
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Table 2

Summary of Previous Investigations – Tailings[1]
Rivermines Mine Tailings Site
Park Hills Missouri

Area	No of Samples	Lead Concentration (mg/kg)			Cadmium Concentration (mg/kg)			Zinc Concentration (mg/kg)		
		Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
Chat Pile Area	48	5143	1700	8890	133	51 3	202	7168	1290	11900
Tailings Area	18	1691	851	4230	72	45	119	3101	1440	5500
Spillway Area	0		-	-				-		
Lead Belt Materials Area	27	5044	1080	11600	78	19 8	157	4164	108	10900

[1] Data is for samples from 20 to 40-centimeter depth

Table 3
Analytical Results for Soil Samples
Doe Run/Rivermines
(concentrations in mg/L)

Location Description / Notes	Location	Date	Cadmium	Lead	Zinc
Spillway Toe of Chat Pile	A-01	08/13/2001	22 3	10800 *	820
Spillway Upper	A 02	08/13/2001	25 3	1430 *	933
Spillway Middle	A 03	08/13/2001	17 6	2420 *	741
Spillway Lower	A-04	08/14/2001	22 3	1030 *	699
Spillway Rail Road Grade	A 05	08/14/2001	5 6	5270 *	186
Spillway Discharge Culvert	A 06	08/14/2001	57 7	3710 *	13600
Spillway Active Rail Road Grade Area	A-07	08/14/2001	28 7	794 *	1380
Spillway Active Rail Road Grade Culvert	A 08	08/14/2001	45 3	1430 *	4950
Spillway Creek Middle	A 09	08/14/2001	30 5	936 *	8240
Spillway Creek Discharge	A 10	08/14/2001	31 2	1420 *	8810
Tailings Area South Side	A 11	08/13/2001	38 5	2330 *	1760
Tailings Area South Side Surface	A 11 S	08/13/2001	31 8	1010 *	1310
Tailings Area Upper Decant Structure	A 12	08/13/2001	38 8	1050 *	1660
Tailings Area North Side	A 13	08/13/2001	29 1	638 *	915
Tailings Area, North Side Surface	A 13 S	08/13/2001	33 7	707 *	1490
LBMOA East Chat Borrow Area	A 14	08/13/2001	130	5080 *	2030
LBMOA West Chat Borrow Area	A 15	08/13/2001	14 4	6870 *	590
LBMOA West Building Footings	A 16	08/14/2001	39 4	2470 *	1910
LBMOA East Building Footings	A 17	08/14/2001	7 5	2020 *	399
Northeast Discharge Creek	A 18	08/14/2001	7 7 *	1770 *	812 *
Southeast Discharge Area	A 19	08/14/2001	21 1 *	8920 *	1860 *
Rail Road Grade Southeast	A 20	08/14/2001	59 4 *	7420 *	2760 *
Rail Road Grade South	A 21	08/14/2001	45 0 *	19300 *	3000 *
Rail Road Grade South Surface	A 21 S	08/14/2001	56 6 *	4590 *	3520 *
Spillway Seep from south side of chat pile	A 22	08/13/2001	26 1 *	1770 *	881 *
Chat Pile exposed rock pile	A 23	08/13/2001	17 1 *	5740 *	934 *
Tailings Area Discharge Pipe	A 24	08/14/2001	24 2 *	735 *	1800 *
Tailings Area Slimes seep area	A 25	08/15/2001	63 7 *	3190 *	3020 *
Tailings Area East Side discharge area	A 26	08/15/2001	34 2 *	1910 *	1570 *
	Lab Blank	08/13/2001	<1 1	<1 2	<2 7
	Lab Blank	08/13/2001	<1 1	<1 2	<2 7
	Lab Blank	08/13/2001	<1 1	<1 2	<2 7
	Lab Blank	08/13/2001	<1 1	<1 2	<2 7
	Lab Blank	08/13/2001		<1 2	<2 7
	Lab Blank	08/13/2001		<1 2	<2 7
	Lab Blank	08/13/2001	--	<1 2	<2 7
	Lab Blank	08/13/2001		<1 2	<2 7
	Lab Blank	08/14/2001	<1 1	<1 2	<2 7
	Lab Blank	08/14/2001	<1 1	<1 2	<2 7
	Lab Blank	08/14/2001	<1 1	<1 2	<2 7
	Lab Blank	08/14/2001		<1 2	<2 7
	Lab Blank	08/14/2001		<1 2	<2 7

-- Not analyzed
* Estimated value QA/QC criteria not met.

Table 4
Analytical Results for Water Samples
Doe Run/Rivermines
(concentrations in mg/L)

Location Description and Notes	Location	Date	Cadmium		Lead		Zinc	
			U (unfiltered)	F (Dissolved)	U (unfiltered)	F (Dissolved)	U (unfiltered)	F (Dissolved)
Spillway Decant Structure Outlet	W-01	08/15/2001	0 0856	0 087	0 0518	0 0373	19 6	19 1
Spillway Discharge Culvert	W-02	08/15/2001	0 0273	0 0272	0 122	0 0809	8 46	8 1
Spillway Discharge to Big River	W-03	08/15/2001	0 0186	0 0175	0 0487	0 0409	4 52	4 31
Spillway Center Seep from the Toe of Chat Pile	W-04	08/15/2001	0 031	0 0325	0 116	0 113	23 5	23 4
Spillway Seep North side Decant Structure Outlet	W-05	08/15/2001	0 0514	0 0482	0 235	0 153	10 4	9 66
Tailings Area, Pond	W-06	08/15/2001	0 0012 j	0 00071 j	0 0050 j	<0 0016	0 0194 jb	0 0119 jb
LBMOA, Cooling Pond	W-07	08/15/2001	0 0035 j	0 0029 j	0 152	0 103	0 364	0 311
Spillway Seep from South Side of Pile	W-08	08/15/2001	0 0513	0 0482	0 365	0 342	2 95	2 99
Northeast Property Line Creek	W-09	08/15/2001	0 0063	0 0064	0 0252	0 0212	0 417	0 459
Southeast Property Line Seep under Rail Road Grade	W 10	08/15/2001	0 0257	0 0238	0 242	0 133	1 76	1 67
Tailings Area Pipe Discharge	W 11	08/15/2001	0 0041 j	0 0028 j	0 0032 j	<0 0016	0 495	0 48
LBMOA, Lower Tailings Area Pond	W 12	08/15/2001	0 0015 j	0 0011 j	0 109	0 0683	0 0712	0 0476
Tailings Area East Side Discharge	W 13	08/15/2001	0 0012 j	0 0068 j	0 0048 j	<0 0016	0 0137 jb	0 0109 jb
	BW-01 Field Blank	08/15/2001	<0 00030	<0 00030	<0 0016	<0 0016	0 0043	0 0021
	Lab Blank	08/15/2001	<0 0003		<0 0016		<0 0016	
	Lab Blank	08/15/2001	<0 0003		<0 0016		<0 0016	
	Lab Blank	08/15/2001	<0 0003		<0 0016		<0 0016	
	Lab Blank	08/15/2001	<0 0003		<0 0016		<0 0016	
	Lab Blank	08/15/2001	<0 0003		<0 0016		<0 0016	
	Lab Blank	08/15/2001	<0 0003		<0 0016		<0 0016	
	Lab Blank	08/15/2001	<0 0003		<0 0016		<0 0016	
	Lab Blank	08/15/2001	<0 0003		<0 0016		<0 0016	
	Lab Blank	08/15/2001	<0 0003		<0 0016		<0 0016	
	Lab Blank	08/15/2001	<0 0003		<0 0016		<0 0016	

-- Not analyzed
b Potential false positive based on blank data validation procedure
j Reported value is less than the stated laboratory quantitation limit and is considered an estimated value

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Table 5

Removal Action Cost Estimate
Summary of Removal Action Alternative Cost Estimates
Rivermines Mine Tailings Site

Task Description	Alternatives									Recommended Alternative (Alternative 3 Plus Indicated Options)		
				Options to Alternative 3								
	1	2	3	4 1	4 2	4.3	4 4A	4.4B	4 5	Included Options	Sum	Extension
Mobilization	$	$	$ 100 000	$	$	$	$	$	$		$	$ 100 000
Cleaning & Grubbing	$	$	$ 7 000	$	$	$	$	$	$		$	$ 7 000
Fencing	$	$ 180 000	$	$	$	$	$	$	$		$	$
Excavation	$	$	$ 1 455 000	$	$ 150 000	$	$ 75 000	$ 75 000	$	4 2 4 4A	$ 225 000	$ 1 680 000
Demolition	$	$	$	$	$	$	$	$	$ 25 000	4 5	$ 25 000	$ 25 000
Stormwater Management	$	$	$ 37 500	$	$	$ 90 000	$	$ 420 000	$	4 3	$ 90 000	$ 127 500
Cover/Vegetation												
Main Site Cover Materials	$	$	$ 879 000	$	$ 465 000	$	$	$	$	4 2	$ 465 000	$ 1 344 000
Direct Revegetation Areas	$	$	$ 32,000	$	$	$	$	$	$		$	$ 32 000
Engineering & Contingencies	$	$ 78 750	$ 1 098,344	$	$ 269 063	$ 39 375	$ 32,813	$ 216 563	$ 10 938	4 2,4 3 4 4A,4 5	$ 352,188	$ 1 450 531
O & M (Net Present Worth)	$	$ 270 000	$ 683 000	$	$	$	$	$ 125 000	$	4 2	$	$ 683 000
Total Cost	$	$ 528 750	$ 4,291 844	$	$ 884 063	$ 129 375	$ 107 813	$ 836 563	$ 35,938		$ 1 157 188	$ 5 449 031

Listed Alternatives

Alternative 1	No Action
Alternative 2	Administrative Controls
Alternative 3	SWP3 With Control of Wind Erosion and Slope Stability Considerations
Alternative 4 1	Reuse/Recycle
Alternative 4 2	Athletic Complex
Alternative 4 3	Decant System
Alternative 4 4A	Spillway Treatment Ponds Excavation Only
Alternative 4 4B	Spillway Treatment Ponds
Alternative 4 5	Mine Shaft Area

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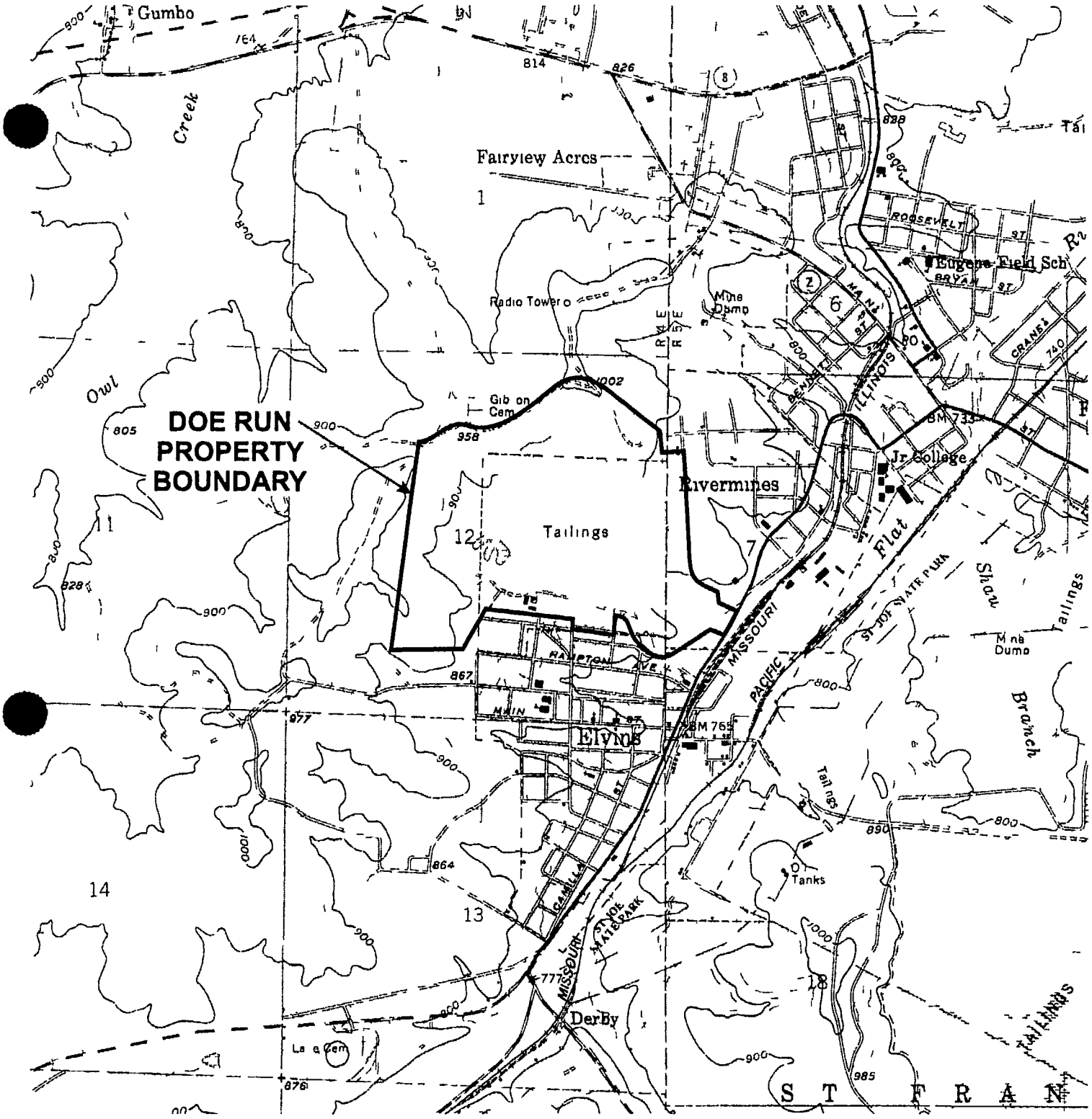


Source USGS 7 5 Quadrangle Flat River MI 1958 Photorevised 1982

QUADRANGLE LOCATION

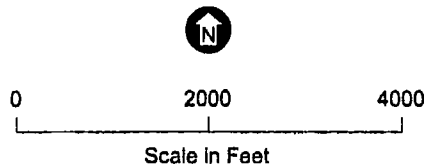
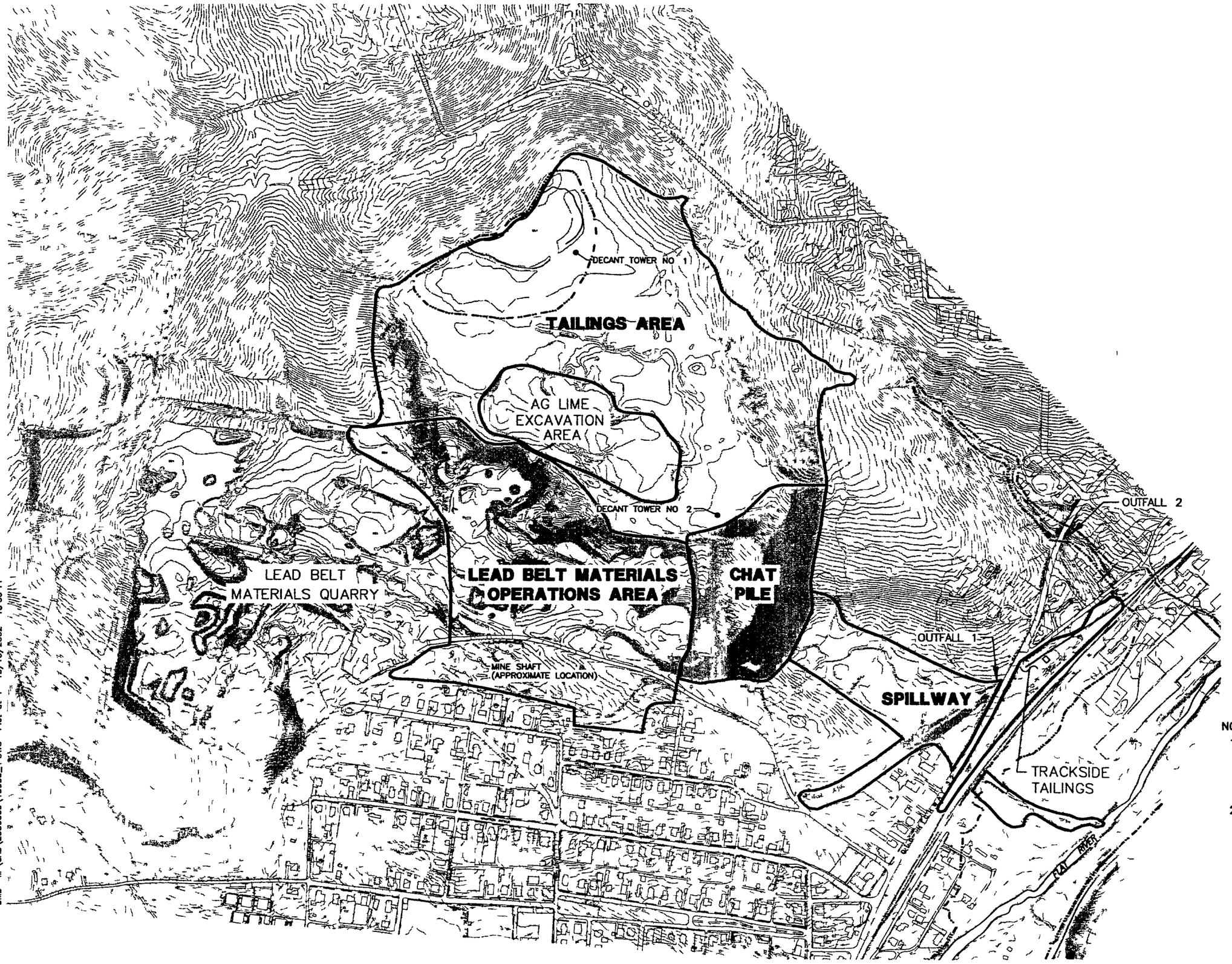
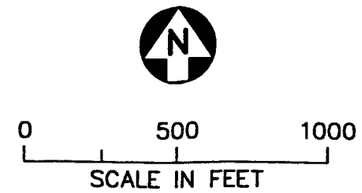


Figure 1

SITE LOCATION MAP
Elvins/Rivermines Mines Tailings Site

P:25\86\009\SITE R RLG 12 27-01





- Sidewalk
- Building
- Foundation
- Fence
- Wall
- Tree Line
- Stream
- Brush/Shrub Line
- 320 Index Contour
- Intermediate Contour
- Depression Contour
- Guard Rail
- Swamp Symbol
- Control Point
- × 325 6 Spot Elevation
- Single Tree
- Located Object
- Catch Basin
- Manhole
- Pole
- Sign
- Fire Hydrant
- Light Pole
- Inlet Symbol
- Railroad
- Paved Road
- Unpaved Road
- Trail
- Pipe line
- Driveway
- 100 Year Flood Boundar

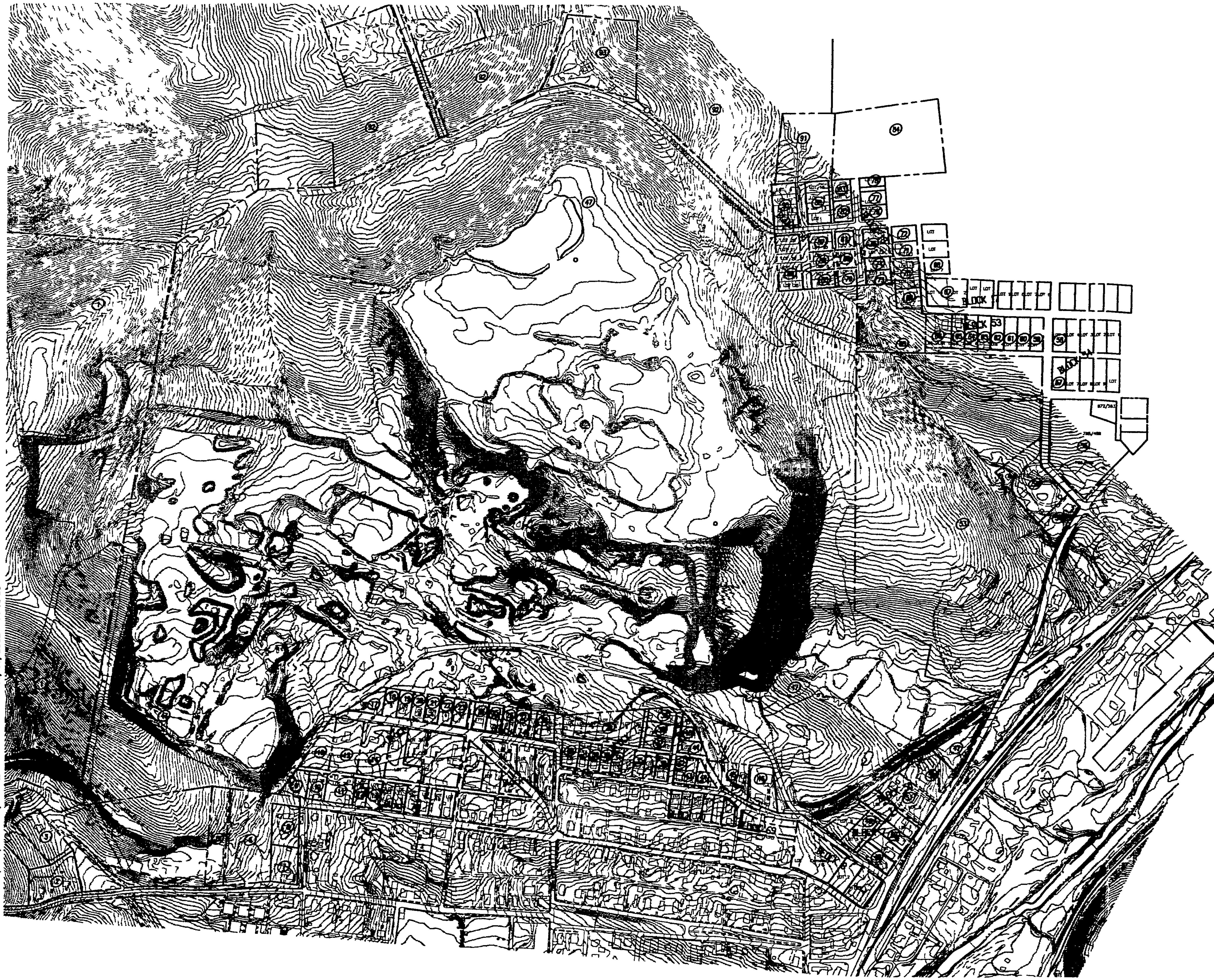
NOTES

1 EXISTING TOPOGRAPHY WAS PREPARED BY WALKER AND ASSOCIATES FROM AERIAL PHOTOGRAPHS TAKEN MARCH 23 2000 MAP DATE AUGUST 29 2000 SURVEY CONTROL BY EFFAN SURVEY

2 DASHED CONTOURS MAY BE UNRELIABLE

Figure 2
SITE BOUNDARIES
AND TOPOGRAPHY
Rivermines Mine Tailings Site
Park Hills MO

Xrefs drawing – M \cad\2586009\13353_1 DWG
DWG M \CAD\2586009\15950_1 DWG Plot at 1 10/10/2002 13 50 11



N

0 500 1000
SCALE IN FEET

	Sidewalk
	Building
	Foundation
	Fence
	Wall
	Tree Line
	Stream
	Brush/Shrub Line
320	Index Contour
	Intermediate Contour
	Depression Contour
	Guard Rail
	Swamp Symbol
	Control Point
× 325 6	Spot Elevation
	Single Tree
	Located Object
	Catch Basin
	Manhole
	Pole
	Sign
	Fire Hydrant
	Light Pole
	Inlet Symbol
	Railroad
	Paved Road
	Unpaved Road
	Trail
	Pipe line
	Driveway
	Property Owner Identification See Table 1
	Property Line (Current)
	Property Line (Superseded)

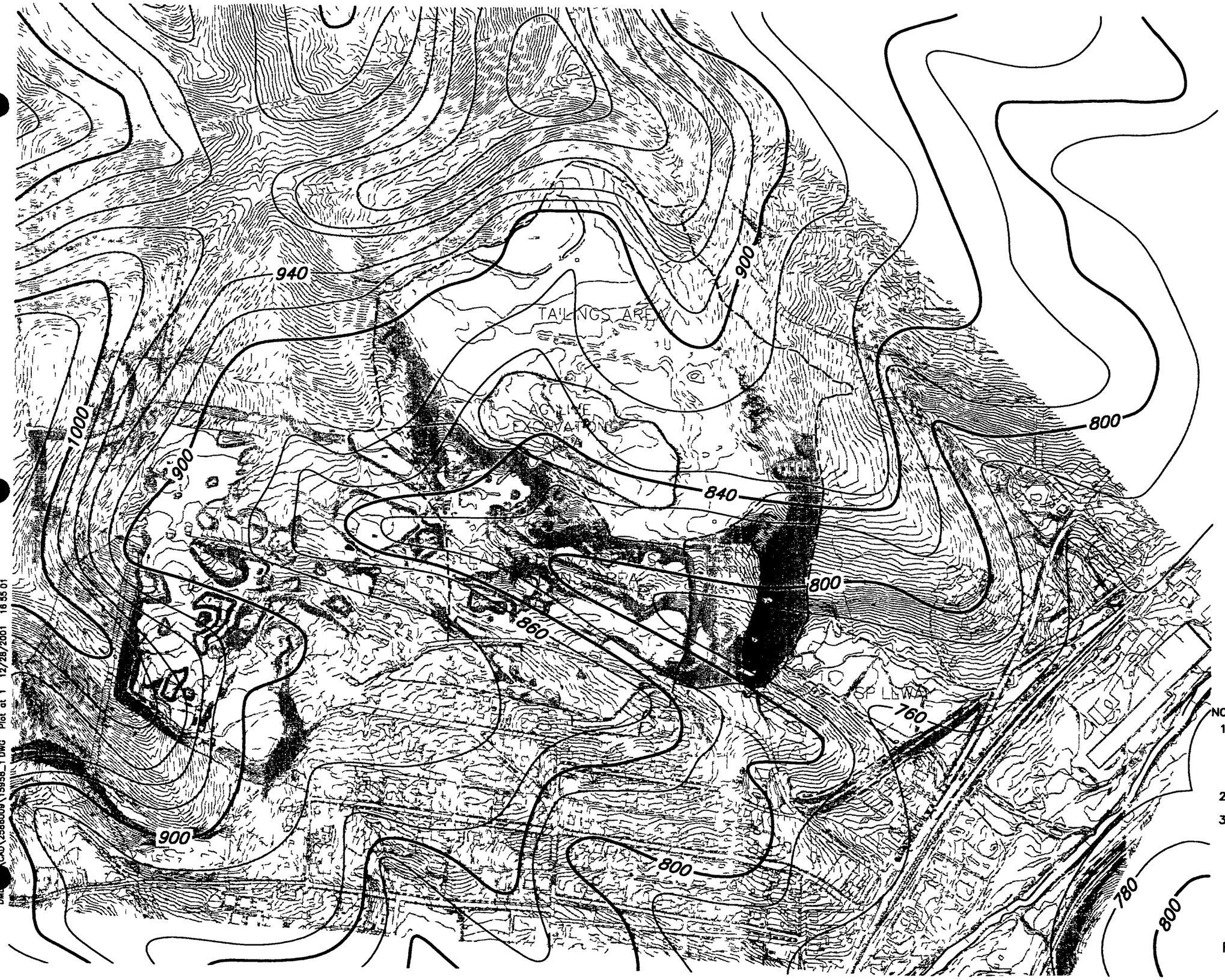
NOTES

1 EXISTING TOPOGRAPHY WAS PREPARED BY WALKER AND ASSOCIATES FROM AERIAL PHOTOGRAPHS TAKEN MARCH 23 2000 MAP DATE AUGUST 29 2000 SURVEY CONTROL BY EFFAN SURVEY

2 DASHED CONTOURS MAY BE UNRELIABLE.

Figure 3
PROPERTY OWNERSHIP MAP
Rivermines Mine Tailings Site
Park Hills MO

Xrefs Drawing - M:\cad\2588009\13353_1 DWG M:\cad\2588009\15110_1 DWG
DWD M:\CAD\2588009\15957_1 DWG Plot at 1 01/09/2002 14 13 50



0 500 1000
SCALE IN FEET

- Intermediate 1905 Contour
- Index 1905 Contour
- Sidewalk
- Building
- Foundation
- Fence
- Wall
- Tree Line
- Stream
- Brush/Shrub Line
- 320 Index Contour
- Intermediate Contour
- Depression Contour
- Guard Rail
- Swamp Symbol
- Control Point
- × 325 6 Spot Elevation
- Single Tree
- Located Object
- Catch Basin
- Manhole
- Pole
- Sign
- Fire Hydrant
- Light Pole
- Inlet Symbol
- Railroad
- Paved Road
- Unpaved Road
- Trail
- P Pipe line
- Driveway

NOTES

1 EXISTING TOPOGRAPHY WAS PREPARED BY WALKER AND ASSOCIATES FROM AERIAL PHOTOGRAPHS TAKEN MARCH 23 2000 MAP DATE AUGUST 29 2000 SURVEY CONTROL BY EFFAN SURVEY

2 DASHED CONTOURS MAY BE UNRELIABLE.

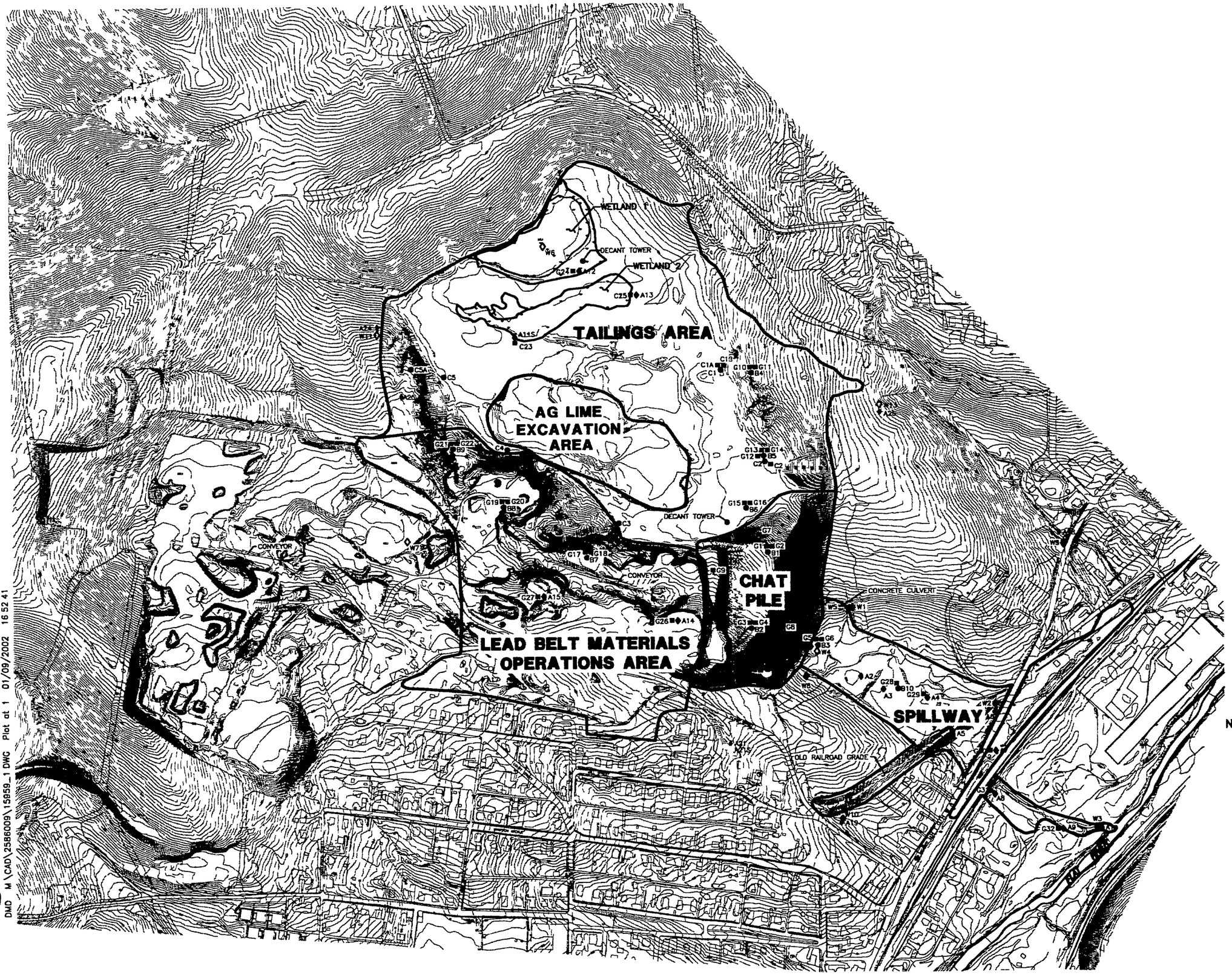
3 1905 CONTOURS DIGITIZED FROM U S G S QUADRANGLE 1905 EDITION REPRINTED 1950 WITH CORRECTIONS CONTOURS AND OTHER PHYSICAL FEATURES ARE SHOWN IN APPROXIMATE LOCATION WITH RESPECT TO SITE.

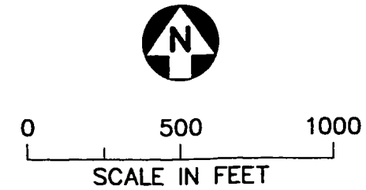
Figure 4
1905 CONTOURS
Rivermines Mine Tailings Site
Park Hills MO

Xrefs In Drawing - M \cad\2586009\13353_1 DWG
DWG CAD\2586009\15958_1 DWG Plot at 1 12/28/2001 16 55 01

Figure 5

1954 AERIAL PHOTOGRAPH
Rivermines Mine tailings Site
Park Hills MO





- Cone Penetronmeter
- Geotechnical Soil Sample
- Analytical Soil Sample
- Analytical Water Sample (Low Flow Only)
- Analytical Water Sample (Low and High Flow)
- Soil Boring
- Sidewalk
- Building
- Foundation
- Fence
- Wall
- Tree Line
- Stream
- Brush/Shrub Line
- Index Contour
- Intermediate Contour
- Depression Contour
- Guard Rail
- Swamp Symbol
- Control Point
- X 325 6 Spot Elevation
- Single Tree
- Located Object
- Catch Basin
- Manhole
- Pole
- Sign
- Fire Hydrant
- Light Pole
- Inlet Symbol
- Railroad
- Paved Road
- Unpaved Road
- Trail
- Pipe line
- Driveway
- Wetland

NOTES

1 EXISTING TOPOGRAPHY WAS PREPARED BY WALKER AND ASSOCIATES FROM AERIAL PHOTOGRAPHS TAKEN MARCH 23 2000 MAP DATE AUGUST 29 2000 SURVEY CONTROL BY EFFAN SURVEY

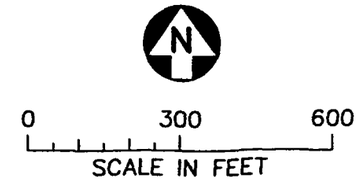
2 DASHED CONTOURS MAY BE UNRELIABLE.

Figure 6

ANALYTICAL SAMPLE LOCATIONS AND WETLAND AREAS

Rivermines Mine Tailings Site
Park Hills MO

DWG M \CAD\2586009\15959_1 DWG Plot at 1 01/09/2002 16 52 41
Xref Drawing - M \cad\2586009\13353_1 DWG



LEGEND

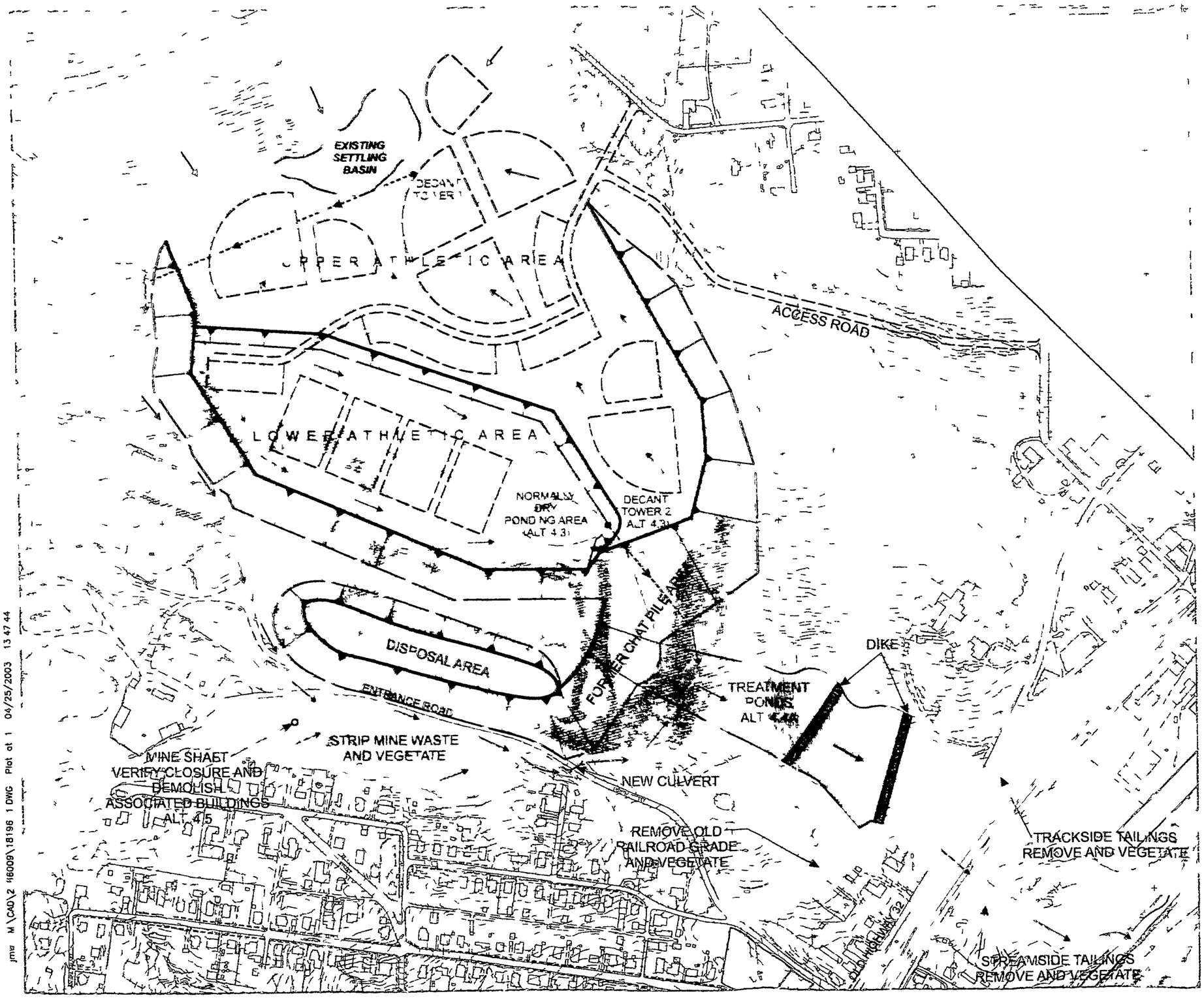
- Sidewalk
- Building
- Foundation
- Fence
- Wall
- Tree Line
- Stream
- Brush/Shrub Line
- 320 Index Contour
- Intermediate Contour
- Depression Contour
- Guard Rail
- Swamp Symbol
- Control Point
- × 325 6 Spot Elevation
- Single Tree
- Located Object
- Catch Basin
- Manhole
- Pole
- Sign
- Fire Hydrant
- Light Pole
- Inlet Symbol
- Railroad
- Paved Road
- Unpaved Road
- Trail
- Pipe line
- Driveway
- Approx Location of Buried Decant Lines
- Tailings Area Surface Drainage

NOTES.

1. EXISTING TOPOGRAPHY WAS PREPARED BY WALKER AND ASSOCIATES FROM AERIAL PHOTOGRAPHS TAKEN MARCH 23 2000
   MAP DATE AUGUST 29 2000
   SURVEY CONTROL BY EFFAN SURVEY
2. DASHED CONTOURS MAY BE UNRELIABLE.

Figure 7
ALTERNATIVE 3 GRADING PLAN
Rivermines Mine Tailings Site
Park Hills MO

Xrefs in Drawing -- M \cad\2586009\13353_1 DWG M \cad\2586009\15955_1 DWG
dmd M \CAD\2586009\16005_1 DWG Plot at 1 05/05/2003 14 37 15



0 400 800
SCALE IN FEET

- Sidewalk
- Building
- Foundation
- Fence
- Wall
- Tree Line
- Stream
- Brush/Shrub Line
- Index Contour
- Intermediate Contour
- Depression Contour
- Guard Rail
- Swamp Symbol
- Control Point
- Spot Elevation
- Single Tree
- Located Object
- Catch Basin
- Manhole
- Pole
- Sign
- Fire Hydrant
- Light Pole
- Inlet Symbol
- Railroad
- Paved Road
- Unpaved Road
- Trail
- Pipe line
- Driveway
- Buried Decant Lines (Approx)
- General Surface Drainage Pattern Associated with Decant Towers Settling Basins and Treatment Ponds
- Revegetated
- Rock Cover
- Pond
- Top of Slope
- Bottom of Slope

NOTES
1. DASHED LINES ARE ATHLETIC FIELDS AND PARKING AREAS OF ALT 4 2
2. SLOPES IN FORMER CHAT P LE AREA ARE AFTER END OF LBM COMPANY OPERATIONS ALT 4 1
3. EXISTING TOPOGRAPHY WAS PREPARED BY WALKER AND ASSOCIATES FROM AER AL PHOTOGRAPHS TAKEN MARCH 23 2000 MAP DATE AUGUST 29 2000 SURVEY CONTROL BY EFFAN SURVEY

Figure 8

RECOMMENDED ALTERNATIVE SCHEMATIC PLAN
Rivermines Mine Tailings Site
Park Hills MO

P 25861009 MMENDEDALTERNATIVE CDR RLG 08 27-03
Xrefs in Drawing – M \cad\2 H 009\13353_1 DWG H \cad\25861009\17829_1 DWG
jmw M \CAD\2 H6009\18196 1 DWG Plot at 1 04/25/2003 13 47 44

Storm Water Pollution Prevention Plan

The Doe Run Company

Elvins/Rivermines, Missouri Facility

Prepared for Compliance with

Missouri Storm Water Regulations

December 18, 1998

The Doe Run Company

Elvins/Rivermines Inactive Mine

Storm Water Pollution Prevention Plan (SWPPP)

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Appendix B Employee Training Outline

Appendix C Record of Training

1.0 Executive Summary

The Doe Run Company Elvins/Rivermines facility is an inactive lead mine/mill facility The mine was an underground operation The process of concentrating ores from ore bearing rock produced large amounts of waste rock Early ore concentrating produced waste rock which was the size of fine gravel 3/8 of an inch in diameter and less This type of waste rock is called Chat Later improved concentrating methods produced waste rock which was much smaller in diameter similar to sand and silt This type of waste rock is called tailings The tailings are deposited in a low flat pile on the north central portion of the site and the chat is deposited in a high pile on the south east portion of the site Both the tailings and the chat contain elevated levels of lead, zinc cadmium copper and fine particulate As a result the tailings and chat which remain exposed have the potential to contaminated storm water runoff

This document is the Storm Water Pollution Prevention Plan (SWPPP) for The Doe Run Company Elvins /Rivermines facility This plan describes the storm water drainage pattern at the facility identifies additional significant materials that have the potential to contaminate storm water discharges from the facility And it describes the BMPs necessary to reduce the potential for contaminating the storm water discharges from the facility

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2 0 Facility Description

2 1 General Description of Facility

The Elvins/Rivermines facility occupies approximately 400 acres and is located west of State Highway 32 between the towns of Elvins and Rivermines Missouri The drainage area contributing storm water flow to the facility is approximately 260 acres Figure 1 shows the general location of the site facility boundaries and the waters of the state that receive facility storm water runoff Approximately 200 acres of the site is discharged through out fall 01 and outfall 02 drains approximately 60 acres The site is approximately 99 percent permeable to storm water The only paved area is the asphalt driveway leading into the site A detailed map which shows significant materials storage storm water runoff flow and storm water structures is included in Figure 2

The production shaft and mill were located on the south side of the facility The mill initially produced Chat which was conveyed to a pile on the southeast side of the facility Later the mill process was improved and tailings were pumped to pond / piles on the northern central and eastern portions of the property The tailings and chat contain elevated levels of lead zinc cadmium, copper and small particulate that can be suspended in storm water runoff Most of the original buildings were demolished when the operations ceased in the late 1950 s The remaining buildings and all of the land is leased to Lead Belt Materials Company Lead Belt Materials Company operates a limestone quarry and an asphalt plant on the southwest side of the facility It is our understanding that Lead Belt Materials has or will have their own NPDES Storm Water Permit The dominant features at the facility are the chat pile tailings pile two decant towers a mostly buried dewatering tunnel and the discharge area The SIC Code for active lead mine/mill operations is 1031

2 2 Drainage Areas

The site is located in a valley Storm water runoff from the adjacent properties up to the ridge line flows onto the property A majority of the storm water runoff from the site is retained in a series of ponds located on the northwestern portion of the property The topography of the remaining site generally slopes from the west to the east / southeast Storm water runoff the remaining areas flows to the east through a spillway where it eventually discharges to the Flat River To a lesser extent storm water runoff

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from the northern portion of the site discharges to a small creek that also flows to the east and connects to the Flat River Two dewatering towers and a concrete culvert appear to connect the northern storm water detention pond to the spillway on the east side of the facility near the toe of the tailings pile In addition the dewatering structure may provide a drainage conveyance for the storm water that collects within the tailings pile The tailings have a detaining property that provides a holding time for the storm water As a result the discharge of storm water from the dewatering structure and the toe of the pile is spread out over a longer period of time past the end of the storm event that produced the runoff

It appears that storm water runoff from the south side of the facility may follow the entrance road out to the main road and enter the ditch / sewer system associated with the adjacent properties This water is eventually discharged to the Flat River Figure 2 contains a detailed site map which shows the drainage areas direction of storm water runoff discharge outfalls best management practices / structures and areas where significant materials are exposed to storm water

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3 0 Identification of Significant Materials and Activities

The purpose of this section is to identify significant materials used at the facility (materials that have a potential to contaminate storm water) and practices that potentially expose those materials to storm water Best Management Practices (BMPs) have been developed for practices related to those significant materials that are exposed to storm water BMPs are described in detail in Section 4 0

3 1 Significant Materials Inventory

Significant Materials

- Tailings (containing lead zinc cadmium copper and contributes to TSS)
- General refuse / trash

3 2 Spill History

The facility has not had a significant spill within the past three years

3 3 Activities with the Potential to Expose Significant Materials to Storm Water

The facility is inactive however tailings piles from past mining activities are currently exposed to and have the potential to impact storm water The property is also occasionally used for unauthorized recreational vehicle use and occasional dumping of general refuse Both activities have the potential to contaminate storm water runoff The largest concern is with off road recreational vehicles because the activity reduces the vegetation which was established to control erosion and suspended solids

This plan assumes that adjacent industries properties as well as leased property located on Doe Run Company property are in compliance with Missouri Clean Water Law

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4 0 Best Management Practices (Measures and Control)

In this section the non structural and structural Best Management Practices (BMPs) employed at this facility are identified and described BMPs including source reduction diversion and treatment were considered Table 1 summarizes areas of concern (areas identified in Section 3 0 as having significant materials that could potentially be exposed to storm water) potential contaminants potential environmental impacts assessment of risk and the BMPs employed for each area of concern

4 1 Non-Structural BMPs

Housekeeping Practices The facility and the surrounding grounds are kept clean though regular inspection collection and proper disposal of debris and significant materials other than tailings which have the potential to contaminate storm water

Spill Prevention and Response Procedures The facility is inactive Significant materials related to industrial activities other than tailings are not stored, handled or otherwise used at this facility Therefore spill prevention and response procedures are not applicable

Preventive Maintenance and Inspection Program A Comprehensive Site Compliance Evaluation is performed annually to ensure the effectiveness of this storm water pollution prevention plan The inspection includes storm water management devices and equipment which have the potential to release and expose significant materials to storm water in the event there is a failure Where necessary preventive maintenance is scheduled to maintain the storm water controls A blank copy of the evaluation form and completed evaluations are included in Appendix A

Employee Training The Doe Run Company has an existing training program that includes storm water issues The site is inspected by environmental management staff who have received storm water pollution prevention training The training addresses spill response good housekeeping and materials management practices as well as site specific information An outline of the training has been attached in Appendix B Appendix C contains a blank form for documenting the training

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4 2 Structural BMPs (Management of Runoff)

The structural controls for the site have been grouped into existing and proposed structures It is expected that the levels of lead and zinc in storm water runoff directly correlate to the amount of suspended solids in the runoff Therefore the structural BMPs are primarily aimed at controlling erosion and preventing suspended solids from contaminating storm water runoff

Existing Structures

A majority of the property is sloped either towards the southwest or to the center of the property Storm water from the northwest is collected in two storm water retention ponds The storm water which collects in the center of the property either percolates into the ground or evaporates A third pond located on the northern portion of the site collects storm water runoff from the northern areas of the property Over flow from this pond appears to flow to the dewatering tower which discharges to the eastern spillway The spillway ends at an old railroad grade Storm water from the spillway is discharged through outfall 01 a concrete culvert in the north end of the rail road grade The culvert discharges to the ditch along State Highway 32 which in turn discharges to the Flat River

Storm water runoff from a portion of the northeast tailings pile is not discharged through out fall 01 Storm water from this area flows to the southeast eventually collecting in a tributary of the Flat River The culvert where this tributary passes underneath State Highway 32 has been designated out fall 02

Vegetation has been established in an effort to control erosion and the introduction of suspended solids into storm water in areas of the site where soil conditions storm water runoff flow and nutrients allow The facility has a seeding and fertilizing program in place to maintain the existing vegetation There is a natural vegetation buffer around the northern and eastern portion of the property which provides erosion control and filtering of storm water runoff Diversion berms have been constructed in the spillway which provide some retention of storm water during heavy rain events In addition the spillway its self provides time for suspended particles to settle out Berms have been constructed on the western side of the property to prevent storm water from flowing west into the residential area Finally a majority of the storm water is collected and detained in ponds located in the north and western portions of the property

The facility has posted signs to discourage trespassing and unauthorized off road vehicle use In addition access roads have been blocked or are gated

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Proposed Structural Controls

This plan outlines preliminary ideas for additional structural controls which are aimed at further reducing the amount of suspended solids lead and zinc contained in the facilities storm water runoff Figure 2 contains a map with the location of the proposed structural controls The map also shows the area which will be effected by the control structure based on the elevation of the structure and upstream area The letter on the map corresponds with the following brief descriptions

Structures A

A series of berms which were installed in the spillway area A will be re engineered and rebuilt The resulting berms or berm will either have a v design or will be a straight berm with an elevated culvert / spillway Either way the berm system will be designed to retain a portion of the storm water runoff The retention of storm water will provide time for particles to drop out of suspension In addition the retention of the storm water will aid in revegetation efforts which provide filtration and prevent erosion

Structure B

Storm water from the south side of the facility currently flows off the property in a ditch on the south side of the entrance road A culvert will be installed to divert this storm water flow from the south side of the road over to the north side back onto the facilities property In addition a berm will be constructed to ensure the diverted water flows to the proposed spillway retention area

Structure C

The portion of the north side of the tailings pile which discharges to the creek on the north side of the property will be regraded and covered with riprap to reduce the erosion Vegetation will be added to supplement the existing vegetation buffer between this area and the creek

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5 0 Non-Storm Water Discharge Certification

Missouri storm water regulations (10 CSR 20 6 200) require certification by the facility that all outfalls that should contain storm water discharges associated with industrial activity have been evaluated for the presence of non storm water discharges other than discharges covered under a state operating permit The following certification statement should be signed by a responsible facility representative in order to meet this requirement

I have evaluated both the on site storm sewer and sanitary sewer configurations at the Elvins/Rivermines facility The facility is inactive there are no industrial activities on site The only past industrial activity that currently exposes significant materials to storm water is the storage of tailings At this time there are no non storm water discharges from this facility The storm water sewers outfalls and conveyances at the facility were inspected during dry conditions on _____ date *to determine if non storm water is discharged to the storm water system With the exception of water flowing from the tailings dewatering structure flow from the storm water system was not observed indicating the absence of non storm water discharges*

_____
Signature

_____
Date

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6 0 Storm Water Monitoring Program

The facility does not currently monitor storm water runoff As part of an EPA study, The Doe Run Company will be performing a study of the Big River to determine the impacts caused by inactive mines A description of the proposed study is located in the Determination of Concentrations of Heavy metals in Fish in the Big River and Flat River Creek of Missouri s Old Lead Belt, prepared by the University of Missouri – Rolla

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7 0 Administrative Procedures

7 1 SWPPP Team

The storm water Pollution Prevention team for this site consists of the following two individuals

At Corporate Level	Mr Environmental Engineer Doe Run Company
At the Facility Level	Mr John Carter Environmental Engineer Manager of Mining Properties Maintenance and Restoration Doe Run Company

These individuals are responsible for managing and implementing this plan as well as meeting the reporting requirements of this plan

7 2 SWPPP Review and Revision

The facility performs an annual comprehensive site compliance inspection This plan shall be updated when conditions observed at the site indicate that a change is required If the site inspection indicates that BMPs are not meeting the objectives of the plan corrective action will be implemented as soon as practical after the observation and the BMP will be restored to full operation as soon as field conditions allow

7 3 Records and Reporting

The inspection records and other storm water reports will be incorporated into this plan The following records will be maintained under this storm water pollution prevention program

- Dates of inspections
- Finding of inspections
- Corrective actions taken
- Documentation of all changes to the SWPP Plan

In addition the operator of the local municipal storm sewer shall be notified of the existence of this permit if this facility discharges storm water to that system

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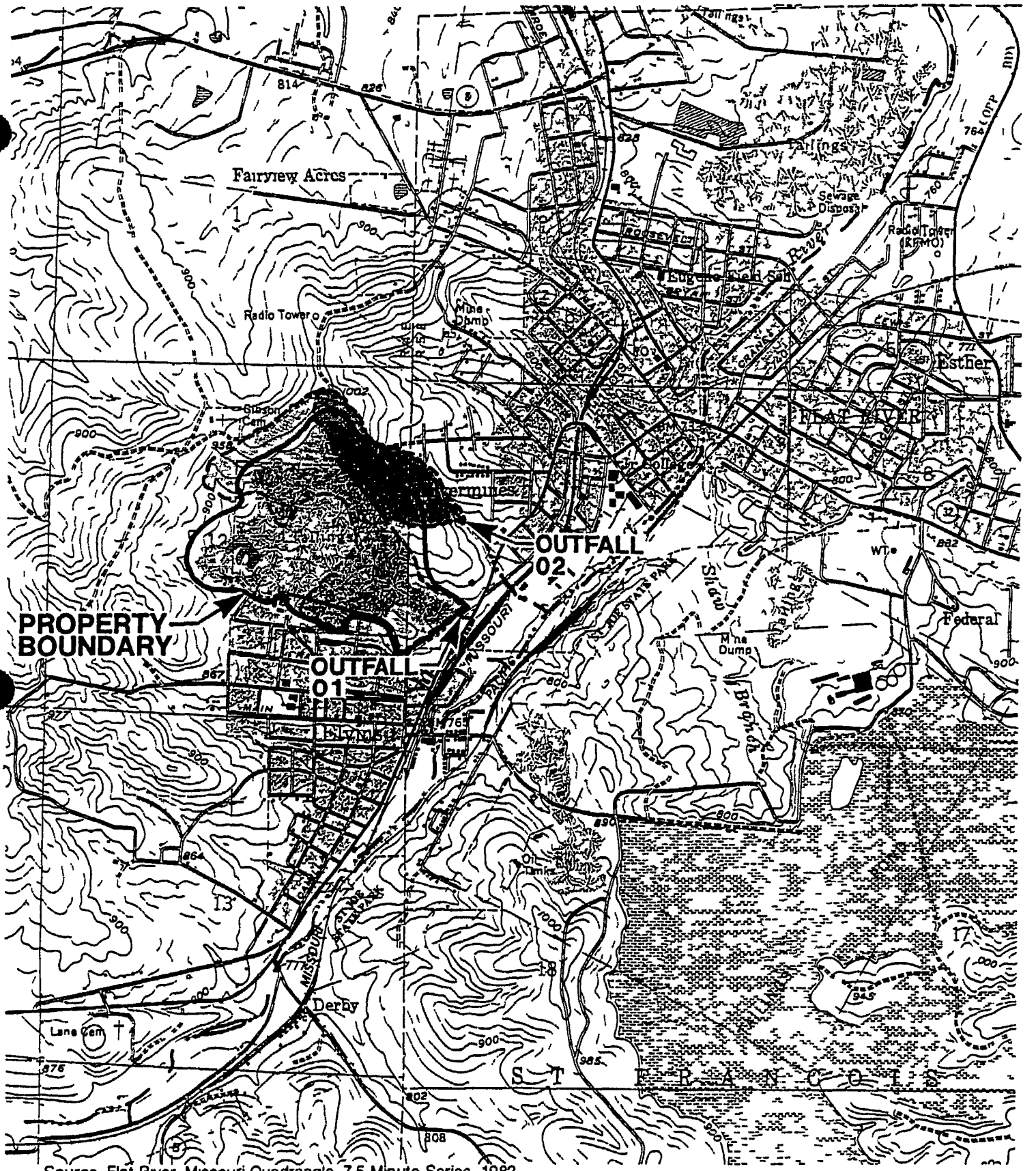
Tables

Table 1
Risk Identification and Summary of Potential Pollutant Source

Source	Potential Contaminant	Environmental Impact	Risk	BMPs Employed	
				Non-Structural	Structural
Tailings / Chat	Suspended Solids Lead Zinc Cadmium and Copper	Turbidity Silt / Sediment Toxicity / Metals	Moderate to High	Preventive Maintenance Post Employee training Inspections	Flow diversion Vegetation Steps with Rip Rap Cover Retention & Detention ponds Rip Rap Spillways Berms Grading Signs
General Refuse	Suspended Solids Oil / Grease / Solvents	Turbidity Sheen Toxicity	Low	Work with local law enforcement Inspection Collection and Disposal of Refuse	Gates Block entrances Post signs
Unauthorized off road vehicle use	Suspended Solids Lead Zinc Cadmium and Copper	Turbidity Silt / Sediment Toxicity / Metals	Moderate to High	Work with local law enforcement Inspection	Post signs Gates Block entrances

Figures



N

0 2000 4000

Scale in Feet

Property Boundary

Drainage Collection Areas

Figure 1

FACILITY LOCATION/ RECEIVING WATER

Doe Run - Elvins Facility

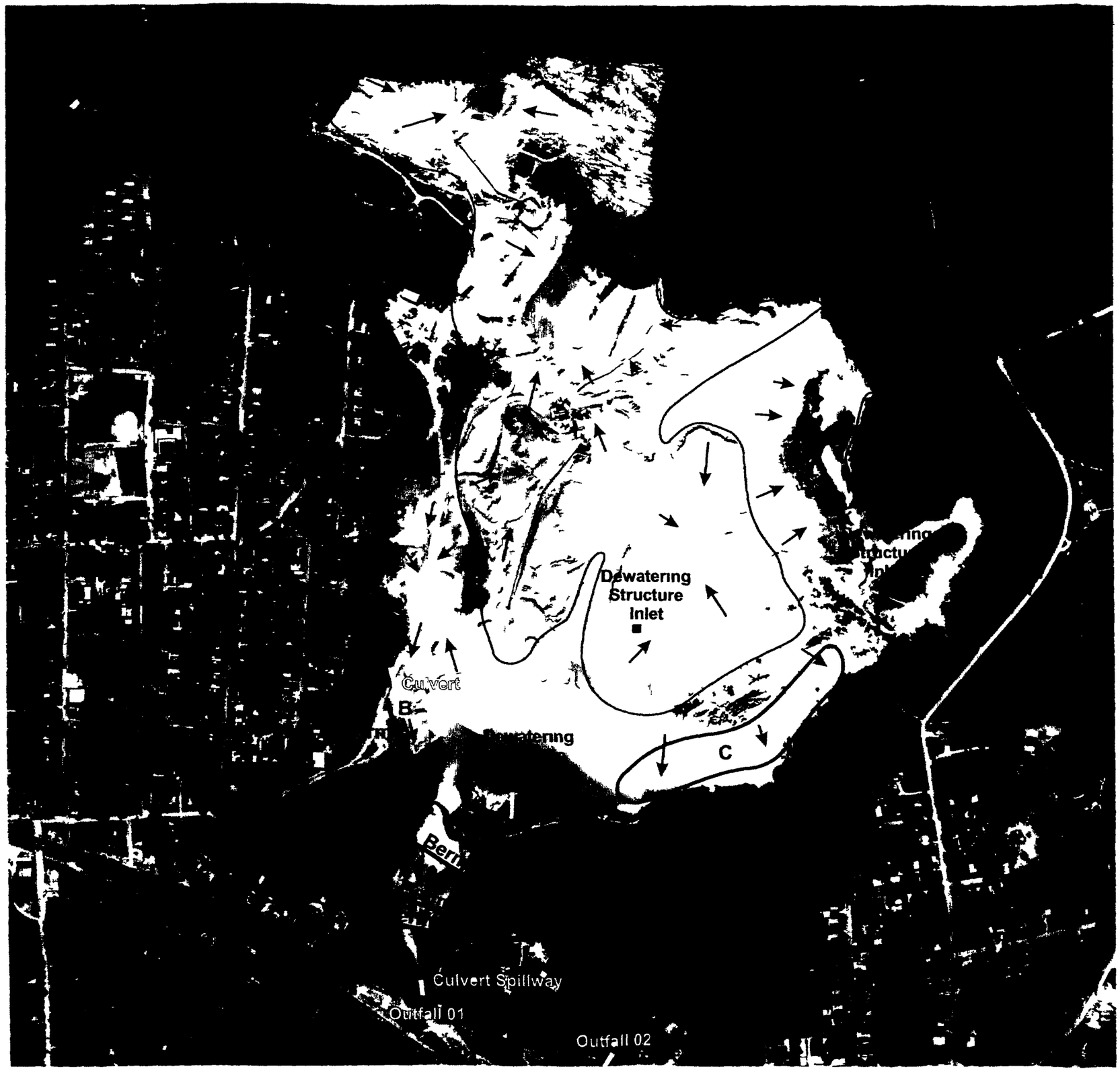


Figure 2

FACILITY STORMWATER RUNOFF MAP
Doe Run Elvins/Rivermines Facility

P 25\8\008\STORMWATERRUNOFFMAP CDR RLG 02-07-01

Appendix A

Comprehensive Site Compliance Evaluation Forms

Elvins / Rivermines Facility Comprehensive Site Compliance Evaluation *And* Preventive Maintenance Inspection	*Inspector /Title*		
	Page 1 of 2	*Date of Inspection /weather conditions*	

Task	*Map ID*	*Observations*	*Corrective Action*	*Date of Repair*
Water at Outfall 01	01			
- color				
- oils films or sheens				
- unnatural floating solids or foams				
- suspended or settlable solids				
- deposits resulting from discharges				
Water at Outfall 02	02			
color				
oils films or sheens				
- unnatural floating solids or foams				
- suspended or settlable solids				
deposits resulting from discharges				
Detention Structures Area A	A			
Structural integrity of berms				
Sediment loading				
Erosion				
Vegetation				
Spillways clear and operating				

Elvins / Rivermines Facility Comprehensive Site Compliance Evaluation *And* Preventive Maintenance Inspection	Inspector /Title	
	Page 2 of 2	Date of Inspection /weather conditions

Task	*Map ID*	*Observations*	*Corrective Action*	*Date of Repair*
Diversion Structures Area B	B			
erosion				
berm structural integrity				
diversion culvert clear and functioning				
Erosion Protection Area C	C			
erosion / protective cover				
vegetation				

Appendix B

Employee Training Outline

Appendix B

Employee Training Outline

Topic 1 General overview of storm water pollution planning requirements (Refer to Section 1 0)

Topic 2 List of materials and activities that have the potential to impact storm water at the Elvins/Rivermines facility (Refer to Section 3 0)

- Tailings
- General refuse, / disposal
- Unauthorized off road vehicle use

Topic 3 Pollution Prevention activities at Elvins/Rivermines (Refer to Section 4 0)

- Good housekeeping
- Spill prevention plan
- Vegetative cover to prevent erosion
- Preventive maintenance
- Employee training
- Flow diversion Structures
- Retention and Detention Berms

Appendix C

Record of Training

Appendix C

Doe Run Company
Elvins/Rivermines Facility Missouri

STORM WATER POLLUTION PREVENTION PLAN
TRAINING RECORD

This record form should be used to document training events conducted to comply with the requirements of the facility storm water pollution prevention program This form should be completed for each training event

Attendance List

Training Date Trainer's Name

Trainee Name	Trainee Signature

A STUDY ON THE POSSIBLE USE OF CHAT AND TAILINGS FROM THE OLD LEAD BELT OF MISSOURI FOR AGRICULTURAL LIMESTONE

by

Bobby G Wixson

Nord L Gale

and

Brian E Davies *

The University of Missouri - Rolla
Rolla, Missouri 65401

* Visiting Professor, University
of Wales - Aberystwyth

December 1983

D Elvins

The Elvins tailings pile borders northern Elvins, Missouri and covers a land area of approxiamtely 0 6 square km (0 25 square miles) Two shallow lakes are found on the southwestern edge of the tailings pile and seepage from the base of the deposit passes through these shallow lakes and then flows into Flat River Creek These waters contain high levels of dissolved calcium, magnesium, zinc and lead which have an impact on the sediments and biota of Flat River Creek

The Elvins tailings pile was studied in 1976 by Kramer (16) and the growth of algae in the zinc rich wastes and seepage water has been reported by Whitton, et al (17) Presently a small asphalt paving plant operates on the southern perimeter of the tailings pile with the tailings being used as a finer sized aggregate source

Figure 9 illustrates the location of 91 sampling sites on the Elvins tailing pile Table 11 gives the metal concentrations of Pb, Cd and Zn found at the sampling locations

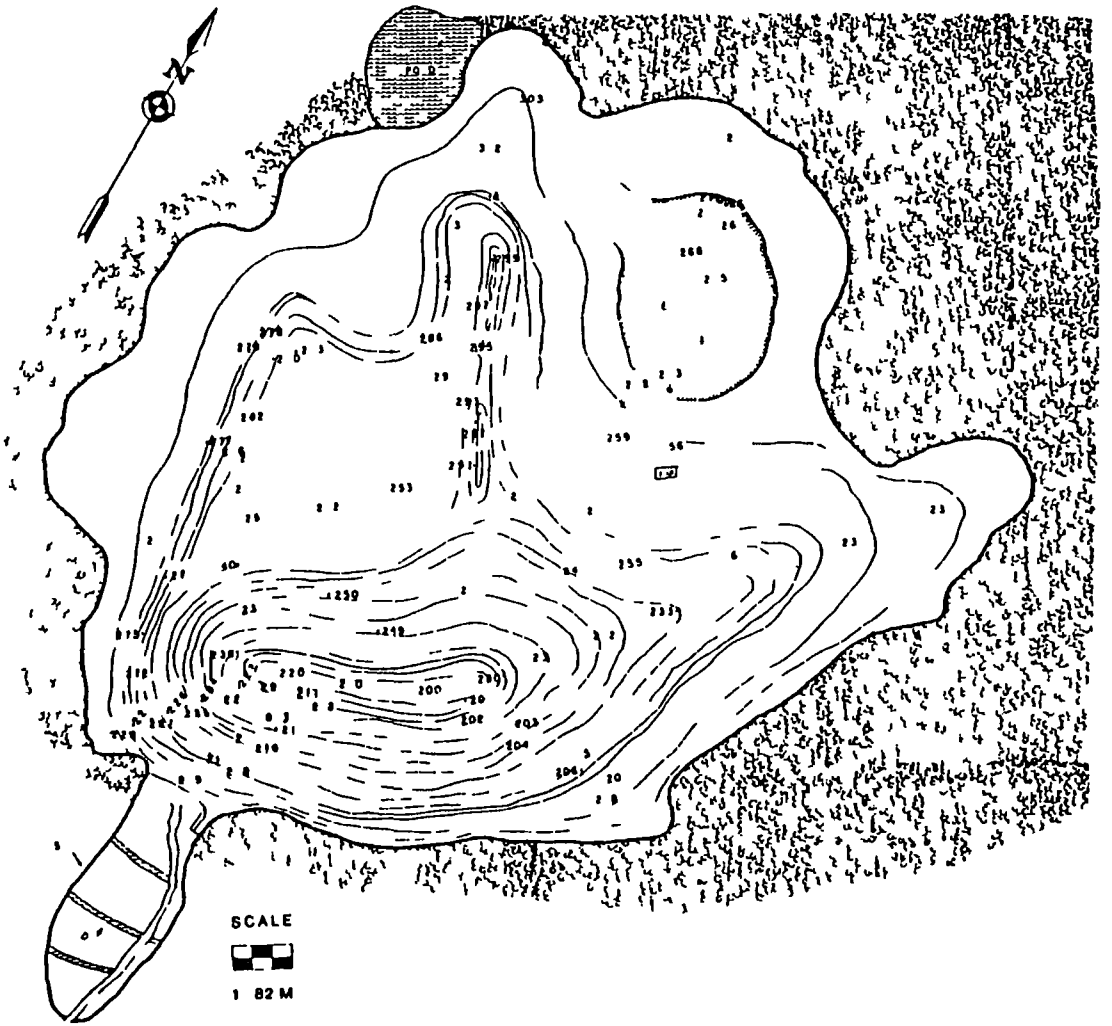


FIGURE 9 LOCATION OF SAMPLING SITES ON ELVINS TAILINGS PILE

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TABLE - 11
ELVINS TAILINGS PILE

Sample No	Metal Conc, ug/g Pb	Cd	Zn
E200	5990	190	6100
E201	6420	180	11200
E202	7950	202	11200
E203	5130	199	10600
E204	4460	165	9210
E205	4200	156	8620
E206	4400	168	9510
E207	3570	140	8210
E208	3650	152	8180
E210	5180	171	11800
E211	4190	179	11400
E212	6000	153	9600
E213	4630	160	9630
E214	5450	155	8610
E215	6780	156	8080
E216	6960	172	9260
E217	5240	120	6870
E218	4980	114	6000
E219	7500	106	5600
E220	4760	168	10500
E221	6820	163	11400
E222	5500	110	6400
E223	5990	114	6100
E224	4470	70 8	4350
E225	5270		8590
E226	4010	92 9	5320
E227	1880	51 5	1290
E228	3680	84 6	5150
E229	5180	132	6480
E230	4550	76 3	6540
E231	4300	189	11900
E232	3880	138	8820
E233	3170	151	2040
E234	2780	126	6510
E235	3630	112	6090
E236	3180	92 5	4560
E237	1300	79 6	4470
E238	8140	106	1760
E239	8360	135	9280
E240	6200	84 0	4290
E241B	8000	95 0	1300
E242	9600	157	10900
E245	11100	91 8	4950
E246	5640	161	9680
E247	7080	159	8360
E248	3780	144	7870
E249	4600	129	6990

TABLE - 11 (Cont)
ELVINS TAILINGS PILE

Sample No	Metal Conc, ug/g Pb	Cd	Zn
E250	6410	138	2040
E251	6190	114	6290
E252	4850	127	7020
E253	4050	118	6340
E254	4440	115	5360
E255	1700	51 3	2480
E256	2750	52 8	221[illegible]
E257	1350	48 3	2290
E258	1170	45 0	2190
E259	2180	54 4	2440
E260	2750	69 8	3300
E261	1060	61 4	2170
E262	1400	110	5500
E263	1270	74 8	3570
E264	1120	72 2	3230
E265	1620	75 5	3770
E266	4230	119	1440
E267	1060	74 7	3620
E268	1050	74 8	3660
E269	991	58 2	2140
E270	851	57 9	2600
E271	1100	74 7	2650
E272	4190	82 3	4240
E273	8890	85 0	4250
E274	4890	63 9	3290
E275	7160	100	4810
E276	9310	19 8	792
E277	9260	31 5	1950
E278	10000	134	8510
E279	11600	163	10900
E280	7200	94 4	5960
E290	4020	62 9	3510
E291	2750	56 1	3000
E292	2890	50 2	2330
E293	1080	41 7	2450
E294	2940	67 6	3380
E295	2190	75 8	3980
E296	2230	99 1	5820
E297		59 3	3600
E298	1890	48 4	2610
E299	3160	61 7	3210
E300	2270	47 3	2360
E301	2080	54 4	2230
E302	1780	42 2	1990
E303	1650	44 9	2120
E304	1900	42 6	108

CONTINUED STUDIES ON VAGRANT LEAD IN FISH, MOLLUSCS, AND SEDIMENTS OF THE BIG RIVER OF SOUTHEASTERN MISSOURI

Nord L Gale
and
Michael J Haas
Department of Life Sciences

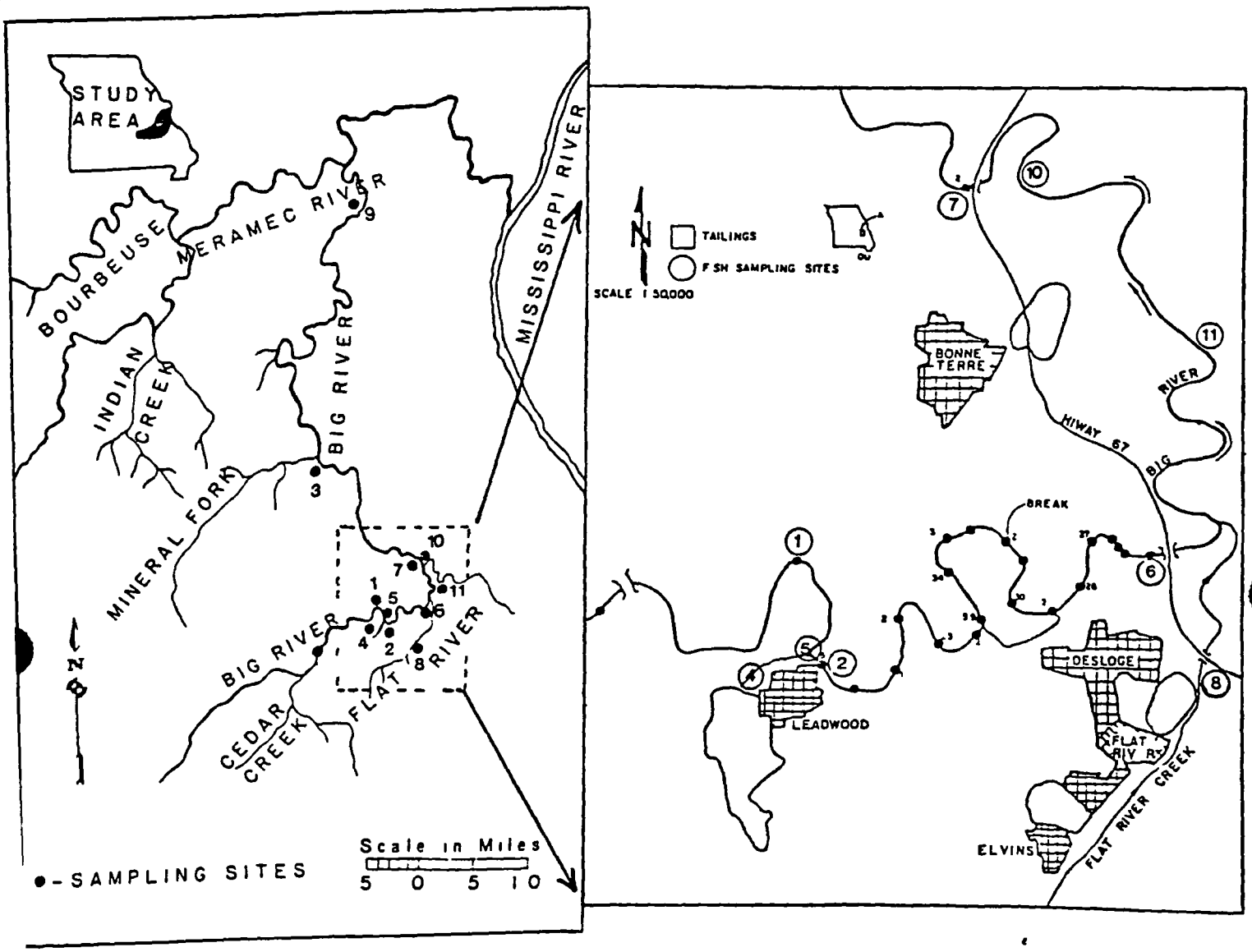
and
Bobby G Wixson
Environmental Research Center
Department of Civil Engineering

A Research Report Submitted to St Joe Minerals Corporation
Clayton, Missouri
March, 1986

University of Missouri - Rolla
Rolla, Missouri 65401

Figure 1

LOCATION OF COLLECTION SITES



LEGEND

1 Big River at Mo -Ill railroad trestle
2 Big River at Leadwood Public Access
3 Big River at Washington State Park
4 Eaton Creek at Highway 8
5 Big River at Eaton Creek
6 Big River at St Francois Cemetery
7 Big River at Bonneterre Hwy 67 North
8 Flat River Creek at National tailings pile
9 Big River at House Springs Public Access
10 Big River at St Francois State Park
11 Big River at Highway K

ble 1

SUMMARY - LEAD IN FISH OLD LEAD BELT SUMMER 1985

SITE NUMBER		SUNFISH	NORTHERN HOGSUCKERS	BLACK REDHORSE	CATFISH	CARP
1		< 048	103	069	--	--
	S	20	4	6	--	--
	N	10	2	3	--	--
*4		239	--	--	812	--
	S	6	--	--	1	--
	N	6	--	--	1	--
5		156	--	--	--	--
	S	6	--	--	--	--
	N	6	--	--	--	--
2		119	379	854	--	087
	S	20	6	2	--	8
	N	10	3	1	--	1
6		220	220	--	--	1 10
	S	25	2	--	--	5
	N	13	1	--	--	1
*8		392	728	--	254	--
	S	6	5	--	2	--
	N	6	5	--	2	--
11		226	676	573	--	--
	S	7	5	5	--	--
	N	7	5	3	--	--
10		173	583	455	--	--
	S	7	3	1	--	--
	N	7	3	1	--	--
7		247	793	446	330	--
	S	10	1	5	2	--
	N	10	1	5	2	--
3		152	377	--	114	--
	S	14	11	--	6	--
	N	7	5	--	2	--
9		149	206	185	--	DRUM 345
	S	17	1	11	--	4
	N	17	1	11	--	4

S = NUMBER OF SAMPLES ANALYZED
N = NUMBER OF INDIVIDUALS
*TRIBUTARIES OF THE BIG RIVER

Lead concentrations are expressed as ug/g (wet weight)

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ED_000859_00001631-00109

Figure 2

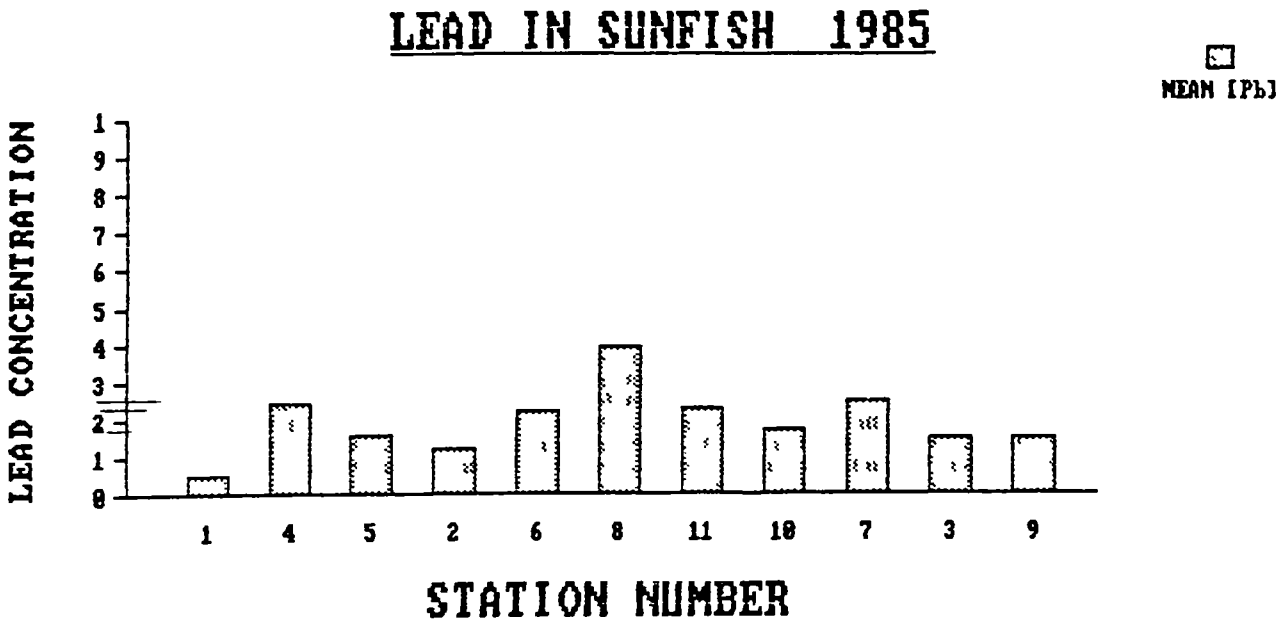

Figure 3

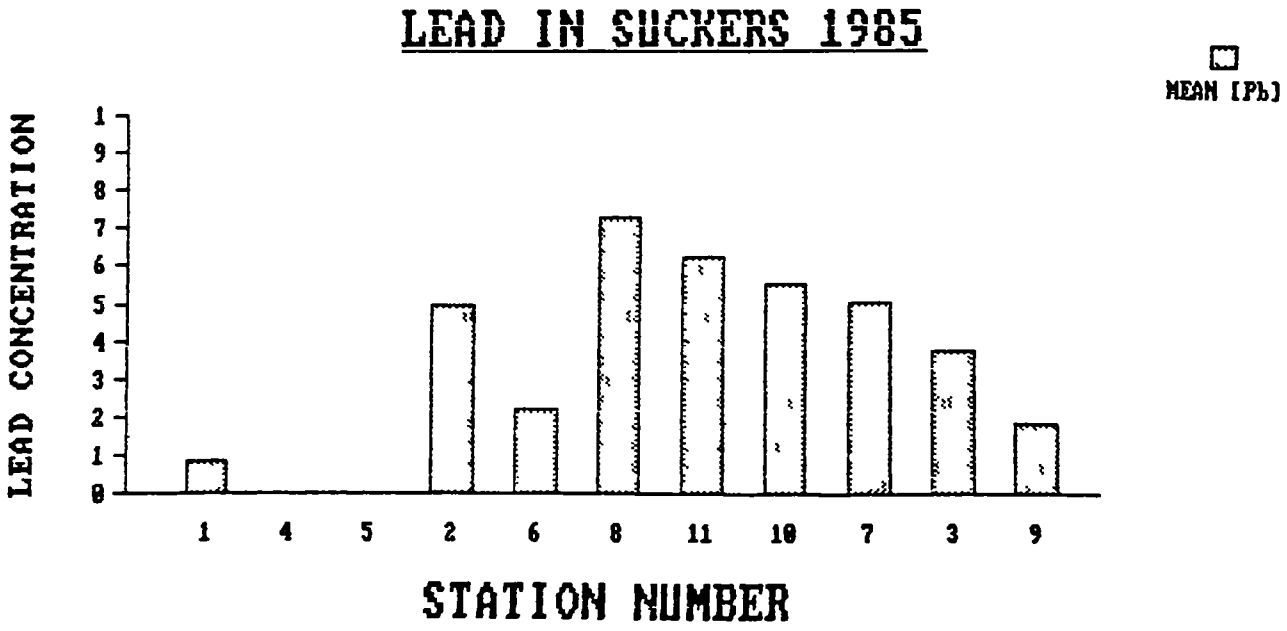

Table 2 HISTORICAL DATA Lead in Longear Sunfish

COLLECTION SITE		1981	1982	1983	1984	1985
Big River at Mo -Ill Railroad Trestle	MEAN	090	052	071	<0 048	<0 048
	STD DEV	050	010	006	007	006
Eaton Creek	MEAN	--	--	--	151	239
	STD DEV	--	--	--	100	101
Big River at Eaton Creek	MEAN	--	107	145	156	156
	STD DEV	--	040	096	090	031
Big River at Leadwood	MEAN	530	200	086	150	119
	STD DEV	350	150	020	080	064
Big River at St Francois Cemetery	MEAN	300	324	184	215	220
	STD DEV	190	440	100	130	075
Flat River Creek at National Tailings Pile	MEAN	910	300	310	439	392
	STD DEV	500	--	170	120	210
Big River at Hwy K Johnson's Campground	MEAN	--	--	--	--	226
	STD DEV	--	--	--	--	097
Big River at St Francois State Park	MEAN	--	--	--	--	173
	STD DEV	--	--	--	--	031
Big River at Bonneterre Hwy 67 North	MEAN	480	240	--	209	247
	STD DEV	350	170	--	110	140
Big River at Washington State Park	MEAN	--	--	--	565	152
	STD DEV	--	--	--	340	082
Big River at House Springs	MEAN	--	--	--	089	149
	STD DEV	--	--	--	065	035
Monsanto Lake	MEAN	--	--	--	<0 047	--
	STD DEV	--	--	--	004	--

Lead concentrations are expressed as ug/g (wet weight)

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Figure 4 Historical Data for Sunfish, Control Site Number 1

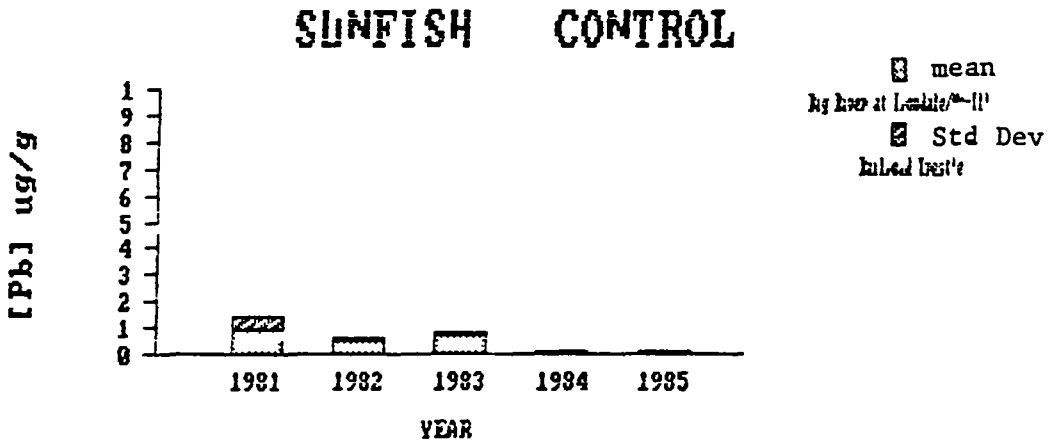


Figure 5 Historical Data for Sunfish, Site Number 4, Eaton Creek

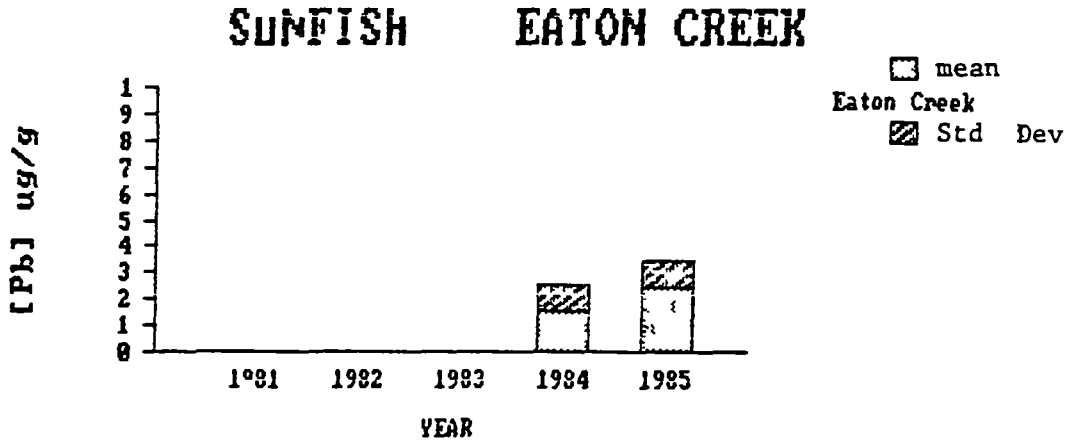


Figure 6 Historical Data for Sunfish, Site Number 5
Big River at Eaton Creek

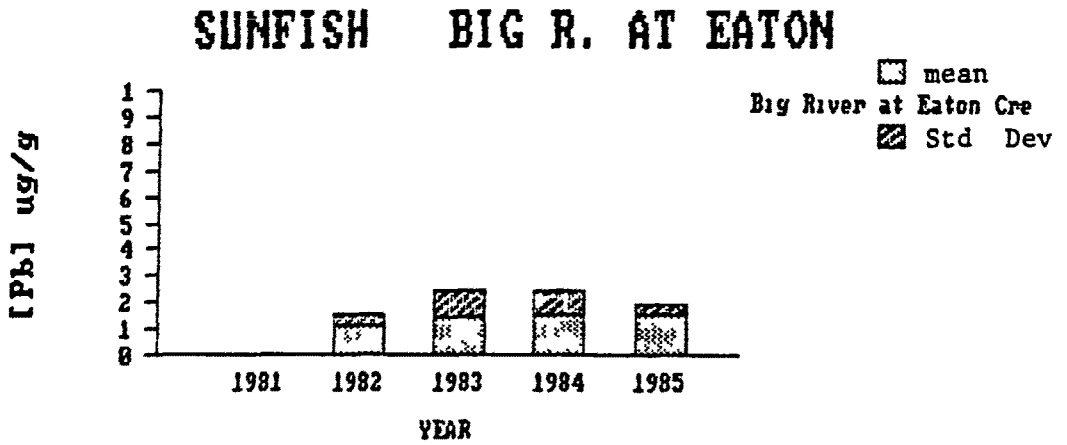


Figure 7 Historical Data for Sunfish, Site Number 2
Leadwood Public Access

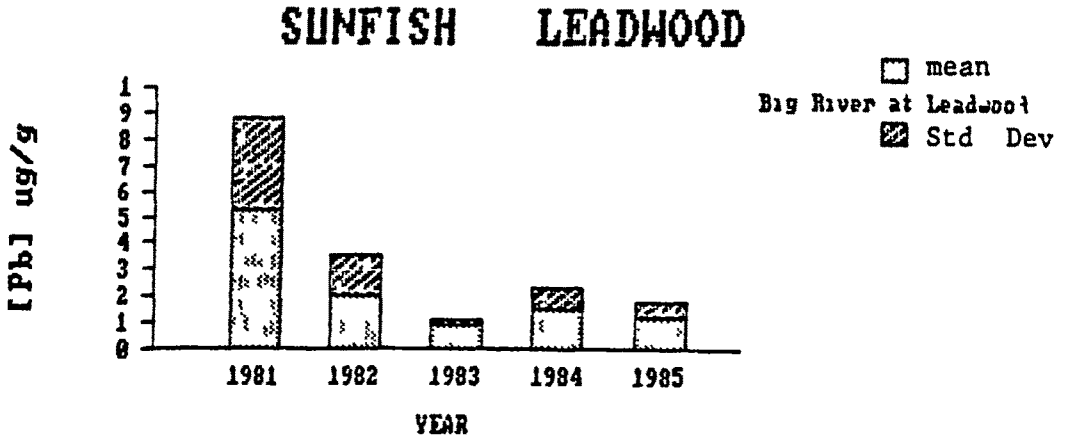


Figure 8 Historical Data for Sunfish, Site Number 6
Big River at St Francois Cemetery

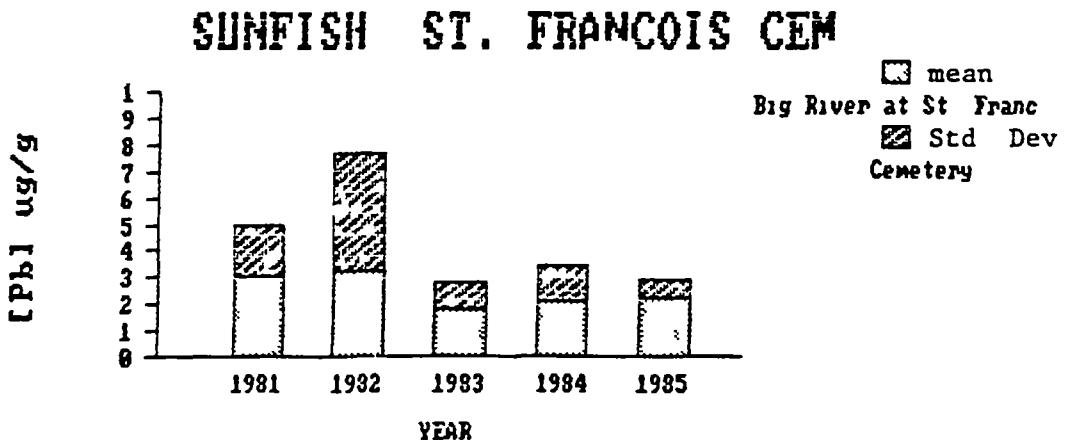


Figure 9 Historical Data for Sunfish, Site Number 8
Flat River Creek at National Tailings Pile

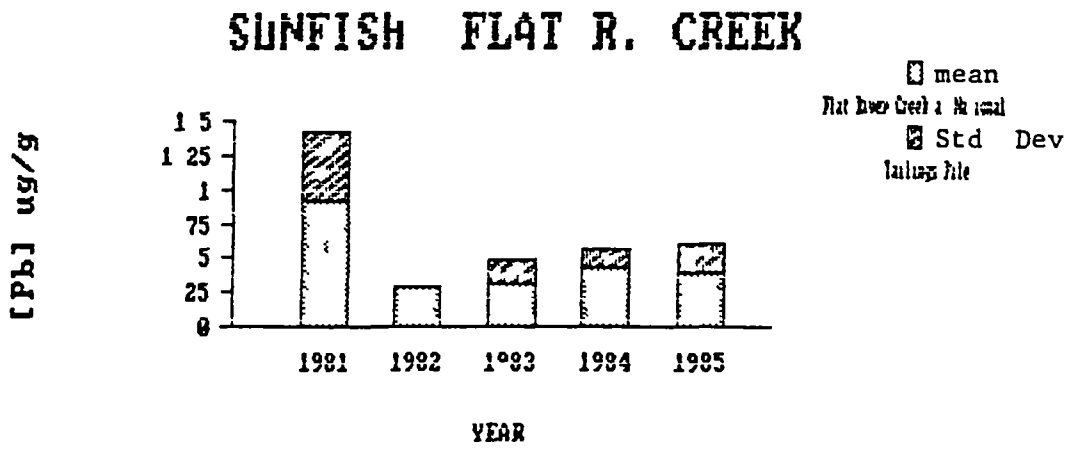


Figure 10 Historical Data for Sunfish, Site Number 7
Big River at Bonneterre (Hwy 67 N)

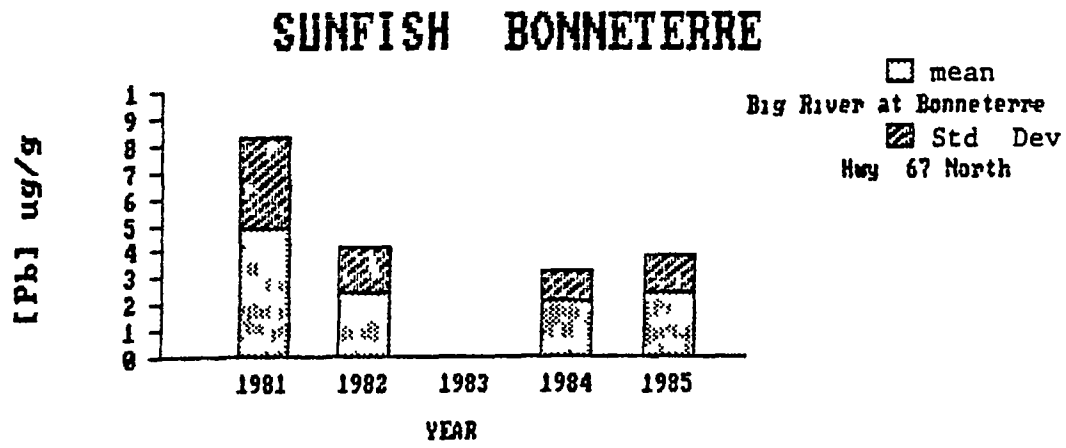


Figure 11 Historical Data for Sunfish, Site Number 3
Big River at Washington State Park

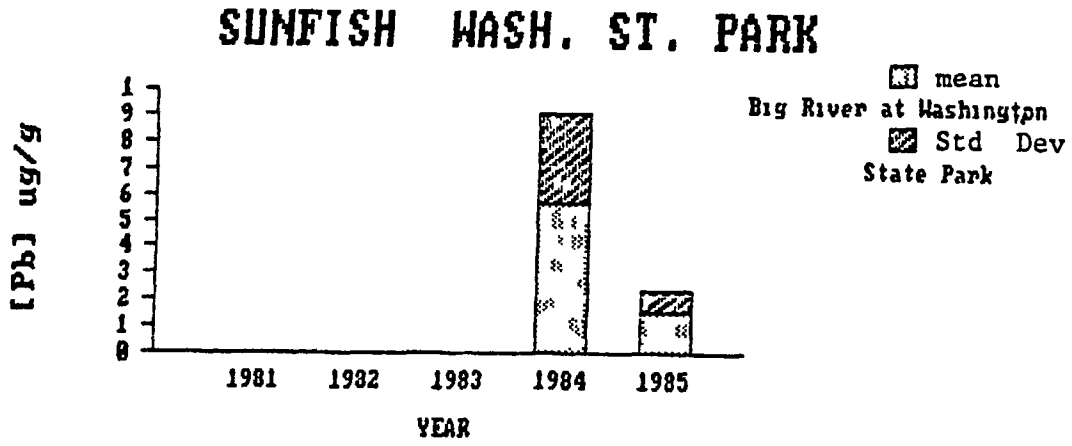
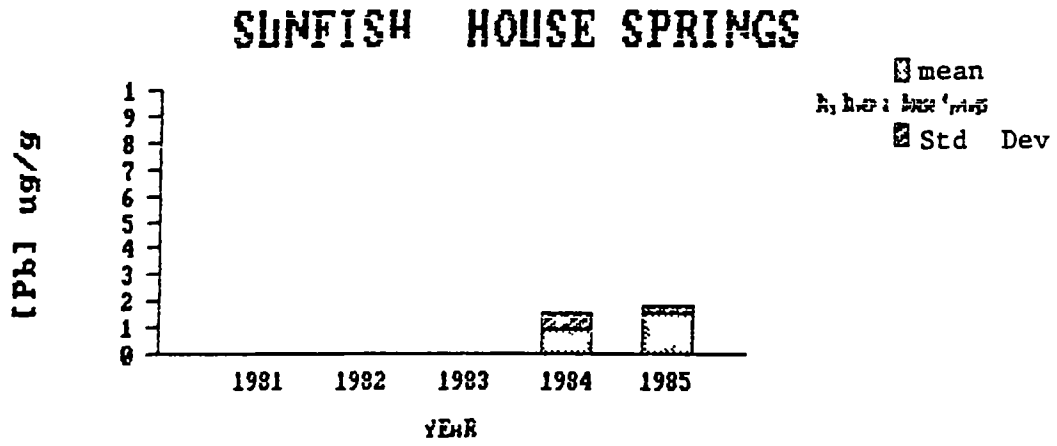


Figure 12 Historical Data for Sunfish, Site Number 9
Big River at House Springs Public Access



le 3 HISTORICAL DATA Lead in Northern Hogsuckers

COLLECTION SITE		1981	1982	1983	1984	1985
Big River at Mo -Ill Railroad Trestle	MEAN	07	03	--	--	103
	STD DEV	04	--	--	--	047
Eaton Creek	MEAN	--	--	--	--	--
	STD DEV	--	--	--	--	--
Big River at Eaton Creek	MEAN	--	--	--	--	--
	STD DEV	--	--	--	--	--
Big River at Leadwood	MEAN	86	480	--	265	379
	STD DEV	17	52	--	05	158
Big River at St Francis Cemetery	MEAN	69	490	--	1 01	220
	STD DEV	15	06	--	47	067
Flat River Creek at National Tailings Pile	MEAN	1 35	66	751	667	728
	STD DEV	1 14	51	40	12	270
Big River at Hwy K Johnson's Campground	MEAN	--	--	--	--	676
	STD DEV	--	--	--	--	180
Big River at St Francis State Park	MEAN	--	--	--	--	588
	STD DEV	--	--	--	--	025
Big River at Bonneterre Hwy 67 North	MEAN	66	49	--	431	793
	STD DEV	09	--	--	02	--
Big River at Washington State Park	MEAN	--	--	--	363	377
	STD DEV	--	--	--	09	175
Big River at House Springs	MEAN	--	--	--	--	206
	STD DEV	--	--	--	--	--

Lead Concentrations are expressed as ug/g (wet weight)

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Table 4 HISTOPICAL TPENDS OF COMBINED/SUCHERS SUMMER 1985

COLLECTION SITE		1981	1982	1983	1984	1985
Big River at Mo -Ill Railroad Trestle	MEAN	074	058	--	--	083
	STD DEV	065	032	--	--	039
Eaton Creek	MEAN	--	--	--	--	--
	STD DEV	--	--	--	--	--
Big River at Eaton Creek	MEAN	375	--	--	--	--
	STD DEV	064	--	--	--	--
Big River at Leadwood	MEAN	754	358	--	300	498
	STD DEV	531	243	--	089	320
Big River at St Francis Cemetery	MEAN	805	470	--	581	220
	STD DEV	462	08	--	392	075
Flat River Creek at National Tailings Pile	MEAN	1 07	31	751	695	728
	STD DEV	850	20	40	281	270
Big River at Hwy K Johnson's Campground	MEAN	--	--	--	--	624
	STD DEV	--	--	--	--	240
Big River at St Francis State Park	MEAN	--	--	--	--	555
	STD DEV	--	--	--	--	070
Big River at Bonneterre Hwy 67 North	MEAN	540	49	--	379	504
	STD DEV	304	--	--	199	159
Big River at Washington State Park	MEAN	--	--	--	363	377
	STD DEV	--	--	--	090	175
Big River at House Springs	MEAN	--	--	--	--	186
	STD DEV	--	--	--	--	061

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Figure 13 Historical Data for Combined Suckers, Control Site Number 1

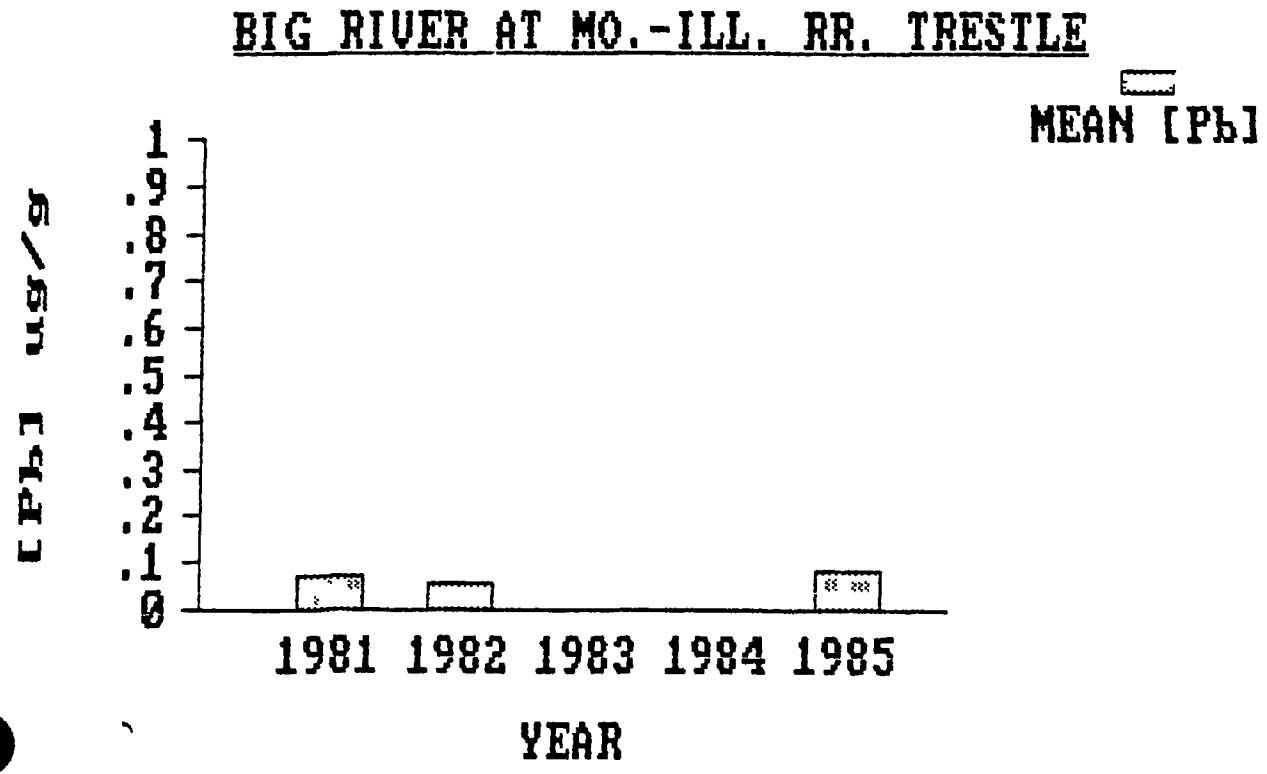


Figure 14 Historical Data for Combined Suckers, Site Number 2
Big River at Leadwood Public Access

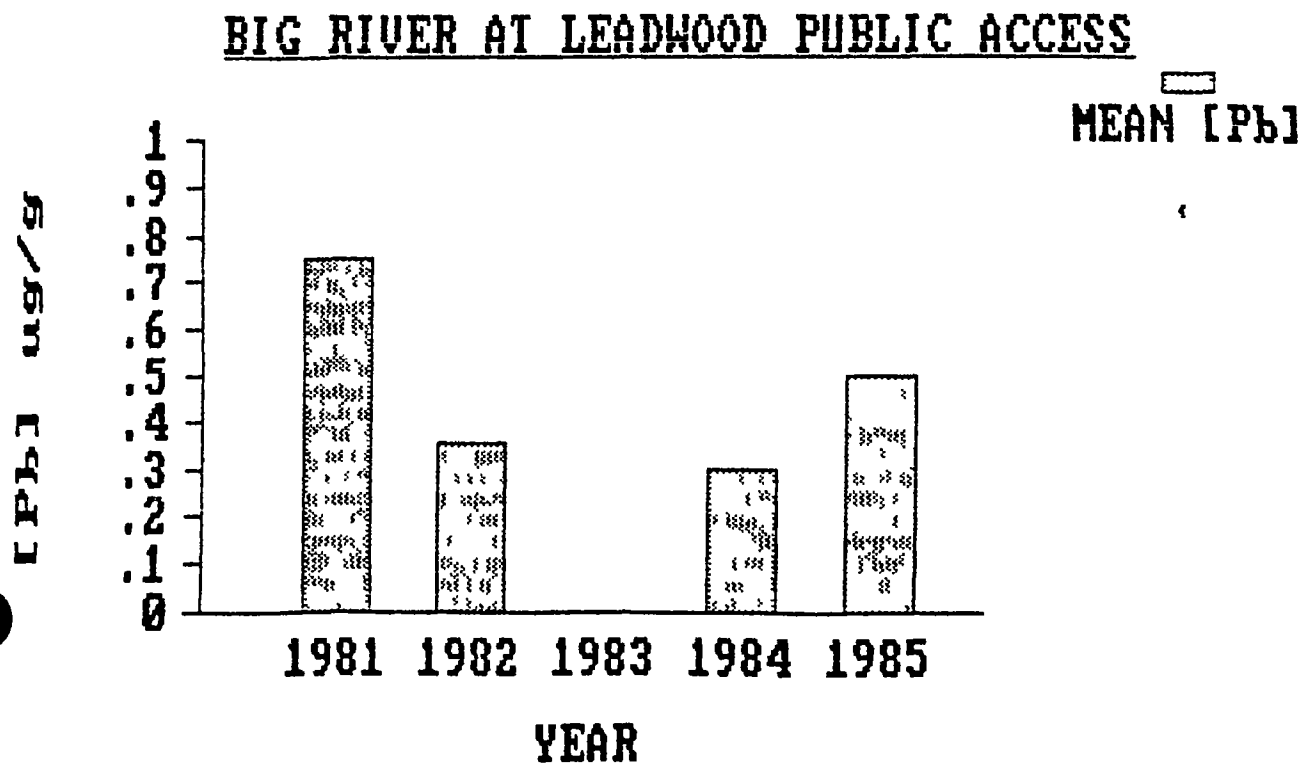


Figure 15 Historical Data for Combined Suckers, Site Number 6
Big River at St Francois Cemetery

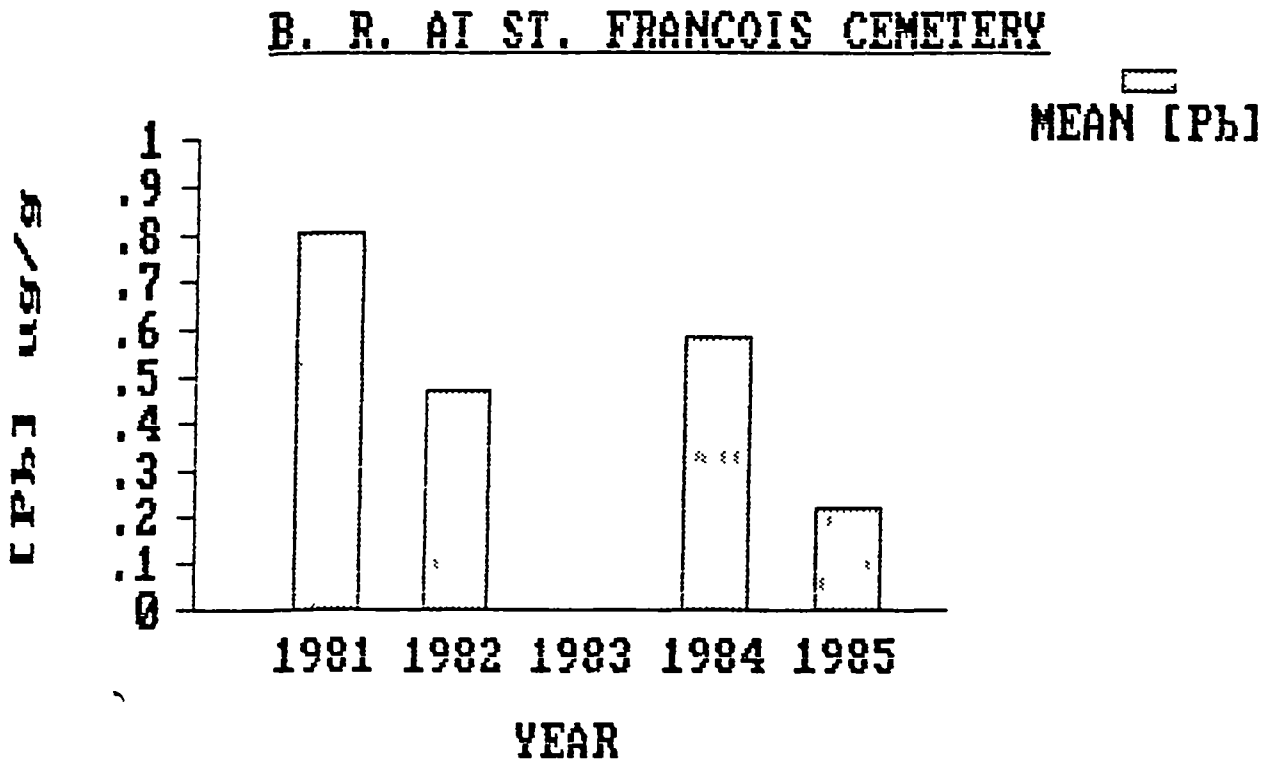


Figure 16 Historical Data for Combined Suckers, Site Number 8
Flat River Creek at National Tailings Pile

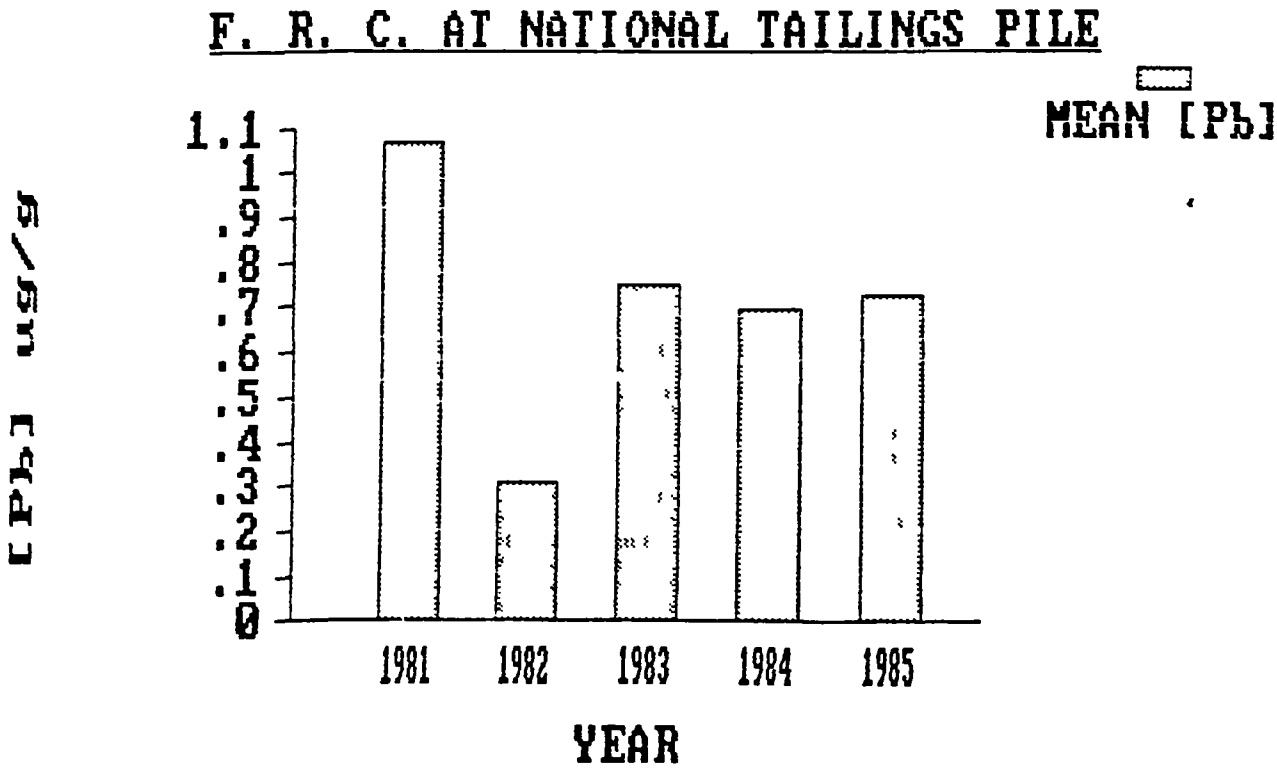


Figure 17 Historical Data for Combined Suckers, Site Number 7
Big River at Bonneterre (Hwy 67 N)

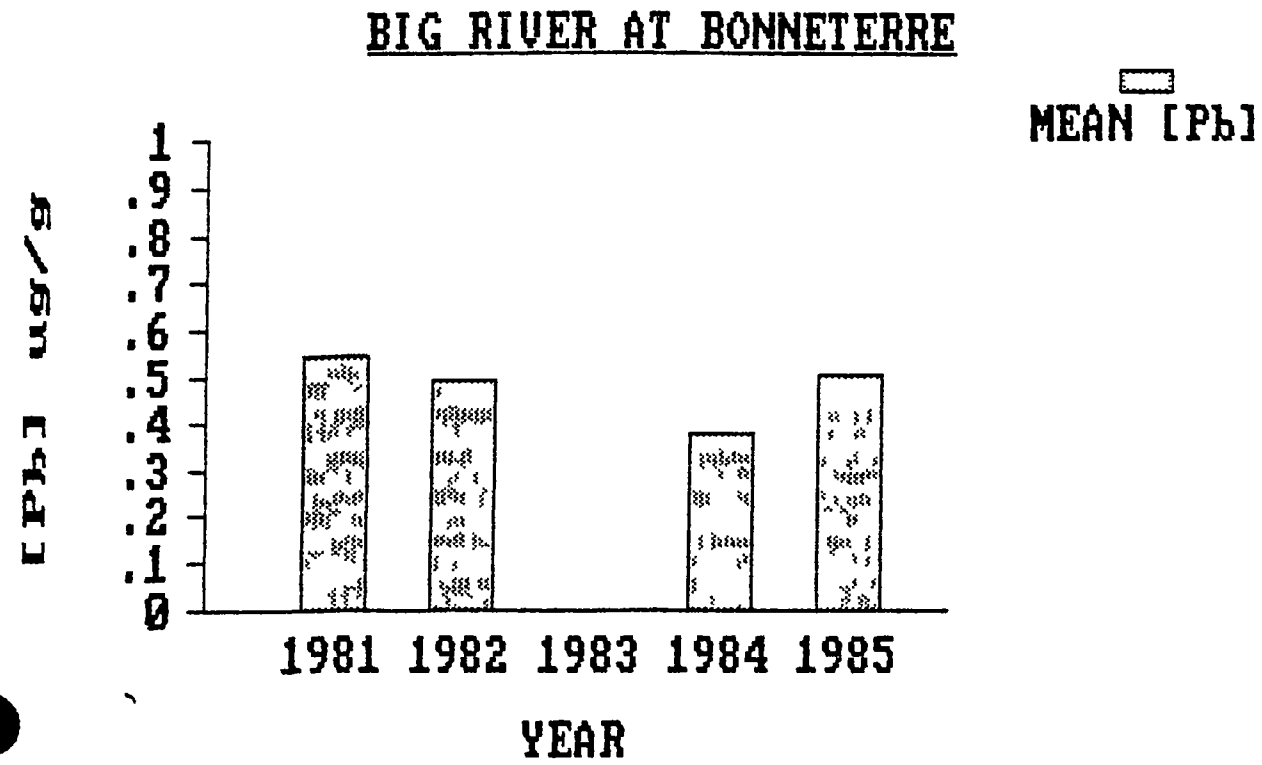


Figure 18 Historical Data for Combined Suckers, Site Number 3
Big River at Washington State Park

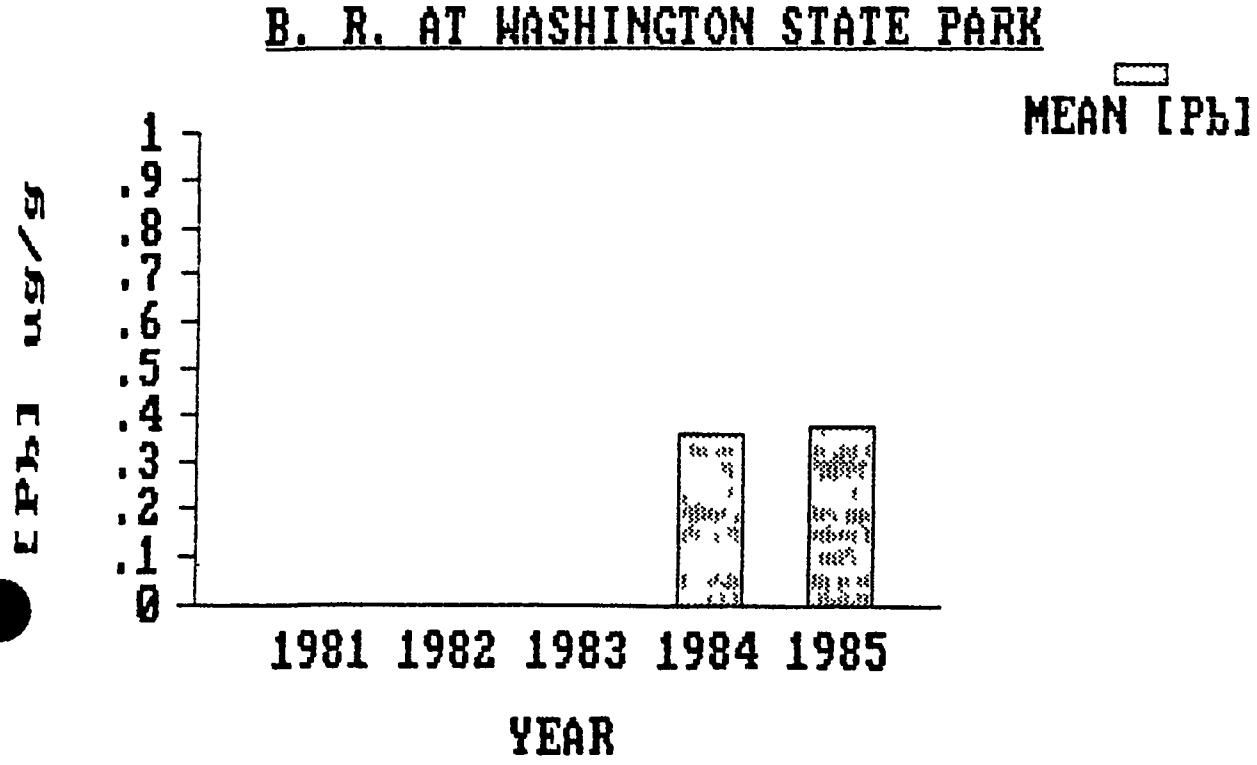


Table 5 SUMMARY - LEAD IN FISH NEW LEAD BELT SUMMER 1985

SITE NUMBER		SUNFISH	NORTHERN HOGSUCKER	LARGEMOUTH BASS	CARP	CATFISH
12	MEAN	068 (4)	061 (5)	--	793 (1)	040
	STD DEV	023	007	--	--	--
13	MEAN	070 (7)	117 (6)	--	320 (1)	--
	STD DEV	027	031	--	--	--
16	MEAN	* 093 (5)	--	--	--	--
	STD DEV	065		--	--	--
14	MEAN	150 (6)	698 (5)	049 (1)	725 (4)	--
	STD DEV	049	200	--	438	--
15	MEAN	198 (6)**	--	116 (5)	--	--
	STD DEV	058		023	--	--

( ) = n
* MIXED SPECIES OF SUNFISH
** BLUEGILL

ED_000859_00001631-00122

Figure 19

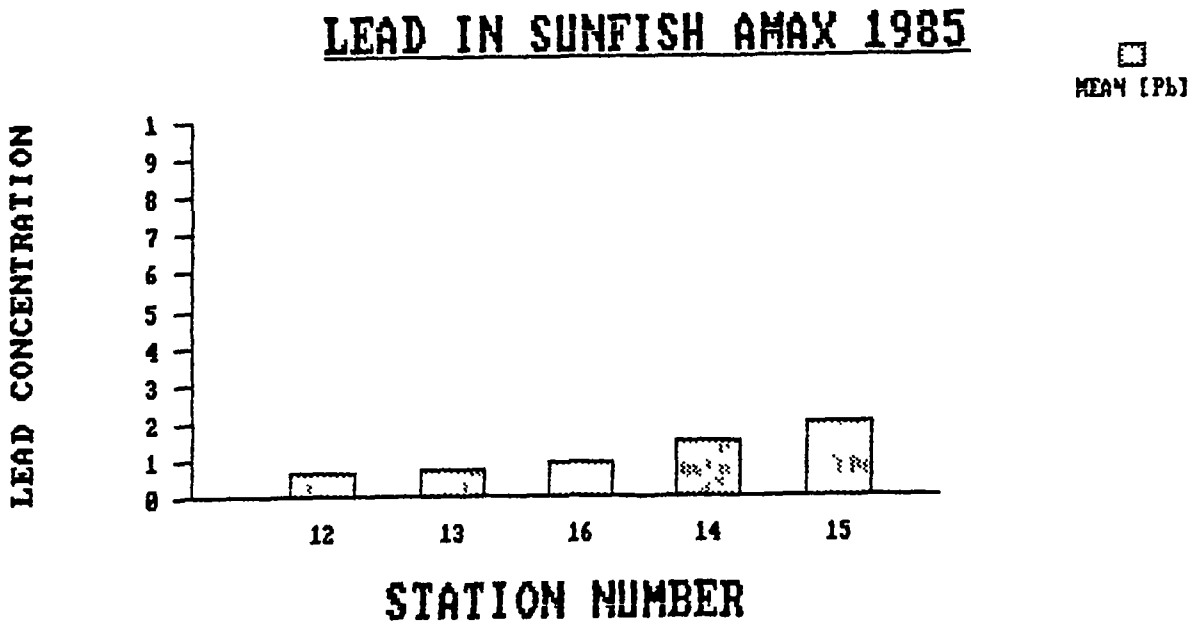


Figure 20

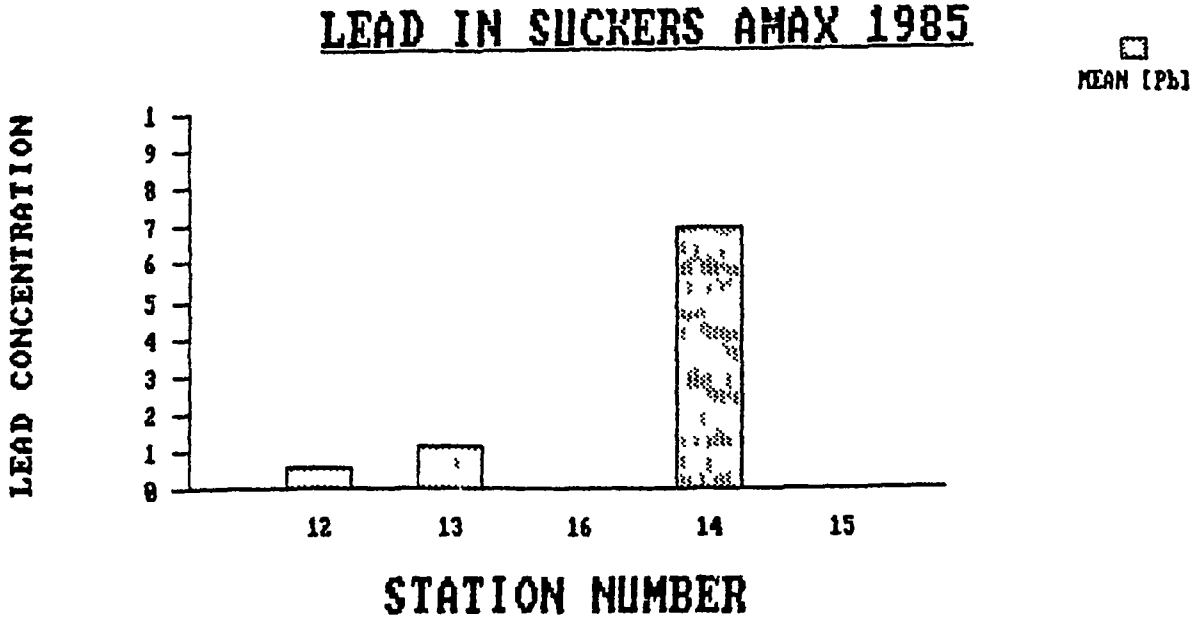


Table 10

Heavy Metals in Sediments, 1984

SITE #	Cd	Co	Cr	Cu	Ni	Pb	Ca	Fe	Mg	Mn	Zn
4	496	33	4	76	18	1790	138000	19400	73000	2865	26800
4 1	150	420	9	43	170	1310	54500	14150	16000	13850	35800
5	333	17	20 8	22	9 60	2200	95070	17500	48500	2450	7690
5 1	145	17	1	68	17	2450	109000	15500	53000	7200	19400
2	107	12	6 80	6 50	7 60	2550	38100	10600	19700	1500	5730
7	7 70	11	1	24	10	850	124000	24100	58000	3150	480

Sites

4 Eaton Creek at Hwy 8
4 1 Eaton Creek 200 yds above Hwy 8
5 Big River at Eaton Creek, Riffle zone
5 1 Big River at Eaton Creek, old tire carcass
6 Big River at Leadwood Public Access
7 Big River at Bonneterre, Hwy 67 North

ED_000859_00001631-00123

ED_000859_00001631-00124

Figure 34

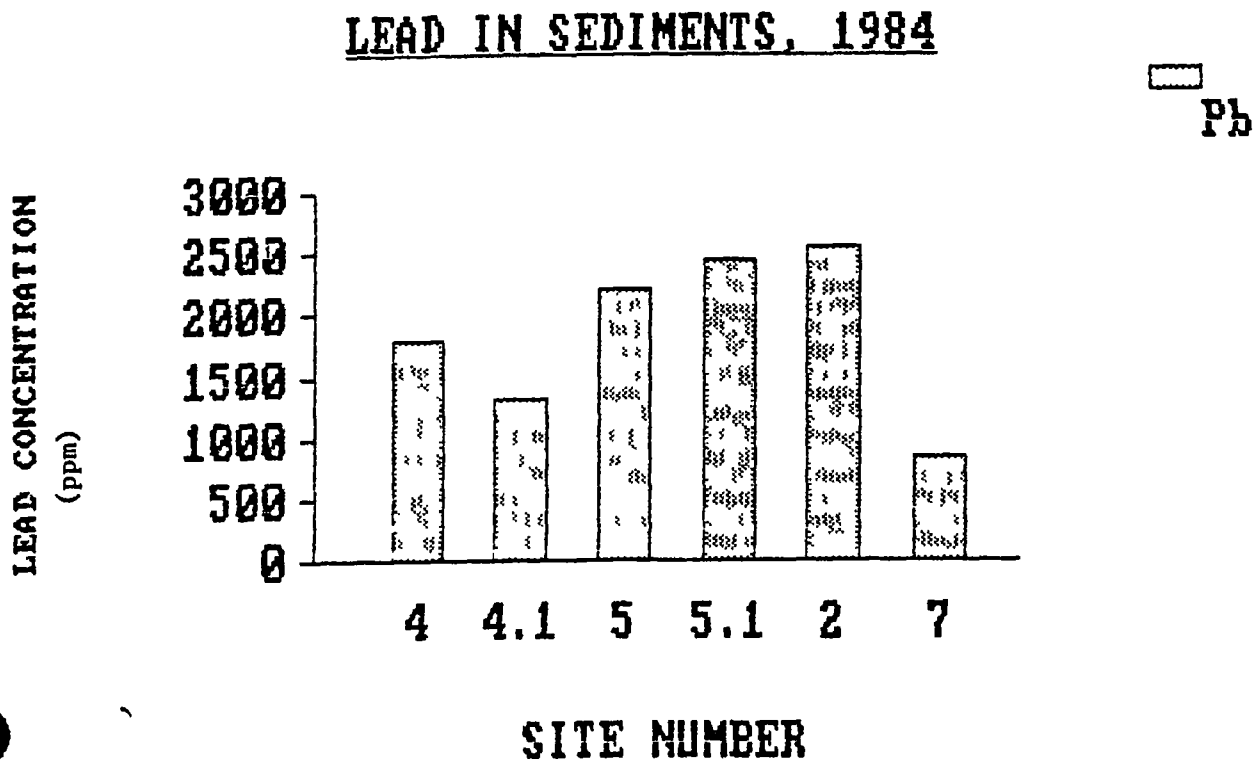
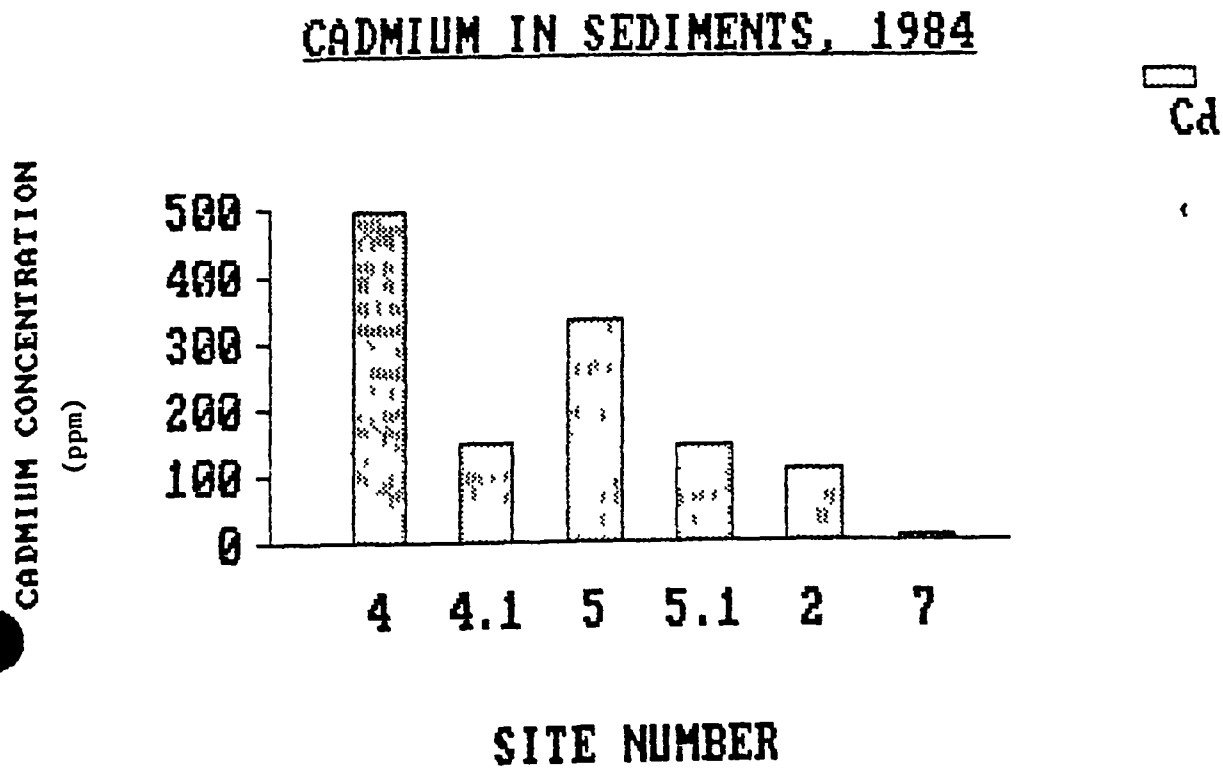


Figure 35



ED_000859_00001631-00125

Figure 36

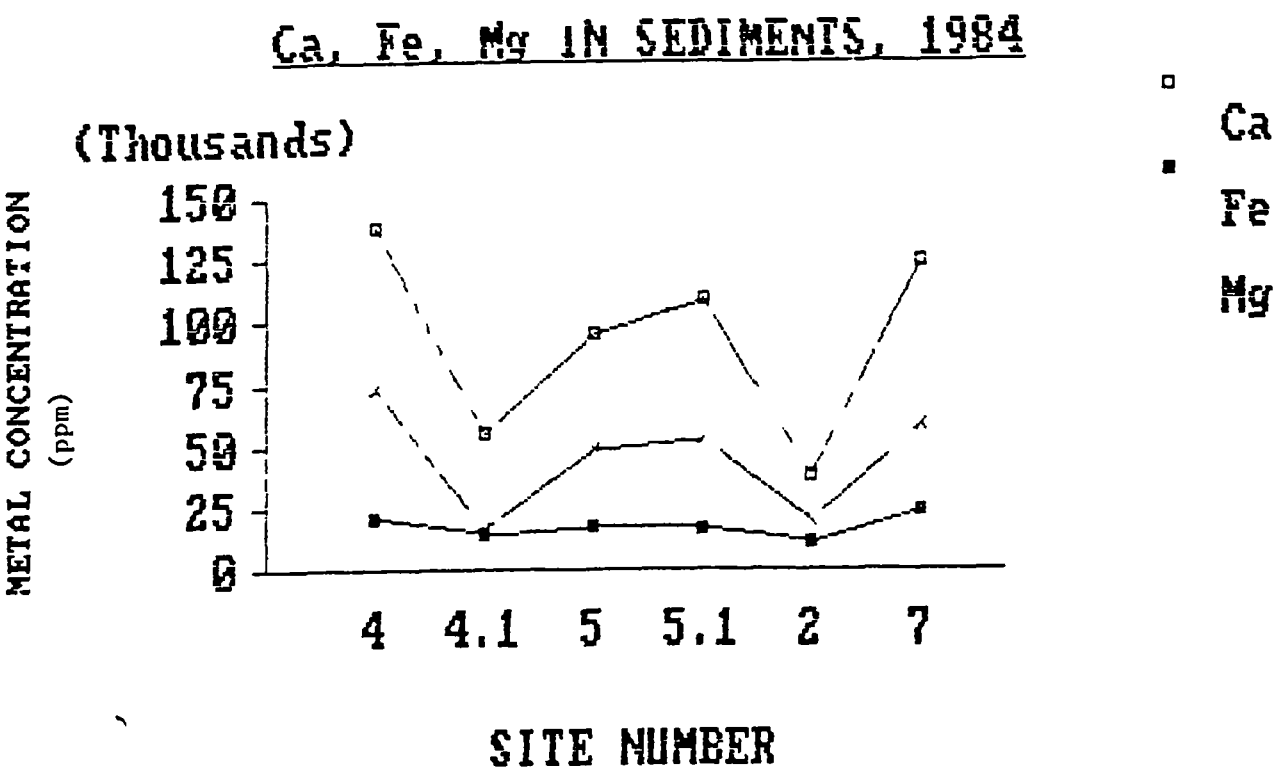
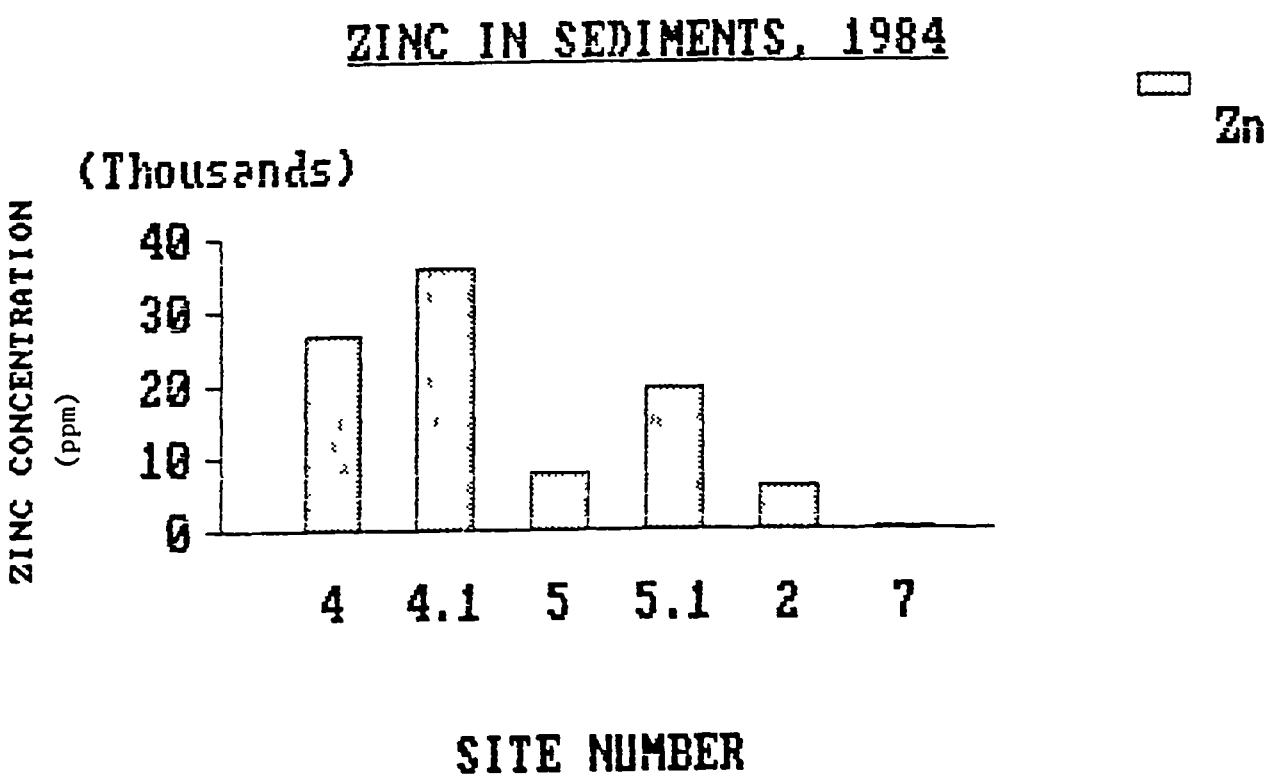


Figure 37



ble 11 HEAVY METALS IN SEDIMENTS, 1985

STATION		Cd	Co	Cr	Cu	Ni	Pb	Ca	Fe	Mg	Mn	Zn
1	Pool	<0 2	3 10	10	1 60	3	14	544	6280	306	148	23
	Riffle	<0 2	4 30	11 50	3 80	5 45	135	1390	7825	647	354	31
4	Pool	125	27	6 50	72	12	770	162000	21700	78900	3190	6465
	Riffle											
5	Pool											
	Riffle	165	13	7	32	7 95	3585	62600	12700	31200	1475	8900
2	Pool	217	8 30	9 20	7 70	5 95	1220	15400	9870	7500	486	8795
	Riffle	33	8 30	7 30	3 60	7 70	1483	11700	6520	5720	405	1500
6	Pool	46	10 70	<1 00	7 70	6 95	1200	157700	24200	74900	3260	2200
	Riffle											
8	Pool	6 50	55	<1 00	245	39 30	1060	180000	35250	81450	4000	378
	Riffle	6	35	<1 00	160	25	1200	180000	37300	83800	4270	2819
11	Pool	21	14	<1 00	33	8 60	1000	144000	24200	67500	3220	1100
	Riffle	30	17	<1 00	28	9 90	1550	161000	26800	75700	3530	1580
10	Pool	5 70	10	2 40	7 50	7 90	625	93500	18750	44350	2275	362
	Riffle	4	13	8	7	9 60	840	118000	22400	56000	2740	316
7	Pool	8 60	16	2	23	9 20	710	110000	20800	51900	2660	188
	Riffle	4	10	3	5	6 60	550	111000	20500	52500	2590	307
3	Pool	2 20	8	10	5	5 60	430	27600	10500	13700	864	162
	Riffle	2	7	8	6	4 70	470	54400	11000	17100	1020	140
9	Pool	40	1 65	3 75	1 50	2	66	717	2500	242	105	33
	Riffle	< 20	1	3 60	90	1	46	291	2010	114	80	26
NEW LEHO BELT												
12	Pool	30	18	7 20	5 30	20	134	6070	4700	1480	356	85
	Riffle											
13	Pool	< 20	67	6	6 50	96	110	15000	5930	8490	1060	230
	Riffle	< 20	41	6 90	5 50	51	73	10800	6990	5850	576	153
14	Pool	2	160	10	35	170	508	15300	7830	8660	569	875
	Riffle	95	80	8	14	67	307	23500	5800	13500	470	375

ED_000859_00001631-00126

ED_000859_00001631-00127

Figure 38

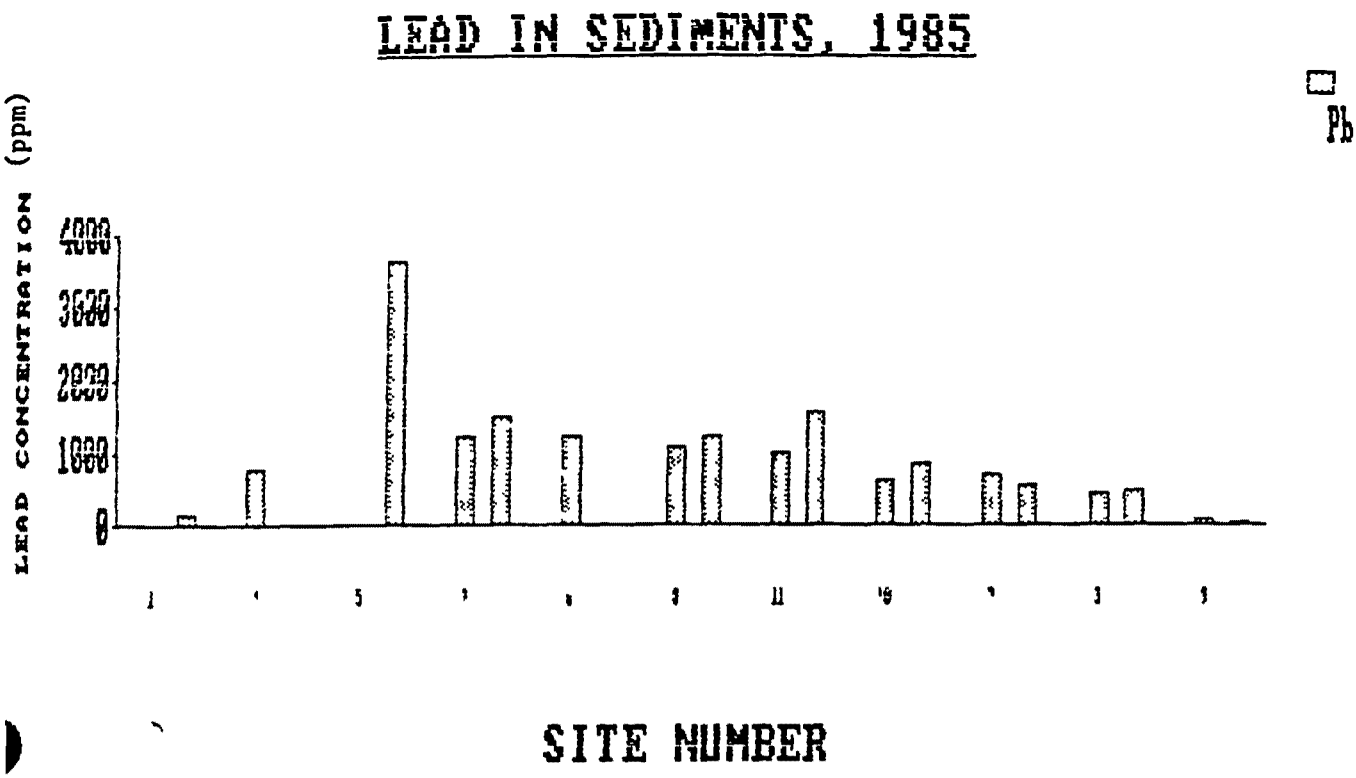
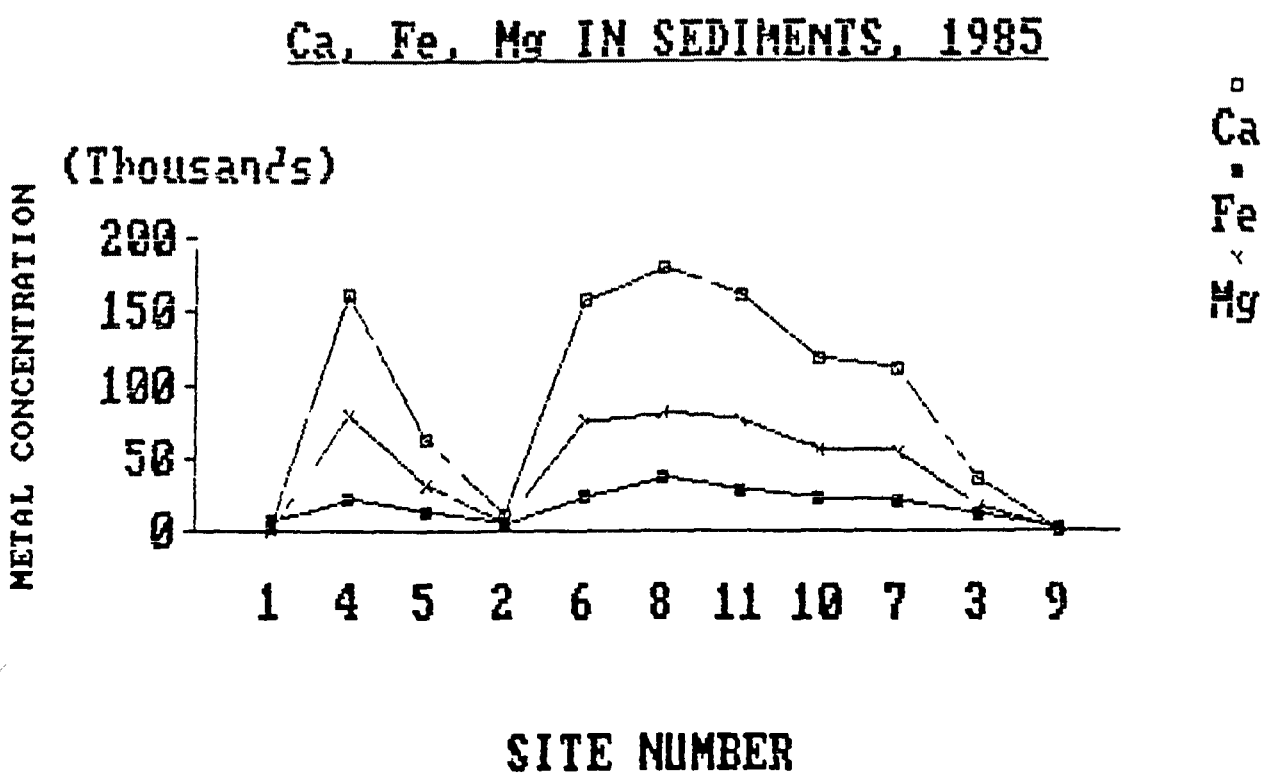


Figure 39



2 Riffle zone at Leadwood Public Access below concrete crossing
7 Big River at Bonneterre, Hwy 67 North, below riffle zone

Graphic presentations of data concerning metals of particular interest and/or unusually elevated concentrations are shown in Figures 34-37 Unusually high concentrations of cadmium and zinc at sites 4 and 5 should be noted Elevated concentrations of Ca and Mg are probably indicative of the presence of bulk tailings in benthic sediments

SEDIMENT SAMPLES COLLECTED IN 1985

In 1985 sediment samples were collected from all sites Where appropriate or possible, samples were taken from both riffle and pool zones to determine if significant or consistent differences would become apparent Information regarding detection limits and values obtained using standard reference materials were included in Appendix 3 A complete presentation of raw data regarding ICAP analyses of 1985 sediment samples is given in Appendix 5 Concentrations of eleven major elements of potential interest estimated from those raw data are summarized in Table 11 Lead concentrations in sediments were highest at site number 5 (Big River at Eaton Creek), where values approached 3600 ppm From Leadwood Public Access downstream to Site number 7 (Big River at Bonneterre), mean lead concentrations remain between 600 and 1200 ppm, as indicated in Figure 38 Lead concentrations in sediments at House Springs Public Access (Site number 9) were not much above background levels

Zinc and cadmium concentrations remained markedly elevated at sites 4 (Eaton Creek), 5 (Big River at Eaton Creek), and 2 (Leadwood Public Access), though they were significantly lower in 1985 than in samples taken from these sites the previous year

The influence of dolomitic tailings materials in river sediments is perhaps best indicated by the presence of large concentrations of calcium and magnesium, graphically illustrated for riffle sediment samples in Figure 39 Despite anomalously low concentrations of these elements at site number 2 (Leadwood Public Access), the levels of Ca and Mg remain elevated in samples taken throughout most of the old mining district, then drop abruptly at sites beyond Bonneterre Abundant sandy sediments observed at House Springs Public Access (Site number 9) apparently contain little dolomite

One final comment must be made about the comparatively higher concentrations of cobalt in sediments collected in the New Lead Belt Only one site in the Old Lead Belt (Site number 8, Flat River Creek near National Tailings Pile) displayed cobalt concentrations approaching those seen in Strother Creek sediments

CONCLUSIONS

1 Analyses of sunfish collected during 1985 indicated that specimens from one of the eleven Old Lead Belt locations tested had concentrations of lead above the 0 3 ppm limit recommended by the World Health Organization A mean lead concentration of 0 392 ppm was observed in sunfish collected from Flat River Creek near the old National Tailings Pile Therefore, sunfish from most sites throughout the Old Lead Belt

could be considered safe for human consumption even by the most stringent WHO guidelines

2 Differences in lead concentration between skinless fish filets and filets with attached skin were generally insignificant

3 Concentrations of lead in filets of Northern Hogsucker were above the 0 3 ppm limit recommended by the WHO in six of the 9 sampling locations for which data were available in 1985 Mean lead concentrations were, however, well below the 1 0 ppm limit established for commercial food within the United Kingdom Highest abolute lead concentrations (0 887 ppm) were observed in a specimen caught at site number 8 (Flat River Creek near National Tailings Pile)

4 Lead concentrations in filets of Black Redhorse suckers were above the 0 3 ppm limit at four of the six sites for which data were available in 1985 Highest absolute lead concentration (1 21 ppm) was observed in a specimen caught at site number 2 (Leadwood Public Access)

5 Lead concentrations in suckers were generally high throughout the entire Old Lead Belt area Highest mean concentrations were observed in the vicinity of the National Tailings Pile, gradually decreasing with distance downstream in the Big River At House Springs Public Access, lead concentrations in suckers were only slightly above background However, several specimens of bottom-feeding Freshwater Drum taken at House Springs displayed mean lead concentrations of 0 345 ppm, approximately twice the value observed in Black Redhorse Sucker at that site

6 A single large carp taken at site number 6 (Big River at St Francois Cemetery) displayed 1 10 ppm lead in samples of filet Another large carp taken at site number 2 (Leadwood Public Access) showed only 0 087 ppm lead

7 A large 43 cm long catfish taken at Washington State Park was found to contain only 0 093 ppm lead in its filets In the few other catfish specimens taken at various sites, lead concentrations were fairly nominal

8 Clams were found at three sites along the Big River Big River at Eaton Creek, Washington State Park, and House Springs Public Access Specimens were routinely purged for 96 hours prior to analysis Longer purging periods appear to be unnecessary for Corbicula leana Greatest mean lead concentrations in soft tissues (17 3ppm) and shell (68 9 ppm) were observed in specimens taken from a riffle zone at Washington State Park In a small number of large mussels where various different tissues could be effectively sampled, large differences in lead concentrations were found Concentrations of 130 ppm were found in gill tissue, 61 2 ppm in intestinal tissue, and 8 26 ppm in large adductor muscles of a specimen of Unio, a large freshwater mussel taken at Washington State Park, allowed to purge for 96 hours in clean springwater

9 Attempts to correlate rainfall or major erosion events at the Desloge Tailings Pile with observed concentrations of lead in fish were, for the most part, unsuccessful Slight inverse relationships were found between rainfall and lead concentrations in sunfish at many sites, though low lead concentrations made correlation difficult Erratic concentrations of lead in suckers had no apparent correlation with rainfall or known major erosion events

10 Lead concentrations in river sediments were highest at site number 5 (Big River at Eaton Creek), where 3585 ppm lead were observed, abruptly dropping to levels below 1000 ppm at sites downstream from site number 11 (Big River at Hwy K east of Bonneterre)

11 Anomalous concentrations of zinc and cadmium were observed in the vicinity of the Leadwood Tailings Pile, Big River at Eaton Creek, and Leadwood Public Access in 1984 and 1985 Elevated concentrations of these metals probably represent a greater environmental threat than lead

12 Elevated concentrations of Ca and Mg in sediment samples collected between the Leadwood Tailings Pile and the Big River at Bonneterre clearly indicate the influence of eroded tailings material throughout the region, and decreasing abruptly at points downstream of Bonneterre

1 of 2

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

September 6, 2001

Greg Patton
BARR ENGINEERING
3236 Emerald Lane
Jefferson City, MO 65109

25/86-009 PTS 003

Project/Location	**RIVERMINES**
SDG ID	**47330**
SWLO ID	47330 01 – 47330 21

Dear Mr Patton

Enclosed please find the forms package for a portion of your soil samples received August 17, 2001 for the above-referenced project

Thank you for choosing Southwest Laboratory If you should have any questions or require additional information please do not hesitate to call

Sincerely,

Randy Staggs
Project Officer

RES/jt

Enclosure

RECEIVED
SEP 7 2001
BARR ENGINEERING CO
MISSOURI

We certify that the following report meets all required NELAC reporting standards as specified in NELAC 5 13 July 1 1999 Any deviation or variance is noted in the case narrative(s) and estimated uncertainties regarding these analyses are presented in the Quality Control Section of this report "

1700 West Albany • Broken Arrow OK 74012 1421 • Office (918) 251 2858 • Fax (918) 251 2599

CHAIN OF CUSTODY RECORD

SOUTHWEST LABORATORY OF OKLAHOMA, INC
1700 W Albany Broken Arrow Oklahoma 74012 1421
Office 918 251 2858 Fax 918 251 2599

TM

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
Barr Eng	Ward Swanson / Greg Patton	800-632-2277 888-324-3933

P O or PROPOSAL NUMBER	PROJECT NAME
25/86/009/PTS	River mines 25/86/009/PTS/003

SAMPLER (Signature): [signature]

1 of 2

ANALYTICAL TESTS REQUESTED: Pb, Cd, Zn

SAMPLE NO	DATE	TIME	COMP	GRAB	LOCATION	MATRIX	NUMBER OF CONTAINERS	Pb, Cd, Zn								REMARKS
A-01	8/13/01	5 20p		x		Soil	1	x								SW-846 6010 w/ Minimum Detection
A-02	8/13/01	5 38p		x			1	x								limit of 4 ug/L
A-03	8/13/01	5 40p		x			1	x								
A-04	8/14/01	4 35p		x			1	x								If a different method is to be
A-05	8/14/01	4'40p		x			1	x								used call first →
A-06	8/14/01	3'15p		x			1	x								Ward Swanson 800-632-2277 or
A-07	8/14/01	3'00p		x			1	x								Greg Patton 888-324-3933
A-08	8/14/01	3'35p		x			1	x								
A-09	8/14/01	3 46p		x			1	x								
A-10	8/14/01	3.55p		x			1	x								
A-11	8/13/01	3 43p		x			1	x								
A-11-S	8/13/01	3'43p		x			1	x								
A-12	8/13/01	3'01 p		x			1	x								
A-13	8/13/01	3'30p		x			1	x								
A-13 S	8/13/01	3'29p		x			1	x								
A-14	8/13/01	4'30p		x			1	x								

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)
[signature]	8/16/01	1'00p	

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED FOR LABORATORY BY (Signature)
	8/17/01	8 20	[signature]

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)

REMARKS: 6.2°C

[SR012 1192-03]

CHAIN OF CUSTODY RECORD

SOUTHWEST LABORATORY OF OKLAHOMA, INC
1700 W Albany Broken Arrow Oklahoma 74012 1421
Office 918 251 2858 Fax 918-251 2599

TM

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
Barr Eng	Greg Patten	888-324-3933

P O or PROPOSAL NUMBER	PROJECT NAME
25/86/009/PTS	Rivermines 25/86/009/PTS/003

SAMPLER (Signature)

ANALYTICAL TESTS REQUESTED: Pb, Cd, Zn

2 of 2

SAMPLE NO	DATE	TIME	COMP	GRAB	LOCATION	MATRIX	NUMBER OF CONTAINERS	Pb, Cd, Zn	REMARKS
A-15	8/13/01	4:43 p		X		Soil	1	X	SW-846 6010 or other method
A-16	8/14/01	11 10 A		X			1	X	that achieves a detection
A-17	8/14/01	11 20 A		X			1	X	Limit of 4 ug/L or better
A-18	8/14/01	2:45 p		X			1	X	
A-19	8/14/01	1:50 p		X			1	X	Call Ward Swanson 1-800 632 2272
A-20	8/14/01	2 00 p		X			1	X	Greg Patten 888-324-3933 if
A 21	8/14/01	12 25 p		X			1	X	a different method is going to be
A-21-5	8/14/01	12 25 p		X			1	X	used or if you have any
A-22	8/13/01	5:30 P		X			1	X	questions
A-23	8/13/01	5:30 P		X			1	X	
A-24	8/14/01	5:15 P		X			1	X	
A-25	8/15/01	8:00 A		X			1	X	
A-26	8/15/01	8 45 A		X			1	X	

Rush SDG

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)
	8/16/01	1 00 p	

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED FOR LABORATORY BY (Signature)
	8/17/01	8 20	

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)

REMARKS

6-2

R012 1192-03]

COOLER RECEIPT / SAMPLE LOG IN SHEET

COOLER RECEIPT / SAMPLE LOG-IN SHEET (115-ATT2 WB1) / SWL-GA-115 REV 5 0 / GA-115-CRLOGIN-F

LAB NAME SOUTHWEST LABORATORY OF OKLAHOMA

PAGE 1 OF 1

RECEIVED BY (PRINT NAME) JASON SPRIGGS

RECEIVED BY (SIGNATURE)

LOGGED IN BY (SIGNATURE)

REC D DATE 08/17/01

TIME REC'D 08 20

LOG-IN DATE 2001-08 18 07 49

PROJECT RIVERMINES

EPISODE 47330

SAMPLE DELIVERY GROUP 47330

Remarks

1 CUSTODY SEAL(S) Present/Absent
Intact/ Broken

2 CUSTODY SEALS NOS
N/A

3 CHAIN OF CUSTODY Present/Absent
Sealed In Plastic? Yes/ No
Taped To Lid? Yes/ No
Properly Filled Out
(Ink Signed ETC)? Yes/ No

4 AIRBILL AirBil/ Sticker
Present/Absent

5 AIRBILL NO
790133728677

6 COOLER CONDITIONS
Enough Ice? Yes/ No
Type of Ice? Wet
Type of Packing? Bubble Wrap

7 SAMPLE TAGS Present/Absent

8 SAMPLE CONDITION Intact/ Broken / Leaking
Bottles Sealed In Separate Plastic Bags? Yes/ No
Correct Containers Used For Tests Indicated? Yes/ No
Correct Preservative? Yes/ No
Sufficient Sample? Yes/ No
Labels Complete (I D Date Time Signature Preservative? Yes/ No
VOA Samples Without Bubbles? Yes/ No~

9 Does Information on Custody Records Labels Tags Agree? Yes/ No

10 RAD SCREEN WITH GIEGER COUNTER? Yes/ No

11 P O Called? Yes/ No

Client Sample #	Sample Fraction @	Assigned LAB#	Cooler I D	pH Check	ACID/ BASE LOT#	REMARKS CONDITION OF SAMPLE SHIPMENT ETC
A 01	M	47330 01	08/17/01 1	N		6 2c
A-02		47330 02	08/17/01 1	N		6 2c
A-03		47330 03	08/17/01 1	N		6 2c
A-04		47330 04	08/17/01 1	N		6 2c
A-05		47330 05	08/17/01 1	N		6 2c
A-06		47330 06	08/17/01 1	N		6 2c
A-07		47330 07	08/17/01 1	N		6 2c
A-08		47330 08	08/17/01 1	N		6 2c
A-09		47330 09	08/17/01 1	N		6 2c
A 10		47330 10	08/17/01 1	N		6 2c
A 11		47330 11	08/17/01 1	N		6 2c
A 11 5		47330 12	08/17/01 1	N		6 2c
A 12		47330 13	08/17/01 1	N		6 2c
A 13		47330 14	08/17/01 1	N		6 2c
A 13-5		47330 15	08/17/01 1	N		6 2c
A 14		47330 16	08/17/01 1	N		6 2c
A 15		47330 17	08/17/01 1	N		6 2c
A 16		47330 18	08/17/01 1	N		6 2c
A 17		47330 19	08/17/01 1	N		6 2c
A 17		47330 20	08/17/01 1	N		6 2c
A 17		47330 21	08/17/01 1	N		6 2c

Contact PO and attach record of resolution

@ Sample Fractions B=SV GC/MS V= VOA GC/MS or GC P=Pesticide H=Herbicide D=Dioxin A=Air I=Inorganics C=Cyanide M=Metals R=Radiochemistry

~ Note samples with bubbles under remarks section

SOUTHWEST LABORATORY OF OKLAHOMA, INC
1700 West Albany – Broken Arrow Oklahoma 74012 – Office (918) 251 2858 – Fax (918) 251 2599

INORGANICS CLP QUALIFIER FLAGS

B	The reported values were obtained from a reading that was less that the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL) if the analyte was analyzed but not detected a U must be entered
E	The reported value is estimated because of the presence of interference An explanatory note must be included under Comments on the Cover Page if the problem applies to all samples or on the specific Form 1 if it is an isolated problem
M	Duplicate injection precision not met
N	Spike recovery not within control limits
S	The reported value was determined by the Method of Standard Additions (MSA)
W	Post Digestion spike for GFAA analysis is out of control limits (85 115%) while sample absorbance is less than 50% of spike absorbance
*	Duplicate analysis not within control limits
+	Correlation coefficient for the MSA is less than 0 995

SOUTHWEST LABORATORY OF OKLAHOMA, INC
1700 West Albany / Broken Arrow Oklahoma 74012 / Office (918) 251 2858 / Fax (918) 251 2599

SDG NARRATIVE

CONTRACT BARR **DATE September 6, 2001**
SDG 47330 **EPISODE NO 47330**

INORGANIC METAL FRACTION

Nineteen soil samples plus one matrix spike and one matrix spike duplicate were submitted for ICP analysis No major problems occurred during the digestion or analysis of these samples Please see the DC-1 (Sample Log-In Sheet) for sample conditions and cooler temperatures at receipt The sample's analyses were completed according to the following

SWL SOP #	Method SOP is based
SWL-IN-205	SW846 3050B / 6010B

The cover page of the Inorganic Analyses Data Package cross-references client and laboratory sample ID s Manual integration was not used for the data presented in this Inorganic Analyses Data Package

Initial and Continuing Calibration Checks No problems

Initial and Continuing Calibration Blanks The absolute value of the Initial Calibration Blank for lead and zinc was over the MDL, but less than the PQL No action required

Linearity near the CRDL (CRA & CRI) The result for lead was outside our in-house control limits of 80 – 120% This will be monitored for trends No action required

Preparation Blank Zinc showed low level concentrations below the Practical Quantitation Limit in the Preparation Blank No action required

Lab Control Spikes No problems

Matrix Spikes The sample results for lead and zinc were greater than four times the spike added thus no action was taken Cadmium was within control limits for the matrix spike, but outside the control limits for the matrix spike duplicate All Form 1 s are flagged with an ' N" flag for cadmium No further action required

Duplicate(s) (LCSD and MSD) The LCS/LCSD was within precision limits The MS/MSD were outside the precision limits of 20% for lead and zinc All Form 1's for these elements are flagged with an "*"

SOUTHWEST LABORATORY OF OKLAHOMA, INC
1700 West Albany / Broken Arrow Oklahoma 74012 / Office (918) 251 2858 / Fax (918) 251 2599

Serial Dilution (ICP) The serial dilution analysis was within the control limits of 10% for all Elements

Sincerely,

Steve L Markham
Inorganic Program Manager

ED_000859_00001631-00137

COVER PAGE - INORGANIC ANALYSES DATA PACKAGE

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

OW No SW846__

EPA Sample No	Lab Sample ID
_A-01_____	_47330 01_____
_A-02_____	_47330 02_____
_A-03_____	_47330 03_____
_A-04_____	_47330 04_____
_A-05_____	_47330 05_____
_A-06_____	_47330 06_____
_A-07_____	_47330 07_____
_A-08_____	_47330 08_____
_A-09_____	_47330 09_____
_A-10_____	_47330 10_____
_A-11_____	_47330 11_____
_A-11-5_____	_47330 12_____
_A-12_____	_47330 13_____
_A-13_____	_47330 14_____
_A-13-5_____	_47330 15_____
_A-14_____	_47330 16_____
_A-15_____	_47330 17_____
_A-16_____	_47330 18_____
_A-17_____	_47330 19_____
_A-17S_____	_47330 20S_____

ere ICP interelement corrections applied ? Yes/No YES

ere ICP background corrections applied ? Yes/No YES
If yes - were raw data generated before application of background corrections ? Yes/No NO_

omments
___ICP_BATCH#=010821I1_____

certify that this data package is in compliance with the terms and onditions of the contract, both technically and for completeness, for ther than the conditions detailed above Release of the data contained n this hardcopy data package and in the computer-readable data submitted n diskette has been authorized by the Laboratory Manager or the anager's designee, as verified by the following signature

ignature Steve L. Markham Name Steve L Markham

ate 09/06/01 Title Inorganics Program Manager

COVER PAGE - IN

COVER PAGE - INORGANIC ANALYSES DATA PACKAGE

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

SOW No SW846__

EPA Sample No	Lab Sample ID
_A-17M_____	_47330 21SD_____

Were ICP interelement corrections applied ? Yes/No YES

Were ICP background corrections applied ? Yes/No YES

If yes - were raw data generated before application of background corrections ? Yes/No NO_

Comments

____ICP_BATCH#=010821I1_____

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature

Signature _____ Name Steve L Markham

Date _____ Title Inorganics Program Manager

COVER PAGE - IN

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-01

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

atrix (soil/water) SOIL_ Lab Sample ID 47330 01

evel (low/med) LOW__ Date Received 08/17/01

Solids _83 1

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	22 3		N	P
7439-92-1	Lead	10800		*	P
7440-66-6	Zinc	820		*	P

olor Before BROWN____ Clarity Before _____ Texture COURSE

olor After YELLOW___ Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

5

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-02

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

Matrix (soil/water) SOIL_ Lab Sample ID 47330 02

Level (low/med) LOW__ Date Received 08/17/01

% Solids _95 3

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	25 3		N	P
7439-92-1	Lead	1430		*	P
7440-66-6	Zinc	933		*	P

Color Before BROWN____ Clarity Before _____ Texture COURSE

Color After YELLOW___ Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-03

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

atrix (soil/water) SOIL_ Lab Sample ID 47330 03

evel (low/med) LOW__ Date Received 08/17/01

Solids _81 8

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	17 6		N	P
7439-92-1	Lead	2420		*	P
7440-66-6	Zinc	741		*	P

olor Before BROWN____ Clarity Before _____ Texture COURSE

olor After YELLOW___ Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-04

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

Matrix (soil/water) SOIL_ Lab Sample ID 47330 04

Level (low/med) LOW__ Date Received 08/17/01

% Solids _81 2

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	22 3		N	P
7439-92-1	Lead	1030		*	P
7440-66-6	Zinc	699		*	P

Color Before BROWN____ Clarity Before _____ Texture COURSE

Color After YELLOW___ Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-05

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

atrix (soil/water) SOIL_ Lab Sample ID 47330 05

evel (low/med) LOW__ Date Received 08/17/01

Solids _96 6

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	5 6		N	P
7439-92-1	Lead	5270		*	P
7440-66-6	Zinc	186		*	P

olor Before BROWN____ Clarity Before _____ Texture COURSE

olor After YELLOW___ Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-06

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

Matrix (soil/water) SOIL_ Lab Sample ID 47330 06

Level (low/med) LOW__ Date Received 08/17/01

% Solids _79 0

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	57 7		N	P
7439-92-1	Lead	3710		*	P
7440-66-6	Zinc	13600		*	P

Color Before BROWN____ Clarity Before _____ Texture COURSE

Color After YELLOW___ Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

10

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-07

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

atrix (soil/water) SOIL_ Lab Sample ID 47330 07

evel (low/med) LOW__ Date Received 08/17/01

Solids _91 7

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	28 7		N	P
7439-92-1	Lead	794		*	P
7440-66-6	Zinc	1380		*	P

olor Before BROWN____ Clarity Before _____ Texture FINE__

olor After YELLOW___ Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-08

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

Matrix (soil/water) SOIL_ Lab Sample ID 47330 08

Level (low/med) LOW__ Date Received 08/17/01

% Solids _80 3

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	45 3		N	P
7439-92-1	Lead	1430		*	P
7440-66-6	Zinc	4950		*	P

Color Before BROWN____ Clarity Before _____ Texture COURSE

Color After YELLOW___ Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

12

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-09

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

atrix (soil/water) SOIL_ Lab Sample ID 47330 09

evel (low/med) LOW__ Date Received 08/17/01

Solids _77 7

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	30 5		N	P
7439-92-1	Lead	936		*	P
7440-66-6	Zinc	8240		*	P

olor Before BROWN____ Clarity Before _____ Texture MEDIUM

olor After YELLOW___ Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-10

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

Matrix (soil/water) SOIL_ Lab Sample ID 47330 10

Level (low/med) LOW__ Date Received 08/17/01

% Solids _79 6

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	31 2		N	P
7439-92-1	Lead	1420		*	P
7440-66-6	Zinc	8810		*	P

Color Before BROWN____ Clarity Before _____ Texture COURSE

Color After YELLOW___ Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-11

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

atrix (soil/water) SOIL_ Lab Sample ID 47330 11

evel (low/med) LOW__ Date Received 08/17/01

Solids _82 5

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	38 5		N	P
7439-92-1	Lead	2330		*	P
7440-66-6	Zinc	1760		*	P

olor Before BROWN____ Clarity Before _____ Texture MEDIUM

olor After YELLOW___ Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-11-5

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

Matrix (soil/water) SOIL_ Lab Sample ID 47330 12

Level (low/med) LOW__ Date Received 08/17/01

% Solids _97 5

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	31 8		N	P
7439-92-1	Lead	1010		*	P
7440-66-6	Zinc	1310		*	P

Color Before BROWN____ Clarity Before _____ Texture MEDIUM

Color After YELLOW___ Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-12

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

atrix (soil/water) SOIL_ Lab Sample ID 47330 13

evel (low/med) LOW__ Date Received 08/17/01

Solids _83 1

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	38 8		N	P
7439-92-1	Lead	1050		*	P
7440-66-6	Zinc	1660		*	P

olor Before BROWN____ Clarity Before _____ Texture MEDIUM

olor After YELLOW___ Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

17

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-13

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

Matrix (soil/water) SOIL_ Lab Sample ID 47330 14

Level (low/med) LOW__ Date Received 08/17/01

% Solids _78 6

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	29 1		N	P
7439-92-1	Lead	638		*	P
7440-66-6	Zinc	915		*	P

Color Before BROWN____ Clarity Before _____ Texture MEDIUM

Color After YELLOW___ Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-13-5

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

atrix (soil/water) SOIL_ Lab Sample ID 47330 15

evel (low/med) LOW__ Date Received 08/17/01

Solids _82 9

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	33 7		N	P
7439-92-1	Lead	707		*	P
7440-66-6	Zinc	1490		*	P

olor Before BROWN____ Clarity Before _____ Texture MEDIUM

olor After YELLOW___ Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-14

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

Matrix (soil/water) SOIL_ Lab Sample ID 47330 16

Level (low/med) LOW__ Date Received 08/17/01

% Solids _94 9

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	130		N	P
7439-92-1	Lead	5080		*	P
7440-66-6	Zinc	2030		*	P

Color Before BROWN____ Clarity Before _____ Texture MEDIUM

Color After YELLOW___ Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-15

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

atrix (soil/water) SOIL_ Lab Sample ID 47330 17

evel (low/med) LOW__ Date Received 08/17/01

Solids _97 0

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	14 4		N	P
7439-92-1	Lead	6870		*	P
7440-66-6	Zinc	590		*	P

olor Before BROWN____ Clarity Before _____ Texture COURSE

olor After YELLOW___ Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-16

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

Matrix (soil/water) SOIL_ Lab Sample ID 47330 18

Level (low/med) LOW__ Date Received 08/17/01

% Solids _94 6

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	39 4		N	P
7439-92-1	Lead	2470		*	P
7440-66-6	Zinc	1910		*	P

Color Before BROWN____ Clarity Before _____ Texture COURSE

Color After YELLOW___ Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

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U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-17

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

atrix (soil/water) SOIL_ Lab Sample ID 47330 19

evel (low/med) LOW__ Date Received 08/17/01

Solids _87 4

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	7 5		N	P
7439-92-1	Lead	2020		*	P
7440-66-6	Zinc	399		*	P

olor Before BROWN____ Clarity Before _____ Texture COURSE

olor After YELLOW___ Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

2A

INITIAL AND CONTINUING CALIBRATION VERIFICATION

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

Initial Calibration Source EPA-LV_____

Continuing Calibration Source IN VEN _____

Concentration Units ug/L

Analyte	Initial Calibration True	Initial Calibration Found	Initial Calibration %R(1)	Continuing Calibration True	Continuing Calibration Found	Continuing Calibration %R(1)	Continuing Calibration Found	Continuing Calibration %R(1)	M
Cadmium	125 0	127 92	102 3	500 0	507 92	101 6	503 17	100 6	P
Lead	250 0	256 39	102 6	500 0	511 58	102 3	505 38	101 1	P
Zinc	250 0	258 01	103 2	500 0	517 44	103 5	510 19	102 0	P

FORM II (PART 1) - IN

ED_000859_00001631-00159

U S EPA - CLP

2A
INITIAL AND CONTINUING CALIBRATION VERIFICATION

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

nitial Calibration Source EPA-LV_____

ontinuing Calibration Source IN VEN _____

Concentration Units ug/L

Analyte	Initial Calibration True	Initial Calibration Found	Initial Calibration %R(1)	Continuing Calibration True	Continuing Calibration Found	Continuing Calibration %R(1)	Continuing Calibration Found	Continuing Calibration %R(1)	M
Cadmium				500 0	505 55	101 1	506 10	101 2	P
Lead				500 0	510 12	102 0	510 03	102 0	P
Zinc				500 0	510 96	102 2	509 36	101 9	P

FORM II (PART 1) - IN

ED_000859_00001631-00160

U S EPA - CLP

2A
INITIAL AND CONTINUING CALIBRATION VERIFICATION

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

Initial Calibration Source EPA-LV_____

Continuing Calibration Source IN VEN _____

Concentration Units ug/L

Analyte	Initial Calibration True	Initial Calibration Found	Initial Calibration %R(1)	Continuing Calibration True	Continuing Calibration Found	Continuing Calibration %R(1)	Continuing Calibration Found	Continuing Calibration %R(1)	M
Cadmium									NR
Lead	250 0	244 10	97 6	500 0	503 31	100 7	490 49	98 1	P
Zinc	250 0	249 79	99 9	500 0	503 99	100 8	492 66	98 5	P

FORM II (PART 1) - IN

U S EPA - CLP

2A
INITIAL AND CONTINUING CALIBRATION VERIFICATION

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

nitial Calibration Source EPA-LV_____

ontinuing Calibration Source IN VEN _____

Concentration Units ug/L

Analyte	Initial Calibration True	Initial Calibration Found	Initial Calibration %R(1)	Continuing Calibration True	Continuing Calibration Found	Continuing Calibration %R(1)	Continuing Calibration Found	Continuing Calibration %R(1)	M
Cadmium									NR
Lead				500 0	493 23	98 6	507 89	101 6	P
Zinc				500 0	495 57	99 1	510 08	102 0	P

FORM II (PART 1) - IN

97

U S EPA - CLP

2B
CRDL STANDARD FOR AA AND ICP

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

AA CRDL Standard Source PLASMACHEM__

ICP CRDL Standard Source IN VEN _____

Concentration Units ug/L

Analyte	CRDL Standard for AA			CRDL Standard for ICP				
					Initial		Final	
	True	Found	%R	True	Found	%R	Found	%R
Cadmium				6 0	5 66	94 3		
Lead				10 0	7 91	79 1		
Zinc				20 0	21 38	106 9		

FORM II (PART 2) - IN

ED_000859_00001631-00163

U S EPA - CLP

2B
CRDL STANDARD FOR AA AND ICP

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

A CRDL Standard Source PLASMACHEM__

CP CRDL Standard Source IN VEN _____

Concentration Units ug/L

Analyte	CRDL Standard for AA True	Found	%R	CRDL Standard for ICP True	Initial Found	%R	Final Found	%R
Cadmium								
Lead				10 0	9 30	93 0		
Zinc				20 0	20 92	104 6		

FORM II (PART 2) - IN

ED_000859_00001631-00164

U S EPA - CLP
3
BLANKS

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

Preparation Blank Matrix (soil/water) SOIL_

Preparation Blank Concentration Units (ug/L or mg/kg) MG/KG

Analyte	Initial Calib Blank (ug/L)	C	Continuing Calibration Blank (ug/L) 1	C	2	C	3	C	Prepa-ration Blank	C	M
Cadmium	11	U	11	U	11	U	11	U	0 11	U	P
Lead	-20	B	12	U	12	U	12	U	0 12	U	P
Zinc	126	B	27	U	27	U	27	U	1 54	B	P

FORM III - IN

ED_000859_00001631-00165

U S EPA - CLP
3
BLANKS

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

reparation Blank Matrix (soil/water) _____

reparation Blank Concentration Units (ug/L or mg/kg) _____

Analyte	Initial Calib Blank (ug/L)	C	Continuing Calibration Blank (ug/L) 1	C	2	C	3	C	Prepa-ration Blank	C	M
Cadmium			11	U							P
Lead			12	U							P
Zinc			27	U							P

FORM III - IN

U S EPA - CLP
3
BLANKS

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

Preparation Blank Matrix (soil/water) _____

Preparation Blank Concentration Units (ug/L or mg/kg) _____

Analyte	Initial Calib Blank (ug/L)	C	Continuing Calibration Blank (ug/L) 1	C	2	C	3	C	Prepa-ration Blank	C	M
Cadmium											NR
Lead	12	U	12	B	12	U	12	U			P
Zinc	27	U	27	U	27	U	27	U			P

FORM III - IN

ED_000859_00001631-00167

U S EPA - CLP
3
BLANKS

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

reparation Blank Matrix (soil/water) _____

reparation Blank Concentration Units (ug/L or mg/kg) _____

Analyte	Initial Calib Blank (ug/L)	C	Continuing Calibration Blank (ug/L) 1	C	2	C	3	C	Prepa-ration Blank	C	M
Cadmium											NR
Lead			12	U							P
Zinc			27	U							P

FORM III - IN

U S EPA - CLP
4
ICP INTERFERENCE CHECK SAMPLE

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

ICP ID Number TJA ET3_____ ICS Source EPA-LV91____

Concentration Units ug/L

Analyte	True Sol A	True Sol AB	Initial Found Sol A	Initial Found Sol AB	Initial Found %R	Final Found Sol A	Final Found Sol AB	Final Found %R
Cadmium	0	1000	0	1025 4	102 5	0		
Lead	0	50	-1	49 4	98 8			
Zinc	0	1000	1	978 9	97 9			

FORM IV - IN

ED_000859_00001631-00169

U S EPA - CLP
4
ICP INTERFERENCE CHECK SAMPLE

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

CP ID Number TJA ET3_____ ICS Source EPA-LV91____

Concentration Units ug/L

Analyte	True Sol A	True Sol AB	Initial Found Sol A	Initial Found Sol AB	Initial Found %R	Final Found Sol A	Final Found Sol AB	Final Found %R
Cadmium								
Lead	0	50	-1	48 2	96 4	0		
Zinc	0	1000	11	979 9	98 0			

FORM IV - IN

ED_000859_00001631-00170

U S EPA - CLP
5A
SPIKE SAMPLE RECOVERY

Client SAMPLE ID

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____ A-17M

Lab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_
Matrix __SOIL_____ Level (low/med) _LOW____
% Solids for Sample _87 4

Concentration Units (ug/L or mg/kg dry weight) MG/KG

Analyte	Control Limit %R	Spiked Sample Result (SSR)	C	Sample Result (SR)	C	Spike Added (SA)	%R	Q	M
Cadmium	75-125	10 8241		7 5018		5 55	59 9	N	P
Lead		1526 9509		2016 2391		55 54	-881 0		P
Zinc		318 3353		398 5275		55 54	-144 4		P

Comments

FORM V (Part 1) - IN

ED_000859_00001631-00171

U S EPA - CLP
5A
SPIKE SAMPLE RECOVERY

Client SAMPLE ID

A-17S

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_
atrix __SOIL_____ Level (low/med) _LOW____
Solids for Sample _87 4

Concentration Units (ug/L or mg/kg dry weight) MG/KG

Analyte	Control Limit %R	Spiked Sample Result (SSR)	C	Sample Result (SR)	C	Spike Added (SA)	%R	Q	M
Cadmium	75-125	13 1699		7 5018		5 55	102 1		P
Lead		2676 7840		2016 2391		55 54	1189 3		P
Zinc		390 9905		398 5275		55 54	-13 6		P

omments

FORM V (Part 1) - IN

U S EPA - CLP
6
DUPLICATES

CLIENT SAMPLE ID

A-17M

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

Matrix (soil/water) SOIL_ Level (low/med) _LOW__

% Solids for Sample _87 4 % Solids for Duplicate __87 4

Concentration Units (ug/L or mg/kg dry weight) MG/KG

Analyte	Control Limit	Sample (S)	C	Duplicate (D)	C	RPD	Q	M
Cadmium		13 1699		10 8241		19 6		P
Lead		2676 7840		1526 9509		54 7	*	P
Zinc		390 9905		318 3353		20 5	*	P

FORM VI - IN

U S EPA - CLP
6
DUPLICATES

CLIENT SAMPLE ID

LCSSD

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

atrix (soil/water) SOIL_ Level (low/med) _LOW__

Solids for Sample 100 0 % Solids for Duplicate _100 0

Concentration Units (ug/L or mg/kg dry weight) MG/KG

Analyte	Control Limit	Sample (S)	C	Duplicate (D)	C	RPD	Q	M
Cadmium		4 8989		4 8841		0 3		P
Lead		8 5592		8 2359		3 8		P
Zinc		52 8005		52 8879		0 2		P

FORM VI - IN

ED_000859_00001631-00174

U S EPA - CLP
7
LABORATORY CONTROL SAMPLE

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

Solid LCS Source IN VEN _____

Aqueous LCS Source _____

Analyte	Aqueous (ug/L) True	Found	%R	Solid (mg/kg) True	Found	C	Limits		%R
Cadmium				5 00	4 90		4 00	6 00	98 0
Lead				8 00	8 56		6 40	9 60	107 0
Zinc				50 00	52 80		40 00	60 00	105 6

FORM VII - IN

ED_000859_00001631-00175

U S EPA - CLP
7
LABORATORY CONTROL SAMPLE

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

olid LCS Source IN VEN _____

queous LCS Source _____

Analyte	Aqueous (ug/L) True	Found	%R	Solid (mg/kg) True	Found	C	Limits		%R
Cadmium				5 00	4 88		4 00	6 00	97 6
Lead				8 00	8 24		6 40	9 60	103 0
Zinc				50 00	52 89		40 00	60 00	105 8

FORM VII - IN

U S EPA - CLP

8
STANDARD ADDITION RESULTS

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

Concentration Units ug/L

EPA Sample No	An	0 ADD ABS	1 ADD CON	1 ADD ABS	2 ADD CON	2 ADD ABS	3 ADD CON	3 ADD ABS	Final Conc	r	Q

FORM VIII - IN ILM02 1

ED_000859_00001631-00177

U S EPA - CLP
9
ICP SERIAL DILUTION

Client SAMPLE ID

A-17L

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

atrix (soil/water) SOIL_ Level (low/med) LOW__

Concentration Units ug/L

Analyte	Initial Sample Result (I)	C	Serial Dilution Result (S)	C	% Difference	Q	M
Cadmium	67 53		66 73		1 2		P
Lead	18150 59		18816 25		3 7		P
Zinc	3587 62		3777 10		5 3		P

FORM IX - IN

U S EPA - CLP
10
Instrument Detection Limits (Quarterly)

Name SOUTHWEST_LABORATORIES___ Contract BARR_____
Lab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_
ICP ID Number TJA_ET3_____ Date 06/01/01
Flame AA ID Number _____
Furnace AA ID Number _____

Analyte	Wave-length (nm)	Back-ground	CRDL (ug/L)	IDL (ug/L)	M
Cadmium	226 50		6	1 1	P
Lead	220 35		10	1 2	P
Zinc	213 86		20	2 7	P

Comments

FORM X - IN

U S EPA - CLP
11A
ICP Interelement Correction Factors (Annually)

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

CP ID Number TJA ET3_____ Date 06/08/01

Analyte	Wave-length (nm)	Interelement Correction Factors for Al	Ca	Fe	Mg	BA_
Cadmium__	226 50__	0 0000000	0 0000000	0 0000890	0 0000000	0 0000000
Lead_____	220 35__	0 0004660	0 0000000	0 0000620	0 0000000	0 0000000
Zinc_____	213 86__	0 0000000	0 0000000	0 0001580	0 0000680	0 0000000

omments

FORM XI (Part 1) - IN

U S EPA - CLP
11B
ICP Interelement Correction Factors (Annually)

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

ICP ID Number TJA ET3_____ Date 06/08/01

Analyte	Wave-length (nm)	Interelement Correction Factors for CO_	CR_	CU_	MN_	NI_
Cadmium__	226 50	-0 0001610	0 0000000	0 0000000	0 0000000	0 0000000
Lead_____	220 35	-0 0015830	0 0000000	0 0000000	0 0000000	0 0000000
Zinc_____	213 86	0 0000000	0 0000000	0 0008210	0 0000000	0 0044040

Comments

FORM XI (Part 2) - IN

ED_000859_00001631-00181

U S EPA - CLP
11B
ICP Interelement Correction Factors (Annually)

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

CP ID Number TJA ET3_____ Date 06/08/01

Analyte	Wave-length (nm)	Interelement Correction Factors for SC_	SN_	TI_	V__	___
Cadmium__	_226 50__	_0 0000000	_0 0000000_	_0 0000000	_0 0000000	
Lead_____	_220 35__	_0 0000000	_0 0000000_	-0 0005190	-0 0002350	
Zinc_____	_213 86__	_0 0000000	_0 0000000_	_0 0000000	_0 0000000	

omments

FORM XI (Part 2) - IN

U S EPA - CLP
12
ICP Linear Ranges (Quarterly)

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330 SAS No _____ SDG No 47330_

ICP ID Number TJA ET3_____ Date 07/02/01

Analyte	Integ Time (sec)	Concentration (ug/L)	M
Cadmium	15 00	10000 0	P
Lead	15 00	80000 0	P
Zinc	15 00	10000 0	P

Comments

FORM XII - IN

18

U S EPA - CLP
13
PREPARATION LOG

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No _47330 SAS No _____ SDG No 47330_

ethod P_

Client Sample No	Prep Date	Weight (gram)	Volume (mL)
A-01	08/21/01	1 01	100
A-02	08/21/01	1 02	100
A-03	08/21/01	1 04	100
A-04	08/21/01	1 02	100
A-05	08/21/01	1 02	100
A-06	08/21/01	1 02	100
A-07	08/21/01	1 05	100
A-08	08/21/01	1 02	100
A-09	08/21/01	1 03	100
A-10	08/21/01	1 05	100
A-11	08/21/01	1 04	100
A-11-5	08/21/01	1 02	100
A-12	08/21/01	1 00	100
A-13	08/21/01	1 04	100
A-13-5	08/21/01	1 04	100
A-14	08/21/01	1 01	100
A-15	08/21/01	1 00	100
A-16	08/21/01	1 03	100
A-17	08/21/01	1 03	100
A-17M	08/21/01	1 03	100
A-17S	08/21/01	1 03	100
LCSS	08/21/01	1 00	100
LCSSD	08/21/01	1 00	100
PBS	08/21/01	1 00	100

FORM XIII - IN

ANALYSIS RUN LOG

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

Instrument ID Number TJA ET3_____ Method P_

Start Date 08/31/01 End Date 08/31/01

Client Sample No	D/F	Time	% R	Analytes																						
				CD	PB	ZN																				
S0	1	0910		X	X	X																				
S	1	0917		X	X	X																				
S	1	0923		X	X	X																				
ICV	1	0930		X	X	X																				
ICB	1	0937		X	X	X																				
CRI	1	0944		X	X	X																				
ICSA	1	0951		X	X	X																				
ICSAB	1	0957		X	X	X																				
CCV	1	1004		X	X	X																				
CCB	1	1011		X	X	X																				
PBS	1	1023		X	X	X																				
LCSS	1	1030																								
SSD	1	1037		X	X	X																				
01	1	1047		X		X																				
A-02	1	1054		X	X	X																				
A-03	1	1101		X	X	X																				
A-04	1	1108		X	X	X																				
A-05	1	1115		X	X	X																				
ZZZZZZ	1	1126																								
CCV	1	1133		X	X	X																				
CCB	1	1140		X	X	X																				
A-06	1	1147		X	X																					
A-07	1	1154		X	X																					
A-08	1	1200		X	X																					
A-09	1	1207		X	X																					
A-10	1	1214		X	X																					
A-11	1	1221		X	X																					
A-11-5	1	1227		X	X																					
A-12	1	1234		X	X																					
A-13	1	1241		X	X	X																				
ZZZZZZ	1	1253																								
CCV	1	1300		X	X	X																				

FORM XIV - IN

ANALYSIS RUN LOG

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

nstrument ID Number TJA ET3_____ Method P_

tart Date 08/31/01 End Date 08/31/01

Client Sample No	D/F	Time	% R	Analytes																							
				CD	PB	ZN																					
CCB	1	1306		X	X	X																					
A-13-5	1	1313		X	X																						
A-14	1	1320		X	X																						
A-15	1	1327		X	X	X																					
A-16	1	1334		X	X																						
A-17	1	1340		X	X	X																					
A-17L	5	1347		X	X	X																					
A-17S	1	1354		X	X	X																					
A-17M	1	1401		X	X	X																					
LCSS	1	1408		X	X	X																					
ZZZZZZ	1	1419																									
CCV	1	1426		X	X	X																					
CCB	1	1433		X	X	X																					

FORM XIV - IN

14

ANALYSIS RUN LOG

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

Instrument ID Number TJA ET3_____ Method P_

Start Date 09/01/01 End Date 09/01/01

Client Sample No	D/F	Time	% R	Analytes																							
				CD	PB	ZN																					
S0	1	0657			X	X																					
S	1	0704			X	X																					
S	1	0711			X	X																					
ICV	1	0718			X	X																					
ICB	1	0725			X	X																					
CRI	1	0731			X	X																					
ICSA	1	0738			X	X																					
ICSAB	1	0745			X	X																					
CCV	1	0752			X	X																					
CCB	1	0759			X	X																					
ZZZZZZ	1	0806																									
ZZZZZZ	1	0812																									
ZZZZZZ	1	0819																									
ZZZZZZ	1	0826																									
ZZZZZZ	1	0833																									
ZZZZZZ	1	0840																									
ZZZZZZ	1	0851																									
CCV	1	0858			X	X																					
CCB	1	0905			X	X																					
A-01	2	0912			X																						
A-06	20	0919				X																					
A-07	2	0926				X																					
A-08	5	0932				X																					
A-09	10	0939				X																					
A-10	10	0946				X																					
A-11	2	0953				X																					
A-11-5	2	1000				X																					
ZZZZZZ	1	1011																									
CCV	1	1018			X	X																					
CCB	1	1025			X	X																					
A-12	2	1032				X																					
A-13-5	2	1039				X																					

FORM XIV - IN

ED_000859_00001631-00187

ANALYSIS RUN LOG

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47330_ SAS No _____ SDG No 47330_

nstrument ID Number TJA ET3_____ Method P_

tart Date 09/01/01 End Date 09/01/01

Client Sample No	D/F	Time	% R	Analytes																							
				CD	PB	ZN																					
A-14	2	1046				X																					
A-16	2	1052				X																					
ZZZZZZ	1	1104																									
CCV	1	1111			X	X																					
CCB	1	1118			X	X																					

FORM XIV - IN

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

September 6, 2001

Greg Patton
BARR ENGINEERING
3236 Emerald Lane
Jefferson City, MO 65109

25/86-009 PTS 003

Project/Location	**RIVERMINES**
SDG ID	**47331**
SWLO ID	47331 01 – 47331 12

Dear Mr Patton

Enclosed please find the forms package for a portion of your soil samples received August 17, 2001 for the above-referenced project

Thank you for choosing Southwest Laboratory If you should have any questions or require additional information, please do not hesitate to call

Sincerely,

Randy Staggs
Project Officer

RES/mc

Enclosure

RECEIVED
SEP 7 2001
BARR ENGINEERING CO
MISSOURI

We certify that the following report meets all required NELAC reporting standards as specified in NELAC 5 13 July 1 1999 Any deviation or variance is noted in the case narrative(s) and estimated uncertainties regarding these analyses are presented in the Quality Control Section of this report

1700 West Albany • Broken Arrow OK 74012 1421 • Office (918) 251-2858 • Fax (918) 251-2599

CHAIN OF CUSTODY RECORD

SOUTHWEST LABORATORY OF OKLAHOMA, INC
1700 W Albany Broken Arrow Oklahoma 74012 1421
Office 918 251 2858 Fax 918 251 2599

TM

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
Barr Eng	Greg Patten	888-324-3933

P O or PROPOSAL NUMBER	PROJECT NAME
25/86/009/PTS	Rivermines 25/86/009/PTS/003

SAMPLER (Signature)

2 of 2

ANALYTICAL TESTS REQUESTED

SAMPLE NO	DATE	TIME	COMP	GRAB	LOCATION	MATRIX	NUMBER OF CONTAINERS	Pb, Cd, Zn								REMARKS
A-15	8/13/01	4:43 p		X		Soil	1	X								SW-846 6010 or other method
A-16	8/14/01	11 10 A		X			1	X								that achieves a detection
A-17	8/14/01	11 20 A		X			1	X								Limit of 4 ug/L or better
A-18	8/14/01	2:45 p		X			1	X								
A-19	8/14/01	1:50 p		X			1	X								Call Ward Swanson 1-800 632 2272
A-20	8/14/01	2:00 p		X			1	X								Greg Patten 888-324-3933 if
A 21	8/14/01	12 25 p		X			1	X								a different method is going to be
A-21-5	8/14/01	12 25 p		X			1	X								used or if you have any
A-22	8/13/01	5 30 P		X			1	X								questions
A-23	8/13/01	5:30 P		X			1	X								
A-24	8/14/01	5:15 P		X			1	X								
A-25	8/15/01	8:00 A		X			1	X								
A-26	8/15/01	8 45 A		X			1	X								

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)
	8/16/01	1 00 p	

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED FOR LABORATORY BY (Signature)
	8/17/01	8:20	

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)

REMARKS

6-2°C

[SR012 1192-03]

COOLER RECEIPT / SAMPLE LOG IN SHEET

COOLER RECEIPT / SAMPLE LOG-IN SHEET (115-ATT2.WB1) / SWL-GA 115 REV 5 0 / GA-115-CRLOGIN-F

LAB NAME SOUTHWEST LABORATORY OF OKLAHOMA

PAGE ___ OF ___

RECEIVED BY (PRINT NAME) JASON SPRIGGS

RECEIVED BY (SIGNATURE)

LOGGED IN BY (SIGNATURE)

REC D DATE 08/17/01

TIME REC D 08 20

LOG-IN DATE 2001-08-18 07 53

PROJECT RIVERMINES

EPISODE 47331

SAMPLE DELIVERY GROUP 47331

Remarks

1 CUSTODY SEAL(S) Present/Absent
Intact/ Broken

2 CUSTODY SEALS NOS
N/A

3 CHAIN-OF CUSTODY Present/Absent
Sealed In Plastic? Yes/ No
Taped To Lid? Yes/ No
Properly Filled Out
(Ink Signed ETC)? Yes/ No

4 AIRBILL AirBill/ Sticker
Present/Absent

5 AIRBILL NO
790133728677

6 COOLER CONDITIONS
Enough Ice? Yes/ No
Type of Ice? Wet
Type of Packing? Bubble Wrap

7 SAMPLE TAGS Present/Absent

8 SAMPLE CONDITION Intact/ Broken / Leaking
Bottles Sealed In Separate Plastic Bags? Yes/ No
Correct Containers Used For Tests Indicated? Yes/ No
Correct Preservative? Yes/ No
Sufficient Sample? Yes/ No
Labels Complete (I D Date Time Signature Preservative? Yes/ No
VOA Samples Without Bubbles? Yes/ No~

9 Does Information on Custody Records Labels Tags Agree? Yes/ No

10 RAD SCREEN WITH GIEGER COUNTER? Yes/ No

11 P O Called? Yes/ No

Client Sample #	Sample Fraction @	Assigned LAB#	Cooler I D	pH Check	ACID/ BASE LOT#	REMARKS CONDITION OF SAMPLE SHIPMENT ETC
A 18	M	47331 01	08/14/01 1	N		
A 19		47331 02	08/14/01 1	N		
A 20		47331 03	08/14/01 1	N		
A 21		47331 04	08/14/01 1	N		
A 21 5		47331 05	08/14/01 1	N		
A 22		47331 06	08/14/01 1	N		
A 23		47331 07	08/14/01 1	N		
A 24		47331 08	08/14/01 1	N		
A 25		47331 09	08/14/01 1	N		
A 26		47331 10	08/14/01 1	N		
A 26		47331 11	08/14/01 1	N		
A 26		47331 12	08/14/01 1	N		

Contact PO and attach record of resolution

@ Sample Fractions B=SV GC/MS V= VOA GC/MS or GC P=Pesticide H=Herbicide D=Dioxin A=Air I=Inorganics C=Cyanide M=Metals R=Radiochemistry

~ Note samples with bubbles under remarks section

SOUTHWEST LABORATORY OF OKLAHOMA, INC
1700 West Albany – Broken Arrow Oklahoma 74012 – Office (918) 251 2858 – Fax (918) 251 2599

INORGANICS CLP QUALIFIER FLAGS

B	The reported values were obtained from a reading that was less that the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL) if the analyte was analyzed but not detected a U' must be entered
E	The reported value is estimated because of the presence of interference An explanatory note must be included under Comments on the Cover Page if the problem applies to all samples or on the specific Form 1 if it is an isolated problem
M	Duplicate injection precision not met.
N	Spike recovery not within control limits
S	The reported value was determined by the Method of Standard Additions (MSA)
W	Post Digestion spike for GFAA analysis is out of control limits (85 115%) while sample absorbance is less than 50% of spike absorbance
*	Duplicate analysis not within control limits
+	Correlation coefficient for the MSA is less than 0 995

SOUTHWEST LABORATORY OF OKLAHOMA, INC
1700 West Albany / Broken Arrow, Oklahoma 74012 / Office (918) 251 2858 / Fax (918) 251 2599

SDG NARRATIVE

CONTRACT BARR **DATE August 30, 2001**
SDG 47331 **EPISODE NO 47331**

INORGANIC METAL FRACTION

Ten soil samples plus one matrix spike and one matrix spike duplicate were submitted for ICP analysis No major problems occurred during the digestion or analysis of these samples Please see the DC-1 (Sample Log-In Sheet) for sample conditions and cooler temperatures at receipt The sample's analyses were completed according to the following

SWL SOP #	Method SOP is based
SWL-IN-205	SW846 3050B / 6010B

The cover page of the Inorganic Analyses Data Package cross-references client and laboratory sample ID's Manual integration was not used for the data presented in this Inorganic Analyses Data Package

Initial and Continuing Calibration Checks The absolute value of the Initial Calibration Blank for lead was over the MDL, but less than the PQL No action required

Linearity near the CRDL (CRA & CRI) The result for lead was outside our in house control limits of 80 – 120% This will be monitored for trends No action required

Preparation Blank Zinc and lead showed low level concentrations below the Practical Quantitation Limit in the Preparation Blank No action required

Lab Control Spikes No problems

Matrix Spikes The sample results for all elements were greater than four times the spike added No action required

Duplicate(s) (LCSD and MSD) The LCS/LCSD was within precision limits The MS/MSD were outside the precision limits of 20% for lead and zinc All Form 1's for these elements are flagged with an "*"

ED_000859_00001631-00193

SOUTHWEST LABORATORY OF OKLAHOMA, INC
1700 West Albany / Broken Arrow Oklahoma 74012 / Office (918) 251 2858 / Fax (918) 251 2599

Serial Dilution (ICP) The serial dilution analysis was outside the control limits of 10% for all elements indicating a possible matrix interference All Form 1's are flagged with an "E" flag

Sincerely,

Steve L Markham
Inorganic Program Manager

ED_000859_00001631-00194

COVER PAGE - INORGANIC ANALYSES DATA PACKAGE

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

SOW No SW846__

EPA Sample No	Lab Sample ID
_A-18_____	_47331 01_____
_A-19_____	_47331 02_____
_A-20_____	_47331 03_____
_A-21_____	_47331 04_____
_A-21-5_____	_47331 05_____
_A-22_____	_47331 06_____
_A-23_____	_47331 07_____
_A-24_____	_47331 08_____
_A-25_____	_47331 09_____
_A-26_____	_47331 10_____
_A-26S_____	_47331 11S_____
_A-26M_____	_47331 12SD_____

Were ICP interelement corrections applied ? Yes/No YES

Were ICP background corrections applied ? Yes/No YES

If yes - were raw data generated before application of background corrections ? Yes/No NO_

Comments

____ICP_BATCH_#=010823I1_____

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature

Signature Steve L Markham Name Steve L Markham

Date 08/31/01 Title Inorganics Program Manager

COVER PAGE - IN

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-18

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331_ SAS No _____ SDG No 47331_

atrix (soil/water) SOIL_ Lab Sample ID 47331 01

evel (low/med) LOW__ Date Received 08/17/01

Solids _76 6

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	7 7		E	P
7439-92-1	Lead	1770		E*	P
7440-66-6	Zinc	812		E*	P

olor Before BROWN____ Clarity Before _____ Texture MEDIUM

olor After YELLOW___ Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

4

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-19

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331_ SAS No _____ SDG No 47331_

Matrix (soil/water) SOIL_ Lab Sample ID 47331 02

Level (low/med) LOW__ Date Received 08/17/01

% Solids _74 0

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium__	21 1	_	E	P_
7439-92-1	Lead_____	8920	_	E*	P_
7440-66-6	Zinc_____	1860	_	E*	P_

Color Before BROWN____ Clarity Before _____ Texture COURSE

Color After YELLOW___ Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

5

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-20

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331_ SAS No _____ SDG No 47331_

atrix (soil/water) SOIL_ Lab Sample ID 47331 03

evel (low/med) LOW__ Date Received 08/17/01

Solids _95 3

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	59 4		E	P
7439-92-1	Lead	7420		E*	P
7440-66-6	Zinc	2760		E*	P

olor Before BROWN____ Clarity Before _____ Texture MEDIUM

olor After YELLOW___ Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

6

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-21

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331_ SAS No _____ SDG No 47331_

Matrix (soil/water) SOIL_ Lab Sample ID 47331 04

Level (low/med) LOW__ Date Received 08/17/01

% Solids _71 3

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	45 0		E	P
7439-92-1	Lead	19300		E*	P
7440-66-6	Zinc	3000		E*	P

Color Before BROWN____ Clarity Before _____ Texture MEDIUM

Color After YELLOW___ Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-21-5

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331_ SAS No _____ SDG No 47331_

atrix (soil/water) SOIL_ Lab Sample ID 47331 05

evel (low/med) LOW__ Date Received 08/17/01

Solids _74 8

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	56 6		E	P
7439-92-1	Lead	4590		E*	P
7440-66-6	Zinc	3520		E*	P

olor Before BROWN____ Clarity Before _____ Texture MEDIUM

olor After YELLOW___ Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

8

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-22

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331_ SAS No _____ SDG No 47331_

Matrix (soil/water) SOIL_ Lab Sample ID 47331 06

Level (low/med) LOW__ Date Received 08/17/01

% Solids _87 7

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	26 1		E	P
7439-92-1	Lead	1770		E*	P
7440-66-6	Zinc	881		E*	P

Color Before BROWN____ Clarity Before _____ Texture COURSE

Color After YELLOW___ Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-23

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331_ SAS No _____ SDG No 47331_

atrix (soil/water) SOIL_ Lab Sample ID 47331 07

evel (low/med) LOW__ Date Received 08/17/01

Solids _93 0

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	17 1		E	P
7439-92-1	Lead	5740		E*	P
7440-66-6	Zinc	934		E*	P

olor Before BROWN____ Clarity Before _____ Texture MEDIUM

olor After YELLOW___ Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

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U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-24

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331_ SAS No _____ SDG No 47331_

Matrix (soil/water) SOIL_ Lab Sample ID 47331 08

Level (low/med) LOW__ Date Received 08/17/01

% Solids _70 7

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	24 2		E	P
7439-92-1	Lead	735		E*	P
7440-66-6	Zinc	1800		E*	P

Color Before BROWN____ Clarity Before _____ Texture MEDIUM

Color After YELLOW___ Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-25

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331_ SAS No _____ SDG No 47331_

atrix (soil/water) SOIL_ Lab Sample ID 47331 09

evel (low/med) LOW__ Date Received 08/17/01

Solids _88 0

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	63 7		E	P
7439-92-1	Lead	3190		E*	P
7440-66-6	Zinc	3020		E*	P

olor Before BROWN____ Clarity Before _____ Texture MEDIUM

olor After YELLOW___ Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

A-26

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331_ SAS No _____ SDG No 47331_

Matrix (soil/water) SOIL_ Lab Sample ID 47331 10

Level (low/med) LOW__ Date Received 08/17/01

% Solids _60 4

Concentration Units (ug/L or mg/kg dry weight) MG/KG

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium__	34 2	_	E	P_
7439-92-1	Lead_____	1910	_	E*	P_
7440-66-6	Zinc_____	1570	_	E*	P_

Color Before BROWN____ Clarity Before _____ Texture MEDIUM

Color After YELLOW___ Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

13

U S EPA - CLP

2A
INITIAL AND CONTINUING CALIBRATION VERIFICATION

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

nitial Calibration Source EPA-LV_____

ontinuing Calibration Source IN VEN _____

Concentration Units ug/L

Analyte	Initial Calibration True	Initial Calibration Found	Initial Calibration %R(1)	Continuing Calibration True	Continuing Calibration Found	Continuing Calibration %R(1)	Continuing Calibration Found	Continuing Calibration %R(1)	M
Cadmium	125 0	125 52	100 4	500 0	500 26	100 1	500 60	100 1	P
Lead	250 0	249 97	100 0	500 0	500 36	100 1	500 07	100 0	P
Zinc	250 0	254 27	101 7	500 0	505 08	101 0	503 47	100 7	P

FORM II (PART 1) - IN

U S EPA - CLP

2A
INITIAL AND CONTINUING CALIBRATION VERIFICATION

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

Initial Calibration Source EPA-LV_____

Continuing Calibration Source IN VEN _____

Concentration Units ug/L

Analyte	Initial Calibration True	Initial Calibration Found	Initial Calibration %R(1)	Continuing Calibration True	Continuing Calibration Found	Continuing Calibration %R(1)	Continuing Calibration Found	Continuing Calibration %R(1)	M
Cadmium				500 0	503 15	100 6			P
Lead				500 0	503 16	100 6			P
Zinc				500 0	504 48	100 9			P

FORM II (PART 1) - IN

ED_000859_00001631-00207

U S EPA - CLP

2A
INITIAL AND CONTINUING CALIBRATION VERIFICATION

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

nitial Calibration Source EPA-LV_____

ontinuing Calibration Source IN VEN _____

Concentration Units ug/L

Analyte	Initial Calibration True	Initial Calibration Found	Initial Calibration %R(1)	Continuing Calibration True	Continuing Calibration Found	Continuing Calibration %R(1)	Continuing Calibration Found	Continuing Calibration %R(1)	M
Cadmium									NR
Lead	250 0	250 92	100 4	500 0	504 97	101 0	503 45	100 7	P
Zinc	250 0	253 90	101 6	500 0	507 17	101 4	505 23	101 0	P

FORM II (PART 1) - IN

ED_000859_00001631-00208

U S EPA - CLP

2B
CRDL STANDARD FOR AA AND ICP

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

AA CRDL Standard Source PLASMACHEM__

ICP CRDL Standard Source IN VEN _____

Concentration Units ug/L

Analyte	CRDL Standard for AA			CRDL Standard for ICP				
					Initial		Final	
	True	Found	%R	True	Found	%R	Found	%R
Cadmium				6 0	5 89	98 2		
Lead				10 0	7 66	76 6		
Zinc				20 0	20 54	102 7		

FORM II (PART 2) - IN

ED_000859_00001631-00209

U S EPA - CLP

2B
CRDL STANDARD FOR AA AND ICP

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

A CRDL Standard Source PLASMACHEM__

CP CRDL Standard Source IN VEN _____

Concentration Units ug/L

Analyte	CRDL Standard for AA			CRDL Standard for ICP				
	True	Found	%R	True	Initial Found	%R	Final Found	%R
Cadmium								
Lead				10 0	10 06	100 6		
Zinc				20 0	21 06	105 3		

FORM II (PART 2) - IN

U S EPA - CLP
3
BLANKS

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

Preparation Blank Matrix (soil/water) SOIL_

Preparation Blank Concentration Units (ug/L or mg/kg) MG/KG

Analyte	Initial Calib Blank (ug/L)	C	Continuing Calibration Blank (ug/L) 1	C	2	C	3	C	Prepa-ration Blank	C	M
Cadmium	1 1	U	1 1	U	1 1	U	1 1	U	0 11	U	P
Lead	-1 7	B	1 2	U	1 2	U	1 2	U	0 16	B	P
Zinc	2 7	U	2 7	U	2 7	U	2 7	U	0 43	B	P

FORM III - IN

ED_000859_00001631-00211

U S EPA - CLP
3
BLANKS

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

reparation Blank Matrix (soil/water) _____

reparation Blank Concentration Units (ug/L or mg/kg) _____

Analyte	Initial Calib Blank (ug/L)	C	Continuing Calibration Blank (ug/L) 1	C	2	C	3	C	Prepa-ration Blank	C	M
Cadmium											NR
Lead	12	U	12	U	12	U					P
Zinc	27	U	27	U	27	U					P

FORM III - IN

U S EPA - CLP
4
ICP INTERFERENCE CHECK SAMPLE

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

ICP ID Number TJA ET3_____ ICS Source EPA-LV91____

Concentration Units ug/L

Analyte	True Sol A	True Sol AB	Initial Found Sol A	Initial Found Sol AB	Initial Found %R	Final Found Sol A	Final Found Sol AB	Final Found %R
Cadmium	0	1000	0	1029 8	103 0	0		
Lead	0	50	-2	47 7	95 4			
Zinc	0	1000	-1	982 7	98 3			

FORM IV - IN

ED_000859_00001631-00213

U S EPA - CLP
4
ICP INTERFERENCE CHECK SAMPLE

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

CP ID Number TJA ET3_____ ICS Source EPA-LV91____

Concentration Units ug/L

Analyte	True Sol A	True Sol AB	Initial Found Sol A	Initial Found Sol AB	Initial Found %R	Final Found Sol A	Final Found Sol AB	Final Found %R
Cadmium								
Lead	0	50	0	51 5	103 0	0		
Zinc	0	1000	1	981 5	98 1			

FORM IV - IN

22

U S EPA - CLP
5A
SPIKE SAMPLE RECOVERY

Client SAMPLE ID

A-26M

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_
Matrix __SOIL_____ Level (low/med) _LOW____
% Solids for Sample _60 4

Concentration Units (ug/L or mg/kg dry weight) MG/KG

Analyte	Control Limit %R	Spiked Sample Result (SSR)	C	Sample Result (SR)	C	Spike Added (SA)	%R	Q	M
Cadmium		37 1359		34 2215		8 04	36 2		P
Lead		1674 4024		1905 2702		80 37	-287 3		P
Zinc		1485 8969		1573 5852		80 37	-109 1		P

Comments

FORM V (Part 1) - IN

U S EPA - CLP
5A
SPIKE SAMPLE RECOVERY

Client SAMPLE ID

A-26S

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_
atrix __SOIL_____ Level (low/med) _LOW____
Solids for Sample _60 4

Concentration Units (ug/L or mg/kg dry weight) MG/KG

Analyte	Control Limit %R	Spiked Sample Result (SSR)	C	Sample Result (SR)	C	Spike Added (SA)	%R	Q	M
Cadmium		45 0677		34 2215		8 04	134 9		P
Lead		2132 0511		1905 2702		80 37	282 2		P
Zinc		1897 9435		1573 5852		80 37	403 6		P

omments

FORM V (Part 1) - IN

U S EPA - CLP
6
DUPLICATES

CLIENT SAMPLE ID

A-26M

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

Matrix (soil/water) SOIL_ Level (low/med) _LOW__

% Solids for Sample _60 4 % Solids for Duplicate __60 4

Concentration Units (ug/L or mg/kg dry weight) MG/KG

Analyte	Control Limit	Sample (S)	C	Duplicate (D)	C	RPD	Q	M
Cadmium		45 0677		37 1359		19 3		P
Lead		2132 0511		1674 4024		24 0	*	P
Zinc		1897 9435		1485 8969		24 4	*	P

FORM VI - IN

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U S EPA - CLP
6
DUPLICATES

CLIENT SAMPLE ID

LCSSD

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

atrix (soil/water) SOIL_ Level (low/med) _LOW__

Solids for Sample 100 0 % Solids for Duplicate _100 0

Concentration Units (ug/L or mg/kg dry weight) MG/KG

Analyte	Control Limit	Sample (S)	C	Duplicate (D)	C	RPD	Q	M
Cadmium		5 2338		5 1233		2 1		P
Lead		8 4674		8 1506		3 8		P
Zinc		56 3045		53 0521		5 9		P

FORM VI - IN

U S EPA - CLP
7
LABORATORY CONTROL SAMPLE

Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

Solid LCS Source IN VEN _____

Aqueous LCS Source _____

Analyte	Aqueous (ug/L) True	Found	%R	Solid (mg/kg) True	Found	C	Limits		%R
Cadmium				5 00	5 23		4 00	6 00	104 6
Lead				8 00	8 47		6 40	9 60	105 9
Zinc				50 00	56 30		40 00	60 00	112 6

FORM VII - IN

U S EPA - CLP
7
LABORATORY CONTROL SAMPLE

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

olid LCS Source IN VEN _____

queous LCS Source _____

Analyte	Aqueous (ug/L) True	Found	%R	Solid (mg/kg) True	Found	C	Limits		%R
Cadmium				5 00	5 12		4 00	6 00	102 4
Lead				8 00	8 15		6 40	9 60	101 9
Zinc				50 00	53 05		40 00	60 00	106 1

FORM VII - IN

U S EPA - CLP

8
STANDARD ADDITION RESULTS

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

Concentration Units ug/L

EPA Sample No	An	0 ADD ABS	1 ADD CON	1 ADD ABS	2 ADD CON	2 ADD ABS	3 ADD CON	3 ADD ABS	Final Conc	r	Q

FORM VIII - IN ILM02 1

ED_000859_00001631-00221

U S EPA - CLP
9
ICP SERIAL DILUTION

Client SAMPLE ID

A-26L

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

atrix (soil/water) SOIL_ Level (low/med) LOW__

Concentration Units ug/L

Analyte	Initial Sample Result (I)	C	Serial Dilution Result (S)	C	% Difference	Q	M
Cadmium	212 90		247 82		16 4	E	P
Lead	11853 07		14442 92		21 8	E	P
Zinc	9789 59		12794 30		30 7	E	P

FORM IX - IN

U S EPA - CLP
10
Instrument Detection Limits (Quarterly)

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____
Lab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_
ICP ID Number TJA_ET3_____ Date 06/01/01
Flame AA ID Number _____
Furnace AA ID Number _____

Analyte	Wave-length (nm)	Back-ground	CRDL (ug/L)	IDL (ug/L)	M
Cadmium	226 50		6	1 1	P
Lead	220 35		10	1 2	P
Zinc	213 86		20	2 7	P

Comments

FORM X - IN

U S EPA - CLP
11A
ICP Interelement Correction Factors (Annually)

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

CP ID Number TJA ET3_____ Date 06/08/01

Analyte	Wave-length (nm)	Interelement Correction Factors for Al	Ca	Fe	Mg	BA_
Cadmium__	_226 50__	_0 0000000	_0 0000000_	_0 0000890	_0 0000000	_0 0000000
Lead_____	_220 35__	_0 0004660	_0 0000000_	_0 0000620	_0 0000000	_0 0000000
Zinc_____	_213 86__	_0 0000000	_0 0000000_	_0 0001580	_0 0000680	_0 0000000

omments

FORM XI (Part 1) - IN

U S EPA - CLP
11B
ICP Interelement Correction Factors (Annually)

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

ICP ID Number TJA ET3_____ Date 06/08/01

Analyte	Wave-length (nm)	Interelement Correction Factors for CO_	CR_	CU_	MN_	NI_
Cadmium__	226 50__	-0 0001610	0 0000000	0 0000000	0 0000000	0 0000000
Lead_____	220 35__	-0 0015830	0 0000000	0 0000000	0 0000000	0 0000000
Zinc_____	213 86__	0 0000000	0 0000000	0 0008210	0 0000000	0 0044040

Comments

FORM XI (Part 2) - IN

U S EPA - CLP
11B
ICP Interelement Correction Factors (Annually)

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

CP ID Number TJA ET3_____ Date 06/08/01

Analyte	Wave-length (nm)	Interelement Correction Factors for SC_	SN_	TI_	V__	___
Cadmium__	226 50	0 0000000	0 0000000	0 0000000	0 0000000	
Lead_____	220 35	0 0000000	0 0000000	-0 0005190	-0 0002350	
Zinc_____	213 86	0 0000000	0 0000000	0 0000000	0 0000000	

omments

FORM XI (Part 2) - IN

U S EPA - CLP
12
ICP Linear Ranges (Quarterly)

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331 SAS No _____ SDG No 47331_

ICP ID Number TJA ET3_____ Date 07/02/01

Analyte	Integ Time (sec)	Concentration (ug/L)	M
Cadmium__	15 00	10000 0_	P
Lead_____	15 00	80000 0_	P
Zinc_____	15 00	10000 0_	P

Comments

FORM XII - IN

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U S EPA - CLP
13
PREPARATION LOG

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No _47331 SAS No _____ SDG No 47331_

ethod P_

Client Sample No	Prep Date	Weight (gram)	Volume (mL)
A-18	08/23/01	1 00	100
A-19	08/23/01	1 04	100
A-20	08/23/01	1 01	100
A-21	08/23/01	1 03	100
A-21-5	08/23/01	1 04	100
A-22	08/23/01	1 03	100
A-23	08/23/01	1 01	100
A-24	08/23/01	1 04	100
A-25	08/23/01	1 02	100
A-26	08/23/01	1 03	100
A-26M	08/23/01	1 03	100
A-26S	08/23/01	1 03	100
LCSS	08/23/01	1 00	100
LCSSD	08/23/01	1 00	100
PBS	08/23/01	1 00	100

FORM XIII - IN

ED_000859_00001631-00228

ANALYSIS RUN LOG

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47331_ SAS No _____ SDG No 47331_

Instrument ID Number TJA ET3_____ Method P_

Start Date 08/29/01 End Date 08/29/01

Client Sample No	D/F	Time	% R	Analytes																							
				CD	PB	ZN																					
S0	1	0837		X	X	X																					
S	1	0844		X	X	X																					
S	1	0851		X	X	X																					
ICV	1	0858		X	X	X																					
ICB	1	0905		X	X	X																					
CRI	1	0911		X	X	X																					
ICSA	1	0918		X	X	X																					
ICSAB	1	0925		X	X	X																					
CCV	1	0932		X	X	X																					
CCB	1	0939		X	X	X																					
PBS	1	0956		X	X	X																					
LCSS	1	1003		X	X	X																					
LCSSD	1	1010		X	X	X																					
A-18	1	1017		X	X	X																					
A-19	1	1023		X	X																						
A-20	1	1030		X	X																						
A-21	1	1037		X																							
A-21-5	1	1044		X	X																						
ZZZZZZ	1	1057																									
CCV	1	1104		X	X	X																					
CCB	1	1111		X	X	X																					
A-22	1	1118		X	X	X																					
A-23	1	1124		X	X	X																					
A-24	1	1131		X	X																						
A-25	1	1138		X	X																						
A-26	1	1145		X	X	X																					
A-26L	5	1152		X	X	X																					
A-26S	1	1158		X	X																						
A-26M	1	1205		X	X	X																					
ZZZZZZ	1	1219																									
CCV	1	1225		X	X	X																					
CCB	1	1251		X	X	X																					

FORM XIV - IN

ANALYSIS RUN LOG

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47331_ SAS No _____ SDG No 47331_

nstrument ID Number TJA ET3_____ Method P_

tart Date 08/30/01 End Date 08/30/01

Client Sample No	D/F	Time	% R	Analytes																							
				CD	PB	ZN																					
S0	1	1308			X	X																					
S	1	1315			X	X																					
S	1	1322			X	X																					
ICV	1	1329			X	X																					
ICB	1	1335			X	X																					
CRI	1	1342			X	X																					
ICSA	1	1349			X	X																					
ICSAB	1	1356			X	X																					
CCV	1	1403			X	X																					
CCB	1	1409			X	X																					
A-19	2	1416				X																					
A-20	5	1423				X																					
A-21	5	1430			X	X																					
A-21-5	5	1437				X																					
A-24	2	1444				X																					
A-25	5	1450				X																					
A-26S	2	1457				X																					
ZZZZZZ	1	1507																									
CCV	1	1514			X	X																					
CCB	1	1521			X	X																					

FORM XIV - IN

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

August 29, 2001

Greg Patton
BARR ENGINEERING
3236 Emerald Lane
Jefferson City, MO 65109

RECEIVED
SEP - 4 2001
BARR ENGINEERING CO

Project/Location	**RIVERMINES**
SDG ID	**47332**
SWLO ID	47332 01 – 47332 17

Dear Mr Patton

Enclosed please find the forms package for a portion of your water samples received August 18 2001 for the above-referenced project

Thank you for choosing Southwest Laboratory If you should have any questions or require additional information please do not hesitate to call

Sincerely

Randy Staggs
Project Officer

RES/sle

Enclosure

We certify that the following report meets all required NELAC reporting standards as specified in NELAC 5 13 July 1, 1999 Any deviation or variance is noted in the case narrative(s) and estimated uncertainties regarding these analyses are presented in the Quality Control Section of this report

1700 West Albany • Broken Arrow OK 74012 1421 • Office (918) 251 2858 • Fax (918) 251 2599

SOUTHWEST LABORATORY OF OKLAHOMA, INC
1700 West Albany / Broken Arrow, OK 74012 / Office (918) 251 2858 / Fax (918) 251 2599

CASE NARRATIVE

CONTRACT Barr Engineering | **DATE August 23, 2001**
Case No 47332 | **PROJECT NAME Rivermines**
SDG # 47332 | **EPISODE # 47332**

INORGANIC METAL FRACTION
Fifteen water samples were submitted for ICP analysis No major problems occurred during the digestion or analysis of this sample Please see the *Cooler Receipt/Sample Log-In Sheet* for sample conditions and cooler temperatures at receipt The sample's analyses were completed according to the following

SWL SOP #	Method SOP is based
SWL-IN-205	SW846 3010A and 6010B ICP Digestion & Analysis

The cover page of the Inorganic Analyses Data Package cross-references client and laboratory sample ID's Manual integration was not used for the data presented in this Inorganic Analyses Data Package

Initial and Continuing Calibration Checks No problems

Initial and Continuing Calibration Blanks Cadmium was detected above the MDL, but less than the PQL No further action required

Linearity near the CRDL (CRA & CRI) The following ICP CRI and Hg CRA analysis were outside our in-house control limits of 80 – 120% None No action required

Preparation Blank Zinc was detected above the MDL, but below the PQL No other target analytes were detected in the preparation blanks above the MDL

Lab Control Spikes All laboratory control samples were within QC limits

Matrix Spikes. All matrix spikes were within the control limits of 75 – 125%

Duplicates (LCSD and MSD). All LCS/LCD and MS/MSD results were within the precision control limits of 20%

Serial Dilution The percent difference for zinc in the serial dilution was greater than the control limits of 10% All Form 1's are flagged with an "E" flag

I certify that this data is technically accurate, complete, and in compliance with the terms and conditions of the contract for other than the conditions detailed above Release of the data contained in this hardcopy data package and its electronic data deliverable submitted on diskette has been authorized by the Laboratory Manager or his/her designee, as verified by the following signature "

Sincerely,

Steve L Markham
Inorganic Program Manager

COVER PAGE - INORGANIC ANALYSES DATA PACKAGE

ıb Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ıb Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

)W No SW846__

EPA Sample No	Lab Sample ID
W-01-F	47332 02
W-01-U	47332 01
W-02-F	47332 04
W-02-U	47332 03
W-03-F	47332 06
W-03-U	47332 05
W-04-F	47332 08
W-04-U	47332 07
W-05-F	47332 10
W-05-U	47332 09
W-06-F	47332 12
W-06-U	47332 11
W-07-F	47332 14
W-07-U	47332 13
W-08-F	47332 15
W-08-FS	47332 16S
W-08-FM	47332 17SD

ere ICP interelement corrections applied ? Yes/No YES

ere ICP background corrections applied ? Yes/No YES
If yes - were raw data generated before application of background corrections ? Yes/No NO_

omments
___ICP_BATCH_#=010820I2

certify that this data package is in compliance with the terms and onditions of the contract, both technically and for completeness, for ther than the conditions detailed above Release of the data contained n this hardcopy data package and in the computer-readable data submitted n diskette has been authorized by the Laboratory Manager or the anager's designee, as verified by the following signature

ignature Steve L. Markham Name Steve L Markham

ate 08/23/01 Title Inorganics Program Manager

COVER PAGE - IN

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-01-F

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

Matrix (soil/water) WATER Lab Sample ID 47332 02

Level (low/med) LOW__ Date Received 08/17/01

% Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	87 0			P
7439-92-1	Lead	37 3			P
7440-66-6	Zinc	19100		E	P

Color Before COLORLESS Clarity Before CLEAR_ Texture _____

Color After COLORLESS Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-01-U

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

atrix (soil/water) WATER Lab Sample ID 47332 01

evel (low/med) LOW__ Date Received 08/17/01

Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	85 6			P
7439-92-1	Lead	51 8			P
7440-66-6	Zinc	19600		E	P

olor Before COLORLESS Clarity Before CLEAR_ Texture _____

olor After COLORLESS Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

7

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-02-F

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

Matrix (soil/water) WATER Lab Sample ID 47332 04

Level (low/med) LOW__ Date Received 08/17/01

% Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	27 2			P
7439-92-1	Lead	80 9			P
7440-66-6	Zinc	8100		E	P

Color Before COLORLESS Clarity Before CLEAR_ Texture _____

Color After COLORLESS Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-02-U

ıb Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ıb Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

ıtrix (soil/water) WATER Lab Sample ID 47332 03

·vel (low/med) LOW__ Date Received 08/17/01

Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	27 3			P
7439-92-1	Lead	122			P
7440-66-6	Zinc	8460		E	P

ɔlor Before COLORLESS Clarity Before CLEAR_ Texture _____

ɔlor After COLORLESS Clarity After CLEAR_ Artifacts _____

ɔmments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-03-F

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

Matrix (soil/water) WATER Lab Sample ID 47332 06

Level (low/med) LOW__ Date Received 08/17/01

% Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	17 5			P
7439-92-1	Lead	40 9			P
7440-66-6	Zinc	4310		E	P

Color Before COLORLESS Clarity Before CLEAR_ Texture _____

Color After COLORLESS Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

10

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-03-U

ıb Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ıb Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

ıtrix (soil/water) WATER Lab Sample ID 47332 05

·vel (low/med) LOW__ Date Received 08/17/01

Solıds __0 0

Concentratıon Unıts (ug/L or mg/kg dry weıght) UG/L_

CAS No	Analyte	Concentratıon	C	Q	M
7440-43-9	Cadmium	18 6			P
7439-92-1	Lead	48 7			P
7440-66-6	Zınc	4520		E	P

ɔlor Before COLORLESS Clarıty Before CLEAR_ Texture _____

ɔlor After COLORLESS Clarıty After CLEAR_ Artıfacts _____

ɔmments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-04-F

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

Matrix (soil/water) WATER Lab Sample ID 47332 08

Level (low/med) LOW__ Date Received 08/17/01

% Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium__	32 5			P
7439-92-1	Lead_____	113			P
7440-66-6	Zinc_____	23400		E	P

Color Before COLORLESS Clarity Before CLEAR_ Texture _____

Color After COLORLESS Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-04-U

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

atrix (soil/water) WATER Lab Sample ID 47332 07

evel (low/med) LOW__ Date Received 08/17/01

Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium__	31 0	_		P_
7439-92-1	Lead_____	116	_		P_
7440-66-6	Zinc_____	23500	_	E	P_

olor Before COLORLESS Clarity Before CLEAR_ Texture _____

olor After COLORLESS Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-05-F

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

Matrix (soil/water) WATER Lab Sample ID 47332 10

Level (low/med) LOW__ Date Received 08/17/01

% Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium__	48 2			P
7439-92-1	Lead_____	153			P
7440-66-6	Zinc_____	9660		E	P

Color Before COLORLESS Clarity Before CLEAR_ Texture _____

Color After COLORLESS Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-05-U

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

atrix (soil/water) WATER Lab Sample ID 47332 09

evel (low/med) LOW__ Date Received 08/17/01

Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium__	51 4			P
7439-92-1	Lead_____	235			P
7440-66-6	Zinc_____	10400		E	P

olor Before COLORLESS Clarity Before CLEAR_ Texture _____

olor After COLORLESS Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-06-F

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

Matrix (soil/water) WATER Lab Sample ID 47332 12

Level (low/med) LOW__ Date Received 08/17/01

% Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium__	0 71	B		P_
7439-92-1	Lead_____	1 6	U		P_
7440-66-6	Zinc_____	11 9	B	E	P_

Color Before COLORLESS Clarity Before CLEAR_ Texture _____

Color After COLORLESS Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-06-U

ıb Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ıb Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

ıtrıx (soıl/water) WATER Lab Sample ID 47332 11

·vel (low/med) LOW__ Date Receıved 08/17/01

Solıds __0 0

Concentratıon Unıts (ug/L or mg/kg dry weıght) UG/L_

CAS No	Analyte	Concentratıon	C	Q	M
7440-43-9	Cadmium__	1 2	B		P_
7439-92-1	Lead_____	5 0	B		P_
7440-66-6	Zınc_____	19 4	B	E	P_

ɔlor Before COLORLESS Clarıty Before CLEAR_ Texture _____

ɔlor After COLORLESS Clarıty After CLEAR_ Artıfacts _____

ɔmments

FORM I - IN ILM02 1

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-07-F

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

Matrix (soil/water) WATER Lab Sample ID 47332 14

Level (low/med) LOW__ Date Received 08/17/01

% Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium__	2 9	B		P_
7439-92-1	Lead_____	103			P_
7440-66-6	Zinc_____	311		E	P_

Color Before COLORLESS Clarity Before CLEAR_ Texture _____

Color After COLORLESS Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-07-U

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

atrix (soil/water) WATER Lab Sample ID 47332 13

evel (low/med) LOW__ Date Received 08/17/01

Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium__	3 5	B		P_
7439-92-1	Lead_____	152			P_
7440-66-6	Zinc_____	364		E	P_

olor Before COLORLESS Clarity Before CLEAR_ Texture _____

olor After COLORLESS Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-08-F

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

Matrix (soil/water) WATER Lab Sample ID 47332 15

Level (low/med) LOW__ Date Received 08/17/01

% Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	48 2			P
7439-92-1	Lead	342			P
7440-66-6	Zinc	2990		E	P

Color Before COLORLESS Clarity Before CLEAR_ Texture _____

Color After COLORLESS Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

2A
INITIAL AND CONTINUING CALIBRATION VERIFICATION

ıb Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ıb Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

ıitial Calibratıon Source EPA-LV_____

ɔntınuıng Calıbratıon Source IN VEN _____

Concentratıon Unıts ug/L

Analyte	Initial Calibration True	Initial Calibration Found	Initial Calibration %R(1)	Continuing Calibration True	Continuing Calibration Found	Continuing Calibration %R(1)	Continuing Calibration Found	Continuing Calibration %R(1)	M
Cadmium	125 0	126 22	101 0	500 0	522 81	104 6	509 77	102 0	P
Lead	250 0	254 62	101 8	500 0	524 95	105 0	513 80	102 8	P
Zinc	250 0	255 93	102 4	500 0	530 34	106 1	526 29	105 3	P

FORM II (PART 1) - IN

U S EPA - CLP

2A

INITIAL AND CONTINUING CALIBRATION VERIFICATION

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

Initial Calibration Source EPA-LV_____

Continuing Calibration Source IN VEN _____

Concentration Units ug/L

Analyte	Initial Calibration True	Initial Calibration Found	Initial Calibration %R(1)	Continuing Calibration True	Continuing Calibration Found	Continuing Calibration %R(1)	Continuing Calibration Found	Continuing Calibration %R(1)	M
Cadmium				500 0	526 99	105 4	518 63	103 7	P
Lead				500 0	532 39	106 5	528 96	105 8	P
Zinc				500 0	543 30	108 7	541 16	108 2	P

FORM II (PART 1) - IN

U S EPA - CLP

2A
INITIAL AND CONTINUING CALIBRATION VERIFICATION

b Name SOUTHWEST_LABORATORIES___ Contract BARR_____

b Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

ıtıal Calıbratıon Source EPA-LV_____

ntınuıng Calıbratıon Source IN VEN _____

Concentratıon Unıts ug/L

nalyte	Initial Calibration True	Found	%R(1)	Continuing Calibration True	Found	%R(1)	Found	%R(1)	M
admium				500 0	491 60	98 3			P
ead				500 0	511 06	102 2			P
ınc				500 0	528 56	105 7			P

FORM II (PART 1) - IN

U S EPA - CLP

2B
CRDL STANDARD FOR AA AND ICP

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

AA CRDL Standard Source PLASMACHEM__

ICP CRDL Standard Source IN VEN _____

Concentration Units ug/L

Analyte	CRDL Standard for AA			CRDL Standard for ICP				
				Initial			Final	
	True	Found	%R	True	Found	%R	Found	%R
Cadmium				6 0	6 37	106 2		
Lead				10 0	9 72	97 2		
Zinc				20 0	20 26	101 3		

FORM II (PART 2) - IN

ED_000859_00001631-00254

U S EPA - CLP
3
BLANKS

ıb Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ıb Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

eparatıon Blank Matrıx (soıl/water) WATER

eparatıon Blank Concentratıon Unıts (ug/L or mg/kg) UG/L_

ınalyte	Initıal Calıb Blank (ug/L)	C	Contınuıng Calıbratıon Blank (ug/L) 1	C	2	C	3	C	Prepa-ratıon Blank	C	M
Cadmium	0 3	U	0 3	U	0 3	U	0 3	U	0 30	U	P
Lead	1 6	U	1 6	U	1 6	U	1 6	U	1 60	U	P
Zınc	1 6	U	1 6	U	1 6	U	1 6	U	5 96	B	P

FORM III - IN

U S EPA - CLP
3
BLANKS

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

Preparation Blank Matrix (soil/water) _____

Preparation Blank Concentration Units (ug/L or mg/kg) _____

Analyte	Initial Calib Blank (ug/L)	C	Continuing Calibration Blank (ug/L) 1	C	2	C	3	C	Prepa-ration Blank	C	M
Cadmium			0 3	B	0 4	B					P
Lead			1 6	U	1 6	U					P
Zinc			1 6	U	1 6	U					P

FORM III - IN

ED_000859_00001631-00256

U S EPA - CLP
4
ICP INTERFERENCE CHECK SAMPLE

b Name SOUTHWEST_LABORATORIES___ Contract BARR_____

b Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

P ID Number TJA ET2_____ ICS Source EPA-LV91____

Concentration Units ug/L

Analyte	True Sol A	True Sol AB	Initial Found Sol A	Initial Found Sol AB	Initial Found %R	Final Found Sol A	Final Found Sol AB	Final Found %R
Cadmium	0	1000	-1	916 0	91 6	0		
Lead	0	50	-1	46 6	93 2			
Zinc	0	1000	-1	982 8	98 3			

FORM IV - IN

U S EPA - CLP
5A
SPIKE SAMPLE RECOVERY

Client SAMPLE ID

W-08-FM

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_
Matrix __WATER_____ Level (low/med) _LOW____
% Solids for Sample __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

Analyte	Control Limit %R	Spiked Sample Result (SSR)	C	Sample Result (SR)	C	Spike Added (SA)	%R	Q	M
Cadmium	75-125	97 8980		48 1930		50 00	99 4		P
Lead		410 7750		342 3770		80 00	85 5		P
Zinc		3384 5560		2987 4300		500 00	79 4		P

Comments

FORM V (Part 1) - IN

ED_000859_00001631-00258

U S EPA - CLP
5A
SPIKE SAMPLE RECOVERY

Client SAMPLE ID

b Name SOUTHWEST_LABORATORIES___ Contract BARR_____ W-08-FS

b Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_
trix __WATER_____ Level (low/med) _LOW____
Solids for Sample __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

Analyte	Control Limit %R	Spiked Sample Result (SSR)	C	Sample Result (SR)	C	Spike Added (SA)	%R	Q	M
admium__	75-125_	98 2560_	_	48 1930	_	50 00	100 1	_	P_
ead_____		422 4060_	_	342 3770	_	80 00	100 0	_	P_
inc_____		3439 4920_	_	2987 4300	_	500 00	90 4	_	P_

omments

FORM V (Part 1) - IN

29

U S EPA - CLP
6
DUPLICATES

CLIENT SAMPLE ID

LCSWD

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

Matrix (soil/water) WATER Level (low/med) _LOW__

% Solids for Sample __0 0 % Solids for Duplicate ___0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

Analyte	Control Limit	Sample (S)	C	Duplicate (D)	C	RPD	Q	M
Cadmium		53 4970		52 1510		2 5		P
Lead		83 7580		80 9200		3 4		P
Zinc		543 5690		533 5610		1 9		P

FORM VI - IN

ED_000859_00001631-00260

U S EPA - CLP
6
DUPLICATES

CLIENT SAMPLE ID

W-08-FM

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

atrix (soil/water) WATER Level (low/med) _LOW__

Solids for Sample __0 0 % Solids for Duplicate ___0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

Analyte	Control Limit	Sample (S)	C	Duplicate (D)	C	RPD	Q	M
Cadmium		98 2560		97 8980		0 4		P
Lead		422 4060		410 7750		2 8		P
Zinc		3439 4920		3384 5560		1 6		P

FORM VI - IN

ED_000859_00001631-00261

U S EPA - CLP

7

LABORATORY CONTROL SAMPLE

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

Solid LCS Source _____

Aqueous LCS Source EPA0392_____

Analyte	Aqueous (ug/L) True	Found	%R	Solid (mg/kg) True	Found	C	Limits		%R
Cadmium	50 0	53 50	107 0						
Lead	80 0	83 76	104 7						
Zinc	500 0	543 57	108 7						

FORM VII - IN

ED_000859_00001631-00262

U S EPA - CLP
7
LABORATORY CONTROL SAMPLE

ıb Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ıb Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

ɔlıd LCS Source _____

ɟueous LCS Source EPA0392_____

Analyte	Aqueous (ug/L) True	Found	%R	Solid (mg/kg) True	Found	C	Limits		%R
Cadmium	50 0	52 15	104 3						
Lead	80 0	80 92	101 1						
Zinc	500 0	533 56	106 7						

FORM VII - IN

U S EPA - CLP

8
STANDARD ADDITION RESULTS

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

Concentration Units ug/L

EPA Sample No	An	0 ADD ABS	1 ADD CON	1 ADD ABS	2 ADD CON	2 ADD ABS	3 ADD CON	3 ADD ABS	Final Conc	r	Q

FORM VIII - IN ILM02 1

ED_000859_00001631-00264

U S EPA - CLP
9
ICP SERIAL DILUTION

Client SAMPLE ID

W-08-FL

ıb Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ıb Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

ıtrıx (soıl/water) WATER Level (low/med) LOW__

Concentratıon Unıts ug/L

Analyte	Initial Sample Result (I)	C	Serial Dilution Result (S)	C	% Differ-ence	Q	M
Cadmium	48 19		50 42		4 6		P
Lead	342 38		354 38		3 5		P
Zınc	2987 43		3346 41		12 0	E	P

FORM IX - IN

35

U S EPA - CLP
10
Instrument Detection Limits (Quarterly)

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____
Lab Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_
ICP ID Number TJA_ET2_____ Date 01/09/01
Flame AA ID Number _____
Furnace AA ID Number _____

Analyte	Wave-length (nm)	Back-ground	CRDL (ug/L)	IDL (ug/L)	M
Cadmium	226 50		6	0 3	P
Lead	220 35		10	1 6	P
Zinc	213 86		20	1 6	P

Comments

FORM X - IN

36

U S EPA - CLP
11A
ICP Interelement Correction Factors (Annually)

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

CP ID Number TJA ET2_____ Date 12/22/00

Analyte	Wave-length (nm)	Interelement Correction Factors for Al	Ca	Fe	Mg	BA_
Cadmium__	226 50__	0 0000000	0 0000000	0 0000830	0 0000000	0 0000000
Lead_____	220 35__	0 0005180	0 0000000	0 0000780	0 0000000	0 0000000
Zinc_____	213 86__	0 0000000	0 0000000	0 0000820	0 0000420	0 0000000

omments

FORM XI (Part 1) - IN

U S EPA - CLP
11B
ICP Interelement Correction Factors (Annually)

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

ICP ID Number TJA ET2_____ Date 12/22/00

Analyte	Wave-length (nm)	Interelement Correction Factors for CO_	CR_	CU_	MN_	NI_
Cadmium	226 50	-0 0001570	0 0000000	0 0000000	0 0000000	0 0000000
Lead	220 35	-0 0012700	0 0000000	0 0000000	0 0000000	0 0000000
Zinc	213 86	0 0000000	0 0000000	0 0005230	0 0000000	0 0041950

Comments

FORM XI (Part 2) - IN

U S EPA - CLP
11B
ICP Interelement Correction Factors (Annually)

ıb Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ıb Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

P ID Number TJA ET2_____ Date 12/22/00

Analyte	Wave-length (nm)	Interelement Correction Factors for SC_	SN_	TI_	V__	___
admium__	_226 50__	_0 0000000	_0 0000000_	_0 0000000	_0 0000000	
ıead_____	_220 35__	_0 0000000	_0 0000000_	-0 0005590	-0 0002600	
'ınc_____	_213 86__	_0 0000000	_0 0000000_	_0 0000000	_0 0000000	

ɔmments

FORM XI (Part 2) - IN

U S EPA - CLP
12
ICP Linear Ranges (Quarterly)

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332 SAS No _____ SDG No 47332_

ICP ID Number TJA ET2_____ Date 06/18/01

Analyte	Integ Time (sec)	Concentration (ug/L)	M
Cadmium__	15 00	10000 0_	P
Lead_____	15 00	60000 0_	P
Zinc_____	15 00	10000 0_	P

Comments

FORM XII - IN

U S EPA - CLP

13
PREPARATION LOG

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No _47332_ SAS No _____ SDG No 47332_

ethod P_

EPA Sample No	Preparation Date	Weight (gram)	Volume (mL)
LCSW	08/20/01		50
LCSWD	08/20/01		50
PBW	08/20/01		50
W-01-F	08/20/01		50
W-01-U	08/20/01		50
W-02-F	08/20/01		50
W-02-U	08/20/01		50
W-03-F	08/20/01		50
W-03-U	08/20/01		50
W-04-F	08/20/01		50
W-04-U	08/20/01		50
W-05-F	08/20/01		50
W-05-U	08/20/01		50
W-06-F	08/20/01		50
W-06-U	08/20/01		50
W-07-F	08/20/01		50
W-07-U	08/20/01		50
W-08-F	08/20/01		50
W-08-FM	08/20/01		50
W-08-FS	08/20/01		50

FORM XIII - IN ILM02 1

ANALYSIS RUN LOG

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

Instrument ID Number TJA ET2_____ Method P_

Start Date 08/22/01 End Date 08/22/01

Client Sample No	D/F	Time	% R	Analytes																						
				CD	PB	ZN																				
S0	1	0957		X	X	X																				
S	1	1001		X	X	X																				
S	1	1006		X	X	X																				
ICV	1	1011		X	X	X																				
ICB	1	1016		X	X	X																				
CRI	1	1021		X	X	X																				
ICSA	1	1036		X	X	X																				
ICSAB	1	1041		X	X	X																				
CCV	1	1046		X	X	X																				
CCB	1	1051		X	X	X																				
PBW	1	1056		X	X	X																				
LCSW	1	1100		X	X	X																				
[illegible]WD	1	1105		X	X	X																				
W-01-U	1	1110		X	X																					
W-01-F	1	1115		X	X																					
W-02-U	1	1120		X	X	X																				
W-02-F	1	1124		X	X	X																				
W-03-U	1	1129		X	X	X																				
ZZZZZZ	1	1152																								
CCV	1	1157		X	X	X																				
CCB	1	1202		X	X	X																				
W-03-F	1	1206		X	X	X																				
W-04-U	1	1211		X	X																					
W-04-F	1	1216		X	X																					
W-05-U	1	1221		X	X																					
W-05-F	1	1226		X	X	X																				
W-06-U	1	1230		X	X	X																				
W-06-F	1	1235		X	X	X																				
ZZZZZZ	1	1258																								
CCV	1	1303		X	X	X																				
CCB	1	1308		X	X	X																				
W-07-U	1	1312		X	X	X																				

FORM XIV - IN

42

ANALYSIS RUN LOG

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47332_ SAS No _____ SDG No 47332_

nstrument ID Number TJA ET2_____ Method P_

tart Date 08/22/01 End Date 08/22/01

Client Sample No	D/F	Time	% R	Analytes																							
				CD	PB	ZN																					
N-07-F	1	1317		X	X	X																					
N-08-F	1	1322		X	X	X																					
N-08-FS	1	1327		X	X	X																					
N-08-FM	1	1332		X	X	X																					
N-08-FL	5	1336		X	X	X																					
ZZZZZZ	1	1400																									
CCV	1	1405		X	X	X																					
CCB	1	1410		X	X	X																					
N-01-U	5	1445				X																					
N-01-F	5	1455				X																					
N-04-U	5	1500				X																					
N-04-F	5	1504				X																					
N-05-U	2	1509				X																					
ZZZZZZ	1	1523																									
CCV	1	1528		X	X	X																					
CCB	1	1533		X	X	X																					

FORM XIV - IN

Chain-of-Custody

CHAIN OF CUSTODY RECORD

SOUTHWEST LABORATORY OF OKLAHOMA, INC
1700 W Albany Broks Arrow Oklahoma 74012 1421
Office 918 251 2858 Fax 918-251 2599

TM

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
Barr Eng	Ward Swanson	800-632-2277

P O or PROPOSAL NUMBER	PROJECT NAME
25/86/009/PTS	Rivermines 25/86/009/PTS/003

SAMPLER (Signature)

ANALYTICAL TESTS REQUESTED: Pb, Cd, Zn

1 of 2

SAMPLE NO	DATE	TIME	COMP	GRAB	LOCATION	MATRIX	NUMBER OF CONTAINERS	Pb, Cd, Zn	REMARKS
W-01-U	8/15/01	2 20 P		X		Water	1	X	SW 846 6010 W/ Minimum Detection
W-01-F	8/15/01	2'20 P		X			1	X	Limit of 4 ug/L
W 02 U	8/15/01	12 10 A		X			1	X	
W-02 F	8/15/01	12:10 P		X			1	X	If you have any questions
W 03 U	8/15/01	11:20 A		X			1	X	on the analysis or Detection
W-03 F	8/15/01	11 20 A		X			1	X	Limits Call
W 04 W	8/15/01	1 49 P		X			1	X	Ward Swanson 800 632-2277
W-04 F	8/15/01	1 49 P		X			1	X	
W-05 U	8/15/01	2:05 P		X			1	X	
W-05 F	8/15/01	2 05 P		X			1	X	
W-06 U	8/15/01	9:26 A		X			1	X	
W-06 F	8/15/01	9:26 A		X			1	X	
W-07 U	8/15/01	10 30 A		X			1	X	
W-07 F	8/15/01	10:30 A		X			1	X	
W-08 U	8/15/01	11 20 A		X			1	X	
W-08 F	8/15/01	11 20 A		X			1	X	

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)
	8/16/01	1:00 P	

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED FOR LABORATORY BY (Signature)
	8-17-01	8 20	

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)

REMARKS: 14.6°C

[SR012 1192-03]

COOLER RECEIPT / SAMPLE LOG IN SHEET

COOLER RECEIPT / SAMPLE LOG IN SHEET (115-ATT2 WB1) / SWL-GA 115 REV 5 0 / GA 115-CRLOGIN F

LAB NAME SOUTHWEST LABORATORY OF OKLAHOMA

PAGE 1 OF 1

RECEIVED BY (PRINT NAME) JASON SPRIGGS

RECEIVED BY (SIGNATURE)

LOGGED IN BY (SIGNATURE)

REC D DATE 08/18/01

TIME REC D 08 20

LOG IN DATE 2001-08-18 08 38

PROJECT RIVERMINES

EPISODE 47332

SAMPLE DELIVERY GROUP 47332

Remarks

1 CUSTODY SEAL(S) Present/Absent
Intact/ Broken

2 CUSTODY SEALS NOS
N/A

3 CHAIN-OF CUSTODY Present/Absent
Sealed In Plastic? Yes/ No
Taped To Lid? Yes/ No
Properly Filled Out
(Ink Signed ETC)? Yes/ No

4 AIRBILL AirBill/ Sticker
Present/Absent

5 AIRBILL NO
790133728379

6 COOLER CONDITIONS
Enough Ice? Yes/ No
Type of Ice? Wet
Type of Packing? None

7 SAMPLE TAGS Present/Absent

8 SAMPLE CONDITION Intact/ Broken / Leaking

Bottles Sealed In Separate Plastic Bags? Yes/ No

Correct Containers Used For Tests Indicated? Yes/ No

Correct Preservative? Yes/ No

Sufficient Sample? Yes/ No

Labels Complete (I D Date Time Signature Preservative? Yes/ No

VOA Samples Without Bubbles? Yes/ No~

9 Does Information on Custody Records Labels Tags Agree? Yes/ No

10 RAD SCREEN WITH GIEGER COUNTER? Yes/ No

11 P O Called? Yes/ No

Client Sample #	Sample Fraction @	Assigned LAB#	Cooler I D	pH Check	ACID/ BASE LOT#	REMARKS CONDITION OF SAMPLE SHIPMENT ETC
W 01 U	M	47332 01	08/17/01 1	N		14 6c
W-01 F		47332 02	08/17/01 1	N		14 6c
W-02 U		47332 03	08/17/01 1	N		14 6c
W 02 F		47332 04	08/17/01 1	N		14 6c
W 03 U		47332 05	08/17/01 1	N		14 6c
W 03 F		47332 06	08/17/01 1	N		14 6c
W-04 U		47332 07	08/17/01 1	N		14 6c
W-04-F		47332 08	08/17/01 1	N		14 6c
W 05-U		47332 09	08/17/01 1	N		14 6c
W 05-F		47332 10	08/17/01 1	N		14 6c
W 06-U		47332 11	08/17/01 1	N		14 6c
W-06 F		47332 12	08/17/01 1	N		14 6c
W-07 U		47332 13	08/17/01 1	N		14 6c
W-07 F		47332 14	08/17/01 1	N		14 6c
W 08 F		47332 15	08/17/01 1	N		14 6c
W-08 F		47332 16	08/17/01 1	N		14 6c
W 08 F		47332 17	08/17/01 1	N		14 6c

Contact PO and attach record of resolution

@ Sample Fractions B=SV GC/MS V= VOA GC/MS or GC P=Pesticide H=Herbicide D=Dioxin A=Air I=Inorganics C=Cyanide M=Metals R=Radiochemistry

~ Note samples with bubbles under remarks section

Attachment 45

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

August 29, 2001

Greg Patton
BARR ENGINEERING
3236 Emerald Lane
Jefferson City, MO 65109

RECEIVED
SEP - 4 2001
BARR ENGINEERING CO

Project/Location	**RIVERMINES**
SDG ID	**47333**
SWLO ID	47333 01 – 47333 15

Dear Mr Patton

Enclosed please find the forms package for a portion of your water samples received August 18 2001 for the above-referenced project

Thank you for choosing Southwest Laboratory If you should have any questions or require additional information, please do not hesitate to call

Sincerely,

Randy Staggs
Project Officer

RES/sle

Enclosure

We certify that the following report meets all required NELAC reporting standards as specified in NELAC 5 13 July 1 1999 Any deviation or variance is noted in the case narrative(s) and estimated uncertainties regarding these analyses are presented in the Quality Control Section of this report

1700 West Albany • Broken Arrow OK 74012 1421 • Office (918) 251 2858 • Fax (918) 251-2599

SOUTHWEST LABORATORY OF OKLAHOMA, INC
1700 West Albany / Broken Arrow Oklahoma 74012 / Office (918) 251 2858 / Fax (918) 251 2599

SDG NARRATIVE

CONTRACT BARR **DATE August 28, 2001**
SDG 47333 **EPISODE NO 47333**

INORGANIC METAL FRACTION

Thirteen water samples plus one matrix spike and one matrix spike duplicate were submitted for ICP analysis No major problems occurred during the digestion or analysis of these samples Please see the DC-1 (Sample Log-In Sheet) for sample conditions and cooler temperatures at receipt The sample's analyses were completed according to the following

SWL SOP #	Method SOP is based
SWL-IN-205	SW846 3010A / 6010B

The cover page of the Inorganic Analyses Data Package cross-references client and laboratory sample ID's Manual integration was not used for the data presented in this Inorganic Analyses Data Package

Initial and Continuing Calibration Checks No problems

Linearity near the CRDL (CRA & CRI) All elements were within QC limits

Preparation Blank Zinc showed low level concentrations below the Contract Required Detection Limit in the Preparation Blank No action required

Lab Control Spikes No problems

Matrix Spikes No problems

Duplicate(s) (LCSD and MSD) No problems

Serial Dilution (ICP) No problems

Sincerely,

Steve L Markham
Inorganic Program Manager

U S EPA - CLP

COVER PAGE - INORGANIC ANALYSES DATA PACKAGE

Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

SOW No SW846__

EPA Sample No	Lab Sample ID
_BW-01-F_____	_47333 12_____
_BW-01-U_____	_47333 11_____
_W-08-U_____	_47333 13_____
_W-09-F_____	_47333 02_____
_W-09-U_____	_47333 01_____
_W-10-F_____	_47333 04_____
_W-10-U_____	_47333 03_____
_W-11-F_____	_47333 06_____
_W-11-U_____	_47333 05_____
_W-12-F_____	_47333 08_____
_W-12-U_____	_47333 07_____
_W-13-F_____	_47333 10_____
_W-13-U_____	_47333 09_____
_W-08-US_____	_47333 14S_____
_W-08-UM_____	_47333 15SD_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Were ICP interelement corrections applied ? Yes/No YES

Were ICP background corrections applied ? Yes/No YES
If yes - were raw data generated before application of background corrections ? Yes/No NO_

Comments
____BATCH_ID_NUMBER_-_ICP _01082013_____

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature

Signature Steve L Markham Name Steve L Markham

Date 08/28/01 Title Inorganics Program Manager

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

BW-01-F

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333_ SAS No _____ SDG No 47333_

atrix (soil/water) WATER Lab Sample ID 47333 12

evel (low/med) LOW__ Date Received 08/18/01

Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium__	0 30	U		P_
7439-92-1	Lead_____	1 6	U		P_
7440-66-6	Zinc_____	2 1	B		P_

olor Before COLORLESS Clarity Before CLEAR_ Texture _____

olor After COLORLESS Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

BW-01-U

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333_ SAS No _____ SDG No 47333_

Matrix (soil/water) WATER Lab Sample ID 47333 11

Level (low/med) LOW__ Date Received 08/18/01

% Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	0 30	U		P
7439-92-1	Lead	1 6	U		P
7440-66-6	Zinc	4 3	B		P

Color Before COLORLESS Clarity Before CLEAR_ Texture _____

Color After COLORLESS Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

4

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-08-U

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333_ SAS No _____ SDG No 47333_

atrix (soil/water) WATER Lab Sample ID 47333 13

evel (low/med) LOW__ Date Received 08/18/01

Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	51 3			P
7439-92-1	Lead	365			P
7440-66-6	Zinc	2950			P

olor Before COLORLESS Clarity Before CLEAR_ Texture _____

olor After COLORLESS Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-09-F

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333_ SAS No _____ SDG No 47333_

Matrix (soil/water) WATER Lab Sample ID 47333 02

Level (low/med) LOW__ Date Received 08/18/01

% Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	6 4			P
7439-92-1	Lead	21 2			P
7440-66-6	Zinc	459			P

Color Before COLORLESS Clarity Before CLEAR_ Texture _____

Color After COLORLESS Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-09-U

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333_ SAS No _____ SDG No 47333_

atrix (soil/water) WATER Lab Sample ID 47333 01

evel (low/med) LOW__ Date Received 08/18/01

Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium__	6 3			P_
7439-92-1	Lead_____	25 2			P_
7440-66-6	Zinc_____	417			P_

olor Before COLORLESS Clarity Before CLEAR_ Texture _____

olor After COLORLESS Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-10-F

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333_ SAS No _____ SDG No 47333_

Matrix (soil/water) WATER Lab Sample ID 47333 04

Level (low/med) LOW__ Date Received 08/18/01

% Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium__	23 8			P
7439-92-1	Lead_____	133			P
7440-66-6	Zinc_____	1670			P

Color Before COLORLESS Clarity Before CLEAR_ Texture _____

Color After COLORLESS Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

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U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-10-U

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333_ SAS No _____ SDG No 47333_

atrix (soil/water) WATER Lab Sample ID 47333 03

evel (low/med) LOW__ Date Received 08/18/01

Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium__	25 7			P_
7439-92-1	Lead_____	242			P_
7440-66-6	Zinc_____	1760			P_

olor Before COLORLESS Clarity Before CLEAR_ Texture _____

olor After COLORLESS Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-11-F

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333_ SAS No _____ SDG No 47333_

Matrix (soil/water) WATER Lab Sample ID 47333 06

Level (low/med) LOW__ Date Received 08/18/01

% Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	2 8	B		P
7439-92-1	Lead	1 6	U		P
7440-66-6	Zinc	480			P

Color Before COLORLESS Clarity Before CLEAR_ Texture _____

Color After COLORLESS Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

10

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-11-U

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333_ SAS No _____ SDG No 47333_

atrix (soil/water) WATER Lab Sample ID 47333 05

evel (low/med) LOW__ Date Received 08/18/01

Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	4 1	B		P
7439-92-1	Lead	3 2	B		P
7440-66-6	Zinc	495			P

olor Before COLORLESS Clarity Before CLEAR_ Texture _____

olor After COLORLESS Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-12-F

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333_ SAS No _____ SDG No 47333_

Matrix (soil/water) WATER Lab Sample ID 47333 08

Level (low/med) LOW__ Date Received 08/18/01

% Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	1 1	B		P
7439-92-1	Lead	68 3			P
7440-66-6	Zinc	47 6			P

Color Before COLORLESS Clarity Before CLEAR_ Texture _____

Color After COLORLESS Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

U S EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-12-U

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333_ SAS No _____ SDG No 47333_

atrix (soil/water) WATER Lab Sample ID 47333 07

evel (low/med) LOW__ Date Received 08/18/01

Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium	1 5	B		P
7439-92-1	Lead	109			P
7440-66-6	Zinc	71 2			P

olor Before COLORLESS Clarity Before CLEAR_ Texture _____

olor After COLORLESS Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-13-F

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333_ SAS No _____ SDG No 47333_

Matrix (soil/water) WATER Lab Sample ID 47333 10

Level (low/med) LOW__ Date Received 08/18/01

% Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium__	0 68	B		P_
7439-92-1	Lead_____	1 6	U		P_
7440-66-6	Zinc_____	10 9	B		P_

Color Before COLORLESS Clarity Before CLEAR_ Texture _____

Color After COLORLESS Clarity After CLEAR_ Artifacts _____

Comments

FORM I - IN ILM02 1

ED_000859_00001631-00291

U S EPA - CLP

1

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO

W-13-U

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333_ SAS No _____ SDG No 47333_

atrix (soil/water) WATER Lab Sample ID 47333 09

evel (low/med) LOW__ Date Received 08/18/01

Solids __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

CAS No	Analyte	Concentration	C	Q	M
7440-43-9	Cadmium__	1 2	B		P_
7439-92-1	Lead_____	4 8	B		P_
7440-66-6	Zinc_____	13 7	B		P_

olor Before COLORLESS Clarity Before CLEAR_ Texture _____

olor After COLORLESS Clarity After CLEAR_ Artifacts _____

omments

FORM I - IN ILM02 1

U S EPA - CLP

2A
INITIAL AND CONTINUING CALIBRATION VERIFICATION

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

Initial Calibration Source EPA-LV_____

Continuing Calibration Source IN VEN _____

Concentration Units ug/L

Analyte	Initial Calibration True	Initial Calibration Found	Initial Calibration %R(1)	Continuing Calibration True	Continuing Calibration Found	Continuing Calibration %R(1)	Continuing Calibration Found	Continuing Calibration %R(1)	M
Cadmium	125 0	128 34	102 7	500 0	503 66	100 7	507 53	101 5	P
Lead	250 0	255 62	102 2	500 0	504 84	101 0	506 09	101 2	P
Zinc	250 0	257 70	103 1	500 0	506 79	101 4	511 06	102 2	P

FORM II (PART 1) - IN

ED_000859_00001631-00293

U S EPA - CLP

2A
INITIAL AND CONTINUING CALIBRATION VERIFICATION

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

nitial Calibration Source EPA-LV_____

ontinuing Calibration Source IN VEN _____

Concentration Units ug/L

Analyte	Initial Calibration True	Initial Calibration Found	Initial Calibration %R(1)	Continuing Calibration True	Continuing Calibration Found	Continuing Calibration %R(1)	Continuing Calibration Found	Continuing Calibration %R(1)	M
Cadmium				500 0	501 98	100 4	521 25	104 2	P
Lead				500 0	501 11	100 2	516 13	103 2	P
Zinc				500 0	506 97	101 4	523 57	104 7	P

FORM II (PART 1) - IN

U S EPA - CLP

2B
CRDL STANDARD FOR AA AND ICP

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

AA CRDL Standard Source _____

ICP CRDL Standard Source IN VEN _____

Concentration Units ug/L

Analyte	CRDL Standard for AA			CRDL Standard for ICP				
					Initial		Final	
	True	Found	%R	True	Found	%R	Found	%R
Cadmium				6 0	6 36	106 0		
Lead				3 0	10 59	353 0		
Zinc				20 0	19 86	99 3		

FORM II (PART 2) - IN

ED_000859_00001631-00295

U S EPA - CLP
3
BLANKS

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

reparation Blank Matrix (soil/water) WATER

reparation Blank Concentration Units (ug/L or mg/kg) UG/L_

Analyte	Initial Calib Blank (ug/L)	C	Continuing Calibration Blank (ug/L) 1	C	2	C	3	C	Prepa-ration Blank	C	M
Cadmium	0 3	U	0 3	U	0 3	U	0 3	U	0 30	U	P
Lead	1 6	U	1 6	U	1 6	U	1 6	U	1 60	U	P
Zinc	1 6	U	1 6	U	1 6	U	1 6	U	5 84	B	P

FORM III - IN

U S EPA - CLP
3
BLANKS

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

Preparation Blank Matrix (soil/water) _____

Preparation Blank Concentration Units (ug/L or mg/kg) _____

Analyte	Initial Calib Blank (ug/L)	C	Continuing Calibration Blank (ug/L) 1	C	2	C	3	C	Prepa-ration Blank	C	M
Cadmium			0 3	U							P
Lead			1 6	U							P
Zinc			1 6	U							P

FORM III - IN

ED_000859_00001631-00297

U S EPA - CLP
4
ICP INTERFERENCE CHECK SAMPLE

ıb Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ıb Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

'P ID Number TJA ET2_____ ICS Source EPA-LV91____

Concentratıon Unıts ug/L

Analyte	True Sol A	True Sol AB	Initial Found Sol A	Initial Found Sol AB	-R	Final Found Sol A	Final Found Sol AB	%R
Cadmıum	0	1000	-1	931 0	93 1	0		
Lead	0	50	3	49 2	98 4			
Zınc	0	1000	-1	991 6	99 2			

FORM IV - IN

ED_000859_00001631-00298

U S EPA - CLP
5A
SPIKE SAMPLE RECOVERY

Client SAMPLE ID

W-08-UM

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_
Matrix __WATER_____ Level (low/med) _LOW____
% Solids for Sample __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

Analyte	Control Limit %R	Spiked Sample Result (SSR)	C	Sample Result (SR)	C	Spike Added (SA)	%R	Q	M
Cadmium__	75-125_	102 2380_	_	51 3180	_	50 00	101 8	_	P_
Lead_____		442 6390_	_	365 1730	_	80 00	96 8	_	P_
Zinc_____		3418 6920_	_	2951 8820	_	500 00	93 4	_	P_

Comments

FORM V (Part 1) - IN

ED_000859_00001631-00299

U S EPA - CLP
5A
SPIKE SAMPLE RECOVERY

Client SAMPLE ID

W-08-US

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_
atrix __WATER_____ Level (low/med) _LOW____
Solids for Sample __0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

Analyte	Control Limit %R	Spiked Sample Result (SSR)	C	Sample Result (SR)	C	Spike Added (SA)	%R	Q	M
Cadmium	75-125	109 1240		51 3180		50 00	115 6		P
Lead		474 8160		365 1730		80 00	137 1		P
Zinc		3662 3610		2951 8820		500 00	142 1		P

mments

FORM V (Part 1) - IN

U S EPA - CLP
6
DUPLICATES

CLIENT SAMPLE ID

LCSWD

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

Matrix (soil/water) WATER Level (low/med) _LOW__

% Solids for Sample __0 0 % Solids for Duplicate ___0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

Analyte	Control Limit	Sample (S)	C	Duplicate (D)	C	RPD	Q	M
Cadmium		53 9040		51 8500		3 9		P
Lead		85 5490		81 3720		5 0		P
Zinc		544 7950		526 9910		3 3		P

FORM VI - IN

ED_000859_00001631-00301

U S EPA - CLP
6
DUPLICATES

CLIENT SAMPLE ID

W-08-UM

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

atrix (soil/water) WATER Level (low/med) _LOW__

Solids for Sample __0 0 Solids for Duplicate ___0 0

Concentration Units (ug/L or mg/kg dry weight) UG/L_

Analyte	Control Limit	Sample (S)	C	Duplicate (D)	C	RPD	Q	M
Cadmium		109 1240		102 2380		6 5		P
Lead		474 8160		442 6390		7 0		P
Zinc		3662 3610		3419 0000		6 9		P

FORM VI - IN

ED_000859_00001631-00302

U S EPA - CLP
7
LABORATORY CONTROL SAMPLE

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

Solid LCS Source _____

Aqueous LCS Source EPA0392_____

Analyte	Aqueous (ug/L) True	Found	%R	Solid (mg/kg) True	Found	C	Limits		%R
Cadmium	50 0	53 90	107 8						
Lead	80 0	85 55	106 9						
Zinc	500 0	544 79	109 0						

FORM VII - IN

ED_000859_00001631-00303

U S EPA - CLP
7
LABORATORY CONTROL SAMPLE

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

olid LCS Source _____

queous LCS Source EPA0392_____

Analyte	Aqueous (ug/L) True	Found	%R	Solid (mg/kg) True	Found	C	Limits		%R
Cadmium	50 0	51 85	103 7						
Lead	80 0	81 37	101 7						
Zinc	500 0	526 99	105 4						

FORM VII - IN

U S EPA - CLP

8
STANDARD ADDITION RESULTS

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

Concentration Units ug/L

EPA Sample No	An	0 ADD ABS	1 ADD CON	1 ADD ABS	2 ADD CON	2 ADD ABS	3 ADD CON	3 ADD ABS	Final Conc	r	Q

FORM VIII - IN ILM02 1

ED_000859_00001631-00305

U S EPA - CLP
9
ICP SERIAL DILUTION

Client SAMPLE ID

W-08-U

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

atrix (soil/water) WATER Level (low/med) LOW__

Concentration Units ug/L

Analyte	Initial Sample Result (I)	C	Serial Dilution Result (S)	C	% Difference	Q	M
Cadmium	51 32		51 70		0 7		P
Lead	365 17		369 47		1 2		P
Zinc	2951 88		3094 87		4 8		P

FORM IX - IN

ED_000859_00001631-00306

U S EPA - CLP
10
Instrument Detection Limits (Quarterly)

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____
Lab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_
ICP ID Number TJA_ET2_____ Date 01/09/01
Flame AA ID Number _____
Furnace AA ID Number _____

Analyte	Wave-length (nm)	Back-ground	CRDL (ug/L)	IDL (ug/L)	M
Cadmium	226 50		6	0 3	P
Lead	220 35		10	1 6	P
Zinc	213 86		20	1 6	P

Comments

FORM X - IN

U S EPA - CLP
11A
ICP Interelement Correction Factors (Annually)

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

CP ID Number TJA ET2_____ Date 02/02/01

Analyte	Wave-length (nm)	Interelement Correction Factors for Al	Ca	Fe	Mg	BA_
Cadmium__	_226 50__	_0 0000000	_0 0000000_	_0 0000990	_0 0000000	_0 0000000
Lead_____	_220 35__	_0 0007370	_0 0000000_	_0 0000780	_0 0000000	_0 0000000
Zinc_____	_213 86__	_0 0000000	_0 0000000_	_0 0000000	_0 0000460	_0 0000000

omments

FORM XI (Part 1) - IN

U S EPA - CLP
11B
ICP Interelement Correction Factors (Annually)

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

ICP ID Number TJA ET2_____ Date 02/02/01

Analyte	Wave-length (nm)	Interelement Correction Factors for CO_	CR_	CU_	MN_	NI_
Cadmium__	_226 50__	-0 0001220	_0 0000000_	_0 0000000	_0 0000000	_0 0000000
Lead_____	_220 35__	-0 0018900	_0 0000000_	_0 0000000	_0 0000000	_0 0002060
Zinc_____	_213 86__	_0 0000000	_0 0000000_	_0 0000000	_0 0000000	_0 0049080

Comments

FORM XI (Part 2) - IN

ED_000859_00001631-00309

U S EPA - CLP
11B
ICP Interelement Correction Factors (Annually)

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

CP ID Number TJA ET2_____ Date 02/02/01

Analyte	Wave-length (nm)	Interelement Correction Factors for TL_	V__	ZN_	___	___
Cadmium__	_226 50__	_0 0000000	_0 0000000_	_0 0000000		
Lead_____	_220 35__	_0 0000000	_0 0000000_	_0 0000000		
Zinc_____	_213 86__	_0 0000000	_0 0000000_	_0 0000000		

omments

FORM XI (Part 2) - IN

U S EPA - CLP
12
ICP Linear Ranges (Quarterly)

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333 SAS No _____ SDG No 47333_

ICP ID Number TJA ET2_____ Date 08/15/01

Analyte	Integ Time (sec)	Concentration (ug/L)	M
Cadmium	15 00	10000 0	P
Lead	15 00	60000 0	P
Zinc	15 00	10000 0	P

Comments

FORM XII - IN

ED_000859_00001631-00311

U S EPA - CLP

13
PREPARATION LOG

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No _47333_ SAS No _____ SDG No 47333_

ethod P_

EPA Sample No	Preparation Date	Weight (gram)	Volume (mL)
BW-01-F	08/20/01		50
BW-01-U	08/20/01		50
LCSW	08/20/01		50
LCSWD	08/20/01		50
PBW	08/20/01		50
W-08-U	08/20/01		50
W-08-UM	08/20/01		50
W-08-US	08/20/01		50
W-09-F	08/20/01		50
W-09-U	08/20/01		50
W-10-F	08/20/01		50
W-10-U	08/20/01		50
W-11-F	08/20/01		50
W-11-U	08/20/01		50
W-12-F	08/20/01		50
W-12-U	08/20/01		50
W-13-F	08/20/01		50
W-13-U	08/20/01		50

FORM XIII - IN ILM02 1

ED_000859_00001631-00312

ANALYSIS RUN LOG

Lab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

Lab Code SWOK__ Case No 47333_ SAS No _____ SDG No 47333_

Instrument ID Number TJA ET2_____ Method P_

Start Date 08/23/01 End Date 08/23/01

Client Sample No	D/F	Time	% R	Analytes																						
				CD	PB	ZN																				
S0	1	0906		X	X	X																				
S	1	0911		X	X	X																				
S	1	0916		X	X	X																				
ICV	1	0921		X	X	X																				
ICB	1	0925		X	X	X																				
CRI	1	0930		X	X	X																				
ICSA	1	0935		X	X	X																				
ICSAB	1	0940		X	X	X																				
CCV	1	0945		X	X	X																				
CCB	1	0950		X	X	X																				
[illegible]W	1	0954		X	X	X																				
[illegible]SW	1	0959		X	X	X																				
LCSWD	1	1004		X	X	X																				
W-09-U	1	1009		X	X	X																				
W-09-F	1	1014		X	X	X																				
W-10-U	1	1018		X	X	X																				
W-10-F	1	1023		X	X	X																				
W-11-U	1	1028		X	X	X																				
ZZZZZZ	1	1051																								
CCV	1	1055		X	X	X																				
CCB	1	1100		X	X	X																				
W-11-F	1	1105		X	X	X																				
W-12-U	1	1110		X	X	X																				
W-12-F	1	1115		X	X	X																				
W-13-U	1	1120		X	X	X																				
W-13-F	1	1124		X	X	X																				
BW-01-U	1	1129		X	X	X																				
BW-01-F	1	1134		X	X	X																				
ZZZZZZ	1	1157																								
CCV	1	1202		X	X	X																				
CCB	1	1206		X	X	X																				
W-08-U	1	1211		X	X	X																				

FORM XIV - IN

14

ANALYSIS RUN LOG

ab Name SOUTHWEST_LABORATORIES___ Contract BARR_____

ab Code SWOK__ Case No 47333_ SAS No _____ SDG No 47333_

nstrument ID Number TJA ET2_____ Method P_

tart Date 08/23/01 End Date 08/23/01

Client Sample No	D/F	Time	% R	Analytes																							
				CD	PB	ZN																					
W-08-US	1	1216		X	X	X																					
W-08-UM	1	1221		X	X	X																					
W-08-U	5	1226		X	X	X																					
ZZZZZZ	1	1246																									
CCV	1	1251		X	X	X																					
CCB	1	1256		X	X	X																					

FORM XIV - IN

ED_000859_00001631-00314

Chain-of-Custody

38
Km 9/29/01

CHAIN OF CUSTODY RECORD

SOUTHWEST LABORATORY OF OKLAHOMA, INC
1700 W Albany Broken Arrow Oklahoma 74012 1421
Office 918 251 2858 Fax 918 251 2599

TM

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
Barr Eng	Ward Swanson	800 632-2277

P O or PROPOSAL NUMBER	PROJECT NAME
25/86/009/PTS	Rivermines 25/86/009/PTS/003

SAMPLER (Signature)

ANALYTICAL TESTS REQUESTED

2 of 2

SAMPLE NO	DATE	TIME	COMP	GRAB	LOCATION	MATRIX	NUMBER OF CONTAINERS	Pb, Cd, Zn								REMARKS
W 09-U	8/15/01	11 45 A		X		Water	1	X								SW 846 6010 W/ Mnmum
W 09-F	8/15/01	11 45 A		X			1	X								Detection Limits of 4 ug/L
W-10-U	8/15/01	11 00 A		X			1	X								
W-10-F	8/15/01	11 00 A		X			1	X								If you have any questions
W-11 U	8/15/01	9 40 A		X			1	X								on the methods on Detection
W-11 F	8/15/01	9 40 A		X			1	X								Limits call
W-12 U	8/15/01	10 50 A		X			1	X								Ward Swanson 800 632-2277
W 12 F	8/15/01	10 50 A		X			1	X								
W-13 U	8/15/01	8 50 A		X			1	X								
W-13 F	8/15/01	8 50 A		X			1	X								
BW01 U	8/15/01	2 35 P		X			1	X								
BW01 F	8/15/01	2 35 P		X			1	X								

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)
	8/16/01	1100 P	

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED FOR LABORATORY BY (Signature)
	8-17-01	8 20	

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)

REMARKS: 146°C

[SR012 1192-03]

COOLER RECEIPT / SAMPLE LOG IN SHEET

COOLER RECEIPT / SAMPLE LOG-IN SHEET (115-ATT2.WB1) / SWL-GA-115 REV 5 0 / GA-115-CRLOGIN-F

LAB NAME SOUTHWEST LABORATORY OF OKLAHOMA

PAGE 1 OF 1

RECEIVED BY (PRINT NAME) JASON SPRIGGS

RECEIVED BY (SIGNATURE)

LOGGED IN BY (SIGNATURE)

REC'D DATE 08/18/01

TIME REC D 08 20

LOG-IN DATE 2001-08-18 08 51

PROJECT RIVERMINES

EPISODE 47333

SAMPLE DELIVERY GROUP 47333

Remarks

1 CUSTODY SEAL(S) Present/Absent
Intact/ Broken

2 CUSTODY SEALS NOS
N/A

3 CHAIN OF CUSTODY Present/Absent
Sealed In Plastic? Yes/ No
Taped To Lid? Yes/ No
Properly Filled Out
(Ink Signed ETC)? Yes/ No

4 AIRBILL AirBill/ Sticker
Present/Absent

5 AIRBILL NO
790133728379

6 COOLER CONDITIONS
Enough Ice? Yes/ No
Type of Ice? Wet
Type of Packing? None

7 SAMPLE TAGS Present/Absent

8 SAMPLE CONDITION Intact/ Broken / Leaking
Bottles Sealed In Separate Plastic Bags? Yes/ No
Correct Containers Used For Tests Indicated? Yes/ No
Correct Preservative? Yes/ No
Sufficient Sample? Yes/ No
Labels Complete (I D Date Time Signature Preservative? Yes/ No
VOA Samples Without Bubbles? Yes/ No~

9 Does Information on Custody Records Labels Tags Agree? Yes/ No

10 RAD SCREEN WITH GIEGER COUNTER? Yes/ No

1 P O Called? Yes/ No

Client Sample #	Sample Fraction @	Assigned LAB#	Cooler I D	pH Check	ACID/ BASE LOT#	REMARKS CONDITION OF SAMPLE SHIPMENT ETC
W 09-U	M	47333 01	08/18/01 1	N Y		14 6c
W-09 F		47333 02	08/18/01 1	N Y		14 6c
W 10-U		47333 03	08/18/01 1	N Y		14 6c
W 10 F		47333 04	08/18/01 1	N Y		14 6c
W 11 U		47333 05	08/18/01 1	N Y		14 6c
W 11 F		47333 06	08/18/01 1	N Y		14 6c
W 12 U		47333 07	08/18/01 1	N Y		14 6c
W 12 F		47333 08	08/18/01 1	N Y		14 6c
W 13-U		47333 09	08/18/01 1	N Y		14 6c
W 13 F		47333 10	08/18/01 1	N Y		14 6c
BW01-U		47333 11	08/18/01 1	N Y		14 6c
BW 01 F		47333 12	08/18/01 1	N Y		14 6c
W-08 U		47333 13	08/18/01 1	N Y		14 6c
W-08 U		47333 14	08/18/01 1	N Y		14 6c
W-08 U	V	47333 15	08/18/01 1	N Y		14 6c

Contact PO and attach record of resolution

@ Sample Fractions B=SV GC/MS V= VOA GC/MS or GC P=Pesticide H=Herbicide D=Dioxin A=Air I=Inorganics C=Cyanide M=Metals R=Radiochemistry

~ Note samples with bubbles under remarks section

The Doe Run Company
Rivermines/Elvins Mine Tailings Site

Geotechnical Laboratory Sample Information

Project Name Rivermines/Elvins Mine Tailings Site
Project Number 25/86 009 PTS
Contact Name Tim Skoglund
(952) 632 2779

Invoicing Deanna Selg
Barr Engineering Company
4700 West 77th Street
Minneapolis MN55435-4803
(952) 832 2933

General Description of Samples

Sample #	Boring	Depth	Type of Material	Sample #	Boring	Depth	Type of Material
G1	B1	Surface 25	Sand	G20	B8	50 – 55	Clay
G2	B1	30 – 45	Sand/Gravel	G21	B9	Surface 40	Sand/Silt
G3	B2	Surface 30	Sand	G22	B9	45 – 55	Sand
G4	B2	35 – 100	Sand/Gravel	G23	Surface Sample	0 5 1	Sand
G5	B3	Surface – 8	Sand	G24	Surface Sample	0 5 1	Sand
G6	B5	Surface 10	Sand	G25	Surface Sample	0 5 1	Sand
G7	Surface Sample	0 5 1	Sand	G26	Surface Sample	0 5 1	Sand
G8	Surface Sample	0 5 1	Sand	G27	Surface Sample	0 5 1	Sand
G9	Surface Sample	0 5 1	Sand	G28	B10	Surface 10	Sand
G10	B4	Surface 15	Sand	G29	Surface Sample	0 5 1	Sand
G11	B4	20 – 23	Clay	G30	Surface Sample	0 5 1	Sand
G12	B5	15 – 30	Slimes	G31	Surface Sample	0 5 1	Sand
G13	B5	35 – 65	Sand	G32	Surface Sample	0 5 1	Sand
G14	B5	70 – 73	Clay	G33	Surface Sample	0 5 1	Sand
G15	B6	Surface 43	Slimes	G34	B1	50 – 100	Sand/Gravel
G16	B6	48 – 63	Sand	G35	B6	68 – 83	Slimes
G17	B7	Surface 30	Sand	G36	B6	88 – 92	Clay
G18	B7	35 – 75	Sand/Gravel	G37	B9	60 – 64	Clay
G19	B8	Surface 45	Sand/Gravel	G38	B10	15 – 17	Clay

Instructions

1. Complete a sieve analysis on all of the samples
2. Complete a hydrometer on any sample with 25% or more passing the 200 sieve
3. Complete moisture content analysis on any sample with 25% or more passing the 200 sieve
4. Complete Atterberg limits on any sample with 25% or more passing the 200 sieve that shows characteristics of plasticity

Grain Size Distribution

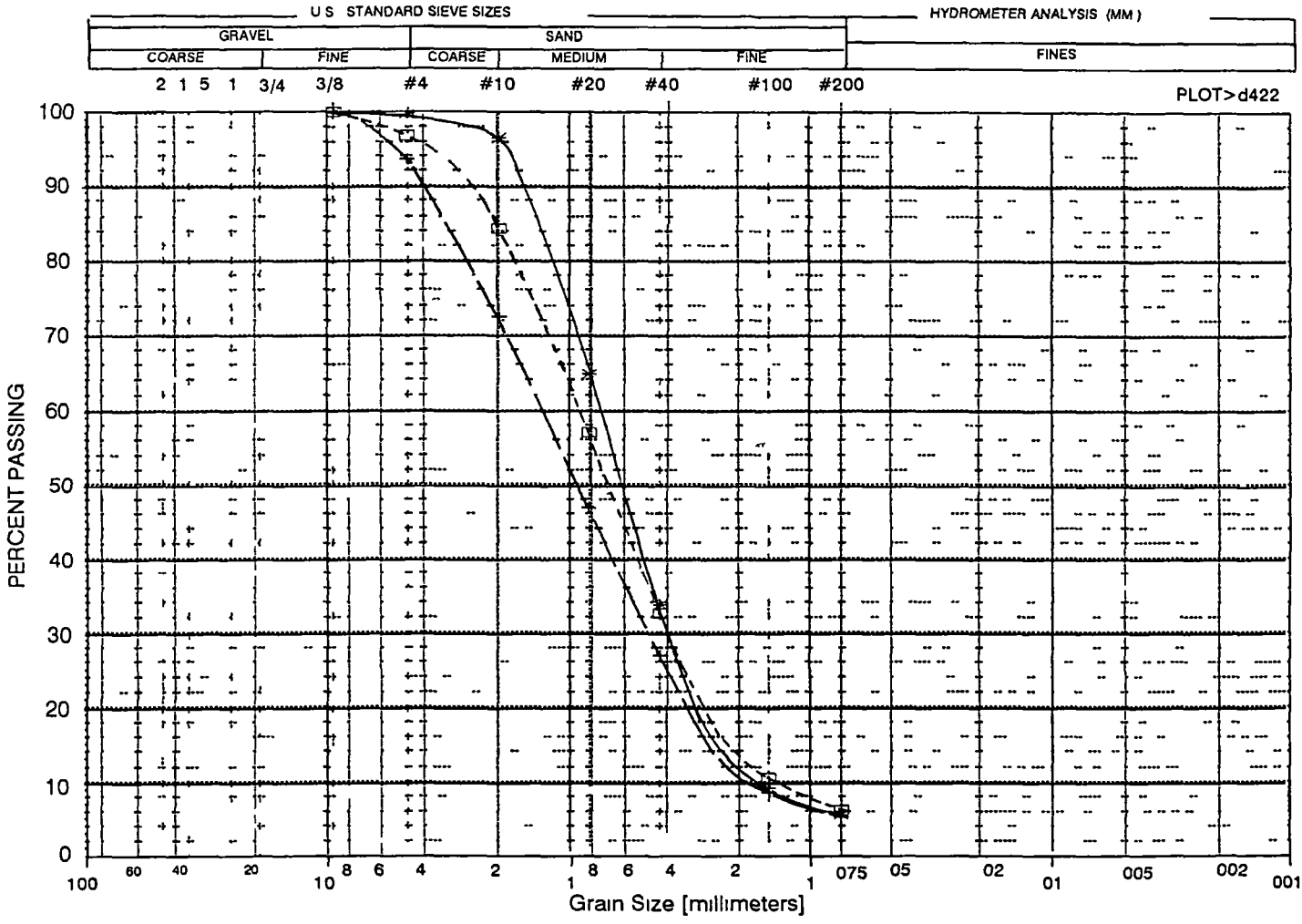
Job No 4263

PROJECT Rivermines/Elvins Mine Tailings Site # 25/86 009PTS

REPORTED TO Barr Engineering Company

Date 9-10 01

	Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
x	B 1	G 1	0 25	Bag	Sand w/silt medium to fine grained (SP SM/SP)
+	B 1	G 2	30 45	Bag	Sand w/silt and a little gravel medium grained (SP SM/SP)
▯	B 2	G 3	0 30	Bag	Sand w/silt and a trace of gravel medium grained (SP SM)



OTHER TESTS

	x	+	▯
Liquid Limit (%)			
Plastic Limit (%)			
Plasticity Index			
Water Content (%)	4 9	6 6	5 7
Dry Density [pcf]			
Specific Gravity			
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			

A sumed V I

PERCENT PASSING

	x	+	▯
Mass [gm]	2479	2038	2575
2			
1 1/2			
1			
3/4			
3/8	100 0	100 0	100 0
#4	99 7	93 6	96 8
#10	96 5	72 5	84 4
#20	64 8	46 8	56 9
#40	33 6	27 0	32 5
#100	9 1	8 4	10 4
#200	5 5	5 2	6 1

ASTM D422 S 6V6 S 1

	x	+	▯
D_{60}			
D_{30}			
D_{10}			
C_u			
C_c			

Remarks

F'l 4263

ARS

9301 Bryant Avenue South Suite 107

SOIL ENGINEERING TESTING INC

Bloomington Minnesota 55420 3436

ED_000859_00001631-00319

Grain Size Distribution

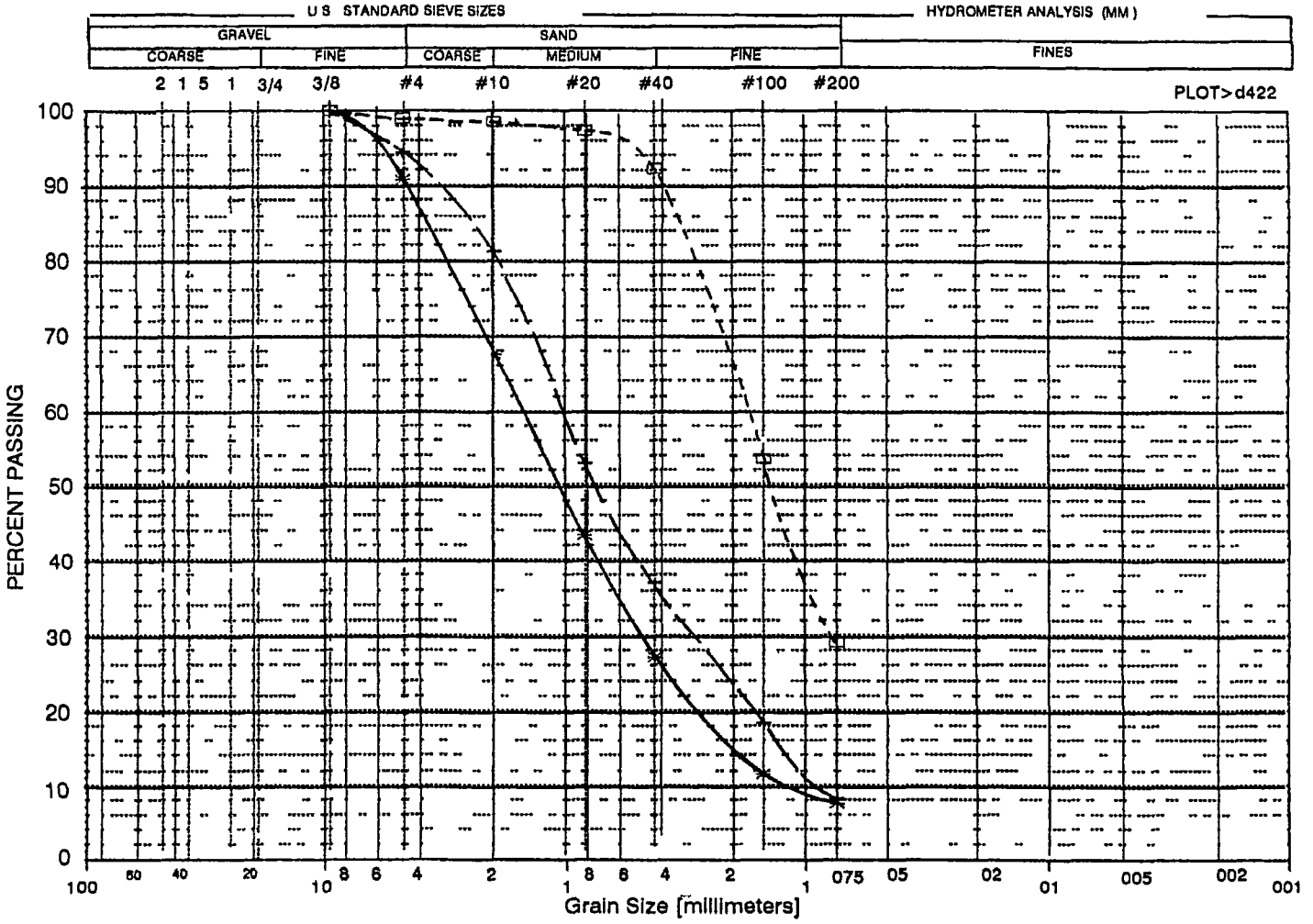
Job No 4263

PROJECT Rivermines/Elvins Mine Tailings Site # 25/86 009PTS

REPORTED TO Barr Engineering Company

Date 9-10 01

	Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
	B 2	G 4	35 100	Bag	Sand w/silt and a little gravel medium grained (SP SM)
+	B 3	G 5	0 8	Bag	Sand w/silt and a little gravel medium to fine grained (SP SM)
▯	B 5	G 6	0 10	Bag	Silty sand (SM)



OTHER TESTS

	x	+	▯
Liquid Limit (%)			
Plastic Limit (%)			
Plasticity Index			
Water Content (%)	4 4	11 2	12 5
Dry Density [pcf]			
Specific Gravity			
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			

As med Val e

PERCENT PASSING

	x	+	▯
Mass [gm]	4375	1342	1571
2			
1 1/2			
1			
3/4			
3/8	100 0	100 0	100 0
#4	90 6	94 4	99 0
#10	67 5	81 2	98 4
#20	43 3	53 0	97 4
#40	27 0	37 0	92 2
#100	11 4	18 3	53 5
#200	7 4	8 1	29 0

ASTM D422 Sieve Set

	x	+	▯
D_{60}			
D_{30}			
D_{10}			
C_u			
C_c			

Remarks

F1 4263

ARS

9301 Bryant Avenue South Suite 107

SOIL ENGINEERING TESTING INC

Bloomington Minnesota 55420 3436

Grain Size Distribution

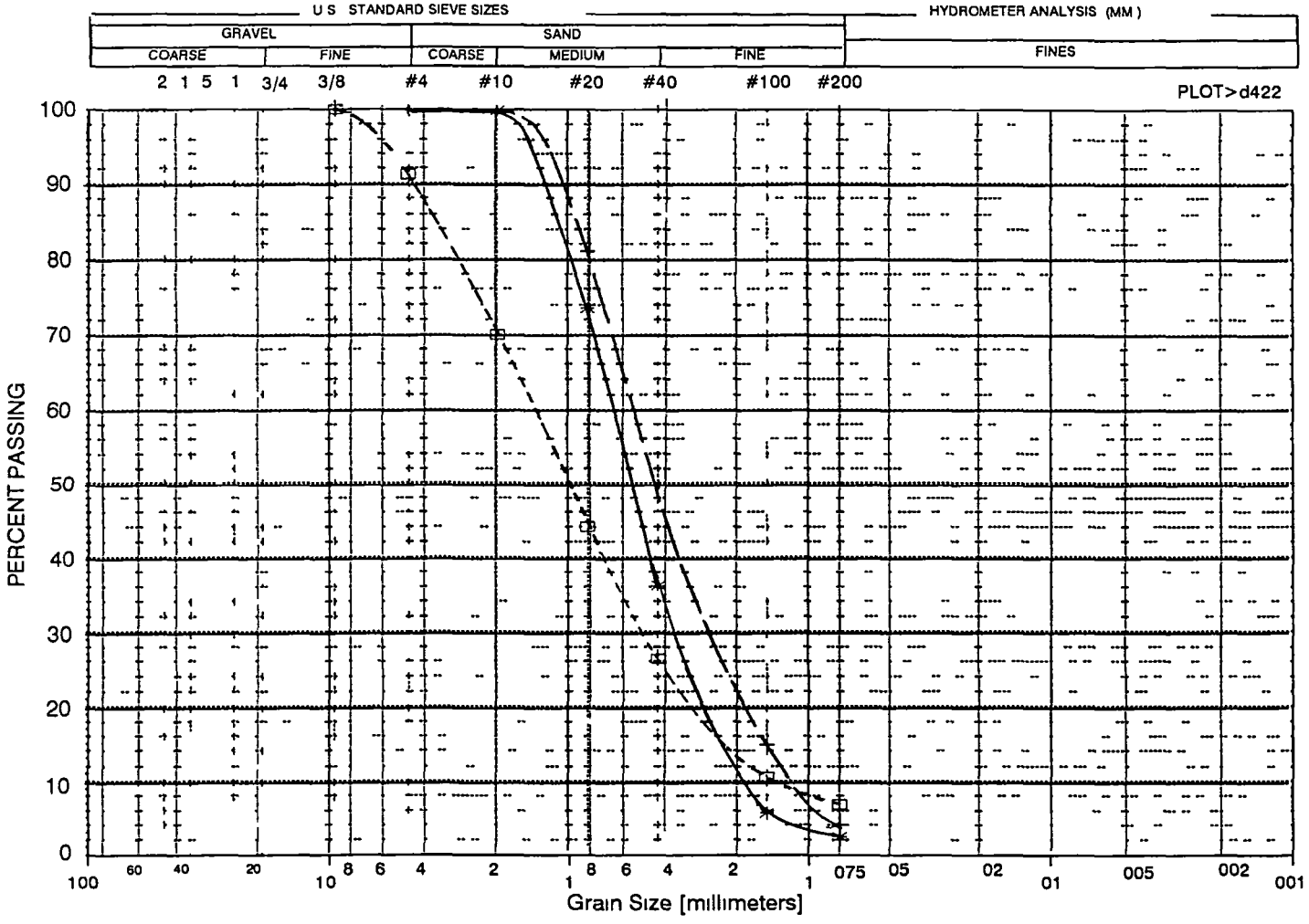
Job No 4263

PROJECT Rivermines/Elvins Mine Tailings Site # 25/86 009 PTS

REPORTED TO Barr Engineering Company

Date 9 10 01

	Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
x	Surface Sample	G 7	0 5 1	Bag	Sand medium to fine grained (SP)
+	Surface Sample	G 8	0 5 1	Bag	Sand medium grained (SP)
▯	Surface Sample	G 9	0 5 1	Bag	Sand w/silt and a little gravel medium grained (SP SM)



OTHER TESTS

	x	+	▯
Liquid Limit (%)			
Plastic Limit (%)			
Plasticity Index			
Water Content (%)	3 8	4 9	3 2
Dry Density [pcf]			
Specific Gravity			
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			

A sumed V I

PERCENT PASSING

Mass [gm]	x	+	▯
	4747	4483	5709
2			
1 1/2			
1			
3/4			
3/8	100 0	100 0	100 0
#4	100 0	100 0	91 2
#10	99 8	99 8	70 0
#20	73 4	81 0	43 9
#40	36 1	49 7	26 3
#100	5 6	14 8	10 5
#200	2 3	4 0	6 8

ASTM D422 S t

	x	+	▯
D_{60}			
D_{30}			
D_{10}			
C_u			
C_c			

Remarks

F'l 42632

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Bloomington Minnesota 55420 3436

ED_000859_00001631-00321

Grain Size Distribution

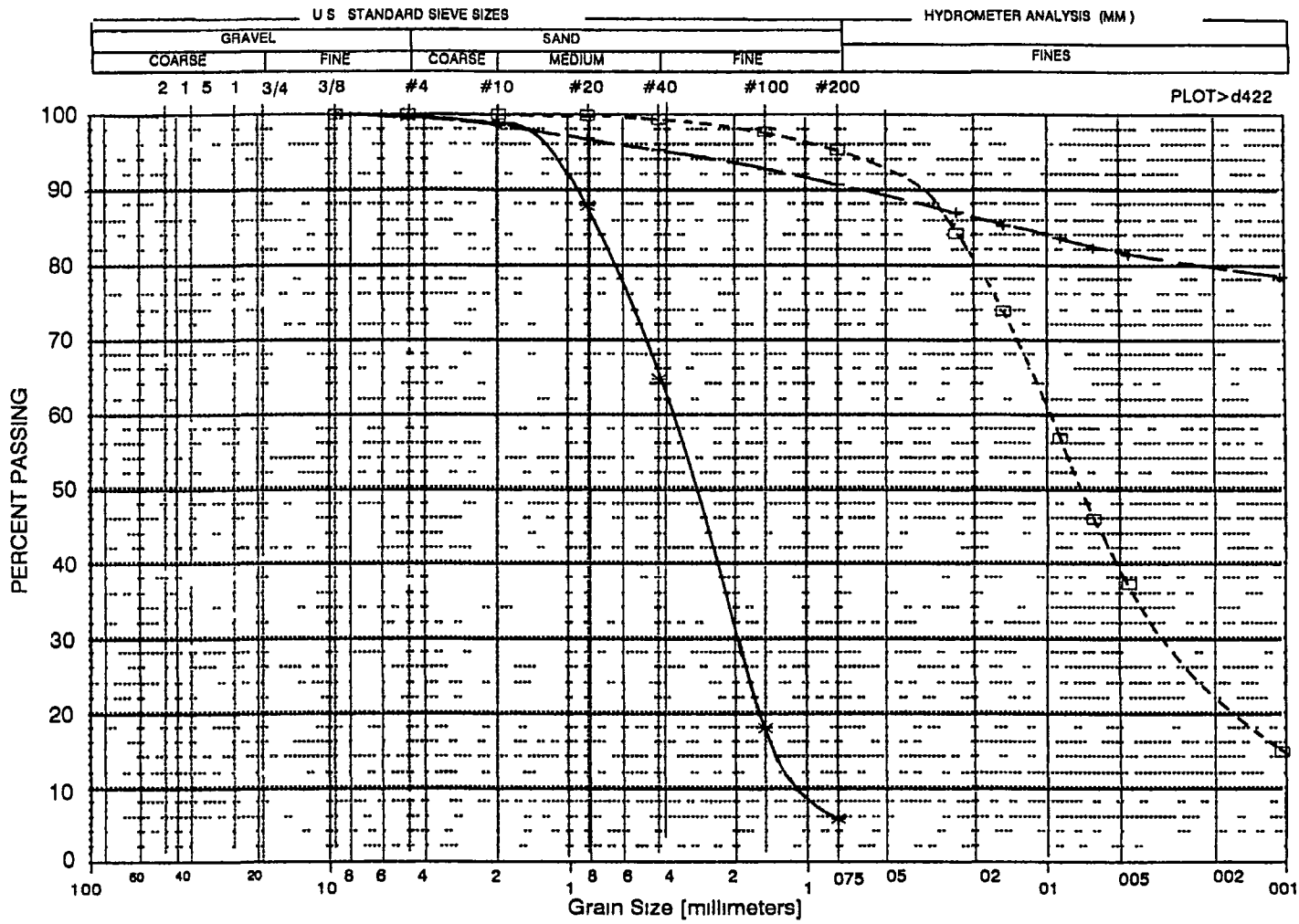
Job No 4263

PROJECT Rivermines/Elvins Mine Tailings Site # 25/86 009 PTS

REPORTED TO Barr Engineering Company

Date 9-10 01

Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
B 4	G 10	0 15	Bag	Sand w/silt fine to medium grained (SP SM)
B 4	G 11	20 23	Bag	Fat clay (CH)
B 5	G 12	15 30	Bag	Lean clay (CL/CL ML)



OTHER TESTS

	x	+	▯
Liquid Limit (%)		83 6	24 1
Plastic Limit (%)		36 5	16 3
Plasticity Index		47 1	7 8
Water Content (%)	10 5	32 1	29 0
Dry Density [pcf]			
Specific Gravity		2 75*	2 87
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			

Ass med Val e

PERCENT PASSING

	x	+	▯
Mass [gm]	1742	139	2012
2			
1 1/2			
1			
3/4			
3/8	100 0	100 0	100 0
#4	99 6	99 6	100 0
#10	98 5	98 4	99 9
#20	87 8	96 6	99 7
#40	64 6	95 1	99 3
#100	17 9	92 7	97 6
#200	5 7	90 6	95 2

ASTM D422 Sieve Set

	x	+	▯
D_{60}			
D_{30}			
D_{10}			
C_u			
C_c			

Remarks

F'I 42633

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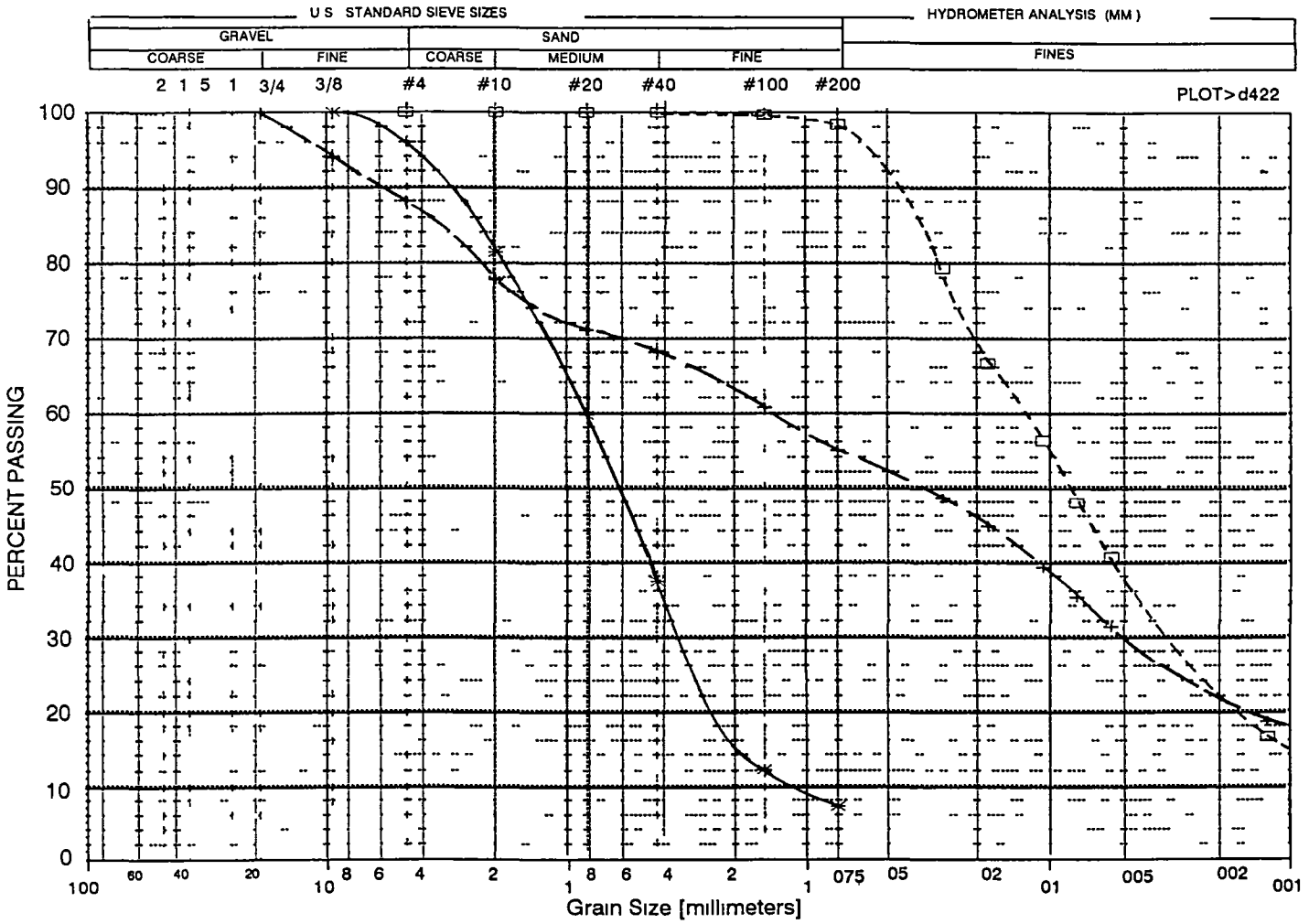
Bloomington Minnesota 55420 3436

Grain Size Distribution

Job No 4263

PROJECT Rivermines/Elvins Mine Tailings Site # 25/86 009 PTS	
REPORTED TO Barr Engineering Company	Date 9 11 01

	Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
x	B 5	G 13	35 65	Bag	Sand w/silt and a trace of gravel medium to fine grained (SP SM)
+	B 5	G 14	70 73	Bag	Sandy lean clay w/a little gravel (CL)
▯	B 6	G 15	0 43	Bag	Lean clay (CL)



OTHER TESTS	x	+	▯
Liquid Limit (%)		43 2	25 7
Plastic Limit (%)		19 8	15 1
Plasticity Index		23 4	10 6
Water Content (%)	4 9	32 0	24 5
Dry Density [pcf]			
Specific Gravity		2 75*	2 88
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			

A m d Val e

PERCENT PASSING	x	+	▯
Mass [gm]	2500	241	425
2			
1 1/2			
1			
3/4	100 0	100 0	
3/8	100 0	93 8	
#4	96 0	88 0	100 0
#10	81 3	77 7	100 0
#20	59 6	70 9	100 0
#40	37 3	68 1	100 0
#100	12 1	60 5	99 6
#200	7 1	54 8	98 2

ASTM D422 S e e Set

	x	+	▯
D_{60}			
D_{30}			
D_{10}			
C_u			
C_c			

Remarks

F1 42634

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ED_000859_00001631-00323

Grain Size Distribution

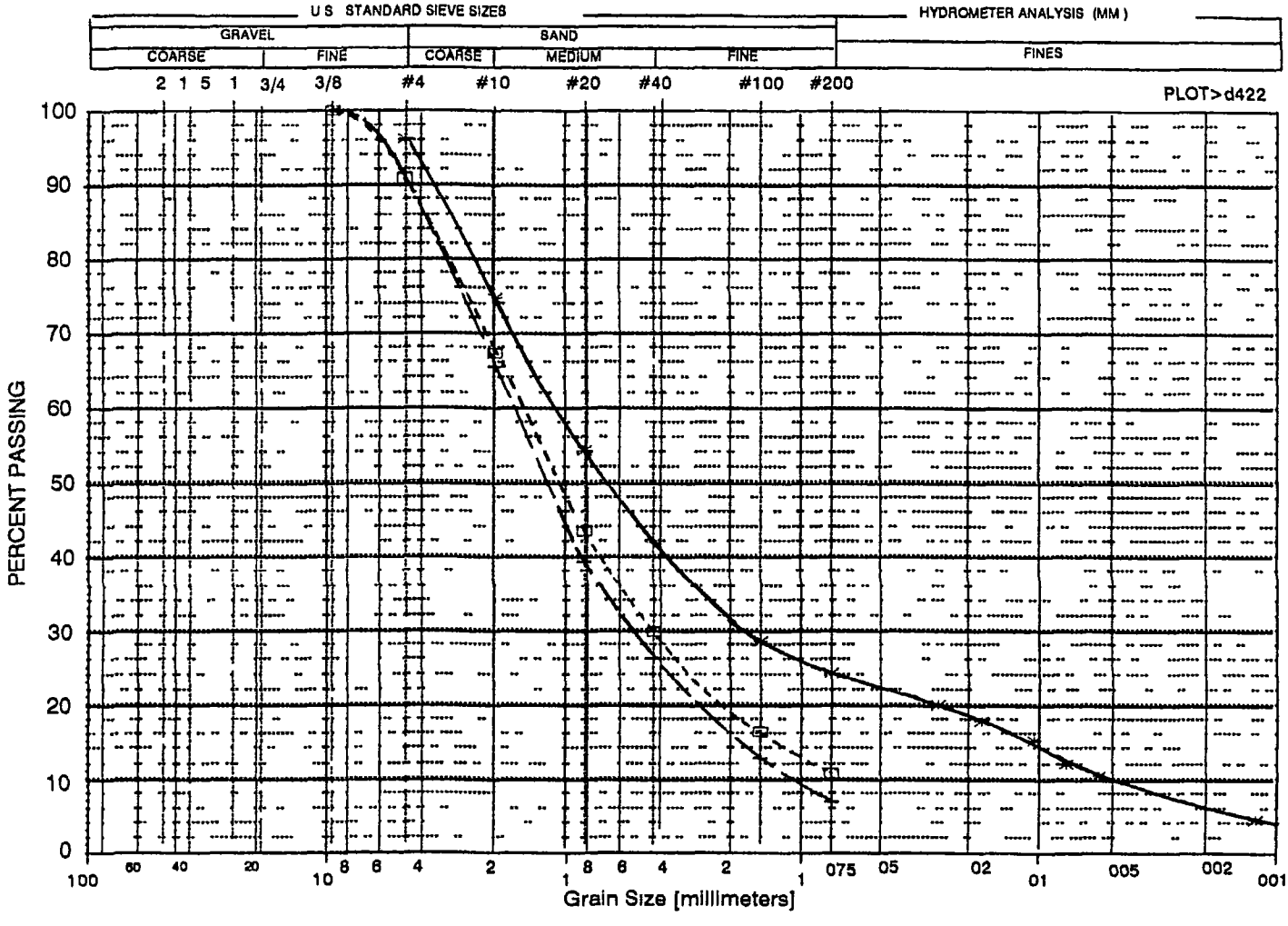
Job No 4263

PROJECT Rivermines/Elvins Mine Tailings Site # 25/86-009 PTS

REPORTED TO Barr Engineering Company

Date 9 11 01

	Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
	B 6	G 16	48 63	Bag	Silty sand w/a trace of gravel (SM)
+	B 7	G 17	0 30	Bag	Silty sand (SM)
▯	B 7	G 18	35 75	Bag	Sand w/silt and a little gravel medium grained (SP SM)



OTHER TESTS

	x	+	▯
Liquid Limit (%)			
Plastic Limit (%)			
Plasticity Index			
Water Content (%)	12 2	4 4	4 5
Dry Density [pcf]			
Specific Gravity	2 90*		
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			

Assumed Value

PERCENT PASSING

	x	+	▯
Mass [gm]	1453	3395	3470
2			
1 1/2			
1			
3/4			
3/8	100 0	100 0	100 0
#4	96 1	91 5	90 7
#10	74 7	65 5	67 2
#20	54 3	39 3	43 4
#40	41 8	26 1	29 7
#100	28 3	12 6	16 2
#200	24 1	6 8	10 5

ASTM D422 S & SBT

	x	+	▯
D_{60}			
D_{30}			
D_{10}			
C_u			
C_c			

Remarks

Fil 42635

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Bloomington Minnesota 55420 3436

ED_000859_00001631-00324

Grain Size Distribution

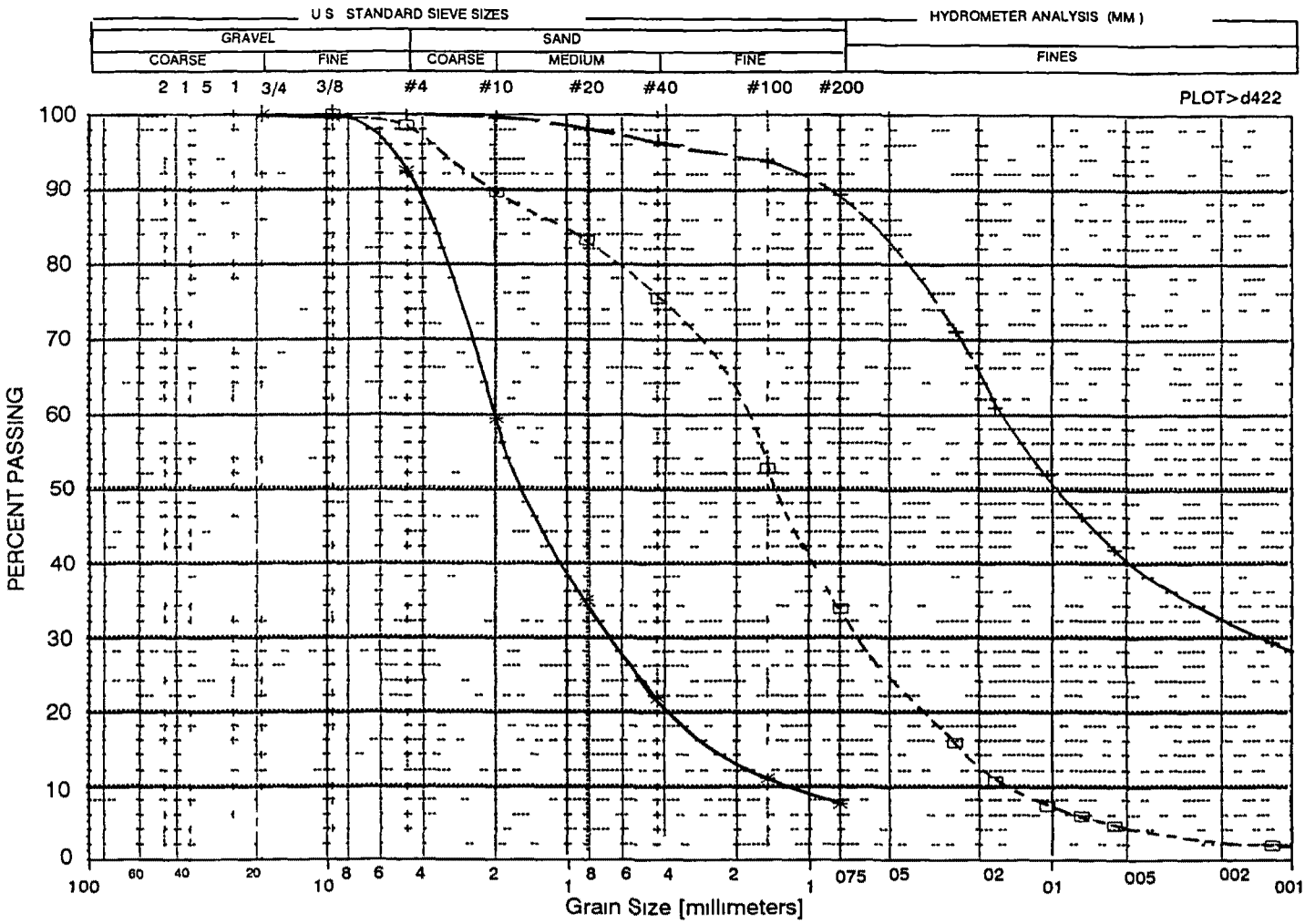
Job No 4263

PROJECT Rivermines/Elvins Mine Tailings Site # 25/86 009 PTS

REPORTED TO Barr Engineering Company

Date 9-11 01

	Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
x	B 8	G 19	0 45	Bag	Sand w/silt and a little gravel medium to coarse grained (SP SM)
+	B 8	G 20	50 55	Bag	Lean clay (CL)
▯	B 9	G 21	0-40	Bag	Silty sand (SM)



OTHER TESTS	x	+	▯
Liquid Limit (%)		43 8	
Plastic Limit (%)		18 4	
Plasticity Index		25 4	
Water Content (%)	4 3	23 3	10 9
Dry Density [pcf]			
Specific Gravity		2 69*	2 90*
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			

A sumed V I

PERCENT PASSING	x	+	▯
Mass [gm]	3373	455	3456
2			
1 1/2			
1			
3/4	100 0		
3/8	99 6	100 0	100 0
#4	92 3	100 0	98 5
#10	59 3	99 8	89 6
#20	34 8	98 0	83 1
#40	21 7	96 4	75 5
#100	10 8	93 7	52 7
#200	7 5	89 2	33 6

ASTM D422 S 6 Set

	x	+	▯
D_{60}			
D_{30}			
D_{10}			
C_u			
C_c			

Remarks

F'1 42636

ARS

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SOIL ENGINEERING TESTING INC

Bloomington Minnesota 55420 3436

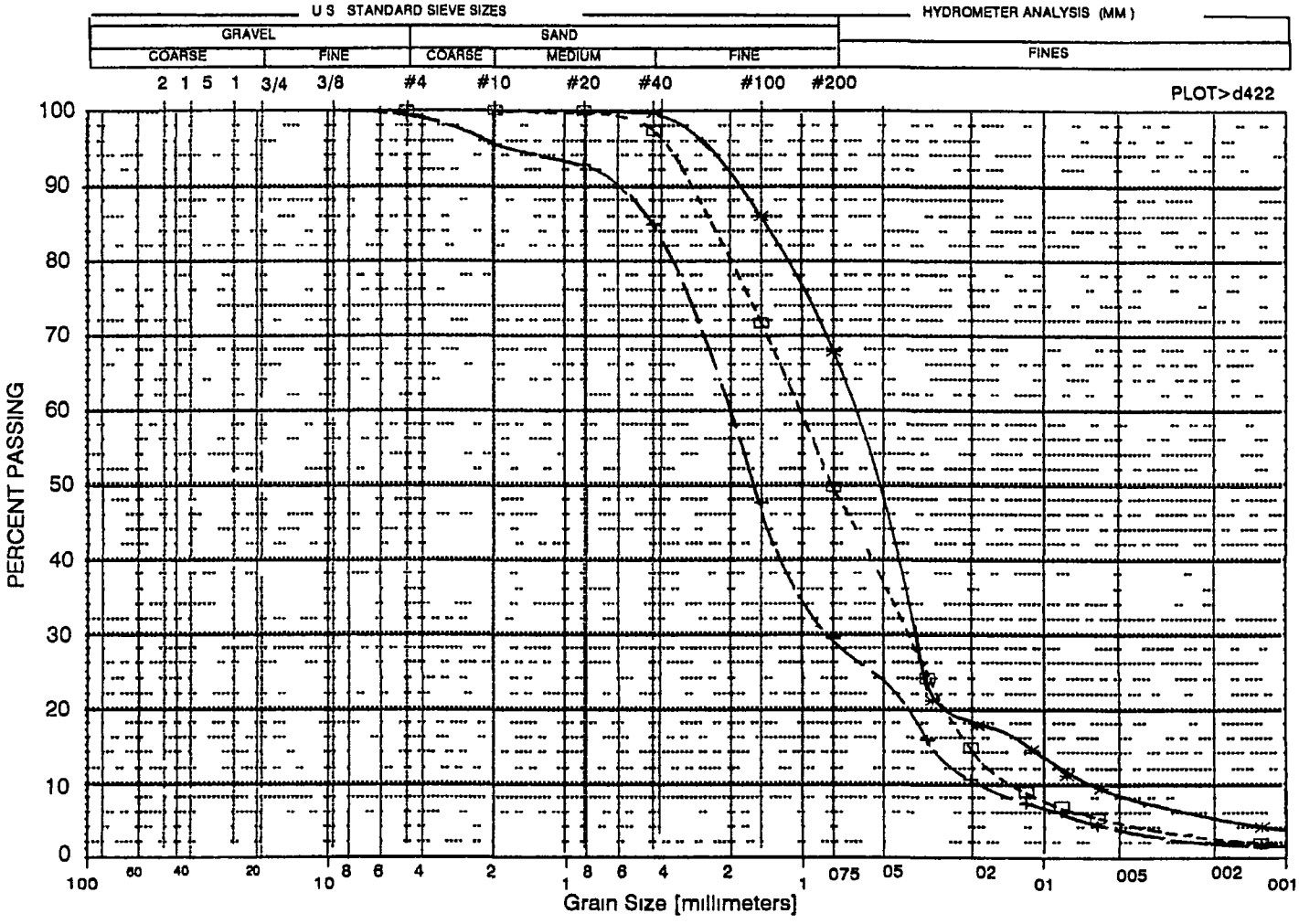
ED_000859_00001631-00325

Grain Size Distribution

Job No 4263

PROJECT Rivermines/Elvins Mine Tailings Site # 25/86 009 PTS	
REPORTED TO Barr Engineering Company	Date 9-11 01

	Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
	B 9	G 22	45 55	Bag	Sandy silt (ML)
+	Surface Sample	G 23	0 5 1	Bag	Silty sand w/a little gravel (SM)
▯	Surface Sample	G 24	0 5 1	Bag	Silty sand w/roots (SM/ML)



OTHER TESTS

	x	+	▯
Liquid Limit (%)			
Plastic Limit (%)			
Plasticity Index			
Water Content (%)	19 2	12 2	16 9
Dry Density [pcf]			
Specific Gravity	2 90	2 90*	2 85*
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			

Assumed V lu

PERCENT PASSING

	x	+	▯
Mass [gm]	426	4317	4993
2			
1 1/2			
1			
3/4			
3/8		100 0	
#4	100 0	99 2	100 0
#10	100 0	95 5	100 0
#20	99 9	92 6	99 8
#40	99 6	84 9	97 3
#100	86 0	47 5	71 6
#200	67 7	29 4	49 5

ASTM* D422 Sieve Set

	x	+	▯
D_{60}			
D_{30}			
D_{10}			
C_u			
C_c			

Remarks

File 42637

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SOIL ENGINEERING TESTING INC

Bloomington Minnesota 55420 3436

ED_000859_00001631-00326

Grain Size Distribution

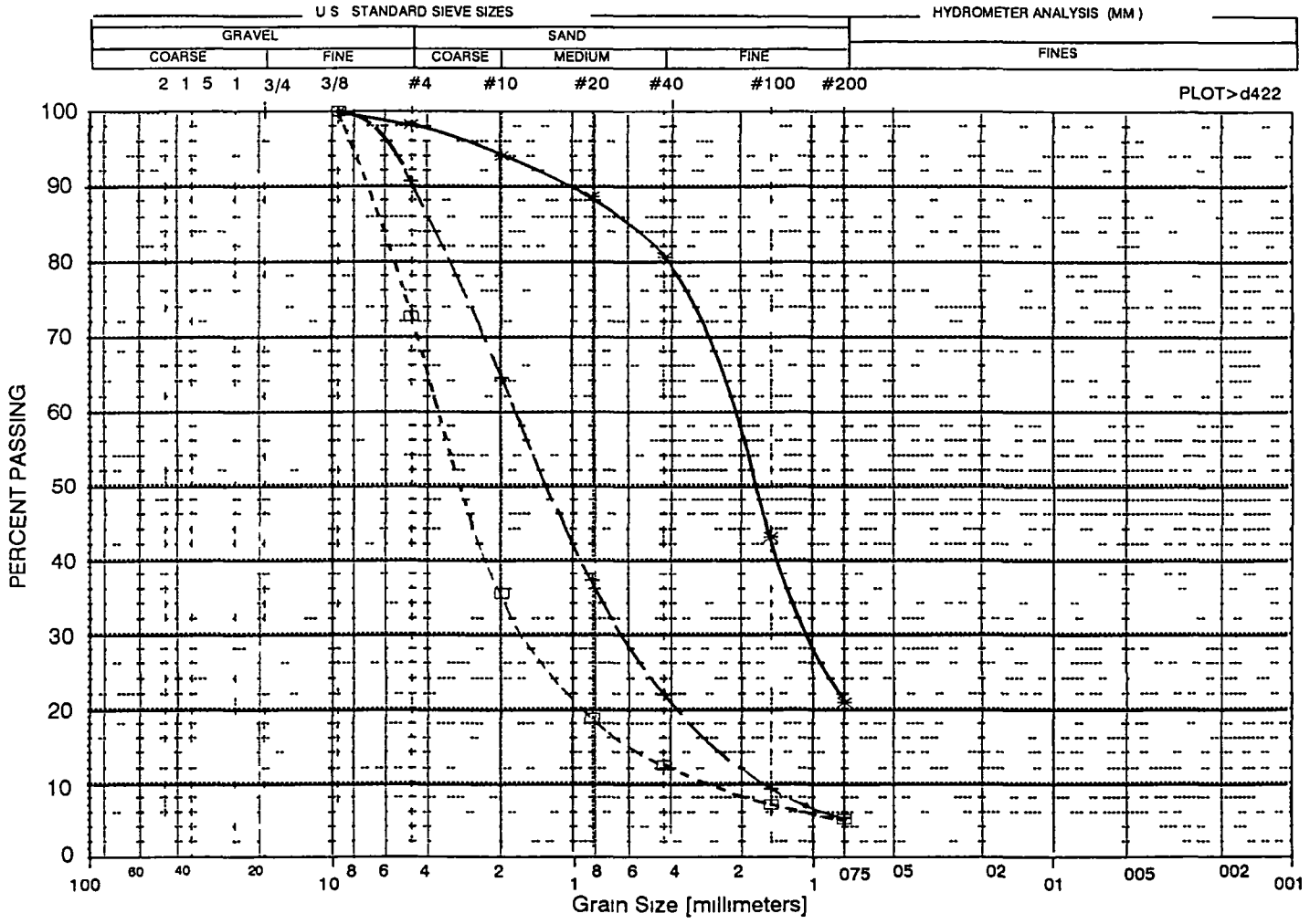
Job No 4263

PROJECT Rivermines/Elvins Mine Tailings Site # 25/86 009 PTS

REPORTED TO Barr Engineering Company

Date 9 11 01

	Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
x	Surface Sample	G 25	0 5 1	Bag	Silty sand (SM)
+	Surface Sample	G 26	0 5 1	Bag	Sand w/silt and a little gravel (SP SM/SP)
▯	Surface Sample	G 27	0 5 1	Bag	Sand w/silt and gravel coarse to medium grained (SP SM/SP)



OTHER TESTS

	x	+	▯
Liquid Limit (%)			
Plastic Limit (%)			
Plasticity Index			
Water Content (%)	15 7	3 1	2 2
Dry Density [pcf]			
Specific Gravity			
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			

A sumed V I

PERCENT PASSING

	x	+	▯
Mass [gm]	4507	5934	5785
2			
1 1/2			
1			
3/4		100 0	
3/8	100 0	100 0	100 0
#4	98 2	90 5	72 6
#10	93 9	64 5	35 3
#20	88 6	37 2	18 6
#40	80 6	21 9	12 3
#100	42 9	9 1	7 0
#200	20 8	5 3	5 0

ASTM D422 S 6V8 S6t

	x	+	▯
D_{60}			
D_{30}			
D_{10}			
C_u			
C_c			

Remarks

F1 42638

ARS

9301 Bryant Avenue South Suite 107

SOIL ENGINEERING TESTING INC

Bloomington Minnesota 55420 3436

ED_000859_00001631-00327

Grain Size Distribution

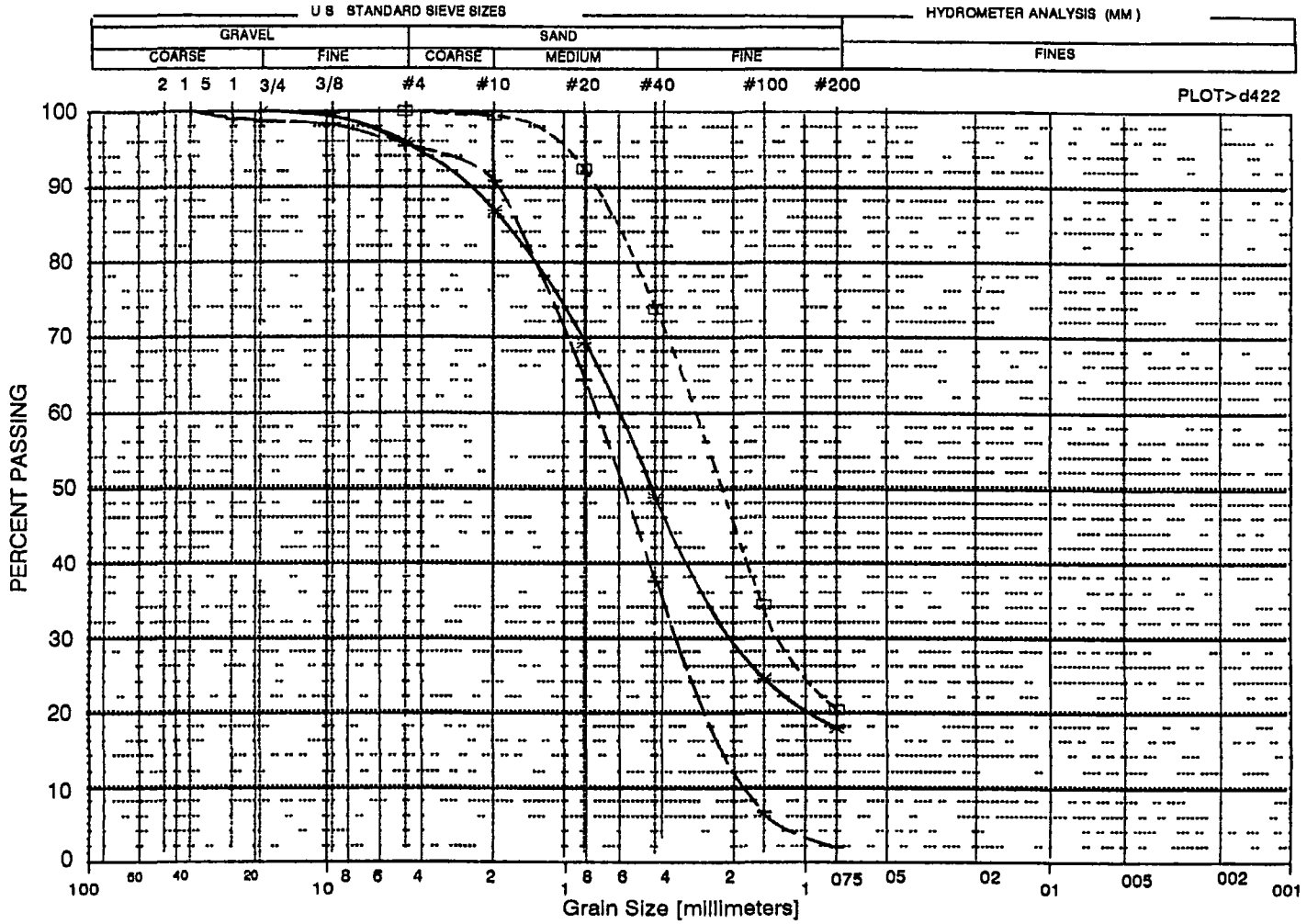
Job No 4263

PROJECT Rivermines/Elvins Mine Tailings Site # 25/86 009 PTS

REPORTED TO Barr Engineering Company

Date 9-11 01

	Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
	B 10	G 28	0 10	Bag	Silty sand w/a little gravel (SM)
+	Surface Sample	G 29	0 5 1	Bag	Sand w/a little gravel medium to fine grained (SP)
▯	Surface Sample	G 30	0 5 1	Bag	Silty sand (SM)



OTHER TESTS	x	+	▯
Liquid Limit (%)			
Plastic Limit (%)			
Plasticity Index			
Water Content (%)	12 9	11 1	9 6
Dry Density [pcf]			
Specific Gravity			
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			
Ass med Value			

PERCENT PASSING	x	+	▯
Mass [gm]	1084	7232	4793
2			
1 1/2		100 0	
1		98 9	
3/4	100 0	98 6	
3/8	99 7	98 4	
#4	95 9	95 3	100 0
#10	86 7	90 8	99 4
#20	68 9	64 2	92 3
#40	48 6	37 4	73 6
#100	24 2	6 6	34 3
#200	17 6	1 9	20 1

ASTM D422 Sieve Set

	x	+	▯
D_{60}			
D_{30}			
D_{10}			
C_u			
C_c			

Remarks

Fil 42639

ARS

9301 Bryant Avenue South Suite 107

SOIL ENGINEERING TESTING INC

Bloomington Minnesota 55420 3436

ED_000859_00001631-00328

Grain Size Distribution

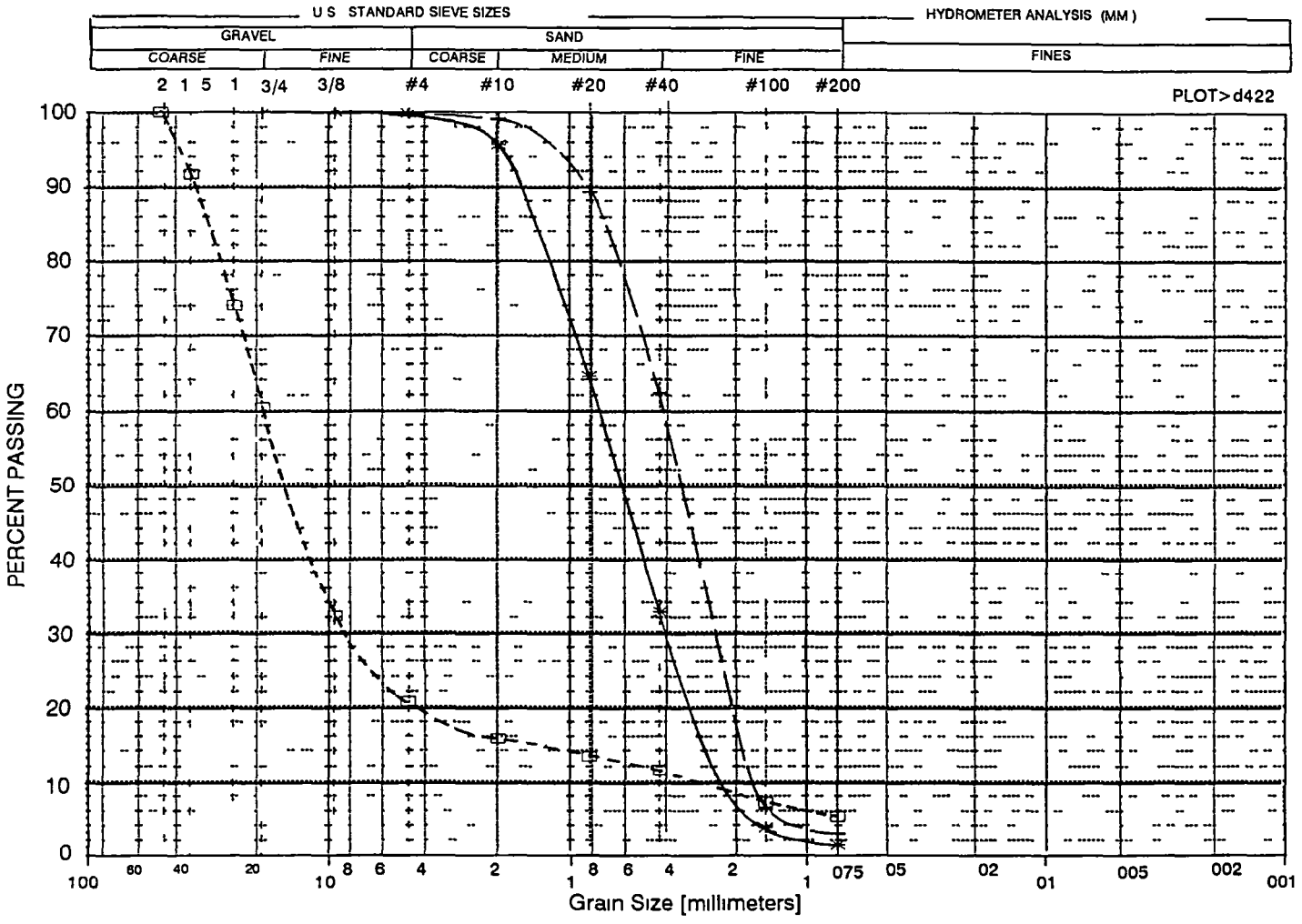
Job No 4263

PROJECT Rivermines/Elvins Mine Tailings Site # 25/86-009 PTS

REPORTED TO Barr Engineering Company

Date 9 11 01

	Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
x	Surface Sample	G 31	0 5 1	Bag	Sand medium to fine grained (SP)
+	Surface Sample	G 32	0 5 1	Bag	Sand fine to medium grained (SP)
▯	Surface Sample	G 33	0 5 1	Bag	Gravel w/silt and sand (GP GM/GP)



OTHER TESTS	x	+	▯
Liquid Limit (%)			
Plastic Limit (%)			
Plasticity Index			
Water Content (%)	13 3	19 5	1 7
Dry Density [pcf]			
Specific Gravity			
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			

A sumed V I

PERCENT PASSING	x	+	▯
Mass [gm]	6313	5602	8488
2			100 0
1 1/2			91 7
1			74 0
3/4		100 0	60 3
3/8	100 0	99 9	32 2
#4	99 8	99 8	20 6
#10	95 6	99 1	15 7
#20	64 3	89 2	13 3
#40	32 7	62 3	11 5
#100	3 7	6 4	7 2
#200	1 4	2 9	5 2

ASTM D422 Sieve Set

	x	+	▯
D_{60}			
D_{30}			
D_{10}			
C_u			
C_c			

Remarks

F1 426310

ARS

9301 Bryant Avenue South Suite 107

SOIL ENGINEERING TESTING INC

Bloomington Minnesota 55420 3436

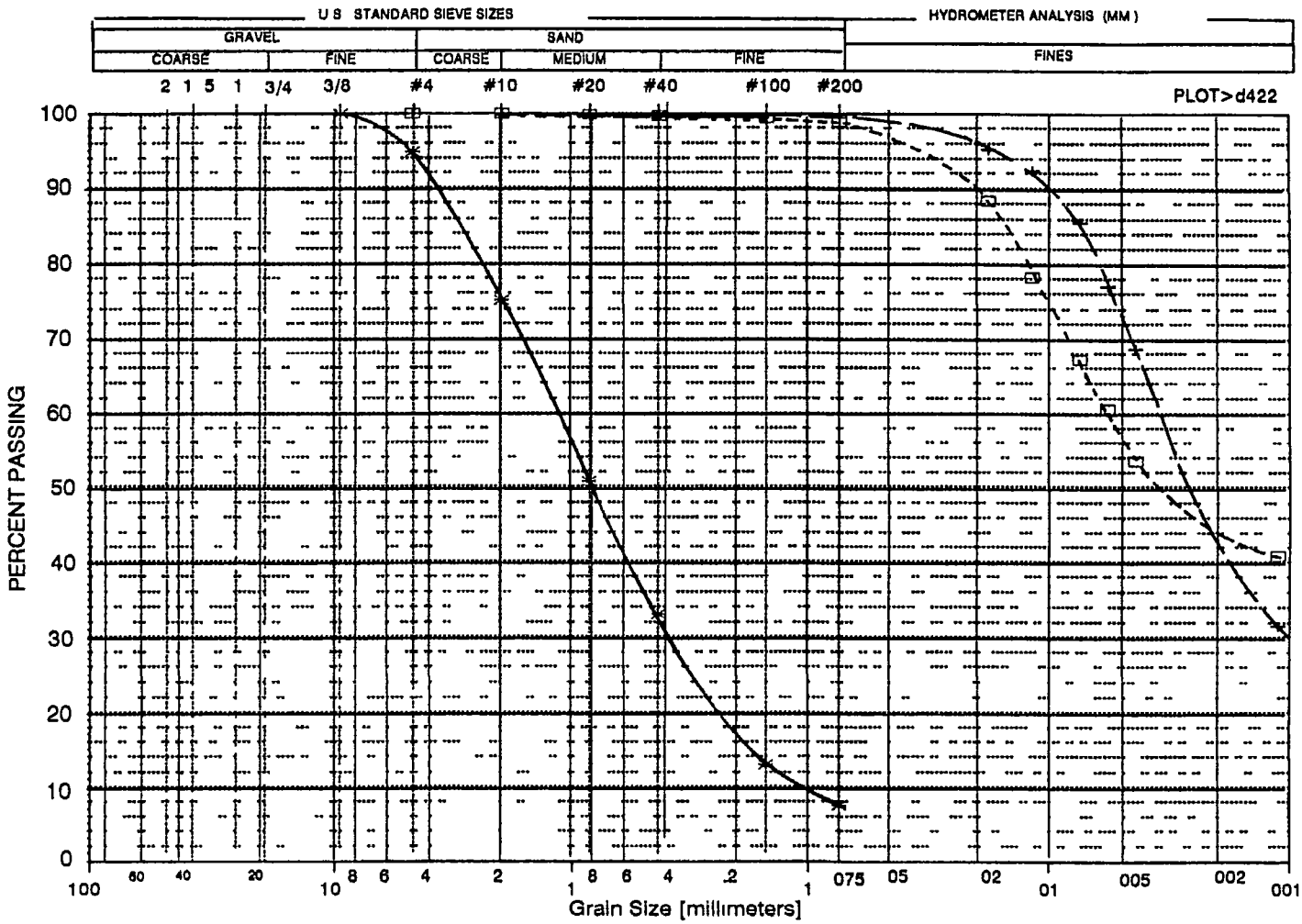
ED_000859_00001631-00329

Grain Size Distribution

Job No 4263

PROJECT Rivermines/Elvins Mine Tailings Site # 25/86-009 PTS	
REPORTED TO Barr Engineering Company	Date 9-11 01

	Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
●	B 1	G 34	50 100	Bag	Sand w/silt and a little gravel medium to fine grained (SP SM)
+	B 6	G-35	68 83	Bag	Lean clay (CL)
□	B 6	G 36	88 92	Bag	Fat clay (CH)



OTHER TESTS

	x	+	□
Liquid Limit (%)		39 9	64 7
Plastic Limit (%)		19 8	23 4
Plasticity Index		20 1	41 3
Water Content (%)	3 4	33 3	25 5
Dry Density [pcf]			
Specific Gravity		2 87*	2 72*
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			

As umed V I

PERCENT PASSING

Mass [gm]	x	+	□
	3670	514	158
2			
1 1/2			
1			
3/4			
3/8	100 0		
#4	94 8	100 0	100 0
#10	75 1	100 0	100 0
#20	50 8	99 9	99 8
#40	33 0	99 8	99 7
#100	12 9	99 8	99 2
#200	7 5	99 7	98 8

ASTM D422 Sieve Set

	x	+	□
D_{60}			
D_{30}			
D_{10}			
C_u			
C_c			

Remarks

FII 426311

ARS

9301 Bryant Avenue South Suite 107

SOIL ENGINEERING TESTING INC

Bloomington Minnesota 55420 3436

ED_000859_00001631-00330

Grain Size Distribution

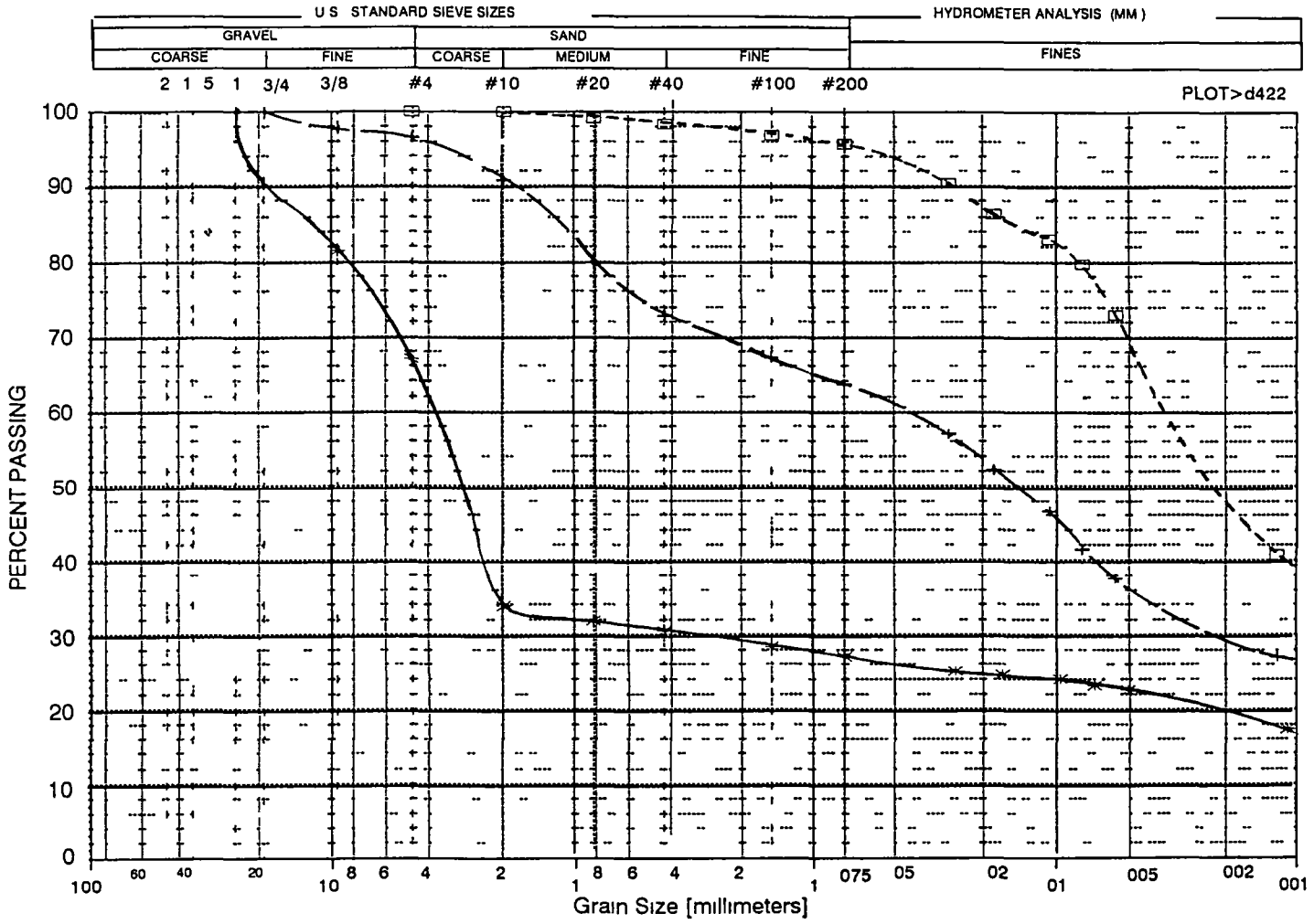
Job No 4263

PROJECT Rivermines/Elvins Mine Tailings Site # 25/86 009 PTS

REPORTED TO Barr Engineering Company

Date 9 12 01

	Boring Number	Sample Number	Depth (feet)	Type of Sample	Soil Classification
x	B 9	G 37	60 64	Bag	Clayey sand w/gravel (SC)
+	B 10	G 38 Brown	15 17	Bag	Fat clay w/sand and a little gravel (CH)
▯	B 10	G 38 Gray	15 17	Bag	Fat clay (CH)



OTHER TESTS

	x	+	▯
Liquid Limit (%)	84 3	53 1	72 9
Plastic Limit (%)	23 1	16 7	20 8
Plasticity Index	61 2	36 4	52 1
Water Content (%)	23 5	22 9	26 0
Dry Density [pcf]			
Specific Gravity	2 75*	2 70*	2 74*
Porosity			
Organic Content (%)			
pH			
Shrinkage Limit [SL]			
Penetrometer [tsf]			
Qu [psf]			

A m d V I

PERCENT PASSING

	x	+	▯
Mass [gm]	209	146	159
2			
1 1/2			
1	100 0		
3/4	90 0	100 0	
3/8	81 5	97 7	
#4	67 0	96 5	100 0
#10	33 8	90 6	100 0
#20	31 8	80 1	99 2
#40	30 5	72 8	98 2
#100	28 3	67 1	96 8
#200	27 0	63 6	95 6

ASTM D422 S 6 6 Set

	x	+	▯
D_{60}			
D_{30}			
D_{10}			
C_u			
C_c			

Remarks

F1 426311

ARS

9301 Bryant Avenue South Suite 107

SOIL ENGINEERING TESTING INC

Bloomington Minnesota 55420 3436

ED_000859_00001631-00331

Brotcke Well & Pump

August 28, 2001

Mr Paul Swenson
Barr Engineering Company
4700 West 77th Street
Minneapolis, Minnesota 55435-4803

RE Letter Report
Rivermines Tailings Site

Dear Mr Swenson

Brotcke Well & Pump completed the drilling at the Rivermines Tailing Site on August 17, 2001 Following report summarizes the results of our exploration of the site

PROJECT DESCRIPTION
The project consisted of drilling ten test borings at locations selected by Barr Engineering Company Descriptive logs and samples were obtained from the borings

FIELD INVESTIGATION
Ten test borings were made at locations selected by Barr Engineering Company The borings were drilled the week of August 13, 2001 using a CME 550x drill rig The project was performed under the supervision of Barr's representative Brotcke's site superintendent and driller, Mr Donald Houston, maintained driller's logs as the borings were advanced

Drilling and sampling were accomplished in accordance with good drilling practice and ASTM procedures where applicable Split spoon samples were obtained at 5 0 foot intervals All samples were secured, sealed, and transported to a laboratory for further inspection and testing The sampling intervals, soil descriptions, standard penetration test (SPT) results, and other pertinent field data are summarized on the boring logs presented as Field Boring Log, Boring Nos 1 – 10 as an attachment to this report

SITE DESCRIPTION
The borings are located in at the Rivermines Mine Tailings Site in Park Hills, Missouri Borings 1 and 2 were drilled on top of the Chat Pile Borings 3 and 10 were drilled in the Spillway Borings 4, 5, and 6 were drilled in the Tailings Area Lastly, Borings 7, 8, and

9 were drilled south of the AG Lime Excavation Area in an area referred to as the Tailings Field in Barr's Scope of Work

SUBSURFACE DESCRIPTION

Boring B-1

Boring No 1 penetrated to 100 feet below ground surface Sand was encountered from the surface to about 85 feet Small gravel extended from 85 feet to the termination depth No groundwater was encountered

Boring B-2

Boring No 2 penetrated to 100 feet below ground surface Sand was encountered throughout the boring No groundwater was found

Boring B-3

Boring No 3 penetrated to 7 5 feet Sand was encountered throughout the boring Refusal was met at 7 5 feet The borehole was described as wet throughout the boring

Boring B-4

Boring No 4 penetrated to 25 feet Sand was found from the surface to 10 feet Wet natural clay was encountered from 10 feet to bedrock refusal at 22 5 feet

Boring B-5

Boring No 5 penetrated to 72 5 feet Sand was found in the top 10 feet Below the sand a silty slime extended from 10 feet to 35 feet Sand was encountered from 35 feet to 69 feet Clay extended from 69 feet to the termination depth of 72 5 feet Auger refusal was met at 72 5 feet No groundwater was encountered

Boring B-6

Boring No 6 penetrated to 91 5 feet The top 20 feet consisted of sand The driller switched from hollow stem augers to mud rotary drilling techniques at 20 feet Slime was encountered from 20 feet to 43 feet From 43 feet to 58 feet was a course sand A fine wet sand was found from 58 feet to 78 feet Sand was found from 78 feet to 83 feet below which a clay layer existed to 88 feet The bit hit bedrock refusal at 91 5 feet Groundwater was not reported in the borehole

Boring B-7

Boring No 7 penetrated to 75 feet Sand was encountered from the surface to 30 feet From 30 feet to 75 feet the sand was mixed with small gravel Refusal was met at 75 feet Water was encountered at 64 feet

Boring B-8

Boring No 8 penetrated to 55 feet Sand was found throughout the boring Refusal was met at 55 feet Groundwater was not observed

Boring B-9
Boring No 9 penetrated to 64 feet Sand was encountered from the surface to 40 feet followed by slime from 40 feet to 55 feet Clay was found from 60 feet to refusal at 64 feet Groundwater was not observed

Boring B-10
Boring No 10 penetrated 16 5 feet Sand was encountered throughout the borehole Refusal was met at 16 5 feet Groundwater was observed at 12 feet

If you have any questions concerning this report, please do not hesitate to contact me at (636) 343-3029

Sincerely
BROTCKE WELL & PUMP INC

Sara Heartlein
Project Manager

Attachments

Brotcke Well & Pump

FIELD BORING LOG

Boring No B-1

Project Rivermines Tailing Site Job No 01854 Date Aug 13 2001

Location Park Hills MO Crew D Houston and D Adams

Drilling Method X HSA ___ CFA ___ Rotary ___ Rock Coring ___ Drilling Fluid ___

Elevation

DEPTH, FT			SAMPLE			SPT Blows
FROM	TO	DESCRIPTION	TYPE	DEPTH, FT	RECOVERY	N/6"
0	100	S-1 SAND	SPT	0-2 5		1-3 5
		S-2	SPT	5-6 5	12	0-1 2
		S-3	SPT	10-11 5	14	1-1 3
		S-4	SPT	15-16 5	16	1-2-3
		S-5	SPT	20-21 5	14	1-3-4
		S-6	SPT	25-26 5	14	2-4-5
		S-7 MORE MOISTURE	SPT	30-31 5	14	2-3-4
		S-8	SPT	35-36 5	14	3-5 5
		S-9	SPT	40-41 5	14	4-4-4
		S-10	SPT	45-46 5	14	3-5-6
		S-11	SPT	50-51 5	14	4-8 8
		S-12	SPT	55-56 5	16	5-8-8
		S-13 GOT DRYER	SPT	60-61 5	14	6-9-11
		S-14	SPT	65-66 5	12	6-8 8
		S-15	SPT	70-71 5	14	6-9-9
		S-16	SPT	75-76 5	14	9-10 9
		S-17	SPT	80-81 5	11	9-8-9
		S-18 BEGINNING SMALL GRAVEL	SPT	85-86 5	13	10 10-15
		S-19	SPT	90-91 5	16	8-8-9
		S-20	SPT	95-96 5	12	6-9-13
		S-21	SPT	100-101 5	13	6-8-9

WATER LEVEL OBSERVATIONS

DURING DRILLING Dry FT

AT COMPLETION ___ FT

AFTER ___ HRS ___ FT

AFTER ___ HRS ___ FT

AFTER ___ HRS ___ FT

NOTES

Piezometer Installed ___ YES X NO

Depth 80 Ft

Using 3¾ hollow stem augers

Sampling with 1⅜ ID Split Spoon (SPT)

Qualifying terms Trace < 10% Some ~ 10 – 50%

rotcke Well & Pump

FIELD BORING LOG

Boring No B-2

Project Rivermines Tailing Site Job No 01854 Date Aug 13, 2001

Location Park Hills MO Crew D Houston and D Adams

Drilling Method X HSA ___ CFA ___ Rotary ___ Rock Coring ___ Drilling Fluid ___

Elevation

DEPTH, FT			SAMPLE			SPT Blows
FROM	TO	DESCRIPTION	TYPE	DEPTH, FT	RECOVERY	N/6"
0	100	S-1 SAND				
		S-2	SPT	5-6 5	13	1-3-4
		S 3	SPT	10-11 5	15	1-3 3
		S-4	SPT	15-16 5	12	2-3 5
		S 5	SPT	20-21 5	14	2-3-6
		S 6	SPT	25-26 5	15	4-6 7
		S-7	SPT	30-31 5	12"	5-8-8
		S-8	SPT	35-36 5	11	3-5-6
		S-9	SPT	40-41 5	15	5-6-8
		S 10	SPT	45-46 5	13	5 8-10
		S 11	SPT	50-51 5	14	3 5 8
		S 12	SPT	55-56 5	14	9-10-10
		S-13	SPT	60-61 5	15	7 11 9
		S-14	SPT	65-66 5	14"	9-13-11
		S 15	SPT	70-71 5	15"	8-11-11
		S 16	SPT	75-76 5	15"	6-9-8
		S-17	SPT	80-81 5	11	6 8-13
		S-18	SPT	85-86 5	16	7-8-9
		S-19	SPT	90-91 5	14	11-11 12
		S 20	SPT	95-96 5	16	6 8-11
		S-21	SPT	100-101 5	17"	9-11-14

WATER LEVEL OBSERVATIONS			
DURING DRILLING	Dry		FT
AT COMPLETION			FT
TER		HRS	FT
AFTER		HRS	FT
AFTER		HRS	FT

NOTES Piezometer Installed ___ YES X NO

Depth 101 5 Ft

Using 3¾ hollow stem augers

Sampling with 1¾ ID Split Spoon (SPT)

Qualifying terms Trace < 10%, Some ~ 10 – 50%

Brotcke Well & Pump

FIELD BORING LOG

Boring No B-3

Project Rivermines Tailing Site **Job No** 01854 **Date** Aug 13 2001

Location Park Hills MO **Crew** D Houston and D Adams

Drilling Method X HSA ___ CFA ___ Rotary ___ Rock Coring ___ Drilling Fluid ___

Elevation

DEPTH, FT			SAMPLE			SPT Blows
FROM	TO	DESCRIPTION	TYPE	DEPTH, FT	RECOVERY	N/6"
0	7 5	S-1 Sand	SPT	0-2 5	13	1-2 2
		S-2	SPT	5-6 5	14	1-2-2
		S-3 REFUSEL AT 7 5 - NO GROUT	SPT	10-11 5		

WATER LEVEL OBSERVATIONS			
DURING DRILLING	Wet		FT
AT COMPLETION			FT
AFTER		HRS	FT
AFTER		HRS	FT
AFTER		HRS	FT

NOTES Piezometer Installed ___ YES X NO

Depth 7 5 Ft

Using 3¾ hollow stem augers

Sampling with 1⅜ ID Split Spoon (SPT)

Qualifying terms Trace < 10% Some ~ 10 – 50%

Brotcke Well & Pump

FIELD BORING LOG

Boring No B-4

Project Rivermines Tailing Site Job No 01854 Date Aug 13, 2001

Location Park Hills, MO Crew D Houston and D Adams

Drilling Method X HSA ___ CFA ___ Rotary ___ Rock Coring ___ Drilling Fluid ___

Elevation

DEPTH, FT			SAMPLE			SPT Blows
FROM	TO	DESCRIPTION	TYPE	DEPTH, FT	RECOVERY	N/6"
0	15	S-1	SPT	0-2 5	14	0 1-1
		S-2	SPT	5-6 5	14	1 1 2
		S-3	SPT	10-11 5	15	2-4-4
10	15	S-4 WET NATURAL CLAY IN SHOE	SPT	15 16 5	12	1 2 2
15	20	S-5 CLAY	SPT	20-21 5	16	1-4 7
20	25	S-6 22 5 ON ROCK REFUSAL				

WATER LEVEL OBSERVATIONS			
DURING DRILLING			FT
COMPLETION			FT
AFTER		HRS	FT
AFTER		HRS	FT
AFTER		HRS	FT

NOTES Piezometer Installed ___ YES X NO

Depth 22 5 Ft

Using 3¾ hollow stem augers

Sampling with 1⅜ ID Split Spoon (SPT)

Qualifying terms Trace < 10% Some ~ 10 – 50%

Brotcke Well & Pump

FIELD BORING LOG

Boring No B-5

Project Rivermines Tailing Site Job No 01854 Date Aug 13 2001

Location Park Hills, MO Crew D Houston and D Adams

Drilling Method X HSA ___ CFA ___ Rotary ___ Rock Coring ___ Drilling Fluid ___

Elevation

DEPTH, FT			SAMPLE			SPT Blows
FROM	TO	DESCRIPTION	TYPE	DEPTH, FT	RECOVERY	N/6"
0	10	S-1 SAND	SPT	0-2 5	14	1-2-4
		S-2	SPT	5-6 5	15	2-4-4
		S-3	SPT	10-11 5	15	2-1-1
10	35	S-4 SILT SLIMES	SPT	15 16 5	22	0-0-0
		S 5	SPT	20-21 5	1	0-0 0
		S-6	SPT	25-26 5	24	0-0-0
		S-7	SPT	30 31 5	10	2-2-4
		S-8	SPT	35-36 5	13	2 3-4
35	69	S 9 SAND	SPT	40-41 5	13	2-4 8
		S-10	SPT	45-46 5	13	3-3-4
		S 11	SPT	50-51 5	12	3-6 6
		S-12	SPT	55-56 5	14	7-10 10
		S 12	SPT	60-61 5	12	6 8 8
		S-14	SPT	65-66 5	11	3-7-7
69	70	S-15 CLAY STARTED AT 69	SPT	70-71 5	17	8-27-50
		S-16 72 5 AUGER REFUSAL	SPT	75-76 5		

WATER LEVEL OBSERVATIONS			
DURING DRILLING	Dry		FT
AT COMPLETION			FT
AFTER		HRS	FT
AFTER		HRS	FT
AFTER		HRS	FT

NOTES

Piezometer Installed ___ YES X NO

Depth 72 5 Ft

Using 3¾ hollow stem augers

Sampling with 1⅜ ID Split Spoon (SPT)

Qualifying terms Trace < 10% Some ~ 10 – 50%

Brotcke Well & Pump

FIELD BORING LOG

Boring No B-6

Project Rivermines Tailing Site Job No 01854 Date Aug 13 2001

Location Park Hills, MO Crew D Houston and D Adams

Drilling Method X HSA ___ CFA X Rotary ___ Rock Coring ___ Drilling Fluid ___

Elevation

DEPTH, FT			SAMPLE			SPT Blows
FROM	TO	DESCRIPTION	TYPE	DEPTH, FT	RECOVERY	N/6"
0	20	S-1 SAND				
		S-2	SPT	5-6 5	3	0-0-1
		S-3	SPT	10-11 5	24	0 0-1
		S-4	SPT	15-16 5	16	0 0-0
		S-5	SPT	20-21 5	24	1 0-1
		SWITCH TO ROTARY WASH (8/15/01)				
20	43	S-6 SLIME	SPT	28-29 5	26	0-0-0
		S-7	SPT	33-34 5	24	0 0-0
		S-8	SPT	38-39 5	23	0 0-0
		S-9	SPT	43-44 5	22	0-0-0
43	58	S-10 COURSE SAND	SPT	48-49 5	14	7-7-8
		S-11	SPT	53-54 5	8	5-5-7
		S-12	SPT	58-59 5	8	5-4-5
58	78	S-13 FINE WET SAND	SPT	63-64 5	24	0-1-2
		S-14	SPT	68-69 5	24	0-1-3
		S-15	SPT	73-74 5	22	0-1-3
		S-16	SPT	78-79 5	14	4-6-5
78	83	S-17 SAND	SPT	83-84 5	12	4-8-12
83	88	S-18 CLAY	SPT	88-89 5	18	3 7 9
88	91 5	S-19 HIT ROCK @ 91 5	SPT			

WATER LEVEL OBSERVATIONS

DURING DRILLING Dry FT

COMPLETION ___ FT

AFTER ___ HRS ___ FT

AFTER ___ HRS ___ FT

AFTER ___ HRS ___ FT

NOTES

Piezometer Installed ___ YES X NO

Depth 91 5 Ft.

Using 3¾ hollow stem augers

Sampling with 1⅜ ID Split Spoon (SPT)

Qualifying terms Trace < 10% Some ~ 10 – 50%

Brotcke Well & Pump

FIELD BORING LOG

Boring No B-7

Project Rivermines Tailing Site Job No 01854 Date Aug 13 2001

Location Park Hills MO Crew D Houston and D Adams

Drilling Method X HSA ___ CFA ___ Rotary ___ Rock Coring ___ Drilling Fluid ___

Elevation

DEPTH, FT FROM	DEPTH, FT TO	DESCRIPTION	SAMPLE TYPE	SAMPLE DEPTH, FT	SAMPLE RECOVERY	SPT Blows N/6"
0	30	S-1 SAND	SPT	5-6 5	11	2-0-1
		S-2	SPT	10-11 5	8	1-2 3
		S-3	SPT	15-16 5	14	5-11-7
		S-4	SPT	20-21 5	14	7-10-9
		S-5	SPT	25-26 5	13	5 10-10
		S-6	SPT	30-31 5	12	6-7-10
30	70	S-7 SAND AND SMALL GRAVEL	SPT	35-35 5	15	9 15 15
		S 8	SPT	40-41 5	14	8 13 13
		S-9	SPT	45-46 5	14	5 10 10
		S-10	SPT	50-51 5	14	10-13-11
		S-11	SPT	55-56 5	13	6 12 15
		S-12	SPT	60-61 5	12	6-11-9
		S-13	SPT	65-66 5	11	4-8-11
		S-14	SPT	70-71 5	19	6-7-12
70	75	S-15 REFUSAL @ 75				

WATER LEVEL OBSERVATIONS

DURING DRILLING ___ FT

AT COMPLETION 64 FT

AFTER ___ HRS ___ FT

AFTER ___ HRS ___ FT

AFTER ___ HRS ___ FT

NOTES Piezometer Installed ___ YES X NO

Depth 75 Ft.

Using 3¾ hollow stem augers

Sampling with 1⅜ ID Split Spoon (SPT)

Qualifying terms Trace < 10% Some ~ 10 – 50%

Grotcke Well & Pump

FIELD BORING LOG

Boring No B-8

Project Rivermines Tailing Site Job No 01854 Date Aug 13 2001

Location Park Hills, MO Crew D Houston and D Adams

Drilling Method X HSA ___ CFA ___ Rotary ___ Rock Coring ___ Drilling Fluid ___

Elevation

DEPTH, FT			SAMPLE			SPT Blows
FROM	TO	DESCRIPTION	TYPE	DEPTH, FT	RECOVERY	N/6"
0	50	S 1 SAND	SPT	0 2 5	14	9 10-13
		S-2	SPT	5 6 5	13	8 10-13
		S-3	SPT	10-11 5	14	3-4-4
		S-4	SPT	15-16 5	12	3 5-8
		S 5	SPT	20-21 5	14	3-5-6
		S-6	SPT	25-26 5	11	3 6-6
		S-7	SPT	30-31 5	11"	4-5-6
		S-8	SPT	35-36 5	12	3-5-7
		S-9	SPT	40-41 5	13	4-6-7
		S-10	SPT	45-46 5	12	5 6-7
		S-11	SPT	50-51 5	14"	4-4-7
50	55	S-12 SPOON REFUSAL	SPT	55		50/0

WATER LEVEL OBSERVATIONS			
DURING DRILLING			FT
AT COMPLETION			FT
AFTER		HRS	FT
AFTER		HRS	FT
AFTER		HRS	FT

NOTES

Piezometer Installed ___ YES X NO

Depth 55 Ft

Using 3¾ hollow stem augers

Sampling with 1⅜ ID Split Spoon (SPT)

Qualifying terms Trace < 10% Some ~ 10 – 50%

Brotcke Well & Pump

FIELD BORING LOG

Boring No B-9

Project Rivermines Tailing Site Job No 01854 Date Aug 13 2001

Location Park Hills MO Crew D Houston and D Adams

Drilling Method X HSA ___ CFA ___ Rotary ___ Rock Coring ___ Drilling Fluid ___

Elevation

DEPTH, FT			SAMPLE			SPT Blows
FROM	TO	DESCRIPTION	TYPE	DEPTH, FT	RECOVERY	N/6"
0	40	S-1 SAND	SPT	0-2 5	14	1-4 5
		S-2	SPT	5-6 5	16	4 9-11
		S-3	SPT	10-11 5	13	1-3-4
		S-4	SPT	15-16 5	16	1-3-5
		S-5	SPT	20-25 5	16	2-3-4
		S-6	SPT	25-26 5	21	2-6-5
		S-7	SPT	30-31 5	15	3-7-9
		S-8	SPT	35-36 5	16	4-6-6
		S-9	SPT	40-41 5	14	5-7 6
40	55	S-10 SLIME	SPT	45-46 5	20	1-2-3
		S-11	SPT	50-51 5	20	1-2-2
		S-12	SPT	55 56 5	24	0-2-1
55	60	S-13 CLAY	SPT	60-61 5	8	4-7-9
60	64	CLAY REFUSAL @ 64				

WATER LEVEL OBSERVATIONS			
DURING DRILLING	Dry		FT
AT COMPLETION			FT
AFTER		HRS	FT
AFTER		HRS	FT
AFTER		HRS	FT

NOTES Piezometer Installed ___ YES X NO

Depth 64 Ft

Using 3¾ hollow stem augers

Sampling with 1⅜ ID Split Spoon (SPT)

Qualifying terms Trace < 10% Some ~ 10 – 50%

Brotcke Well & Pump

FIELD BORING LOG

Boring No B-10

Project Rivermines Tailing Site **Job No** 01854 **Date** Aug 13 2001

Location Park Hills, MO **Crew** D Houston and D Adams

Drilling Method X HSA ___ CFA ___ Rotary ___ Rock Coring ___ Drilling Fluid ___

Elevation

DEPTH, FT			SAMPLE			SPT Blows
FROM	TO	DESCRIPTION	TYPE	DEPTH, FT	RECOVERY	N/6"
0	20	S-1	SPT	0-2 5	14	1-1 2
		S-2	SPT	5-6 5	15	1-1-1
		S-3	SPT	10-11 5	2	W O H
		S-4	SPT	15-16 5	10	1-3 6
20	25	S-5 REFUSAL @ 16 5	SPT	20 21 5		

WATER LEVEL OBSERVATIONS			
DURING DRILLING			FT
COMPLETION	12		FT
AFTER		HRS	FT
AFTER		HRS	FT
AFTER		HRS	FT

NOTES

Piezometer Installed ___ YES X NO

Depth 16 5 Ft

Using 3¾ hollow stem augers

Sampling with 1⅜" ID Split Spoon (SPT)

Qualifying terms Trace < 10% Some ~ 10 – 50%

Geotechnical Services Inc.

September 27, 2000

Barr Engineering
4700 West 77th Street
Minneapolis Minnesota 55435

Attn Mr Ivan Contreras

RE **ELECTRONIC PIEZOCONE SOUNDINGS AND SOIL SAMPLING FOR THE RIVERMINE MINE TAILINGS SITE, PARK HILLS, MISSOURI, GSI JOB #001392**

Dear Mr Contreras

This letter presents cone penetration test data of August 28 – August 29, 2000 made with the cone penetration equipment for the above referenced project The work was conducted as authorized by Barr Engineering based on the agreement dated August 15, 2000

PENETRATION TEST DATA

The piezocone penetration test (CPTU) data were obtained using a Hogentogler Type 2, 10 ton electronic subtraction cone The cone has a tip angle of 60 degrees, a tip area of 10 cm^2, a net area ratio correction factor of 0 8, and a friction sleeve area of 150 cm^2 The cone was pushed hydraulically by a 20-ton cone truck at a rate of about 1-inch per second Data was collected at 5-cm intervals and is reported as an average over a 25-cm depth interval The CPTU was made in substantial compliance with ASTM D 3441 The cone data were processed using procedures developed by Hogentogler & Co , and modified by GSI

The CPTU data are presented in both tabular and graphical form on the enclosed tables and figures The figures present the peizocone data and graphic logs containing our evaluation of the geologic materials from the piezocone data The tabular data list the soil behavior type (soil classification) based on the Simplified Soil Classification Chart for Standard Electronic Friction Cone by Robertson and Campanella (1986) and Roberston, et al (1986) Although this interpretation provides a general indication of soil type based on tip resistance and friction ratio the actual soil types may differ from those inferred The relative density is determined using the correlation proposed by Jamiolkowski et al (1985) The drained friction angle was determined using the correlation proposed by Kulhawy and Mayne (1990) The abbreviations used for the CPTU data are as follows

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q_c	Tip Resistance, Uncorrected	μ_o	Hydrostatic Pore Water Pressure
q_T	Tip Resistance Corrected	σ_{vo}	Effective Overburden Stress
f_s	Sleeve Friction	B_q	Pore Pressure Ratio
R_f	Friction Ratio	F	Normalized Friction Ratio
f_s/σ_{vo}	Normalized Sleeve Friction	I_c	Soil Behavior and Classification
Q	Normalized Net Tip Resistance	Φ	Friction Angle
μ	Penetration Pore Water Pressure	D_r	Relative Density
σ_{vo}	Total Overburden Stress		

The 6 piezocone penetration soundings were made at the locations shown on the attached site plan The piezocone penetration soundings were located in the field by Barr Engineering We understand Barr Engineering will determine the ground surface elevations at the cone locations at a later time

INTERPRETATION OF DATA

The piezocone soundings were made to obtain subsurface information concerning the depth and thickness of the lead mine tailings and to identify the depth to a dense formation believed by Barr Engineering to be bedrock This information will be used to aid in determination of the stability of the tailings and associated tailings dam Soil descriptions of the tailings as fine-grained or coarse-grained materials are based on our evaluation of the cone data and are provided as part of the graphical presentation of the cone data Piezocone soundings C-1, C-2, C-2a, C-3, C 4 and C-5 were made thru the tailings pile as shown on the enclosed location plan The results of the cone soundings indicate a layering of fine and coarse grained soundings of various depths underlain by the denser formation believed to be bedrock

PORE PRESSURE DISSIPATION DATA

The piezocone penetration soundings were interrupted at various depths during the sounding process to monitor and record the dissipation of generated excess pore water pressures into the tailings formation The measured penetration pore water pressure was recorded with time to provide an estimate of the equilibrium pore water pressure The equilibrium pore water pressure at the completion of the dissipation test is thought to represent the static pore water pressure at the test depth In most instances, the data collected indicated the water table had not been encountered The depths and duration of the dissipation tests were determined in the field by Barr Engineering The dissipation test data are represented in graphical form in the enclosed figures Measurements of the static water level in the open hole were made with an electronic water level indicator Water levels where detected, are recorded as part of the tabular data in the enclosed tables The sounding holes were then filled with granulated bentonite

SOIL SAMPLING

Soil samplings were obtained using a 1 1/4 ' diameter discrete soil sampler pushed with the cone rods Samples were collected from a separate penetration hole adjacent to peizocone soundings C-2 and C-5 The samples were collected at depths and in quantities as determined by Barr Engineering, and were turned over to Barr Engineering on site The sample holes were then filled with granulated bentonite

We look forward to working with you on other projects to apply this exploration technology If you have any questions regarding this information or need further information, please contact our office

Respectfully,
GEOTECHNICAL SERVICES, INC

Jorge Santos
Senior Engineering Technician

Steven R Saye, P E
Senior Engineer

Enclosures

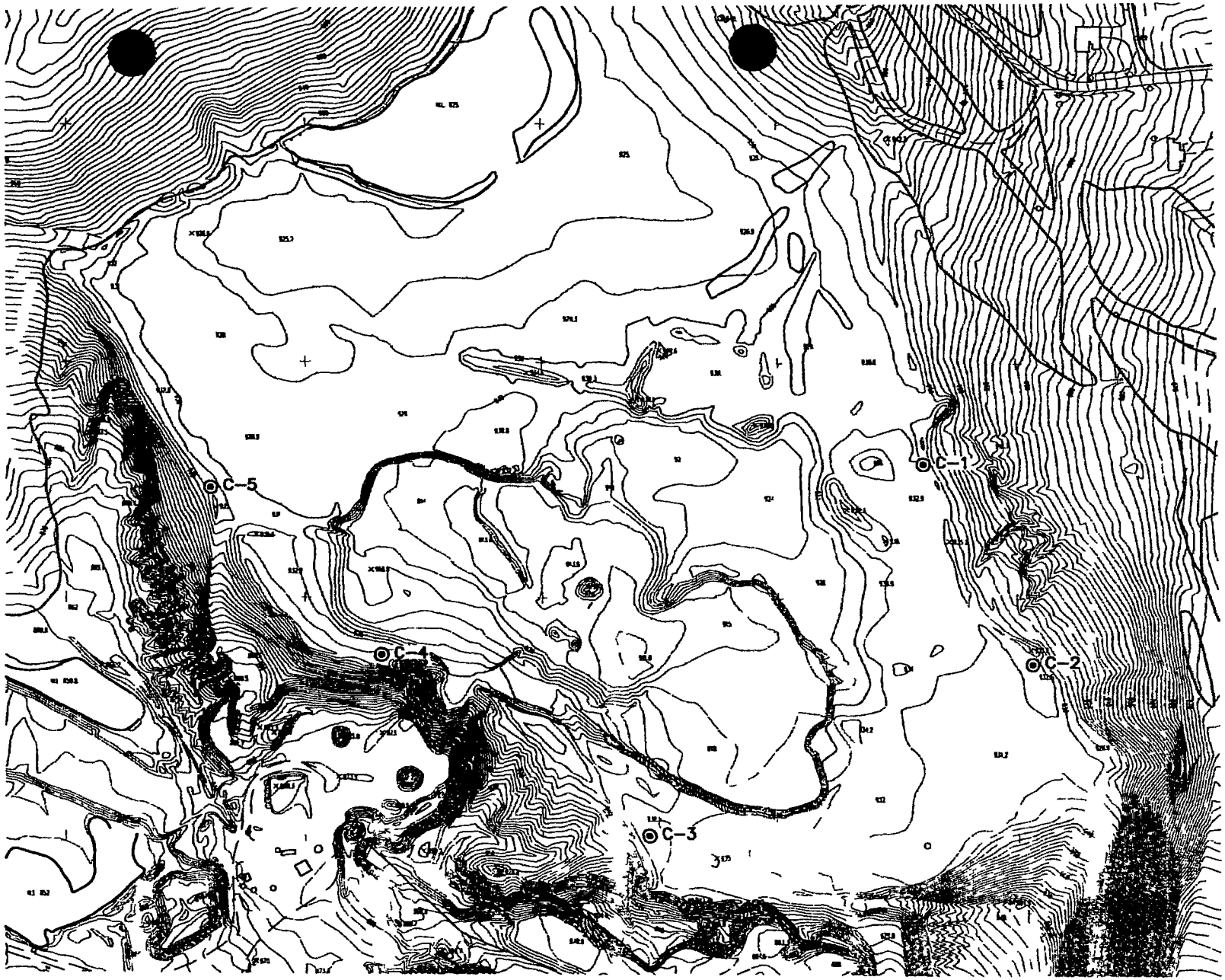
TABLE OF REFERENCES

Robertson, P K and R G Campanella, Guidelines fro Use, Interpretation and Application of the CPT and CPTU , Hogentogler and Company, Inc 3rd ed , November 1986

Robertson, P K , R G Campanella, D Gillespie, and J Grieg, Use of Piezometer Cone Data ', Proceedings of In Situ 86, ASCE Specialty Conference, Blacksburg, Virginia 1986

Jamiolkowski, M G Baldi, R Bellotti V Ghionna and E Pasqualini, Penetration Resistance and Liquefaction of Sand , Proceedings, 11th International Conference on Soil Mechanics and Foundation Engineering, Vol 4 San Francisco 1985 pp 1891-1896

Kulhawy, F H and P W Mayne, Manual on Estimating Soil Properties for Foundation Design August 1990, EL-6800 Electric Power Research Institute, Palo Alto, California



0 200 400
SCALE IN FEET

Con P trometer Soundi g Only
Index Contour
Intermed t Cont ur
Depression Cont ur
Gu d R l
Swamp Symb l
Cont l Po nt
Sidewalk
Bu ld' g
Fo nd tio
Tree Line
Stream
Brush/Shrub Lune
P ved Road
U pa ed R ad
Trail
Driveway
X 325 6 Spot Elevat n
Single Tree
Located Object
C tch Ba in
Manhole
Pol
Sign
I let Symb l

Figure 3
CONE PENETROMETER SOUNDING LOCATIONS
Rivermine Mines Tailings Site
Park Hills MO

SOUNDING INFORMATION

PROJECT	R mm es M es	PROJECT LOCATION	Park Hills M ssouri			Depth	U t W ght	D pth	U t W ght		
CPT DESIGNATION	CPTU-C 1	PROJECT NUMBER	001392			(ft)	(p f)	(ft)	(pcf)	Water tabl depth us d f r σ_{vo} c lculat	
ELEVATION		DATE	08/28/2000			0	121	17 5	117 8	feet	
STATION		SUPERVISOR	J Santos	W ter tabl Datum	N t Detect d	5	113	24	121		
OFFSET		PUSHED BY	GSI	W ter Depth ATD	Not Detected	13 5	117 8	28	116		
CONE USED	33	DRILLING EQUIPMENT	Co Truck	D l y d W ter Le l	Not Measured	15	11 5	33	113		
CONE SIZE	H gent gl r 10 ton	NET AREA RATIO	0 8	T me of Del y	No read g take						Sounding terminated at planned depth

001392 CPTU C 1 Rivermines Mines

Park Hills Missouri

DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ_o	q_E (mPa)	μ (psi)	σ_{vo} (ksf)	μ_o (ksf)	σ_{vo} (ksf)	B_q	Q	F (%)	I_c	ϕ (Degrees)	D_r (%)
0 49	24	0 5	1 61	6 59	1 1	0 1	0 06	0 0	0 06	-0 01	396 60	2 22	1 79	37 7	33 1
1 31	239	2 5	1 07	16 15	11 4	0 2	0 16	0 0	0 16	0 00	1504 59	1 07	1 28	46 4	85 4
2 13	201	1 6	0 78	6 36	9 6	0 2	0 26	0 0	0 26	0 00	778 41	0 78	1 26	44 4	73 4
2 95	175	1 3	0 74	3 64	8 4	0 2	0 36	0 0	0 36	0 00	487 90	0 74	1 34	42 9	64 7
3 77	153	1 1	0 73	2 41	7 3	0 2	0 46	0 0	0 46	0 00	333 26	0 72	1 43	41 7	57 4
4 59	91	1 0	1 06	1 73	4 4	0 2	0 56	0 0	0 56	0 00	163 59	1 05	1 77	38 8	39 9
5 41	37	0 6	1 69	0 95	1 8	1 2	0 65	0 0	0 65	0 03	55 96	1 70	2 25	34 1	11 7
6 23	10	0 5	16 37	0 61	0 5	0 5	0 74	0 0	0 74	0 05	13 07	4 65	3 02	27 7	26 5
7 05	61	0 7	1 14	0 82	2 9	0 1	0 84	0 0	0 84	0 00	71 73	1 14	2 06	35 9	22 3
7 87	18	0 4	3 10	0 48	0 9	0 2	0 93	0 0	0 93	0 01	18 60	2 57	2 74	29 9	13 8
8 69	25	0 4	1 90	0 43	1 2	0 1	1 02	0 0	1 02	0 01	23 66	1 82	2 57	31 2	5 8
9 51	5	0 3	4 85	0 23	0 2	1 1	1 11	0 0	1 11	0 28	3 44	6 67	3 58	23 2	53 7
10 33	5	0 3	-4 92	0 27	0 2	5 2	1 21	0 0	1 21	1 34	3 20	8 29	3 66	23 1	54 2
11 15	11	0 2	54 88	0 16	0 5	6 6	1 30	0 0	1 30	0 71	7 21	2 22	3 05	26 5	33 9
11 97	30	0 5	2 35	0 38	1 4	0 6	1 39	0 0	1 39	0 02	20 58	1 83	2 62	31 3	5 2
12 80	90	0 7	0 79	0 46	4 3	0 7	1 49	0 0	1 49	0 01	59 69	0 78	2 03	36 4	25 4
13 62	93	0 8	0 84	0 50	4 5	0 0	1 58	0 0	1 58	0 00	58 03	0 86	2 06	36 4	25 4
14 44	92	0 7	0 83	0 44	4 4	0 0	1 68	0 0	1 68	0 00	53 82	0 83	2 08	36 2	24 2
15 26	21	0 4	2 23	0 23	1 0	1 9	1 74	0 0	1 74	0 10	11 19	2 06	2 87	29 1	18 4
16 08	7	0 2	2 93	0 10	0 3	7 4	1 75	0 0	1 75	1 39	3 04	3 24	3 45	23 8	50 0
16 90	6	0 2	4 79	0 12	0 2	14 2	1 76	0 0	1 76	3 41	2 38	4 89	3 64	23 0	55 0
17 72	94	0 7	0 81	0 42	4 5	1 1	1 80	0 0	1 80	0 01	51 48	0 81	2 09	36 1	23 9
18 54	110	0 8	0 71	0 41	5 3	0 6	1 90	0 0	1 90	0 01	57 02	0 71	2 02	36 7	27 6
19 36	96	0 8	0 84	0 40	4 6	2 5	1 99	0 0	1 99	0 03	47 31	0 85	2 13	36 0	23 0
20 18	54	0 8	1 89	0 39	2 6	6 1	2 09	0 0	2 09	0 12	24 90	1 54	2 51	33 1	5 8
21 00	5	0 2	3 64	0 09	0 1	19 6	2 19	0 0	2 19	6 08	1 47	5 84	3 85	22 0	60 9
21 82	70	0 6	1 51	0 24	3 3	6 2	2 28	0 0	2 28	0 09	29 75	0 82	2 30	34 2	12 0
22 64	98	0 7	0 76	0 31	4 7	1 0	2 38	0 0	2 38	0 01	40 17	0 78	2 17	35 6	21 0
23 46	97	0 7	0 70	0 27	4 6	0 7	2 48	0 0	2 48	0 01	38 16	0 71	2 17	35 5	20 1
24 28	124	0 7	0 58	0 28	5 9	1 2	2 57	0 0	2 57	0 01	47 17	0 60	2 05	36 6	26 6
25 10	150	0 8	0 56	0 31	7 2	1 0	2 67	0 0	2 67	0 01	55 24	0 57	1 98	37 4	31 6

DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ_{vo}	q_E (mPa)	μ (psi)	σ_{vo} (ksf)	μ_o (ksf)	σ'_{vo} (ksf)	B_q	Q	F (%)	I_c	ϕ (Degrees)	D_r (%)
25 92	163	0 9	0 58	0.34	7 8	2 4	2 77	0 0	2 77	0 01	57 86	0 59	1 97	37 7	33 4
26 74	170	1 2	0 68	0 40	8 1	3.3	2 87	0 0	2 87	0 02	58 17	0 70	2 01	37 8	34 1
27 56	174	1 1	0 66	0 38	8 3	3 6	2.97	0 0	2 97	0 02	57 50	0 67	2 00	37 9	34 2
28 38	71	0 9	1 39	0 29	3 4	8 0	3 07	0 0	3 07	0 12	22 22	1.29	2 51	33 5	8.2
29 20	118	1 0	0 83	0 31	5 6	7 4	3 16	0 0	3 16	0 06	36 36	0 85	2.23	35 9	22 3
30 02	82	1 0	1 42	0 32	3 9	9 9	3 26	0 0	3.26	0 13	24 30	1 32	2 48	34 1	11 5
30 84	27	0 5	2.22	0 16	1 1	23.3	3 35	0 0	3 35	0 99	7 01	2.25	3 06	28 6	21 0
31 66	72	0 7	1 05	0 22	3 4	10 3	3 45	0 0	3 45	0 15	19 74	1 09	2 51	33 3	6 7
32 48	72	0 9	1 55	0 27	3 3	11 3	3 54	0 0	3.54	0 17	19 18	1 39	2 58	33.2	6 3
33 30	68	1 1	2 07	0.31	3 1	16 1	3 64	0 0	3 64	0 25	17 68	1 74	2 66	32 9	4 4
34 12	12	0 2	2 10	0 06	0.3	40 2	3 73	0 0	3 73	4 91	2 19	2 93	3 55	24 5	-45 8
34 94	11	0.2	1 42	0 04	0 2	47 5	3 82	0 0	3 82	6 46	1 92	2 12	3 54	24 1	-48 1
35 76	20	0 3	1 96	0 08	0 7	44.3	3 92	0 0	3 92	2 76	4 11	1 84	3 22	26 9	31 7
36 58	22	0.3	1.23	0 07	0 8	43 4	4 01	0 0	4 01	2 38	4 55	1 45	3 13	27 3	29 0
37 40	14	0 1	0 54	0 02	0 4	43 8	4 10	0 0	4 10	4 43	2 41	0 77	3 28	25 0	-42 6
38.22	12	0 2	1 53	0 04	0 4	25 9	4 19	0 0	4 19	3 50	1 76	2 33	3 59	24 1	-48 3
39 04	58	1 3	3 08	0 31	2 6	21 4	4.29	0 0	4.29	0 40	12 48	2 45	2 87	31 7	2 6
39 86	12	0 1	0 66	0 02	0.2	53 5	4.38	0 0	4.38	7 47	1 64	1 06	3 49	24 0	-49 1
40 68	44	0 5	1 56	0 12	1 8	51 9	4 47	0 0	4 47	1 30	8 94	1 33	2 85	30 4	10 7

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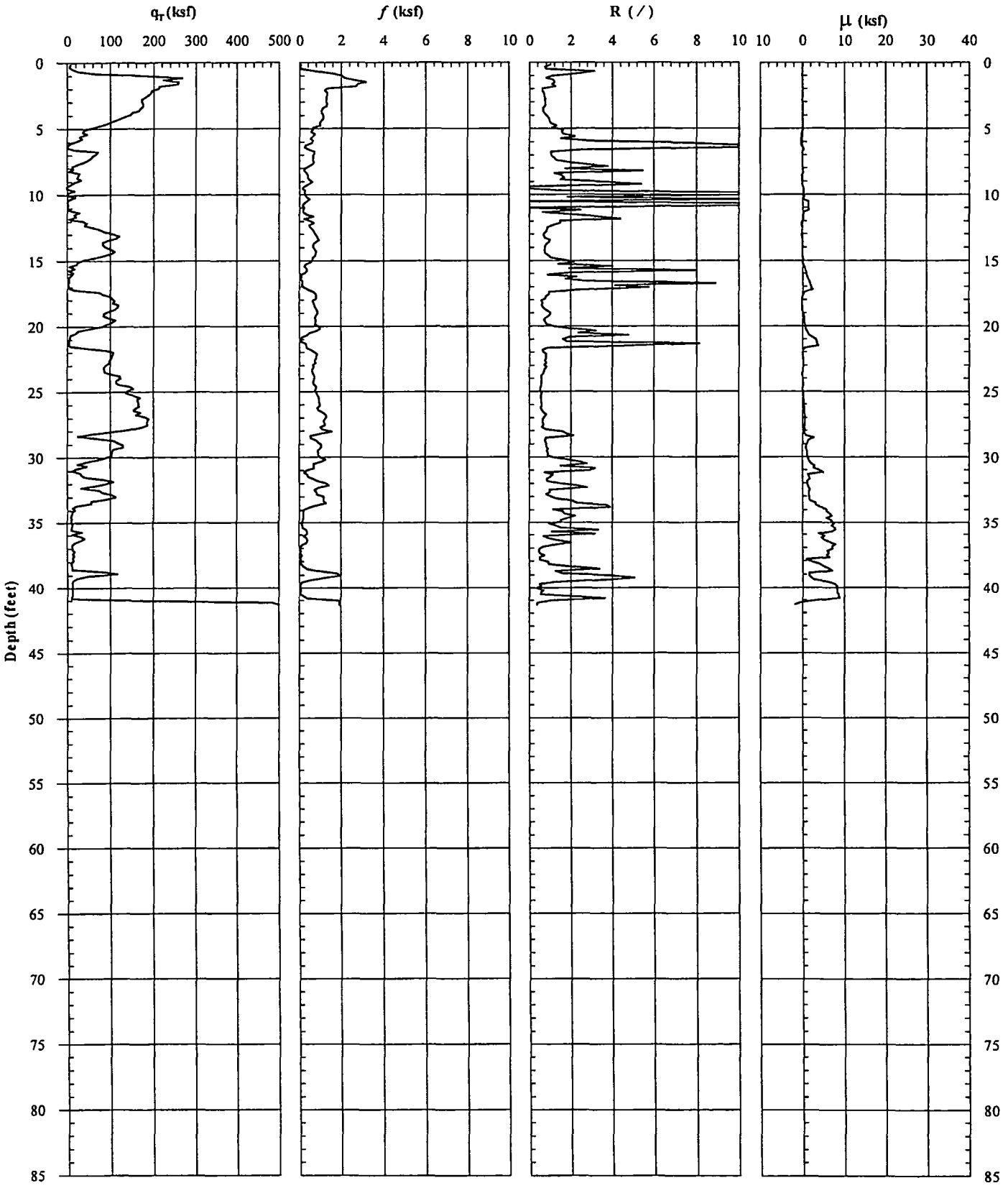
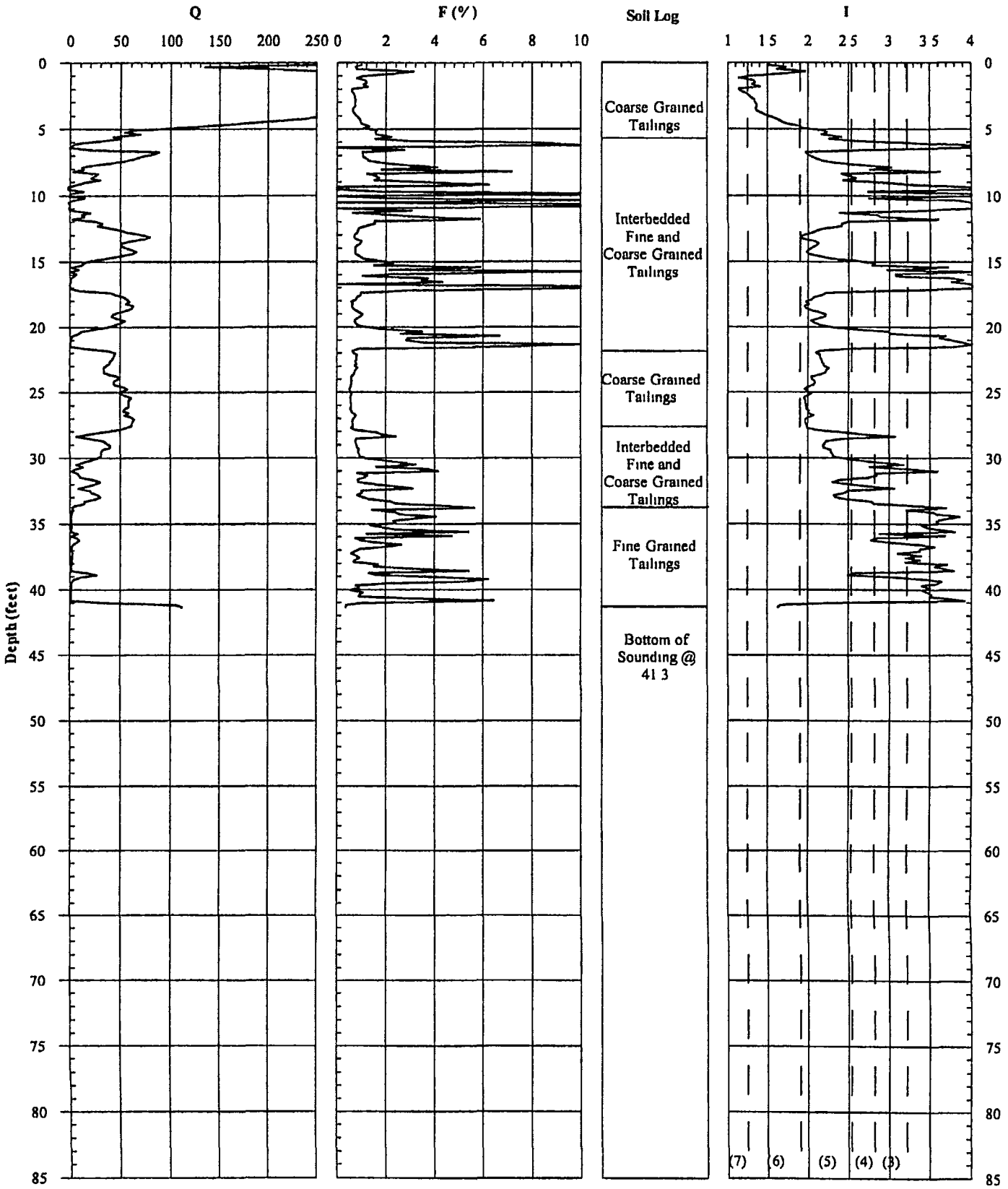
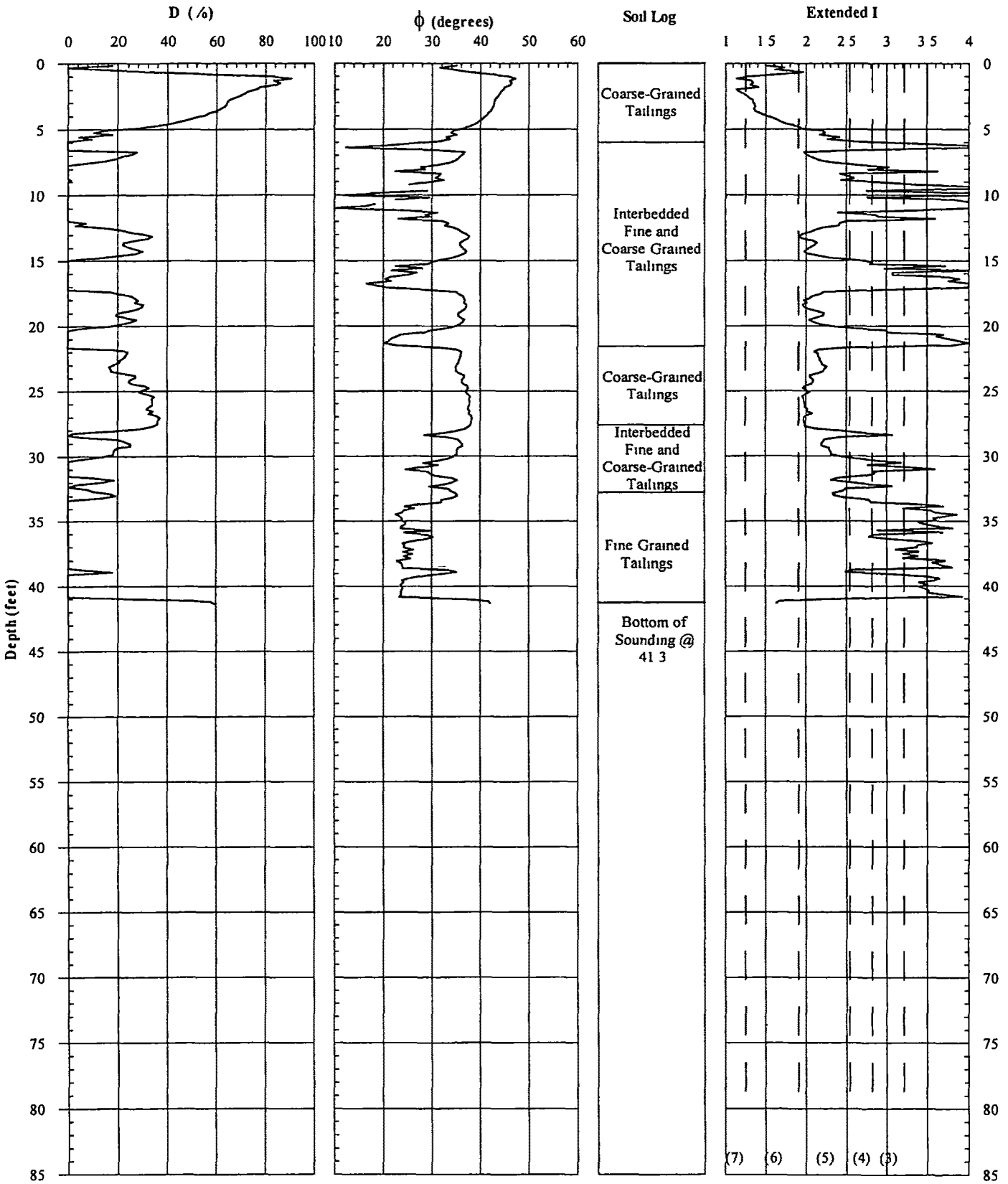
CPTU C1


q_T (ksf)
0 100 200 300 400 500
f (ksf)
0 2 4 6 8 10
R (/)
0 2 4 6 8 10
μ (ksf)
10 0 10 20 30 40
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85

CPTU C1


Q
0 50 100 150 200 250
F (%)
0 2 4 6 8 10
Soil Log
I
1 1.5 2 2.5 3 3.5 4
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
Coarse Grained Tailings
Interbedded Fine and Coarse Grained Tailings
Coarse Grained Tailings
Interbedded Fine and Coarse Grained Tailings
Fine Grained Tailings
Bottom of Sounding @ 41.3
(7) (6) (5) (4) (3)

CPTU C1


D (%)
0 20 40 60 80 100
ϕ (degrees)
10 20 30 40 50 60
Soil Log
Extended I
1 1.5 2 2.5 3 3.5 4
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
Coarse-Grained Tailings
Interbedded Fine and Coarse Grained Tailings
Coarse-Grained Tailings
Interbedded Fine and Coarse-Grained Tailings
Fine Grained Tailings
Bottom of Sounding @ 41.3
(7) (6) (5) (4) (3)

SOUNDING INFORMATION

PROJECT	Rivermines Mines	PROJECT LOCATION	Park Hills, Missouri			Depth (ft)	Unit Weight (pcf)	Depth (ft)	Unit Weight (pcf)	Water table depth used for σ'_{vo} calculation	
CPT DESIGNATION	CPTU-C 2	PROJECT NUMBER	001392			0	120	70	114 6	feet	
ELEVATION		DATE	08/28/2000			10	111.5				
STATION		SUPERVISOR	J Santos	Water table Datum	Not Detected	24.5	121				
OFFSET		PUSHED BY	GSI	Water Depth ATD	Not Detected	40	124 2				
CONE USED	243	DRILLING EQUIPMENT	Cone Truck	Delayed Water Level	Not Measured						
CONE SIZE	Hogentogler 10 ton	NET AREA RATIO	0 8	Time of Delay	No reading taken						Sounding terminated at planned depth

001392 CPTU C 2 Rivermines Mines

Park Hills Missouri

DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ_o	q_E (mPa)	μ (psi)	σ_{vo} (ksf)	μ_o (ksf)	σ'_{vo} (ksf)	B_q	Q	F (%)	I_c	ϕ (Degrees)	D_r (%)
0 49	73	0 3	0 46	5.26	3 5	0 0	0 06	0 0	0 06	0 00	1239 87	0 41	0 91	43 1	65 6
1 31	129	0 9	0 68	5 64	6.2	0 1	0 16	0 0	0 16	0 00	816 36	0 68	1 19	43 4	67 7
2 13	138	1 0	0 70	3 81	6 6	-0 1	0.26	0 0	0 26	0 00	538 88	0 70	1 29	42 6	62 8
2 95	121	1 0	0 79	2 71	5 8	-0 1	0 35	0 0	0 35	0 00	339 69	0 79	1 46	41 2	54 3
3 77	137	1 0	0 70	2 11	6 5	0 1	0 45	0 0	0 45	0 00	300 62	0 70	1 46	41 2	54.3
4 59	139	1 0	0 73	1 87	6 7	-0 1	0 55	0 0	0 55	0 00	251 40	0 74	1 53	40 8	52 0
5 41	109	0 9	0 84	1 38	5 2	0 5	0 65	0 0	0 65	0 00	167 49	0 82	1 68	39 3	42 8
6.23	37	0 6	2 31	0 83	1.8	3 4	0 75	0 0	0 75	0 09	49 13	1 69	2 29	33 8	10 0
7 05	53	0 5	2 65	0 64	2 5	4 1	0 85	0 0	0 85	0 08	61 90	1 05	2 09	35.2	18.3
7 87	67	0 5	0 81	0 58	3.2	1 0	0 94	0 0	0 94	0 01	70 19	0 81	1 98	36 1	23 4
8 69	62	0 4	0 69	0 41	2 9	2 1	1 04	0 0	1 04	0 03	57 99	0 71	2 01	35 4	19 5
9 51	25	0 3	1 48	0 29	1 2	5.3	1 14	0 0	1 14	0.22	20 89	1 38	2 54	30 9	7 6
10 33	0	0 1	-64 00	0 08	0 1	12 1	1 24	0 0	1 24	9 15	1 07	7 24	#N/A	#N/A	#N/A
11 15	1	0 1	0 66	0 04	-0 1	16 1	1 33	0 0	1 33	20 58	-0 59	7 15	#N/A	12 2	119 5
11 97	5	0 2	12 12	0 11	0 1	11 8	1 42	0 0	1 42	3 48	2 40	4 47	3 61	22 5	57 9
12 80	2	0 0	8 91	0 03	0 0	15 1	1 51	0 0	1 51	24 99	0 40	6 28	4 36	18 4	82 4
13 62	0	0 0	3 06	0 02	0 1	19 0	1 60	0 0	1 60	14 70	0 81	1 85	#N/A	9 1	138 5
14 44	1	0 0	11 65	0 03	0 1	18 1	1 69	0 0	1 69	18 56	0 57	-4 93	#N/A	13 0	115 0
15 26	2	0 0	1 98	0 03	0 1	24 2	1 78	0 0	1 78	38 27	0 35	7 58	4 45	18 7	81 0
16 08	3	0 1	2 36	0 03	-0 1	30 6	1 88	0 0	1 88	36.21	0 45	7 57	4.36	19 1	78 3
16 90	3	0 1	2 69	0 04	-0 1	33 6	1 97	0 0	1 97	24 71	0 69	6 47	4 16	19 9	73.2
17 72	3	0 1	1 93	0 03	-0 1	32 8	2 06	0 0	2 06	25 51	0 62	4 98	4 14	19 9	73 7
18 54	4	0 1	1 53	0 03	-0 1	34 6	2 15	0 0	2 15	20 04	0 80	3 48	3 98	20 5	70 1
19 36	5	0 1	1 50	0 03	0 0	33 5	2 24	0 0	2 24	13 93	1 07	2 83	3 82	21 2	65 6
20 18	4	0 1	1 57	0 03	0 0	33 1	2 33	0 0	2 33	15 77	0 90	3 24	3 92	20 9	67 5
21 00	7	0 2	2 93	0 08	0 1	35 7	2 42	0 0	2 42	8 66	1 70	4 46	3 74	22 7	56 8
21 82	6	0 1	1 94	0 05	0 2	20 3	2 52	0 0	2 52	5 19	1 55	3 28	3 71	22 5	57 9
22 64	53	0 3	1 54	0 13	2 4	20 6	2 61	0 0	2 61	0 41	19 28	0 69	2 43	32 5	2 0
23 46	81	0 4	0 52	0 16	3 9	3 9	2 70	0 0	2 70	0 05	29 14	0 53	2 22	34 5	13 9
24 28	83	0 4	0 44	0 13	3 9	4 3	2 79	0 0	2 79	0 05	28 75	0 46	2 20	34 5	14 0
25 10	92	0 4	0 47	0 15	4 4	4 4	2 89	0 0	2 89	0 05	30 88	0 48	2 18	34 9	16 4

DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ_{vo}	q_E (mPa)	μ (psi)	σ_{vo} (ksf)	μ_o (ksf)	σ_{vo} (ksf)	B_q	Q	F (%)	I_c	ϕ (Degrees)	D_r (%)
25 92	109	0 5	0 45	0 16	5 2	4 4	2 99	0 0	2 99	0 04	35 62	0 46	2 11	35 6	20 9
26 74	108	0 5	0 50	0 18	5 2	4 4	3 09	0 0	3 09	0 04	34 13	0 52	2 15	35 5	20 2
27 56	106	0 5	0 46	0 15	5 0	4 3	3 19	0 0	3 19	0 04	32 30	0 47	2 15	35 3	19 1
28 38	120	0 5	0 43	0 16	5 7	4 2	3 29	0 0	3 29	0 04	35 43	0 44	2 11	35 8	22 1
29 20	130	0 6	0 44	0 17	6 2	4 2	3 38	0 0	3 38	0 03	37 50	0 45	2 09	36 2	24 1
30 02	126	0 6	0 47	0 17	6 0	4 2	3 48	0 0	3 48	0 03	35 08	0 49	2 13	35 9	22 7
30 84	101	0 5	0 48	0 14	4 8	4 1	3 58	0 0	3 58	0 04	27 19	0 50	2 23	34 8	16 0
31 66	107	0 5	0 44	0 13	5 1	4 1	3 68	0 0	3 68	0 04	28 19	0 45	2 20	35 0	17 4
32 48	118	0 5	0 42	0 13	5 6	4 1	3 78	0 0	3 78	0 04	30 33	0 43	2 16	35 4	19 8
33 30	129	0 6	0 44	0 15	6 2	4 1	3 88	0 0	3 88	0 03	32 30	0 45	2 15	35 8	21 9
34 12	115	0 5	0 43	0 13	5 5	4 0	3 98	0 0	3 98	0 04	28 00	0 45	2 20	35 2	18 3
34 94	124	0 5	0 41	0 12	5 9	3 9	4 08	0 0	4 08	0 03	29 37	0 42	2 17	35 5	20 0
35 76	138	0 6	0 43	0 14	6 6	3 8	4 18	0 0	4 18	0 03	32 00	0 44	2 15	35 9	22 7
36 58	143	0 6	0 41	0 14	6 8	3 9	4 28	0 0	4 28	0 03	32 46	0 43	2 13	36 1	23 5
37 40	157	0 7	0 44	0 16	7 5	3 8	4 38	0 0	4 38	0 03	34 77	0 45	2 12	36 4	25 7
38 22	162	0 8	0 47	0 17	7 7	3 8	4 48	0 0	4 48	0 02	35 15	0 48	2 12	36 5	26 3
39 04	151	0 9	0 59	0 19	7 2	3 8	4 58	0 0	4 58	0 03	32 03	0 60	2 20	36 2	24 0
39 86	165	1 1	0 63	0 22	7 9	3 8	4 68	0 0	4 68	0 02	34 33	0 66	2 19	36 5	26 3
40 68	421	1 9	0 46	0 40	20 1	3 7	4 78	0 0	4 78	0 01	87 15	0 46	1 76	40 9	52 8
41 50	383	1 4	0 35	0 28	18 3	3 6	4 88	0 0	4 88	0 01	77 50	0 36	1 76	40 4	49 8
42 32	198	0 4	0 21	0 08	9 5	3 5	4 98	0 0	4 98	0 02	38 75	0 21	1 96	37 2	30 6
43 14	159	0 3	0 19	0 06	7 6	3 5	5 08	0 0	5 08	0 02	30 35	0 20	2 05	36 2	24 0
43 96	206	0 6	0 29	0 12	9 8	3 4	5 18	0 0	5 18	0 02	38 69	0 31	2 01	37 3	31 1
44 78	299	1 1	0 37	0 21	14 3	3 3	5 29	0 0	5 29	0 01	55 53	0 38	1 90	39 1	41 5
45 60	285	0 8	0 29	0 15	13 6	3 3	5 39	0 0	5 39	0 01	51 86	0 30	1 89	38 8	39 9
46 42	310	1 0	0 31	0 18	14 8	3 2	5 49	0 0	5 49	0 01	55 42	0 33	1 88	39 1	42 0
47 24	184	0 4	0 20	0 07	8 8	3 2	5 59	0 0	5 59	0 02	31 99	0 21	2 04	36 6	26 9
48 06	167	0 3	0 19	0 06	8 0	3 1	5 69	0 0	5 69	0 02	28 34	0 20	2 08	36 1	23 8
48 88	162	0 3	0 18	0 05	7 7	3 0	5 80	0 0	5 80	0 02	26 95	0 18	2 09	35 9	22 6
49 70	166	0 3	0 20	0 06	7 9	3 0	5 90	0 0	5 90	0 02	27 18	0 20	2 10	36 0	23 1
50 52	168	0 3	0 17	0 05	8 0	2 9	6 00	0 0	6 00	0 02	27 00	0 18	2 09	36 0	23 2
51 34	179	0 4	0 21	0 06	8 6	2 9	6 10	0 0	6 10	0 02	28 38	0 22	2 09	36 3	24 8
52 16	247	0 8	0 30	0 12	11 8	2 9	6 20	0 0	6 20	0 01	38 89	0 32	2 01	37 8	33 8
52 98	232	0 8	0 32	0 12	11 1	2 9	6 30	0 0	6 30	0 01	35 76	0 34	2 06	37 4	31 7
53 81	191	0 5	0 27	0 08	9 1	2 9	6 41	0 0	6 41	0 02	28 89	0 28	2 12	36 5	26 0
54 63	195	0 5	0 27	0 08	9 3	2 8	6 51	0 0	6 51	0 02	28 98	0 28	2 11	36 5	26 3
55 45	230	0 7	0 31	0 11	11 0	2 9	6 61	0 0	6 61	0 01	33 79	0 32	2 07	37 3	30 8
56 27	224	0 7	0 29	0 10	10 7	2 9	6 71	0 0	6 71	0 01	32 34	0 30	2 08	37 1	29 8
57 09	244	0 8	0 34	0 12	11 6	2 9	6 81	0 0	6 81	0 01	34 76	0 34	2 07	37 5	32 0
57 91	228	0 7	0 31	0 10	10 9	2 8	6 92	0 0	6 92	0 01	32 03	0 33	2 10	37 1	30 0
58 73	203	0 6	0 27	0 08	9 7	2 8	7 02	0 0	7 02	0 01	27 97	0 28	2 13	36 6	26 4

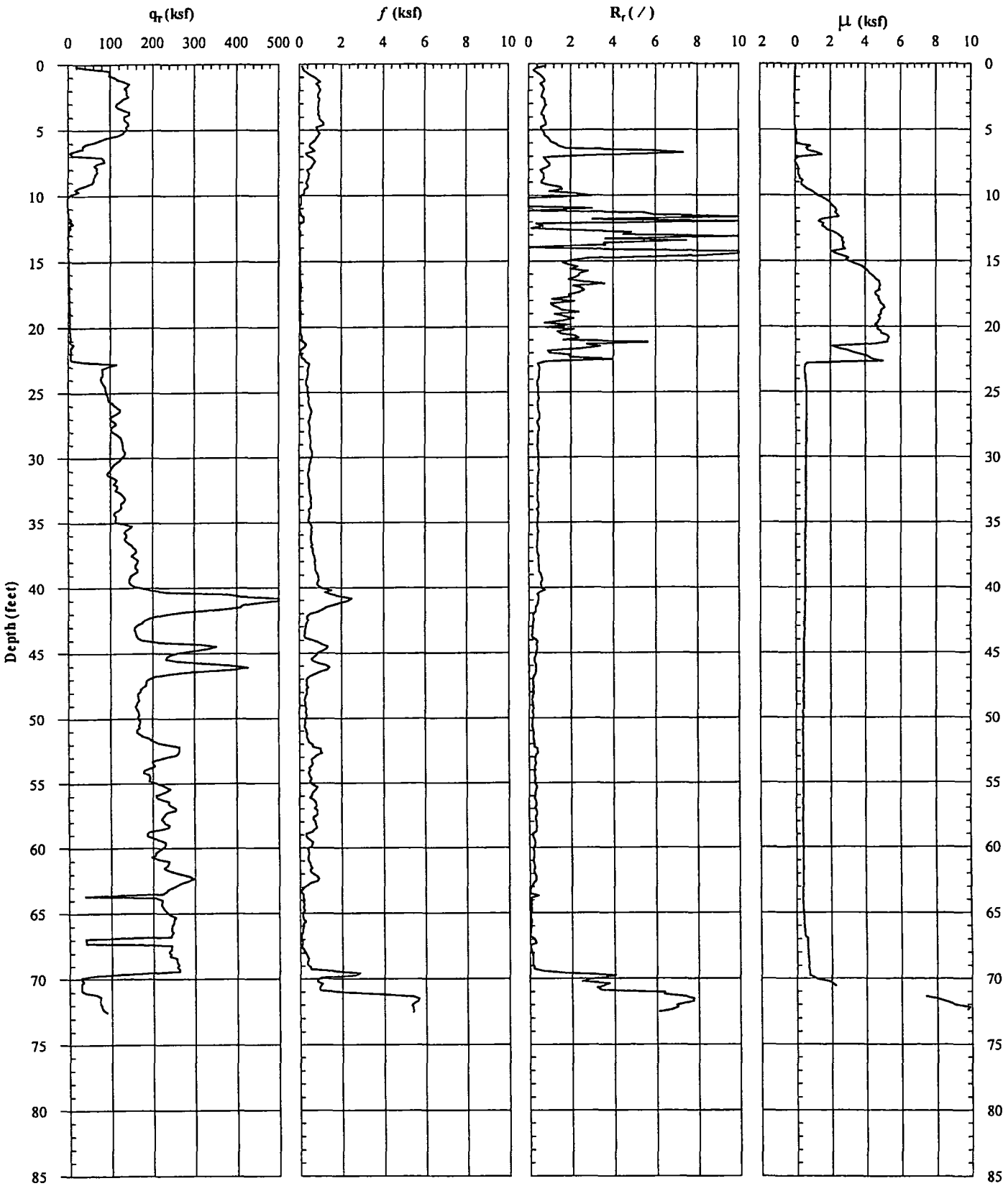
CPTU C 2

Rivermines Mines

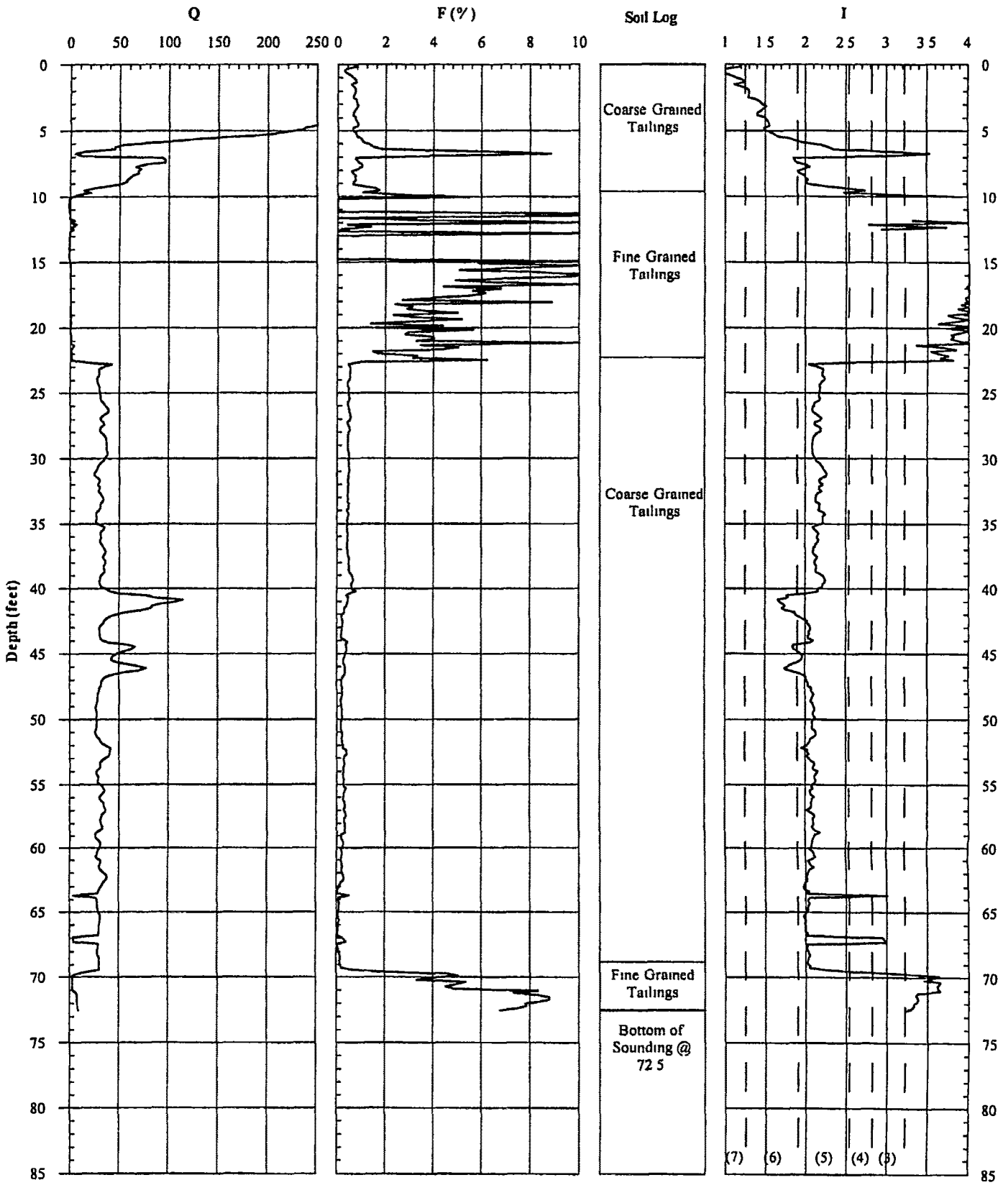
Park Hills Missouri

DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ_{vo}	q_E (mPa)	μ (psi)	σ_{vo} (ksf)	μ_o (ksf)	σ'_{vo} (ksf)	B_q	Q	F (%)	I_c	ϕ (Degrees)	D_r (%)
59 55	221	0 5	0.24	0 07	10 6	2 8	7 12	0 0	7 12	0 01	30 05	0 25	2 09	36 9	28 6
60 37	209	0 4	0.20	0 06	10 0	2 8	7.22	0 0	7 22	0 01	27 89	0.21	2 09	36 6	26 7
61 19	230	0 5	0 21	0 07	11 0	2 8	7.32	0 0	7 32	0 01	30 35	0 22	2 06	37 0	29 3
62 01	267	0 7	0.25	0 09	12 8	2 7	7 43	0 0	7 43	0 01	35 02	0 26	2 03	37 7	33 5
62 83	259	0 4	0 15	0 05	12 4	2 7	7 53	0 0	7 53	0 01	33 42	0 16	1 99	37 5	32 4
63 65	185	0 2	0 14	0 02	8 9	2 7	7 63	0 0	7 63	0 02	23 29	0 09	2 11	35 9	22 6
64 47	224	0 2	0 09	0 03	10 7	2 7	7 73	0 0	7 73	0 01	27 98	0 09	2 03	36 8	27 8
65 29	246	0 2	0 07	0 02	11 8	2 9	7 83	0 0	7 83	0 01	30 41	0 07	1 99	37 2	30.3
66 11	246	0.2	0 06	0 02	11 8	3 2	7 93	0 0	7 93	0 01	29 99	0 06	1 99	37 2	30 1
66 93	121	0 1	0 16	0 01	5 7	4 0	8 04	0 0	8 04	0 04	14 01	0 08	2 33	33 7	9 5
67 75	242	0 2	0 07	0 02	11 6	4 4	8 14	0 0	8 14	0 02	28 74	0 07	2 01	37 0	29.3
68 57	254	0 4	0 14	0 04	12 1	4 6	8.24	0 0	8.24	0 02	29 80	0 15	2 03	37 2	30 5
69 39	204	1 6	1 34	0 19	9 7	4 9	8 34	0 0	8 34	0 02	23 46	0 83	2 39	36 2	24 0
70 21	30	1 0	3 24	0 11	1 3	11 6	8 44	0 0	8 44	0 54	2 53	4 48	3 59	26 9	31 3
71 03	46	2 7	5 34	0 32	1 6	89 7	8 53	0 0	8 53	2.37	4 43	7 25	3 51	29 0	18 8
71 85	74	5 5	7 37	0 63	3 1	61 4	8 63	0 0	8 63	0 93	7 62	8 32	3 36	31 3	5 4

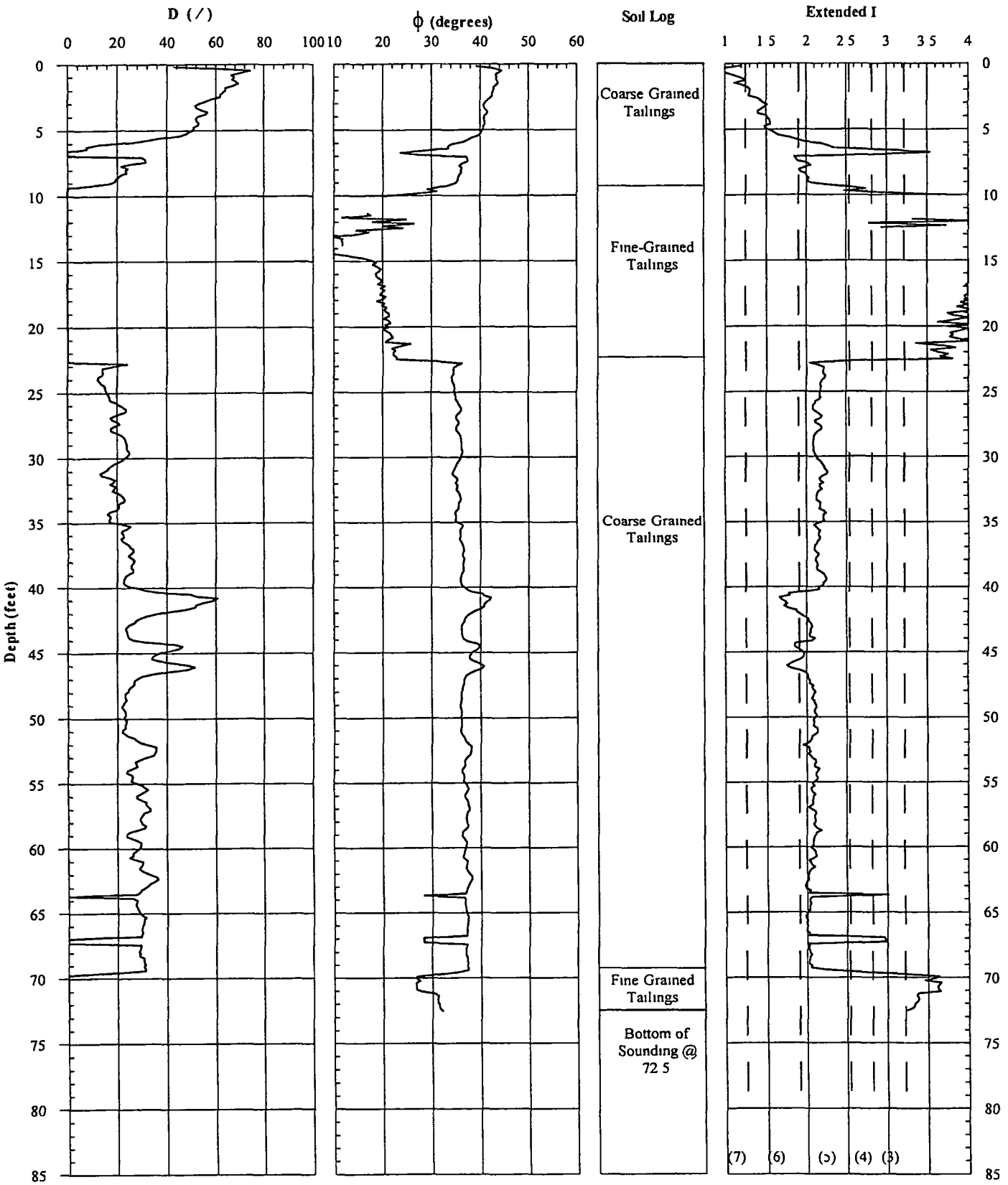
CPTU C2


q_T (ksf)
0 100 200 300 400 500
f (ksf)
0 2 4 6 8 10
R_f (/)
0 2 4 6 8 10
μ (ksf)
2 0 2 4 6 8 10
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85

CPTU C2


Q
0 50 100 150 200 250
F (%)
0 2 4 6 8 10
Soil Log
I
1 1.5 2 2.5 3 3.5 4
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
Coarse Grained Tailings
Fine Grained Tailings
Coarse Grained Tailings
Fine Grained Tailings
Bottom of Sounding @ 72.5
(7) (6) (5) (4) (3)

CPTU C2


D (/)
0 20 40 60 80 100
ϕ (degrees)
10 20 30 40 50 60
Soil Log
Extended I
1 1 5 2 2 5 3 3 5 4
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
Coarse Grained Tailings
Fine-Grained Tailings
Coarse Grained Tailings
Fine Grained Tailings
Bottom of Sounding @ 72 5
(7) (6) (5) (4) (3)

SOUNDING INFORMATION

PROJECT	Rivermines Mines	PROJECT LOCATION	Park Hills, Missouri			Depth (ft)	Unit Weight (pcf)	Depth (ft)	Unit Weight (pcf)	Water table depth used for σ'_{vo} calculation	
CPT DESIGNATION	CPTU-C 2a	PROJECT NUMBER	001392								
ELEVATION		DATE	08/28/2000			0	120			feet	
STATION		SUPERVISOR	J Santos	Water table Datum	Not Detected	10	111.5				
OFFSET		PUSHED BY	GSI	Water Depth ATD	Not Detected	24 5	1 1				
CONE USED	233	DRILLING EQUIPMENT	Cone Truck	Delayed Water Level	Not Measured						
CONE SIZE	Hogentogler 10 ton	NET AREA RATIO	0.8	Time f Delay	No reading taken						Sounding terminated at planned depth

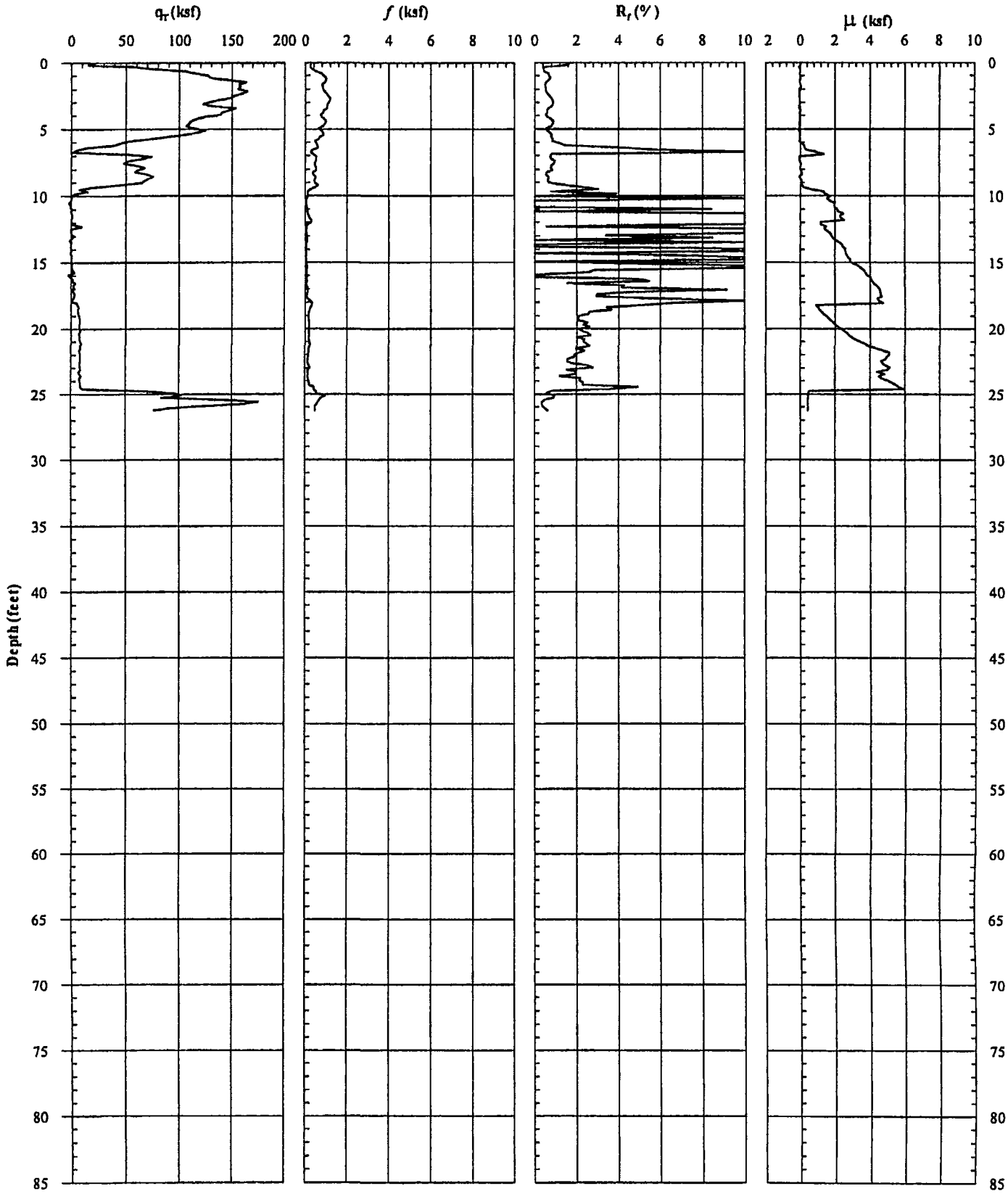
001392 CPTU-C 2a Rivermines Mines

Park Hills Missouri

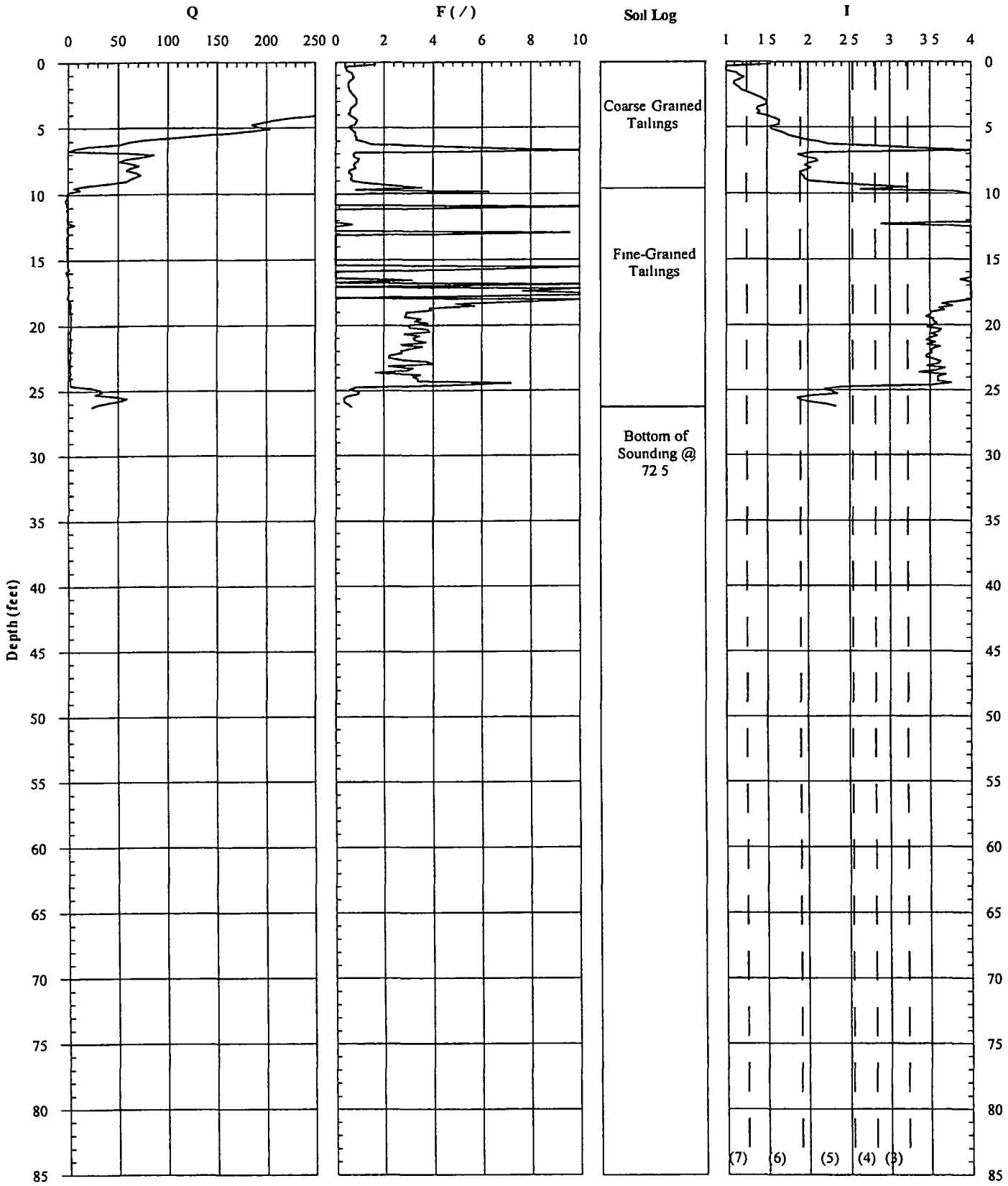
DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ_{vo}	q_E (mPa)	μ (psi)	σ_{vo} (ksf)	μ_o (ksf)	σ'_{vo} (ksf)	B_q	Q	F (%)	I	ϕ (Degrees)	D (%)
0 49	74	0 4	0 72	7 77	3 5	-0 1	0 06	0 0	0 06	0 00	1246 60	0 57	1 05	43 1	65 8
1 31	145	0 9	0 65	6 12	6 9	0 0	0 16	0 0	0 16	0 00	917 73	0 64	1 15	44 0	71 1
2 13	158	1 0	0 60	3 72	7 6	-0 2	0.26	0 0	0 26	0 00	617 49	0 60	1 21	43 3	66 7
2 95	134	1 1	0 84	3 22	6 4	-0.3	0 35	0 0	0 35	0 00	376 59	0 85	1 45	41 7	57 2
3 77	141	0 9	0 61	1 93	6 7	-0 3	0 45	0 0	0 45	0 00	309 62	0 62	1 41	41 3	55 1
4 59	111	0 9	0 78	1 59	5.3	-0 4	0 55	0 0	0 55	0 00	200.37	0 79	1 62	39 7	45 5
5 41	102	0 8	0 77	1 19	4 9	-0.2	0 65	0 0	0 65	0 00	155 33	0 77	1 69	38 9	40 6
6 23	32	0 5	2 65	0 68	1 5	1 2	0 75	0 0	0 75	0 04	41 93	1 62	2 34	33 1	5 6
7 05	48	0 4	3 94	0 52	2 3	3 0	0 85	0 0	0 85	0 06	56 05	0 94	2 09	34 7	15 5
7 87	59	0 5	0 79	0 49	2 8	0 2	0 94	0 0	0 94	0 00	61 58	0 80	2 02	35 4	19 8
8 69	70	0 5	0 65	0 43	3 3	0 4	1 04	0 0	1 04	0 01	65 65	0 66	1 95	36 0	23 0
9 51	18	0 3	2.29	0.28	0 8	5.2	1 14	0 0	1 14	0 31	14 58	1 87	2 75	29 3	17 4
10 33	0	0 1	13.21	0 06	0 1	12 4	1 24	0 0	1 24	10 07	1 00	-6 15	#N/A	#N/A	#N/A
11 15	0	0 1	-0 62	0 10	-0 1	15 4	1 33	0 0	1 33	18.21	0 64	15 16	#N/A	11 7	122 9
11 97	3	0 2	70 98	0 14	0 0	12 1	1 42	0 0	1 42	10 03	0 85	16 19	4 29	19 6	75.3
12 80	1	0 1	24 06	0 05	0 0	11 7	1 51	0 0	1 51	17 95	0 43	12 26	#N/A	14 1	108 3
13 62	0	0 1	9 49	0 05	-0 1	16 4	1 60	0 0	1 60	9 50	1 08	-4 16	#N/A	#N/A	#N/A
14 44	0	0 1	6 87	0 03	-0 1	18 9	1 69	0 0	1 69	13 99	-0 80	-4 15	#N/A	9 5	136 2
15 26	1	0 1	37 93	0 04	-0 1	22 9	1 78	0 0	1 78	28 44	0 45	9 44	#N/A	14 3	106 9
16 08	1	0 1	6 43	0 05	-0 2	27 5	1 88	0 0	1 88	24 52	-0 60	7 84	#N/A	13 0	115 1
16 90	2	0 1	4 77	0 05	-0 1	30 9	1 97	0 0	1 97	59 10	0 27	19 10	4 76	18 6	81 5
17 72	3	0 2	50 90	0 09	-0 1	32 0	2 06	0 0	2 06	51 42	0 30	28 94	4 81	18 8	80 1
18 54	6	0 2	3 49	0 10	0 3	7 9	2 15	0 0	2 15	1 84	2 01	5 19	3 71	22 9	55 5
19 36	8	0.2	2 21	0 08	0 3	12 4	2 24	0 0	2 24	2 17	2 55	3 08	3 51	23 8	50 1
20 18	8	0 2	2 42	0 08	0 3	17 4	2 33	0 0	2 33	3 20	2 34	3 45	3 57	23 6	51 3
21 00	8	0 2	2 35	0 08	0.2	23 9	2 42	0 0	2 42	3 94	2 50	3 30	3 53	23 9	-49 4
21 82	8	0 2	2 06	0 07	0 2	33 9	2 52	0 0	2 52	5 78	2 33	2 94	3 53	23 8	50 3
22 64	8	0 2	2 04	0 07	0 2	33 7	2 61	0 0	2 61	5 77	2 24	2 94	3 55	23 7	50 6
23 46	8	0 1	1 78	0 05	0 2	32 5	2 70	0 0	2 70	5 81	2 07	2 57	3 55	23 6	51 6
24 28	9	0 3	3 06	0 10	0.2	38 0	2 79	0 0	2 79	5 88	2 32	4 46	3 62	24 0	-48 9
25 10	98	0 7	0 75	0 24	4 7	3 3	2 89	0 0	2 89	0 04	32 89	0 75	2 24	35 2	18 2

DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ_{vo}	q_E (mPa)	μ (psi)	σ_{vo} (ksf)	μ_o (ksf)	σ_{vo} (ksf)	B_q	Q	F (%)	I_c	ϕ (Degrees)	D_r (%)
25 92	126	0 5	0 45	0 18	6 0	3 2	2 99	0 0	2 99	0 03	41 25	0 43	2 04	36 3	25 0

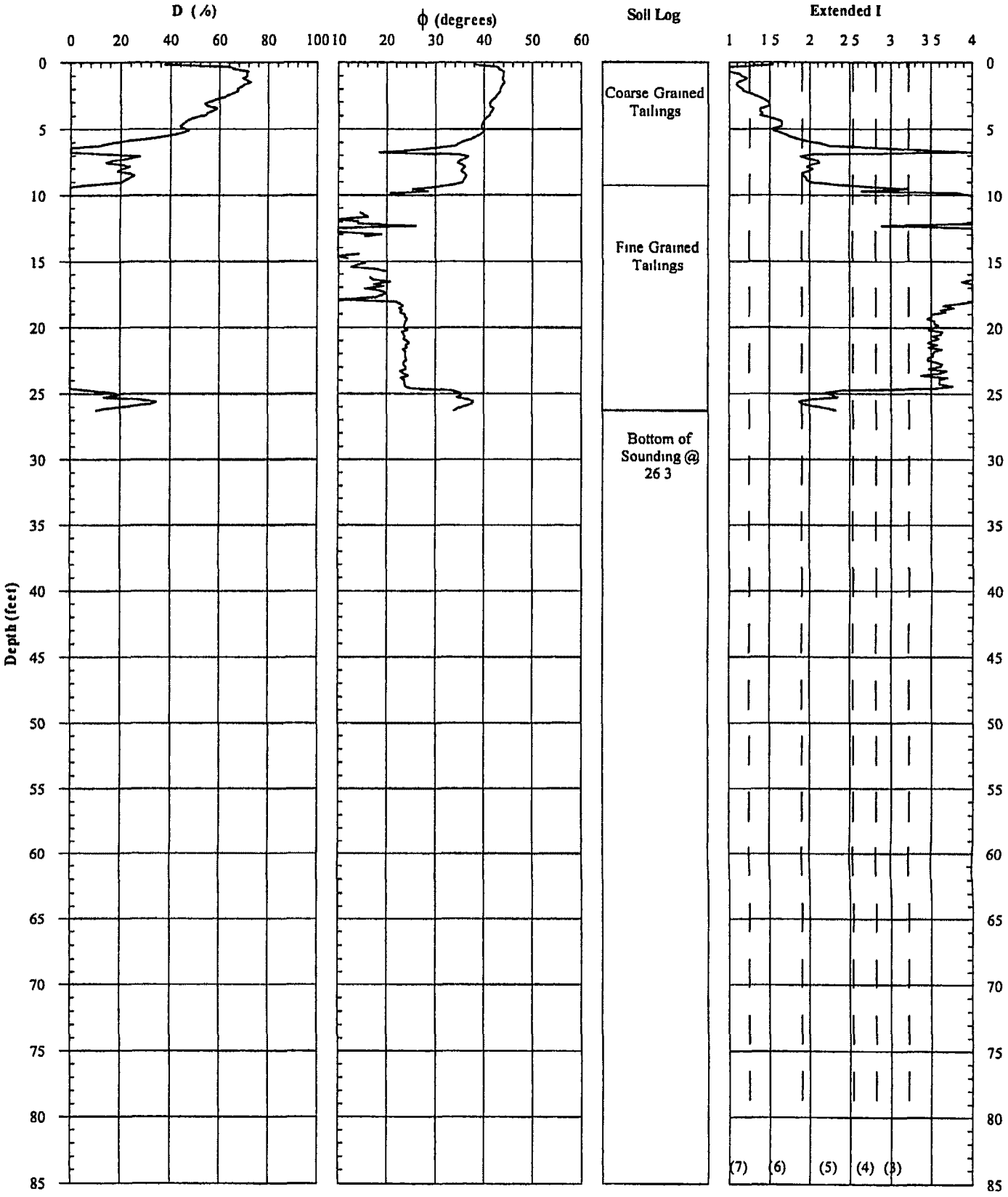
CPTU C2a


q_T (ksf)
0 50 100 150 200
f (ksf)
0 2 4 6 8 10
R_f (%)
0 2 4 6 8 10
μ (ksf)
2 0 2 4 6 8 10
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85

CPTU C2a


Q
0 50 100 150 200 250
F (/)
0 2 4 6 8 10
Soil Log
I
1 1 5 2 2 5 3 3 5 4
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
Coarse Grained Tailings
Fine-Grained Tailings
Bottom of Sounding @ 72 5
(7) (6) (5) (4) (3)

CPTU C2a


D (%)
0 20 40 60 80 100
ϕ (degrees)
10 20 30 40 50 60
Soil Log
Extended I
1 1.5 2 2.5 3 3.5 4
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
Coarse Grained Tailings
Fine Grained Tailings
Bottom of Sounding @ 26.3
(7) (6) (5) (4) (3)

SOUNDING INFORMATION

PROJECT	R rm es M es	PROJECT LOCATION	Park H lls Miss uri			Depth	U t W ght	Depth	U t W ght		
CPT DESIGNATION	CPTU C 3	PROJECT NUMBER	001392			(ft)	(pcf)	(ft)	(pcf)	W ter tabl d pth us d for σ	l l t
ELEVATION		DATE	08/28/2000			0	120				feet
STATION		SUPERVISOR	J Santos	Water table D tum	N t Det t d	42	124 2				
OFFSET		PUSHED BY	GSI	Water D pth ATD	N t Detect d						
CONE USED	233	DRILLING EQUIPMENT	Co Tru k	D layed Water Lev l	Not Measured						
CONE SIZE	H gentogl 10 t	NET AREA RATIO	0 8	T me f Del y	No eading taken						Sounding terminated at planned depth

001392 CPTU C 3 Rivermines Mines

Park Hills Missouri

DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ_o	q_E (mPa)	μ (psi)	σ_{vo} (ksf)	μ_o (ksf)	σ'_{vo} (ksf)	B_q	Q	F (%)	I_c	φ (Degrees)	D (%)
0 49	25	0 2	1 15	3 79	1 2	0 1	0 06	0 0	0 06	0 00	419 57	0 98	1 48	37 9	34 6
1 31	150	1 1	0 75	7 11	7 2	0 1	0 16	0 0	0 16	0 00	954 03	0 75	1 20	44 2	72 2
2 13	177	1 4	0 78	5 44	8 5	0 1	0 26	0 0	0 26	0 00	689 25	0 78	1 28	43 8	69 8
2 95	173	1 2	0 71	3 50	8 3	0 1	0 35	0 0	0 35	0 00	488 49	0 71	1 33	42 9	64 7
3 77	153	1 2	0 75	2 55	7 3	0 0	0 45	0 0	0 45	0 00	337 46	0 75	1 45	41 7	57 6
4 59	184	1 1	0 61	2 03	8 8	0 0	0 55	0 0	0 55	0 00	332 03	0 61	1 38	42 1	59 9
5 41	143	0 9	0 66	1 42	6 8	0 0	0 65	0 0	0 65	0 00	218 52	0 65	1 53	40 5	50 4
6 23	108	0 9	0 84	1 21	5 2	0 1	0 75	0 0	0 75	0 00	143 86	0 84	1 74	38 9	40 5
7 05	113	0 9	0 81	1 05	5 4	0 2	0 85	0 0	0 85	0 00	131 97	0 80	1 76	38 8	39 8
7 87	110	1 0	0 90	1 04	5 3	0 0	0 94	0 0	0 94	0 00	115 21	0 90	1 84	38 4	37 5
8 69	86	0 9	1 00	0 82	4 1	0 6	1 04	0 0	1 04	0 01	81 45	1 01	1 98	37 0	29 1
9 51	115	0 9	0 81	0 81	5 5	0 8	1 14	0 0	1 14	0 01	99 99	0 81	1 85	38 2	36 2
10 33	167	1 2	0 71	0 95	8 0	0 2	1 24	0 0	1 24	0 00	134 05	0 71	1 72	39 8	45 7
11 15	148	1 2	0 82	0 90	7 1	0 1	1 34	0 0	1 34	0 00	109 93	0 82	1 82	39 0	41 2
11 97	156	1 3	0 81	0 88	7 5	0 1	1 44	0 0	1 44	0 00	107 73	0 82	1 83	39 1	41 6
12 80	170	1 5	0 86	0 95	8 2	0 0	1 54	0 0	1 54	0 00	109 88	0 86	1 84	39 3	43 1
13 62	191	1 5	0 81	0 94	9 2	0 1	1 63	0 0	1 63	0 00	116 17	0 81	1 80	39 7	45 6
14 44	214	1 6	0 76	0 94	10 2	0 1	1 73	0 0	1 73	0 00	122 47	0 77	1 77	40 1	47 9
15 26	125	1 3	1 04	0 69	6 0	0 1	1 83	0 0	1 83	0 00	67 21	1 02	2 05	37 4	31 7
16 08	154	1 4	0 88	0 70	7 4	0 7	1 93	0 0	1 93	0 00	78 82	0 89	1 96	38 3	37 0
16 90	107	1 1	0 99	0 52	5 1	0 7	2 03	0 0	2 03	0 01	51 86	1 00	2 14	36 5	25 9
17 72	131	1 2	0 90	0 55	6 3	0 9	2 13	0 0	2 13	0 01	60 57	0 91	2 06	37 3	30 9
18 54	137	1 2	0 92	0 55	6 6	0 9	2 22	0 0	2 22	0 01	60 47	0 91	2 06	37 4	31 5
19 36	156	1 3	0 83	0 54	7 5	0 6	2 32	0 0	2 32	0 00	66 19	0 82	2 00	37 9	34 7
20 18	169	1 3	0 79	0 55	8 1	0 1	2 42	0 0	2 42	0 00	68 88	0 80	1 98	38 2	36 4
21 00	131	1 2	0 92	0 48	6 3	0 5	2 52	0 0	2 52	0 00	50 84	0 93	2 13	36 9	28 4
21 82	147	1 1	0 78	0 44	7 1	0 8	2 62	0 0	2 62	0 01	55 31	0 79	2 06	37 4	31 3
22 64	221	1 8	0 84	0 68	10 6	1 5	2 72	0 0	2 72	0 01	80 28	0 84	1 94	39 2	42 4
23 46	212	1 8	0 87	0 66	10 2	1 6	2 81	0 0	2 81	0 01	74 38	0 88	1 98	38 9	40 7
24 28	201	1 7	0 87	0 60	9 6	1 5	2 91	0 0	2 91	0 01	68 05	0 88	2 01	38 6	38 7
25 10	222	1 8	0 81	0 60	10 7	1 0	3 01	0 0	3 01	0 00	72 81	0 82	1 97	39 0	41 1

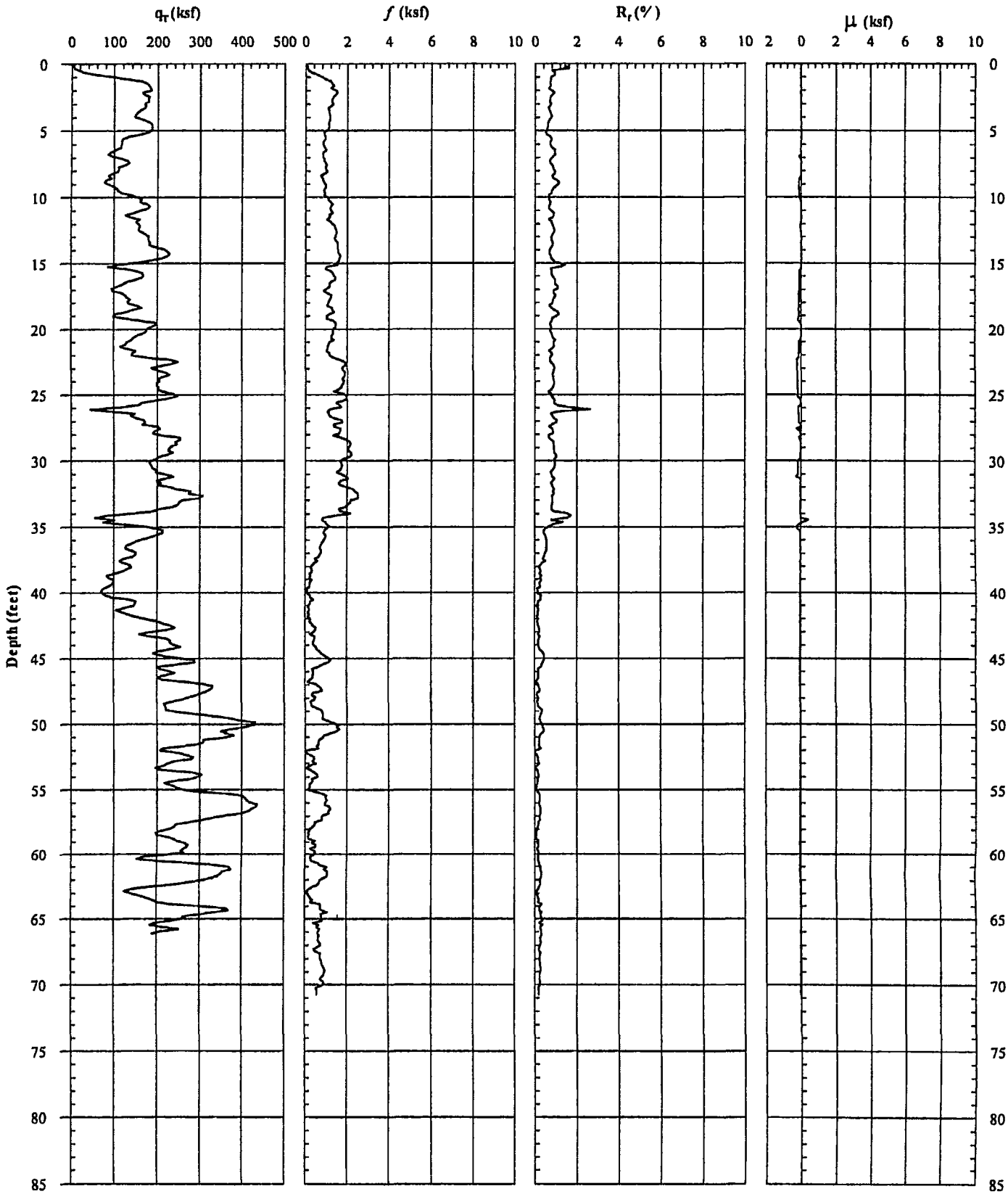
DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ_{vo}	q_E (mPa)	μ (psi)	σ_{VO} (ksf)	μ_O (ksf)	σ_{VO} (ksf)	B_q	Q	F (%)	I_c	ϕ (Degrees)	D_r (%)
25 92	116	1 4	1 42	0 46	5 6	-0 7	3 11	0 0	3 11	0 01	36.24	1 26	2 32	35 8	21 9
26 74	155	1 4	0 91	0 44	7 4	1 0	3 21	0 0	3 21	0 01	47 31	0 94	2 15	37 1	29 9
27 56	192	1 5	0 81	0 47	9 2	-0 5	3 31	0 0	3 31	0 00	56 91	0 82	2 06	38 1	35 5
28 38	241	1 9	0 77	0 55	11 5	-0 3	3 41	0 0	3 41	0 00	69 73	0 78	1 97	39 1	41 6
29 20	229	2 1	0 93	0 61	11 0	-0 1	3 50	0 0	3 50	0 00	64 40	0 95	2 05	38 8	39 8
30 02	191	1 8	0 96	0 51	9 1	-0 9	3 60	0 0	3 60	0 00	51 98	0 98	2 13	37 8	34 2
30 84	208	1 7	0 83	0 47	10 0	1 4	3 70	0 0	3 70	0 01	55 22	0 85	2 07	38 2	36 2
31 66	212	1 8	0 86	0 48	10 1	-0 1	3 80	0 0	3 80	0 00	54 74	0 87	2 08	38.2	36 4
32 48	280	2 5	0 88	0 63	13 4	-0 1	3 90	0 0	3 90	0 00	70 91	0 89	2 00	39 5	44 0
33 30	240	2 0	0 83	0 50	11 5	-0 1	4 00	0 0	4 00	0 00	59 02	0 84	2 05	38 7	39 2
34 12	115	1 4	1 29	0 34	5 5	0 5	4 09	0 0	4 09	0 00	27 10	1.26	2 43	35 1	17 8
34 94	154	1 0	0 77	0 24	7 4	-0 6	4 19	0 0	4 19	0 00	35 69	0 68	2 19	36 4	25 8
35 76	183	0 9	0 51	0 22	8 8	-0 1	4.29	0 0	4 29	0 00	41 64	0 52	2 07	37 2	30 4
36 58	136	0 7	0 55	0 17	6 5	-0 1	4 39	0 0	4 39	0 00	29 96	0 57	2 22	35 7	21 6
37 40	129	0 6	0 44	0 13	6 2	0 0	4 49	0 0	4 49	0 00	27 83	0 45	2 21	35 5	19 9
38 22	124	0 3	0 25	0 07	5 9	-0 1	4 59	0 0	4 59	0 00	26 02	0 26	2 15	35.2	18 3
39 04	93	0 3	0.28	0 06	4 4	-0 1	4 68	0 0	4 68	0 00	18 83	0 29	2 30	33 8	9 8
39 86	77	0.2	0 20	0 03	3 7	-0 2	4 78	0 0	4 78	0 00	15 12	0.22	2 36	32 8	4 1
40 68	135	0 3	0 20	0 05	6 5	-0 2	4 88	0 0	4 88	0 00	26 64	0 20	2 11	35 5	19 9
41 50	126	0 2	0 15	0 04	6 0	-0.2	4 98	0 0	4 98	0 00	24 28	0 15	2 12	35 1	17 6
42 32	212	0.3	0 16	0 07	10 1	-0.2	5 08	0 0	5 08	0 00	40 69	0 17	1 91	37 5	32 2
43 14	194	0 4	0 21	0 08	9 3	-0 2	5 18	0 0	5 18	0 00	36 37	0 22	1 99	37 0	29 4
43 96	237	0.5	0 19	0 09	11 4	-0 2	5.28	0 0	5.28	0 00	43 94	0 20	1 90	38 0	34 9
44 78	228	1 0	0 42	0 18	10 9	-0 2	5 39	0 0	5.39	0 00	41 41	0 43	2 04	37 7	33 5
45 60	234	0 7	0.28	0 12	11.2	-0 2	5 49	0 0	5 49	0 00	41 63	0 29	1 97	37 8	34 0
46 42	228	0 3	0 14	0 06	10 9	-0 2	5 59	0 0	5 59	0 00	39 79	0 14	1 91	37 6	33 0
47 24	319	0 6	0.20	0 11	15 3	-0 2	5 69	0 0	5 69	0 00	55 11	0.20	1 81	39 2	42 4
48 06	257	0 4	0 15	0 06	12 3	0 3	5 79	0 0	5 79	0 00	43 28	0 15	1 88	38 1	35 8
48 88	240	0 7	0.27	0 11	11 5	-0.3	5 90	0 0	5 90	0 00	39 79	0.28	1 99	37 8	33 7
49 70	394	1 1	0 28	0 19	18 9	-0 3	6 00	0 0	6 00	0 00	64 66	0.29	1 79	40 1	47 6
50 52	375	1 4	0 36	0 22	18 0	0 3	6 10	0 0	6 10	0 00	60 55	0.37	1 86	39 8	46 0
51 34	306	0 7	0 22	0 11	14 6	-0 3	6 20	0 0	6 20	0 00	48.28	0 22	1 87	38 8	39 9
52 16	244	0.3	0 12	0 05	11 7	-0 3	6.30	0 0	6 30	0 00	37 70	0 12	1 92	37 7	33 2
52 98	231	0.3	0 13	0 05	11 0	-0 3	6 40	0 0	6 40	0 00	35 01	0 14	1 96	37 4	31 3
53 81	275	0 4	0 16	0 07	13 2	-0 3	6 51	0 0	6 51	0 00	41.25	0 17	1 91	38 2	36 1
54 63	238	0 3	0 11	0 04	11 4	-0.3	6 61	0 0	6 61	0 00	35 06	0 11	1 94	37 5	31 8
55 45	374	0 9	0 22	0 13	17 9	-0 4	6 71	0 0	6 71	0 00	54 77	0 23	1 83	39 6	44 5
56 27	426	1 1	0 25	0 16	20 4	0 3	6 81	0 0	6 81	0 00	61 59	0 26	1 80	40.2	48 1
57 09	335	0 8	0 24	0 12	16 0	-0 3	6 91	0 0	6 91	0 00	47 48	0 25	1 90	39 0	41 0
57 91	224	0 3	0 13	0 04	10 7	-0 3	7 02	0 0	7 02	0 00	30 96	0 14	2 01	37 0	29.2
58 73	234	0 3	0 11	0 04	11 2	-0 4	7 12	0 0	7 12	0 00	31 88	0 11	1 99	37 2	30.2

ED_000859_00001631-00367

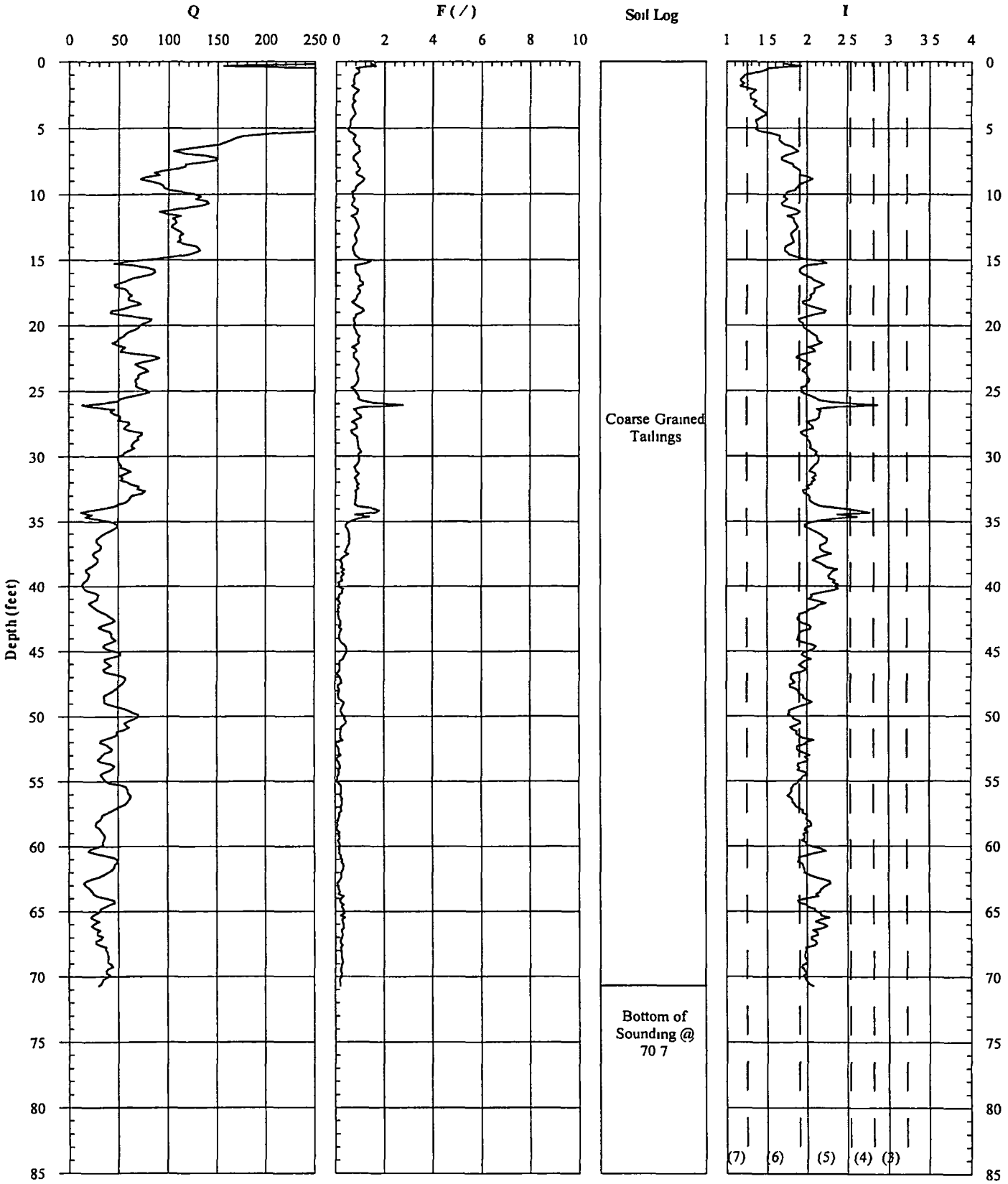
DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ_{vo}	q_E (mPa)	μ (psi)	σ_{vo} (ksf)	μ_o (ksf)	σ_{vo} (ksf)	B_q	Q	F (%)	I_c	ϕ (Degrees)	D_r (%)
59 55	264	0 4	0 16	0 06	12 6	0 3	7 22	0 0	7 22	0 00	35 57	0 17	1 97	37 7	33 5
60 37	203	0 4	0 18	0 05	9 7	-0 3	7 32	0 0	7 32	0 00	26 79	0 19	2 10	36 5	25 8
61 19	359	1 0	0 27	0 13	17 2	0 3	7 42	0 0	7 42	0 00	47 31	0 28	1 91	39 1	41 9
62 01	298	0 8	0 27	0 11	14 3	0 3	7 52	0 0	7 52	0 00	38 64	0 28	2 00	38 2	36 4
62 83	150	0 2	0 14	0 03	7 2	0 3	7 63	0 0	7 63	0 00	18 64	0 15	2 24	34 9	16 5
63 65	221	0 5	0 21	0 06	10 6	0 3	7 73	0 0	7 73	0 00	27 62	0 23	2 11	36 7	27 4
64 47	325	0 8	0 26	0 11	15 6	0 3	7 83	0 0	7 83	0 00	40 53	0 26	1 97	38 5	38 3
65 29	217	0 7	0 31	0 08	10 4	0 3	7 93	0 0	7 93	0 00	26 40	0 32	2 17	36 6	26 6
66 11	225	0 7	0 30	0 08	10 8	0 3	8 03	0 0	8 03	0 00	27 04	0 31	2 16	36 7	27 4
66 93	253	0 6	0 25	0 08	12 1	0 3	8 14	0 0	8 14	0 00	30 09	0 26	2 09	37 2	30 6
67 75	293	0 7	0 24	0 09	14 0	0 3	8 24	0 0	8 24	0 00	34 55	0 25	2 03	37 9	34 6
68 57	340	0 9	0 27	0 11	16 3	0 3	8 34	0 0	8 34	0 00	39 75	0 27	1 98	38 6	38 7
69 39	353	0 9	0 24	0 10	16 9	0 3	8 44	0 0	8 44	0 00	40 85	0 25	1 96	38 8	39 6
70 21	322	0 7	0 21	0 08	15 4	0 3	8 54	0 0	8 54	0 00	36 68	0 22	1 99	38 3	36 8

ED_000859_00001631-00368

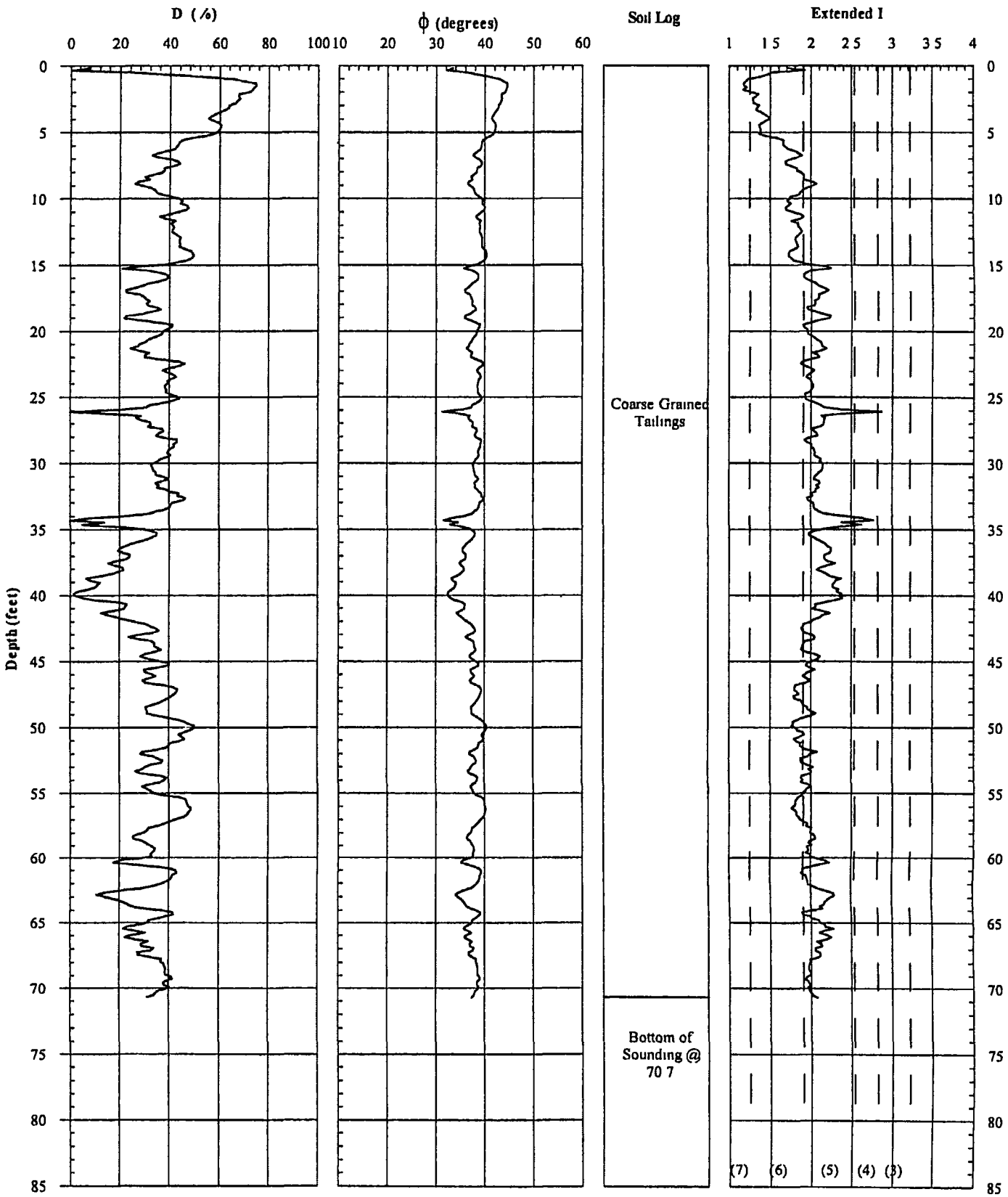
CPTU C3


q_T (ksf)
0 100 200 300 400 500
f (ksf)
0 2 4 6 8 10
R_f (%)
0 2 4 6 8 10
μ (ksf)
2 0 2 4 6 8 10
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85

CPTU C3


Q
0 50 100 150 200 250
F (/)
0 2 4 6 8 10
Soil Log
I
1 1 5 2 2 5 3 3 5 4
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
Coarse Grained Tailings
Bottom of Sounding @ 70 7
(7) (6) (5) (4) (3)

CPTU C3


D (%)
0 20 40 60 80 100
ϕ (degrees)
10 20 30 40 50 60
Soil Log
Extended I
1 1.5 2 2.5 3 3.5 4
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
Coarse Grained Tailings
Bottom of Sounding @ 70.7
(7) (6) (5) (4) (3)

SOUNDING INFORMATION

PROJECT	R erm nes M es	PROJECT LOCATION	Park H lls M sour			Depth	Un t W ght	Depth	U t We ght		
CPT DESIGNATION	CPTU C-4	PROJECT NUMBER	001392			(ft)	(pcf)	(ft)	(p f)	Water table depth used fo σ'_{vo} calc l t on	
ELEVATION		DATE	08/28/2000			0	122 5			feet	
STATION		SUPERVISOR	J Sant	W t tabl D tum	N t Detect d	12	119				
OFFSET		PUSHED BY	GSI	W ter Depth ATD	Not Detected	29	116				
CONE USED	243	DRILLING EQUIPMENT	Co e Truck	D layed Water Lev l	N t Measured	47	122.5				
CONE SIZE	H gentogl 10 t	NET AREA RATIO	0 8	T m f D l y	N adi g taken						Sounding terminated at planned depth

001392 CPTU C 4 Rivermines Mines

Park Hills Missouri

DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ_o	q_E (mPa)	μ (psi)	σ_{vo} (ksf)	μ_o (ksf)	σ'_{vo} (ksf)	B_q	Q	F (%)	I_c	ϕ (Degrees)	D_r (%)
0 49	53	0 3	0 97	5 60	2 5	0 1	0 06	0 0	0 06	0 00	872 12	0 61	1 14	41 5	55 9
1 31	144	0 8	0 59	5 32	6 9	0 4	0 16	0 0	0 16	0 00	892 94	0 59	1 12	43 9	70 6
2 13	168	0 8	0 47	3 04	8 0	0 2	0 26	0 0	0 26	0 00	641 93	0 47	1 11	43 5	68 1
2 95	198	0 9	0 46	2 55	9 5	0 1	0 36	0 0	0 36	0 00	547 28	0 46	1 15	43 5	68 2
3 77	172	0 9	0 54	2 01	8 2	0 0	0 46	0 0	0 46	0 00	370 45	0 54	1 31	42 2	60 6
4 59	160	0 6	0 40	1 14	7 6	0 1	0 56	0 0	0 56	0 00	282 86	0 40	1 31	41 4	55 7
5 41	165	0 6	0 36	0 89	7 9	0 1	0 66	0 0	0 66	0 00	247 51	0 36	1 33	41 2	54 2
6 23	160	0 7	0 47	0 97	7 7	0 1	0 76	0 0	0 76	0 00	208 79	0 47	1 45	40 7	51 4
7 05	186	1 0	0 52	1 13	8 9	0 1	0 86	0 0	0 86	0 00	214 58	0 52	1 48	41 1	53 9
7 87	166	1 0	0 60	1 04	8 0	0 2	0 96	0 0	0 96	0 00	171 47	0 60	1 59	40 3	49 1
8 69	162	1 0	0 62	0 93	7 8	0 1	1 07	0 0	1 07	0 00	151 07	0 62	1 64	40 0	46 9
9 51	219	1 2	0 56	1 05	10 5	0 0	1 17	0 0	1 17	0 00	187 00	0 56	1 54	41 2	54 3
10 33	264	1 6	0 60	1 26	12 6	0 0	1 27	0 0	1 27	0 00	207 41	0 61	1 53	41 9	58 4
11 15	301	1 8	0 59	1 30	14 4	0 1	1 37	0 0	1 37	0 00	218 93	0 59	1 50	42 3	61 1
11 97	350	1 7	0 49	1 16	16 7	0 1	1 47	0 0	1 47	0 00	237 43	0 49	1 42	42 9	64 4
12 80	286	1 8	0 61	1 12	13 7	0 1	1 56	0 0	1 56	0 00	181 75	0 62	1 58	41 8	57 7
13 62	211	1 6	0 78	0 95	10 1	-0 1	1 66	0 0	1 66	0 00	125 80	0 75	1 75	40 2	48 1
14 44	167	1 5	0 98	0 86	8 0	0 0	1 76	0 0	1 76	0 00	93 88	0 91	1 91	38 9	40 6
15 26	188	1 3	0 70	0 69	9 0	0 1	1 86	0 0	1 86	0 00	100 05	0 68	1 81	39 3	43 2
16 08	81	1 0	1 31	0 54	3 9	0 1	1 95	0 0	1 95	0 00	40 66	1 32	2 29	35 2	18 5
16 90	145	1 0	0 71	0 48	6 9	0 0	2 05	0 0	2 05	0 00	69 41	0 70	1 95	37 9	34 2
17 72	100	1 3	1 65	0 60	4 8	0 2	2 15	0 0	2 15	0 00	45 66	1 30	2 25	36 0	23 1
18 54	106	0 9	1 10	0 39	5 1	0 2	2 25	0 0	2 25	0 00	45 96	0 84	2 14	36 1	23 9
19 36	153	1 3	0 84	0 54	7 3	0 4	2 35	0 0	2 35	0 00	64 16	0 85	2 02	37 8	33 9
20 18	267	1 4	0 54	0 57	12 8	0 6	2 44	0 0	2 44	0 00	108 10	0 53	1 72	40 4	49 3
21 00	246	2 0	0 82	0 78	11 8	0 6	2 54	0 0	2 54	0 00	95 77	0 81	1 87	39 9	46 4
21 82	176	1 6	0 91	0 60	8 4	0 7	2 64	0 0	2 64	0 00	65 63	0 92	2 03	38 2	36 3
22 64	183	1 6	0 88	0 58	8 8	0 9	2 74	0 0	2 74	0 00	66 02	0 88	2 02	38 3	37 0
23 46	170	1 9	1 10	0 66	8 1	0 9	2 83	0 0	2 83	0 01	58 92	1 12	2 12	37 9	34 2
24 28	113	1 5	1 48	0 53	5 4	0 9	2 93	0 0	2 93	0 01	37 55	1 41	2 34	35 8	22 1
25 10	29	0 8	3 24	0 28	1 4	0 6	3 03	0 0	3 03	0 02	8 61	3 19	3 07	29 3	17 3

DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ_{vo}	q_E (mPa)	μ (psi)	σ_{vo} (ksf)	μ_o (ksf)	σ'_{vo} (ksf)	B_q	Q	F (%)	I_c	ϕ (Degrees)	D_r (%)
25 92	47	0 8	1 99	0.24	2 2	1 3	3 13	0 0	3 13	0 03	14 02	1 73	2 74	31 5	-4 0
26 74	136	1 3	0 98	0 41	6 5	1 3	3 22	0 0	3 22	0 01	41 15	1 00	2 22	36 5	26 0
27 56	142	1 3	0 92	0 39	6 8	1 4	3.32	0 0	3 32	0 01	41 78	0 94	2 20	36 6	26 9
28 38	114	1 4	1 98	0 40	5 4	1 4	3 42	0 0	3 42	0 01	32.20	1 24	2 36	35 5	20 0
29 20	10	0 2	2 46	0 07	0 5	4 0	3 52	0 0	3 52	0 58	1 97	3 35	3 62	24 0	-48 8
30 02	52	1.2	3 57	0 32	2.5	3 7	3 61	0 0	3 61	0 08	13 33	2 40	2 84	31 6	3.3
30 84	90	1.2	1 57	0.33	4.3	3 1	3 71	0 0	3 71	0 04	23 30	1 40	2 51	34.2	12.2
31 66	46	0 5	1 48	0 12	2 2	4 9	3 80	0 0	3 80	0 11	11 18	1 07	2 73	30 9	7 2
32 48	94	1 3	1 83	0 34	4 5	2 3	3 90	0 0	3 90	0 03	23 16	1 48	2 52	34 3	12 8
33 30	11	0.3	2 50	0 07	0 5	6 9	3 99	0 0	3 99	1 06	1 64	4 53	3 76	23 8	50 4
34 12	51	0 8	2 32	0.20	2 4	8 6	4 09	0 0	4 09	0 18	11 56	1 74	2 82	31 3	5 3
34 94	17	0 6	3 48	0 14	0 7	9 4	4 18	0 0	4 18	0 74	3 03	4 65	3 54	25 9	37 6
35 76	33	0 8	2.39	0 18	1 5	10 4	4 28	0 0	4 28	0 36	6 82	2 60	3 10	29 1	18.2
36 58	29	0 6	2 40	0 13	1 3	12 6	4 37	0 0	4 37	0 51	5 62	2 34	3 15	28 4	22 7
37 40	90	1 3	1 43	0 28	4 3	3 9	4 47	0 0	4 47	0 05	19 17	1 48	2 59	33 7	9 6
38 22	111	1 4	1 58	0 31	5 3	0 6	4 56	0 0	4 56	0 01	23 37	1 34	2 50	34 7	15 3
39 04	68	0 9	1 69	0.20	3.2	4 6	4 66	0 0	4 66	0 07	13 59	1 48	2 72	32 3	0 9
39 86	66	1 4	3 08	0 30	3 1	5.3	4 75	0 0	4 75	0 09	12 89	2 31	2 84	32 1	-0.2
40 68	31	0 6	2.29	0 13	1 4	13 6	4 85	0 0	4 85	0 53	5 34	2 36	3 17	28 4	22 4
41 50	59	1 3	3 09	0 26	2 7	10 5	4 94	0 0	4 94	0 20	10 85	2 37	2 91	31 4	-4 2
42 32	40	0 6	1 93	0 11	1 8	17.3	5 04	0 0	5 04	0 49	6 96	1 62	2 99	29 6	15 4
43 14	110	1 5	1 90	0.29	5 3	2.5	5 13	0 0	5 13	0 02	20 50	1 42	2 56	34 4	13 4
43 96	100	1 2	1 83	0 22	4 8	3 8	5.23	0 0	5.23	0 04	18 15	1 24	2 57	33 9	10 3
44 78	142	1 2	0 85	0 22	6 8	1 8	5 32	0 0	5 32	0 01	25 59	0 88	2 37	35 5	20 0
45 60	107	1 3	1.28	0 25	5 1	2 0	5 42	0 0	5 42	0 02	18 68	1 33	2 58	34 1	11 6
46 42	115	1 9	1 83	0 35	5 5	5 3	5.51	0 0	5 51	0 05	19 92	1 74	2 62	34 4	13 6
47 24	128	0 6	0 49	0 12	6 1	2 5	5 61	0 0	5 61	0 02	21 78	0 53	2 33	34 9	16 3
48 06	125	0 4	0 32	0 07	6 0	2 9	5 71	0 0	5 71	0 02	20 84	0 33	2 27	34 7	15 4
48 88	139	0 5	0 35	0 08	6 6	2 9	5 81	0 0	5 81	0 02	22 85	0 36	2.25	35 2	18 1
49 70	139	0 4	0 32	0 07	6 6	2 9	5 91	0 0	5 91	0 02	22 48	0 33	2.25	35 1	17 9
50 52	270	0 7	0 27	0 12	12 9	2 8	6 01	0 0	6 01	0 01	43 94	0 27	1 94	38 3	36 8
51 34	161	0 4	0 49	0 07	7 7	2 7	6 11	0 0	6 11	0 02	25 39	0 28	2 17	35 8	21 8
52 16	149	0 4	0.29	0 07	7 1	2 6	6 21	0 0	6 21	0 02	22 97	0 30	2 22	35 4	19 2
52 98	126	0 3	0 23	0 05	6 0	2 7	6 31	0 0	6 31	0 02	18 91	0.26	2 28	34 5	14 1
53 81	104	0 2	0 15	0 02	5 0	2 6	6 41	0 0	6 41	0 03	15 19	0 16	2 33	33 6	8 5
54 63	148	0 3	0 23	0 05	7 1	2 6	6 52	0 0	6 52	0 02	21 67	0 24	2 22	35 2	18 3
55 45	202	0 5	0 25	0 08	9 7	2 6	6 62	0 0	6 62	0 01	29 61	0 26	2 09	36 7	27 1
56 27	230	0 6	0 28	0 10	11 0	2 5	6 72	0 0	6 72	0 01	33 25	0 29	2 06	37 2	30 6
57 09	346	1 0	0 30	0 15	16 5	2 5	6 82	0 0	6 82	0 01	49 72	0 31	1 91	39.2	42 0
57 91	188	0 5	0 26	0 07	9 0	2 5	6 92	0 0	6 92	0 01	26.21	0 27	2 15	36 2	24 4
58 73	126	0 3	0 20	0 04	6 0	2 4	7 02	0 0	7 02	0 02	17 00	0 21	2 30	34 3	12 8

ED_000859_00001631-00373

DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ	q_E (mPa)	μ (psi)	σ_{vo} (ksf)	μ_o (ksf)	σ'_{vo} (ksf)	B_q	Q	F (%)	I_c	ϕ (Degrees)	D (%)
59 55	112	0 2	0 20	0 03	5 3	2 4	7 12	0 0	7 12	0 02	14 68	0 21	2 37	33 7	9 0
60 37	184	0 5	0 29	0 07	8 8	2 3	7 22	0 0	7 22	0 01	24 49	0 28	2 18	36 0	23 2
61 19	179	0 3	0 18	0 04	8 6	2 1	7 32	0 0	7 32	0 01	23 47	0 19	2 16	35 8	22 2
62 01	131	0 3	0 23	0 04	6 3	2 1	7 42	0 0	7 42	0 02	16 64	0 24	2 33	34 3	13 0
62 83	224	0 6	0 26	0 08	10 7	2 0	7 52	0 0	7 52	0 01	28 73	0 27	2 11	36 8	28 1
63 65	286	0 7	0 26	0 10	13 7	2 1	7 62	0 0	7 62	0 01	36 57	0 27	2 01	38 0	35 0
64 47	179	0 4	0 24	0 06	8 5	1 9	7 72	0 0	7 72	0 01	22 15	0 25	2 21	35 7	21 4
65 29	157	0 3	0 20	0 04	7 5	1 9	7 82	0 0	7 82	0 01	19 13	0 20	2 25	35 1	17 5
66 11	192	0 6	0 33	0 08	9 2	1 9	7 92	0 0	7 92	0 01	23 22	0 35	2 24	36 0	23 0
66 93	161	0 4	0 26	0 05	7 7	1 9	8 02	0 0	8 02	0 01	19 05	0 27	2 29	35 1	17 8
67 75	160	0 5	0 27	0 06	7 7	1 8	8 12	0 0	8 12	0 01	18 74	0 30	2 30	35 1	17 5
68 57	260	0 8	0 33	0 10	12 4	1 8	8 22	0 0	8 22	0 01	30 64	0 33	2 12	37 4	31 2
69 39	155	0 4	0 28	0 05	7 4	1 7	8 32	0 0	8 32	0 01	17 67	0 29	2 33	34 9	16 3
70 21	148	0 4	0 24	0 04	7 1	1 7	8 42	0 0	8 42	0 01	16 53	0 25	2 34	34 6	14 6
71 03	134	0 4	0 27	0 04	6 4	1 7	8 52	0 0	8 52	0 01	14 68	0 29	2 40	34 1	11 6
71 85	138	0 5	0 33	0 05	6 6	1 7	8 63	0 0	8 63	0 01	15 04	0 35	2 42	34 2	12 4
72 67	147	0 4	0 27	0 04	7 0	1 7	8 73	0 0	8 73	0 01	15 88	0 28	2 37	34 5	14 1
73 49	174	0 5	0 27	0 05	8 3	1 7	8 83	0 0	8 83	0 01	18 73	0 29	2 30	35 3	18 7
74 31	265	0 9	0 36	0 11	12 7	1 7	8 93	0 0	8 93	0 01	28 63	0 37	2 16	37 2	30 5
75 13	194	0 7	0 37	0 08	9 3	1 7	9 03	0 0	9 03	0 01	20 52	0 39	2 31	35 7	21 5
75 95	184	0 6	0 34	0 07	8 8	1 7	9 13	0 0	9 13	0 01	19 14	0 36	2 32	35 4	19 8
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77 59	180	0 6	0 35	0 07	8 6	1 8	9 33	0 0	9 33	0 01	18 32	0 37	2 35	35 3	18 9
78 41	160	0 4	0 24	0 04	7 7	1 7	9 43	0 0	9 43	0 01	16 00	0 26	2 35	34 7	15 4
79 23	174	0 6	0 33	0 06	8 3	1 7	9 53	0 0	9 53	0 01	17 30	0 34	2 36	35 1	17 6
80 05	175	0 6	0 35	0 06	8 4	1 7	9 63	0 0	9 63	0 01	17 14	0 37	2 37	35 1	17 5
80 87	213	0 8	0 39	0 09	10 2	1 7	9 73	0 0	9 73	0 01	20 92	0 41	2 30	36 0	23 1
81 69	305	1 4	0 47	0 14	14 6	1 7	9 83	0 0	9 83	0 01	30 07	0 46	2 18	37 7	33 2
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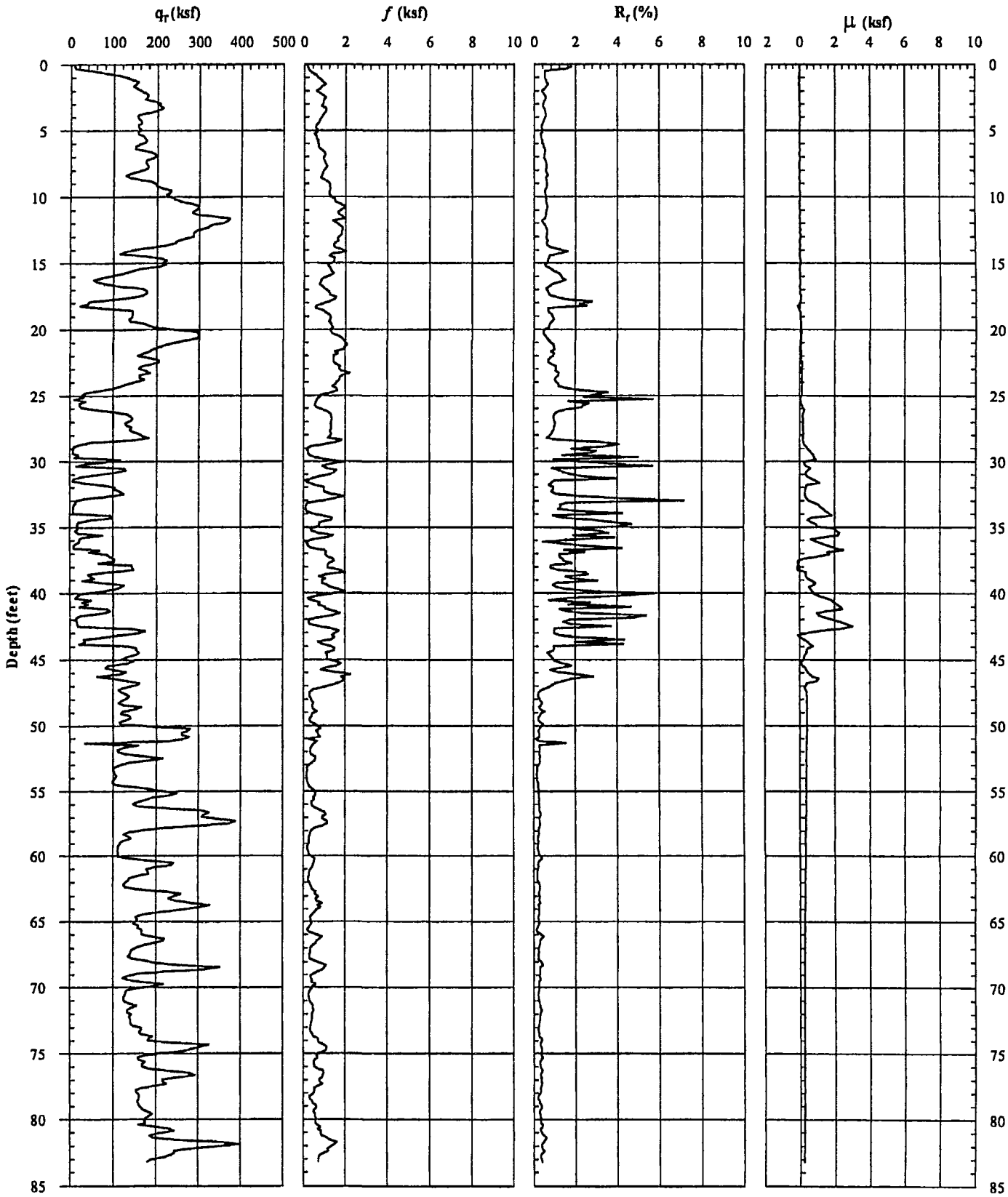
CPTU C4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f (ksf)
0 2 4 6 8 10
R_f (%)
0 2 4 6 8 10
μ (ksf)
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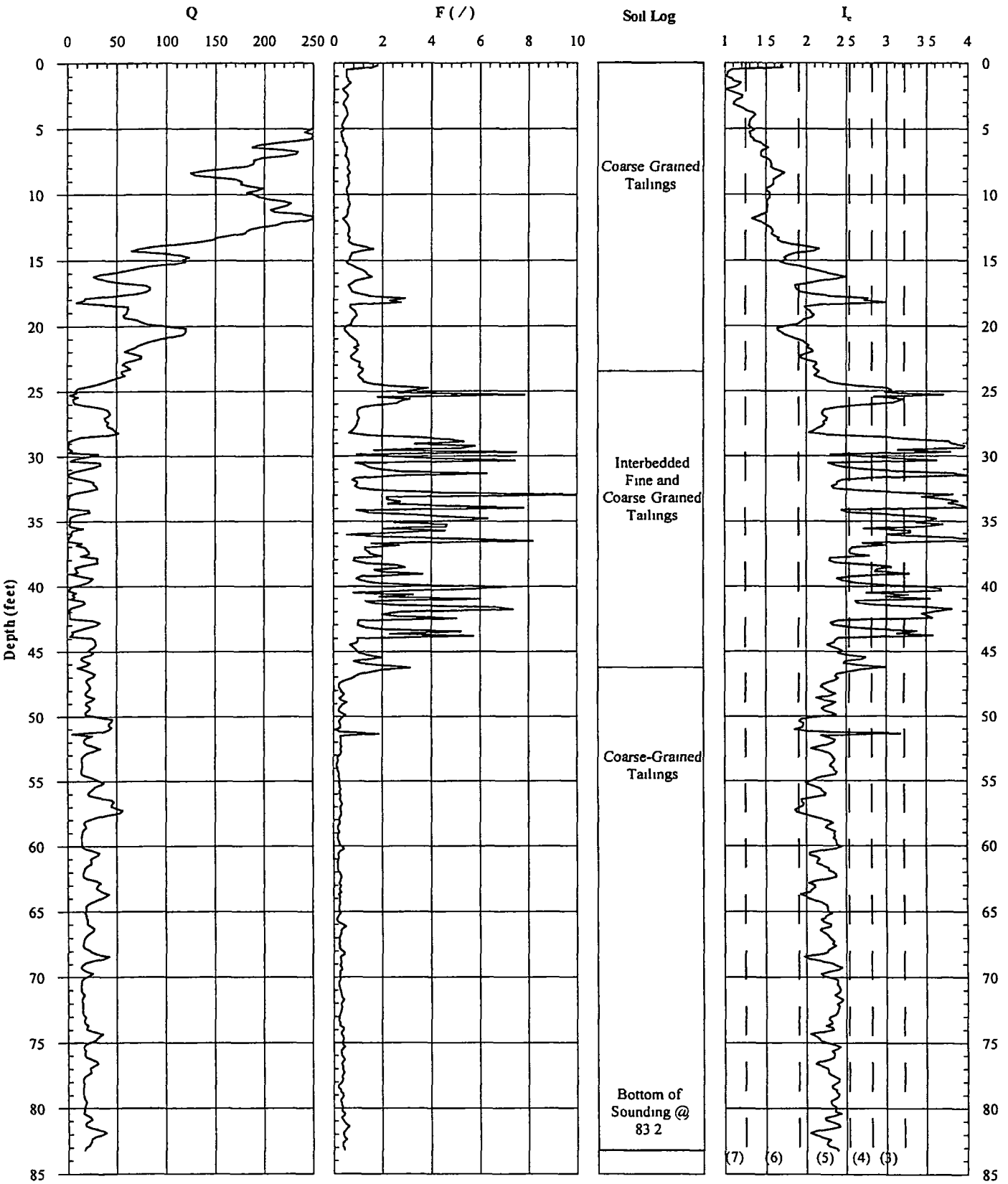
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85

CPTU C4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F (/)
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Soil Log
I_c
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Depth (feet)
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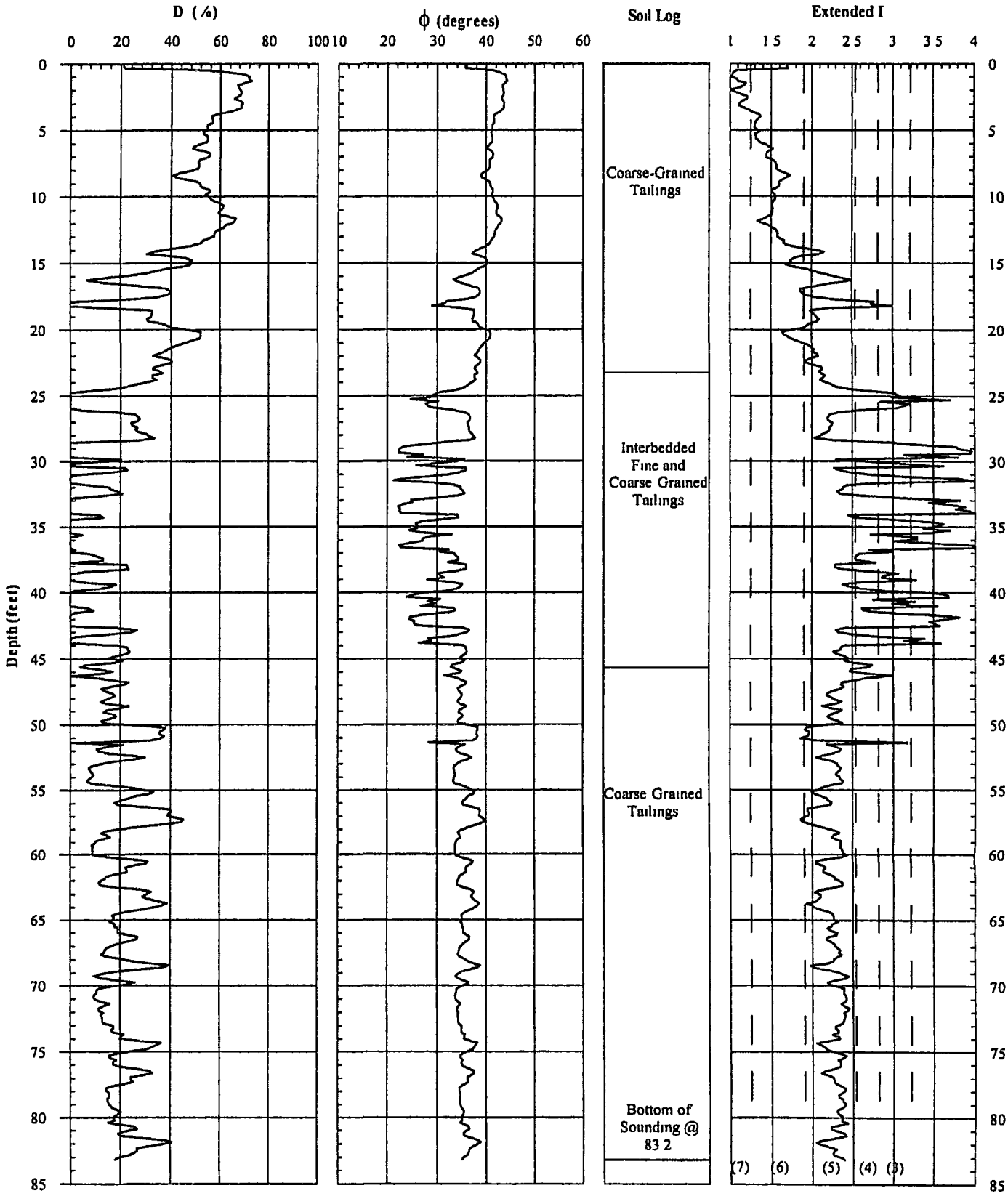
Coarse Grained Tailings
Interbedded Fine and Coarse Grained Tailings
Coarse-Grained Tailings
Bottom of Sounding @ 83.2
(7) (6) (5) (4) (3)

CPTU C4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ϕ (degrees)
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Soil Log
Extended I
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Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
Coarse-Grained Tailings
Interbedded Fine and Coarse Grained Tailings
Coarse Grained Tailings
Bottom of Sounding @ 83.2
(7) (6) (5) (4) (3)

SOUNDING INFORMATION

PROJECT	R erm M es	PROJECT LOCATION	Park H lls Miss uri		
CPT DESIGNATION	CPTU C 5	PROJECT NUMBER	001392		
ELEVATION		DATE	08/28/2000		
STATION		SUPERVISOR	J Santos	Water table Datum	Not Detected
OFFSET		PUSHED BY	GSI	Wate Depth ATD	N t D tect d
CONE USED	233	DRILLING EQUIPMENT	C Truck	D l yed W t Lev l	N t Measured
CONE SIZE	Hog t gl 10 to	NET AREA RATIO	0 8	Time f Del y	N readi g tak n

Depth (ft)	U t W ght (pcf)	D pth (ft)	U t We ght (pcf)	W t tabl depth us d for σ cal l t
0	119			feet
60	113			

Sounding terminated at planned depth

001392 CPTU C 5 Rivermines Mines

Park Hills Missouri

DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ_o	q_E (mPa)	m (psi)	σ_{vo} (ksf)	μ_o (ksf)	σ'_{vo} (ksf)	B_q	Q	F (%)	I_c	f (Degrees)	D_r (%)
0 49	29	0 2	0 87	4 21	1 4	-0 1	0 06	0 0	0 06	0 00	494 16	0 70	1 32	38 7	39 2
1 31	107	0 6	0 54	3 73	5 1	-0 1	0 16	0 0	0 16	0 00	684 91	0 54	1 14	42 6	62 6
2 13	118	0 7	0 56	2 57	5 7	0 2	0 25	0 0	0 25	0 00	463 96	0 55	1 25	41 9	58 4
2 95	104	0 8	0 75	2 19	5 0	0 1	0 35	0 0	0 35	0 00	293 73	0 74	1 48	40 5	50 0
3 77	101	0 7	0 71	1 57	4 8	0 1	0 45	0 0	0 45	0 00	223 52	0 70	1 55	39 8	45 7
4 59	144	0 8	0 58	1 53	6 9	0 2	0 55	0 0	0 55	0 00	262 81	0 58	1 44	41 0	53 1
5 41	155	0 8	1 02	1 27	7 4	0 0	0 64	0 0	0 64	0 00	240 11	0 54	1 45	41 0	52 9
6 23	190	1 3	0 67	1 73	9 1	0 2	0 74	0 0	0 74	0 00	255 40	0 68	1 49	41 6	56 7
7 05	162	1 3	0 80	1 53	7 8	0 2	0 84	0 0	0 84	0 00	192 38	0 80	1 63	40 5	50 4
7 87	135	1 4	1 04	1 45	6 5	0 1	0 94	0 0	0 94	0 00	143 46	1 02	1 80	39 4	43 6
8 69	88	0 9	1 21	0 92	4 2	0 1	1 03	0 0	1 03	0 00	84 29	1 09	1 99	37 1	29 9
9 51	134	1 2	0 87	1 03	6 4	0 1	1 13	0 0	1 13	0 00	117 43	0 88	1 82	38 9	40 6
10 33	118	1 1	0 93	0 89	5 6	0 0	1 23	0 0	1 23	0 00	94 56	0 94	1 91	38 1	35 7
11 15	41	0 9	2 99	0 68	2 0	0 9	1 33	0 0	1 33	0 02	29 97	2 28	2 54	32 9	4 5
11 97	28	0 4	4 77	0 28	1 3	4 0	1 43	0 0	1 43	0 15	18 42	1 55	2 62	30 8	7 9
12 80	156	1 1	0 71	0 73	7 4	0 1	1 52	0 0	1 52	0 00	101 14	0 72	1 82	38 9	40 6
13 62	143	1 2	0 82	0 72	6 9	0 1	1 62	0 0	1 62	0 00	87 41	0 83	1 91	38 4	37 4
14 44	142	1 1	0 76	0 62	6 8	0 1	1 72	0 0	1 72	0 00	81 83	0 76	1 91	38 2	36 4
15 26	183	1 2	0 66	0 66	8 8	0 1	1 82	0 0	1 82	0 00	99 87	0 67	1 80	39 3	42 8
16 08	190	1 6	0 82	0 82	9 1	0 2	1 91	0 0	1 91	0 00	98 53	0 83	1 86	39 3	43 2
16 90	188	1 6	0 84	0 79	9 0	0 1	2 01	0 0	2 01	0 00	92 44	0 85	1 89	39 2	42 1
17 72	178	1 6	0 90	0 76	8 5	0 1	2 11	0 0	2 11	0 00	83 41	0 91	1 95	38 8	39 8
18 54	145	1 3	1 23	0 58	6 9	0 1	2 21	0 0	2 21	0 00	64 53	0 91	2 04	37 7	33 2
19 36	204	1 8	0 90	0 80	9 8	0 1	2 30	0 0	2 30	0 00	87 48	0 91	1 93	39 2	42 4
20 18	207	2 1	1 00	0 86	9 9	0 2	2 40	0 0	2 40	0 00	85 11	1 01	1 97	39 2	42 3
21 00	190	2 0	1 04	0 80	9 1	0 0	2 50	0 0	2 50	0 00	75 22	1 06	2 02	38 7	39 3
21 82	160	1 6	1 60	0 61	7 6	0 1	2 60	0 0	2 60	0 00	60 49	1 01	2 09	37 8	33 7
22 64	103	1 5	1 53	0 56	4 9	0 2	2 69	0 0	2 69	0 00	37 28	1 50	2 36	35 6	20 7
23 46	49	0 9	2 83	0 33	2 3	1 6	2 79	0 0	2 79	0 04	16 54	1 98	2 71	32 0	1 2
24 28	123	1 5	1 27	0 50	5 9	0 0	2 89	0 0	2 89	0 00	41 49	1 21	2 26	36 3	24 7
25 10	134	1 2	0 93	0 42	6 4	0 3	2 99	0 0	2 99	0 00	43 76	0 95	2 19	36 6	26 6

CPTU C 5

Rivermines Mines

Park Hills, Missouri

DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ_{vo}	q_E (mPa)	m (psi)	σ_{vo} (ksf)	μ_o (ksf)	σ'_{vo} (ksf)	B_q	Q	F (%)	I_c	f (Degrees)	D_r (%)
25 92	200	1 7	0 86	0 55	9 6	-0 1	3 08	0 0	3 08	0 00	63 83	0 86	2 03	38 4	37 7
26 74	156	1 5	0 99	0 48	7 5	-0 1	3 18	0 0	3 18	0 00	48 06	1 00	2 16	37 2	30 2
27 56	145	1 6	1 07	0 47	6 9	-0 1	3 28	0 0	3 28	0 00	43 15	1 10	2 23	36 7	27 6
28 38	131	1 4	1 07	0 41	6 3	-0 1	3.38	0 0	3 38	0 00	37 72	1 09	2 27	36.2	24 2
29 20	170	1 5	0 91	0 44	8 1	0 1	3 47	0 0	3 47	0 00	47 86	0 91	2 14	37 4	31 3
30 02	116	1 6	1 74	0 46	5 6	0 1	3 57	0 0	3 57	0 00	31 51	1 46	2 41	35 5	20 0
30 84	109	1 3	1.33	0 36	5.2	-0.3	3 67	0 0	3 67	0 00	28 82	1 25	2 40	35 1	17 9
31 66	98	1 0	1 03	0.27	4 7	-0 8	3 77	0 0	3 77	-0 01	25 06	1 06	2 42	34 6	14 5
32 48	109	1 3	1 35	0 35	5 2	1 1	3 87	0 0	3 87	-0 01	27 26	1 27	2 43	35 0	17 1
33 30	101	1 1	1 08	0.27	4 8	-0 6	3 96	0 0	3 96	-0 01	24 37	1 12	2 44	34 6	14 4
34 12	135	1 2	0 86	0.28	6 5	2 0	4 06	0 0	4 06	-0 02	32 16	0 88	2 28	35 9	22 4
34 94	163	1 4	0 85	0 33	7 8	1 7	4 16	0 0	4 16	-0 01	38 16	0 87	2 22	36 7	27 6
35 76	148	1 6	1 15	0 39	7 1	1 8	4 26	0 0	4.26	-0 01	33 79	1 14	2 32	36.2	24 5
36 58	124	1 4	1 13	0 32	5 9	1 3	4 35	0 0	4.35	-0 01	27 50	1 17	2 41	35 3	19 1
37 40	113	1 8	1 84	0 39	5 4	1 2	4 45	0 0	4 45	-0 01	24 36	1 62	2 53	34 8	16 1
38 22	112	1 4	2 17	0 30	5 4	-0 5	4 55	0 0	4 55	0 00	23 62	1 27	2 48	34 7	15 5
39 04	246	1 9	0 78	0 41	11 8	0.2	4 65	0 0	4 65	0 00	51 97	0 79	2 08	38 4	37 8
39 86	169	1 9	1 13	0 40	8 1	-0 3	4 74	0 0	4 74	0 00	34 67	1 16	2 32	36 6	26 8
40 68	170	1 8	1 05	0 37	8.2	-0 4	4 84	0 0	4 84	0 00	34 19	1 08	2 31	36 6	26 7
41 50	189	1 7	0 91	0.35	9 1	1 0	4 94	0 0	4 94	-0 01	37 35	0 93	2 24	37 1	29 4
42 32	158	1 7	1 08	0 34	7 6	-0 8	5 04	0 0	5 04	0 01	30 45	1 11	2 36	36 2	24 0
43 14	162	1 9	1 18	0 36	7 8	1 8	5 13	0 0	5 13	-0 01	30 63	1 19	2 37	36.2	24 5
43 96	105	1 5	1 60	0 29	5 0	2 3	5 23	0 0	5 23	-0 02	19 07	1 52	2 60	34 1	11 7
44 78	134	1 6	1 61	0 30	6 4	-0 9	5 33	0 0	5.33	0 01	24 10	1 25	2 47	35 2	18 4
45 60	165	2 0	1 25	0.36	7 9	-0 8	5 43	0 0	5 43	-0 01	29 48	1 23	2 39	36 2	24 2
46 42	163	1 5	0 94	0 27	7 8	2 2	5 52	0 0	5 52	-0 01	28 53	0 95	2 34	36 1	23 5
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48 06	132	1 5	1 16	0 26	6 3	1 2	5 72	0 0	5 72	-0 01	22 07	1 18	2 49	35 0	17 0
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49 70	215	2 0	0 94	0 34	10 3	-0 1	5 91	0 0	5 91	0 00	35.29	0 96	2 27	37 2	30 4
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52 16	176	1 7	1 00	0 28	8 4	0 9	6 21	0 0	6 21	0 01	27 34	1 03	2 38	36 2	24 0
52 98	165	2 0	1.25	0 31	7 9	0 7	6 31	0 0	6 31	0 00	25 22	1.23	2 45	35 8	22 0
53 81	75	1 5	2 31	0 23	3 5	18 9	6 40	0 0	6 40	0 27	10 77	2 18	2 89	32 0	-0 7
54 63	230	2 0	0 85	0 30	11 0	7 7	6 50	0 0	6 50	0 03	34 36	0 87	2 26	37 3	31 0
55 45	219	2 1	0 97	0 32	10 5	1 1	6 60	0 0	6 60	0 00	32 15	1 00	2 31	37 0	29 4
56 27	200	2 2	1 16	0 32	9 6	-0 7	6 70	0 0	6 70	0 00	28 89	1 12	2 38	36 6	26 6
57 09	103	1 6	1 64	0 23	4 9	1 0	6 79	0 0	6 79	0 01	14 14	1 64	2 73	33 4	7 3
57 91	55	1 3	2 35	0 19	2 6	2 8	6 89	0 0	6 89	0 06	7 02	2 67	3 10	30 4	10 7
58 73	66	1 2	2 10	0 17	3 1	10 3	6 99	0 0	6 99	0 17	8 46	2 00	2 96	31 2	5 7

DEPTH (ft)	q_T (ksf)	f_s (ksf)	R_f (%)	f_s/σ_{vo}	q_E (mPa)	m (psi)	σ_{vo} (ksf)	μ_o (ksf)	σ_{vo} (ksf)	B_q	Q	F (%)	I_c	f (Degrees)	D_r (%)
59 55	79	2 1	2 82	0 29	3 7	13 4	7 09	0 0	7 09	0 19	10 15	2 86	2 98	32 0	0 8
60 37	36	1 1	3 03	0 15	1 6	19 4	7 18	0 0	7 18	0 67	4 04	3 71	3 38	28 2	23 4
61 19	51	2 5	4 76	0 34	2 4	8 2	7 27	0 0	7 27	0 19	5 98	5 65	3 34	29 8	13 9
62 01	74	3 5	4 73	0 48	3 5	8 8	7 37	0 0	7 37	0 13	9 10	5 22	3 17	31 6	3 1
62 83	77	3 0	3 94	0 41	3 6	10 1	7 46	0 0	7 46	0 15	9 35	4 36	3 11	31 8	2 2
63 65	72	2 9	4 06	0 39	3 4	11 3	7 55	0 0	7 55	0 17	8 56	4 53	3 16	31 4	-4 3
64 47	76	3 8	5 08	0 50	3 5	11 8	7 64	0 0	7 64	0 17	8 90	5 65	3 20	31 6	3 1
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66 11	60	2 9	4 93	0 38	2 8	6 4	7 83	0 0	7 83	0 12	6 67	5 63	3 30	30 5	10 1
66 93	54	2 2	4 13	0 28	2 5	6 9	7 92	0 0	7 92	0 15	5 80	4 85	3 31	29 9	13 4
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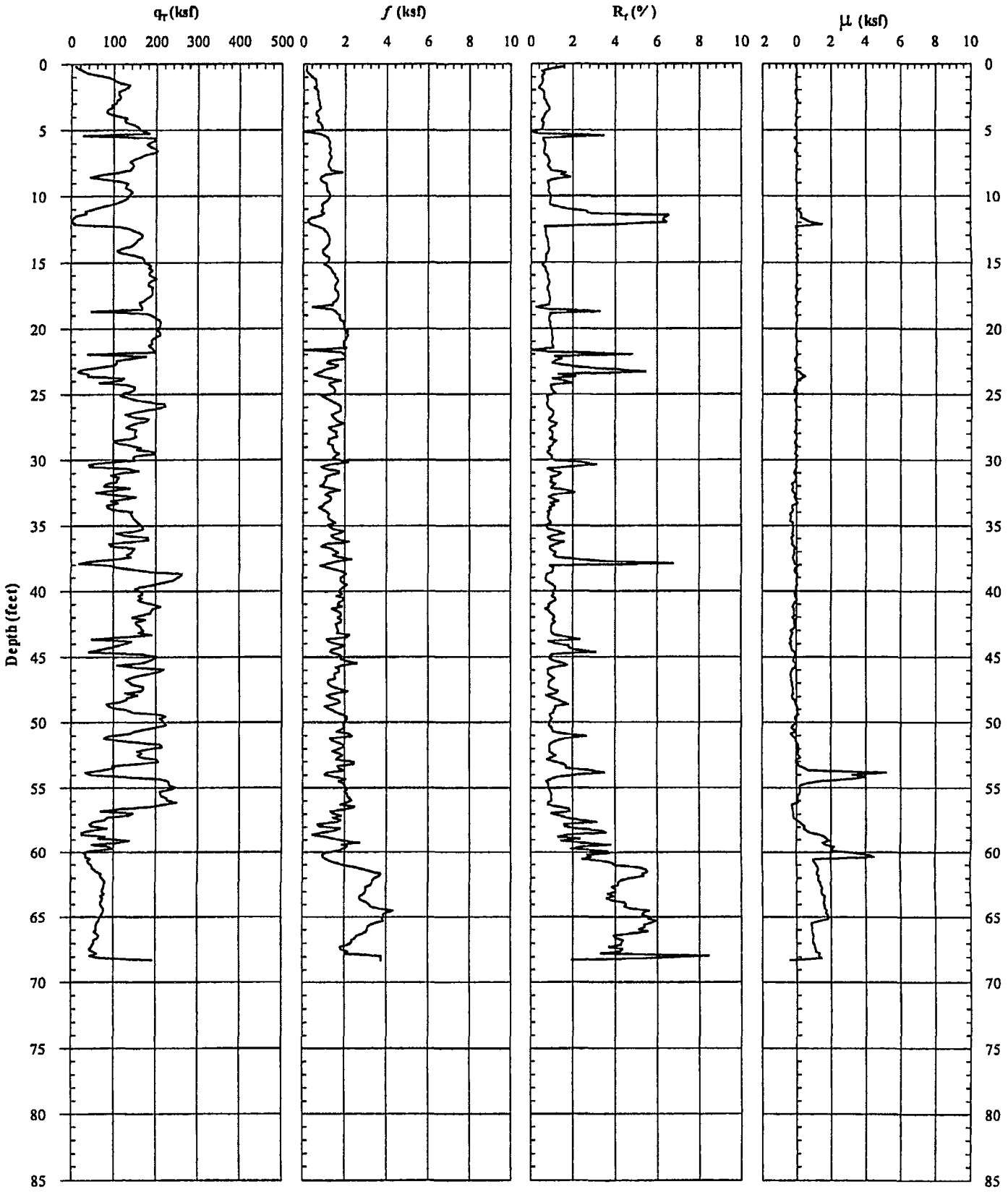
CPTU C5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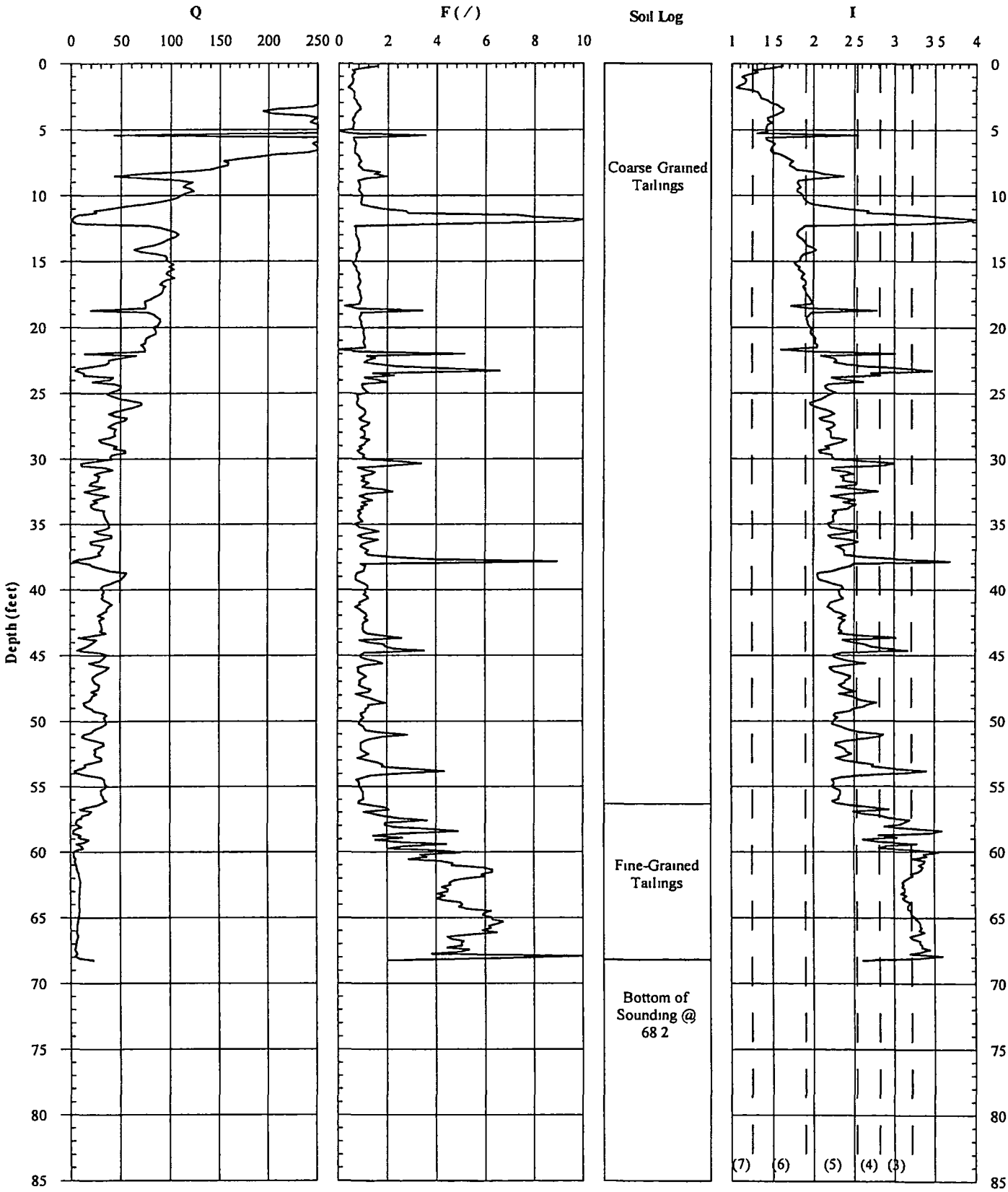
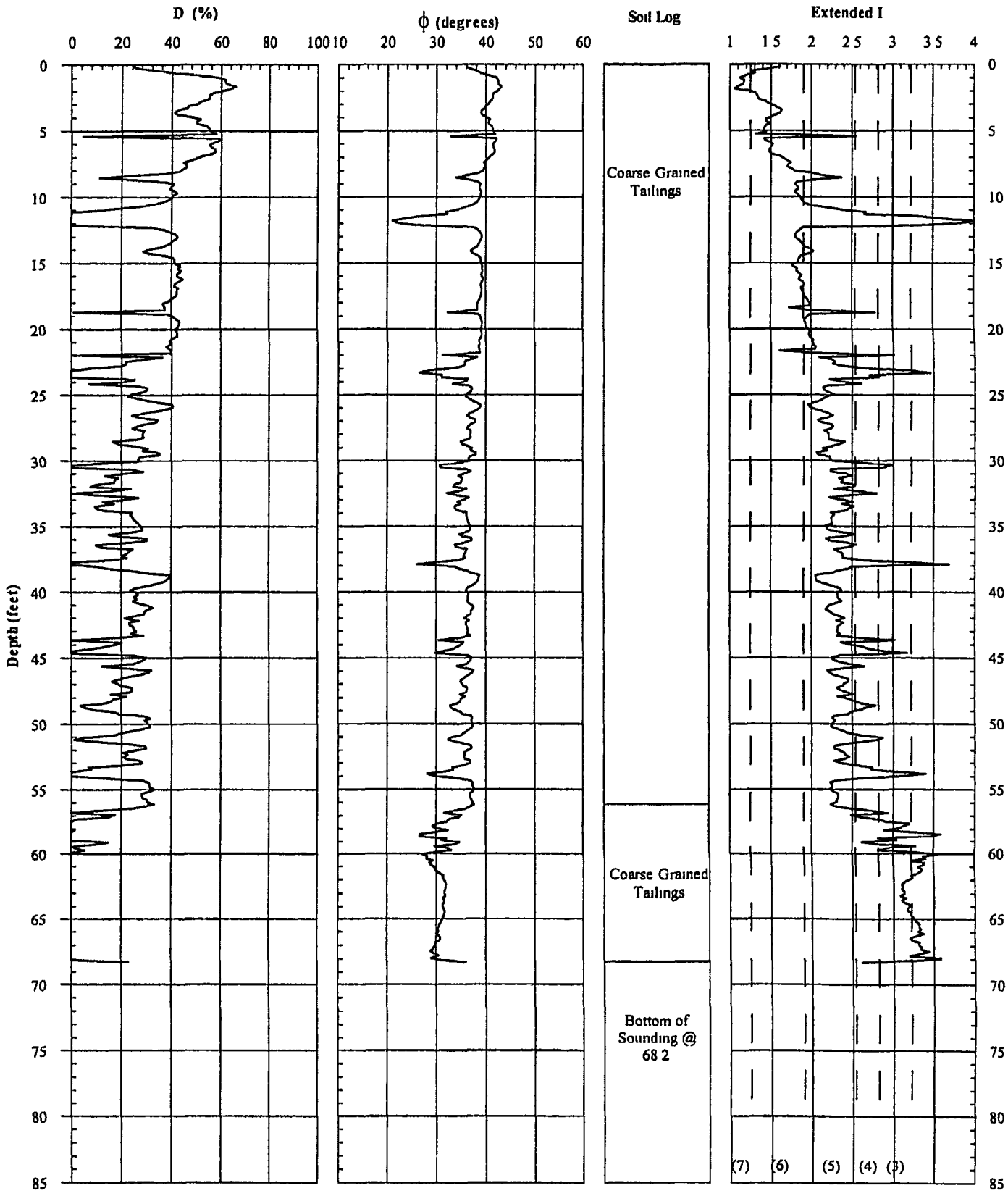
f (ksf)
0 2 4 6 8 10
R_f (%)
0 2 4 6 8 10
μ (ksf)
2 0 2 4 6 8 10
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85

CPTU C5


Q
0 50 100 150 200 250
F (/)
0 2 4 6 8 10
Soil Log
I
1 1 5 2 2 5 3 3 5 4
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
Coarse Grained Tailings
Fine-Grained Tailings
Bottom of Sounding @ 68 2
(7) (6) (5) (4) (3)

CPTU C5


D (%)
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ϕ (degrees)
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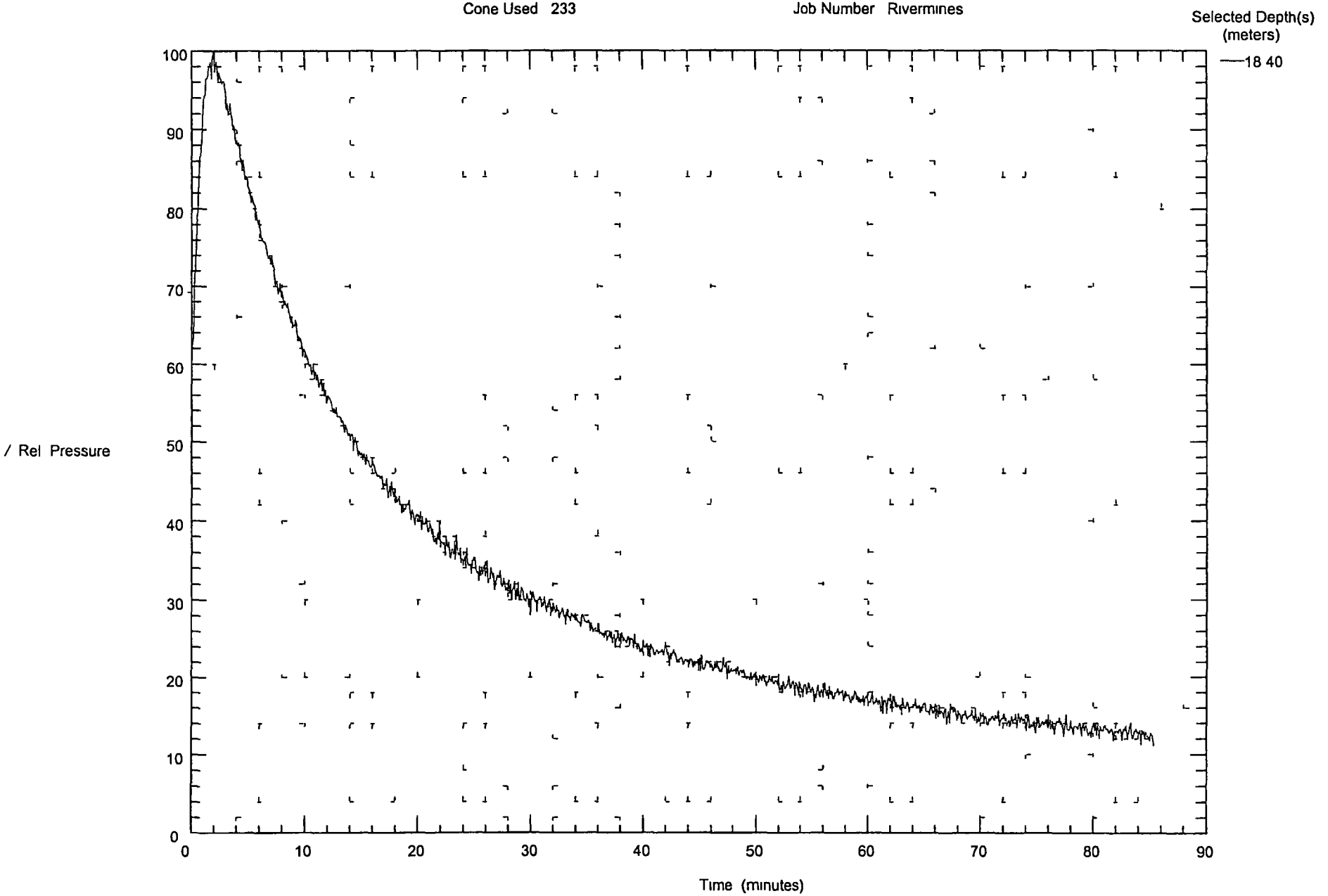
Soil Log
Extended I
1 1.5 2 2.5 3 3.5 4
Depth (feet)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
Coarse Grained Tailings
Coarse Grained Tailings
Bottom of Sounding @ 68.2
(7) (6) (5) (4) (3)

Geotechnical Services Inc

Operator J SANTOS
Sounding CPT197
Cone Used 233

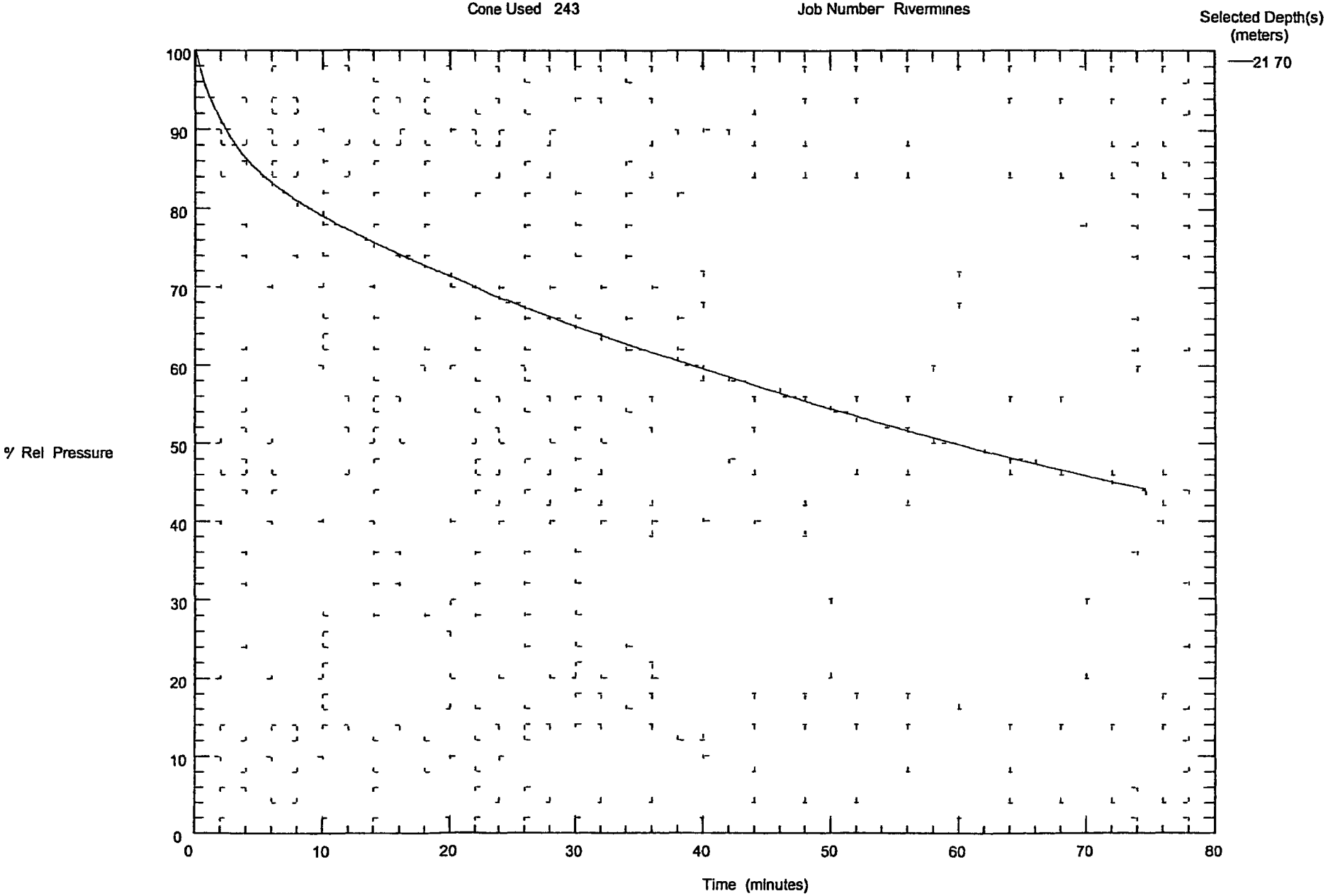
CPT Date/Time 08 28 00 09 20
Location C 5
Job Number Rivermines



Geotechnical Services Inc

Operator J SANTOS
Sounding CPT200
Cone Used 243

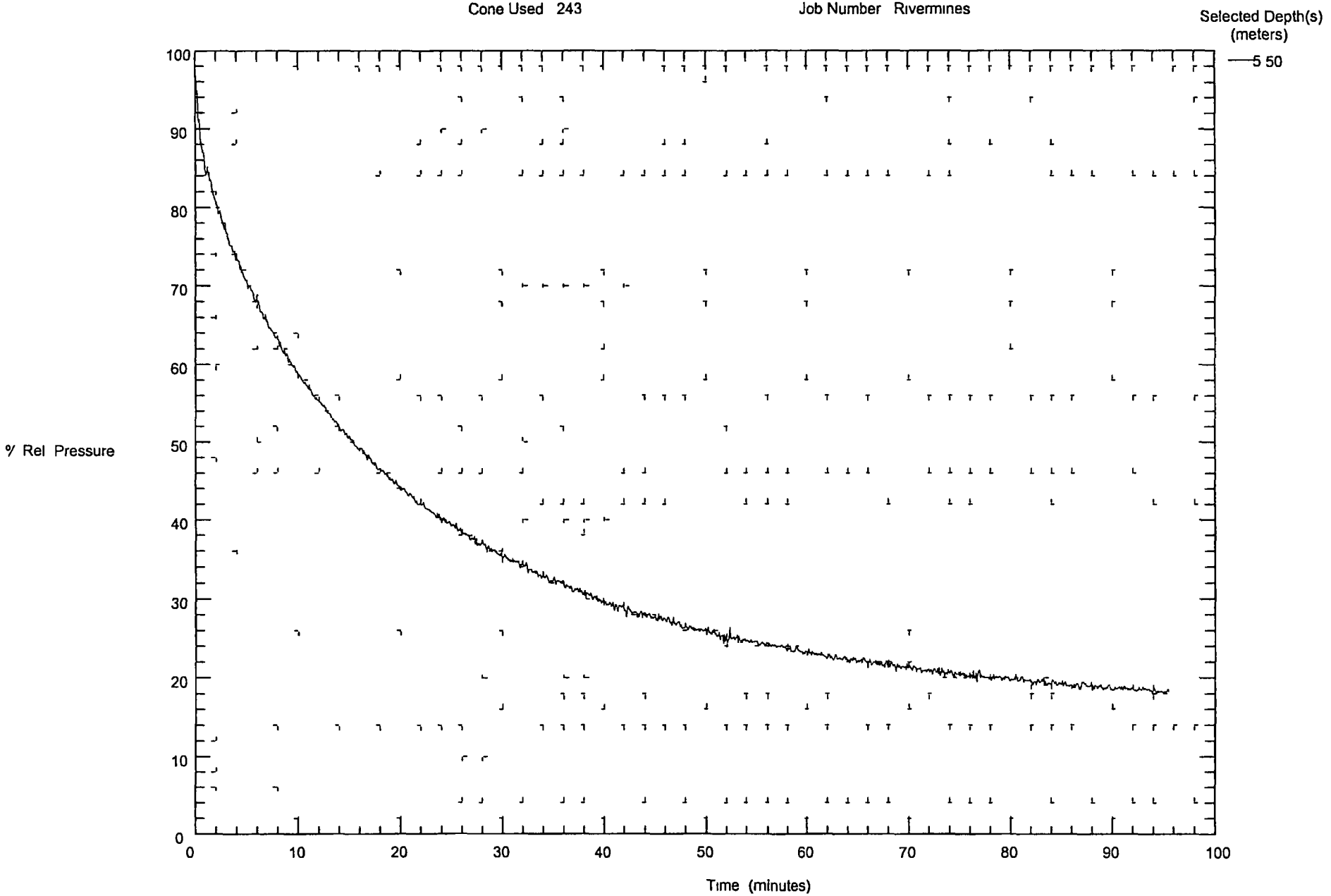
CPT Date/Time 08-28-00 16 31
Location C-2
Job Number Rivermines



Geotechnical Services Inc

Operator J SANTOS
Sounding CPT201
Cone Used 243

CPT Date/Time 08 29 00 07 31
Location C 2a
Job Number Rivermines



Geotechnical Services Inc

Operator J SANTOS
Sounding CPT202
Cone Used 233

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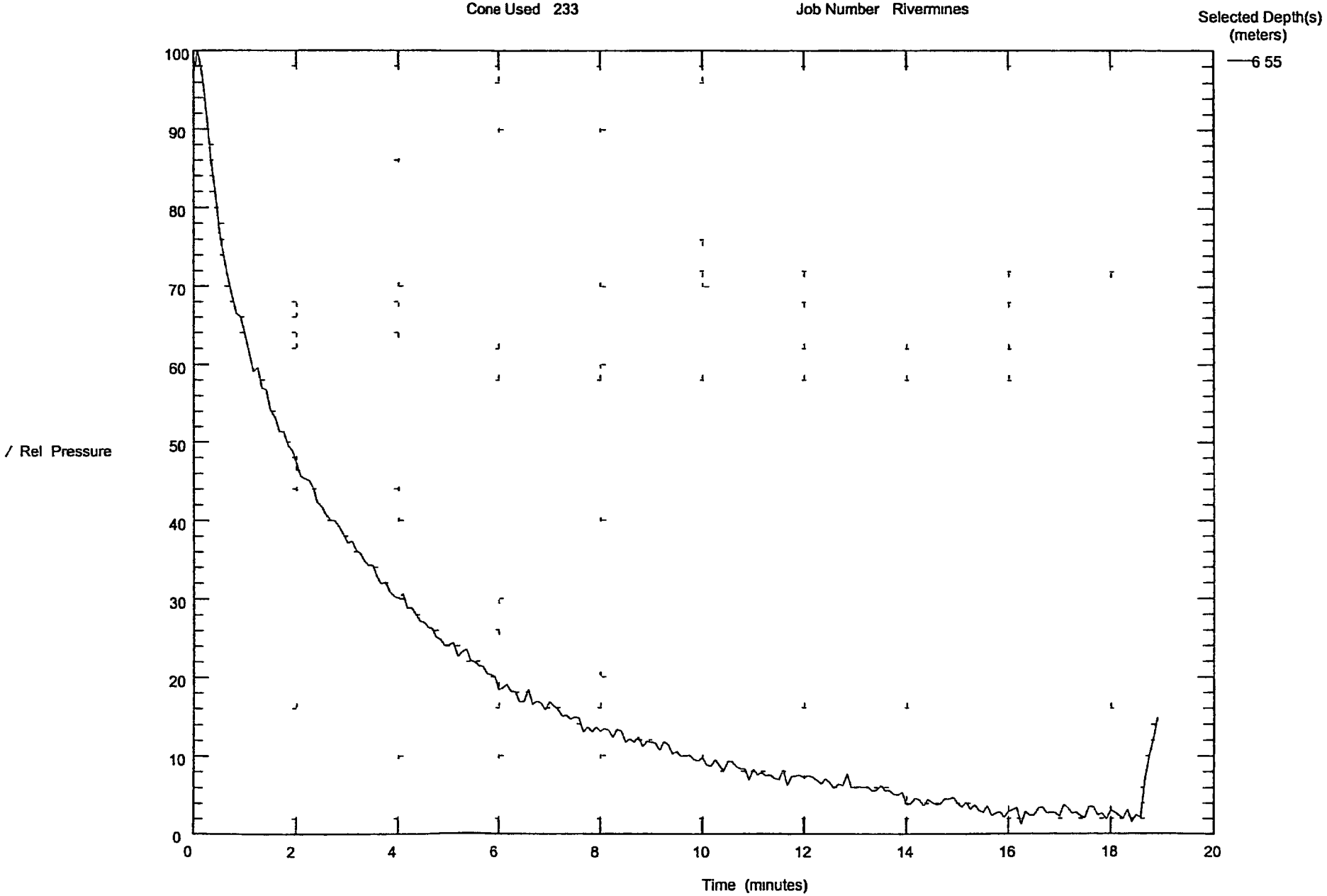
Location C 1
Job Number Rivermines



Appendix E

Rivermines Mine Tailings Site
Slope Stability Analysis

1 1 Introduction

Geotechnical information obtained at the site was used to perform stability analysis of the proposed regrading of the Rivermines Mines Tailings Site, Park Hills, Missouri This Appendix contains a description of the geotechnical exploration and the results of the geotechnical investigation and analysis It describes the modeling technique used and the assumptions made for the static and seismic analyses, and presents conclusions of the analyses

The existing abandoned tailings material includes a large pile of chat tailings presumably placed by conveyer and a more extensive zone of material referred as the tailings area The existing chat pile has a maximum height of about 200 feet above the surrounding ground surface with side slopes of 29 to 32 degrees from the horizontal plane The tailings field located adjacent to the chat pile on the northwest side, has a height of about 70 feet above the surrounding ground It is fairly flat on its upper surface Some of the side slopes of the tailings field have been eroded away in areas where slimes are present, giving exposure to a bad lands' appearance

The proposed modification of the chat pile includes regrading the outer slope to three horizontal to one vertical (3H 1V) and reducing the top elevation to 930 The outer slope of the tailings field will be buttressed with chat A middle bench will be created at elevation 915 in the proposed buttress on the west side of the tailings field

1 2 Geotechnical Exploration

A comprehensive geotechnical investigation was conducted to identify the soil stratigraphy and determine properties of the materials involved in the slopes The field investigation included 10 Standard Penetration Tests (SPT) soil borings, 13 surface geotechnical samples, and 6 Cone Penetration Test (CPT) soundings Figure E-1 presents a plan view of the surface sampling locations borings, and soundings conducted during this investigation

A total of ten SPT borings were drilled at the site to measure the standard penetration resistance and obtain representative soil samples Borings were drilled by the hollow stem auger method taking samples every 5 feet The borings have depths varying between 12 feet and 100 feet Eight of the borings were extended until they hit the naturally occurring clay or auger refusal by the bedrock The boring logs and laboratory test results including grain size analysis and Atterberg limits are included in Appendix D

To complement the SPT borings a different in-situ testing method was also used Specifically the CPT was used because it offers a number of advantages over the SPT including the following

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1 It is more economical to perform than the SPT which allows a more comprehensive subsurface investigation

2 The test procedure is simpler more standardized and thus more reproducible than the SPT

3 It provides a continuous record of penetration resistant throughout a soil deposit

A total of 6 CPT soundings were conducted in the area to provide better characterization of the slimes including strength parameters and phreatic surface

A subcontractor GSI Inc from Omaha, Nebraska conducted the soundings GSI used a truck mounted CPT rig with a 20-ton thrust capacity All the equipment used in the investigation was calibrated according to ASTM D-5578 95

In the CPT a cylindrical cone is pushed vertically into the ground at a constant rate of penetration of 20 mm/sec During penetration measurements are made of the tip resistance the side friction and pore water pressure generated by cone penetration The cone utilized during this investigation was manufactured by Hogentogler & Co The cone used had a 10 cm^2 base area and 150 cm^2 sleeve area The fluid used for saturation of the filter was silicone and the unequal area end ratio (a) is 0 8 The CPT logs of all soundings are included in Appendix D

At selected locations dissipation tests were performed Dissipation tests were performed by stopping the cone penetration and measuring the decay of pore water pressure with time The rate of dissipation depends on the coefficient of consolidation which in turns depends on the permeability of the soil The dissipation test can be continued until no further dissipation is observed to measure the in-situ pore water pressure

In addition to providing a detailed lithological profile based on interpreted soil behavior the CPT data were also used for engineering analyses, i e liquefaction potential undrained shear strength friction angle, and flow characteristics

1 3 Results of the Geotechnical Exploration

1 3 1 Chat Pile

The material in the chat pile at Rivermines consists of well-graded medium to fine sand The material also contains variable quantities of silt and gravel Surface bag samples and SPT samples were collected from the upper chat pile to obtain geotechnical data for the stability analysis Grain size distribution tests on the upper chat pile samples indicated that the material consists of well-graded medium to fine sand The surface material of the upper pile classifies as (SP-SM) according to the Unified Soil Classification System (USCS) Details of the grain size tests are included in Appendix D

As previously mentioned three SPT borings were conducted at the chat pile The results from the SPT reveal that the material in the upper pile is in a medium to dense condition The N blow count from the SPT ranges from 3 to 19 blows per foot The relationship between SPT and Overburden Pressures developed by Gibbs and Holtz (1957) was used to estimate the relative

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density The SPT data indicate that the relative density of the upper pile deposit averages approximately 40 to 50 percent

1 3 2 Tailings Field

Six soil borings and six CPT soundings were conducted in the tailings field to identify the subsurface material and develop a representative lithological profile for stability analysis At location C-2 the boring and the CPT indicate the presence of coarse tailings material from the ground surface to the 10 foot depth Underlying the coarse tailings a layer of slimes is found with a thickness of approximately 12 ft This layer exhibits very soft consistency with a corrected tip penetration resistance q_t of 2 tsf Below the slimes coarse tailings are found to a depth of approximately 70 ft Below the tailings the natural clay is found The natural clay is underlain by bedrock Similar subsurface conditions are found at Location B-6, with the exception that the slimes layer is 40 ft thick approximately

At location C-4 the CPT sounding indicates the presence of 16-foot thick layer of coarse tailings at the ground surface Underlying the coarse tailings is an 18-foot thick layer of a mixture of fine tailings and slimes, which is present to a depth of 34 feet Underlying the layer of fine tailings and slimes the coarse tailings are found again with a thickness of approximately 44 ft Below the coarse tailings, the native layer of clay is found to a depth of 54 feet where bedrock was detected

At location C-1 the CPT sounding indicates the presence of coarse tailings in the upper 6 ft Underlain the coarse tailings, a 7 ft thick layer of fine tailings mixed with slimes is present Below this layer mostly coarse tailings are found to the depth of 34 ft where the natural clay was detected The layer of fine tailings mixed with slimes is not as soft as found at CPT sounding C-2 The corrected cone penetration q_t is 15 tsf in average

At soundings C-3 and C-5 coarse tailings were found in the upper 60 ft At sounding C-5 the natural clay was found below the coarse tailings to the explored depths of 67 ft

1 4 Lithological Profile

The information collected from the SPT and CPT was used to develop representative cross sections of the chat pile and tailings field and obtain representative geotechnical parameters of the different materials involved for stability analysis

Data collected from the CPT was used to interpret soil properties of the coarse tailings and fine tailings/slimes for stability analyses and liquefaction assessment The empirical chart based on calibration chamber test data proposed by Robertson and Campanella (1983) was used to estimate the friction angle of the coarse/frictional tailings Estimation of the undrained shear strength of the slimes from CPT cone resistance, was made using the following equation

$$s_u = \frac{(q_t - \sigma_{vo})}{N_{kt}}$$

Where N_{kt} is an empirical cone factor, σ_{vo} is the total in-situ vertical stress, and q_t is the corrected cone tip resistance

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The CPT data interpretation was conducted using CPTINT ver 5 2 a computer program developed by the University of British Columbia In situ Testing Group CPTINT uses the most recent and recognized correlations to interpret CPT data and produce relevant soils parameters for design The data interpretation is included in Appendix D

Figure E 2 shows the summary of the shear strength associated with the coarse tailings material obtained from the CPT The solid line in Figure E-2 represents the lower bound of the values measured with the cone It can be seen from Figure E-2 that the lower bound line exhibits a non-linear behavior Data in Figure E-2 was used to establish the shear strength of coarse/frictional material in the stability analysis The interpreted coarse tailings friction angle of the lower boundary line ϕ exhibits values between 26 and 28 degrees

Similarly the interpreted CPT profile also allowed estimation of the strength associated with the layer of fine tailings/slimes and natural native clay The slimes displays an undrained shear strength ratio Su/σ in the range of 0 07 This is a very low strength and is consistent with the observation on the soil boring in which the slimes show a penetration resistance of weight of hammer (WHO) The mixture of fine tailings/slimes show higher strength with an undrained shear strength ratio of 0 27 The in-situ native clay displays an undrained shear strength ratio Su/σ in the range of 0 45 These relatively high undrained shear strength ratios suggest that the natural red clay is stiff The undrained shear strength ratio is defined as the undrained shear strength divided by the overburden pressure

Pore water pressure measurements during CPT penetration and dissipation tests were used to interpret the groundwater conditions at the Rivermines tailings field It was determined that the coarse/frictional tailings and fine tailings/slimes mixture are not saturated The dissipation test data indicated that no flow is taking place in the fine tailings/slime layer at the site The pore water pressure decayed to zero fairly rapidly after cone penetration

1 5 Slope Stability Modeling

The slope stability analyses were conducted using Slope/W, a computer-modeling program developed by GEO-Slope International Slope/W uses the limit equilibrium theory to compute the factor of safety of earth and rock slopes It is capable of modeling a variety of methods to compute the factor of safety of a slope while analyzing complex geometry stratigraphy and loading conditions

Spencer s method was used as the search technique to determine the factor of safety of the embankment in this stability analysis This method is considered adequate because it provides a factor of safety based on both force and moment equilibrium

Seven cross sections were developed to evaluate the subsurface conditions Their locations are shown in Figure E 1 which shows the plan view location of these cross sections Cross sections B and G were considered the most critical for stability due to their geometry and most importantly the presence of the slimes layer as identified in CPT soundings C-2 and C-4 As a result these cross sections were selected for analysis

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These cross sections included the proposed modified topography with outer slopes of 3H 1V The material used to build the outer slopes is coarse tailings from the chat pile It is assumed that this material will be compacted with a bulldozer and truck traffic Figure E-1 shows the plan view location of cross sections B and G Figures E-3 and E-4 show the cross sections and stratigraphy

Information obtained from CPT sounding C-2 and SPT boring B-5 was used to develop the stratigraphy associated with cross section B and shown in Figure E-3 Since sounding C-2 and boring B-5 are located approximately 40 ft from the edge/crest of the existing slope the extent of the slimes layer towards the face of the slope is unknown For analysis purposes it was assumed that the slimes layer extends to the face of the existing slope in the static stability analysis In the seismic stability analysis, in addition to assuming the slimes layer at the face of the existing slope a sensitivity analysis was performed assuming the slimes layer at 5 ft 10 ft and 15 ft from the face of the existing slope

Information obtained from CPT sounding C-4 and SPT boring B-9 was used to develop the stratigraphy associated with cross section G shown in Figure E-4 It is proposed that the fine tailings/slimes mixture near the toe at cross section G be removed before placing and compacting the new coarse tailings

Table E-1 shows the material properties used in the analyses For the newly placed and compacted coarse tailings, a conservative friction angle of 32 degrees was used For the existing in-situ coarse tailings a conservative friction angle of 26 to 28 degrees as shown in Figure E-1 (low boundary) based on CPT and SPT results was used It is anticipated that these values are conservative because most of the CPT data indicate higher friction angles

For the slimes the average undrained shear strength ratio from the CPT tests of 0 07 was used For the fine tailings/slimes mixture the undrained shear strength ratio of 0 27 was used The in-situ natural clay was characterized with the undrained shear strength ratio of 0 45 obtained from the CPT tests

The groundwater table was assumed to be located at the top of the slimes and/or fine tailings/slimes layer This is also a conservative assumption when analyzing the slopes because the field investigation indicated the absence of groundwater flow and unsaturated conditions

Table E–1 Material Properties Used in Stability Analysis

Material Type	Unit Weight (pcf)	Undrained Strength Ratio	Friction Angle (degrees)
Compacted coarse tailings	120		32
In situ coarse tailings	115		26 to 28 (Fig E 1)
Slimes	110	0 07	
Fine tailings/slimes mixture	110	0 27	
Natural red clay	120	0 45	

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1 5 1 Static Stability

As previously mentioned two geotechnical cross sections were analyzed at the Rivermines tailings field and chat pile These cross sections are B and G These cross sections were considered critical from the geometry and material composition The minimum computed factors of safety for the analyzed cross-sections under static conditions are given in Table E-2 The locations of the critical failure surfaces are shown on the attached Figures E-5 and E 6 The static factors of safety at the analyzed cross sections are 1 577 and 1 641 These factors of safety are greater than the commonly used criteria of 1 5 indicating that cross sections B and G will perform adequately under static conditions

Table E-2 Static Factor of Safety

Cross Section	Factor of Safety
B	1 58
G	1 64

1 5 2 Seismic Stability

The seismic stability of the dikes was evaluated in two stages The first stage consists of assessing liquefaction potential of the slimes and the second stage consists of evaluating the deformations associated with the slope under earthquake shaking

1 5 3 Liquefaction Assessment

Liquefaction potential susceptibility of tailings slimes was reviewed in two stages as follows

(a) The grain sizes of the slimes recovered at the site were compared with the range of grain size for tailings slimes with low resistance to liquefaction proposed by Ishihara (1985)

(b) The second stage consisted of using the Chinese Criteria based on index properties and grain size to evaluate the susceptibility of the slimes to strength loss during seismic action The original Chinese Criteria was slightly modified by Perlea (1999) to account for the difference in the testing procedure between the US and China

Comparison of the grain size distribution of the recovered sample from B-5 and B 6 and Ishihara s (1985) boundary curves indicates that the slimes do not have low resistance to liquefaction The grain size distribution of the slimes samples plot outside of the boundary curves for low resistance to liquefaction as proposed by Ishihara (1985)

The index properties and grain size distribution of the slime samples (B-5 and B-6 samples G12 and G35) indicate that the material does not meet the Chinese Criteria for liquefaction susceptibility The Chinese Criteria establish that the fraction finer than 0 005 mm be less than 20% to consider the material susceptible to liquefaction Additionally the liquid limit (LL) should be less than 35% and the natural water content greater than 0 9 LL The recovered samples exhibit 38 and 40 percent less than 0 005 mm The natural water content is less than 0 9 LL and the liquid limit is greater than 35 percent

In summary the slimes samples recovered at borings B-5 and B-6 do not meet the Chinese Criteria for liquefaction

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1 6 Earthquake Induced Deformations in the Slope

It is necessary to evaluate the amount of earthquake induced deformation to determine whether or not excessive deformation is going to take place If necessary corrective remedial measures such as slope modification can be applied The following describes the methodology used to evaluate the earthquake induced deformation

The design earthquake parameters for the seismic stability analysis are taken from the seismic hazard analysis performed by Geosyntec Consultants (Geosyntec 1995) for the Big River Mine Tailings site at Desloge, Missouri This site is located less than 3 miles from the Rivermines site so Geosyntec's seismic hazard analysis is adequate for the Rivermines site

Geosyntec adopted the approach proposed by Johnston and Nava (1994) to delineate the seismic source zones relevant for the project site The approach subdivides the New Madrid seismic source zone into two subzones known as Zone A and Zone B The outcome for the Design Earthquake Sources and Magnitudes indicated a maximum earthquake magnitude (M) of 8 5 for Zone A, referred to as far-field event, and a maximum earthquake magnitude (M) of 6 6 for Zone B referred to as near-field event The design earthquake parameters for the project are summarized in Table E–3

Table E–3 Summary of Design Earthquake Parameters (after Geosyntec, 1995)

Design Seismic Event	Seismic Source Zone	Earthquake Magnitude	Site-to Source Distance	Free-Field PGA at bedrock	Selected Accelerograms
Near field	Zone B	6 6	20 miles	0 20 g	Old Appleton
Far field	Zone A	8 5	89 miles	0 11 g	Taft N21E

It can be seen from Table E–3 that the maximum bedrock peak horizontal ground accelerations (PHGA) for the near and far field event are 0 2 g and 0 11 g, respectively These accelerations can be compared to the Missouri Department of Natural Resources (MDNR 1998) required design acceleration for dam design which is 75 percent of the Probable Maximum Acceleration (PMA) The PMA for St Francois County is 0 26 g Therefore, the computed design acceleration is 0 195 g which is similar to the one obtained using the seismic hazard analysis for the near-field event

The use of conventional pseudostatic methods to compute a factor of safety using a constant horizontal seismic coefficient selected on the basis of the seismicity of the area has been recognized as inadequate (Terzaghi, 1950, Seed and Martin, 1966) As a result evaluation of the seismic stability of the proposed slope was completed using the Newmark (1965) method In this method the permanent deformation of the slope is estimated instead of computing a factor of safety against sliding The procedure consists of computing the yield acceleration and then comparing the yield acceleration with the earthquake induced acceleration in the slope

The yield acceleration is computed by applying an inertial force equal to the failure mass multiplied by the seismic coefficient The seismic coefficient at which the full strength of the sliding mass is mobilized (i e factor of safety equal to 1) is known as the yield acceleration

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When the earthquake induced acceleration of the failure mass exceeds the yield acceleration permanent movements are assumed to occur along the direction of the failure plane and the magnitude of the displacement is evaluated by a simple double integration procedure

Makdisi and Seed (1978) developed a graphical relationship between the magnitude of permanent displacement and the ratio of yield acceleration and maximum earthquake induced acceleration for various earthquake magnitudes less than 8 25 Because an earthquake magnitude of 8 5 had to be considered in this study for the far-field event extrapolated results to a magnitude of 8 5 by Idriss (1985) were used to estimate permanent displacement

Since the failure surface considered in the analysis relates to the tailings within the pile the maximum induced acceleration at the base of the sliding mass is considered to be different from the maximum bedrock peak horizontal ground acceleration (PHGA) As a result a seismic site response analyses was performed at the Rivermines site to evaluate amplification of the ground motions

Site Response Analyses

The theory of one dimensional wave propagation through layered media was used to model the response of tailings field materials to strong ground shaking The analyses were performed using the well-known computer program SHAKE (Schnabel et al 1972) The initial material stiffness characteristics (shear moduli) were estimated from the SPT and CPT The nonlinear material characteristics (modulus reduction and damping) were estimated from those presented by Seed et al (1986)

Analyses were conducted for the response of the tailings deposit to both the near-field and far-field event The records used in the analyses were San Fernando at Castaic Old Ridge Route for the near-field and Sitka for the far-field These records exhibit similar magnitude and distance to the design earthquakes The records were scaled to use similar peak acceleration as shown in Table E 3 In both events the design motions were assumed to occur at a rock outcrop at the site

The soil profile considered in the analysis includes the typical stratigraphy found at Rivermines It consists of native clay overlying the bedrock On top of the natural clay a layer 40 ft thick of coarse tailings was modeled Overlying the coarse tailings a layer of slimes was considered And finally overlying the slimes the layer of coarse tailings was modeled The results indicate that some amplification of the ground motion will take place within the slimes The results of the site-specific analyses are summarized in Table E-4

Table E–4 - Results of Site Response Analysis

Event	Computed Maximum Acceleration (g)
Near field	0 38
Far-field	0 17

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Results of the site-specific seismic response analyses indicate that in the absence of soil liquefaction, the bedrock PHGA could be amplified at the base of the critical failure surface of the slimes by a factor of between 1 55 and 1 9 for the far-field and near-field event respectively

Computation of Yield Acceleration and Permanent Displacement

The yield acceleration was computed by applying an inertial force equal to the failure mass multiplied by the seismic coefficient The seismic coefficient at which the full strength of the sliding mass is mobilized (i e factor of safety equal to 1) is the yield acceleration The computer program SLOPE/W was used to compute the yield acceleration

The computed yield acceleration (from SLOPE/W) and the maximum computed acceleration from the site response analysis (SHAKE) were used along with the graphical relationships proposed by Makdisi and Seed (1978) and Idriss (1985) to estimate the permanent displacement The results of the seismic stability analysis in terms of yield acceleration and permanent displacements are shown in Table E–5 It can be seen from Table E–5 that earthquake-induced permanent deformation varies between 0 7 cm to 60 cm for cross section B depending on the distance of the slimes to the existing slope face For cross section G, the earthquake-induced permanent deformation varies between 0 3 cm to 20 cm

Table E-5 Results of Seismic Stability Analysis

Cross Section	Yield Acceleration	Computed Permanent Displacement (cm)	
		Near field event	Far field event
B (slimes at slope face)	0 092g	8 50	30 70
B (slimes at 5ft from slope face)	0 112g	7 40	10 30
B (slimes at 10 ft from slope face)	0 133g	4 35	3 8
B (slimes at 15 ft from slope face)	0 150g	3 20	0 4 2
G	0 16g	3 20	0 3 1

The magnitude of the computed displacements is not acceptable for cross section B when the slimes are located 10 ft or less from the face of the existing slope For cross section G and B (with slimes at 15 or more from existing slope face) the computed displacements are acceptable and probably will result in minor cracking of the slope In general permanent deformations less than 60 cm (2 ft) are tolerable for earth dams (FERC, 1991) In other words the slope can tolerate the deformations without failure

Hynes and Franklin (1984) performed Newmark permanent deformation analysis using over 350 strong motion records around the world and found that if the yield acceleration of the failure mass is greater than one-third peak ground acceleration of the earthquake induced acceleration permanent displacement will be less than 1 m (3 feet) For the seismic analyses shown in Table E-4 when the yield acceleration is greater than one-third of peak ground acceleration the computed permanent displacements are less than 1 m (3 feet), as expected

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1 7 Conclusions

The factors of safety for the static stability analysis were computed as 1 58 and 1 64 These values are higher than the standard acceptable criteria of 1 5 As a result it is anticipated that the proposed geometry modifications at the chat pile and tailings field will perform satisfactorily under static conditions

Liquefaction assessment indicates that the slimes would not liquefy under earthquake shaking Earthquake induced deformations in the slopes associated with cross section B are unacceptable when the slimes layer is modeled at a distance of 10 feet or less from the face of the existing slope When the slime layer is modeled at a distance of 10 feet or more from the face of the existing slope the computed earthquake induced deformations are acceptable Since the results depend on the location of the slimes it is anticipated that as part of the final design additional investigation will be performed to establish their actual location or alternatively the proposed slope would be modified to allow adequate behavior under seismic conditions

For cross section G the computed earthquake induced permanent deformations are in the range of 0 3 cm to 20 cm These levels of deformation are acceptable because they will not induce slope failure As a result, it is anticipated that this area will perform satisfactorily under seismic conditions

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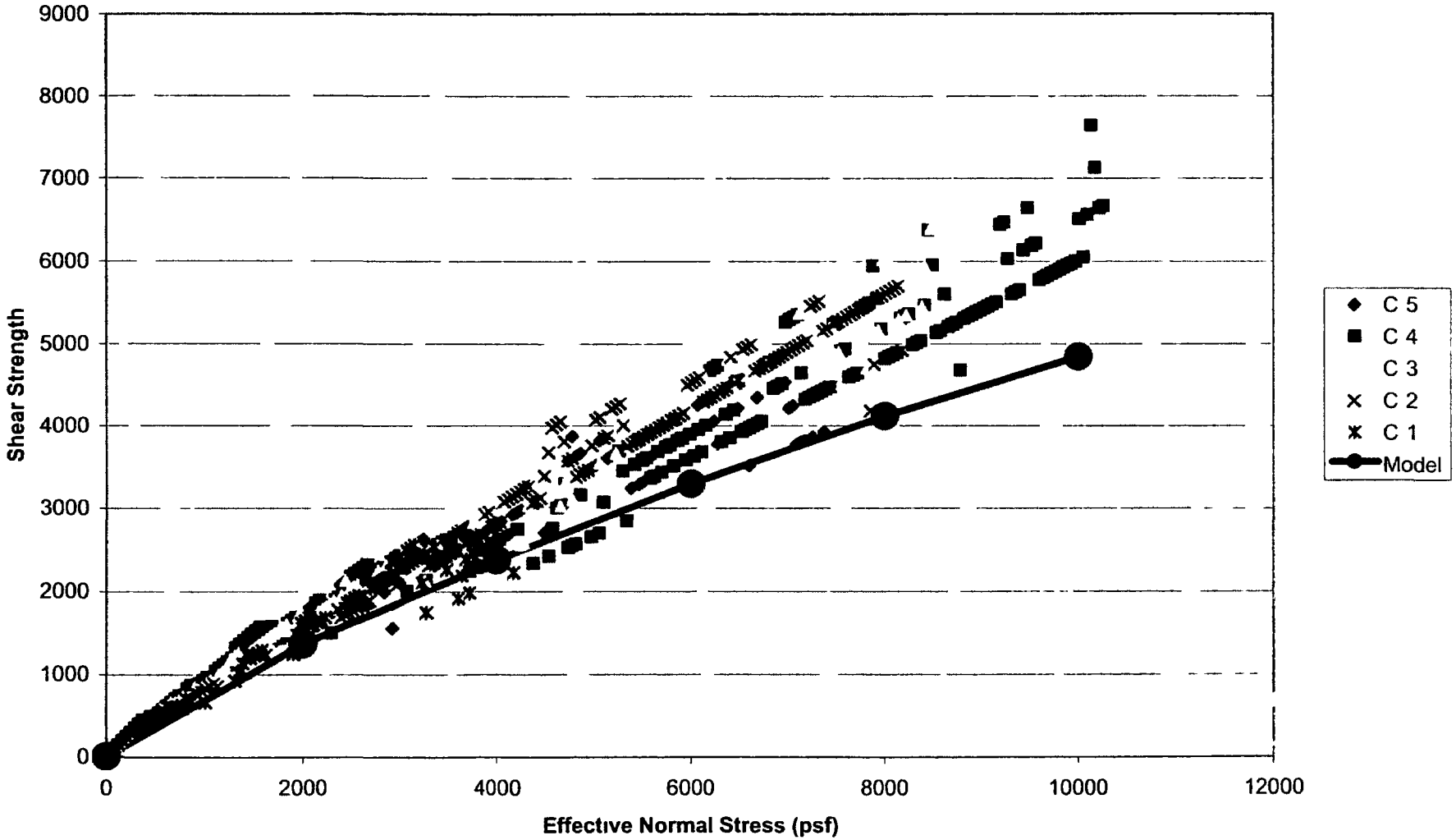
In Drawing - M \cad\2586009\13353_1 DWG M \cad\2586009\15955_1 DWG
\CAD\2586009\16006_1 DWG Plot at 1 12/28/2001 17 00 13

Figure E-2 Shear Strength Failure Envelope, Coarse Tailings
Rivermines Old Lead Belt



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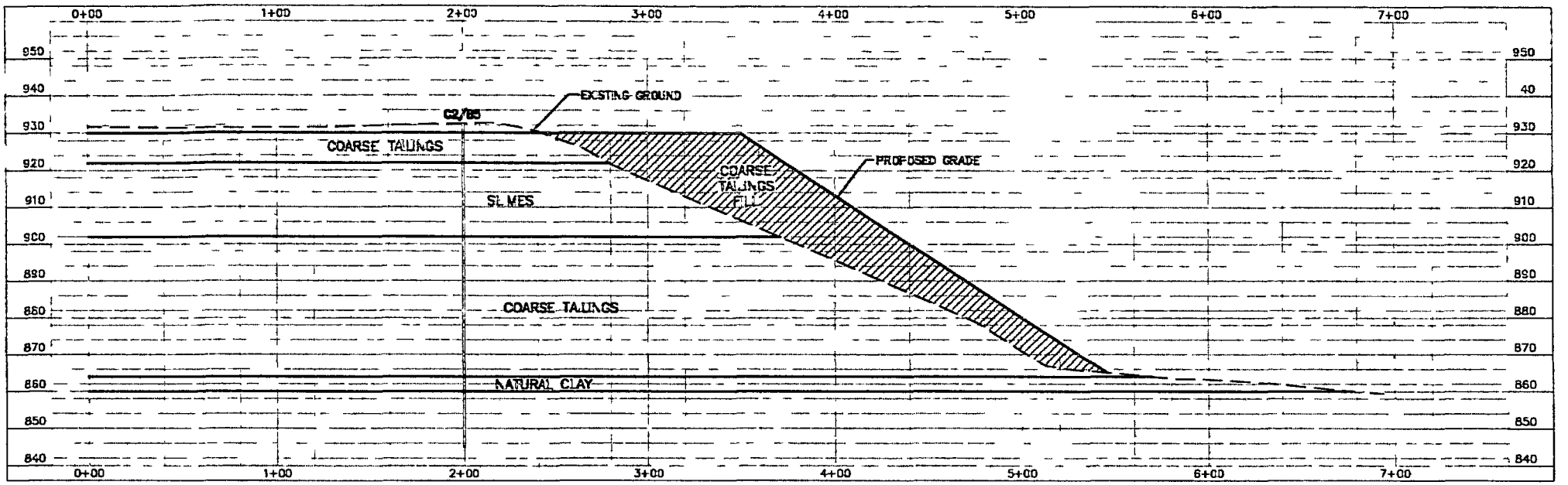
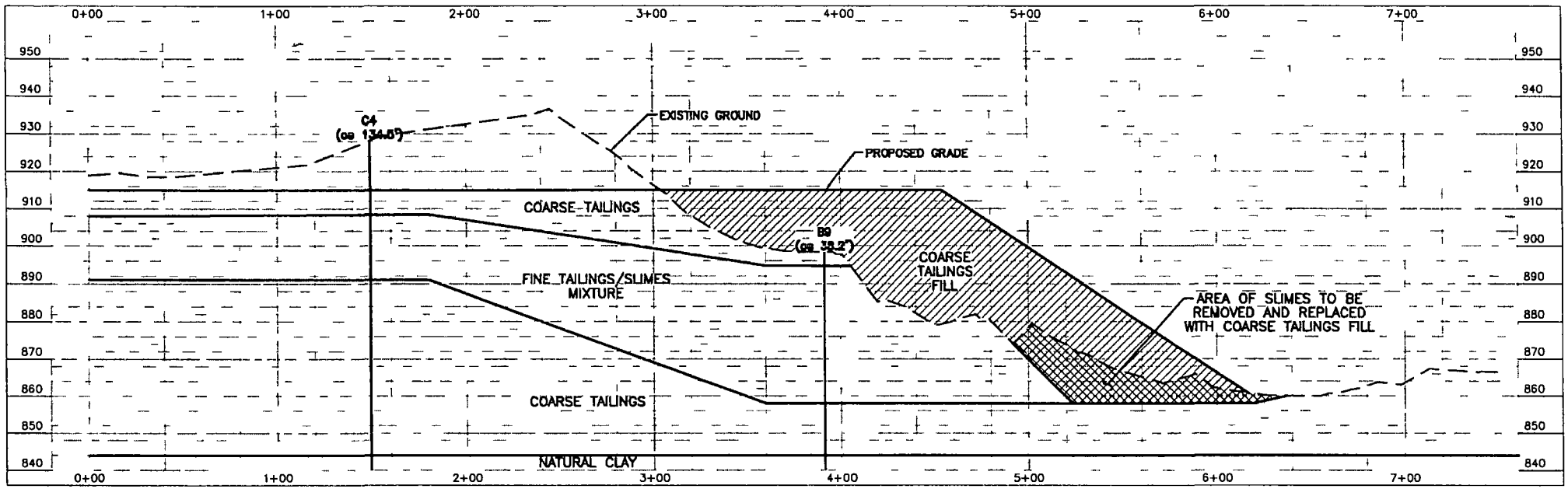


CROSS-SECTION B1 – B1

Figure E-3
CROSS-SECTION B
STRATIGRAPHY



CROSS-SECTION G1 - G1

Figure E-4
CROSS-SECTION G
STRATIGRAPHY

Description River Mines Tailings Site
Comments Cross Section B
File Name cross-section-b slp
Last Saved Date 12/28/2001
Last Saved Time 2 37 58 PM
Analysis Method Spencer
Direction of Slip Movement Left to Right
Slip Surface Option Grid and Radius

Figure E-5 Critical Failure Surface at Cross Section B

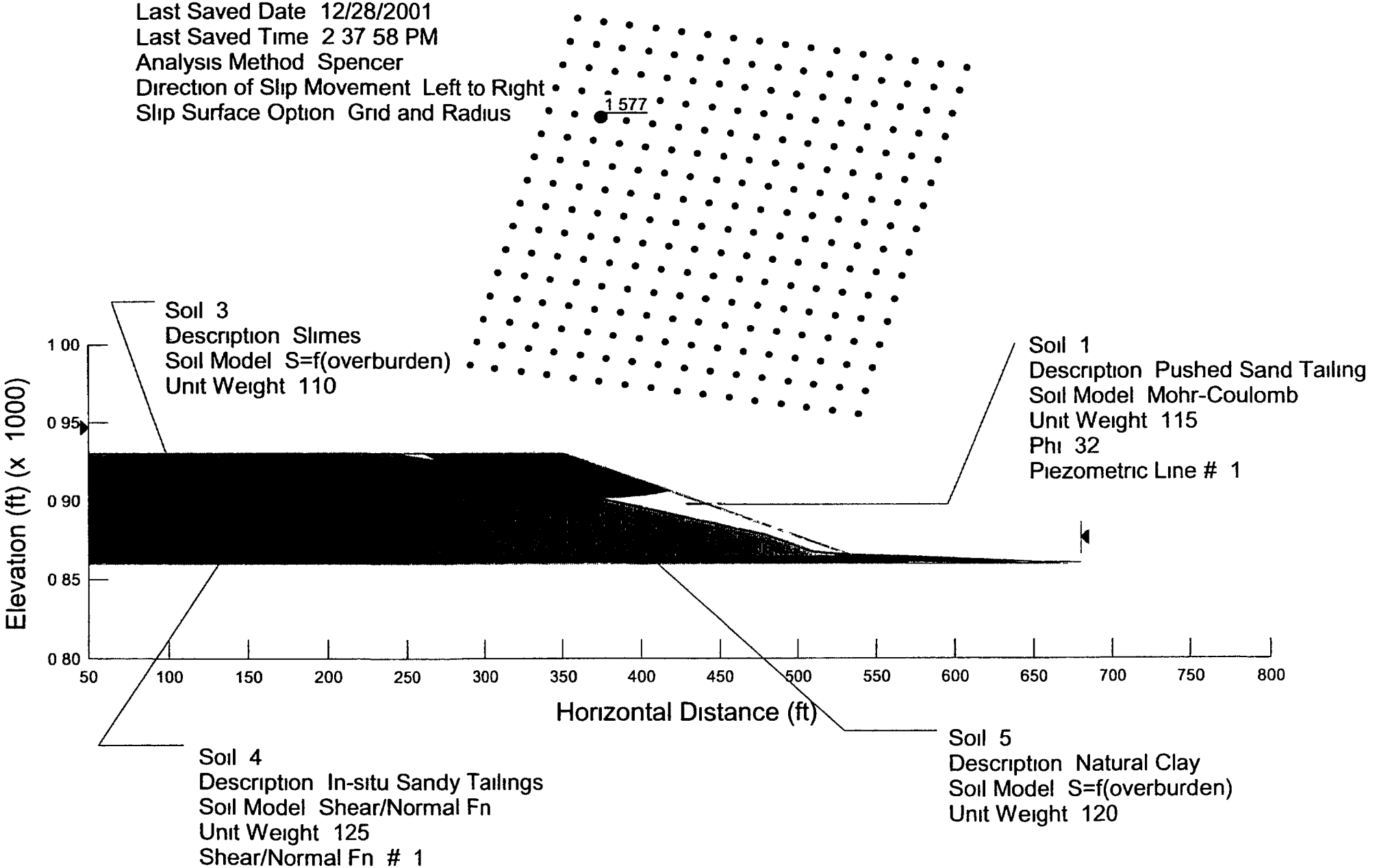
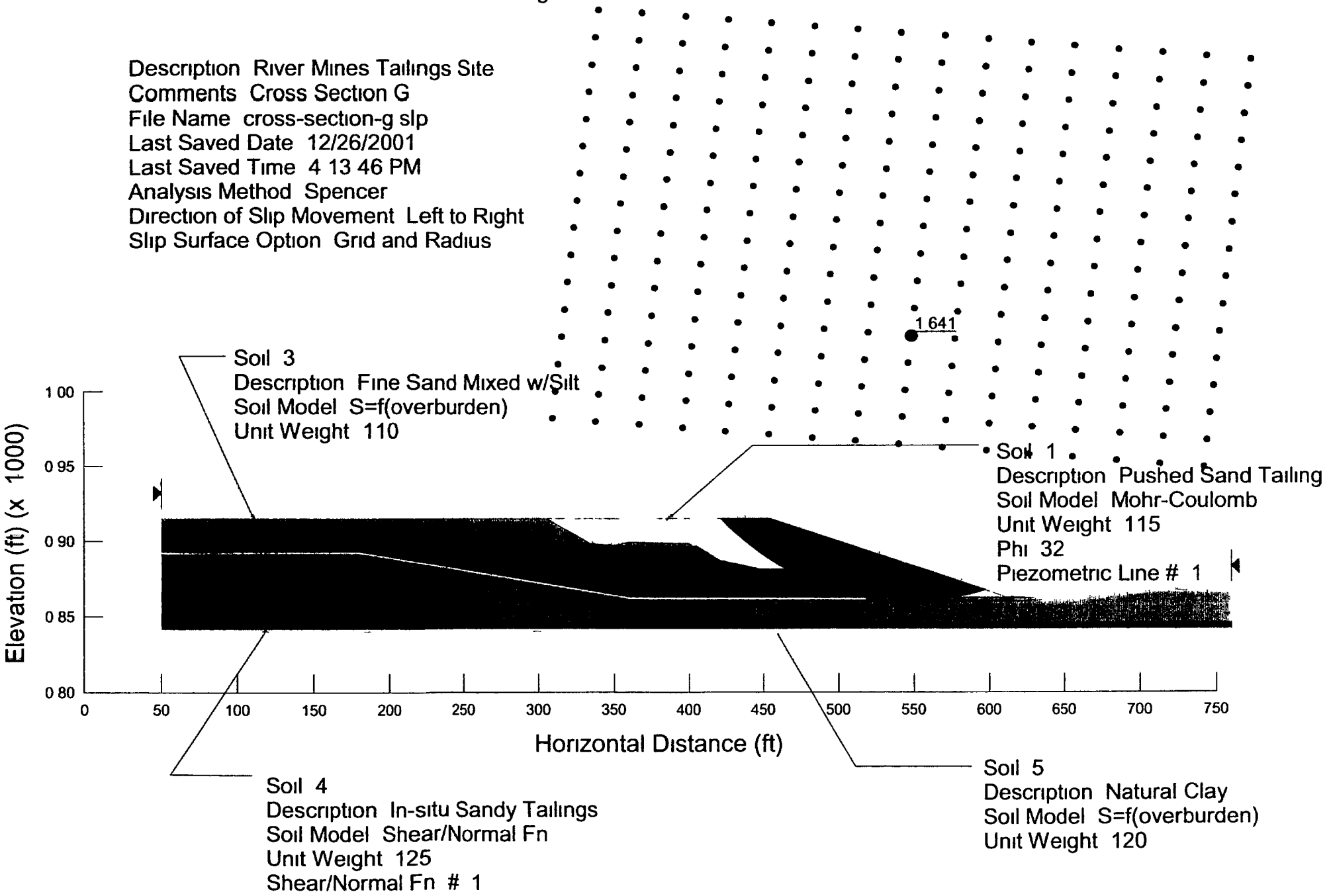


Figure E-6 Critical Failure Surface at Cross Section G



Appendix F
Hydrology

This appendix presents a discussion of the preliminary design and analysis of stormwater management practices for the Rivermines Mine Tailings Site Additional detailed analysis will be necessary as part of final design The purpose of this preliminary analysis is to present the general proposed drainage layout of the site and provide an approximate sizing for the proposed detention ponds The final design will incorporate information such as detailed measurements of existing structures design of additional structures and selected final cover materials This preliminary design is conservative in that it assumes that the largest possible portion of the tailings area is developed for athletic fields with a soil cover

The hydrology of the proposed subwatersheds was reviewed to verify that the proposed drainage features could safely handle large storms Two different storms were considered First was the 100 year 24 hour storm of 7 5 inches The rainfall was assumed to have a Standard Type II distribution (SCS) The second was the 10 year 24 hour storm of 5 2 inches also with a Standard Type II distribution These storm events were used to design and check the capacity of the detention basin outlets Protection against larger storm events will be provided by placing a ridge around the top of the tailings slopes

The hydrologic modeling was performed using the HYDROCAD computer model which is based on the SCS TR20 model The HYDROCAD computer model can also provide the rating curves for pipes and horizontal weirs based upon the geometry entered into the model Copies of the model output are included at the end of this appendix

To determine runoff an SCS curve number of 84 was used for the grassed pervious areas corresponding to clay cover soil (Type D soil) with fair vegetative cover An SCS curve number of 80 was used for the wooded pervious areas corresponding to clay cover soil and fair vegetative cover A curve number of 98 was used for the impervious areas In general the impervious area was assumed to be ten percent of the total area General watershed divides are shown on Figure F 1

Details of the Rivermines Mine Tailings Site hydrology are shown in Tables F 1 through F 5 The total drainage area tributary to the spillway in Subwatershed 4 was determined to be 128 0 acres Of this area approximately 70 acres is planned to be reclaimed tailings This analysis makes the conservative assumption that the reclaimed tailings will be reclaimed with topsoil and grass The

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slope areas will be reclaimed with a rock surface layer These slope areas are assumed to be non contributing (producing no runoff) due to the high infiltration rate of the underlying chat

The area was divided into seven subwatersheds with two outfall locations which lead to the Flat River shown in Figure F 1 Subwatersheds 1 2 3 and 4 discharge at the southwest corner of the site (Outfall 1) and Subwatershed 7 discharges approximately 1 000 feet further north (Outfall 2)

Subwatershed 1 includes a wooded hillside with Type D soils (CN=80) The remainder of Subwatershed 1 and all of Subwatershed 2 are assumed to be reclaimed tailings with Type D topsoil and grass assumed to be in fair condition (CN=84) These subwatersheds are assumed to be developed into a park with 10% impervious surface for paved parking area These areas will have stormwater detention basins The basin characteristics are shown in Tables F 3 and F 4

The detention basin in Subwatershed 1 is based on the surface area of the existing pond and assumes that fill will be placed around the pond to limit its expansion as its level rises during a storm event The discharge structure is the existing decant tower number 1 with a 3 5 foot wide horizontal weir in its side The discharge from Subwatershed 1 is controlled by the capacity of the 12 inch diameter outlet pipe from decant tower number 1 rather than the weir for elevations with greater than 0 6 feet of head on the weir

The discharge from Subwatershed 2 will enter decant tower number 2 A detention basin for Subwatershed 2 will need to be constructed in the vicinity of decant tower number 2 This may be a normally dry basin but is assumed to have the same stage vs area characteristics as the detention basin in Subwatershed 1 Because the culvert exiting the bottom of decant tower number 2 is so large and the height of decant tower number 2 is greater than decant tower number 1 the discharge capacity of decant tower number 2 is controlled by the 3 5 foot wide horizontal weir

Subwatersheds 1 and 2 will be directly vegetated if not used for athletic fields The detention basin and outlet design would remain the same for Subwatershed 1 but runoff would be greatly reduced coming primarily from the forested slope Because of the reduced runoff the outlet for Subwatershed 2 could be eliminated in favor of a normally dry detention basin without an outlet Proper sloping could provide a large storage capacity

Decant tower number 1 discharges through a 12 inch diameter steel pipe which exits beyond the northwest toe of the tailings slope as shown on Figure F 1 The discharge currently then flows south along the toe of the tailings slope and into ponds associated with the quarry operation It is

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assumed that as part of the removal action this discharge will be routed to Subwatershed 3 without mixing with runoff from the land locked quarry area Because the details of this routing have not been designed only the 12 inch pipe is included in the routing model This does not influence the results however because the discharge hydrograph from Subwatershed 1 is so flat As noted in Section 2 6 2 of the report this drainage pattern was not discovered until after completion of the draft EE/CA This revised drainage pattern will add some additional contributing drainage area along the east side of the quarry However it is minimal enough that the drainage divides were not redrawn for the preliminary hydrologic analysis included in the EE/CA

Decant tower number 2 discharges into Subwatershed 4 The culvert connecting decant tower number 2 with Subwatershed 4 is cast in place concrete with a flat bottom For modeling purposes (reach routing) the discharge culvert from tower number 2 into Subwatershed 4 is approximated as 60 inch round

Subwatershed 3 will discharge through a culvert into Subwatershed 4 The culvert will be sized to handle the 10 year peak runoff from Subwatershed 3 and the routed runoff from Subwatershed 1 Subwatershed 3 is assumed to either be stripped to natural clay soils or be provided with a clayey soil cover with grass vegetation (CN=84) This subwatershed does not have its own detention basin but will be served by the detention basin in Subwatershed 4

Subwatershed 4 consists primarily of wooded natural slopes (CN=80) A detention basin will be excavated in the tailings in the spillway portion of Subwatershed 4 For preliminary analysis purposes this basin is assumed to have the same size and weir outlet characteristics as the basin in Subwatershed 2

The overall routing is the discharge from the detention basins in Subwatersheds 1 and 2 plus the runoff from Subwatersheds 3 and 4 all being routed through the detention basin in Subwatershed 4 The discharge from the pond in Subwatershed 4 is known as Outfall 1 For the 100 year 24 hour storm the peak outflow at Outfall 1 is estimated to be 50 cfs with an increase in pond stage of 2 8 feet over the weir elevation

Subwatershed 5 will be a rock covered chat slope without runoff so it is not included in the routing Subwatershed 6 is assumed to be landlocked in the quarry If it does have an outlet it will be very restricted with significant storage Therefore, its influence on flood routing through Subwatershed 4 would be negligible

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Subwatershed 7 is tributary to Outfall 2 Proposed construction will not alter the watershed divides The minor runoff which now occurs from the eastern slope of the tailings deposit will be eliminated by the addition of a chat fill to support the slope Since no drainage modifications are planned in this watershed no hydrologic analysis has been performed for it

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Table F-1 Rivermines Subwatershed Characteristics

Subwatershed	Total Area (ac)	Impervious Area (%)	Weighted Curve Number	100 year	
				Subwatershed Discharge (cfs)	Subwatershed Runoff Volume (ac ft)
1	59 9	10	84	155	27 6
2	31 9	10	85	105	15 1
3	9 3	10	85	35	4 4
4	26 6	10	83	122	12 1
Total	127 7				

Table F-2 Rivermines Channel Characteristics

Channel	Channel Length (ft)	Channel Slope (ft/ft)	Channel Width (ft)	100 year		
				Discharge (cfs)	Depth (ft)	Velocity (fps)
1	1200	n/a	12 Pipe	6	n/a	8 2
2	1125	0 04	60 Pipe	31	0 8	15
3	1000	0 018	10[1]	40	0 9	3 3
4	500	0 02	8[1]	150	2 0	5 1

[1] Channel side slopes assumed to be 3 1

Table F-3 Rivermines Subwatersheds 1, 2, and 4 Basin Stage-Discharge Characteristics

Subwatershed 1			Subwatershed 2			Subwatershed 4		
Elev (ft)	Cum Storage Volume (ac ft)	Discharge (cfs)	Elev (ft)	Cum Storage Volume (ac ft)	Discharge (cfs)	Elev (ft)	Cum Storage Volume (ac ft)	Discharge (cfs)
926	0 0	0	915	0	0	770	0 0	0
926 5	1 7	3 7	916	3 5	10 5	771	3 5	10 5
927 0	3 5	5 2	917	7 2	29 7	772	7 2	29 7
929	11 1	5 4	918	11 1	55	773	11 1	55
932	23 9	5 7				775	19 6	117

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Table F-4 Rivermines Subwatersheds 1, 2, and 4 Basin Outlet Characteristics

	Subwatershed 1	Subwatershed 2	Subwatershed 4
Assumed 3 5 Weir Elevation	926	915	770
Assumed 60 inch Pipe Invert Elevation	n/a	840	n/a
Assumed 12 inch Pipe Invert Elevation	908	n/a	n/a

Table F-5a Rivermines Subwatershed 1 Basin Response to Modeled Storms

Storm Frequency	Rainfall (inches)	Peak Elevation (Feet)	Peak Inflows (cfs)	Peak Outflow (cfs)	Peak Storage (ac ft)	Average Detention Time (hrs)
10 Year	5 2	929 2	96	5 4	12 0	5 7
100 Year	7 5	931 4	155	5 6	21 5	5 9

Table F-5b Rivermines Subwatershed 2 Basin Response to Modeled Storms

Storm Frequency	Rainfall (inches)	Peak Elevation (Feet)	Peak Inflows (cfs)	Peak Outflow (cfs)	Peak Storage (ac ft)	Average Detention Time (hrs)
10 Year	5 2	916 3	66	16	4 8	3 6
100 Year	7 5	917 0	105	31	7 4	3 2

Table F-5c Rivermines Subwatershed 4 Basin (Outfall 1) Response to Modeled Storms

Storm Frequency	Rainfall (inches)	Peak Elevation (Feet)	Peak Inflows (cfs)	Peak Outflow (cfs)	Peak Storage (ac ft)	Average Detention Time (hrs)
10 Year	5 2	771 9	90	27	6 8	2 9
100 Year	7 5	772 8	150	50	10 5	2 6

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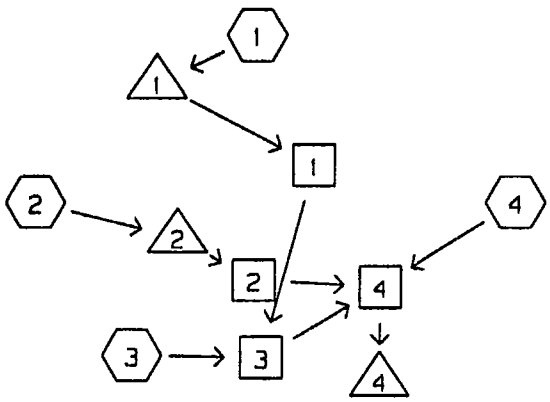
WATERSHED ROUTING ==========



SUBCATCHMENT REACH POND LINK

SUBCATCHMENT 1	= WS1	->	POND 1
SUBCATCHMENT 2	= WS2	->	POND 2
SUBCATCHMENT 3	= WS3	->	REACH 3
SUBCATCHMENT 4	= WS4	->	REACH 4
REACH 1	= Pipe from WS1 to WS3	->	REACH 3
REACH 2	= Pipe from WS2 to WS4	->	REACH 4
REACH 3	= Ditch from WS3 to WS4	->	REACH 4
REACH 4	= Swale from WS2 & WS3 outfalls to Pond 4	->	POND 4
POND 1	= Pond 1	->	REACH 1
POND 2	= WS2 Pond	->	REACH 2
POND 4	= WS4 pond	->	

RUNOFF BY SCS TR-20 METHOD TYPE II 24-HOUR RAINFALL= 7 5 IN, SCS U H

RUNOFF SPAN = 2-24 HRS, dt= 10 HRS, 221 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND COVERS (%CN)--				WGT CN	D C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	59 90	72 7	60%84	10%98	30%80	-	84	-	154 6	12 72	27 62
2	31 90	53 0	90%84	10%98	-	-	85	-	105 1	12 47	15 08
3	9 30	43 3	0%80	10%98	90%84	-	85	-	35 38	12 35	4 41
4	26 60	30 7	61%80	10%98	29%84	-	83	-	122 3	12 20	12 13

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)		n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)
1	12 0	-	-	-	-	013	1200	0250	8 2	2 4	5 64
2	60 0	-	-	-	-	013	1125	0400	15 1	1 2	30 60
3	-	10 0	4 0	30	30	050	1000	0180	3 3	5 1	39 53
4	-	8 0	2 1	30	30	050	500	0200	5 1	1 6	150 1

POND ROUTING BY STOR-IND METHOD

POND NO	START ELEV (FT)	FLOOD ELEV (FT)	PEAK ELEV (FT)	PEAK STORAGE (AF)	------ PEAK FLOW ------- Qin (CFS)	Qout (CFS)	Qpri (CFS)	Qsec (CFS)	---Qout--- ATTEN (%)	LAG (MIN)
1	926 0	932 0	931 4	21 47	154 6	5 64			96	518 1
2	915 0	918 0	917 0	7 36	105 1	30 63			71	52 4
4	770 0	775 0	772 8	10 46	150 1	50 15			67	89 6

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 **WS1**

PEAK= 154 6 CFS @ 12 72 HRS VOLUME= 27 62 AF

ACRES	CN		
36 21	84	grassed D soils	
5 99	98	paved	
17 70	80	wooded D soils	
59 90	84		

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 7 5 IN
SPAN= 2-24 HRS, dt= 1 HRS

Method	Comment	Tc (min)
TR-55 SHEET FLOW	**Segment ID**	43 5
Grass Bermuda n= 41 L=100 P2=3 7 in s= 003 /		
DIRECT ENTRY	**Segment ID**	29 2
	Total Length= 100 ft Total Tc=	72 7

SUBCATCHMENT 2 **WS2**

PEAK= 105 1 CFS @ 12 47 HRS VOLUME= 15 08 AF

ACRES	CN	
28 71	84	grassed D type soils
3 19	98	impervious
31 90	85	

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 7 5 IN
SPAN= 2-24 HRS dt= 1 HRS

Method	Comment	Tc (min)
TR-55 SHEET FLOW	**Segment ID**	28 0
Grass Bermuda n= 41 L=100 P2=3 7 in s= 009 /		
DIRECT ENTRY	**Segment ID**	25 0
	Total Length= 100 ft Total Tc=	53 0

SUBCATCHMENT 3 **WS3**

PEAK= 35 38 CFS @ 12 35 HRS VOLUME= 4 41 AF

ACRES	CN	
0 00	80	wooded D soils
93	98	paved
8 37	84	grassed D soils
9 30	85	

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 7 5 IN
SPAN= 2-24 HRS dt= 1 HRS

Method	Comment	Tc (min)
TR-55 SHEET FLOW	**Segment ID**	20 0
Woods Light underbrush n= 4 L=100 P2=3 7 in s= 02 /		
DIRECT ENTRY	**Segment ID**	23 3
	Total Length= 100 ft Total Tc=	43 3

SUBCATCHMENT 4 **WS4**

PEAK= 122 3 CFS @ 12 20 HRS, VOLUME= 12 13 AF

ACRES	CN	
16 30	80	wooded, D soils
2 66	98	paved
7 64	84	grassed, D soils
26 60	83	

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 7 5 IN
SPAN= 2-24 HRS dt= 1 HRS

Method	Comment	Tc (min)
TR-55 SHEET FLOW	**Segment ID**	11 5
Woods Light underbrush n= 4 L=100 P2=3 7 in s= 08 /		
DIRECT ENTRY	**Segment ID:**	19 2
	Total Length= 100 ft Total Tc=	30 7

REACH 1 **Pipe from WS1 to WS3**

Qin = 5 64 CFS @ 21 35 HRS VOLUME= 6 23 AF
Qout= 5 64 CFS @ 21 44 HRS VOLUME= 6 19 AF ATTEN= 0% LAG= 5 5 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0 0	0 0	0 00
1	0 0	12
2	1	49
3	2	1 10
7	6	4 72
8	7	5 51
9	7	6 00
9	8	6 06
1 0	8	6 00
1 0	8	5 63

12 PIPE
n= 013
LENGTH= 1200 FT
SLOPE= 025 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= 83 FT
PEAK VELOCITY= 8 2 FPS
TRAVEL TIME = 2 4 MIN
SPAN= 2-24 HRS dt= 1 HRS

REACH 2 **Pipe from WS2 to WS4**

Qin = 30 63 CFS @ 13 34 HRS VOLUME= 13 19 AF
Qout= 30 60 CFS @ 13 38 HRS VOLUME= 13 18 AF ATTEN= 0% LAG= 2 5 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0 0	0 0	0 00
5	1 0	10 87
1 0	2 8	45 61
1 5	5 0	102 01
3 5	14 7	436 10
4 0	16 8	509 15
4 5	18 6	555 16
4 7	19 2	560 31
4 9	19 5	555 13
5 0	19 6	520 89

60 PIPE
n= 013
LENGTH= 1125 FT
SLOPE= 04 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= 78 FT
PEAK VELOCITY= 15 1 FPS
TRAVEL TIME = 1 2 MIN
SPAN= 2-24 HRS dt= 1 HRS

REACH 3 **Ditch from WS3 to WS4**

Qin = 40 49 CFS @ 12 35 HRS VOLUME= 10 60 AF
Qout= 39 53 CFS @ 12 50 HRS VOLUME= 10 48 AF ATTEN= 2% LAG= 9 2 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0 0	0 0	0 00
4	4 5	9 06
8	10 1	30 35
1 2	16 8	63 15
1 7	27 1	123 98
2 4	43 2	237 38
3 2	66 1	425 43
4 0	93 3	679 37

10 x 4 CHANNEL
SIDE SLOPE= 3 /
n= 05
LENGTH= 1000 FT
SLOPE= 018 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= 91 FT
PEAK VELOCITY= 3 3 FPS
TRAVEL TIME = 5 1 MIN
SPAN= 2-24 HRS dt= 1 HRS

REACH 4 **Swale from WS2 & WS3 outfalls to Pond 4**

Qin = 153 1 CFS @ 12 24 HRS, VOLUME= 35 79 AF
Qout= 150 1 CFS @ 12 30 HRS, VOLUME= 35 70 AF, ATTEN= 2% LAG= 3 6 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0 0	0 0	0 00
2	1 8	2 57
4	3 9	8 42
6	6 4	17 16
9	9 9	32 82
1 3	15 4	60 97
1 7	22 8	106 03
2 1	31 5	165 12

8 x 2 1 CHANNEL
SIDE SLOPE= 3 /
n= 05
LENGTH= 500 FT
SLOPE= 02 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= 2 00 FT
PEAK VELOCITY= 5 1 FPS
TRAVEL TIME = 1 6 MIN
SPAN= 2-24 HRS dt= 1 HRS

POND 1 **Pond 1**

Qin = 154 6 CFS @ 12 72 HRS VOLUME= 27 62 AF
Qout= 5 64 CFS @ 21 35 HRS VOLUME= 6 23 AF ATTEN= 96% LAG= 518 1 MIN

ELEVATION (FT)	AREA (AC)	INC STOR (AF)	CUM STOR (AF)
926 0	3 40	0 00	0 00
926 5	3 50	1 73	1 73
927 0	3 60	1 78	3 50
929 0	4 00	7 60	11 10
932 0	4 50	12 75	23 85

STOR-IND METHOD
PEAK STORAGE = 21 47 AF
PEAK ELEVATION= 931 4 FT
FLOOD ELEVATION= 932 0 FT
START ELEVATION= 926 0 FT
SPAN= 2-24 HRS dt= 1 HRS
Tdet= 354 2 MIN (6 23 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	926 0	**3 5 ft wier@926,12-inch RCP@908**

ELEV(FT)	DISCH(CFS)
926 0	0 00
926 5	3 70
927 0	5 20
930 0	5 50
932 0	5 70

POND 2 **WS2 Pond**

Qin = 105 1 CFS @ 12 47 HRS VOLUME= 15 08 AF
Qout= 30 63 CFS @ 13 34 HRS VOLUME= 13 19 AF ATTEN= 71% LAG= 52 4 MIN

ELEVATION (FT)	AREA (AC)	INC STOR (AF)	CUM STOR (AF)
915 0	3 40	0 00	0 00
916 0	3 60	3 50	3 50
917 0	3 80	3 70	7 20
918 0	4 00	3 90	11 10

STOR-IND METHOD
PEAK STORAGE = 7 36 AF
PEAK ELEVATION= 917 0 FT
FLOOD ELEVATION= 918 0 FT
START ELEVATION= 915 0 FT
SPAN= 2-24 HRS, dt= 1 HRS
Tdet= 193 5 MIN (13 13 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	915 0	**3 5 BROAD-CRESTED RECTANGULAR WEIR**
			Q=C L H^1 5 C=3 3 3 3 3 3 3 3

POND 4 **WS4 pond**

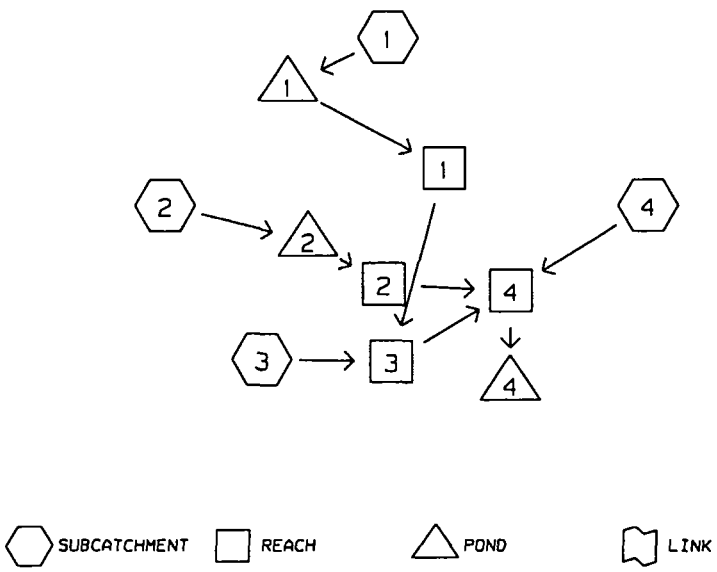
Qin = 150 1 CFS @ 12 30 HRS, VOLUME= 35 70 AF
Qout= 50 15 CFS @ 13 79 HRS VOLUME= 31 10 AF ATTEN= 67%, LAG= 89 6 MIN

ELEVATION (FT)	AREA (AC)	INC STOR (AF)	CUM STOR (AF)
770 0	3 40	0 00	0 00
771 0	3 60	3 50	3 50
772 0	3 80	3 70	7 20
773 0	4 00	3 90	11 10
775 0	4 50	8 50	19 60

STOR-IND METHOD
PEAK STORAGE = 10 46 AF
PEAK ELEVATION= 772 8 FT
FLOOD ELEVATION= 775 0 FT
START ELEVATION= 770 0 FT
SPAN= 2-24 HRS, dt= 1 HRS
Tdet= 158 4 MIN (30 96 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	770 0'	3 5' **BROAD-CRESTED RECTANGULAR WEIR**
			Q=C L H^1 5 C=3 3, 3, 3 3, 3 3 3

WATERSHED ROUTING ==========



SUBCATCHMENT 1	= WS1	->	POND 1
SUBCATCHMENT 2	= WS2	->	POND 2
SUBCATCHMENT 3	= WS3	->	REACH 3
SUBCATCHMENT 4	= WS4	->	REACH 4
REACH 1	= Pipe from WS1 to WS3	->	REACH 3
REACH 2	= Pipe from WS2 to WS4	->	REACH 4
REACH 3	= Ditch from WS3 to WS4	->	REACH 4
REACH 4	= Swale from WS2 & WS3 outfalls to Pond 4	->	POND 4
POND 1	= Pond 1	->	REACH 1
POND 2	= WS2 Pond	->	REACH 2
POND 4	= WS4 pond	->	

RUNOFF BY SCS TR-20 METHOD TYPE II 24-HOUR RAINFALL= 5 2 IN SCS U H

RUNOFF SPAN = 2-24 HRS, dt= 10 HRS 221 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND COVERS (%CN)--	WGT CN	D C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	59 90	72 7	60%84 10%98 30%80 -	84	-	95 85	12 73	16 96
2	31 90	53 0	90%84 10%98 - -	85	-	65 94	12 48	9 34
3	9 30	43 3	0%80 10%98 90%84 -	85	-	22 11	12 35	2 73
4	26 60	30 7	61%80 10%98 29%84 -	83	-	75 47	12 20	7 39

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)		n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)
1	12 0	-	-	-	-	013	1200	0250	8 2	2 5	5 42
2	60 0	-	-	-	-	013	1125	0400	12 5	1 5	16 24
3	-	10 0	4 0	30	30	050	1000	0180	2 9	5 8	25 38
4	-	8 0	2 1	30	30	050	500	0200	4 5	1 9	90 04

POND ROUTING BY STOR-IND METHOD

POND NO	START ELEV (FT)	FLOOD ELEV (FT)	PEAK ELEV (FT)	PEAK STORAGE (AF)	------ PEAK FLOW ------- Qin (CFS)	Qout (CFS)	Qpri (CFS)	Qsec (CFS)	---Qout--- ATTEN (%)	LAG (MIN)
1	926 0	932 0	929 2	12 03	95 85	5 42			94	356 9
2	915 0	918 0	916 3	4 75	65 94	16 24			75	61 0
4	770 0	775 0	771 9	6 78	90 04	27 21			70	125 3

LINK NO	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 **WS1**

PEAK= 95 85 CFS @ 12 73 HRS VOLUME= 16 96 AF

ACRES	CN		
36 21	84	grassed D soils	SCS TR-20 METHOD
5 99	98	paved	TYPE II 24-HOUR
17 70	80	wooded D soils	RAINFALL= 5 2 IN
59 90	84		SPAN= 2-24 HRS dt= 1 HRS

Method	Comment	Tc (min)
TR-55 SHEET FLOW	**Segment ID**	43 5
Grass Bermuda n= 41 L=100' P2=3 7 in s= 003 '/'		
DIRECT ENTRY	**Segment ID**	29 2
	Total Length= 100 ft Total Tc=	72 7

SUBCATCHMENT 2 **WS2**

PEAK= 65 94 CFS @ 12 48 HRS VOLUME= 9 34 AF

ACRES	CN		
28 71	84	grassed, D type soils	SCS TR-20 METHOD
3 19	98	impervious	TYPE II 24-HOUR
31 90	85		RAINFALL= 5 2 IN
			SPAN= 2-24 HRS dt= 1 HRS

Method	Comment	Tc (min)
TR-55 SHEET FLOW	**Segment ID**	28 0
Grass Bermuda n= 41 L=100' P2=3 7 in s= 009 '/'		
DIRECT ENTRY	**Segment ID:**	25 0
	Total Length= 100 ft Total Tc=	53 0

SUBCATCHMENT 3 **WS3**

PEAK= 22 11 CFS @ 12 35 HRS, VOLUME= 2 73 AF

ACRES	CN		
0 00	80	wooded, D soils	SCS TR-20 METHOD
93	98	paved	TYPE II 24-HOUR
8.37	84	grassed D soils	RAINFALL= 5 2 IN
9 30	85		SPAN= 2-24 HRS dt= 1 HRS

Method	Comment	Tc (min)
TR-55 SHEET FLOW	**Segment ID**	20 0
Woods Light underbrush n= 4 L=100' P2=3 7 in s= 02 '/'		
DIRECT ENTRY	**Segment ID**	23 3
	Total Length= 100 ft Total Tc=	43 3

SUBCATCHMENT 4 **WS4**

PEAK= 75 47 CFS @ 12 20 HRS VOLUME= 7 39 AF

ACRES	CN		
16 30	80	wooded D soils	
2 66	98	paved	
7 64	84	grassed D soils	
26 60	83		

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 5 2 IN
SPAN= 2-24 HRS dt= 1 HRS

Method	Comment	Tc (min)
TR-55 SHEET FLOW	**Segment ID**	11 5
Woods Light underbrush n= 4 L=100 P2=3 7 in s= 08 '/		
DIRECT ENTRY	**Segment ID**	19 2
	Total Length= 100 ft Total Tc=	30 7

REACH 1 **Pipe from WS1 to WS3**

Qin = 5 42 CFS @ 18 68 HRS VOLUME= 5 56 AF
Qout= 5 42 CFS @ 18 75 HRS VOLUME= 5 52 AF ATTEN= 0% LAG= 4 6 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0 0	0 0	0 00
1	0 0	12
2	1	49
3	2	1 10
7	6	4 72
8	7	5 51
9	7	6 00
9	8	6 06
1 0	8	6 00
1 0	8	5 63

12" PIPE
n= 013
LENGTH= 1200 FT
SLOPE= 025 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= 79 FT
PEAK VELOCITY= 8 2 FPS
TRAVEL TIME = 2 5 MIN
SPAN= 2-24 HRS dt= 1 HRS

REACH 2 **Pipe from WS2 to WS4**

Qin = 16 24 CFS @ 13 49 HRS VOLUME= 7 84 AF
Qout= 16 24 CFS @ 13 54 HRS VOLUME= 7 83 AF ATTEN= 0% LAG= 2 5 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0 0	0 0	0 00
5	1 0	10 87
1 0	2 8	45 61
1 5	5 0	102 01
3 5	14 7	436 10
4 0	16 8	509 15
4 5	18 6	555 16
4 7	19 2	560 31
4 9	19 5	555 13
5 0	19 6	520 89

60 PIPE
n= 013
LENGTH= 1125 FT
SLOPE= 04 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= 58 FT
PEAK VELOCITY= 12 5 FPS
TRAVEL TIME = 1 5 MIN
SPAN= 2-24 HRS dt= 1 HRS

REACH 3 **Ditch from WS3 to WS4**

Qin = 25 97 CFS @ 12 37 HRS VOLUME= 8 25 AF
Qout= 25 38 CFS @ 12 55 HRS VOLUME= 8 14 AF ATTEN= 2% LAG= 10 5 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0 0	0 0	0 00
4	4 5	9 06
8	10 1	30 35
1 2	16 8	63 15
1 7	27 1	123 98
2 4	43 2	237 38
3 2	66 1	425 43
4 0	93 3	679 37

10' x 4' CHANNEL
SIDE SLOPE= 3 '/'
n= 05
LENGTH= 1000 FT
SLOPE= 018 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= 70 FT
PEAK VELOCITY= 2 9 FPS
TRAVEL TIME = 5 8 MIN
SPAN= 2-24 HRS dt= 1 HRS

REACH 4 **Swale from WS2 & WS3 outfalls to Pond 4**

Qin = 91 74 CFS @ 12 25 HRS VOLUME= 23 36 AF
Qout= 90 04 CFS @ 12 31 HRS VOLUME= 23 28 AF ATTEN= 2% LAG= 3 9 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0 0	0 0	0 00
2	1 8	2 57
4	3 9	8 42
6	6 4	17 16
9	9 9	32 82
1 3	15 4	60 97
1 7	22 8	106 03
2 1	31 5	165 12

8 x 2 1 CHANNEL
SIDE SLOPE= 3 '/
n= 05
LENGTH= 500 FT
SLOPE= 02 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= 1 54 FT
PEAK VELOCITY= 4 5 FPS
TRAVEL TIME = 1 9 MIN
SPAN= 2-24 HRS dt= 1 HRS

POND 1 **Pond 1**

Qin = 95 85 CFS @ 12 73 HRS VOLUME= 16 96 AF
Qout= 5 42 CFS @ 18 68 HRS VOLUME= 5 56 AF, ATTEN= 94% LAG= 356 9 MIN

ELEVATION (FT)	AREA (AC)	INC STOR (AF)	CUM STOR (AF)
926 0	3 40	0 00	0 00
926 5	3 50	1 73	1 73
927 0	3 60	1 78	3 50
929 0	4 00	7 60	11 10
932 0	4 50	12 75	23 85

STOR-IND METHOD
PEAK STORAGE = 12 03 AF
PEAK ELEVATION= 929 2 FT
FLOOD ELEVATION= 932 0 FT
START ELEVATION= 926 0 FT
SPAN= 2-24 HRS dt= 1 HRS
Tdet= 343 2 MIN (5 54 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	926 0	**3 5 ft wier@926 12-inch RCP@908**

ELEV(FT)	DISCH(CFS)
926 0	0 00
926 5	3 70
927 0	5 20
930 0	5 50
932 0	5 70

POND 2 **WS2 Pond**

Qin = 65 94 CFS @ 12 48 HRS VOLUME= 9 34 AF
Qout= 16 24 CFS @ 13 49 HRS VOLUME= 7 84 AF, ATTEN= 75%, LAG= 61 0 MIN

ELEVATION (FT)	AREA (AC)	INC STOR (AF)	CUM STOR (AF)
915 0	3 40	0 00	0 00
916 0	3 60	3 50	3 50
917 0	3 80	3 70	7 20
918 0	4 00	3 90	11 10

STOR-IND METHOD
PEAK STORAGE = 4 75 AF
PEAK ELEVATION= 916 3 FT
FLOOD ELEVATION= 918 0 FT
START ELEVATION= 915 0 FT
SPAN= 2-24 HRS dt= 1 HRS
Tdet= 215 9 MIN (7 84 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	915 0'	**3 5' BROAD-CRESTED RECTANGULAR WEIR**
			Q=C L H^1 5 C=3, 3, 3, 3, 3, 3, 3, 3

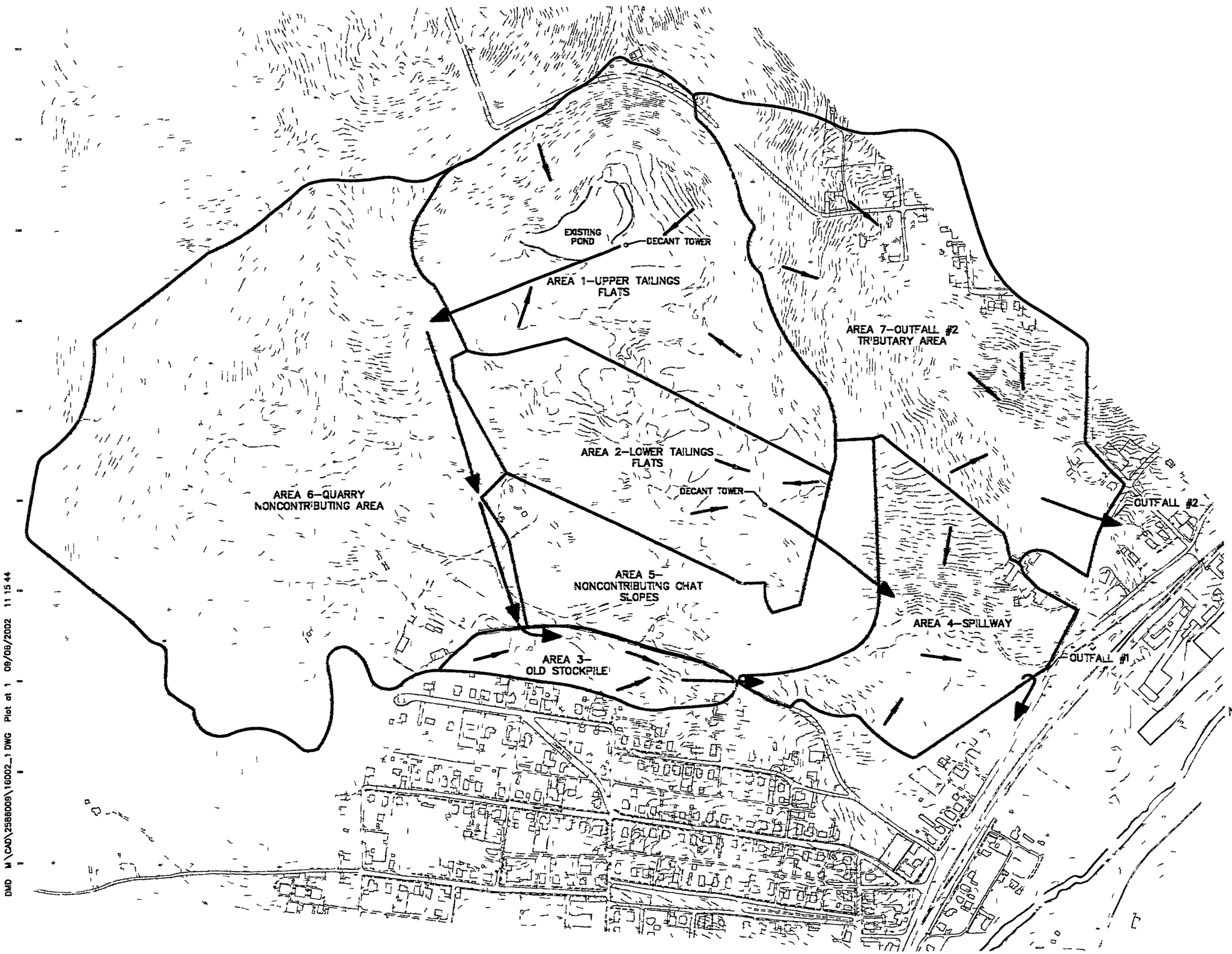
POND 4 **WS4 pond**

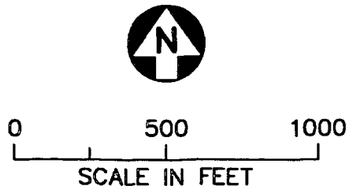
Qin = 90 04 CFS @ 12 31 HRS VOLUME= 23 28 AF
Qout= 27 21 CFS @ 14 40 HRS VOLUME= 19 37 AF ATTEN= 70% LAG= 125 3 MIN

ELEVATION (FT)	AREA (AC)	INC STOR (AF)	CUM STOR (AF)
770 0	3 40	0 00	0 00
771 0	3 60	3 50	3 50
772 0	3 80	3 70	7 20
773 0	4 00	3 90	11 10
775 0	4 50	8 50	19 60

STOR-IND METHOD
PEAK STORAGE = 6 78 AF
PEAK ELEVATION= 771 9 FT
FLOOD ELEVATION= 775 0 FT
START ELEVATION= 770 0 FT
SPAN= 2-24 HRS dt= 1 HRS
Tdet= 175 9 MIN (19 37 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	770 0	**3 5' BROAD-CRESTED RECTANGULAR WEIR**
			Q=C L H^1 5 C=3 3 3 3 3 3 3 3





- Sidewalk
- Building
- Foundation
- Fence
- Wall
- Tree Line
- Stream
- Brush/Shrub Line
- Index Contour
- Intermediate Contour
- Depression Contour
- Guard Rail
- Swamp Symbol
- Control Point
- X 325 6 Spot Elevation
- Single Tree
- Located Object
- Catch Basin
- Manhole
- Pole
- Sign
- Fire Hydrant
- Light Pole
- Inlet Symbol
- Railroad
- Paved Road
- Unpaved Road
- Trail
- Pipe line
- Driveway
- Surface Flow Direction
- Subwatershed Discha ge Locations

NOTES

1 EXISTING TOPOGRAPHY WAS PREPARED BY WALKER AND ASSOCIATES FROM AERIAL PHOTOGRAPHS TAKEN MARCH 23 2000 MAP DATE AUGUST 29 2000 SURVEY CONTROL BY EFFAN SURVEY

2 DASHED CONTOURS MAY BE UNRELIABLE.

Figure F–1
WATERSHED BOUNDARIES
Rivermines Mine Tailings Site
Park Hills MO

Xrefs: Drawing – M:\cad\2586009\13353_1.DWG
DWD M:\CAD\2586009\16002_1.DWG Plot at 1 08/08/2002 11:15:44

Table G 1

Removal Action Cost Estimate
Alternative 1
No Action
Rivermines Mine Tailings Site

Item No	Item	Unit	Unit Price	Est Quant	Cost Extension
1 1	Mobilization				
	All Areas	LS	$100 000		$0
2 1	Clearing & Grubbing				
	Main Site	Ac	$1 000		$0
	South of Entrance Road	Ac	$1 000		$0
	Spillway	Ac	$1 000		$0
	Channel Beyond Old 32	Ac	$1 000		$0
2 2	Fencing				
	Site Perimeter	LF	$15		$0
3 1	Excavation				
	Main Site	CY	$1 50		$0
	South of Entrance Road	CY	$1 50		$0
	Spillway	CY	$1 50		$0
	Channel Beyond Old 32	CY	$3 00		$0
3 2	Demolition				
	Mine Shaft Area	LS	$25 000		$0
4 1	Stormwater Management				
	Decant Tower No 1	LS	$5 000		$0
	Decant Tower No 2	LS	$5 000		$0
	Decant Culvert Repair	LS	$80 000		$0
	Power Street Culvert	LS	$2 500		$0
	Advanced Treatment	LS	$420 000		$0
	Spillway Berms	LS	$15 000		$0
	Spillway Outlet	LS	$20 000		$0
5 1	Main Site Cover Materials				
	Tailings 6 Cover Soil	SY	$0 50		$0
	6' Vegetative Soil	SY	$1 00		$0
	Revegetation	Ac	$1 000		$0
	Chat 12 Graded Rock	SY	$2 75		$0
5 2	Direct Revegetation Areas				
	South Of Entrance Rd	Ac	$2 000		$0
	Spillway	Ac	$2 000		$0
	Channel Beyond Old 32	Ac	$2 000		$0
			Subtotal Construction		$0
			Engineering & Administration	15%	$0
			Contingencies	25%	$0
			Estimated Capital Cost		$0

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Table G 2
Removal Action Cost Estimate
Alternative 2
Administrative Controls
Rivermines Mine Tailings Site

Item No			Unit	Unit Price	Est Quant	Cost Extension
1 1	Mobilization					
		All Areas	LS	$100 000		$0
2 1	Clearing & Grubbing					
		Main Site	Ac	$1 000		$0
		South of Entrance Road	Ac	$1 000		$0
		Spillway	Ac	$1 000		$0
		Channel Beyond Old 32	Ac	$1 000		$0
2 2	Fencing					
		Site Perimeter	LF	$15	12 000	$180 000
3 1	Excavation					
		Main Site	CY	$1 50		$0
		South of Entrance Road	CY	$1 50		$0
		Spillway	CY	$1 50		$0
		Channel Beyond Old 32	CY	$3 00		$0
3 2	Demolition					
		Mine Shaft Area	LS	$25 000		$0
4 1	Stormwater Management					
		Decant Tower No 1	LS	$5 000		$0
		Decant Tower No 2	LS	$5 000		$0
		Decant Culvert Repair	LS	$80 000		$0
		Power Street Culvert	LS	$2 500		$0
		Advanced Treatment	LS	$420 000		$0
		Spillway Berms	LS	$15 000		$0
		Spillway Outlet	LS	$20 000		$0
5 1	Main Site Cover Materials					
	Tailings	6 Cover Soil	SY	$0 50		$0
		6 Vegetative Soil	SY	$1 00		$0
		Revegetation	Ac	$1 000		$0
	Chat	12 Graded Rock	SY	$2 75		$0
5 2	Direct Revegetation Areas					
		South Of Entrance Rd	Ac	$2 000		$0
		Spillway	Ac	$2 000		$0
		Channel Beyond Old 32	Ac	$2 000		$0

Subtotal Construction		$180 000
Engineering & Administration	15%	$27 000
Contingencies	25%	$51 750
Estimated Capital Cost		$258 750

Table G 3

Removal Action Cost Estimate
Alternative 3
SWP3 With Control of Wind Erosion, and Slope Stability Considerations
Rivermines Mine Tailings Site

Item No		Unit	Unit Price	Est Quant	Cost Extension
1 1	Mobilization				
	All Areas	LS	$100 000	1	$100 000
2 1	Clearing & Grubbing				
	Main Site	Ac	$1 000	2	$2 000
	South of Entrance Road	Ac	$1 000	3	$3 000
	Spillway	Ac	$1 000	1	$1 000
	Channel Beyond Old 32	Ac	$1 000	1	$1 000
2 2	Fencing				
	Site Perimeter	LF	$15		$0
3 1	Excavation				
	Main Site	CY	$1 50	830 000	$1 245 000
	South of Entrance Road	CY	$1 50	50 000	$75 000
	Spillway	CY	$1 50	50 000	$75 000
	Channel Beyond Old 32	CY	$3 00	20 000	$60 000
3 2	Demolition				
	Mine Shaft Area	LS	$25 000		$0
4 1	Stormwater Management				
	Decant Tower No 1	LS	$5 000		$0
	Decant Tower No 2	LS	$5 000		$0
	Decant Culvert Repair	LS	$80 000		$0
	Power Street Culvert	LS	$2 500	1	$2 500
	Advanced Treatment	LS	$420 000		$0
	Spillway Berms	LS	$15 000	1	$15 000
	Spillway Outlet	LS	$20 000	1	$20 000
5 1	Main Site Cover Materials				
	Tailings 6 Cover Soil	SY	$0 50	310 000	$155 000
	6 Vegetative Soil	SY	$1 00		$0
	Revegetation	Ac	$1 000	64	$64 000
	Chat 12 Graded Rock	SY	$2 75	240 000	$660 000
5 2	Direct Revegetation Areas				
	South Of Entrance Rd	Ac	$2 000	7	$14 000
	Spillway	Ac	$2 000	8	$16 000
	Channel Beyond Old 32	Ac	$2 000	1	$2 000

Subtotal Construction		$2 510 500
Engineering & Administration	15%	$376 575
Contingencies	25%	$721 769
Estimated Capital Cost		$3 608 844

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Table G 4 1

Removal Action Cost Estimate
Alternative 4 1
Reuse/Recycle
Rivermines Mine Tailings Site

Adds and Deducts Only

Item No	Item	Unit	Unit Price	Est Quant	Cost Extension
1 1	Mobilization				
	All Areas	LS	$100 000		$0
2 1	Clearing & Grubbing				
	Main Site	Ac	$1 000		$0
	South of Entrance Road	Ac	$1 000		$0
	Spillway	Ac	$1 000		$0
	Channel Beyond Old 32	Ac	$1 000		$0
2 2	Fencing				
	Site Perimeter	LF	$15		$0
3 1	Excavation				
	Main Site	CY	$1 50		$0
	South of Entrance Road	CY	$1 50		$0
	Spillway	CY	$1 50		$0
		CY	$3 00		$0
3 2	Demolition				
	Mine Shaft Area	LS	$25 000		$0
4 1	Stormwater Management				
	Decant Tower No 1	LS	$5 000		$0
	Decant Tower No 2	LS	$5 000		$0
	Decant Culvert Repair	LS	$80 000		$0
	Power Street Culvert	LS	$2 500		$0
	Advanced Treatment	LS	$420 000		$0
	Spillway Berms	LS	$15 000		$0
	Spillway Outlet	LS	$20 000		$0
5 1	Main Site Cover Materials				
	Tailings 6 Cover Soil	SY	$0 50		$0
	6 Vegetative Soil	SY	$1 00		$0
	Revegetation	Ac	$1 000		$0
	Chat 12 Graded Rock	SY	$2 75		$0
5 2	Direct Revegetation Areas				
	South Of Entrance Rd	Ac	$2 000		$0
	Spillway	Ac	$2 000		$0
	Channel Beyond Old 32	Ac	$2 000		$0
			Subtotal Construction		$0
			Engineering & Administration	15%	$0
			Contingencies	25%	$0
			Estimated Capital Cost		$0

Table G 4 2

Removal Action Cost Estimate
Alternative 4 2
Athletic Complex
Rivermines Mine Tailings Site

Adds and Deducts Only

Item No	Item	Unit	Unit Price	Est Quant	Cost Extension
1 1	Mobilization				
	All Areas	LS	$100 000	0	$0
2 1	Clearing & Grubbing				
	Main Site	Ac	$1 000		$0
	South of Entrance Road	Ac	$1 000		$0
	Spillway	Ac	$1 000		$0
	Channel Beyond Old 32	Ac	$1 000		$0
2 2	Fencing				
	Site Perimeter	LF	$15		$0
3 1	Excavation				
	Main Site	CY	$1 50	100 000	$150 000
	South of Entrance Road	CY	$1 50		$0
	Spillway	CY	$1 50		$0
		CY	$3 00		$0
3 2	Demolition				
	Mine Shaft Area	LS	$25 000		$0
4 1	Stormwater Management				
	Decant Tower No 1	LS	$5 000		$0
	Decant Tower No 2	LS	$5 000		$0
	Decant Culvert Repair	LS	$80 000		$0
	Power Street Culvert	LS	$2 500		$0
	Advanced Treatment	LS	$420 000		$0
	Spillway Berms	LS	$15 000		$0
	Spillway Outlet	LS	$20 000		$0
5 1	Main Site Cover Materials				
	Tailings 6 Cover Soil	SY	$0 50	310 000	$155 000
	6 Vegetative Soil	SY	$1 00	310 000	$310 000
	Revegetation	Ac	$1 000		$0
	Chat 12 Graded Rock	SY	$2 75		$0
5 2	Direct Revegetation Areas				
	South Of Entrance Rd	Ac	$2 000		$0
	Spillway	Ac	$2 000		$0
	Channel Beyond Old 32	Ac	$2 000		$0
			Subtotal Construction		$615 000
			Engineering & Administration	15%	$92 250
			Contingencies	25%	$176 813
			Estimated Capital Cost		$884 063

Table G 4 3

Removal Action Cost Estimate
Alternative 4 3
Decant System
Rivermines Mine Tailings Site

Adds and Deducts Only

Item No	Item	Unit	Unit Price	Est Quant	Cost Extension
1 1	Mobilization				
	All Areas	LS	$100 000	0	$0
2 1	Clearing & Grubbing				
	Main Site	Ac	$1 000		$0
	South of Entrance Road	Ac	$1 000		$0
	Spillway	Ac	$1 000		$0
	Channel Beyond Old 32	Ac	$1 000		$0
2 2	Fencing				
	Site Perimeter	LF	$15		$0
3 1	Excavation				
	Main Site	CY	$1 50		$0
	South of Entrance Road	CY	$1 50		$0
	Spillway	CY	$1 50		$0
		CY	$3 00		$0
3 2	Demolition				
	Mine Shaft Area	LS	$25 000		$0
4 1	Stormwater Management				
	Decant Tower No 1	LS	$5 000	1	$5 000
	Decant Tower No 2	LS	$5 000	1	$5 000
	Decant Culvert Repair	LS	$80 000	1	$80 000
	Power Street Culvert	LS	$2 500		$0
	Advanced Treatment	LS	$420 000		$0
	Spillway Berms	LS	$15 000		$0
	Spillway Outlet	LS	$20 000		$0
5 1	Main Site Cover Materials				
	Tailings 6 Cover Soil	SY	$0 50		$0
	6 Vegetative Soil	SY	$1 00		$0
	Revegetation	Ac	$1 000		$0
	Chat 12 Graded Rock	SY	$2 75		$0
5 2	Direct Revegetation Areas				
	South Of Entrance Rd	Ac	$2 000		$0
	Spillway	Ac	$2 000		$0
	Channel Beyond Old 32	Ac	$2 000		$0
			Subtotal Construction		$90 000
			Engineering & Administration	15%	$13 500
			Contingencies	25%	$25 875
			Estimated Capital Cost		$129 375

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Table G 4 4A

Removal Action Cost Estimate
Alternative 4 4A
Spillway Treatment Ponds - Excavation Only
Rivermines Mine Tailings Site

Adds and Deducts Only

Item No	Item	Unit	Unit Price	Est Quant	Cost Extension
1 1	Mobilization				
	All Areas	LS	$100 000		$0
2 1	Clearing & Grubbing				
	Main Site	Ac	$1 000		$0
	South of Entrance Road	Ac	$1 000		$0
	Spillway	Ac	$1 000		$0
	Channel Beyond Old 32	Ac	$1 000		$0
2 2	Fencing				
	Site Perimeter	LF	$15		$0
3 1	Excavation				
	Main Site	CY	$1 50		$0
	South of Entrance Road	CY	$1 50		$0
	Spillway	CY	$1 50	50 000	$75 000
		CY	$3 00		$0
3 2	Demolition				
	Mine Shaft Area	LS	$25 000		$0
4 1	Stormwater Management				
	Decant Tower No 1	LS	$5 000		$0
	Decant Tower No 2	LS	$5 000		$0
	Decant Culvert Repair	LS	$80 000		$0
	Power Street Culvert	LS	$2 500		$0
	Advanced Treatment	LS	$420 000		$0
	Spillway Berms	LS	$15 000		$0
	Spillway Outlet	LS	$20 000		$0
5 1	Main Site Cover Materials				
	Tailings 6 Cover Soil	SY	$0 50		$0
	6 Vegetative Soil	SY	$1 00		$0
	Revegetation	Ac	$1 000		$0
	Chat 12 Graded Rock	SY	$2 75		$0
5 2	Direct Revegetation Areas				
	South Of Entrance Rd	Ac	$2 000		$0
	Spillway	Ac	$2 000		$0
	Channel Beyond Old 32	Ac	$2 000		$0
			Subtotal Construction		$75 000
			Engineering & Administration	15%	$11 250
			Contingencies	25%	$21 563
			Estimated Capital Cost		$107 813

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Table G 4 4B

Removal Action Cost Estimate
Alternative 4 4B
Spillway Treatment Ponds
Rivermines Mine Tailings Site

Adds and Deducts Only

Item No	Item	Unit	Unit Price	Est Quant	Cost Extension
1 1	Mobilization				
	All Areas	LS	$100 000		$0
2 1	Clearing & Grubbing				
	Main Site	Ac	$1 000		$0
	South of Entrance Road	Ac	$1 000		$0
	Spillway	Ac	$1 000		$0
	Channel Beyond Old 32	Ac	$1 000		$0
2 2	Fencing				
	Site Perimeter	LF	$15		$0
3 1	Excavation				
	Main Site	CY	$1 50		$0
	South of Entrance Road	CY	$1 50		$0
	Spillway	CY	$1 50	50 000	$75 000
		CY	$3 00		$0
3 2	Demolition				
	Mine Shaft Area	LS	$25 000		$0
4 1	Stormwater Management				
	Decant Tower No 1	LS	$5 000		$0
	Decant Tower No 2	LS	$5 000		$0
	Decant Culvert Repair	LS	$80 000		$0
	Power Street Culvert	LS	$2 500		$0
	Advanced Treatment	LS	$420 000	1	$420 000
	Spillway Berms	LS	$15 000		$0
	Spillway Outlet	LS	$20 000		$0
5 1	Main Site Cover Materials				
	Tailings 6 Cover Soil	SY	$0 50		$0
	6 Vegetative Soil	SY	$1 00		$0
	Revegetation	Ac	$1 000		$0
	Chat 12 Graded Rock	SY	$2 75		$0
5 2	Direct Revegetation Areas				
	South Of Entrance Rd	Ac	$2 000		$0
	Spillway	Ac	$2 000		$0
	Channel Beyond Old 32	Ac	$2 000		$0
			Subtotal Construction		$495 000
			Engineering & Administration	15%	$74 250
			Contingencies	25%	$142 313
			Estimated Capital Cost		$711 563

Table G 4 5

Removal Action Cost Estimate
Alternative 4 5
Mine Shaft Area
Rivermines Mine Tailings Site

Adds and Deducts Only

Item No	Item		Unit	Unit Price	Est Quant	Cost Extension
1 1	Mobilization					
		All Areas	LS	$100 000		$0
2 1	Clearing & Grubbing					
		Main Site	Ac	$1 000		$0
		South of Entrance Road	Ac	$1 000		$0
		Spillway	Ac	$1 000		$0
		Channel Beyond Old 32	Ac	$1 000		$0
2 2	Fencing					
		Site Perimeter	LF	$15		$0
3 1	Excavation					
		Main Site	CY	$1 50		$0
		South of Entrance Road	CY	$1 50		$0
		Spillway	CY	$1 50		$0
			CY	$3 00		$0
3 2	Demolition					
		Mine Shaft Area	LS	$25 000	1	$25 000
4 1	Stormwater Management					
		Decant Tower No 1	LS	$5 000		$0
		Decant Tower No 2	LS	$5 000		$0
		Decant Culvert Repair	LS	$80 000		$0
		Power Street Culvert	LS	$2 500		$0
		Advanced Treatment	LS	$420 000		$0
		Spillway Berms	LS	$15 000		$0
		Spillway Outlet	LS	$20 000		$0
5 1	Main Site Cover Materials					
	Tailings	6 Cover Soil	SY	$0 50		$0
		6 Vegetative Soil	SY	$1 00		$0
		Revegetation	Ac	$1 000		$0
	Chat	12 Graded Rock	SY	$2 75		$0
5 2	Direct Revegetation Areas					
		South Of Entrance Rd	Ac	$2 000		$0
		Spillway	Ac	$2 000		$0
		Channel Beyond Old 32	Ac	$2 000		$0

Subtotal Construction		$25 000
Engineering & Administration	15%	$3 750
Contingencies	25%	$7 188
Estimated Capital Cost		$35 938

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Table G 5

Removal Action Cost Estimate
Operation and Maintenance Projections
Monitoring and Inspection for All Alternatives
Rivermines Mine Tailings Site

Item No	Item	Unit	Unit Price	Est Quant	Cost Extension
1 1	Monitoring				
	All Areas	LS	$12 000	1	$12 000
2 1	Inspections				
	All Areas	LS	$1 000	1	$1 000
		Subtotal Annual O&M			$13 000
		Administration		10%	$1 300
		Contingencies		25%	$3 250
		Total Estimated Annual O&M Cost			$17 550
		Present Value of O&M Costs			**$270,000**
		Rate	5% per year		
		Periods	30 years		

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Table G 6

Removal Action Cost Estimate
Operation and Maintenance Projections
Turf Maintenance Without Soil Cover
Rivermines Mine Tailings Site

Item No			Unit	Unit Price	Est Quant	Cost Extension
1 1	Turf Maintenance	Areas without soil cover	Ac	$1 000	64	$64 000
			Subtotal Annual O&M			$64 000
			Engineering & Administration		15%	$9 600
			Contingencies		25%	$16 000
			Total Estimated Annual O&M Cost			$89 600
			Present Value of O&M Costs			**$1,377,000**
			Rate	5% per year		
			Periods	30 years		

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Table G 7
Removal Action Cost Estimate
Operation and Maintenance Projections
Turf Maintenance for Soil Cover
Rivermines Mine Tailings Site

Item No			Unit	Unit Price	Est Quant	Cost Extension
1 1	Turf Maintenance	Areas with soil cover	Ac	$300	64	$19 200
			Subtotal Annual O&M			$19 200
			Engineering & Administration		15%	$2 880
			Contingencies		25%	$4 800
			Total Estimated Annual O&M Cost			$26 880
			Present Value of O&M Costs			**$413,000**
			Rate	5% per year		
			Periods	30 years		

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Table G 8
Removal Action Cost Estimate
Operation and Maintenance Projections
Wetland Maintenance
Rivermines Mine Tailings Site

Item No		Unit	Unit Price	Est Quant	Cost Extension
1 1	Organic Material Addition	CY	$9	645	$5 808
		Subtotal Annual O&M			$5 808
		Engineering & Administration		15%	$871
		Contingencies		25%	$1 452
		Total Estimated Annual O&M Cost			$8 131
		Present Value of O&M Costs			**$125,000**
		Rate	5% per year		
		Periods	30 years		

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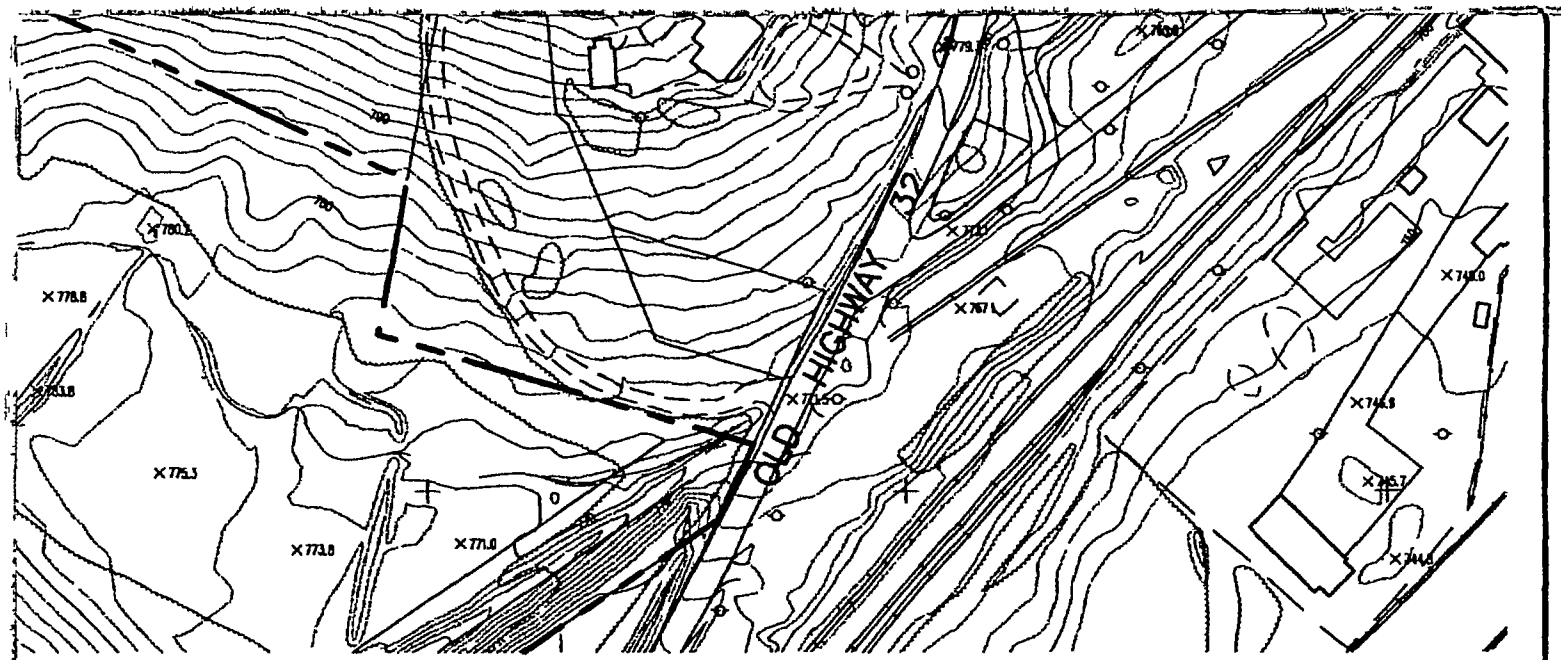

RIVERMINES MINE TAILINGS SITE PARK HILLS, MISSOURI	BARR PROJECT No 2586009
	CLIENT PROJECT No
ATHLETIC FIELDS GENERAL SITE LAYOUT	DWG No 1 / REV No

c The base material is crushed stone gravel or other suitable material

d The excavation is limited to the area necessary for site preparation and all excavated material is removed to the upland and,

e No material is placed in special aquatic sites including wetlands

Dredging to provide access to the boat ramp may be authorized by another NWP regional general permit or individual permit pursuant to Section 10 if located in navigable waters of the United States (Sections 10 and 404)

37 Emergency Watershed Protection and Rehabilitation Work done by or funded by

a The NRCS which is a situation requiring immediate action under its emergency Watershed Protection Program (7 CFR part 624), or

b The USFS under its Burned Area Emergency Rehabilitation Handbook (FSH 509 13) or

c The DOI for wildland fire management burned area emergency stabilization and rehabilitation (DOI Manual part 620, Ch 3)

For all of the above provisions, the District Engineer must be notified in accordance with the General Condition 13 (Also, see 33 CFR 330 1(e)) (Sections 10 and 404)

38 Cleanup of Hazardous and Toxic Waste Specific activities required to effect the containment, stabilization or removal of hazardous or toxic waste materials that are performed ordered, or sponsored by a government agency with established legal or regulatory authority provided the permittee notifies the District Engineer in accordance with the 'Notification General Condition For discharges in special aquatic sites, including wetlands, the notification must also include a delineation of affected special aquatic sites including wetlands Court ordered remedial action plans or related settlements are also authorized by this NWP This NWP does not authorize the establishment of new disposal sites or the expansion of existing sites used for the disposal of hazardous or toxic waste Activities undertaken entirely on a Comprehensive Environmental Response Compensation and Liability Act (CERCLA) site by authority of CERCLA as approved or required by EPA are not required to obtain permits under Section 404 of the CWA or section 10 of the Rivers and Harbors Act (Sections 10 and 404)

39 Residential, Commercial, and Institutional Developments Discharges of dredged or fill material into non tidal waters of the U S excluding non tidal wetlands adjacent to tidal waters for the construction or expansion of residential, commercial, and institutional building foundations and building pads and attendant features that are necessary for the use and maintenance of the structures Attendant features may include but are not limited to roads parking lots, garages, yards utility lines, stormwater management facilities, and recreation facilities such as playgrounds, playing fields, and golf courses (provided the golf course is an integral part of the residential development) The construction of new ski areas or oil and gas wells is not authorized by this NWP

Residential developments include multiple and single unit developments Examples of commercial developments include retail stores, industrial facilities, restaurants, business parks, and shopping centers Examples of institutional developments include schools fire stations, government office buildings, judicial buildings public works buildings libraries hospitals and

U.S. Army Corps of Engineers

Regulatory Program

CURRENT DECISION DOCUMENTS (ENVIRONMENTAL ASSESSMENTS)

Click on the link to download each document or you can download ALL of the documents in one easy to unzip archive!

ALL DECISION DOCUMENTS(zip format)

- Decision Document Nationwide Permit 1
- Decision Document Nationwide Permit 2
- Decision Document Nationwide Permit 3
- Decision Document Nationwide Permit 4
- Decision Document Nationwide Permit 5
- Decision Document Nationwide Permit 6
- Decision Document Nationwide Permit 7
- Decision Document Nationwide Permit 8
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- Decision Document Nationwide Permit 39
- Decision Document Nationwide Permit 40
- Decision Document Nationwide Permit 41
- Decision Document Nationwide Permit 42
- Decision Document Nationwide Permit 43
- Decision Document Nationwide Permit 44

Appendix J

Plan for Continued Use of Chat in Bituminous Mix by Lead Belt Materials Company

1 1 Introduction and Summary

The LBM Co operation has historically made use of residual materials from mining at the Rivermines site to provide two products in high demand They are bituminous pavement mix, using chat as an aggregate and agricultural lime (aglime) using tailings Sales of chat or tailings as aglime will cease as of August 1 2003

The purpose of this operating plan is to describe proposed long term LBM Co chat use operations at the Rivermines Mine Tailings Site (Alternative 4 1) The primary ongoing use of chat will be as an aggregate source for bituminous pavement mix In addition chat may be sold for uses such as fill under commercial buildings in accordance with the mine waste fact sheet Such use will occur only upon written request to the USEPA for each use and the receipt of written approval from the USEPA The EPA has requested a written operating plan covering the period during and after the removal action by Doe Run This plan is necessary for the EPA to consider including continued LBM Co operations as part of the preferred alternative resulting from the EE/CA

The removal action and general operating plan are described in the following paragraphs The term removal action refers to the work to be done by Doe Run over a period of a few years to provide closure for the majority of the site The operating plan describes how LBM Co will continue to remove chat from the site and complete the closure

Reference will be made to several figures Figures 2 7 and 8 in the body of the EE/CA are referred to where appropriate Figure J-1 shows the Recommended Alternative Grading Plan End of Removal Action while Figure J 2 shows the Recommended Alternative Grading Plan End of LBM Co operations These two figures included at the end of this Appendix are modifications of Figure 7 Alternative 3 Grading Plan in the EE/CA Figure J 2 includes revisions to show how the recommended alternative final contours change due to continued LBM Co operations Figure J 3 focuses on the chat pile area and illustrates how the removal of chat will proceed between the end of the initial removal action and final closure These figures will be referred to throughout the remainder of this text

It should be noted that the Alternative 3 Grading Plan is approximate and subject to adjustment in the final design Adjustments may be made both to minimize material movement and provide a cut/fill

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balance In Figures J 1 and J 2 the south slope of the Tailings Area grading plan has been adjusted to allow for continued chat pile removal and conveyor operation It should also be noted that Figures J 1 and J 2 are focused only on the effects of Alternative 4 1 continued use of chat by LBM Co on the Alternative 3 grading plan Alternatives 4 2 4 3 4 4 and 4 5 are illustrated on Figure 8 in the EE/CA

During the removal action Doe Run will add chat as a buttress to the east and west slopes of the Tailings Area (Figure J 1) establishing a 3H 1V grade The south slope of the Tailings Area will be regraded to 4H 1V The slopes will be covered with rock as the final closure of those slopes The top of the Tailings Area (including the existing aglime excavation area) will be regraded capped with a minimum six inch soil cover and vegetated as the final closure Alternatives to the soil cap may be implemented and are subject to EPA approval of a revegetation protocol

Doe Run will reshape the chat pile to a 3H 1V slope on its eastern and southern slopes and cover those slopes with rock cover (Figure J 1) A portion of the west side of the chat pile will be left open for excavation LBM CO will excavate into the chat pile initially hollowing it out without disturbing the rock cover on the east and south faces Eventually LBM Co will gradually remove rock cover from the faces in order to continue its chat excavation When LBM Co is done all that will remain of the chat pile is a stable 3H 1V south facing slope buttressing the Tailings Area (Figure J 2) LBM Co will be excavating to and rocking this final slope as excavation proceeds Details of how wind and water erosion will be controlled and slope stability maintained, as the excavation proceeds are included in Section 1 5

Doe Run will use the portion of LBM Co s current operations area between the access road and the chat conveyor system to dispose of tailings from the spillway and trackside areas (Figures 2 and J 1) Doe Run will also strip the mine wastes from the area south of the entrance road and revegetate this area as final closure (Figure J 1) This will leave approximately a 300 foot wide open space revegetated on natural ground plus a 300 foot wide ridge of material covered with rock as a barrier between LBM Co s chat conveyor and the residences to the south

At the completion of Doe Run s removal action work LBM Co operations will be confined to an area for the bituminous plant on the west the active section of the chat pile on the east and a connecting corridor for the chat conveyor (Figure J 1)

The life of LBM Co s chat removal activities is based on the estimated amount of accessible material on site which can be removed without creating slope stability issues The estimated life of the activities is 30 years (see Section 1 2 below) but is dependent on material demand and the quality of materials uncovered as excavation proceeds This general operating plan provides a guide for the life of the site In

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addition a detailed plan will be prepared every 5 years to guide short term operations in accordance with the long term plan The first 5-year plan will be submitted at the completion of the removal action In addition this general operating plan provides some detail regarding the anticipated first five years of operation

1 2 Life of LBM Co Operations

The LBM Co operations include making bituminous pavement mix using chat as an aggregate A cold mix bituminous product with excellent wear characteristics (due to the use of chat) draws customers from in excess of 100 miles LBM Co also operates a rock quarrying operation immediately west of the site including crushing and screening There are 400 acres of land available for quarry expansion, so quarry life does not place a restriction on the bituminous plant Therefore LBM Co intends to operate the site at least until the available chat is exhausted

A portion of the chat pile must be left in place to provide a buttress for the finer tailings of the Tailings Area This chat buttress will be left in place at a 3H 1V slope with the top of the slope near the interface between the Tailings Area and the existing chat pile (Figure J 2) The precise location of the top of the slope will be determined as part of the removal action design The required chat width outside the finer tailings will be determined by analogy with the slope stability analysis already performed for cross section B (Appendix E) and possibly with additional analysis

The estimated life of LBM Co operations using chat following completion of the removal action is 30 years This estimated life is based on the estimated volume of chat available and the rate of use The estimated chat volume between the contours of the existing pile and those of the minimum chat buttress which must be left in place for slope stability is on the order of one million cubic yards It is difficult to estimate the amount of chat which will be available at the completion of the initial removal action because (1) the existing topography is already three years old and chat removal has continued (2) it is likely at least three more years before the initial removal action is complete (3) the precise amount of chat needed elsewhere on the site won t be known until detailed removal action design is complete and (4) the ground contours under the chat pile in areas where it will be entirely removed can only be inferred from the 1905 20 foot contour interval map and the current natural ground contours adjacent to the pile The available volume of material will be re estimated for the first five year operating plan, using the contours at the end of the initial removal action and then updated in each five-year operating plan The estimated rate of chat consumption provided by LBM Co is forty to fifty thousand tons per year For purposes of estimating operational life this has been converted to 35 000 cubic yards per year The actual

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remaining life in years will depend on the long term demand for the products and the material quality identified as excavation continues In this operating plan the proposed final grading plan (Figure J 2) is based on estimated slope stability requirements rather than on a specific number of years of operation

1 3 Closure Principles

Several basic principles will be applied to the removal action and subsequent LBM Co chat removal operations as follows

1 As much of the site as reasonably possible will be subjected to final closure as part of the initial removal action This will leave open only a chat excavation area a conveyor corridor and a bituminous plant site

2 LBM Co s chat excavation activities will be sequenced and controlled so that the effort necessary to cease activities and go to final closure at the end of any five year operating plan is minimized

3 LBM Co will apply final closure to areas of the chat pile as final contours are reached

4 LBM Co s final closure activities will meet the same standards as those applied by Doe Run as part of the removal action including maximum 3H 1V slopes and placement of cover/cap materials

1 4 Removal Action Activities

The removal action by Doe Run will consist of final closure of as much of the site as possible Doe Run will add chat obtained from the chat pile as a buttress to the east and west slopes of the Tailings Area establishing a 3H 1V grade (Figure J 1) The slopes will be covered with rock creating a permanent closure The top of the Tailings Area including the existing aglime excavation area will be regraded, capped with a minimum six inch soil cover and vegetated as the final closure Alternatives to the soil cap may be implemented and are subject to EPA approval of a revegetation protocol A 4H 1V soil covered slope will be left from the aglime area up to the rest of the Tailings Area (See Figure J 1) The aglime excavation area will be sloped to retain its runoff in an infiltration basin The south slope of the Tailings Area will be graded to 4H 1V and covered with rock for final closure The toe of this southern slope will be located approximately at the location of the chat conveyor The conveyor may have to be moved slightly and reset at a lower elevation This is particularly true of the western most leg of the conveyor system

Doe Run will reshape the chat pile to a 3H 1V slope on its eastern and southern slopes and cover those slopes with rock cover A portion of the west side of the chat pile will be left open for excavation by LBM

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Co (Figure J-2) The top of the existing pile will be bulldozed to the west so that the top of the remaining pile is approximately equal to the elevation of the tailings field LBM Co will continue to remove chat from the west side of the chat pile during the removal action Doe Run and LBM Co will coordinate their activities to avoid interference

Doe Run will remove tailings from the spillway and trackside Tailings Areas (Figure 2) This material is not considered suitable for use by LBM Co It will be disposed of in the portion of LBM Co s current operations area between the access road and the chat conveyor system, final graded and covered with rock (Figure J 1) Doe Run will also strip the mine wastes from the area south of the entrance road and revegetate that area on natural ground as final closure The stripped materials will go into the same disposal area as the spillway and trackside tailings The result will leave approximately a 300 foot wide open space revegetated on natural ground plus a 300 foot wide ridge of material covered with rock as a barrier between LBM Co s operating chat conveyor and the residences to the south (Figure J 1)

At the completion of Doe Run s removal action work, LBM Co will be left with active areas consisting of the bituminous plant area on the west, the open portion of the chat pile on the east and a connecting corridor for the chat conveyor and equipment road

1 5 Operational Activities

The excavation related to the chat pile area will occur over a relatively small portion of the site LBM Co is currently obtaining chat by periodically dozing material off the top of the chat pile and over the west side There it is removed from the toe of the slope and placed on a conveyor which carries it westward to the location of the bituminous plant (Figure J-1) Historically the chat pile extended along the entire length of the south side of the Tailings Area, but has been removed by previous chat excavation activities The material remaining under the route of the conveyor is chat (See Figure 5 a 1954 aerial photo in the EE/CA) Prior to and during the removal action LBM Co will complete any additional removal of chat from the area between the conveyor and the entrance road, along with the removal of any stockpiled materials Removal of material from the top of the pile will also continue Prior to or during the removal action the top of the chat pile will be bulldozed to the west so that the top of the pile is at approximately at the same elevation as the tailings field

As previously noted the east and south slopes of the chat pile will be reduced to 3H 1V and covered with rock (Figure J-1) The west side of the pile will be left ungraded and unrocked to be used as the material removal point for LBM Co The first five years of operation subsequent to the removal action will consist of excavation of material stockpiled on the west side of the pile and cutting the west slope back to 3H 1V

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At the conclusion of the first five years the slope could be rocked and closure completed if necessary with relatively minor regrading

Leaving behind enough chat to provide a buttress for the finer tailings of the Tailings Area is a key factor in the LBM Co operations As shown on Figure J 2 a 3H 1V slope will be left in the chat pile to buttress the southeast corner of the Tailings Area The material below these 3H 1V contours will be left in place as excavation proceeds By never excavating below these final contours the possibility of running short of material to buttress the Tailings Area is avoided

The top of slope (east west 930 contour) shown for the former chat pile area shown on Figure J 1 is based on the assumption that the interface between the chat pile and the fine tailings extends vertically from their interface on the surface If so the slope will likely be stable especially considering that previous analysis in the EE/CA indicates that slimes in the adjacent Tailings Area are not subject to liquefaction After the top of the chat pile is lowered to the elevation of the Tailings Area during the removal action additional borings will be made to verify the location of the chat and the slope stability reviewed These results will be included in the first five year plan

After the design location of the top of the final chat pile slope has been verified it will be marked in the field by laying out a baseline at a defined elevation at the top of the slope The baseline will be permanently marked by setting large steel posts at each end of the baseline This will provide a reference both for LBM operators as they excavate to the final slope and for survey crews as they verify grade before the final slope is rocked

In five year periods subsequent to the initial one LBM Co will begin to excavate into the chat pile from the west initially hollowing it out without disturbing the rock cover on the east and south faces Eventually LBM Co will gradually remove rock cover from the faces in order to continue its chat excavation Removal of rock cover will begin at the top of the east and south faces of the chat pile and work its way down the slopes as excavation proceeds When LBM Co is done all that will remain of the chat pile is a 3H 1V south facing slope buttressing the Tailings Area (Figure J 2) LBM Co will be excavating to and rocking this final slope as work proceeds The final activities by LBM Co will be dismantling the conveyor (Figure J 1) and final closure of the conveyor area with rock cover (Figure J 2)

Each five year plan will include chat pile detail regarding the final slope excavation and rocking to be completed and will provide for leaving a 3H 1V slope on the remainder of the excavation at the end of the five year period Therefore final closure could also be accomplished with relatively minor effort at the end of any five year period by rocking the recently active 3H 1V slopes LBM Co will recycle the slope

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protection rock removed during chat pile excavation by running it through their crushing and screening process The chat fines will be separated so that a clean crushed rock product can be produced for sale

Figure J 3 illustrates how the excavation will proceed to gradually remove the east and south faces of the chat pile by excavating from the inside out It represents a point in time at which the ridge separating the rocked slope from the excavation area is approximately Elevation 900 or 30 feet lower than the top of the rocked slope will be at the end of the initial removal action As the excavation proceeds the ridge line will move down the rocked slope moving east and south as it becomes lower Likewise the area under active excavation will move east and south following the ridge line On the north side of the excavation the chat will be left in place at a 3H 1V slope and periodically rocked as the excavation gets deeper Therefore as the rocked slope left by the initial removal action is destroyed by the advancing excavation a new final rocked slope is created behind the excavation The sediment trap at the low point of the excavation will be maintained as the excavation proceeds and will also move to the southeast as excavation advances The treatment pond will function as the sediment trap during the final stages of chat pile removal

LBM Co operates under an Air Operating Permit (2002 070063) which has recently been filed for renewal The permit covers the working face the conveyors and all handling of chat LBM Co will follow all the conditions of the air permit, in addition to maintaining a working area that is much smaller than the existing exposed chat pile (Figure J 3) Water erosion in the active chat area is unlikely due to the high infiltration rate of the chat The five year plans will include maintaining a sediment trap at the low point of the active area to intercept any eroded material In the unlikely event of overflow from the active area, it would be intercepted by the treatment ponds (Figure 8)

If at any time chat from the uncovered areas is detected migrating offsite additional control measures will be rapidly implemented These may include enclosure of the conveyor system placing daily cover (soil or rock) on open areas retention/settling ponds and dust suppression measures such as water sprays and stockpile sealants Should additional control measures fail to prevent the offsite migration of chat Lead Belt Material will need to cease all site activities that disturb chat and a final cover placed on all remaining open areas of chat

1 6 Hydrologic Modifications

Continued bituminous operations by LBM Co may allow some changes in the runoff control plan Currently the decant tower 1 discharge drains along the west toe of the Tailings Area and into LBM Co s pond system (see Figure 8 of EE/CA) This can continue as long as the bituminous plant is in operation

because some of the water can be used as makeup for the wet scrubber The completion of channel construction to route this flow to the treatment ponds in the spillway as described in the EE/CA may be delayed until the end of LBM Co operations Any discharge necessary from the LBM Co ponds (after the initial removal action is complete) will be routed to the treatment ponds in the spillway

The recommended alternative in the EE/CA includes repairing the decant tower 2 outlet or abandoning it if the athletic fields are not developed If LBM Co operations continue chat excavation will ultimately expose a significant portion of the downstream end of the concrete culvert (compare Figures 7 and 8 of EE/CA) allowing it to be demolished rather than repaired Therefore abandonment or repair of the decant tower 2 outlet culvert can be left until the conclusion of the LBM Co operations

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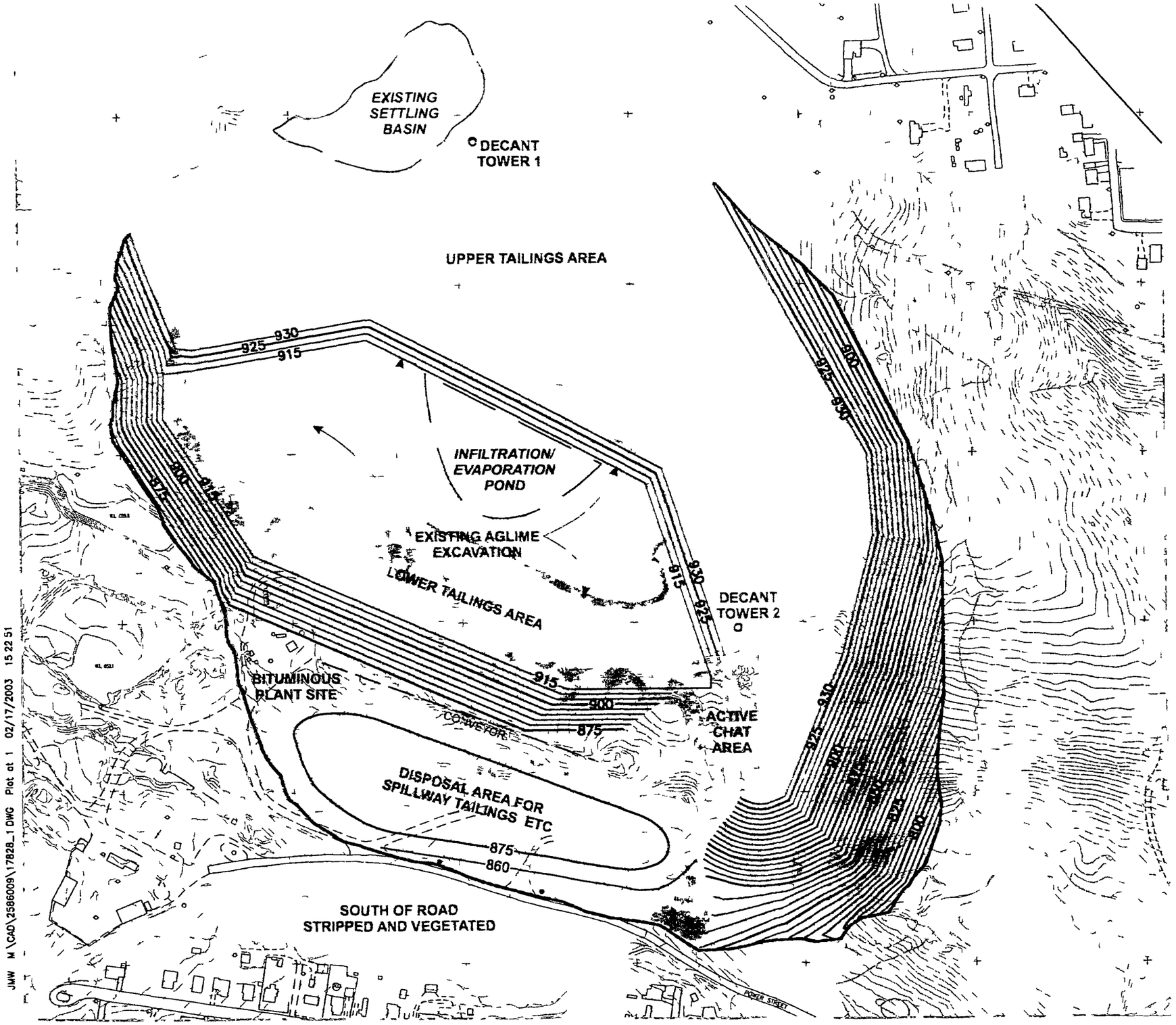
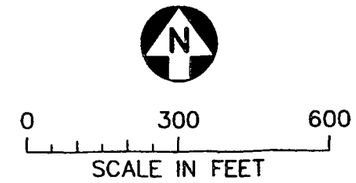




- Sidewalk
- Building
- Foundation
- Fence
- Wall
- Tree Line
- Stream
- Brush/Shrub Line
- Index Contour
- Intermediate Contour
- Depression Contour
- Guard Rail
- Swamp Symbol
- Control Point
- X 325 6 Spot Elevation
- Single Tree
- Located Object
- Catch Basin
- Manhole
- Pole
- Sign
- Fire Hydrant
- Light Pole
- Inlet Symbol
- Railroad
- Paved Road
- Unpaved Road
- Trail
- Pipe line
- Driveway

- Revegetated
- Rock Cover

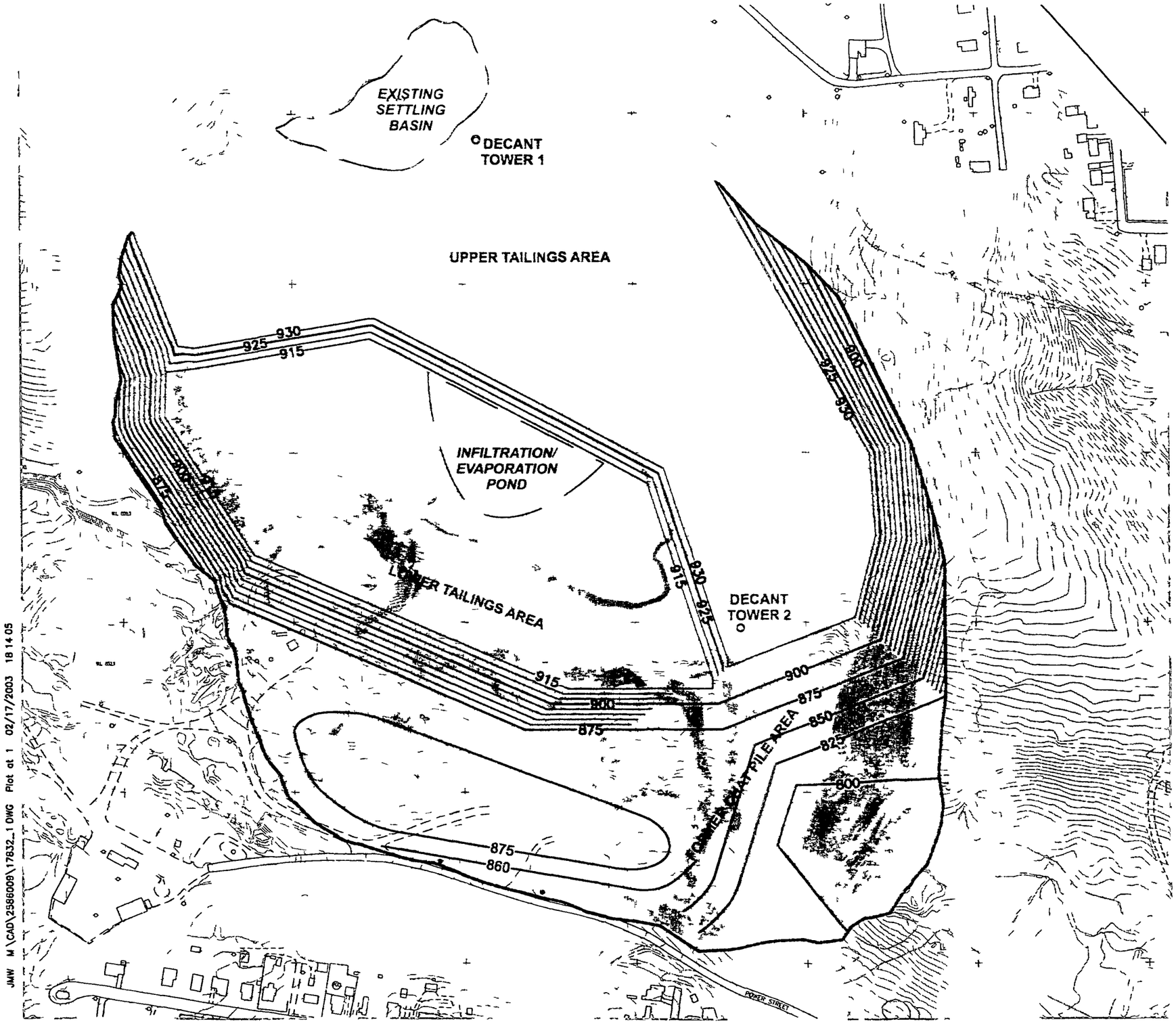
NOTES

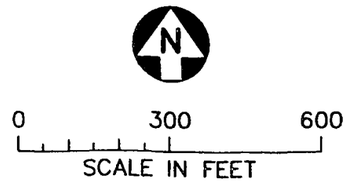
1. EXISTING TOPOGRAPHY WAS PREPARED BY WALKER AND ASSOCIATES FROM AERIAL PHOTOGRAPHS TAKEN MARCH 23 2000 MAP DATE AUGUST 29 2000 SURVEY CONTROL BY EFFAN SURVEY
2. DASHED CONTOURS MAY BE UNRELIABLE

Figure J-1

RECOMMENDED ALTERNATIVE GRADING PLAN
END OF REMOVAL ACTION
Rivermines Mine Tailings Site
Park Hills MO

P 2586\009\GRADINGPLANA CDR RLG 08 27 03
Xrefs In Drawing – M \cad\2586009\13353_1 DWG M \cad\2586009\17829_1 DWG
JMW M \CAD\2586009\17828_1 DWG Plot at 1 02/17/2003 15 22 51





- Sidewalk
- Building
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- Wall
- Tree Line
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- Index Contour
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- Depression Contour
- Guard Rail
- Swamp Symbol
- Control Point
- X 325 6 Spot Elevation
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- Located Object
- Catch Basin
- Manhole
- Pole
- Sign
- Fire Hydrant
- Light Pole
- Inlet Symbol
- Railroad
- Paved Road
- Unpaved Road
- Trail
- Pipe line
- Driveway

- Revegetated
- Rock Cover

NOTES

1. EXISTING TOPOGRAPHY WAS PREPARED BY WALKER AND ASSOCIATES FROM AERIAL PHOTOGRAPHS TAKEN MARCH 23 2000 MAP DATE AUGUST 29 2000 SURVEY CONTROL BY EFFAN SURVEY
2. DASHED CONTOURS MAY BE UNRELIABLE

Figure J-2

RECOMMENDED ALTERNATIVE GRADING PLAN
END OF LBM COMPANY OPERATIONS
Rivermines Mine Tailings Site
Park Hills MO

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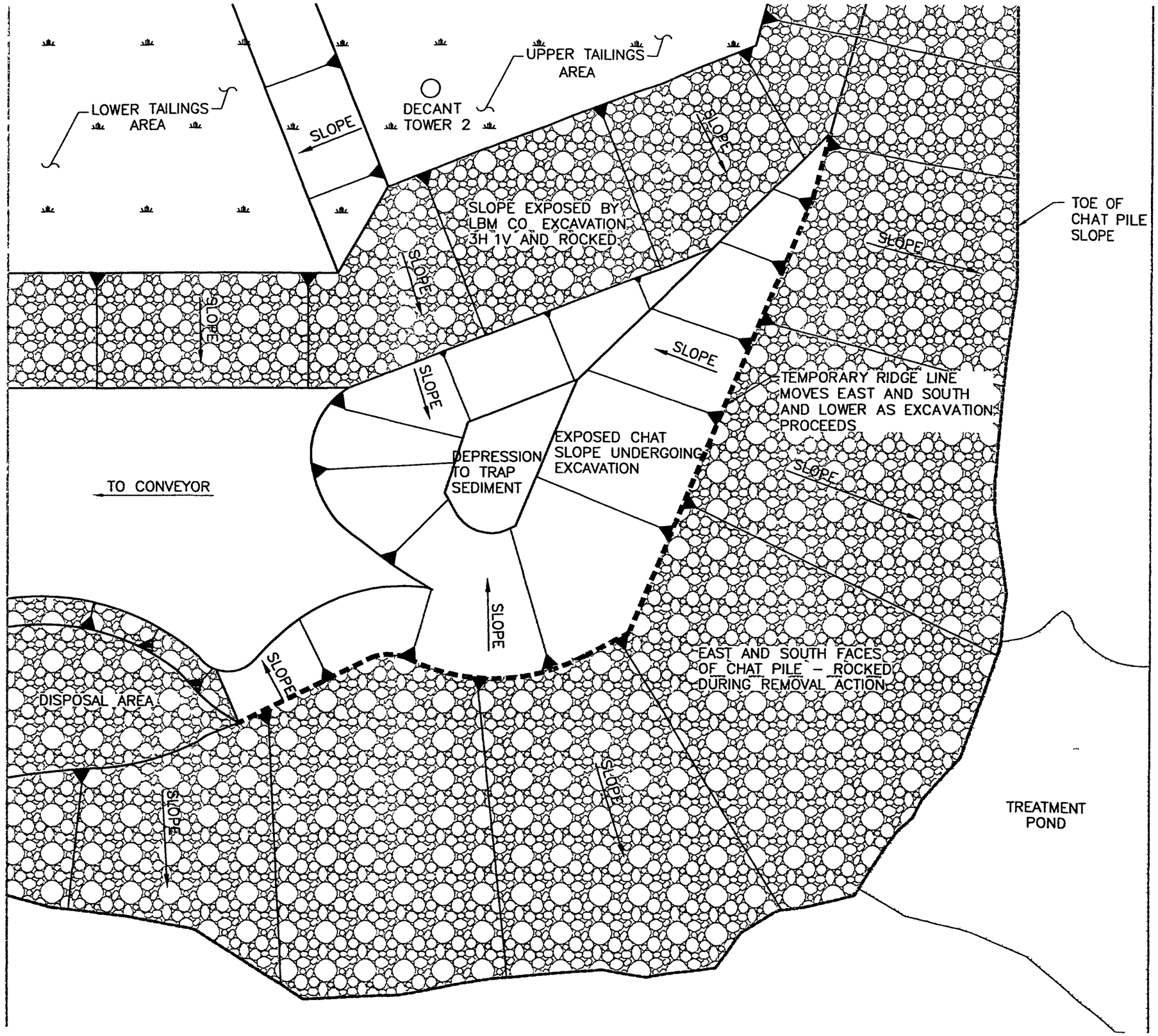
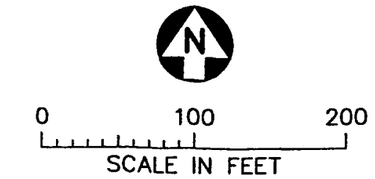
JMW M \CAD\2586009\17832_1 DWG Plot at 1 02/17/2003 18 14 05





LEGEND

- ROCK SLOPE PROTECTION
- VEGETATED AREA
- WATER

Figure J-3
CONDITIONS AT CHAT PILE
DURING ONGOING CHAT EXCAVATION
SUBSEQUENT TO REMOVAL ACTION

Xrefs in Drawing - M:\cad\2586009\13353_1.DWG M:\cad\2586009\15955_1.DWG
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