REMEDIAL ACTION DESIGN REPORT

For

Former National Zinc Site

Cherryvale, Montgomery County, Kansas

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ENVIRONMENTAL REMEDIATION

July 2004

Presented to:

Kansas Department of Health and Environment

Prepared by:

Salomon Smith Barney Holdings, Inc.

United States Steel Corporation

and

A & M Engineering and Environmental Services, Inc.

BER SCANNED
FEB 0 6 2013

DOERNER, SAUNDERS, DANIEL & ANDERSON, L.L.P.

ATTORNEYS AT LAW

SAM P. DANIEL
WILLIAM C. ANDERSON
VARLEY H. TAYLOR, JR.
G. MICHAEL LEWIS
LAWRENCE T. CHAMBERS, JR.
DALLAS E. FERGUSON
SAM G. BRATTON II
GARY M. McDONALD
H. WAYNE COOPER
KEVIN C. COUTANT
RICHARD P. HIX
LYNN PAUL MATTSON
WILLIAM F. RIGGS
LEWIS N. CARTER
LINDA C. MARTIN
JAMES P. McCANN
RICHARD H. FOSTER
CHARLES S. PLUMB
LEONARD I. PATAKI
S. DOUGLAS DODD
ELISE DUNITZ BRENNAN
JON E. BRIGHTMIRE
TOM Q. FERGUSON
RICHARD J. EAGLETON
REBECCA M. FOWLER

320 SOUTH BOSTON AVENUE, SUITE 500
TULSA, OKLAHOMA 74103-3725
TELEPHONE (918) 582-1211
FACSIMILE (918) 591-5360

ONE LEADERSHIP SQUARE, SUITE 501
211 NORTH ROBINSON
OKLAHOMA CITY, OKLAHOMA 73102-7112
TELEPHONE (405) 319-3500
FACSIMILE (405) 319-3509
www.dsda.com

MICHAEL C. REDMAN
STEVEN K. METCALF
SHELLY L. DALRYMPLE
RUSSELL W. KROLL
RACHEL BLUE
JAMES C. MILTON
AUDRA K. HAMILTON
WILLIAM H. SPITLER
YOUNG PEI
CHAD M. HINRICHS
JOHNATHAN D. HORTON
ROBERT SPOO
SHAWNA S. BAKER
LESLEY FORD RICHER
DAVID L. IANDIORIO
N. LANCE BRYAN

OF COUNSEL:
MICHAEL MINNIS & ASSOCIATES, P.C.
MICHAEL MINNIS
DAVID McCULLOUGH

E. J. DOERNER (1897-1980)
DICKSON M. SAUNDERS (1920-2001)

July 27, 2004

VIA FEDERAL EXPRESS
Mr. Robert Bixby
Environmental Scientist
Remedial Section
Bureau of Environmental Remediation
Kansas Department of Health and Environment
1000 Southwest Jackson, Ste. 410
Topeka, KS 66612-1366

RE: National Zinc Site, Cherryvale, Kansas
Consent Order Case No. 03-E-0022

Dear Mr. Bixby:

Enclosed are three copies of the RAD Report for the National Zinc Site at Cherryvale Kansas. These are being submitted on behalf of the Respondents, United States Steel Corporation and Salomon Smith Barney Holdings, Inc., pursuant to the captioned Consent Order.

Please give me a call if you have any questions.

Sincerely,
RESPONDENTS' PROJECT COORDINATOR,

William C. Anderson

William C. Anderson of
DOERNER, SAUNDERS, DANIEL & ANDERSON, L.L.P.

WCA/sm
Enclosure

cc: Rick Bean (w/o encl.) – Via Federal Express
Kurt Limesand (w/o encl.) – Via Federal Express
Erika Bessey, Esq. (w/o encl.) – Via Federal Express
Ellen O'Brien, Esq. (w/encl.) – Via Federal Express
David Smiga, Esq. (w/encl.) – Via Federal Express
Rick Menozzi (w/encl.) – Via Federal Express
Mark Rupnow (w/encl.) – Via Federal Express
Altay Ertugrul (w/o encl.) – Via Facsimile

ENGINEER'S CERTIFICATION

I the undersigned, Altay M. Ertugrul, a Registered Professional Engineer in the State of Kansas, P.E. No. 10479, and designated Professional Engineer to direct the technical work in conjunction with Consent Order Case No. 03-E-0022, hereby certify under penalty of law that this Remedial Action Design Report (RAD) and its attachments have been prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. In preparing this document and its attachments, conducting all of the required field work, gathering the required information and data to the best of my ability, I relied on and complied with the conditions and guidelines provided in Consent Order Case No. 03-E-0022 and its attachments, my continuous consultation with Kansas Department of Health and Environment (KDHE) officials and Respondents' (U.S. Steel Corporation and Salomon Smith Barney Holdings, Inc.) representatives, interpretation of all of the applicable Federal and State of Kansas regulations and the acceptable engineering practices. I am aware that there are significant penalties in purposely submitting false information.

ALTAY M. ERTUGRUL
LICENSED
07/26/04
NO. 10479
KANSAS
PROFESSIONAL ENGINEER

Altay M. Ertugrul, P.E. (Kansas P.E. No. 10479)
President
A & M Engineering and Environmental Services, Inc.

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1.0 Introduction:

This Removal Action Design (RAD) Report presents the results of studies performed by the Kansas Department of Health and Environment (KDHE), and by U.S. Steel Corporation and Salomon Smith Barney Holdings Inc. (the Respondents), for the former National Zinc Site (the Site) at Cherryvale, Montgomery County, Kansas. The studies conducted by the Respondents were performed in 2003 and 2004 pursuant to KDHE Consent Order No. 03-E-0022 (the Consent Order).

This Report is intended to comply with the National Oil and Hazardous Substances Contingency Plan [NCPL 300.415 (B-1)], and the requirements of the Consent Order, a copy of which is attached hereto as Appendix A.

The objective of this Report is to present removal alternatives, including a preferred alternative, which when implemented, will abate, prevent, minimize or eliminate the release or threatened release of contaminant(s) from the Site. The Site is owned by the City of Cherryvale, and most of the Site is currently subject to restrictive covenants imposed in 1983. By eliminating these restrictive covenants to the extent economically possible, substantial portions of the Site can be returned to productive use and made available for industrial and economic development by the City, thereby benefiting the citizens of the Cherryvale area.

The studies conducted by KDHE investigated both the Site as well as residential areas located south of the Site. A removal action was conducted by EPA on the residential areas in late 2001 and early 2002, resulting in the excavation of contaminated soils from residential yards, backfilling the excavated areas with clean soil, and movement of the excavated soils to an area on the Site hereinafter referred to as the EPA Repository. The EPA Repository is shown on Figure 4. Since the off-site residential removal action has been completed, the data developed by KDHE in its studies dealing with these off site residential areas will not be referenced in this Report.

The removal alternatives developed in this Report, including the preferred alternative, are set forth in detail in Section 6 below. The following is a summary of the principal components of the preferred alternative:

- Soils from those areas on the Site (outside the EPA Repository and outside the active rail line corridor) containing contaminants of concern in concentrations above the Kansas non-residential risk (NRRSK) levels (Lead 1000 mg/kg; Cadmium 1000 mg/kg; Arsenic 38 mg/kg) should be removed to a maximum depth of 18 inches, and the excavated soils should be consolidated on the former lagoon area on the west side of the Site.
  - Areas where soils are removed should be covered with a minimum of six inches of topsoil and graded for proper surface drainage.
  - Areas which continue to target above the Kansas NRRSK levels after removal to a depth of 18 inches should either be removed in additional six inch lifts to a depth at which the Kansas NRRSK levels are no longer exceeded, or should be covered with a cap consisting of 18 inches of clay plus six inches of top soil and continue to be subject to restrictive covenants as to future use.

- Soils placed in the EPA Repository should be left undisturbed, except for one small area around sampling point #18 where the soils exceed the Kansas NRRSK levels. The soils in that area which exceed the NRRSK levels should be excavated and consolidated onto the former lagoon area. The remaining soil material in the EPA Repository should be compacted from the surface and left in place.
  - In view of the depth of the EPA Repository material, any soils beneath the soils placed in the EPA Repository which contain contaminants of concern in concentrations exceeding the Kansas NRRSK levels should be left undisturbed.

- The on-site disposal facility which will be located on top of the former lagoon area will receive excavated soils and sediments and after proper grading will be capped with 18 inches of compacted clay followed with 6 inches of topsoil and proper seeding. The engineering design of the on-site disposal facility, including the specifications and Quality Assurance/Quality Control (QA/QC) plans, will be completed and presented in the Remedial Action (RA) Work Plan.

- The elevation of that portion of the former lagoon area which will receive excavated soils and sediments and be covered by an 18-inch clay liner and 6 inches of topsoil should be raised to prevent groundwater and surface water interaction. The entire surface of the former lagoon area should be raised a minimum of at least three feet in order to prevent interfacing between the groundwater and surface water.

- The existing cap on the former lagoon area should be repaired as needed, and the entire area recontoured to provide proper drainage.

- No action should be taken regarding down gradient groundwater, inasmuch as the groundwater is not impacted by contaminants of concern.

- The visible sediments in the pathway of Unnamed Creek between the west boundary of the Site and Drum Creek should be removed and consolidated onto the former lagoon area as outlined in Section 3.4.2 of this RAD.

- No action should be taken regarding any sediments in Drum Creek in view of the fact that the water quality in Drum Creek is not impacted by contaminants of concern, and sediment removal would be more harmful than leaving the sediments in place.

- All permits required for implementation of the RA Work Plan, including the Army Corps of Engineers Section 404 Permit for removal of sediment from the Unnamed Creek, will be obtained prior to the start of construction.

2.0 Site Evaluation and Description of Operational History:

2.1 Site Location:

The Site is located at the northwestern city limits of Cherryvale, Montgomery County, Kansas, and is located along U.S. Highway 169. Cherryvale is a rural community with some light industry. The population of Cherryvale as of the 1990 census was 2,464 persons. The geographic coordinates of the site are 37°16'45.0" North latitude and 95°33'41" West longitude. The Site is located in Section 8 in Township 32 South, Range 17 East. Site location is shown on Figure 1 (Location Map).

2.2 Site Operational History:

KDHE completed an Expanded Site Evaluation (ESI) at the Site in 2001. According to the ESI Report, the Site consists of approximately 360 acres including the former National Zinc facility on the northern edge of Cherryvale, Kansas. Historical review from Sanborn Fire Insurance maps and historical archive information available during the Brownfields Targeted Assessment (BTA) conducted by KDHE in 1999 indicates that the Edgar Zinc Company began construction of a primary Lead and Zinc smelter at the Site in 1898. The facility initially was constructed with 1,800 retorts and 3 furnace buildings. By 1908 the smelter facility had 4,800 retorts and 24 furnaces. The 1928 Sanborn Map (the most recent available) also indicates the facility had four (4) ore roasters and 24 furnaces in operation, consistent with the 1908 configuration.

The Sanborn Maps indicate the facility operated "day and night". This facility was recognized as the largest Zinc smelter in the world until World War I. Nearly 500 employees worked at this facility at its peak, and the population of Cherryvale was nearly

8,000 during the early 1900s at the peak of the Edgar Zinc facility production. The Edgar Zinc facility was by far the largest employer and industrial facility in Cherryvale during its operational life. The location of the Frisco Railroad line at the eastern edge of the Site, in addition to plentiful shallow natural gas from oil and gas production in the local area, provided the necessary transportation and energy resources for the Edgar Zinc facility. The facility operated as the Edgar Zinc Company until sometime after 1928, when it was reorganized as the National Zinc Company. Production appears to have declined through the 1930s when most active operations ceased.

Sludges and liquid wastes contaminated with heavy metals were contained in large settling lagoons on the far west side of the Site covering approximately 23 acres. The lagoons were used to contain runoff from an estimated 2,000 tons of slag and roasted ore. The National Zinc smelter facility permanently ceased operations on December 24, 1976. As detailed in Section 2.9 below, limited response actions were conducted at the Site in the late 1970's. These included removal of ore and sludge from the Site, consolidation of additional sludge into the former lagoons, and capping the former lagoons. Presently, the Site contains the encapsulated former lagoon area, several abandoned buildings and building foundations, and the remains of the smelter operations. Figure 2 shows the Base Map of the Site.

2.3 Geology:

The Site is located in a broad, low-relief upland of the Osage Questas physiographic area of southeast Kansas. Bedrock of Pennsylvanian age is present at the base of the soil profile. During the installation of temporary monitoring wells (TW) at the Site as part of the BTA conducted by KDHE at the Site in 1999, bedrock was typically encountered between 14 feet (TW-1) and 3.5 feet (TW-8).

The bedrock units underlying the Site are sandstone and limestone of the Cherryvale Shale and Dennis Limestone Formations of the Kansas City Group. A yellowish to reddish-brown sandstone was typically encountered as the bedrock layer upon auger

refusal. Ground water occurrence within the Cherryvale Shale and Dennis Limestone Formations of the Kansas City Group is typically localized with very low (less than 3 gallons per minute) yields of generally poor quality. These bedrock units typically yield little to no water except in the shallow weathered zone near the upper bedrock surface. Oil field intrusion of brines in the Site area from oil production dating back to the early 1900s has impacted shallow ground water quality regionally in this portion of southeast Kansas.

Ground water occurrence in the Site area is primarily restricted to unconsolidated alluvial deposits of the Verdigris River and Cherry Creek. The City of Cherryvale receives water from a surface intake on Big Hill Lake located approximately five (5) miles east of Cherryvale. Significant karst terrain does not exist in the Site area, given the sequential shale-sandstone-limestone stratigraphy of the bedrock units. The City of Cherryvale and Montgomery County Rural Water District # 12 supply water to private residences surrounding the Site.

2.4 Climate:

The climate of Montgomery County is characterized as a continental climate that is typically warm to hot in the summers and cold in the winters with the majority of precipitation events occurring in the spring and early summer. The average annual precipitation in Montgomery County is 36.95 inches per year. The average winter temperature is 36.8° Fahrenheit (F) and the average summer temperature is 78.4° F. Prevailing surface winds in Montgomery County are southerly with an average annual speed of 11 miles per hour. The maximum 24-hour precipitation event recorded for Montgomery County is 6.38 inches.

2.5 Soils:

The undisturbed areas of the Site are typically underlain by Kenoma series soils which are generally deep, moderately well drained, very slowly permeable soils on uplands, of 0

to 2 percent slopes. The surface layer (A horizon) typically consists of a dark grayish brown silt loam about 6-12 inches thick. The upper portion of the subsoil layer (B horizon) is typically 9 inches thick and consists of very dark grayish brown to grayish brown silty clay. The lower portion of the subsoil layer is typically 40 inches thick and consists of dark yellowish brown to dark brown to reddish brown silty clay.
Typical depth of Kenoma soils averages 60 inches or greater. The southern edge of the Site is also within the Dennis series, but the native soil profile for this series is very similar to the Kenoma series. No C horizon is recognized because of the generally deep (60 inches) thickness of these soil types.

The unified soil classification of the A horizon is CL to CL-ML to ML (18-29% clay) with a plasticity index range of 3-18 and a liquid limit range of 24-40. The unified soil classification of the B horizon is CH (40-60% clay) with a plasticity index range of 30-48 and a liquid limit range of 50-75. Available water content is high (0.10-0.24). Surface runoff is slow and shrink-swell potential is high. Permeability generally ranges from 0.2 to 0.6 inches/hour.

2.6 Surface Hydrology:

The Site is bounded by Martin Street on the south, County Road 5200 on the north, County Road 5400 on the east, and Unnamed Creek to the west. The South Kansas and Oklahoma Railroad transects the Site from the southeast to the northwest and a gas pipeline (Williams Pipeline Company) runs parallel to the railroad. Unnamed Creek starts in the middle portion of the Site and runs northwestward to the west edge of the Site and turns southward toward the southeast corner of the Site. Unnamed Creek then turns west and joins Drum Creek. Another stream runs east to west along the southern edge of the Site and joins Unnamed Creek at the western property line. These streams are intermittent seasonal type streams. The area to the east of the railroad line drains to the south/southeast while the area west of the railroad line drains to the south/southwest into Unnamed Creek, which drains to Drum Creek approximately three-quarters of a mile to the southwest.

2.7 Groundwater Hydrology:

In 1978 there were five monitoring wells completed on the Site. These wells were sampled during the BTA and tested high for Cadmium. The BTA Report concluded that the groundwater was not migrating off site, but expressed concern about the groundwater and surface water interface at the west edge of the former lagoon area. The report also recommended further investigations of off site areas for soil, surface water and groundwater. Pursuant to the Consent Order, four additional monitoring wells were drilled for groundwater sampling and assessment. The complete Hydrogeological Investigation Report prepared as required by the Consent Order is included herein as Appendix B. It concluded the following:

- The uppermost groundwater aquifer at the Site is the unconsolidated sediment / fractured limestone and shale of the Dennis formation at a depth of 5 to 20 feet.
- The Site groundwater flows from east to west.
- The groundwater fluctuates as much as 6-7 feet at the site.
- Groundwater quality is impacted inside the lagoon area, but the metal impact is not detected downgradient of the Site.
- Groundwater quality and yield is limited in this entire area and there is no water supply source impacted by the Site's past or present activities.

2.8 Land Use:

The Site consists of approximately 360 acres. The northeast quarter of the Site has not been impacted by previous industrial activities. The Site adjoins the northeast part of the City of Cherryvale. It is owned by the City, and has been zoned an industrial area. It should remain zoned industrial. The City's goal is to have the restrictive covenants

imposed on the Site in 1983 removed insofar as possible to enable redevelopment and use of a major part of the Site.

2.9 Endangered Species Review for Montgomery County, Kansas

The Endangered and Threatened Species for Montgomery County, Kansas are the Bald Eagle, American Burying Beetle and the Neosho Mucket.

Bald Eagle (Haliaeetus leucocephalus)

The Bald Eagle, which was adopted as our national symbol in 1782, was listed as endangered in 1973, but with Federal protection and some pesticide bans has made a remarkable recovery and is now listed as Threatened in Kansas. Approximately 700 to 800 Bald Eagles visit the State of Kansas each year. Most are temporary migrants, but in 1989 Clinton Reservoir in Kansas became the host to the first ever known nesting event to occur in Kansas. The eagles typically arrive in October and start migrating back in February. The eagles generally inhabit areas around large lakes and rivers. The primary threat to Bald Eagles in Kansas is the loss of important riparian habitat and intentional shooting. The proposed removal activities at the Site and Unnamed Creek should not pose a threat or be of any risk to the Bald Eagle.

American Burying Beetle (Nicrophorus americanus)

The American Burying Beetle is the largest carrion beetle in North America. It was once fairly numerous and widespread, but has diminished. The American Burying Beetle (ABB) was listed as endangered in 1989 and was known to exist in only 6 states. Kansas is one of the six with confirmed sightings in Montgomery County. The ABB is a nocturnal insect which becomes active once the nighttime temperatures reach above 60 degrees. They feed and lay their eggs on carrion located by special sensors on their antennae. Once carrion is located, the ABB will bury the carcass, remove all hair and fur, spin the carcass into a ball and lay their eggs on the carcass. The ABB give their young parental care during the larval stage which is an unusual insect trait. After consumption of the carcass, the young will bore into the ground, pupate and emerge as adults. The

adults typically only live one season. The ABB's specific habitat requirements are not well documented; however, their decline is believed to be attributed to habitat fragmentation and urbanization that has squeezed other food competitors into a smaller area. The construction activities associated with the proposed action at the site might disturb some areas where the beetle could exist. A site survey will be conducted, if required, for the American Burying Beetle and, if found on the site, a relocation program based on the methodology outlined in Creighton, et al, "Survey Methods for the American Burying Beetle in Oklahoma and Arkansas", Oklahoma Geological Survey, Norman, Oklahoma. (1993), will be developed and implemented, during the construction.

Neosho Mucket (Lampsilis rafinesqueana)

The Neosho Mucket is a fresh water mussel that is a proposed species for listing. It is endemic to the Neosho and Verdigris basins of the Arkansas River System in Kansas, Oklahoma, Missouri and Arkansas. In the Verdigris basin, the species survives in the Verdigris and Falls Rivers. Drum Creek is a tributary of the Verdigris River. The Neosho Mucket has a very long life span, expanding to as much as 100 years. The major threats to the Mucket are impoundments and agriculture. Impoundments have inundated habitats, altered the hydrology and created barriers. Agriculture has increased siltation and pollution. Other threats to the Mucket are urbanization and heavy metal pollution. Unnamed Creek is a tributary of Drum Creek and drains the area from the former National Zinc site, which empties into the Verdigris River downstream. The Neosho Mucket is documented to be sensitive to heavy metal contamination, partly due to their long life span. Drum Creek discharges into the Verdigris River several miles downstream from the site. The proposed action at the Site and Unnamed Creek will only help the outlook of the Neosho Mucket.

2.10 Site Evaluation

Incidents of surface water contamination were reported to KDHE by adjacent property owners in the 1950's. In April, 1976, the Site was investigated by KDHE following complaints from farmers regarding visual observations of contamination in Drum Creek

and concern over the possibility of a fish kill or cattle illness from surface water consumption. KDHE personnel also inspected the Site on September 27, 1977 for possible surface water or groundwater pollution associated with facility runoff and seeps. At the request of KDHE, limited response actions were initiated at the Site by National Zinc Company in October 1977. Additionally, in 1979, approximately 95 million gallons of fluid from the lagoon were treated and discharged by National Zinc Company into the adjacent Drum Creek. At the same time, ore and sludge were removed from the Site. Some of the remaining sludge (approximately 300 tons) was treated and encapsulated in the former lagoon area on-site. The lagoon was filled with dirt and topsoil, treated with lime, encapsulated and planted with grass.

In 1995 KDHE conducted additional sampling at the Site. Lead was detected at a maximum of 176,750 mg/kg, Cadmium at a maximum of 2,816 mg/kg, and Arsenic at a maximum of 240 mg/kg in soils. Cadmium was detected in Site surface and groundwater up to 0.111 mg/l. In July 1996, sediment/sludge sampling indicated Lead up to 1,786 mg/kg, and Cadmium in Site surface water up to 0.347 mg/l.

In 1999 KDHE conducted the BTA, which included extensive sampling across the Site. Soils, subsurface soils, groundwater, surface water and sediment were sampled during the BTA.

KDHE completed an ESI at the Site in 2001. Additional surface water sampling indicated off site impacts to surface water from Zinc and Cadmium. Off site impacts from Lead, Cadmium, Mercury, and Zinc to sediments in surface water pathways were also identified during the ESI.

KDHE concluded there were documented releases from the Site of heavy metals, especially Lead, Cadmium, and Arsenic: to on-site soils, surface water, sediment and groundwater; to off site residential soils, sediments and surface water; and potentially to off site groundwater. These constituents are hazardous substances as defined in the

National Oil and Hazardous Substances Contingency Plan (NCP) and in the Kansas Environmental Response Act.

KDHE's ESI and BTA reports were utilized to design the Remedial Site Evaluation (RSE) Work Plan attached to the Consent Order to further investigate and evaluate the Site and downgradient areas west of the Site. In accordance with the RSE Work Plan, Respondents conducted sampling of the EPA Repository area; conducted sampling of sediment and surface water in Unnamed and Drum Creeks; constructed a surface water diversion dike; drilled an additional four monitoring wells, three off site downgradient wells to sample off site groundwater, and one on-site well to establish groundwater background levels; sampled the groundwater; and developed a Hydrogeological Investigation Report, an Analytical Report, Surface Water, Sediment and EPA Repository, and a Water Quality and Sediment Sampling Report presenting the results of these Work Plan events. Copies of these Reports are included in this RAD Report as Appendices B, C and D.

3.0 Extent of Contamination On and Off Site:

KDHE studied the Site and reported its findings in the previously identified ESI and BTA Reports. These findings were utilized in developing the RSE Work Plan. The purpose of the RSE Work Plan was to gather additional information required for preparation of this RAD Report and the RA Report. The RSE Work Plan was implemented and the results are incorporated in this report as Appendices B, C and D. The media of concern associated with the Site are categorized as follow:

1. On-site soil contamination.
2. Sediment contamination in surface water pathways of Unnamed and Drum Creeks.
3. Eroded cap and poor drainage over the former lagoon area.
4. Potential off site groundwater contamination.

3.1 Contaminants of Concern:

The contaminants of concern observed by Respondents during their implementation of the RSE Work Plan are described below. These are consistent with the contaminants identified by KDHE in its studies.

3.1.1 On-site:

Contaminants of concern in the EPA Repository area are Lead, Cadmium and Arsenic. Contaminants of concern throughout the rest of the Site (except for the northeast area), are Arsenic, Cadmium and Lead found together, and Arsenic in other isolated locations. For clean-up level purposes, the portion of Unnamed Creek starting at the west boundary of the Site and following said Creek to its termination point at Drum Creek will be classified as off site.

3.1.2 Off Site:

The Respondents collected surface water and sediment samples in Unnamed and Drum Creeks to determine contamination levels and develop a correlation between sediment and surface water pathways. Based on these analyses the contaminants of concern, found primarily in the sediments, are Cadmium, Arsenic, Lead, and Zinc. The analyses reflect that the heavy metal contaminants are immobile in the sediments, and have very little impact on the surface waters. The sediments have varying levels of the four contaminants with many overlapping in the same areas.

3.2 Previous Surveys and Their Analytical Results:

As noted above, there were two major surveys conducted by KDHE: the BTA and the ESI. The BTA was completed by KDHE in February 2000 and consisted of a Site survey; soil sampling; surface water and sediment sampling; groundwater and soil/waste

profile sampling. Figures 3, 3-1 and 3-2 show the analytical results of the KDHE soil sampling for Lead, Cadmium and Arsenic, plotted on isoconcentration maps.

The ESI was completed in March of 2001 and included a review of historical file information; sampling of environmental media; evaluation of the Site utilizing the Hazard Ranking System (HRS); determining a site score for HRS and documentation of HRS factors; and collection of relevant non-sampling information. KDHE utilized the analytical data included in the BTA in preparing the ESI. The Site has the CERCLA information system (CERCLIS) EYA identification number KSH9804 06698.

KDHE's conclusions in the BTA and ESI Reports included the following:

- Surficial soil contamination above the NRRSK of 1,000 mg/kg for Lead was present on the Site.

- Cadmium was detected in water of the Unnamed Creek above its Maximum Contamination Level (MCL) immediately west of the Site.

- Heavy metals, especially Cadmium and Lead, have been documented in Site groundwater and are attributed to the former National Zinc facility.

- Additional investigation would be required to determine the impact to off-site surface water and potential Receptors.

- Additional investigations would be required to determine off-site groundwater impacts.

3.3 Sampling Activities Performed By Respondents:

3.3.1 On-Site Soils:

The KDHE Site soils data were utilized to prepare the isoconcentrations maps (Figures 3, 3-1 and 3-2). Additional confirmatory sampling will be proposed as part of the RA Plan in order to verify the areas to be excavated. The EPA Repository was sampled using a geo-probe composite sampling device. The area was sampled to determine the contamination levels and depths of soil brought on-site from the off site excavation. The Repository area was surveyed and marked in grid sections. The sampling locations and grid map are found on Figure 5. The cross-sectional view of the Repository Area is shown in Figure 6. Each sampling point marked on Figure 5 was sampled and composited at each separate five-foot interval until the bottom of the Repository was reached. The sampling and handling procedures as outlined in the amended sampling plan were followed. The composite samples were split. One set was retained by the sampler and the other set was forwarded to the lab. The results showed that at only one area, sample point 18, the NRRSK of 1,000 mg/kg for Lead and 38 mg/kg for Arsenic were exceeded. All other contaminants and areas sampled were below their respective NRRSK. The analytical results are included in Appendix B.

3.3.2 Off Site Sediments and Surface Waters:

Sediment and surface water samples were collected off site on Unnamed and Drum Creek in compliance with the Phase II Work Plan on June 24, 25 and 26 of 2003. A portion of the Unnamed Creek, located within the Site, was also sampled during the RSE investigation. The purpose of this sampling event was to determine contaminant levels, background levels, and to establish the sediment to surface water relationship. This sampling event represents the low flow conditions in Drum Creek. Unnamed Creek did not have any flow during this sampling, but had standing water at some locations. The laboratory results of the June 24, 25 and 26, 2003 sampling are included in Appendix B.

After discussions with KDHE and at its suggestion, Respondents collected additional water and sediment samples from Drum Creek at two different times, January 30, 2004

and March 1, 2004. In both additional sampling events, samples were taken from around and downstream of the confluence of Drum Creek and Unnamed Creek. The January 30, 2004 sampling event represented the high water flow conditions in Drum Creek while the March 1, 2004 sampling event represented the normal water flow conditions. The water and sediment sampling results for these two additional sampling events are included in the Water Quality and Sediment Sampling report dated April 2004, which is included in Appendix C. Appendix C also presents a summary and comparison of analytical data collected during all three sampling events discussed above.

The following presents a summary of the June 24, 25 and 26, 2003 sampling results:

Off site, discrete composite sediment samples were taken from Unnamed and Drum Creek starting from a point 250 feet east of MW-4. The sampling locations are outlined on Figures 7 and 8. At any location where surface water was encountered on Unnamed Creek, discrete samples were taken for sediment and surface water. The analyzed parameters and laboratory results are listed on Tables 1 through 4. There were a total of six metals analyzed, however only four of those metals showed any levels above the Kansas Residential Risk Levels (RRSK) in the Unnamed and Drum Creek samples. These were Cadmium, Lead, Arsenic, and Zinc, which often exist in the same areas. The analytical results for each of these metals are shown on Figures 9A through 9D, with the corresponding surface water results in parenthesis below. As reflected by Figure 9A, Cadmium was the most common metal, appearing in most of the sediment samples. This indicates that Cadmium was also the most mobile metal. The corresponding water samples had Cadmium concentrations either below detection limits or MCL, with the exception of a few collected in Unnamed Creek near the west boundary of the Site.

Figure 9B, which shows Lead concentrations in the sediment and surface water, presents the same result: Lead is retained in the sediments with very little influence on the surface water pathway. Figures 9C and 9D show that Zinc and Arsenic also behave the same way. These contaminants appear in the same places as Cadmium and Lead, with little or no influence on the surface water pathway.

The following presents a comparison of the analytical data collected during the three sampling events discussed above:

Figure 11 shows the water quality sampling locations for Drum Creek and Figure 12 shows the sediment sampling locations for Drum Creek for all three sampling events. The Water Quality Analytical Data for Drum Creek, which resulted from all three sampling events, are summarized in Table 5. The sediment analytical data for Drum Creek, which resulted from all three sampling events, are summarized in Table 6.

The Respondents, addressing the issues of aquatic life criteria for Drum Creek (under the Kansas Surface Water Quality Standards as adopted by reference and outlined in KAR 28-16-28), have conducted calculations using the criteria in Table 1b of the regulations referenced above. These calculations are set forth in Appendix C and the results of those calculations are set forth in Table 7.

The Water Quality Analytical Data gathered from all sampling events showed the following:

Tables 5 and 7 compare the Drum Creek water quality data to both drinking water standards (MCLs) and the Kansas Surface Water Quality Standard for potential impact on aquatic life at low, normal and high flow levels.

First, as to MCLs, there were only four samples which were not in compliance with drinking water standards. One of these was taken at sample point 6 (upstream from the confluence of Drum Creek and Unnamed Creek, hereinafter the "Confluence"), and exceeded the MCL for lead during high flow conditions. This sample was clearly impacted by the effluent discharge from the new Cherryvale waste treatment system, and is therefore not relevant. The location of the City of Cherryvale effluent discharge is approximately 200 feet upstream from the Confluence as shown on Figures 11 and 12.

Of the remaining three samples which exceeded MCLs, two marginally exceeded the MCL for lead at sample point 8 and sample point 10, respectively, both during high flow conditions; and a third marginally exceeded the MCL for cadmium at sample point 8, also during high flow conditions. Sampling point 8 is at the Confluence, and sampling point 10 is 75 feet downstream from the Confluence. All other samples downstream from sample point 10 were in compliance with MCLs at all flow levels.

With regard to the aquatic life criteria for Drum Creek (under the Kansas Surface Water Quality Standards as adopted by reference and outlined in KAR 28-16-28), A & M prepared calculations for both acute and chronic criteria using Table 1b of the above referenced regulations. The results were similar to the MCL data. Only four samples (excluding sampling point 6) exceed either the acute or chronic criterion levels, all of which were taken during high flow conditions at either the Confluence or the sampling point 75 feet below the Confluence.

The only samples which exceeded either MCLs or the Kansas Surface Water Quality Standard for potential impact on Aquatic life during any flow condition were the above described samples taken during high flow conditions at only two locations: the Confluence and 75 feet downstream from the Confluence.

The laboratory results of the sediment samples from all sampling events showed the following:

The sediment sample results are set forth in Table 6. The samples taken at the Confluence and in the first 300 feet below the Confluence are elevated, comparable to the sediment samples from Unnamed Creek.

Among the four background sediment samples taken from Drum Creek (S-15-D8, S-14-D7, S-14-D6 and S-10-D2), the highest toxic metal concentrations recorded are: Arsenic 7.16 mg/kg; Cadmium 4.63 mg/kg; Chromium 13.90 mg/kg; and Lead 24.50 mg/kg. The sediment sample taken at the Low Water Crossing (Sample S-17-D-10) showed the

following metal concentrations: Arsenic 18.5 mg/kg; Cadmium 14.3 mg/kg; Chromium 11.6 mg/kg; Lead 48.2 mg/kg and Zinc 517 mg/kg. The additional sediment sample taken January 30, 2004 at 300 feet downstream of the Low Water Crossing showed the following concentrations: Arsenic 6.76 mg/kg; Cadmium 2.99 mg/kg; Chromium 14.6 mg/kg; Lead 9.73 mg/kg; and Zinc 24.9 mg/kg. The comparison of the above data clearly indicates that the metal concentrations in the sediment samples taken from sediments downstream from the Confluence area are similar to background concentrations. The new sample taken 300 feet downstream from the Low Water Crossing shows a very noticeable reduction in the metal concentrations in the sediments.

3.3.3 Off Site Groundwater:

The Respondents drilled four additional monitoring wells to determine if the contaminated groundwater documented by KDHE on the Site had migrated off site. Three downgradient wells were installed and one upgradient background well. The wells were developed and sampled for three months. The Hydrogeological Investigation Report is included in Appendix D, and shows no contaminated groundwater off site.

3.3.4 Conclusions:

Based on the sampling results summarized above, the Respondents concluded the following:

- Levels of Lead and Arsenic contamination exceed the NRRSK in one area around sample point 18 in the EPA Repository.
- Lead, Cadmium, Zinc, and Arsenic exist in the sediments of Unnamed Creek above RRSK levels.
- Lead, Cadmium, Zinc and Arsenic exist in the sediments at the Confluence above the RRSK levels.
- Surface water in Unnamed Creek has not been significantly impacted off site with the exception of one location just west of the Site boundary line.

- Surface water in the rest of the unnamed Creek and Drum Creek has not been significantly impacted.
- Groundwater contamination on-site is stationary and has not moved off site.
- Off-site groundwater is not impacted.

3.4 Assessment Of Contamination Associated With The Site:

The assessment of contamination associated with the Site has been established utilizing the data developed in the KDHE sampling events. Additional sampling will be conducted as part of the RA to establish the precise boundaries of areas that exceed the NRRSKs, to ensure that all contaminants above their respective NRRSKs are removed.

3.4.1 Soil Contamination:

The soil contamination at the Site consists mainly in the area of the intersecting railway and former production areas in the southeast portion of the Site. According to the KDHE sampling results, Lead and Arsenic are the contaminants above their NRRSK. These areas are depicted on Figures 3 and 3-2. There is one additional area located to the north of the former lagoon area showing levels of Arsenic above the NRRSK. During the RA, additional samples will be taken to verify the isoconcentration lines above the NRRSK as depicted on Figures 3 and 3-2. All of the additional samples will be analyzed for Lead, Cadmium and Arsenic. This analytical data will be used to develop maps outlining the areas where soil excavation will be required. The sampling procedures are as follows:

- Sample fifty feet outside the contour line within its respective grid as indicated on Figures 3 and 3-2.
- If area is below NRRSK then set stake and move to next area.
- If area is above the NRRSK then move outward an additional fifty feet and resample.

- Repeat the above step until concentrations are below the NRRSK.

- Develop maps showing the areas where soil removal will be required. prior to implementing the RA Plan.

The EPA Repository area was sampled at points referenced on Figure 5. The only area identified above the NRRSK was for Lead and Arsenic at sample point 18. Additional verification sampling at 50-foot and 100-foot intervals around sample point 18 will be required as part of the RA to determine any additional areas above the Lead NRRSK of 1,000 mg/kg and Arsenic NRRSK of 38 mg/kg. The protocol for sampling and soil removal will be the same as outlined above.

3.4.2 Sediment Contamination:

Pursuant to the RSE Work Plan, Unnamed and Drum Creeks were sampled to determine contamination concentrations, establish background levels, and to study the sediment / surface water relationship. The sampling locations are shown on Figures 7 and 8. The levels of contaminant concentration are shown on Figures 9A through 9D. Unnamed Creek was sampled starting at a point 250 feet east of MW-4 and sampled at varying locations plotted on Figures 7 and 8 to its termination point at Drum Creek. Where surface water was encountered on Unnamed Creek, a sample was taken. The analytical results for surface water are also shown on Figures 9A through 9D. The constituents of concern in Unnamed Creek sediments above the RRSK were Cadmium, Lead, Arsenic, and Zinc. Other metals were below the RRSK. See Tables 1 through 4 in Appendix B for all sampled constituents. The metals above the RRSKs are throughout the sediments in Unnamed Creek (many are in duplicated areas). Tables 2 and 6 present summaries of the sediment sampling data for Drum Creek. The surface water throughout Unnamed Creek has essentially not been impacted by the metals contained in the sediments except in one area just west of the Site boundary as shown on Figures 9A through 9D. There are portions of Unnamed Creek that have been washed clean of visible sediments, and a slate

bottom is all that remains. Remedial action is not planned for these areas. These areas are as follows.

From Highway 169 west to Sunnyslope Drive;
From Sunnyslope Drive west to Martin Drive (approximately 600 feet).

The visible sediments in the portion of Unnamed Creek from the west boundary of the Site to Highway 169 will be removed using mechanical equipment.

The remaining portion of Unnamed Creek from Martin Drive crossing to the Confluence is extremely narrow with high banks, and therefore will not accommodate mechanical equipment without causing major impacts to existing environmental conditions. Therefore, sediment removal is not recommended for this portion of Unnamed Creek.

It is recommended that the visible sediments which are to be removed from Unnamed Creek will be removed in accordance with the following:

- Remove all visible sediments and place in former lagoon area.
- Where necessary for maintaining the creek bed slope, place clean soil

After consideration of sediment sampling results together with water quality data discussed in Section 3.4.3, it is concluded that no sediments should be removed from Drum Creek due to the following reasons:

1. Water quality in Drum Creek has not been significantly impacted by sediment.
2. Those minor water quality impacts that do occur in Drum Creek happen only under high flow conditions that are infrequent.
3. Removal of the sediments in Drum Creek could jeopardize the current drinking water quality and existing aquatic life.

4. Sampling points downstream for all the constituents in most cases are lower than the background parameters.
5. Drum Creek and the Verdigris River, which Drum Creek feeds into, do not supply residential drinking water downstream.
6. Creek bank disturbance and vegetation removal including mature trees could prove detrimental to the existing aquatic life in Drum Creek.
7. The aesthetics of Drum Creek would be damaged.

3.4.3 Surface Water Contamination:

As previously presented, the Respondents collected surface water samples from Unnamed and Drum Creek. The water quality data from Unnamed Creek are shown on Table 3 and Figures 3A, 3B and 3C. The water quality data from Drum Creek are shown on Tables 4 and 5 and Figures 3A, 3B, and 3C. Based on the water quality analytical data, the following conclusions are drawn:

1. Proper clean up, closure and capping of the site will eliminate any surface water contamination throughout Unnamed Creek.

2. During low flow conditions, the segment of Drum Creek starting approximately 300 feet downstream from the mouth of Unnamed Creek and extending to the low water crossing, is in the form of a long, narrow pond. The ponding effect was created by the raised stream bottom elevations at the low water crossing and, possibly, at the bridge crossings located throughout this segment of the creek. During low water flow conditions the only visible and accessible sediments in this segment of Drum Creek (between Unnamed Creek and the low water crossing) are those located within 300 feet downstream from the mouth of Unnamed Creek. Any other sediments are inundated even during low flow conditions.

Removal of any sediments in Drum Creek would require major channel alterations in order to remove the ponding effect. By opening up the creek channel, the result would be the sediments will be allowed to freely move downstream.

3. Water quality has not been jeopardized in Drum Creek during all flow conditions.

During low flow conditions, the only metal detected was Zinc, see Tables 5 and 7. The data presented in blue in Table 5 reflects samples taken during low flow conditions. The sampling locations where Zinc was detected during low flow were sample points W4-D1, W8-D3, W9-D4, W10-D5, and W15-D10. All concentrations of Zinc in these samples were below the MCL for Zinc of 5mg/L. Computing the calculations set forth in KAR 28-16-28 for Zinc for these sample points yields the following results: 32.2 at W4-D1; 132 at W8-D3; 132 at W9-D4; 54.4 at W10-D5; and 20.4 at W15-D10. As shown in Table 7, all of these results were well below both the acute and chronic aquatic life criteria.

The data presented in black in Table 5 reflects samples taken during normal flow conditions. Since there were no metals detected in any samples taken during normal flow conditions, there are no calculations presented in Table 7 for either acute or chronic criteria during normal flow conditions.

There were five water samples taken in Drum Creek during high flow conditions. The data presented in red in Table 5 reflects the high flow samples taken at these five sample points: W7-D2, W4-D1, W8-D3, W15-D10 and LWC300.

During high flow conditions, there was one sample point, W4-D1 (the Confluence) that exceeded the acute aquatic life criterion for Zinc. There were four exceedences for the chronic aquatic life criteria, three for Lead, Zinc and Cadmium at W4-D1 (the Confluence), and the fourth for Lead at W8-D3 (75 feet below the Confluence). During high flow conditions, there were three marginal MCL exceedences, for Lead and Cadmium at W4-D1 (the Confluence) and for Lead at W8-D3 (75 feet below the Confluence).

In summary, the foregoing data reflects that there were no MCL exceedences and no acute or chronic aquatic life criteria exceedences during either low or normal flow conditions in Drum Creek. While there were a few exceedences during high flow conditions, these are believed to be insignificant for the following reasons: (1) Precipitation data recorded by the Army Corps of Engineers for Big Hill Lake, located 5 miles East of Cherryvale, reflects that for the years 2002 and 2003, the Cherryvale area received only 10 rainfall events with precipitation measuring over one inch; and only four rainfall events measuring over two inches. Based on these rainfall events over a two-year period, the dominant flow pattern for Drum Creek is most likely to be either low or normal flow conditions. (2) The area where the high flow exceedences occurred is confined to the 75-foot segment of Drum Creek between the Confluence (W4-D1) and the sample point 75 feet downstream (W8-D3). (3) Chronic aquatic life effects are unlikely to occur in Drum Creek. 40 CFR § 131.36 provides that a "Criteria Continuous Concentration = the highest concentration of a pollutant to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects". Based on the precipitation data, the number of times high flow conditions exist

in Drum Creek for a minimum of four continuous days appears to be very limited.

4. The metal concentrations in Drum Creek do not appear to be increasing with the flow rate with the exception of Lead and Chromium during high water flow.

5. Chromium exceeded detection levels in several samples during high water flow conditions. None the less, the levels of Chromium in Drum Creek under all of the flow conditions (low, normal and high) were below its MCL.

6. The trace amount of Lead detected in Sample 6 is from the new City treatment plant. The trace amounts detected in Samples 8 and 10 are within 75 feet of the Confluence.

7. Except for the first 300 feet below the confluence of Unnamed and Drum Creeks, the sediment contamination levels appear to be very similar to background levels.

8. The sediments in Drum Creek do not present a risk to the drinking water quality, unless the sediments are disturbed.

In conclusion, existing surface water quality in Drum Creek and Unnamed Creek is not significantly impacted, and the source control measures at the Site and in the Unnamed Creek will further improve the existing good water quality.

3.4.4 Groundwater Contamination:

As previously mentioned, the Hydrogeological Investigation Report, which is included as Appendix B, concluded that there is no off site groundwater contamination resulting from the Site.

4.0 Potential Exposure to Human Health and Environment:

As previously identified, the contaminants of concern associated with the Site are Lead, Cadmium and Arsenic.

4.1 From Contaminated Site Soils:

KDHE conducted two major studies of the Site. The ESI and BTA reports concluded that Lead, Cadmium and Arsenic contamination to on-site surface soils existed.

Lead is a naturally occurring, bluish-gray metal found in small quantities in the earth's crust. It is present in a variety of compounds and is considered a very toxic element at low dose levels. Human exposure to Lead can occur through inhalation and oral exposure. Children are at a particular risk not only because of their sensitivity to Lead at very low levels, but also because they commonly put hands, toys and other items in their mouth, which may have come in contact with Lead containing dust and dirt. Acute effects from Lead can lead to brain damage, kidney damage and gastrointestinal distress. Chronic or long-term exposure affects the blood, central nervous system, blood pressure, kidneys and Vitamin D metabolism. EPA has classified Lead as a probable human carcinogen.

Cadmium is a soft silver white metal that is usually found in combination with other elements that have a varying degree of solubility. The most likely routes of exposure from Cadmium are from inhalation and ingestion. Cadmium is considered to have a high acute toxicity based on inhalation studies conducted on laboratory animals leading to

pulmonary irritation. Chronic long-term effects of Cadmium exposure are bronchial and pulmonary irritation, bronchiolitis, emphysema. kidney, liver, lung, immune system, blood, and nervous system problems. The EPA considers Cadmium as a probable human carcinogen.

Arsenic is a naturally occurring gray-colored element in the earth's crust, and is usually found combined with other elements. It was used and still is used in home remedies and as an antiparasitic agent in veterinary medicine. Common routes of exposure for Arsenic are inhalation, ingestion and absorption, most commonly from ingestion of food intake. Acute Arsenic exposure by inhalation can result in gastrointestinal, hemolysis, and central and peripheral nervous system disorders. Acute oral exposure to inorganic Arsenic can result in gastrointestinal, central nervous system, cardiovascular system, liver, kidney or blood disorder problems, and at high concentrations, death. Chronic inhalation exposure to Arsenic is reported to cause irritation of skin and mucous membranes. Chronic oral exposure to inorganic Arsenic causes gastrointestinal effects, anemia, peripheral neurology, skin lesions, hyperpigmentation, gangrene of the extremities, vascular lesions, and liver or kidney damage. Arsenic is listed as a Group A carcinogen.

Appendix E includes additional health effects information on Lead, Cadmium and Arsenic obtained from the Agency for Toxic Substances and Disease Registry.

Potential human exposure to contaminants can occur by direct contact with the soil, by wind dust particles where erosion has occurred, and by not having controlled access to the Site, which might allow children and other unauthorized persons to enter the Site. Environmental exposure may occur from wind-blown particles from areas that are sparsely vegetated or with no soil cover barrier, allowing the heavy metals that have attached themselves to soil particles to become airborne and deposited off site in inhabited areas or in streams and rivers.

Implementation of the preferred removal alternative will mitigate the concerns arising from contaminated Site soils by significantly reducing the possibility of public exposure to these soils.

4.2 From Off Site Sediment Contamination:

The parameters of concern in the sediments are Lead, Cadmium, Arsenic and Zinc. The characteristics of these metals were summarized above, except for Zinc.

Zinc is a bluish-white shiny metal and is one of the most common elements found in the earth's crust. Zinc is also essential for human health. Zinc exposure can occur by inhalation and ingestion. Acute symptoms of Zinc overexposure can lead to stomach cramps, nausea, and vomiting. Acute inhalation exposure can lead to metal fume fever. Chronic effects of ingestion overexposure to Zinc can cause anemia, pancreas damage and lower levels of high-density lipoprotein cholesterol. The chronic inhalation hazards of Zinc are not known. Zinc is not listed as a carcinogen.

Appendix E includes additional health effects information on Zinc obtained from the Agency for Toxic Substances and Disease Registry.

Potential exposure to human health can occur by direct contact with the sediments and by sediment particles becoming airborne by the wind. The other means of potential exposure through sediment contamination is by the sediments being washed downstream and accumulating in a water body and absorbed or ingested by lower life forms and being transferred up the food chain and ultimately ingested by humans, or by being distributed onto agriculture fields for human consumption in times of flooding. While these pathways may potentially exist for a few individuals, the expected frequency and duration of any exposure is expected to be minimal for this site. The environmental threat from contaminated sediments is as previously mentioned by sediments being washed and accumulated in a sensitive ecosystem.

The preferred alternative, which includes source removal and capping at the plant site, will stop the further transport of contaminants from the plant site into the surface water pathways. Also, the sediment removal from portions of the Unnamed Creek will provide additional source control and reduce impacts to Drum Creek.

4.3 From On-Site and Off Site Surface Water:

The parameters of concern in surface water are Lead, Arsenic, Cadmium and Zinc. These metals have a tendency to attach themselves to soil and sediment particles and are generally not water soluble under natural conditions. Heavy metals do not generally break down, but usually change forms when exposed to certain chemical environments not typically found in nature. The surface water and sediment analytical results verified that the heavy metals are generally being retained in the sediments and are not leaching out into the surface water. Possible human health exposure could occur by direct contact in surface water pools where sediments have accumulated or by any activities that stir up the sediment into the surface water. Based on the analytical data, environmental concerns from surface water do not pose a threat. Implementation of the preferred removal alternatives will mitigate any concerns arising from surface water.

4.4 From Groundwater:

The nearest water well is ½ of a mile from the Site, located in an upgradient direction. Water wells are generally of poor quality in the whole region due to brine influence from oil field activities, sulfate concentration and hardness. Groundwater studies conducted pursuant to the Consent Order show that the groundwater contamination documented by KDHE on-site has not moved off site. Groundwater has no potential human health exposure and poses no threat to the environment.

4.5 Potential Contamination of Drinking Water:

The City of Cherryvale receives its drinking water from Big Hill Lake which is located upstream of surface drainage from the Site. There are no drinking water reservoirs or public drinking water supplies downstream from the drainage inflow from the Site.

There are a total of 17 private wells within a four-mile radius of the Site. The wells are plotted on Figure 10. The groundwater flow on the Site is from east to west. There is only one well within one-half mile of the Site and it is located upgradient in relation to the Site. There are four additional private wells within a two-mile radius of the Site. However, one is north in an upgradient direction, two are approximately two miles south of the Site, one is approximately two miles southwest of the Site, and none of them is in the downgradient groundwater flow direction. The other twelve wells are outside the two-mile radius.

Due to the non-existence of drinking water wells within a four-mile radius in the downgradient groundwater direction of the Site, and also due to downgradient monitoring wells showing no off-site impact on groundwater, it is concluded that the Site is not contaminating any off-site groundwater quality or drinking water wells.

4.6 Other Situations or Factors Posing a Threat to Public Health, Welfare, and Environment:

Dust generated from the removal and transport of contaminated soil could cause a threat to public health and the environment. The RA Plan will include a means of dust suppression during the course of removal and transport of contaminated soil and roads.

5.0 Cleanup Levels:

5.1 Cleanup Levels for Contaminated Soils:

Cleanup levels for contaminated soils on-site, including the EPA Repository, will be based on the NRRSK based standard for Kansas.

5.2 Cleanup Levels for Sediment Removal:

All visible sediments will be removed from the portions of the Unnamed Creek identified in Section 3.4.2.

5.3 Sampling and Analysis Plan for Confirming the Boundaries of Contaminated Areas:

The areas outlined on Figures 3, 3-2, and 5 depict additional locations which will be sampled to confirm the boundaries of the contaminated soils shown on the isoconcentration maps. After sampling and analysis, the isoconcentration maps will be adjusted to reflect updated findings. The sampling of additional areas will be a composite of the top six inches of soil. The sampling and analysis plan to be followed is outlined in Appendix F.

6.0 Removal Action Design:

6.1 Identification and Listing of Areas Where Removal Action is Needed:

The areas that require removal action are:

- The on-site areas outside the EPA Repository and outside of the active railroad tracks where the Lead, Cadmium and Arsenic levels exceed the NRRSK.

- The on-site area within the EPA Repository as outlined on Figure 5 which exceeds the NRRSK level for Lead and Arsenic.

- The surface water pathway of the Unnamed Creek where all visible sediments are to be removed in those portions of the Creek described in Section 3.4.2.

- The former lagoon area, where excavated soils and sediments will be placed in a disposal facility, the disposal facility covered with a new 18" clay liner plus 6" of topsoil, the entire former lagoon area raised a minimum of 3 feet (including the new clay cap), the existing clay cap repaired as necessary and upon completion, the surface drainage improved over the entire previously closed lagoon area.

6.2 Removal Action Goals:

The Removal Action Goal for soil material exceeding the NRRSK is to prevent any future harm to the public and the environment by either removing the soils or capping them in place. The goal of remediating the contaminated sediments in the designated portions of Unnamed Creek is to eliminate the future environmental degradation by removing these sediments. The goal of repairing the cap over the previously closed pond area is to prevent the erosion of the fill material below the cap and also to limit the percolation of the surface water. The goal of raising the entire surface of the former lagoon area by a minimum of three (3) feet is to prevent interfacing between the groundwater and surface water.

6.3 Identification and Assessment of Applicable Removal Action Alternative Methods for Contaminated Soils:

6.3.1 Evaluation of Removal Alternatives for Contaminated Soils Located Outside of the EPA Repository and Outside of the Active Railroad Track Corridor:

Removal action alternative methods for soil material located in those areas within the Site which exceed the NRRSK are:

1. Do nothing.
2. Cap and leave in place.

3. Remove soils above NRRSK and dispose off site.
4. Remove soils above NRRSK and dispose on-site.

The "Do Nothing" alternative is not considered a viable alternative. To leave the contaminated soil at the surface would result in surface water contamination and possible harm to the public and ecosystems via surface water pathways and wind erosion.

Capping the surface areas which are above the NRRSK will meet the regulatory requirements. The cap would consist of an 18" clay cap and six inches of top soil. However, it will require restricted covenants to continue on the capped areas. Restricted areas can only be used as parking areas and, therefore, will not meet the objectives of the landowner, City of Cherryvale.

Options 2 and 3 do not include on-site disposal. However, the surface of the previously closed lagoon area will still be required to be raised by a minimum of 3 feet. This could only be accomplished under Option 2 or 3 by bringing clean soil from off site at an estimated additional cost of $2,012,500.

Options 3 and 4 are the same, but differ only in the disposal options, with off-site disposal being far more costly. Physically removing the soil material above the NRRSK and placing the excavated soil in an off-site landfill, or on a prepared on-site disposal area and capping, would provide the best long-term solution, would meet the goals of protecting surface water and groundwater, and would meet the goals on protecting human health and environment.

The disadvantages of disposing the material off site are several:

1. The excavated on-site soil will be needed to elevate the closed lagoon area before final capping.
2. There is an increased risk of traffic accidents and material releases in transporting the soils over the highway system to an off-site landfill. It is estimated that 5000 truck round trips will be required to transport the

impacted soils to the nearest landfill, which is approximately 75 miles away. In addition, there will be definite damage to roads and bridges resulting from heavy truck traffic.

3. The closest off-site landfill where the soils could be economically disposed of is approximately 75 miles from the Site. Additional pre-treatment of the soils may be required before the landfill can be used. The time required for pre-treatment and transportation will substantially lengthen the time required to implement the RA Plan.
4. Transporting the soil to an off-site landfill will result in significantly increased costs. See Page 39 for cost comparisons.
5. Transporting the soils to an off-site landfill presents the risk of additional liability for those soils in the event the landfill is improperly managed by the landfill operator.
6. The on-site disposal area designated for the excavated soils is the surface of the previously closed pond area. This area will continue to be subject to restricted covenants in any event, since waste material was placed there in 1979. Putting additional contaminated soils there will thus not results in an increase in the portions of the Site that must remain subject to restrictive covenants.
7. Utilizing the surface of the previously closed pond area will also meet the objective of eliminating the erosion of material below the old cap, and eliminating the potential for surface water penetration below the cap.
8. Removing material and disposing off site would require additional off site soil to be brought to the Site to raise the lagoon area.
9. Remove soil above NRRSK and dispose off site is far more costly than on-site disposal ($16,951,700 compared to $3,880,593).

In view of the foregoing disadvantages of off-site disposal, excavation of impacted soils and disposal on-site is the preferred alternative.

6.3.2 Evaluation of Removal Alternatives for Contaminated Soils Placed Within the EPA Repository:

Removal Action alternative methods for soil material located in the EPA Repository Area which exceed the NRRSK are:

1. Do nothing.
2. Cap and leave in place.
3. Remove soils above the NRRSK level and dispose off site.
4. Remove soils above the NRRSK level and dispose on-site.

The "Do Nothing" alternative is not considered a viable alternative. To leave the contaminated soil at the surface would result in surface water contamination and possible harm to the public and ecosystems via surface water pathways.

Capping and leaving in place is an environmentally acceptable option. The cap would consist of an 18" clay cap, and six inches of topsoil. However, the "Cap and Leave in Place" alternative would require restricted covenants to continue in that area limiting future development. Restricted areas can only be used as parking areas and, therefore, will not meet the objectives of the landowner, City of Cherryvale.

Options 2 and 3 do not include on-site disposal. However, the surface of the previously closed lagoon area will still be required to be raised by a minimum of 3 feet. This could only be accomplished under Option 2 or 3 by bringing clean soil from off site at an estimated additional cost of $2,012,500.

Removal of soils above the NRRSK and disposing off site or on-site are both equally environmentally acceptable methods. For the reasons discussed in Section 6.3.1 above excavation of contaminated soil and on-site disposal is the preferred alternative.

Soils underneath the off-site soils placed in the EPA Repository that exceed the Kansas NRSSK levels will be left in place, since they are covered by the off-site soils placed in the EPA Repository ranging from three to sixteen feet in depth.

6.4 Identification and Assessment of Applicable Removal Action Alternative for Contaminated Sediments:

6.4.1 Unnamed Creek:

The Applicable Removal Action Alternative Methods for contaminated sediments are:

1. Do nothing.
2. Remove visible sediments as outlined in Section 3.4.2 and dispose off site.
3. Remove visible sediments as outlined in Section 3.4.2 and dispose on-site.

Options 2 and 3 include removing the contaminated sediments above the NRRSK for all the heavy metals, disposing either on or off site, re-sampling the remaining soil, grading to proper drainage and re-vegetating. Option 2 or 3 would be a permanent solution that would be more favorable than Option 1 for public health and the environment. For the reasons set forth under Section 6.3.1 above, on-site disposal, Option 3, is the preferred alternative.

6.4.2 Drum Creek:

For the reasons stated in Section 3.4.2, it is recommended that no sediments be removed from Drum Creek.

6.5 Assessment of the Need for Groundwater Removal Action and Identification and Review of the Applicable Alternatives:

The off-site groundwater monitoring data establishes that no off-site groundwater removal action is required.

6.6 Comparison of Applicable Alternative Methods:

The candidate alternative methods for removal action listed above were compared in accordance with their cost, regulatory acceptability, implementability, meeting the Respondents' objectives, and other factors. Shown on Pages 39, 40, 41, and 42 are the estimated costs for implementation of each of the candidate alternative methods.

Presented on Page 43 is the comparison of all the identified candidate alternative removal alternatives utilized in choosing and proposing the preferred alternative.

COST ESTIMATES
NATINAL ZINC SITE
CHERRYVALE, KANSAS

ALTERNATIVES	AREAS OUTSIDE EPA REPOSITORY AND RAILROAD CORRIDOR	WITHIN THE EPA REPOSITORY AREA	SEDIMENT REMOVAL FROM UNNAMED CREEK	CAPPING POND SURFACE	TOTAL COST
Remove Soil Above NRRSK and Dispose On-Site [1]	2,280,900	89,600	175,000	1,335,093	3,880,593
Remove Soil Above NRRSK and Dispose Off-Site [1]	13,986,600	158,600	535,000	2,271,500	16,951,700
Cap and Leave In-Place [1]	2,738,293	143,107	175,000	2,271,500	5,327,900

[1] Backup calculations are provided on Pages 40, 41 and 42

CAP AND LEAVE IN-PLACE

		AMOUNT ($)
Areas Outside EPA Repository and Railroad Corridor		
Mobilization/Demobilization	=	14,000
Plot Grid System	=	20,000
Sampling and Testing	=	25,000
Cap: 59 acres x 43560/27 x 2' x $11.50/cy	=	2,189,293
Surface Drainage and Riprap	=	45,000
Seeding	=	55,000
QA/QC	=	140,000
Construction Supervision	=	65,000
Project Engineer	=	45,000
Surveying	=	40,000
As Built Drawings	=	10,000
Certification and Permitting	=	40,000
Fencing	=	50,000
Sub-Total		**2,738,293**
EPA Repository and Railroad Corridor		
Sampling and Testing	=	5,000
Cap: 1 acre x 43560/27 x 2' x $11.50/cy	=	37,107
Compaction	=	30,000
Surface Drainage and Riprap	=	5,000
Seeding	=	10,000
QA/QC	=	20,000
Construction Supervision	=	10,000
Project Engineer	=	5,000
Surveying	=	5,000
As Built Drawings	=	6,000
Certification	=	10,000
Sub-Total		**143,107**
Sediment Removal and On-Site Disposal from Unnamed Creek	=	**175,000**
Capping Pond Surface		
Material to Raise Pond Area by 3': 175,000 cy x $11.50/cy	=	2,012,500
Surface Drainage and Riprap	=	30,000
Seeding	=	44,000
QA/QC	=	40,000
Construction Supervision	=	40,000
Project Engineer	=	40,000
Surveying	=	20,000
Final Report, As-Built Drawings and Certification	=	45,000
Sub-Total		**2,271,500**
TOTAL		**5,327,900**

REMOVE SOILS ABOVE NRRSK AND DISPOSE OFF-SITE

		AMOUNT ($)
Areas Outside EPA Repository and Railroad Corridor		
Mobilization/Demobilization	=	14,000
Plotting Grid system	=	20,000
Testing to identify areas for excavation	=	30,000
Excavation, testing and loading of Contaminated Soil; 96,400 x $11/cy	=	,060,400
Transportation and Disposal: 96,400 cy x $120/cy	=	11,568,000
Final Grading	=	50,000
Place 1' Soil Cover: 63,000 cy x $10/cy	=	630,000
Surface Drainage and Riprap	=	25,000
Clay Cap: 10 acres x 1.5 ft x 43560/27 x $11.50/cy	=	266,200
Seeding	=	35,000
QA/QC	=	30,000
Surveying	=	13,000
As Built Drawings	=	30,000
Technician: 4 month x 200 HR/MONTH x $55/Hr	=	44,000
Laboratory	=	16,000
Construction Supervision	=	50,000
Project Engineer and Permitting	=	55,000
Fencing	=	50,000
Sub-Total		**13,986,600**
EPA Repository and Railroad Corridor		
Excavation, testing and loading of Contaminated Soil; 600 x $11/cy	=	6,600
Transportation and Disposal: 600 cy x $120/cy	=	72,000
Place Soil Cover: 2,000 cy x $10/cy	=	20,000
Compaction	=	30,000
Surface Drainage and Riprap	=	5,000
Seeding	=	5,000
Surveying	=	5,000
Construction Supervision	=	10,000
Project Engineer	=	5,000
Sub-Total		**158,600**
Sediment Removal and Off-Site Disposal from Unnamed Creek		
Sediment Removal	=	175,000
Transportation & Disposal 3,000 x $120/cy	=	360,000
Sub-Total	=	**535,000**
Capping Pond Surface		
Material to Raise Pond Area by 3': 175,000 cy x $11.50/cy	=	2,012,500
Surface Drainage and Riprap	=	30,000
Seeding	=	44,000
QA/QC	=	40,000
Construction Supervision	=	40,000
Project Engineer	=	40,000
Surveying	=	20,000
Final Report, As-Built Drawings and Certification	=	45,000
Sub-Total	=	**2,271,500**
TOTAL		**16,951,700**

COST ESTIMATE CALCULATIONS FOR
ALTERNATIVE REMOVAL ACTION METHODS

REMOVE SOILS ABOVE NRRSK AND DISPOSE ON-SITE

		AMOUNT ($)
Areas Outside EPA Repository and Railroad Corridor		
Mobilization/Demobilization	=	14,000
Haul Road Construction	=	16,000
Plotting Grid system	=	20,000
Testing to identify areas for excavation	=	30,000
Excavate and Transport Soil To Disposal Area; 99,400 x $7/cy	=	695,800
Place and Compact soil at Disposal Area: 99,400 x $2/cy	=	198,800
Final Grading	=	50,000
Place Soil Cover: 63,000 cy x $10/cy	=	630,000
Surface Drainage and Riprap	=	25,000
Clay Cap: 10 acres x 1.5 ft x 43560/27 x $11.50/cy	=	278,300
Seeding	=	35,000
QA/QC	=	30,000
Surveying	=	13,000
As Built Drawings	=	30,000
Technician: 4 month x 200 HR/MONTH x $55/Hr	=	44,000
Laboratory	=	16,000
Construction Supervision	=	50,000
Project Engineer and Permitting	=	55,000
Fencing	=	50,000
Sub-Total		**2,280,900**
EPA Repository and Railroad Corridor		
Excavation, testing and loading of Contaminated Soil; 600 x $11/cy	=	6,600
Compaction	=	30,000
Transportation and Disposal: 600 cy x $5/cy	=	3,000
Place Soil Cover: 2,000 cy x $10/cy	=	20,000
Surface Drainage and Riprap	=	5,000
Seeding	=	5,000
Surveying	=	5,000
Construction Supervision	=	10,000
Project Engineer	=	5,000
Sub-Total		**89,600**
Sediment Removal and On-Site Disposal from Unnamed Creek	=	**175,000**
Cap the Pond Surface:		
Cap over the excavated soil: 20 acres x 43560/27 x 2 ft x $11.50/cy	=	742,133
Raise 4 acres: 4 acres x 43560/27 x 4.5' x $11.50/cy	=	333,960
Surface Drainage and Riprap	=	30,000
Seeding	=	44,000
QA/QC	=	40,000
Construction Supervision	=	40,000
Project Engineer	=	40,000
Surveying	=	20,000
Final Report, As-Built Drawing and Certification	=	45,000
Sub-Total		**1,335,093**
TOTAL		**3,880,593**

CANDIDATE REMOVAL ACTION METHODS COMPARISON
FORMER NATIONAL ZINC SITE
CHERRYVALE, KANSAS

ACTION LOCATION	METHOD	REGULATORY ACCEPTABILITY	IMPLEMENTABILITY	MEETING RESPONDENT'S AND LAND OWNER'S OBJECTIVES	COST -$-	OTHER FACTORS	RECOMMENDATIONS
Areas Outside of EPA Repository Area and Active Rail Road Corridor	Cap and leave in place	Acceptable	Implementable. However, lagoon area will still be elevated for final capping, requiring off-site soil.	Respondent: Yes Land Owner: No Due to restrictive covenants	5,009,793.00	Capped areas (almost entire site) will require restrictive covenants to remain in place, which will limit future development.	Not Recommended
	Remove soils above NRRSK and dispose off-site	Acceptable	Not easily implementable. Due to the distance to the landfill.	Respondent: No Due to high cost and liabilities. Land Owner: Yes	16,258,100.00	On-site soil will be needed to elevate the lagoon area for final capping, risks of material release during transportation, and liability at the landfill	Not Recommended
	Remove soils above NRRSK and dispose on-site	Acceptable	Implementable.	Best meets objectives of Respondent and Land Owner.	3,615,993.00	Eliminates Risk and Liability	Recommended
Within the EPA Repository Area	Cap and leave in place	Acceptable	Implementable.	Respondent: Yes Land Owner: No Due to restrictive covenants	143,107.00	Will require restrictive covenant to remain, which will limit future development.	Not Recommended
	Remove soils above NRRSK and dispose off-site	Acceptable	Not easily implementable. Due to the distance to the landfill.	Respondent: No Due to high cost and liabilities. Land Owner: Yes	158,600.00	On-site soil will be needed to elevate the lagoon area for final capping, risks of material release during transportation, and liability at the landfill.	Not Recommended
	Remove soils above NRRSK and dispose on-site	Acceptable	Implementable.	Best meets objectives of Respondent and Land Owner.	89,600.00	Eliminates Risk and Liability	Recommended
Unnamed Creek	Remove visible sediments and dispose off-site	Acceptable	Not easily implementable. Due to the distance to the landfill.	Respondent: No Due to high cost and liabilities. Land Owner: Yes	535,000.00	On-site soil will be needed to elevate the lagoon area for final capping, risks of material release during transportation, and liability at the landfill	Not Recommended
	Remove visible sediments and dispose on-site	Acceptable	Implementable.	Best meets objectives of Respondent and Land Owner.	175,000.00	Eliminates Risk and Liability	Recommended

Note: No action is not considered a viable candidate alternative
Land Owner is the City of Cherryvale

6.7 Proposed Removal Action:

After a thorough review of technical, environmental, short-term and long-term risk factors, and the estimated costs for implementation of each alternative method listed in this report, Respondents recommend the Removal Action alternatives presented in this section. The proposed Removal Action alternatives include the following:

- Soils from those areas on the Site (outside the EPA Repository and outside the active rail line corridor) containing contaminants of concern in concentrations above the Kansas NRRSK levels (Lead 1000 mg/kg; Cadmium 1000 mg/kg; Arsenic 38 mg/kg) should be removed to a maximum depth of 18 inches, and the excavated soils should be consolidated on the former lagoon area on the west side of the Site.
    - Areas where soils are removed should be covered with a minimum of six inches of topsoil and graded for proper surface drainage.
    - Areas which continue to target above the Kansas NRRSK levels after removal to a depth of 18 inches should either be removed in additional six inch lifts to a depth at which the Kansas NRRSK levels are no longer exceeded, or should be covered with a cap consisting of 18 inches of clay plus six inches of top soil and continue to be subject to restrictive covenants as to future use.
- Soils placed in the EPA Repository should be left undisturbed, except for one small area around sampling point #18 where the soils exceed the Kansas NRRSK levels. The soils in that area which exceed the NRRSK levels should be excavated and consolidated onto the former lagoon area. The remaining soil material in the EPA Repository should be compacted from the surface and left in place.
    - In view of the depth of the EPA Repository material, any soils beneath the soils placed in the EPA Repository which contain contaminants of concern in concentrations exceeding the Kansas NRRSK levels should be left undisturbed.

- The on-site disposal facility which will be located on top of the former lagoon area will receive excavated soils and sediments and after proper grading will be capped with 18 inches of compacted clay followed with 6 inches of topsoil and proper seeding. The engineering design of the on-site disposal facility, including the engineering specifications and QA/QC plans, will be competed and presented in the RA Work Plan.
- The elevation of that portion of the former lagoon area which will receive excavated soils and sediments and be covered by an 18" clay cap and 6" of topsoil should be raised to prevent groundwater and surface water interaction. The entire surface of the former lagoon area should be raised a minimum of at least three feet in order to prevent interfacing between the groundwater and surface water.
- The existing cap on the former lagoon area should be repaired as needed, and the entire area recontoured to provide proper drainage.
- No action should be taken regarding down gradient groundwater, inasmuch as the groundwater is not impacted by contaminants of concern.
- The visible sediments in the pathway of Unnamed Creek between the west boundary of the Site and Drum Creek should be removed and consolidated onto the former lagoon area as outlined in Section 3.4.2 of this RAD.
- No action should be taken regarding any sediments in Drum Creek in view of the fact that the water quality in Drum Creek is essentially not impacted by contaminants of concern, and sediment removal could be more harmful than leaving the sediments in place.
- All permits required for implementation of the RA Work Plan, including the Army Corps of Engineers Section 404 Permit for removal of sediment from the Unnamed Creek, will be obtained prior to the start of construction activities.

6.8 Soil Removal:

Sections 6.7 and 6.8 of this RAD Report describe in more detail the components of the proposed Removal Action alternative for impacted on-site soils and sediments from the Unnamed Creek.

The proposed soil removal alternative includes the total or partial removal of Site soils exceeding the NRRSK and disposal of the excavated soils at an on-site disposal facility.

The on-site disposal facility will be placed on the surface of the previously closed lagoon area. The following presents a list of the steps that will be employed in soil removal:

- Determine the extent of contamination by analysis.
- Determine areas to be removed.
- Remove the top six inches of specified areas.
- Sample the next six inches for determining if additional excavation is needed.
- If below NRRSK, place a minimum of six inches of clean soil over the excavated areas, grade and re-vegetate.
- If above NRRSK, remove an additional six inches and re-sample.
- Repeat the previous two steps until 18 inches of surface soil material is removed, if required.
- Determine the areas where more than 18 inches of surface soil excavation is needed
- Determine whether to continue excavating below 18 inches with 6 inch increments or to cap and leave in place.

The excavated soils will be physically removed and hauled onto the area designated for on-site disposal of excavated soils. The on-site disposal facility, following the placement and grading of the disposed soils and sediments, will be capped with 18 inches of compacted clay liner followed with 6 inches of topsoil and proper seeding.

To prevent interfacing between surface water and groundwater, the entire former lagoon area, including the disposal facility, will be elevated a minimum of three feet.

The excavated areas will be covered with a minimum of six inches of clean soil, graded for proper drainage and seeded. The areas that require more soil for proper drainage will receive additional soil and be properly graded.

The following presents a list of steps that will be used in removal and disposal of soil material from the EPA Repository:

- Conduct soil sampling around sampling point #18 to determine the boundaries of soil material to be excavated.
- Remove the soil material exceeding the NRRSK.
- Conduct confirmatory sampling to assure that all of the soil material exceeding NRRSK is removed.
- Grade the excavated area and re-vegetate.

6.9 Sediment Removal:

All of the visible sediments removed from Unnamed Creek will be placed onto the prepared area in the former lagoon area for placement and clay capping. The amount of sediments to be removed is estimated to be approximately 2,500 cubic yards. There are isolated pockets of shallow surface water in varying locations along Unnamed Creek. These have been created by erosion or by agricultural equipment moving through the area. These small isolated pockets will be graded when the sediments are removed to prevent water ponding in the future. Listed below are the Removal Action steps for this alternative for Unnamed Creek.

- Remove all visible sediments as outlined in Section 3.4.2 in this RAD.
- Place the sediments in the former lagoon area to be clay capped.

- Grade areas of Creek bed with clean soil where grading is necessary to maintain slope.

6.10 Proposed Removal Action Plan with Tasks and The Sequence of Implementation:

The Consent Order provides that upon approval of this RAD Report by KDHE, including any revisions required to address KDHE comments, the revised RAD Report will be incorporated into the Consent Order as Exhibit 5 thereto.

The Consent Order further requires that within 30 days after KDHE issues its final Removal Action Decision, the Respondents are required to submit a draft RA Plan to KDHE. Within 30 days after KDHE provides its comments on the draft RA Plan, the Respondents are required to submit a revised RA Plan to KDHE, which addresses KDHE's comments. Upon KDHE approval, the revised RA Plan will be incorporated into the Consent Order as Exhibit 6 thereto.

Implementation of the RA Plan will proceed in accordance with the following schedule of Tasks:

Task 1:	Develop and submit a Work Plan to KDHE for RA Plan implementation. Prepare revised Work Plan to address KDHE comments. Obtain needed access and permits. Negotiations regarding performance of RA Work Plan with KDHE as required by the Consent Order. Obtain permits and complete access agreements.
Task 2:	Prepare bid documents, conduct pre-bid job walk and obtain bids.
Task 3:	Award RA contract.
Task 4:	Mobilization.
Task 5:	Flag the Site grid system.
Task 6:	Conduct Site soil sampling to verify boundaries of the contaminated areas.

Task 7: Conduct soil sampling at the EPA Repository Area around sampling point #18.

Task 8: Develop maps outlining the boundaries of the contaminated areas at the Site for contaminated soil removal, including the EPA Repository.

Task 9: Obtain permit for borrow area and conduct geotechnical testing.

Task 10: Mobilize equipment.

Task 11: Prepare on-site disposal area to receive contaminated soil and sediments.

Task 12: Prepare borrow area for operations.

Task 13: Start excavation of soils above the NRRSK from Site.

- 13.1 Remove top six inches of specified areas.
- 13.2 Sample the next six inches to determine if additional excavation is needed.
- 13.3 Below NRRSK, place minimum of six inches of clean soil over the excavated areas, grade and re-vegetate.
- 13.4 Above NRRSK, remove additional six inches and resample.
- 13.5 Repeat the above steps until 18 inches of soil material is removed.
- 13.6 Determine areas where soil excavation will be carried below 18 inches.
- 13.7 Continue excavation below 18 inches, if needed, using the established procedures described above.
- 13.8 Determine the areas where capping and restrictive covenants will be necessary.

Task 14: Start contaminated soil excavation from EPA Repository Area.

- 14.1 Remove soil material exceeding the commercial NRRSK.
- 14.2 Conduct confirmatory sampling to assure that all of the soil material exceeding NRRSK is removed.

Task 15: Grade excavated areas with clean soil and re-vegetate.

Task 16: Cap and vegetate the areas where impacted soils below the 18-inch depth will be left in place.

Task 17: Flag areas for sediment removal in the Unnamed Creek surface water pathway.

Task 18: Remove sediments and transport to on-site disposal area.

Task 19: Grade and backfill, as appropriate, the excavated areas in the Unnamed Creek drainage area.

Task 20: Cap and re-vegetate the on-site disposal area and construct fence.

Task 21: Implement land reclamation plan at borrow area and re-vegetate.

Task 22: Demobilization.

Task 23: Prepare As-built Drawings and Certification Document for job Completion. Includes development of a Post-Closure Care Plan.

6.11 Schedule for Implementing the Proposed Removal Action Plan:

Respondents estimated schedule for implementing the RA Work Plan is as shown on Page 52, subject to adjustment for seasonal construction factors.

6.12 Mitigative Measures During Construction

During the construction of the preferred removal alternative, certain construction activities may impact the environment. These activities and the proposed mitigative measures are identified below:

1. Excavation of the Contaminated Soil Material

   During the excavation of the contaminated soils, potential environmental impacts will be dust generated by these activities and rainfall over the disturbed areas.

   Mitigative measures to be applied include: spray of water for dust control and controlling the run-off during the rain events. The storm run-off management plan, which will be developed for construction activities, will address the mitigative measures for erosion control and prevention of contaminated run-off from disturbed areas leaving the work area.

2. Other earthwork activities including placement of excavated contaminated soil material, placement of soil and clay cap, excavation and transportation

   of borrow material, and other construction activities associated with the project.

The mitigative measures will be the same as listed above.

3. During the Removal of the Sediments from Unnamed Creek

The sediment removal from Unnamed Creek will be carried out during the dry season. For dust control, when required, there will be spraying of water. In order to control the transportation of sediments from the excavation areas in a downstream direction, the excavation areas will be protected from potential stream flow by placement of earth dikes or placement of temporary culverts.

4. Domesticated animals entering the work areas.

Efforts will be made with the adjacent property owners to keep the domesticated animals out of the Site in separate fields and away from the Site.

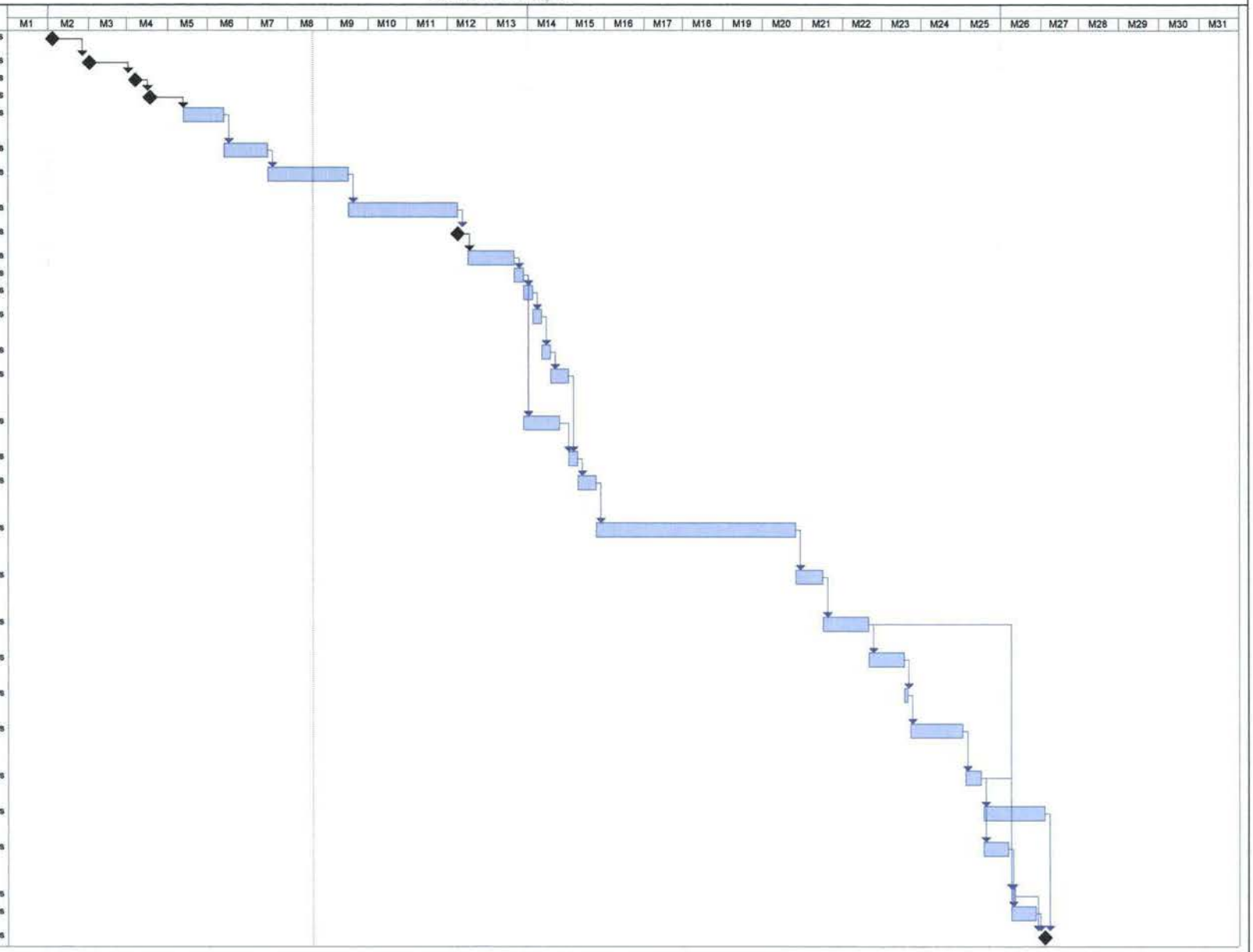
During the construction activities, all necessary mitigative measures in addition to those listed above will be implemented in order to minimize the potential impact from the project on the environment.

6.13 Protection of the Site Following Completion of RA Construction

The areas that will require protection after completion of the RA construction include the disposal area and the areas with continuing restrictive covenants. The disposal area will be fenced in with a 6 feet chain link fence and with a minimum of two gates to provide access to the disposal area.

PROJECT SCHEDULE
PROPOSED REMOVAL ACTION METHODS
NATIONAL ZINC SITE
CHERRYVALE, KANSAS

ID	Task Name	Duration
1	KDHE Removal Action Decision	0 days
2	Submit Draft RA Plan	0 days
3	Finalize RA Plan	0 days
4	RA Implementation Start	0 days
5	Task 1: Develop and Submit a RA Work Plan to KDHE	23 days
6	Task 1: KDHE Approval of the RA Work Plan	23 days
7	Task 1: Negotiate with KDHE the Implementation of the RA Work Plan	44 days
8	Obtain Permits and Complete Access Agreements	60 days
9	Task 2: Prepare and Send Bid Packages to Bidders	0 days
10	Task 3: Contract Award	25 days
11	Task 4: Mobilization	5 days
12	Task 5: Flag the Grid System	5 days
13	Task 6: Conduct Soil Sampling at National Zinc Site	5 days
14	Task 7: Conduct Soil Sampling at EPA Repository Area	5 days
15	Task 8: Receive Test results and Develop Maps of the Contaminated Areas	10 days
16	Task 9: Permitting Borrow Areaand Conduction Geotechnical Testing	20 days
17	Task 10: Mobilization of Equipment	5 days
18	Task 11 & 12: Prepare Borrow Area and on-site Contaminated Soil Disposal Area	10 days
19	Task 13: Excavate National Zinc Site, Sample, Test and Fill with Clean Soil	110 days
20	Task 14: Excavate EPA Repository Site, Sample, Test and Fill with Clean Soil	15 days
21	Task 15: Grade Excavated Areas with Clean Soil and Vegetate	25 days
22	Task 16: Cap and Vegetate the Areas where Impacted Soil Below 18" depth	20 days
23	Task 17: Flag Areas of Contaminated Sediment in the Unnamed Creek	3 days
24	Task 18: Remove Cotaminated Sediments and Transport to On-site Disposal Area	30 days
25	Task 19: Grade the Excavated Areas in the Unnamed Creek Area	10 days
26	Task 20: Cap and Vegetate On-site Disposal Area and Fence	35 days
27	Task 21: Implement Land Reclamation Plan at Borrow Area and Vegetate	15 days
28	Task 22: Demobilization	3 days
29	Task 23: Prepare As Built Drawings	15 days
30	Project Completion	0 days



Project: Project Schedule5-20-03A
Date: Tue 7/20/04

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress | Split | External Tasks | Project Summary | Group By Summary

Note: Duration represent work days (Monday through Friday)

TABLES

Table 1

Sediment Samples from Unnamed Creek near the National Zinc Site - Cherryvale, Kansas

Sample	Mercury (mg/Kg)	Arsenic (mg/Kg)	Cadmium (mg/Kg)	Chromium (mg/Kg)	Lead (mg/Kg)	Zinc (mg/Kg)	pH
S-1	0.059	21.20	20.60	11.20	163.00	1470.0	6.90
S-2	0.070	41.50	32.50	11.30	233.00	2150.0	6.81
S-3	0.086	15.80	44.80	11.00	189.00	3290.0	7.45
S-4	0.240	40.30	51.60	12.80	546.00	11900.0	7.22
S-22	0.098	23.20	333.00	17.40	606.00	14600.0	7.67
S-5	0.560	37.80	704.00	19.00	1190.00	16500.0	7.47
S-6	0.170	5.94	68.70	7.68	238.00	2850.0	7.45
S-19	0.046	18.00	511.00	15.60	368.00	32900.0	7.70
S-18	0.088	58.10	177.00	9.49	192.00	3600.0	7.38
S-9	0.160	15.20	79.30	13.20	145.00	2170.0	7.48
S-8	0.064	0.92	23.50	6.96	9.42	1010.0	7.38
S-7-D1	0.130	30.70	430.00	14.00	473.00	10300.0	7.43
S20-BG1	0.089	6.97	3.98	14.10	22.40	131.0	7.79
S21-BG2	<0.025	11.90	8.94	25.40	70.30	59.6	7.83

Table 2

Sediment Samples from Drum Creek near the National Zinc Site - Cherryvale, Kansas

Sample	Mercury (mg/Kg)	Arsenic (mg/Kg)	Cadmium (mg/Kg)	Chromium (mg/Kg)	Lead (mg/Kg)	Zinc (mg/Kg)	pH
S-15-D8	0.038	2.30	1.80	8.68	8.87	49.9	7.46
S-14-D7	0.052	1.81	1.70	8.20	16.00	81.2	7.06
S-14-D6	0.180	3.17	2.55	9.70	24.50	94.6	7.17
S-10-D2	0.086	7.16	4.63	13.90	20.60	78.8	6.40
S-11-D3	0.099	11.40	90.40	11.70	144.00	3680.0	7.16
S-12-D4	0.120	13.90	73.00	13.50	223.00	5950.0	7.50
S-13-D5	0.100	8.84	71.10	18.60	109.00	1520.0	7.36
S-16-D9	0.046	1.66	1.77	8.86	10.10	49.6	7.22
S-17-D10	0.051	18.50	14.30	11.60	48.20	517.0	7.03
S20-BG1	0.089	6.97	3.98	14.10	22.40	131.0	7.79
S21-BG2	<0.025	11.90	8.94	25.40	70.30	59.6	7.83

Table 3

Water Samples from Unnamed Creek near the National Zinc Site - Cherryvale, Kansas

Sample	Hardness (mg/L)	Mercury (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Zinc (mg/L)	Suspended Solids (mg/L)
W-1	1600	<0.000100	<0.00500	0.039	<0.0100	<0.00500	1.6300	10
W-2	910	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.7910	<5.00
W-17	470	0.0002	<0.00500	0.498	0.0365	0.585	35.9000	3780
W-3	280	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.6950	7
W-16	320	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.2860	18
W-6	300	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.3540	<5.00
W-5	310	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.2240	<5.00
W-4-D1	240	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.0322	10

Table 4

Water Samples from Drum Creek near the National Zinc Site - Cherryvale, Kansas

Sample	Hardness (mg/L)	Mercury (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Zinc (mg/L)	Suspended Solids (mg/L)
W-13-D8	220	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	<0.0100	79
W-12-D7	250	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	<0.0100	<5.00
W-11-D6	230	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	<0.0100	16
W-7-D2	240	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	<0.0100	7
W-8-D3	240	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	<0.0100	33
W-9-D4	230	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.1320	58
W-10-D5	240	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.0544	130
W-14-D9	250	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	<0.0100	60
W-15-D10	220	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.0204	189

TABLE 5
WATER QUALITY ANALYTICAL DATA
DRUM CREEK

SAMPLING POINT	DATE	MERCURY	ARSENIC	CADMIUM	CHROMIUM	LEAD	ZINC	SAMPLING LOCATION
1	6/24/03	BDL	BDL	BDL	BDL	BDL	BDL	W13-D8
2	6/24/03	BDL	BDL	BDL	BDL	BDL	BDL	W12-D7
3	6/24/03	BDL	BDL	BDL	BDL	BDL	BDL	W11-D6
4	6/24/03	BDL	BDL	BDL	BDL	BDL	BDL	W7-D2
5	1/30/04	BDL	BDL	BDL	0.027	BDL	BDL	Upstream same location as #4
6	1/30/04	BDL	BDL	BDL	0.024	0.00938	0.034	Effluent
7	6/24/03	BDL	BDL	BDL	BDL	BDL	0.0322	W4-D1
8	1/30/04	BDL	BDL	0.0112	0.0961	0.0358	1.07	(Confluence) same location as #7
9	6/24/03	BDL	BDL	BDL	BDL	BDL	0.132	W8-D3
10	1/30/04	BDL	BDL	BDL	0.069	0.0251	0.0152	75 Ft downstream same as #9
11	6/24/03	BDL	BDL	BDL	BDL	BDL	0.132	W9-D4
12	6/24/03	BDL	BDL	BDL	BDL	BDL	0.0544	W10-D5
13	6/24/03	BDL	BDL	BDL	BDL	BDL	BDL	W14-D9
14	6/24/03	BDL	BDL	BDL	BDL	BDL	0.0204	W15-D10
15	1/30/04	BDL	BDL	BDL	0.028	BDL	0.0205	Low water crossing Same location as #14
16	3/1/04	BDL	BDL	BDL	BDL	BDL	BDL	Low water crossing same Location as #14 and 15
17	1/30/04	BDL	BDL	BDL	0.028	BDL	0.036	300 Ft below low water crossing
18	3/1/04	BDL	BDL	BDL	BDL	BDL	BDL	300 Ft below low water crossing same as #17
19	3/1/04	BDL	BDL	BDL	BDL	BDL	BDL	2 miles downstream

* Blue indicates low water levels and is reported in the Analytical Report
* Red indicates high water levels
* Black indicates normal water levels
Note: Parameters are in mg/L

MCL's

0.002	0	0.005	0.1	0	5

TABLE 6
SEDIMENT ANALYTICAL DATA
DRUM CREEK

SAMPLING POINT	DATE	MERCURY	ARSENIC	CADMIUM	CHROMIUM	LEAD	ZINC	SAMPLING LOCATION
1	6/24/03	0.038	2.3	1.8	8.68	8.87	49.9	S15-D8
2	6/24/03	0.052	1.81	1.7	8.2	16	81.2	S14-D7
3	6/24/03	0.18	3.17	2.55	9.7	24.5	94.6	S14-D6
4	6/24/03	0.086	7.16	4.63	13.9	20.6	78.8	S10-D2
5	6/24/03	0.13	30.7	430	14	473	10,300	(Confluence) S7-D1
6	6/24/03	0.099	11.4	90.4	11.7	144	3,680	S11-D3
7	6/24/03	0.12	13.9	73	13.5	223	5,950	S12-D4
8	6/24/03	0.1	8.84	71.1	18.6	109	1,520	300 Ft downstream from #5 S13-D5
9	6/24/03	0.046	1.66	1.77	8.86	10.1	49.6	Main Street bridge S16-D9
10	6/24/03	0.051	18.5	14.3	11.6	48.2	517	Low water crossing S17-D10
11	1/30/04	BDL	6.76	2.99	14.6	9.73	24.9	300 Ft below low water crossing

Note: Parameters are in mg/L

TABLE 7

Aquatic Life Support Criteria Calculations Based on K.A.R. 28-16-28

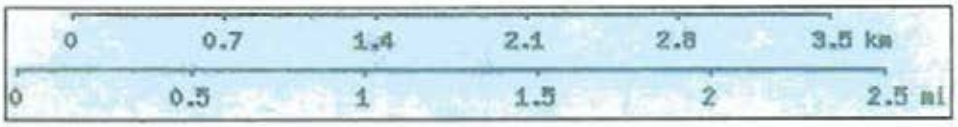
Sample ID	WER	Hardness (mg/L)	Cadmium (µg/L)	Acute Criterion	Chronic Criterion	Chromium (µg/L)	Acute Criterion	Chronic Criterion
W7-D2	1	240		12.1	4.90		3693	177
W7-D2 (H)	1	**240**		12.1	4.90	27	3693	177
Effluent	1	***220***		11.0	4.57	24	3439	164
W4-D1	1	240		12.1	4.90		3693	177
W4-D1 (H)	1	**240**	11.2	12.1	4.90	96.1	3693	177
W8-D3	1	240		12.1	4.90		3693	177
W8-D3 (H)	1	**240**		12.1	4.90	69	3693	177
W9-D4	1	230		11.6	4.73		3567	170
W10-D5	1	240		12.1	4.90		3693	177
W14-D9	1	250		12.7	5.06		3819	183
W15-D10	1	220		11.0	4.57		3439	164
W15-D10 (H)	1	**220**		11.0	4.57	28	3439	164
LWC-300	1							

Sample ID	WER	Hardness (mg/L)	Lead (µg/L)	Acute Criterion	Chronic Criterion	Zinc (µg/L)	Acute Criterion	Chronic Criterion
W7-D2	1	240		249	9.7		252	252
W7-D2 (H)	1	**240**		249	9.7		252	252
Effluent	1	***220***	9.38	223	8.7	34	234	234
W4-D1	1	240		249	9.7	32.2	252	252
W4-D1 (H)	1	**240**	35.8	249	9.7	1070	252	252
W8-D3	1	240		249	9.7	132	252	252
W8-D3 (H)	1	**240**	25.1	249	9.7	15.2	252	252
W9-D4	1	230		236	9.2	132	243	243
W10-D5	1	240		249	9.7	54.4	252	252
W14-D9	1	250		262	10.2		260	260
W15-D10	1	220		223	8.7	20.4	234	234
W15-D10 (H)	1	**220**		223	8.7	20.5	234	234
LWC-300								

FIGURES

CHERRYVALE QUADRANGLE
MONTGOMERY COUNTY, KANSAS

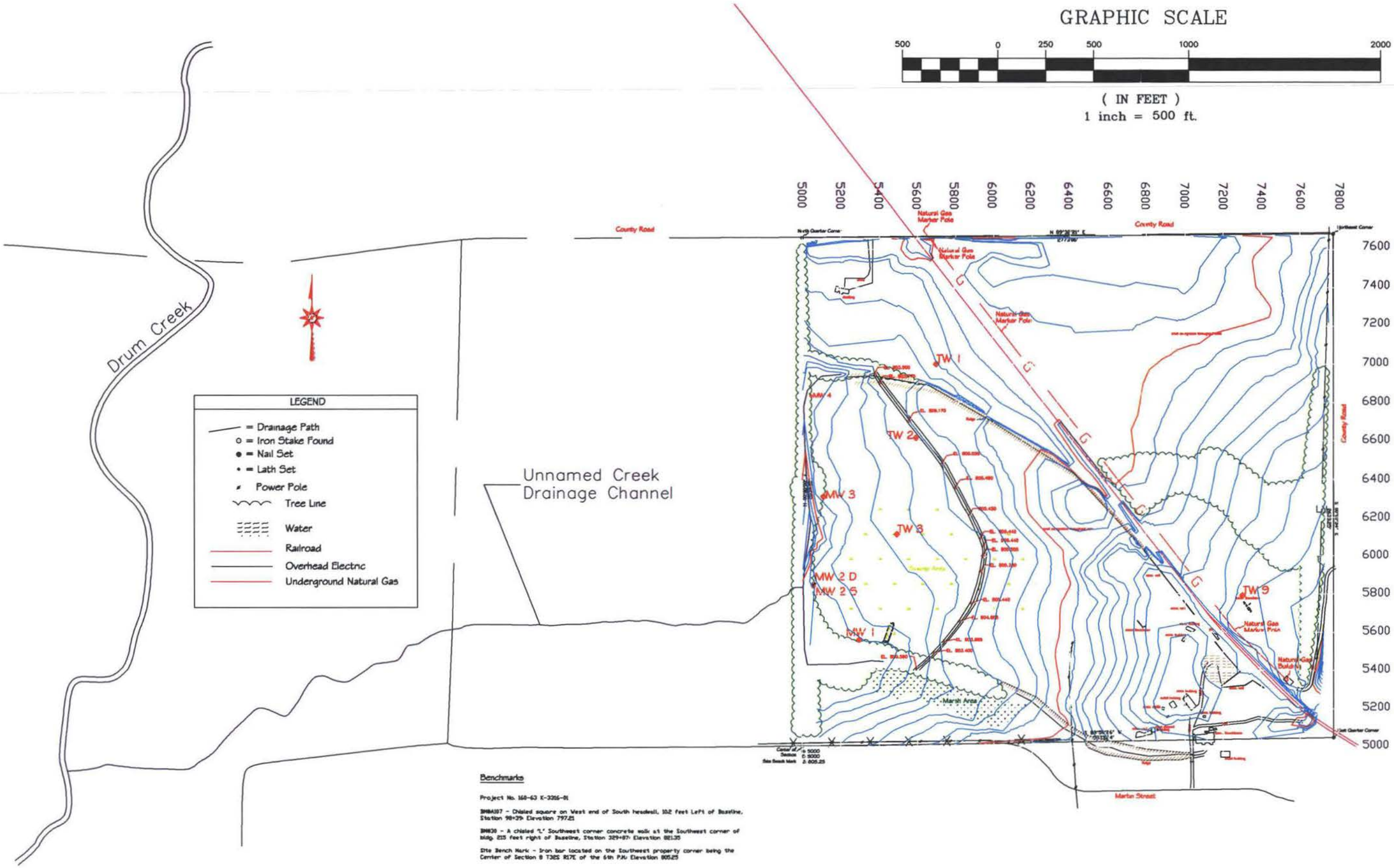
SCALE



A & M ENGINEERING AND
ENVIRONMENTAL SERVICES, INC.

ENGINEERING — ENVIRONMENTAL — CONSTRUCTION

LOCATION MAP		
SCALE: AS SHOWN	DATE: 11/17/03	FIGURE NO. FIGURE 1
APPROVED BY: IT	DRAWN BY: TME	PROJECT NO. 1804-002



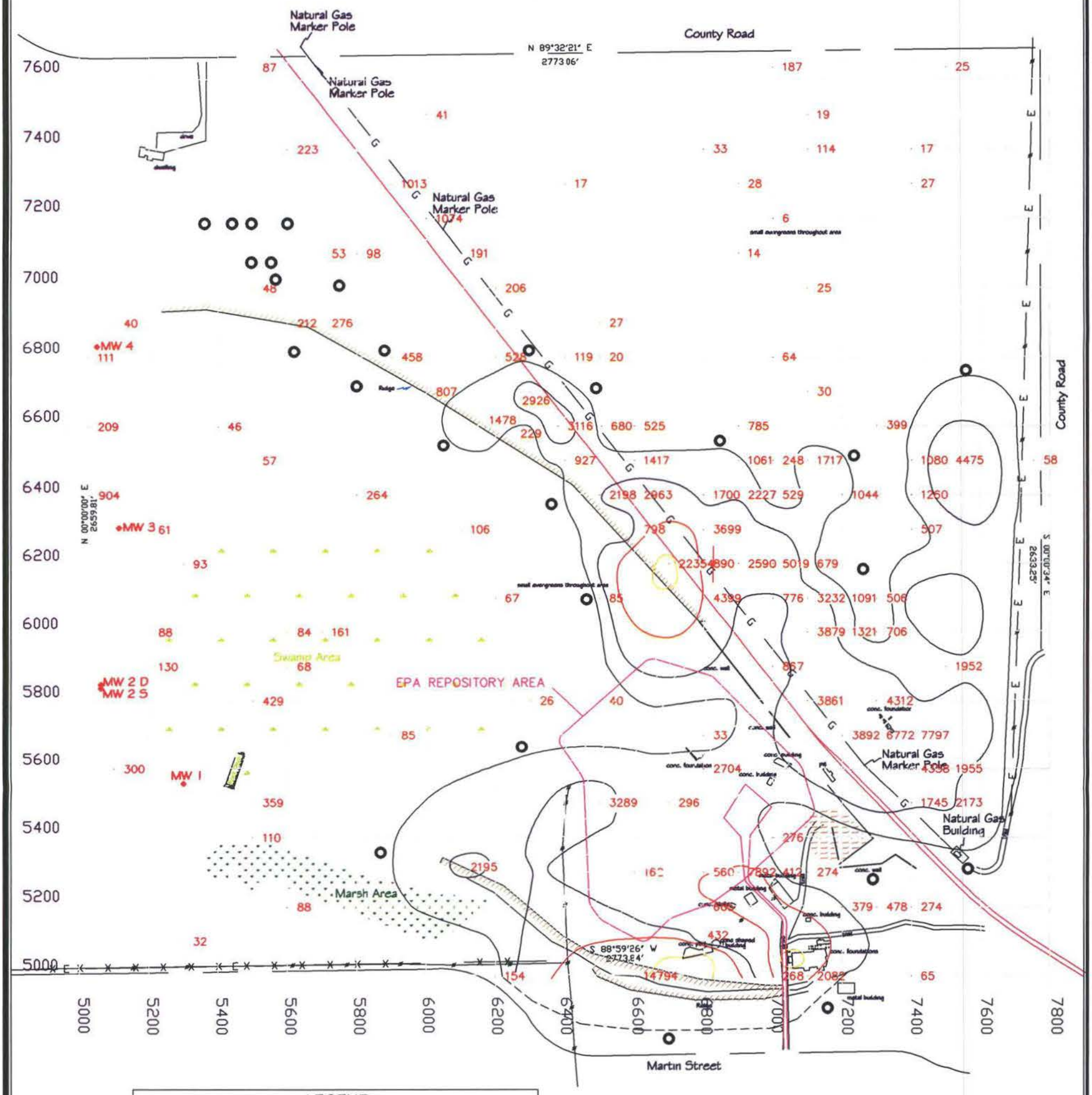
A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

SCALE:	DATE:	FIGURE NO.
1"=500'	03/25/02	2
APPROVED BY: AME	DRAWN BY: JDA	PROJECT NO.

BASE MAP

NATIONAL ZINC SITE
CHERRYVALE, KANSAS



LEGEND

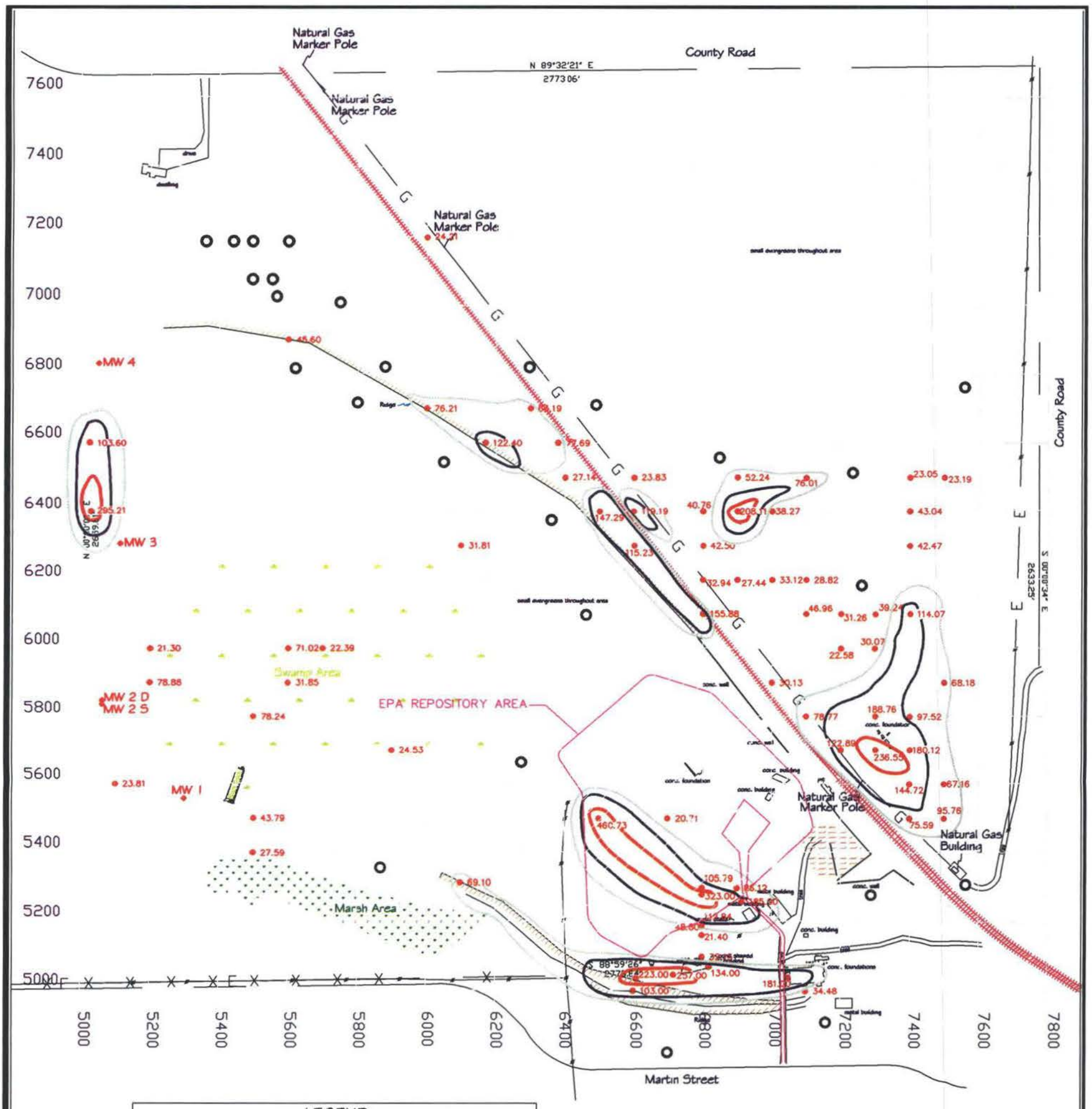
14794 = Sample Location & Concentration (mg/kg)
= 1000 mg/kg Isocontour
= 2000 mg/kg Isocontour
= 5000 mg/kg Isocontour
= 20000 mg/kg or greater Isocontour
• = Lath Set
O = Proposed sample locations
Power Pole
Tree Line
Water
Railroad
E Overhead Electric
G Underground Natural Gas

LEAD
RSK = 1000 mg/Kg
RSK = RISK BASED STANDARD FOR KANSAS

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

KDHE LABORATORY RESULTS & ISOCONCENTRATIONS FOR LEAD
NATIONAL ZINC SITE, CHERRYVALE, KANSAS

SCALE:	DATE:	FIGURE NO.
1" = 300'	3-27-2002	3
APPROVED BY: AME	DRAWN BY: JDA	PROJECT NO.



LEGEND

- 43.79 = State Surface Sampling Location and Concentrations (mg/kg)
- = 50 mg/kg Isocontour
- = 100 mg/kg Isocontour
- = 200 mg/kg Isocontour
- • = Lath Set
- O = Proposed Sample Locations
- ø Power Pole
- Tree Line
- Water
- Railroad
- —— E —— Overhead Electric
- —— G —— Underground Natural Gas

CADMIUM

RSK = 1000 mg/Kg

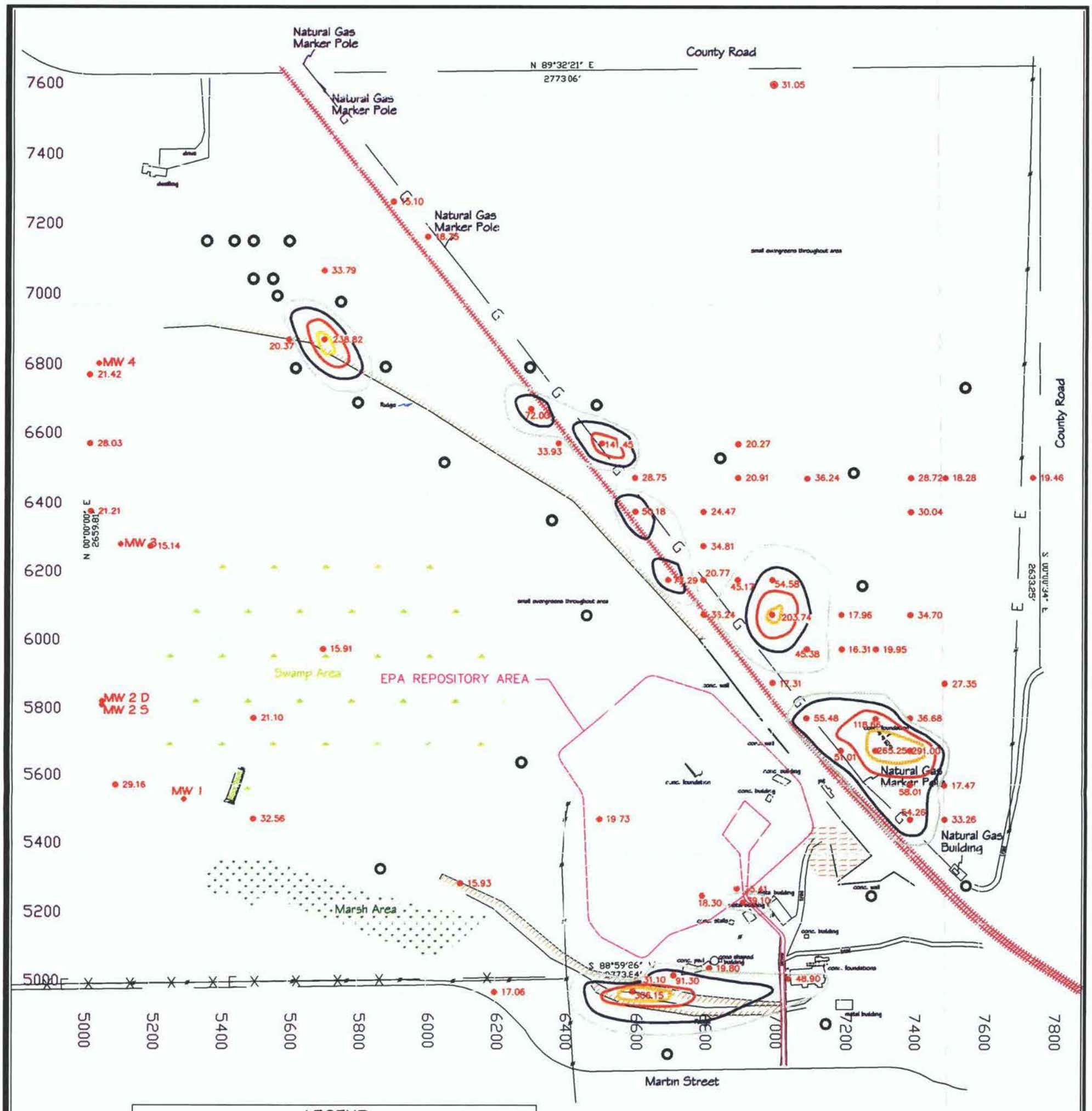
RSK = RISK BASED STANDARD FOR KANSAS

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

KDHE LABORATORY RESULTS & ISOCONCENTRATIONS OF CADMIUM
NATIONAL ZINC SITE, CHERRYVALE, KANSAS

SCALE:	DATE:	FIGURE NO.
1" = 300'	3-27-2002	3-1
APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.



LEGEND

- 17.06 = Sample Location & Concentration (mg/kg)
- = 38 mg/kg Isocontour
- = 50 mg/kg Isocontour
- = 100 mg/kg Isocontour
- = 200 mg/kg Isocontour
- = Lath Set
- = Proposed Sample Locations
- Power Pole
- Tree Line
- Water
- Railroad
- E — Overhead Electric
- G — Underground Natural Gas

ARSENIC

RSK = 38 mg/Kg

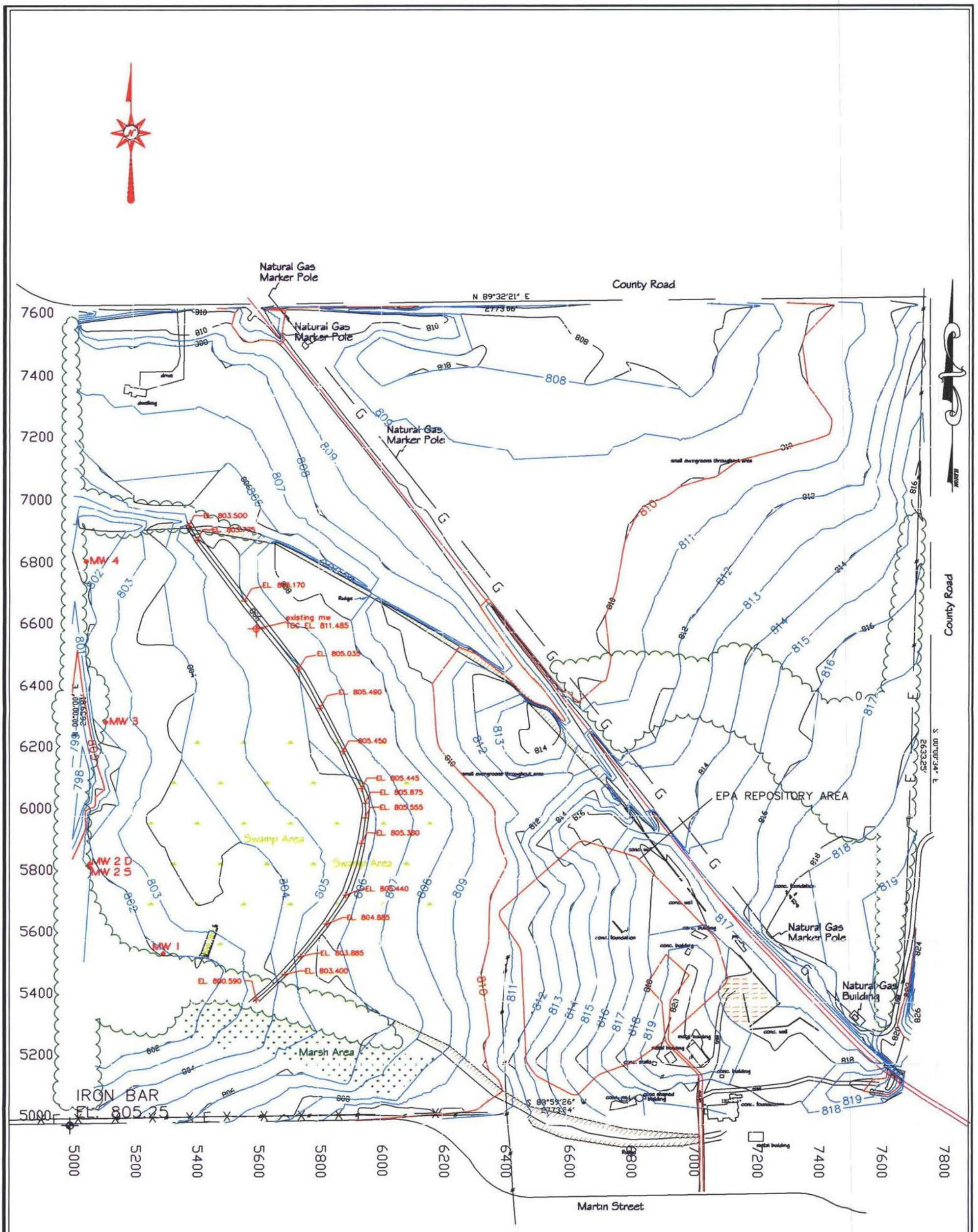
RSK = RISK BASED STANDARD FOR KANSAS

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

KDHE LABORATORY RESULTS & ISOCONCENTRATIONS OF ARSENIC
NATIONAL ZINC SITE, CHERRYVALE, KANSAS

SCALE:	DATE:	FIGURE NO.
1" = 300'	9/10/2002	3-2
APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.



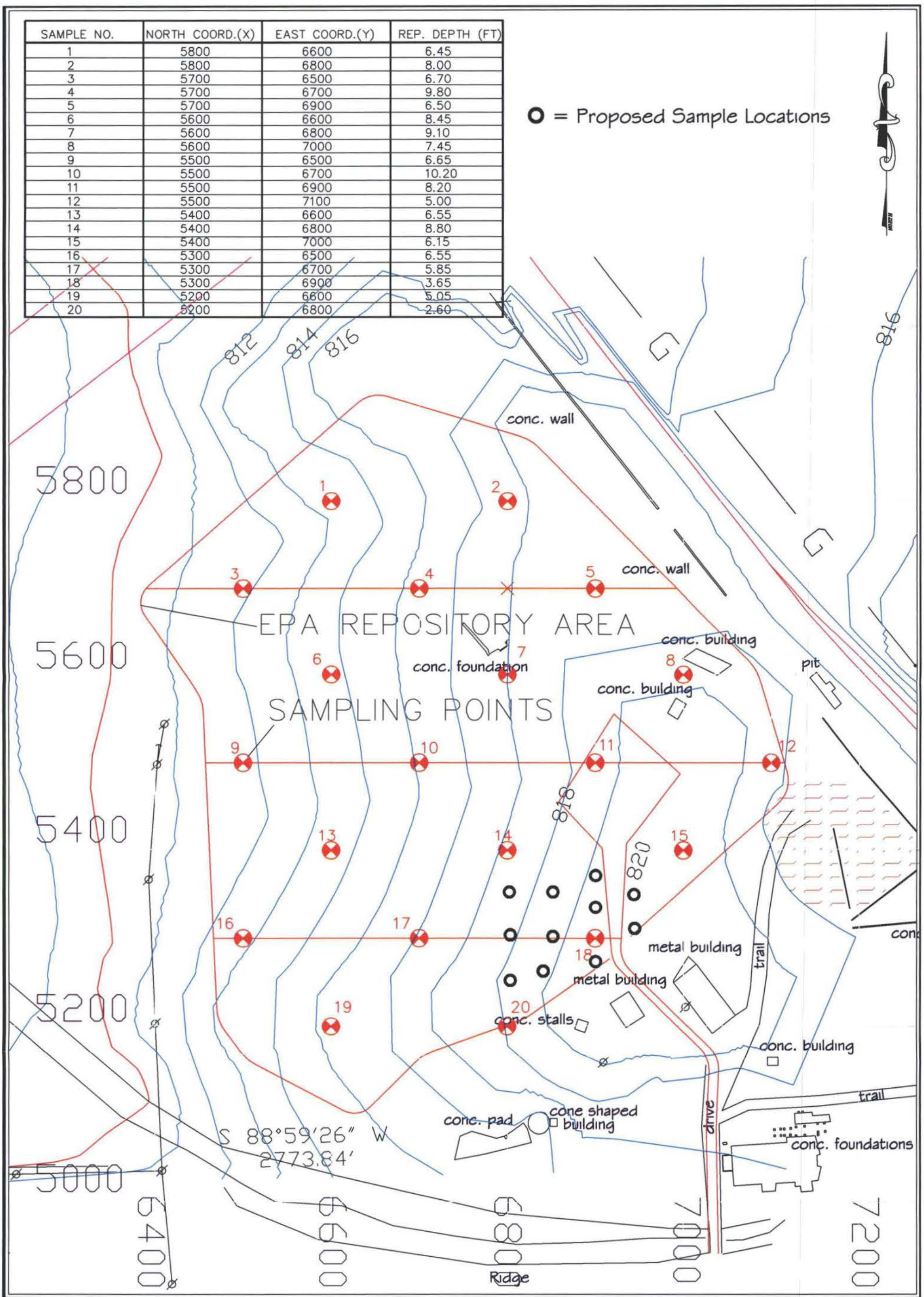
A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

EPA REPOSITORY AREA LOCATION
NATIONAL ZINC SITE, CHERRYVALE, KANSAS

SCALE:	DATE:	FIGURE NO.
1" = 300'	1-7-2004	4
APPROVED BY: AME	DRAWN BY: OME	PROJECT NO.

SAMPLE NO.	NORTH COORD.(X)	EAST COORD.(Y)	REP. DEPTH (FT)
1	5800	6600	6.45
2	5800	6800	8.00
3	5700	6500	6.70
4	5700	6700	9.80
5	5700	6900	6.50
6	5600	6600	8.45
7	5600	6800	9.10
8	5600	7000	7.45
9	5500	6500	6.65
10	5500	6700	10.20
11	5500	6900	8.20
12	5500	7100	5.00
13	5400	6600	6.55
14	5400	6800	8.80
15	5400	7000	6.15
16	5300	6500	6.55
17	5300	6700	5.85
18	5300	6900	3.65
19	5200	6600	5.05
20	5200	6800	2.60

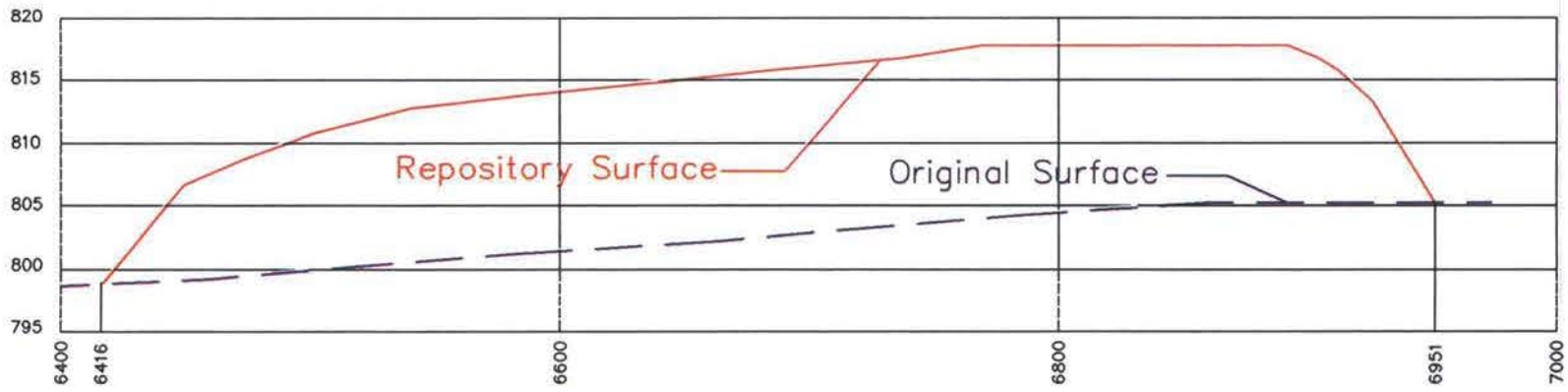


A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

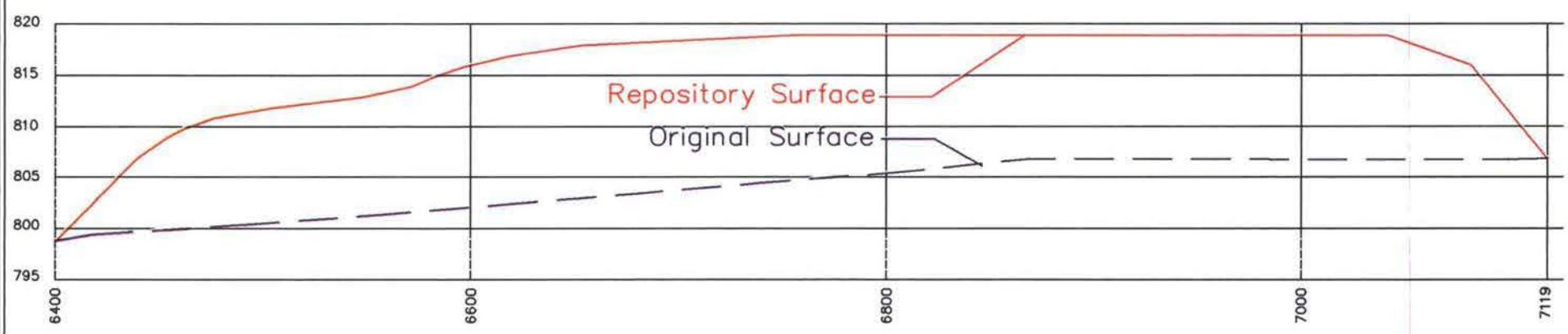
ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

EPA REPOSITORY AREA SAMPLING LOCATIONS
NATIONAL ZINC SITE, CHERRYVALE, KANSAS

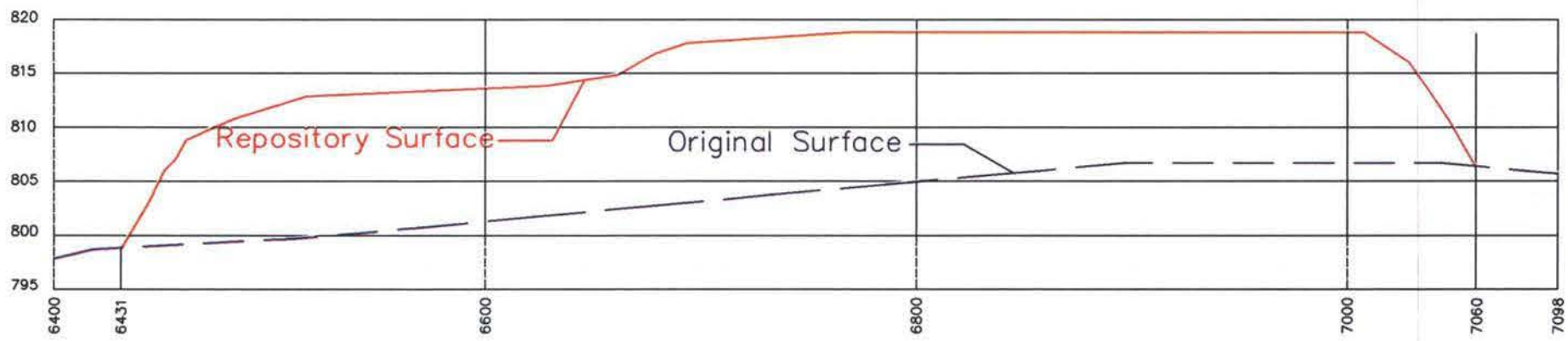
SCALE:	DATE:	FIGURE NO.
1" = 100'	4-28-2003	5
APPROVED BY: AME	DRAWN BY: OME	PROJECT NO.



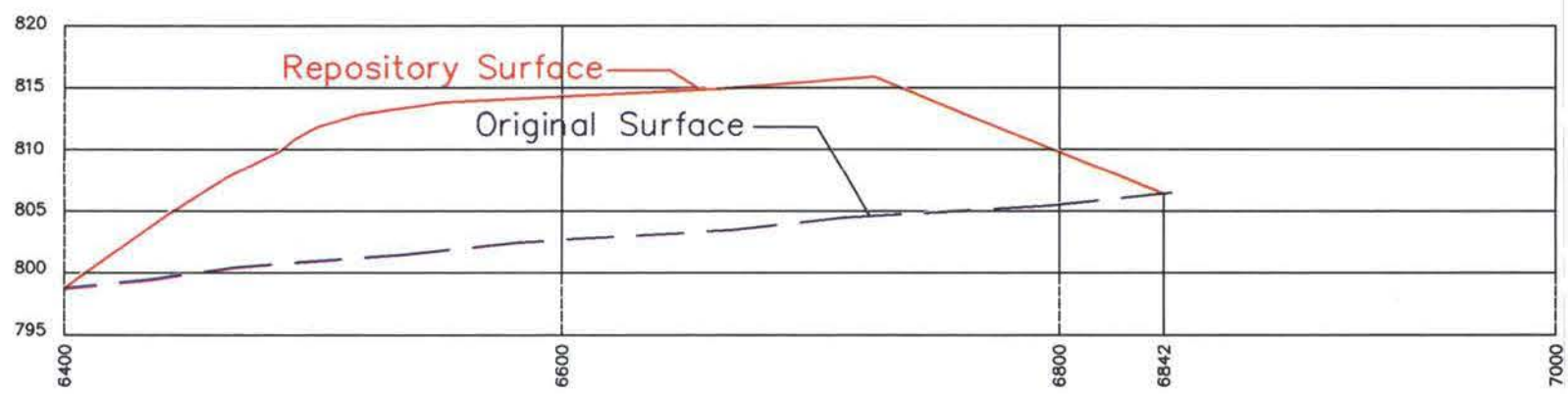
N 5800 CROSSECTION
scale as noted



N 5600 CROSSECTION
scale as noted



N 5400 CROSSECTION
scale as noted



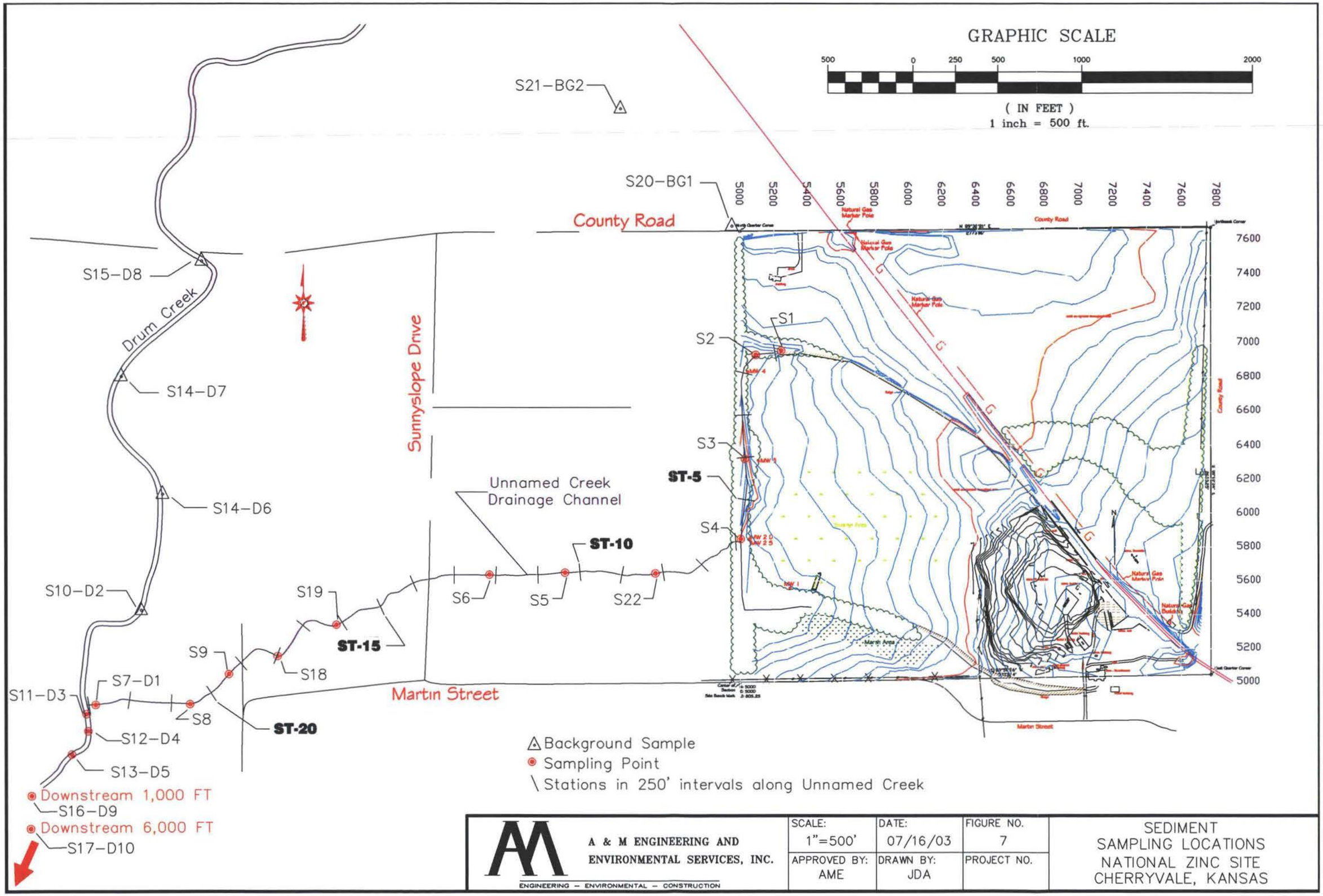
N 5200 CROSSECTION
scale as noted

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

EPA REPOSITORY AREA CROSS SECTIONS
NATIONAL ZINC SITE, CHERRYVALE, KANSAS

SCALE:	DATE:	FIGURE NO.
AS NOTED	4-28-2003	6
APPROVED BY: AME	DRAWN BY: OME	PROJECT NO.



A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC. ENGINEERING – ENVIRONMENTAL – CONSTRUCTION	SCALE: 1"=500'	DATE: 07/16/03	FIGURE NO. 7	SEDIMENT SAMPLING LOCATIONS NATIONAL ZINC SITE CHERRYVALE, KANSAS
	APPROVED BY: AME	DRAWN BY: JDA	PROJECT NO.	

GRAPHIC SCALE

500 0 250 500 1000 2000

(IN FEET)
1 inch = 500 ft.

County Road

Sunnyslope Drive

Unnamed Creek
Drainage Channel

Martin Street

Drum Creek

W13–D8

W12–D7

W11–D6

W7–D2

W8–D3

W4–D1

W9–D4

W10–D5

W5

W6

W16

W3

W17

W1

W2

ST-5

ST-10

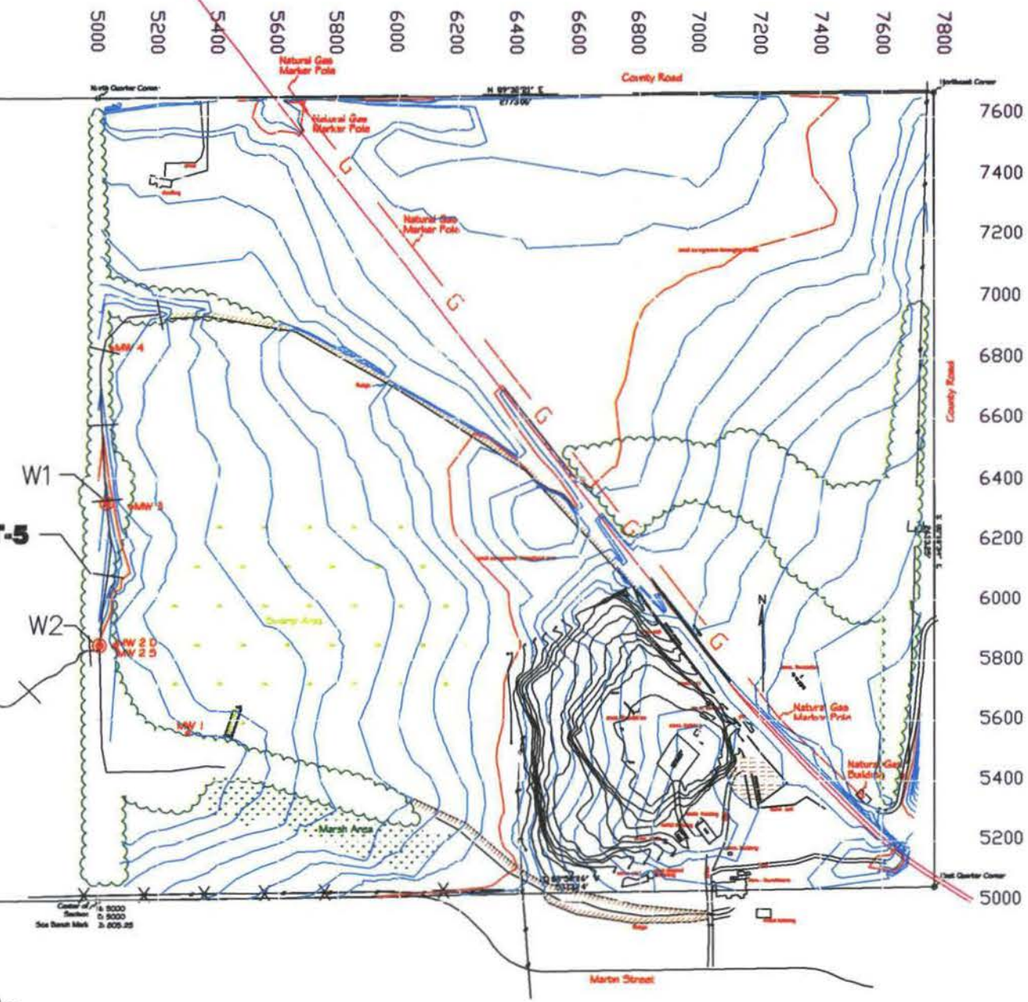
ST-15

ST-20

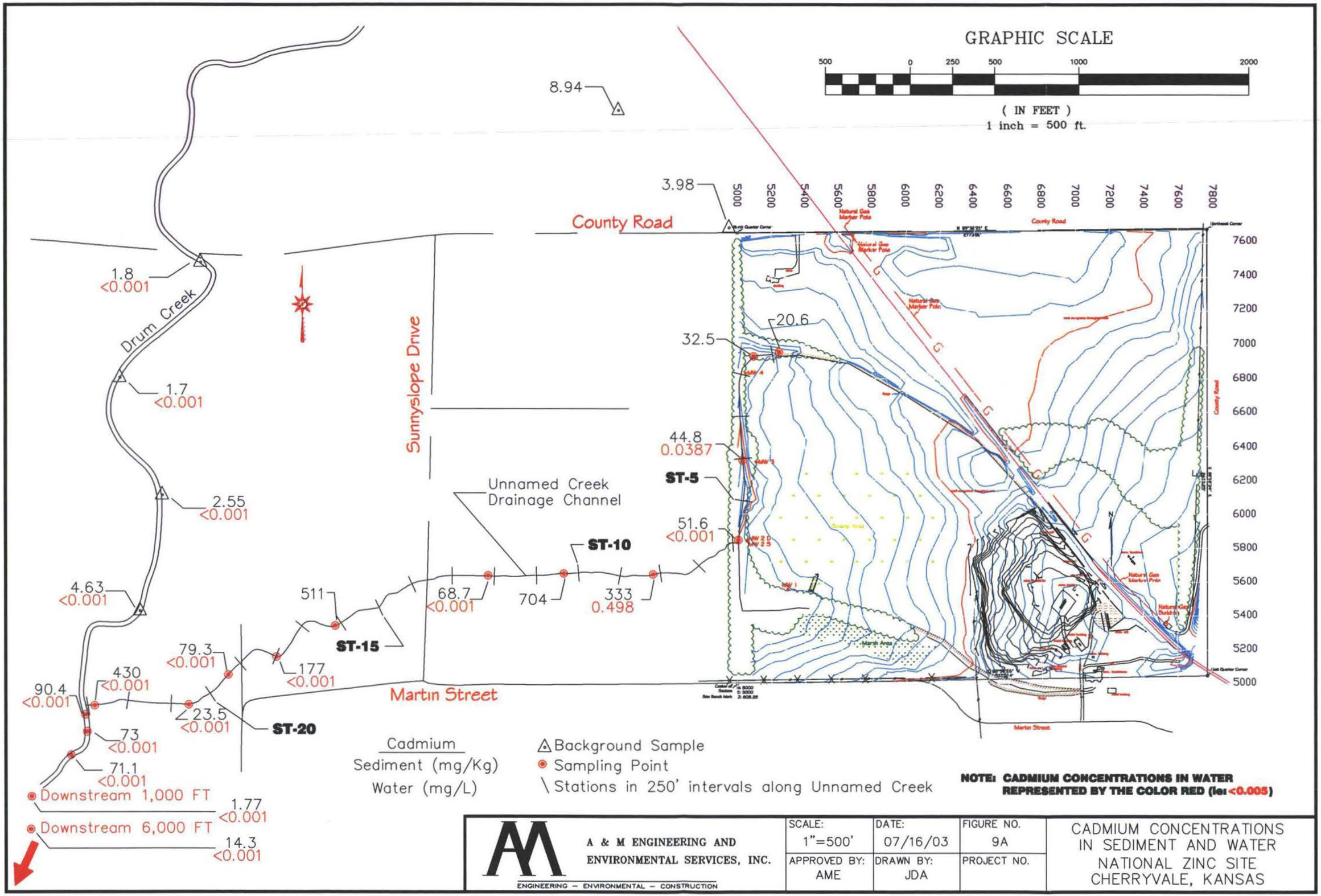
Downstream 1,000 FT
W14–D9

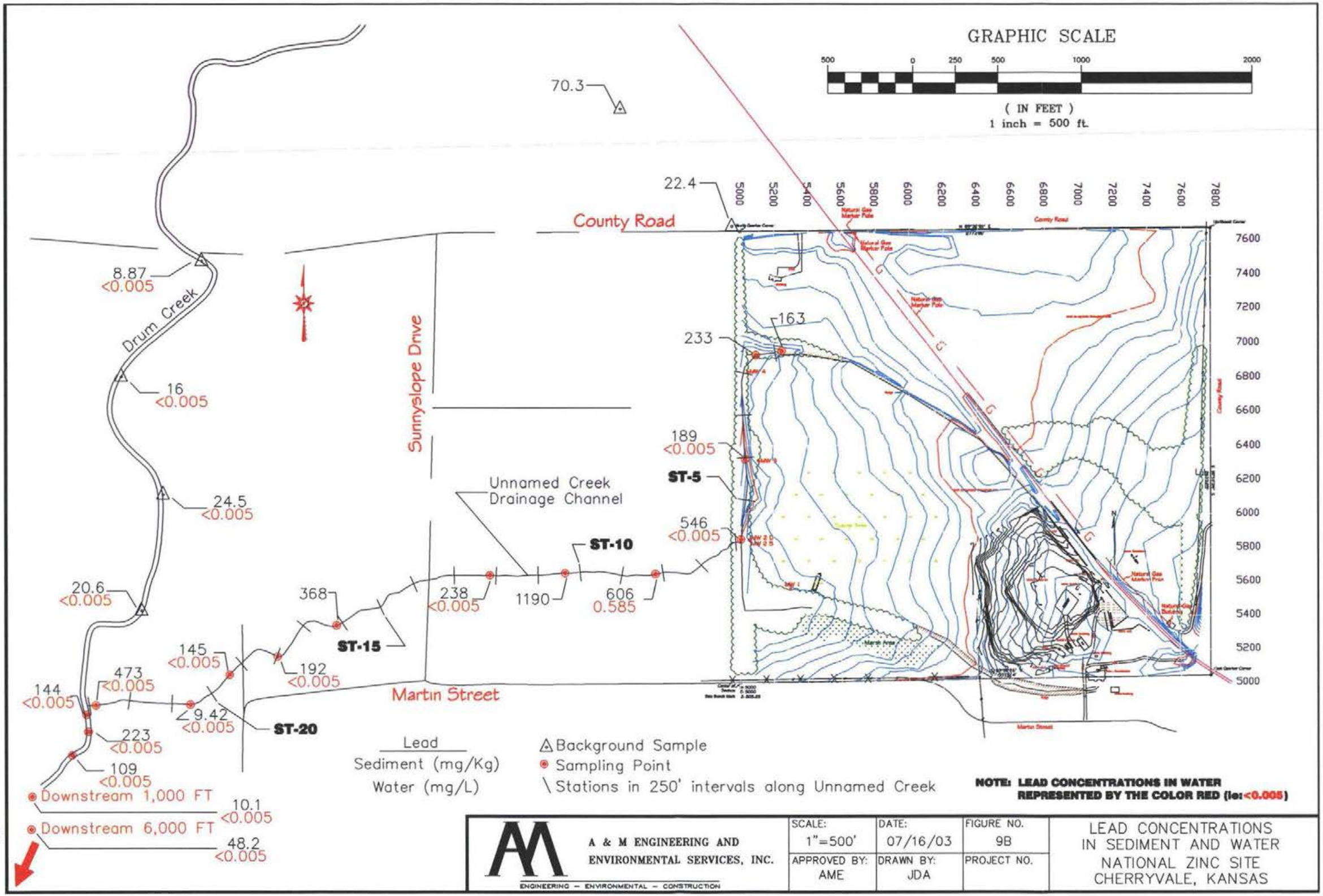
Downstream 6,000 FT
W15–D10

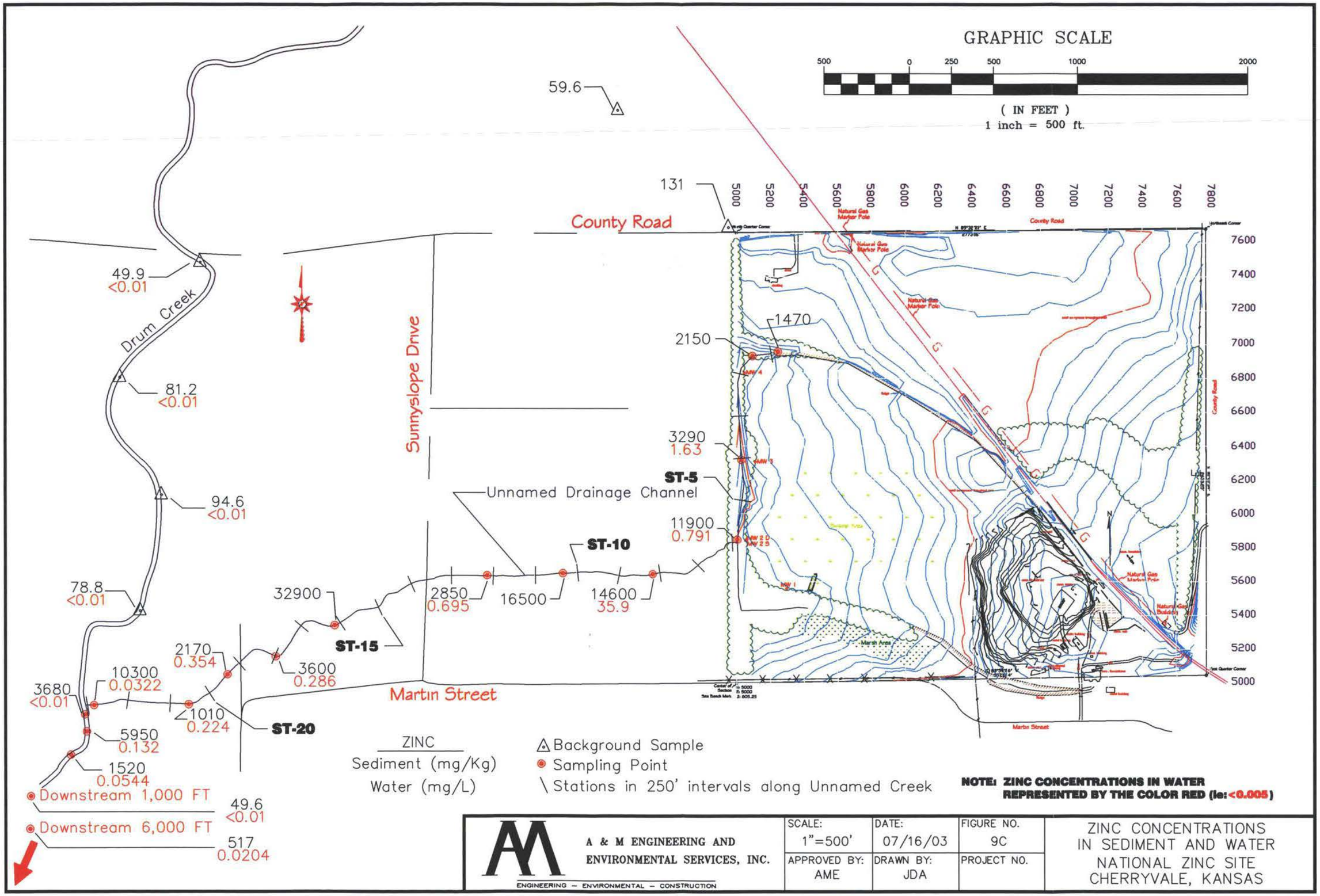
△ Background Sample
◉ Sampling Point
\ Stations in 250' intervals along Unnamed Creek



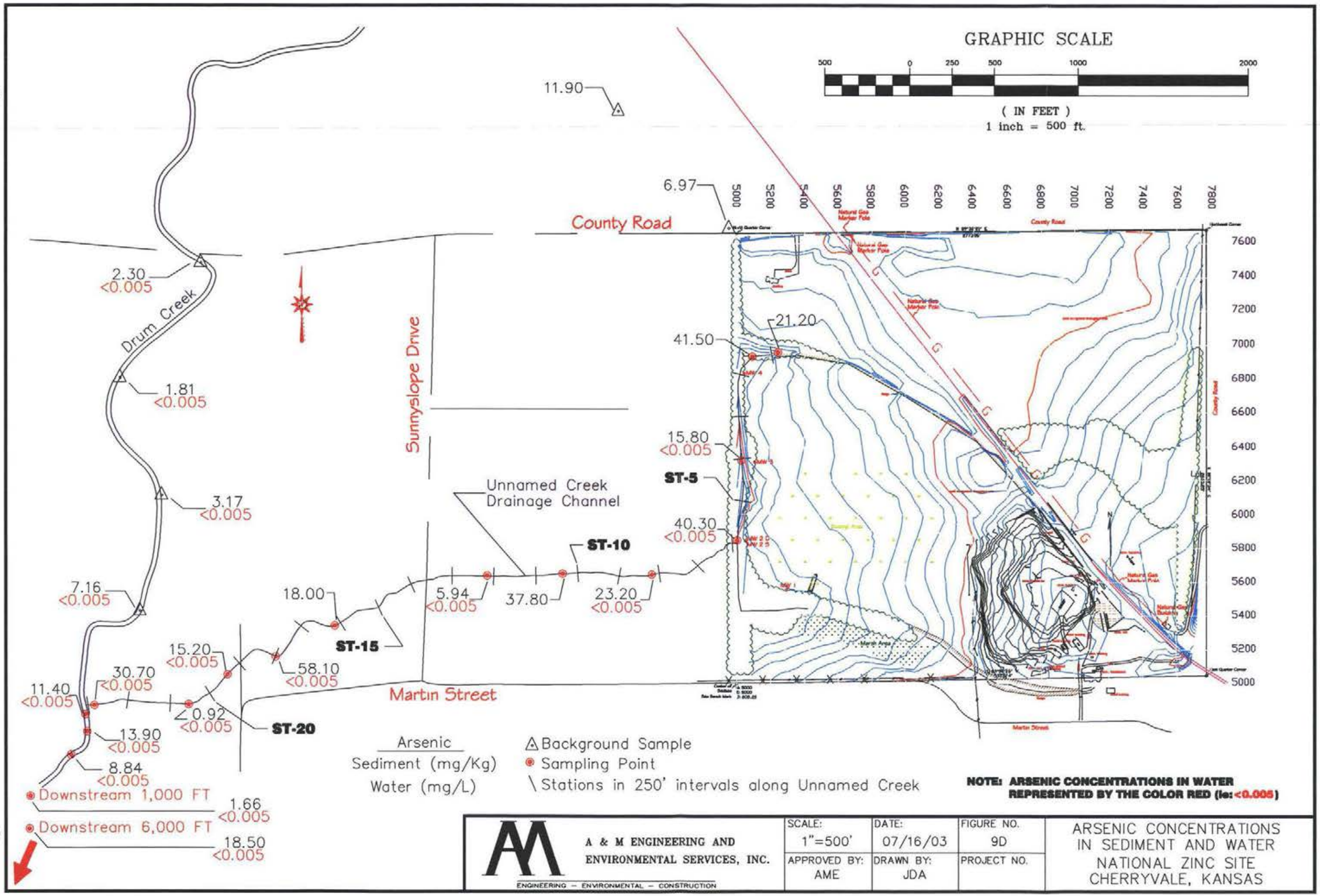
A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC. ENGINEERING – ENVIRONMENTAL – CONSTRUCTION	SCALE: 1"=500'	DATE: 07/16/03	FIGURE NO. 8	WATER SAMPLING LOCATIONS NATIONAL ZINC SITE CHERRYVALE, KANSAS
	APPROVED BY: AME	DRAWN BY: JDA	PROJECT NO.	

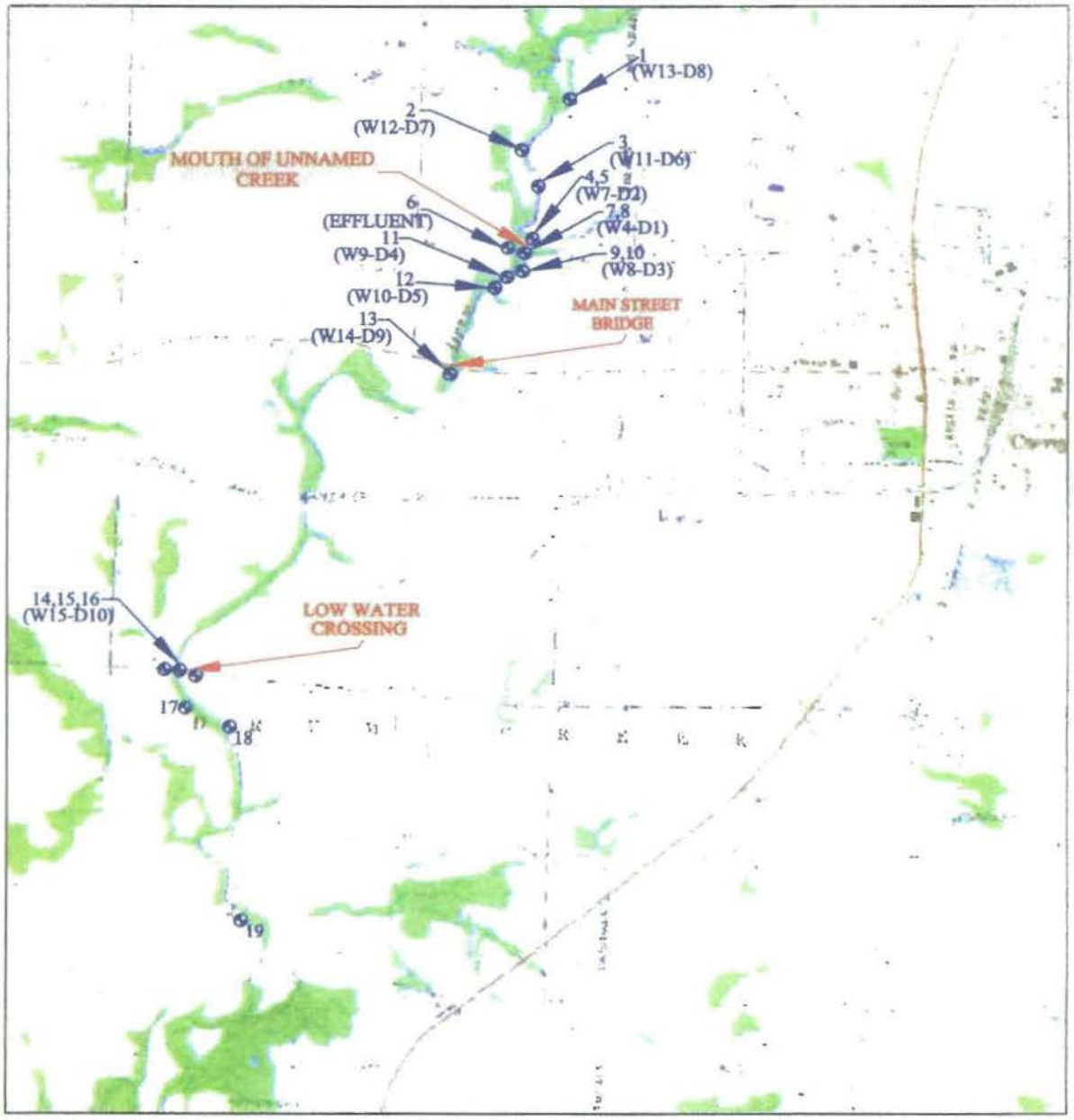

GRAPHIC SCALE
500 0 250 500 1000 2000
(IN FEET)
1 inch = 500 ft.
8.94
3.98
County Road
1.8
<0.001
Drum Creek
1.7
<0.001
Sunnyslope Drive
2.55
<0.001
Unnamed Creek
Drainage Channel
32.5
20.6
44.8
0.0387
ST-5
51.6
<0.001
ST-10
4.63
<0.001
511
68.7
<0.001
704
333
0.498
ST-15
79.3
<0.001
177
<0.001
430
<0.001
90.4
<0.001
23.5
<0.001
ST-20
Martin Street
73
<0.001
71.1
<0.001
Downstream 1,000 FT
1.77
<0.001
Downstream 6,000 FT
14.3
<0.001
Cadmium
Sediment (mg/Kg)
Water (mg/L)
Background Sample
Sampling Point
Stations in 250' intervals along Unnamed Creek
NOTE: CADMIUM CONCENTRATIONS IN WATER REPRESENTED BY THE COLOR RED (le: <0.005)
A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
ENGINEERING – ENVIRONMENTAL – CONSTRUCTION
SCALE: 1"=500'
DATE: 07/16/03
FIGURE NO. 9A
APPROVED BY: AME
DRAWN BY: JDA
PROJECT NO.
CADMIUM CONCENTRATIONS IN SEDIMENT AND WATER
NATIONAL ZINC SITE
CHERRYVALE, KANSAS


GRAPHIC SCALE
500 0 250 500 1000 2000
(IN FEET)
1 inch = 500 ft.
70.3
22.4
County Road
8.87
<0.005
Drum Creek
16
<0.005
Sunnyslope Drive
163
233
189
<0.005
ST-5
546
<0.005
Unnamed Creek
Drainage Channel
ST-10
24.5
<0.005
20.6
<0.005
368
238
<0.005
1190
606
0.585
145
<0.005
ST-15
192
<0.005
473
<0.005
144
<0.005
9.42
<0.005
ST-20
Martin Street
223
<0.005
109
<0.005
Downstream 1,000 FT
10.1
<0.005
Downstream 6,000 FT
48.2
<0.005
Lead
Sediment (mg/Kg)
Water (mg/L)
Background Sample
Sampling Point
Stations in 250' intervals along Unnamed Creek
NOTE: LEAD CONCENTRATIONS IN WATER REPRESENTED BY THE COLOR RED (ie:<0.005)
A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
ENGINEERING – ENVIRONMENTAL – CONSTRUCTION
SCALE: 1"=500'
DATE: 07/16/03
FIGURE NO. 9B
APPROVED BY: AME
DRAWN BY: JDA
PROJECT NO.
LEAD CONCENTRATIONS IN SEDIMENT AND WATER
NATIONAL ZINC SITE
CHERRYVALE, KANSAS



A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC. ENGINEERING – ENVIRONMENTAL – CONSTRUCTION	SCALE: 1"=500'	DATE: 07/16/03	FIGURE NO. 9C	ZINC CONCENTRATIONS IN SEDIMENT AND WATER NATIONAL ZINC SITE CHERRYVALE, KANSAS
	APPROVED BY: AME	DRAWN BY: JDA	PROJECT NO.	


GRAPHIC SCALE
500 0 250 500 1000 2000
(IN FEET)
1 inch = 500 ft.
11.90
6.97
County Road
2.30
<0.005
Drum Creek
1.81
<0.005
Sunnyslope Drive
21.20
41.50
15.80
<0.005
ST-5
Unnamed Creek
Drainage Channel
40.30
<0.005
ST-10
3.17
<0.005
7.16
<0.005
18.00
5.94
<0.005
37.80
23.20
<0.005
ST-15
15.20
<0.005
58.10
<0.005
30.70
<0.005
11.40
<0.005
0.92
<0.005
ST-20
Martin Street
13.90
<0.005
8.84
<0.005
Downstream 1,000 FT
1.66
<0.005
Downstream 6,000 FT
18.50
<0.005
Arsenic
Sediment (mg/Kg)
Water (mg/L)
Background Sample
Sampling Point
Stations in 250' intervals along Unnamed Creek
NOTE: ARSENIC CONCENTRATIONS IN WATER REPRESENTED BY THE COLOR RED (ie: <0.005)
A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
ENGINEERING – ENVIRONMENTAL – CONSTRUCTION
SCALE: 1"=500'
DATE: 07/16/03
FIGURE NO. 9D
APPROVED BY: AME
DRAWN BY: JDA
PROJECT NO.
ARSENIC CONCENTRATIONS IN SEDIMENT AND WATER
NATIONAL ZINC SITE
CHERRYVALE, KANSAS



● SAMPLE POINTS

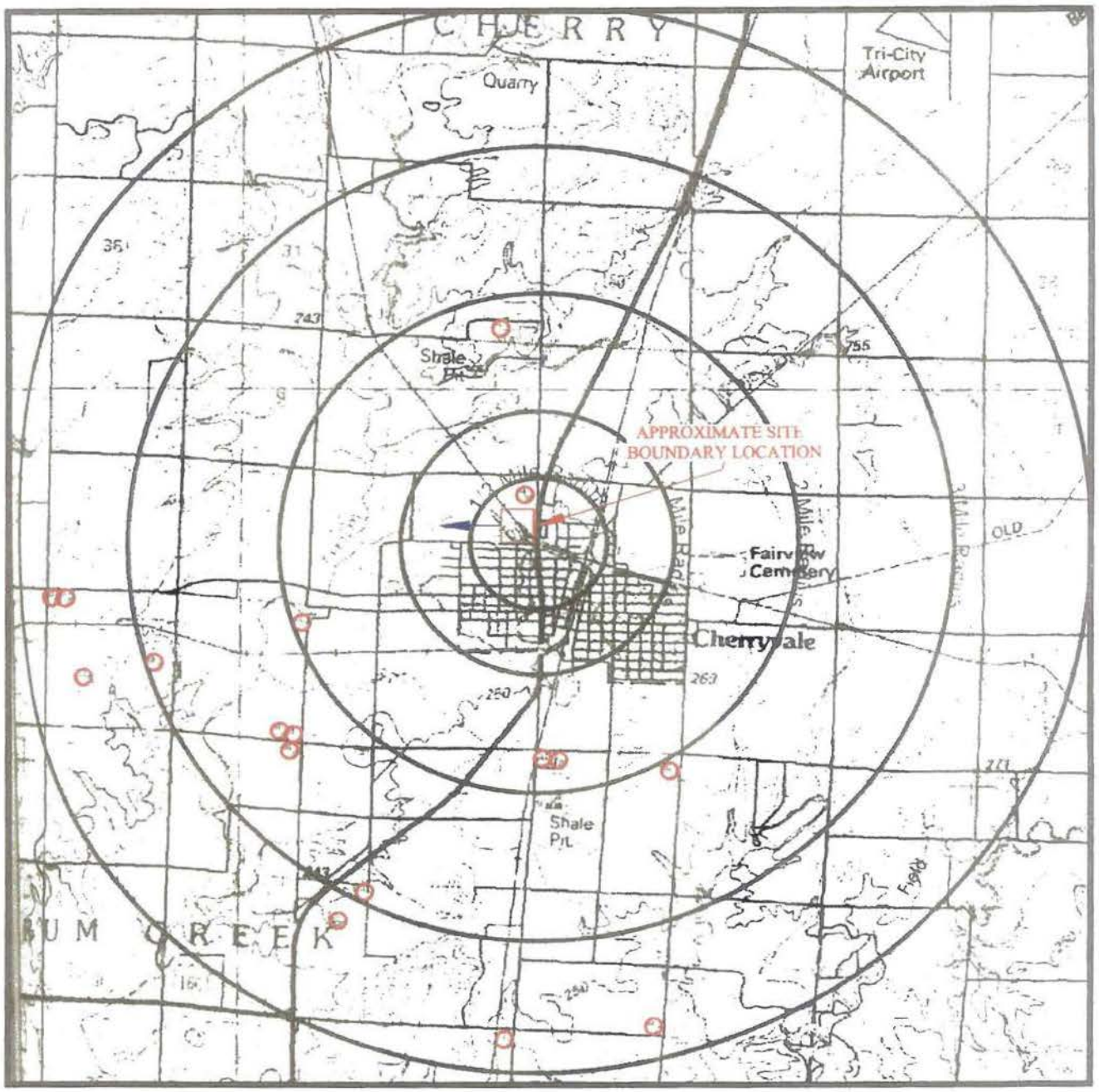
NORTH

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

WATER QUALITY SAMPLING LOCATIONS FOR DRUM CREEK

SCALE:	DATE:	FIGURE NO.
NOT TO SCALE	03/31/04	FIGURE 11
APPROVED BY:	DRAWN BY:	PROJECT NO.
AME	TME	1804-002



WATER WELL LOCATIONS MAP

NATIONAL ZINC SITE
CHERRYVALE, KANSAS

GROUNDWATER FLOW DIRECTION

WATER WELL LOCATION

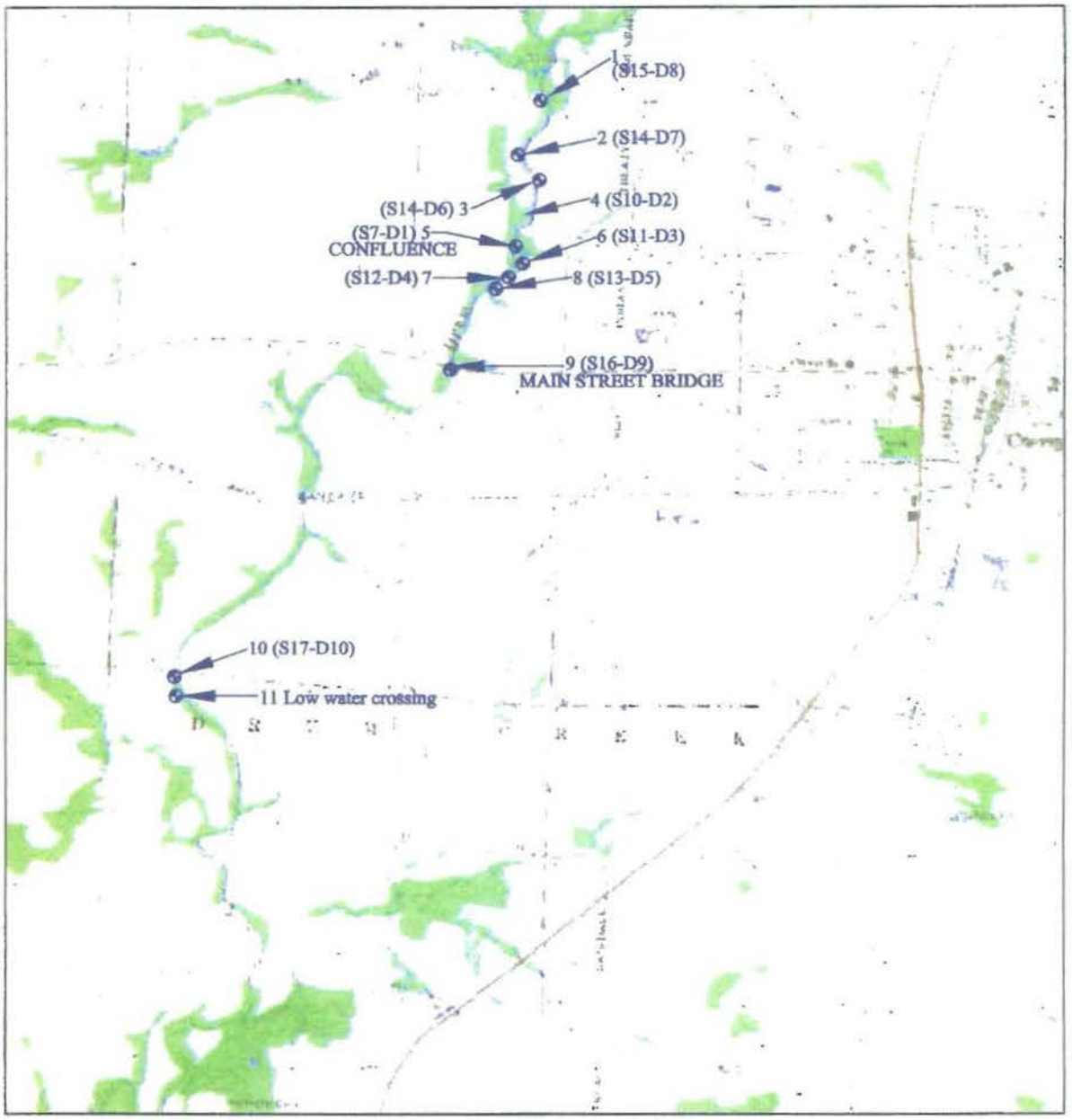
NORTH

SOURCE: USGS TOPOGRAPHIC QUADRANGLE COFFEYVILLE, KANSAS., 1990. UNITED STATES CENSUS TIGER DATA FILES, 1990

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING — ENVIRONMENTAL — CONSTRUCTION

WATER WELL LOCATIONS MAP		
SCALE: AS SHOWN	DATE: 01/08/04	FIGURE NO. FIGURE 10
APPROVED BY: IT	DRAWN BY: TME	PROJECT NO.



• SAMPLE POINTS

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING — ENVIRONMENTAL — CONSTRUCTION

SEDIMENT SAMPLING LOCATIONS FOR DRUM CREEK		
SCALE: NOT TO SCALE	DATE: 03/31/04	FIGURE NO. FIGURE 12
APPROVED BY: AME	DRAWN BY: TME	PROJECT NO. 1804-002-1002

APPENDIX A

CONSENT ORDER

K A N S A S

RODERICK L. BREMBY, SECRETARY — KATHLEEN SEBELIUS, GOVERNOR

DEPARTMENT OF HEALTH AND ENVIRONMENT

March 10, 2003

William C. Anderson, Esq.
Doerner, Saunders, Daniel & Anderson, LLP
Suite 500
320 South Boston Avenue
Tulsa, Oklahoma 74103-3725

David L. Smiga, Esq.
General Attorney
US Steel
600 Grant Street, Rm 1500
Pittsburgh, PA 15219-2800

Re: National Zinc Site, Cherryvale, Kansas
Consent Order Case No. 03-E-0022

Dear Mr. Anderson and Mr. Smiga:

Attached for your review and signature by your respective clients, is the final Consent Order for the National Zinc Site in Cherryvale, Kansas. Please return the document with the original signature of the authorized representative to me at the address below. I will then forward it to the secretary of the Kansas Department of Health and Environment for signature. Thank you for your assistance in this matter.

Sincerely,

Erika Bessey
Attorney

enclosure

pc: Jean Underwood (with enclosure)

OFFICE OF THE SECRETARY
Legal Services
CURTIS STATE OFFICE BUILDING, 1000 SW JACKSON ST., STE. 560, TOPEKA, KS 66612-1368
Voice 785-296-5334 Fax 785-296-7119 http://www.kdhe.state.ks.us

BUREAU OF ENVIRONMENTAL REMEDIATION/REMEDIAL SECTION

GUIDELINE

REMOVAL SITE EVALUATION (RSE)/REMOVAL ACTION DESIGN(RAD)/REMOVAL ACTION (RA)

BER POLICY#BER-RS-031
DATE: 1995, Updated 1996
PAGES: 4

A Removal Action can be defined as a prompt response action to actual or imminent threats to human health and/or the environment. Removal Actions are conducted to mitigate releases or potential releases of contaminants to minimize potential exposure or threats to health and the environment. Removal Actions under this Scope of Work (SOW) include:

- Drum, waste or contaminated soil removal;
- Security fencing or other measures to prevent access;
- Construction of drainage controls, stabilization of release mechanisms;
- Capping of contaminated surficial areas;
- Providing an alternate water supply; and
- Preventing exposure to human health and/or the environment.

This SOW for a **Removal Site Evaluation and Removal Action (RSE/RA)** provides an outline to abate, prevent, minimize, stabilize, mitigate or eliminate the release or the threat of release of a contaminant(s) from the site. Conditions considered appropriate for a Removal Action are defined by the National Oil and Hazardous Substances Contingency Plan (NCP) §300.415 (b-1) and include:

1) Actual or potential exposure to human health and/or environment from a hazardous substance(s), pollutant(s) or contaminant(s);

2) Actual or potential contamination of drinking water supplies or sensitive ecosystems;

3) High levels of hazardous substances(s), pollutant(s), or contaminant(s) in soils largely at or near the surface which may migrate and act as source areas to contaminate adjacent soils, sediment, surface and ground water; and

4) Other situations or factors posing a threat to public health, welfare, or the environment.

The RSE/RA is intended to be a flexible process in which portions can be waived or modified upon discretion of the KDHE Project Manager.

The primary objectives of the **Removal Site Evaluation (RSE)** are described as follows:

1) Determine the extent of contamination by contaminants of concern and evaluate the threat to human health and/or the environment;

2) Determine the migration of and the chemical/physical properties of the contaminants;

3) Collect the data necessary to select an appropriate removal action; and

4) Gather a sufficient amount of data to support the design parameters of the proposed removal action.

The RSE may be waived if adequate site information is present in another form, i.e. as a Screening Site Inspection or Expanded Site Inspection (SSI or ESI), KDHE approved Preliminary Investigation (PI), Comprehensive Investigation (CI) or equivalent investigation if the designated KDHE Project Manager agrees that adequate information exists which meets the objectives noted above; and if the investigation indicated a removal action is appropriate. If the RSE is waived the process can proceed directly to the Removal Action (RA) phase, with the existing investigative data summarized and/or included in the Removal Action Design (RAD) Plan.

The primary objectives of the **Removal Action Design (RAD)** are described below:

1) To evaluate the feasibility, effectiveness, and cost of at least two (2) viable removal actions based on the findings of the RSE and to evaluate the "no action" alternative;

2) To recommend and justify a specific removal action for the site consistent with long term remedial goals;

3) To determine the health and environmental effects of the Removal Action;

4) Establish up- and down-gradient ground water monitoring criteria for the performance of the Removal Action; and

5) To provide adequate documentation to support the Removal Action as being consistent with long-term remedial goals in the absence of a Corrective Action Study (CAS) if the KDHE Project Manager has determined that a CAS is not necessary for the site.

This SOW outlines the activities to be completed as part of the RSE/RAD. A Work Plan describing in detail the RSE/RAD activities must be developed and submitted to KDHE for review and approval. In addition, the Work Plan shall include the following section or appendices as appropriate: 1) Removal Site Evaluation Plan; 2) Quality Assurance Project Plan; 3) Health and Safety Plan; and 4) Removal Action Design Plan. An implementation schedule of all RSE/RAD activities outlined in this SOW should be included in the RSE/RAD Work Plan.

REMOVAL SITE EVALUATION

The RSE shall at a minimum include the following components:

1.0 A review of available information and documented findings;

2.0 A description of the physical characteristics of the site including the geology, soils, hydrogeology, surface hydrology, land use, and meteorology, at a minimum;

3.0 Detailed description of the type(s) of contaminants involved, release characteristics and contaminated media;

4.0 Procedures used to determine the nature and extent of the contaminant(s) and evaluate the transport pathways;

5.0 A screening risk assessment appropriate for determining site risk and removal goals may be required. The KDHE Project Manager will establish the need for and the scope of the risk assessment. The risk assessment should concentrate on the specific impacts and exposure threats the removal is to address in order to evaluate potential threat to human health and the environment, and establish appropriate removal action response goals.

REMOVAL ACTION DESIGN REPORT

The RAD shall evaluate at least two possible removal action alternatives from data collected. The removal action alternatives and "no action" alternative shall address threats to human health and the environment. The evaluation shall include:

1) Summary of RSE work completed (if appropriate);

2) Description of contaminants of concern, including a discussion and summary of data collected (with appropriate QA/QC and data validation information);

3) An evaluation of possible exposure pathways including areal extent of contaminants of concern;

4) Removal action goals and appropriate action levels;

5) A description of at least two potential removal action alternatives and a "no action" alternative for the site, including an evaluation of the effectiveness of the removal action alternatives in terms of the long term remedial objectives and reduction of risk to health and the environment;

6) A comparison and justification of the costs of each removal action;

7) A consideration of appropriate regulations, ARARs, etc. pertinent to each removal action alternative evaluated;

8) Selection of an appropriate removal action giving adequate supporting rationale for its selection based on the above defined criteria. Necessary plans, diagrams, etc. to implement the proposed removal action should be included; and,

9) Establishment of adequate post-removal confirmation sampling to determine removal action performance.

REMOVAL ACTION PLAN

If determined necessary by the KDHE Project Manager after approval of the RAD, a Removal Action Plan containing additional designs, technical specifications, etc. of the preferred removal alternative will be submitted to KDHE for review and approval according to the KDHE-approved schedule.

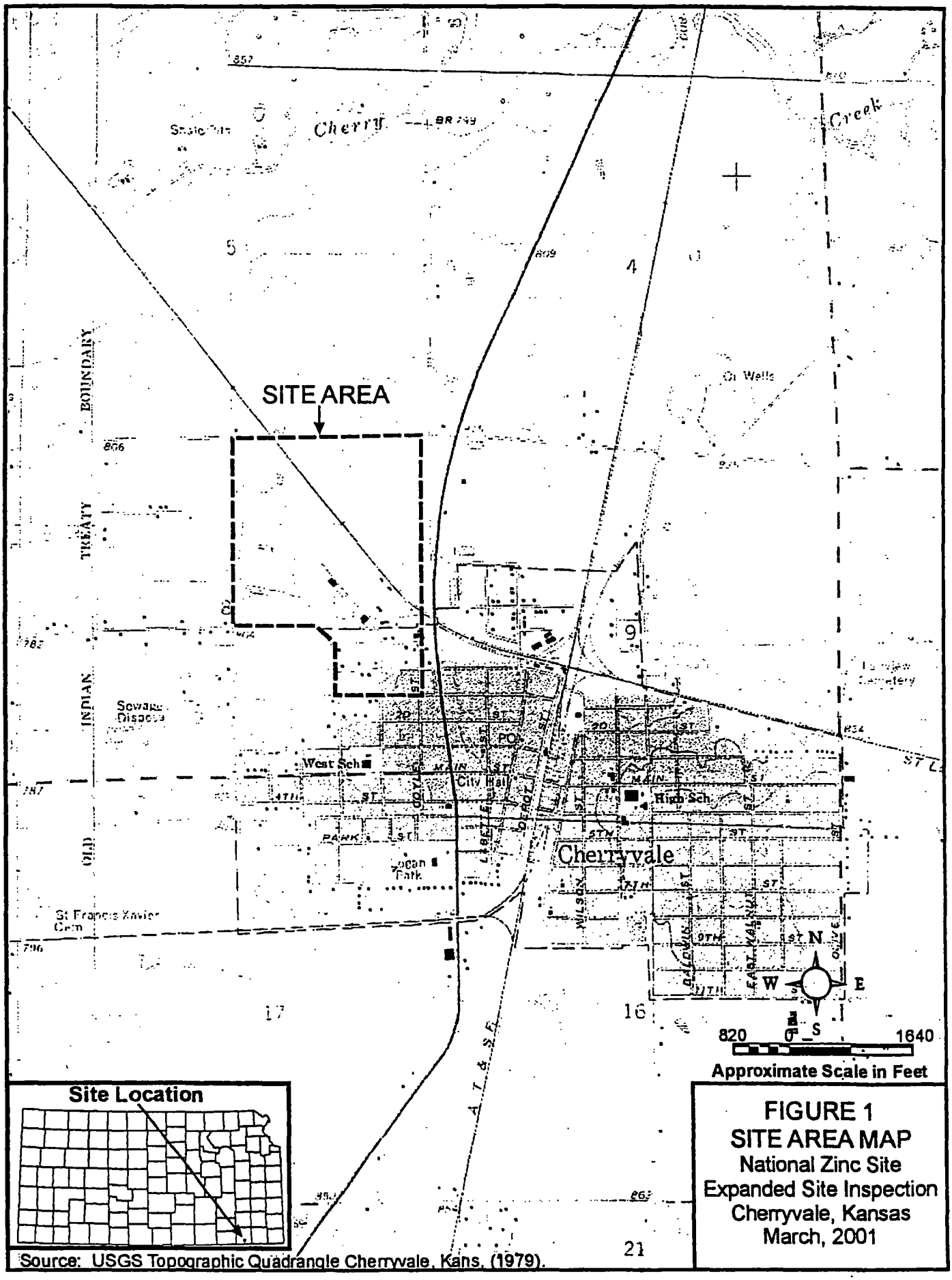
Note: For those removal actions which the KDHE Project Manager has determined will entail long-term monitoring or constitute a portion of a longer term remedial action, the removal action process should be consistent with the remedial action (investigation /remediation) for the site. The removal action alternative selected should be consistent with the preferred alternative selected in the Corrective Action Decision for the site. For example, the CAS may identify the previously implemented removal action in addition to institutional controls and long-term monitoring as the preferred alternative, if appropriate.

REMOVAL ACTION SUMMARY REPORT

A Removal Action Summary Report shall be submitted after completion of the removal action performed according to the KDHE-approved RAD. The Removal Action Summary Report shall include a final summary of removal action activity and an evaluation of the post-removal action confirmation sampling relative to removal action goals.

COMMUNITY RELATIONS ACTIVITIES

A Public Information Program (Policy #BER-RS-002) should be followed for <u>all</u> activities under this SOW. An NCP-consistent Community Relations Plan (CRP) may be necessary at certain sites and will be implemented upon discretion of the KDHE Project Manager.



Source: USGS Topographic Quadrangle Cherryvale, Kans. (1979).

FIGURE 1
SITE AREA MAP
National Zinc Site
Expanded Site Inspection
Cherryvale, Kansas
March, 2001

Exhibit 3
Schedule of Deliverables and Milestones
for the
Removal Site Evaluation (RSE)/Removal Action Design (RAD)/Removal Action (RA)

Deliverable	Due Date
Commence Implementation of RSE Work Plan*	Within 30 Days of Execution of the Consent Order.
Submit Draft RSE/RAD Report	Within 180 Days of Execution of the Consent Order.
Submit Final RSE/RAD Report	Due within 30 days of receipt of KDHE comment on the Draft RSE/RAD Report.
Submit Draft RA Work Plan**	Due within 30 days of effective date of KDHE removal action decision.
Submit Final RA Work Plan	Due within 30 days of receipt of KDHE comment on the Draft RA Work Plan.
Commence Implementation of Final RA Work Plan	To be established in amendment to Consent Order.
Submit Draft and Final RA Summary Reports	To be established in amendment to Consent Order.
Submit Operations and Maintenance (O&M) Reports	To be established in amendment to Consent Order.
Community Relations Plan (CRP) or Public Information Plan (PIP)	As necessary, KDHE will prepare the CRP or PIP.
Submit Quarterly Progress Reports	Due quarter-annually upon or before the anniversary of the effective date of the Consent Order.

* - As described in Paragraph 35 of the Consent Order, the RSE Work Plan corresponds to Phase 2 (Plan for Field Sampling and Construction of Interim Drainage System) of the September 2002 *Revised Plan for Former National Zinc Site.*

** - Including detailed RA implementation schedule (e.g., Gantt chart) and O&M plan.

BEFORE THE KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
Charles Curtis Building
1000 SW Eighth Street
Topeka, Kansas 66612-1368

IN THE MATTER OF:	)	
	)	**CONSENT ORDER**
POLLUTION AT	)	**Case No.** 03-E-0022
	)	
NATIONAL ZINC SITE,	)	
	)	
CHERRYVALE, KANSAS.	)	

PRELIMINARY STATEMENT

The parties hereto, the Kansas Department of Health and Environment ("KDHE"), and United States Steel Corporation and Salomon Smith Barney Holdings, Inc. (hereinafter "Respondents"), having agreed that settlement of this matter is in the best interests of all parties and the public, hereby represent and state as follows:

1. KDHE is a duly authorized agency of the State of Kansas, created by act of the legislature.

2. KDHE has general jurisdiction of matters involving hazardous substance and hazardous substance cleanups under the authority of the Kansas Environmental Response Act (K.S.A. 65-3452a *et seq.*), as well as hazardous waste and its clean up (K.S.A. 65-3430 *et seq.*) and has general authority and responsibility to protect the waters and soils of the state under the authority of K.S.A. 65-161, *et seq.*

3. The Respondents agree to undertake all actions required by the terms and conditions of this Consent Order. In any action by KDHE to enforce the terms of this Consent Order, the Respondents agree not to contest the authority or jurisdiction of the

Secretary of Health and Environment to issue this Consent Order.

4. This Consent Order shall apply to and be binding upon KDHE and the Respondents, their agents, successors, and assigns. The signatories to this Consent Order certify that they are authorized to execute and legally bind the parties they represent to this Consent Order. No change in the ownership or corporate status of the Respondents shall alter its responsibilities under this Consent Order.

5. The Respondents shall provide a copy of this Consent Order to the City of Cherryvale, Kansas, which is the owner of the majority of the Site identified in Paragraph 9 hereof, and shall further request said City to provide a copy of this Consent Order to any subsequent owners or successors before ownership rights are transferred. The Respondents shall provide a copy of this Consent Order to all contractors, subcontractors, laboratories, and consultants which are retained to conduct any work performed under this Consent Order, within fourteen (14) days after the effective date of this Consent Order or the date of retaining their services. Notwithstanding the terms of any contract, Respondents are responsible for compliance with this Consent Order and for ensuring that their contractors and agents comply with this Consent Order.

6. Neither entry into nor performance of this Consent Order shall constitute or be construed as an admission or acknowledgment by either Respondent of any fact, legal issue, or conclusion of law, or of any liability, fault or responsibility, or of a waiver of any rights, privileges, or defenses, by either of them, or as evidence of such with respect to the Site described in Paragraph 9 below and the surrounding environment, nor shall it be admitted in evidence against Respondents in any proceeding other than a proceeding by KDHE to enforce this Consent Order, and

Respondents expressly deny any liability, fault or responsibility with respect to said Site.

7. The Findings of Fact and Conclusions of Law made by KDHE as set forth below are not admitted by Respondents. However, solely for the purposes of this Consent Order, and subject to the provisions of Paragraph 6 above, Respondents consent that said Findings of Fact and Conclusions of Law shall govern and control their obligations, rights and duties under this Consent Order.

8. While the Respondents to this Consent Order do not admit liability for the contamination at the Site identified in Paragraph 9 hereof and the surrounding environment, nevertheless they agree to enter into this Consent Order to undertake the activities contained in the approved Work Plan and Scope of Work as described below.

FINDINGS OF FACT

9. The National Zinc Site (the "Site") is located at the northwestern city limits of Cherryvale, Montgomery County, Kansas. The geographic coordinates of the Site are 39° 42' 30.0" North latitude and 96° 25' 00" West longitude. The Site is located in Section 8 in Township 32 South, Range 17 East and is illustrated in the attached map incorporated herein as Exhibit 2.

10. The Site consists of approximately 360 acres including the former National Zinc smelter facility on the northern edge of Cherryvale, Kansas. Review of historical information indicates that the Edgar Zinc Company began construction of a primary lead and zinc smelter at the Site in 1898. The facility initially was constructed with 1,800 retorts and three furnace buildings. By 1908 the smelter facility had 4,800 retorts and 24 furnaces. By 1928 the facility had four (4) massive ore roasters and

24 furnaces in operation. This facility was recognized as the largest zinc smelter in the world until World War I. At least one half of the demand for primary zinc production was for galvanizing purposes.

11. The facility operated as the Edgar Zinc Company until sometime after 1928, when it was reorganized as the National Zinc Company. Production appears to have declined through the 1930s when most active operations ceased.

12. Sludges and liquid wastes contaminated with heavy metals were contained in large settling ponds covering approximately 23 acres. The lagoons were used to contain runoff from an estimated 2,000 tons of slag and roasted ore. The National Zinc smelter facility permanently terminated operations on December 24, 1976. Presently, the Site contains the encapsulated former lagoon, several abandoned buildings and building foundations, and the remains of the smelter operations.

13. Incidents of surface water contamination in the 1950s were reported to KDHE by adjacent property owners when contaminated water breached the large pond. On April 1976, the Site was investigated by KDHE following complaints from farmers regarding visual observations of contamination in Drum Creek and concern over the possibility of a fish kill or cattle illness from surface water consumption. KDHE personnel also inspected the Site on September 27, 1977 for possible surface water or groundwater pollution associated with facility runoff and seeps. At the request of KDHE, limited response actions were initiated at the Site by the National Zinc Company in October 1977. Beginning in 1979, approximately 95 million gallons of fluid from the lagoon were treated and discharged into the adjacent Drum Creek. Ore and sludge were removed from the Site; some of the remaining sludge (approximately 300 tons) was encapsulated on-site. The lagoon was filled with dirt

and top soil, treated with lime, and planted with grass. Five monitoring wells were installed in the western and southern edges of the large pond. Analytical results of groundwater samples collected in 1982, 1983, and 1984 showed high levels of cadmium and lead.

14. A restrictive covenant limiting use or development of part of the property was prepared in 1983 and still governs a majority of the Site. The City of Cherryvale currently owns the majority of the property containing the former National Zinc smelter.

15. In 1995 KDHE conducted additional sampling at the Site. Lead was detected at a maximum of 176,750 mg/kg, cadmium at 2,816 mg/kg, and arsenic at a maximum of 240 mg/kg in soils. Cadmium was detected in surface and groundwater up to 0.111 mg/l. In July 1996, sediment/sludge sampling indicated lead up to 1,786 mg/kg, and cadmium in surface water up to 0.347 mg/l on-site in standing water. Preliminary Assessment (PA) and Site Inspection forms were completed by KDHE in 1981 and the Site was assigned the CERCLA Identification System (CERCLIS) identification number KSD980406698.

16. In 1999 KDHE conducted a Brownfields Targeted Assessment (BTA) of the Site which included extensive sampling across the Site. Soils, subsurface soils, groundwater, surface water and sediment were sampled during the BTA. The maximum X-ray fluorescence (XRF) detection for lead during the BTA was 160,000 mg/kg and the maximum laboratory detection for lead was 120,800 mg/kg. The maximum detection for arsenic in soils was 306 mg/kg and the maximum cadmium detection was 1,488 mg/kg.

17. Toxicity Characteristic Leachate Procedure (TCLP) data collected for the BTA

indicated exceedences for cadmium (TCLP threshold 1 mg/l) and lead (TCLP threshold 5 mg/l) in several samples. Lead indicated a maximum TCLP detection of 288 mg/l, well over its TCLP threshold of 5.0 mg/l. The maximum cadmium TCLP value indicated was 70.2 mg/l.

18. Lead and cadmium were detected in groundwater at maximum detections of 0.136 mg/l and 3.062 mg/l respectively, above respective Maximum Contaminant Levels (MCLs) during the BTA.

19. Surface water analytical results obtained during the BTA indicated a maximum detection for lead of 1.789 mg/l, cadmium at 2.965 mg/l and arsenic at 0.063 mg/l. Sediment samples also indicated a maximum lead detection of 668.24 mg/kg, a maximum cadmium detection of 88.42 mg/kg, and a maximum arsenic detection of 289.82 mg/kg.

20. KDHE conducted a Phase I Removal Site Evaluation (RSE) of the Cherryvale Residential Yards site adjacent to the Site in 2001. Multiple residential yards were identified to be impacted with lead, cadmium and arsenic above KDHE residential Risk-based Standards for Kansas (RSKs). KDHE referred the site to United States Environmental Protection Agency (EPA) Region VII for initiation of a Fund-lead removal action consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The Action Memorandum was completed in August 2001. A Phase II RSE was also conducted by KDHE to screen additional residential yards for heavy metals contamination. To date 34 residential yards have been addressed through the EPA-lead removal action.

21. KDHE completed the Expanded Site Inspection (ESI) at the Site in 2001. Additional surface water sampling indicates off-site impacts from zinc and cadmium to surface

water. Off-site impacts from lead, cadmium, mercury, and zinc to sediments were also identified during the ESI. The Site is ready for preparation of a Hazard Ranking System (HRS) package for inclusion to the National Priorities List (NPL).

22. The investigations thus completed have documented releases from the Site of heavy metals, especially lead, cadmium, and arsenic, to on-site soils, surface water, sediments and groundwater, to off-site residential soils, sediments and surface water, and potentially to off-site groundwater. These constituents are hazardous substances as defined in § 302.4 of the NCP and as adopted by the Kansas Environmental Response Act, K.S.A. 65-3452a.

23. KDHE has completed a Potentially Responsible Party (PRP) search for the facility and identified Respondents as PRPs through a series of acquisitions and mergers.

24. The above investigations have determined that the soils and groundwater at the Site are contaminated by hazardous substances and hazardous wastes which are the result of one or more releases of hazardous substance(s) and hazardous waste(s).

25. The contamination of the groundwater beneath the Site and the potential for contamination to groundwater at adjacent areas is causing or threatens to cause pollution of the waters of the State or is or threatens to become a hazard to persons, public health, or safety.

CONCLUSIONS OF LAW

26. Respondents are "persons" within the meaning of K.S.A. 65-164 *et seq.*, K.S.A. 65-3430, *et seq.*, and K.S.A. 65-3452a, *et seq.*

27. The presence of the contaminants identified in the groundwater underlying the Site constitutes "pollution" as defined by K.S.A. 65-171d.

28. Some of the contaminants identified in the groundwater underlying the Site are

"hazardous substances" as defined by K.S.A. 65-3453 and "hazardous wastes" as defined by K.S.A. 65-3430.

29. The area defined in Paragraph 9 and identified as the Site constitutes a "site" within the meaning of K.S.A. 65-3453.

30. The facts above constitute:

    A. the discharge, abandonment, or disposal of hazardous substances or hazardous wastes;

    B. the pollution of the land or waters of the state or the threat of pollution of the land or waters of the state;

    C. a hazard to persons, property or public health or threatens to become a hazard to persons, property or public health.

31. Under the facts as shown above, the KDHE has concluded, and the Secretary has confirmed, that there is a need for a response action to prevent a continuing release or threat of release of hazardous substances.

32. The evaluation of such discharges is necessary to determine the potential threat to public health and safety and the environment. If a potential threat exists, the clean up of such discharges is necessary to remove the pollution or hazard and to protect the public health and safety and the environment, giving rise to the authority of the KDHE to enter this Consent Order. A necessary part of this evaluation is an investigation of the nature and extent of the threat to the public health or welfare or the environment caused by the release or threatened release of hazardous substances, pollutants, or contaminants on or from the Site.

33. The KDHE has authority to enter the Consent Order herein, and to make the Findings of Fact and Conclusions of Law herein stated.

34. The Secretary of Health and Environment is authorized by K.S.A. 65-3453, K.S.A. 65-164, *et seq.*, K.S.A. 65-3430, *et seq.* and the regulations issued pursuant thereto to enter an order confirming the agreement of the parties, and ordering the actions and obligations required by the foregoing findings of fact and conclusions of law. The parties hereto agree to the following activities and the commitments.

ORDER

35. Respondents have submitted, and KDHE approved on November 26, 2002, the *Revised Plan for Former National Zinc Site* (Revised Plan) which consists of five (5) phases: Phase 1–Develop Framework for Revised Plan; Phase 2–Plan for Field Sampling and Construction of Interim Drainage System (Phase 2 Work Plan); Phase 3–Develop Corrective Action Plan; Phase 4–Develop a Work Plan for Construction Activities; and, Phase 5–Execute the Construction Work Plan. The Revised Plan (consisting of the original Revised Plan submitted to KDHE September 16, 2002 and Amendment No. 1 submitted November 22, 2002) is incorporated herein as Exhibit 4. The investigative and mitigative measures described in the Phase 2 Work Plan are consistent with applicable Removal Site Evaluation (RSE) portions of the Scope of Work (SOW) attached hereto, marked Exhibit 1. Subsequent corrective measure development and design, as part of Phases 3 and 4, is to be consistent with applicable Removal Action Design (RAD) portions of the attached SOW. As referenced in Paragraph 77 hereof, execution of Phase 5 activities will be addressed in a future amendment to this Consent Order or execution of an additional Consent Order consistent with applicable removal action (RA) portions of the attached SOW. All documents and deliverables will be identified consistent with terminology used in the attached RSE/RAD/RA SOW.

36. Within thirty (30) days from the effective date of this Consent Order Respondents shall commence the implementation of the tasks detailed in the approved RSE Work Plan (Phase 2 of the above described Revised Plan); within thirty (30) days from the effective date of this Consent Order or after obtaining necessary access rights, Respondents shall commence the implementation of the off-site tasks detailed in the approved RSE Work Plan (Phase 2 of the above described Revised Plan). The work shall be conducted in accordance with the standards and specifications in the RSE Work Plan.

37. Within one hundred and eighty days (180) days from the effective date of this Consent Order, Respondent shall submit a draft RAD Report for KDHE approval; provided, KDHE shall grant an extension of this one hundred and eighty (180) day submittal date to the extent necessary due to any significant delays that may be encountered by Respondents in obtaining required off-site access rights. The draft RAD Report is to be prepared consistent with the RSE/RAD/RA SOW and is to specifically include a summary of RSE work completed.

38. KDHE shall provide comments on the draft RAD Report. Within thirty (30) days of receipt of KDHE's comments, Respondent shall submit for final approval a revised RAD Report that addresses KDHE's comments. Upon KDHE approval, the revised RAD Report shall become incorporated into this Consent Order and a part thereof as Exhibit 5.

39. Within thirty (30) days of issuance of the KDHE final Removal Action Decision, Respondent shall submit for KDHE approval a draft RA Plan consistent with the Removal Action Decision and the RSE/RAD/RA SOW.

40. KDHE shall provide comments on the draft RA Plan. Within thirty (30) days of receipt

of KDHE's comments, Respondent shall submit for final approval a revised RA Plan that addresses KDHE comments. Upon KDHE approval, the revised RA Plan shall become incorporated into this Consent Order and a part hereof as Exhibit 6.

41. Respondents shall provide preliminary and final reports and plans to KDHE according to the deliverables and milestones schedule contained in Exhibit 3 in a form responsive to KDHE's comments. After KDHE reviews the preliminary report or plan and after KDHE reviews the final report or plan, KDHE shall notify Respondents in writing, of KDHE's approval or disapproval of the report or plan or any part thereof. KDHE may also notify Respondents in writing of KDHE disapproval of Respondents' implementation of the approved RSE Work Plan.

42. In the event of any KDHE disapproval of a submitted report or plan or disapproval of Respondents' implementation of the approved RSE Work Plan, KDHE shall send Respondents a Notice of Disapproval delineating the deficiencies, requiring revisions to the reports or plan or modified work to cure the deficiencies in the work and setting a schedule for response by Respondents, provided however that any such requirements are consistent with the objectives of the Work Plans and Consent Order.

43. Thereafter, Respondents shall amend and submit to KDHE revised reports to cure the deficiencies in the reports in accordance with KDHE's requirements.

44. Subject to the dispute resolution provisions set forth herein, KDHE may determine that additional tasks are necessary, in addition to those identified in the deliverables and milestones schedule contained in Exhibit 3, to complete the SOW attached hereto as Exhibit 1 (other than implementation of any remedial alternative that may be selected by KDHE, such implementation being outside the scope of this Consent

Order) and to enable KDHE to promptly select a remedial alternative. KDHE may request Respondents to implement any such additional tasks within a timeframe specified by KDHE. Failure by Respondents to implement additional tasks as requested by KDHE, shall be considered a violation of this Consent Order.

45. All work performed pursuant to this Consent Order shall be under the direction and supervision of a professional engineer or geologist licensed in Kansas with expertise in hazardous waste site investigations and remediation. Within thirty (30) days of the effective date of this Consent Order, Respondents shall notify KDHE in writing of the name, title, and qualification of the engineer or geologist, and of any contractors or subcontractors and their personnel to be used in carrying out the terms of this Consent Order.

46. Any reports, plans, specifications, schedules and attachments required by this Consent Order are, upon approval by KDHE, incorporated into this Consent Order. Any noncompliance with such approved reports, plans, specifications, schedules, and attachments shall be considered a violation of this Consent Order.

47. No informal advice, guidance, suggestions, or comments by KDHE regarding reports, plans, specifications, and any other writing submitted to Respondents will be construed as relieving Respondents of their obligation to obtain written approval, if and when required by this Consent Order.

QUALITY ASSURANCE

48. All samples analyzed pursuant to this Consent Order shall be analyzed using laboratory methodologies approved by KDHE.

49. All sample collection and analysis shall be performed in compliance with the approved Work Plan, including scheduling of analyses, documentation of sample collection,

handling and analysis.

50. Laboratory analytical report forms shall be submitted to KDHE for all analytical work performed pursuant to this Consent Order. Any deviations from the procedures and methods set forth in these documents must be approved in writing by KDHE prior to use. Respondents will notify KDHE in writing within five (5) working days of notice or knowledge of a potential deviation from prescribed procedures or methods. Such notice shall provide information as to the nature of the deviation, if known, and outline a proposed investigation to determine whether the sample or results are potentially representative or should not be considered valid. If the results cannot be validated by evaluation of the Quality Assurance/Quality Control procedures, historical data, or laboratory protocol, Respondents will resample upon KDHE's approval and discretion. Respondents will notify KDHE at least seven (7) days before conducting resampling. Failure to follow the above procedure for notification of deviations will be considered violations of this Consent Order and will be subject to an administrative penalty of $1,000 per violation and the data resulting therefrom shall be invalid.

51. Respondents shall use the quality assurance, quality control, and chain of custody procedures specified in the Quality Assurance Project Plan, which is part of Appendix B of the RSE Plan, for all sample collection and analysis performed pursuant to this Consent Order, unless otherwise agreed to in writing by KDHE.

52. All contracts for field work shall provide that KDHE representatives are allowed access, for auditing and evaluation purposes, at reasonable times upon reasonable request, to all personnel utilized by Respondents for sample collection and analysis and other field work. Upon request by KDHE, the laboratories shall perform analysis of a reasonable number of known samples provided by KDHE to demonstrate the

quality of the analytical data.

REPORTING

53. Respondents shall provide KDHE with written progress reports quarterly, pursuant to the effective date of the Consent Order. At a minimum, these progress reports shall: (1) describe the actions, progress, and status of projects which have been taken toward achieving compliance with this Consent Order, as well as the actions which are scheduled for the next quarter; (2) identify any requirements under this Consent Order that were not completed as provided and any problem areas and anticipated problem areas in complying with this Consent Order; and (3) include all results of sampling, tests, data, and conclusions drawn from data generated pursuant to the Work Plan(s).

ACCESS

54. KDHE and any of its agents or contractors are authorized by Respondents to enter and freely move about all property at the Site, subject to Respondents' obtaining access rights to the Site from the City of Cherryvale or other owners thereof for the purposes of, *inter alia*; interviewing site personnel and contractors; inspecting records, operating logs, and contracts related to the activities set out in the Work Plan; reviewing the progress of Respondents in carrying out the terms of this Consent Order; conducting such sampling and tests as KDHE deems necessary; using a camera, sound recording, or other documentary type equipment; and verifying the reports and data submitted to KDHE by Respondents. Respondents shall permit such persons to inspect and copy all records, files, photographs, documents, and other writings, including all sampling and monitoring data, that pertain to work undertaken pursuant to this Paragraph.

55. To the extent that work required by the Work Plan must be done on property not owned or controlled by Respondents, Respondents shall use their best effort to obtain site access agreements from the present owner(s) of such property within sixty (60) days of the effective date of this Consent Order. Best efforts include, but are not limited to, reasonable payment of monies to the property owner. Any such access agreement shall be incorporated by reference into this Consent Order. In the event that agreements for site access are not obtained within thirty (30) days of the effective date of this Consent Order, Respondents shall notify KDHE regarding both the lack of and their failure to obtain such agreements within seven (7) days thereafter. In the event that KDHE obtains access for Respondents, all costs incurred by KDHE shall be reimbursed by Respondents. Upon KDHE's obtaining access for Respondents, Respondents shall undertake approved work on such property. KDHE shall not be responsible for any injury or damage to persons or property caused by the negligent or willful acts or omissions of Respondents, their officers, employees, agents, successors, assigns, contractors, or any other person acting on Respondents' behalf in carrying out any activities pursuant to the terms of this Consent Order.

SAMPLING AND DATA/DOCUMENT AVAILABILITY

56. Respondents shall make available to KDHE all results of sampling, tests, or other data generated by or on its behalf with respect to the implementation of this Consent Order. Respondents shall submit these results in the progress reports described in the "Reporting" section of this Consent Order. KDHE will make sampling results and other data available to Respondents.

57. Respondents shall notify KDHE at least seven (7) days before conducting any well

drilling, installation of equipment, or sampling. At the request of KDHE, Respondents shall provide or allow KDHE or its authorized representatives to take split samples of all samples collected by Respondents pursuant to this Consent Order. Similarly, at the request of Respondents KDHE shall allow Respondents or their authorized representatives to take split or duplicate samples of all samples collected by KDHE under this Consent Order. KDHE shall notify Respondents at least seven (7) days before conducting any sampling under this Consent Order, provided, however, that if seven (7) days notice of sample collection activity is not possible, KDHE and Respondents shall give such advance notice to enable each party to have a representative present during said sample collection activity.

RECORD PRESERVATION

58. Respondents agree that they shall preserve, during the pendency of this Consent Order and for a minimum of six (6) years after its termination, all records and documents which have not previously been provided to KDHE in its possession or in the possession of divisions, employees, agents or consultants or contractors which relate in any way to this Consent Order or to hazardous substance and hazardous waste management and disposal at the site. At the conclusion of six (6) years, Respondents shall then make such records available to KDHE for inspection or KDHE's retention or shall provide copies of any such records to KDHE.

STIPULATED PENALTIES

59. For each period of time that Respondents fail to submit reports or deliverables at the times set out in Exhibit 3 which is part of this Consent Order, Respondents shall pay as stipulated penalties the following: $1,000 for the first week of delay or part thereof; $2,000 per day for each day of delay for the 8th through 14th day; and,

$4,000 per day of delay thereafter. Any stipulated penalties shall be payable within twenty-one (21) days after Respondents' receipt of demand by KDHE and shall be paid by certified check to:

Secretary of Health and Environment
Attn: Bureau of Environmental Remediation
Administration
1000 SW Jackson Suite 410
Topeka, Kansas 66612-1367

A copy of the check and a transmittal letter shall be sent to the KDHE contact specified herein. Respondents shall each remit a check for the full amount of penalty stated in the demand.

60. Should Respondents fail to comply with a time requirement of any tasks required by this Consent Order, the period of noncompliance shall terminate upon Respondents' performance of said requirement.

OTHER CLAIMS AND PARTIES

61. KDHE and Respondents retain their respective rights to assert claims against other persons not parties to this Consent Order, and nothing in this Consent Order shall constitute or be construed as a release for any claim, cause of action or demand in law or equity against any person, firm, partnership, or corporation not a signatory to this Consent Order for any liability it may have arising out of or relating in any way to the generation, storage, treatment, handling, transportation, release, or disposal of any hazardous constituents, hazardous substances, hazardous wastes, pollutants, or contaminants found at, taken to, or taken from the Site.

OTHER APPLICABLE LAWS

62. All actions required to be taken pursuant to this Consent Order shall be undertaken

in accordance with the substantive requirements of all applicable local, state, and federal laws and regulations.

PROJECT COORDINATORS

63. On or before the effective date of this Consent Order, KDHE and Respondents shall each designate a Project Coordinator. Each Project Coordinator shall be responsible for overseeing the implementation of this Consent Order. The KDHE Project Coordinator will be KDHE's designated representative. To the maximum extent possible, all communications between Respondents and KDHE and all documents, reports, approvals, and other correspondence concerning the activities performed pursuant to the terms and conditions of this Consent Order, shall be directed through the Project Coordinators. The parties agree to provide at least seven (7) days written notice prior to changing Project Coordinators. The absence of the KDHE Project Coordinator from the Site shall not be cause for the stoppage of work.

NOTIFICATION

64. Unless otherwise specified or until written notification is provided by any of the parties, reports, notice or other submissions required under this Consent Order shall be in writing, or by facsimile, or upon prior verbal approval from the KDHE contact, email transmission and shall be sent to:

a. **For KDHE:**
E. Jean Underwood
Bureau of Environmental Remediation
Administration
1000 SW Jackson Suite 410
Topeka, Kansas 66612-1367
(785) 296-1681
Fax: (785) 296-7030
Email: junderwo@kdhe.state.ks.us

b. **For United States Steel Corporation:**

David L. Smiga, Esq.
General Attorney
US Steel
600 Grant Street, Rm 1500
Pittsburgh, PA 15219-2800
Fax: (412) 433-2811
Email: DLSmiga@uss.com

AND

Chuck Wentz
U.S. Steel Corporation
P.O. Box 336
George West, Texas 78022
Fax: (361) 449-2892
Email: CNWentz@uss.com

c. **For Salomon Smith Barney Holdings, Inc.:**

Ellen O'Brien, Esq.
300 St. Paul Place BSP07D
Baltimore, Maryland 21202
Fax: (410) 322-2947
Email: obriene@citi.com

AND:

William C. Anderson, Esq.
Doerner, Saunders, Daniel & Anderson, LLP
Suite 500
320 South Boston Avenue
Tulsa, Oklahoma 74103-3725
Fax: (918) 591-5362
Email: wanderson@dsda.com

d. **For Engineer Designated in Accordance with Paragraph 45**
Altay M. Ertugrul, P.E.
A&M Engineering and Environmental Services, Inc.
10010 E. 16th Street
Tulsa, OK 74128-4813
Fax: (918) 665-6576
Email: aertugrul@aandmengineering.com

REIMBURSEMENT OF COSTS

65. Three (3) months after the effective date of this Consent Order and quarterly thereafter, KDHE shall submit to Respondents an accounting of all oversight costs incurred by KDHE with respect to this Consent Order during the previous three (3) month period.

66. Based on the data developed by EPA in the Expanded Site Investigation Report and by KDHE in the Brownfields Targeted Assessment Report, KDHE does not presently believe that a Baseline Risk Assessment is necessary for the Site. However, if KDHE determines a Baseline Risk Assessment is appropriate, Respondent may, at its option, perform such assessment for submittal to KDHE for approval. In this event the Respondent shall pay KDHE's contractor to review the assessment on behalf of KDHE. In the event the Respondent elects not to perform the assessment, KDHE shall submit to Respondent an accounting for the cost of performing the Baseline Risk Assessment. Upon receipt of such accounting, Respondent agrees to reimburse KDHE for such amount in accordance with Paragraph 69 below. KDHE agrees to use a qualified contractor to perform such Risk Assessment.

67. If KDHE determines that a Community Relations Plan is appropriate with respect to this Consent Order, it shall submit to Respondents an accounting for the cost of development of a Plan for Community Relations, and implementation of such Plan. Upon receipt of such accounting, Respondents agree to reimburse KDHE for such amount in accordance with Paragraph 69 below. KDHE agrees to perform such work itself or use a qualified contractor to develop and implement such Plan.

68. KDHE shall submit to Respondents the cost of preparing and maintaining the

Administrative Record with respect to this Consent Order, including but not limited to photocopying, assembling, mailing, updating, storage and other maintenance services. Upon receipt of such accounting, Respondents agree to reimburse KDHE for such amount in accordance with Paragraph 69 below.

69. KDHE shall submit to Respondents an accounting of all oversight costs incurred by KDHE with respect to this Consent Order during the previous fiscal year. Respondents shall each, within thirty (30) calendar days from receipt of this and quarterly accounting, remit a check for one-half of the total amount of those costs made payable to the Secretary of Health and Environment. Checks should specifically reference the identity of this Site, and should be addressed to:

Secretary of Health and Environment
Attn: Bureau of Environmental Remediation
Administration
1000 SW Jackson Suite 410
Topeka, Kansas 66612-1367

A copy of the check and transmittal letter shall be sent to the KDHE contact specified herein.

DISPUTE RESOLUTION

70. If Respondents disagree, in whole or in part, with any decision by KDHE pursuant to this Consent Order, Respondents shall notify KDHE within thirty (30) days of receipt of the decision. The parties shall then have an additional thirty (30) working days to attempt to resolve the dispute. If an agreement is reached, the resolution shall be reduced to writing, signed by each Party and incorporated thereupon into this Consent Order. If agreement is not reached, KDHE shall issue a final written decision on the dispute.

71. Respondents reserve their right to appeal any decision of the KDHE, which is not consistent with law or which is arbitrary or capricious concerning a dispute under this Consent Order, to an administrative body with applicable jurisdiction and thereafter in compliance with the Kansas Administrative Procedures Act. The final decision or resolution of the applicable authority or court shall be incorporated as a part of this Consent Order. For purposes of this Consent Order, final order or decision shall mean an order or decision from which no appeal may be taken.

72. In the event that Respondents seek dispute resolution concerning a date for performance of an act set out in the Work Plan, the date for performance of such act shall be extended for a period equal to the delay resulting from the invocation of the dispute resolution provision. However, such extension does not alter the schedule for performance of completion of other tasks required by this Consent Order unless also specifically altered by the amendment of this Consent Order.

73. However, in the event that it is determined that dispute resolution was not sought in good faith, administrative penalties may be assessed at the rate of $1,000 per day for each day of delay caused by such invocation of the dispute resolution provisions.

FORCE MAJEURE

74. Delays that result from causes not foreseeable and beyond the Respondents' control and which cannot be overcome by due diligence shall not be a violation of the Respondents' obligations under this Consent Order. The Respondents shall notify KDHE orally as soon as possible, but no later than five (5) business days after the Respondents know of any delay or anticipated delay in compliance with the requirements of this Consent Order, and in writing no later than ten (10) business days after the oral notification of the delay. The written notice shall describe the

nature of the delay, whether and why the delay was unforeseeable and beyond the control of the Respondents, the actions taken and/or that will be taken to mitigate, prevent and/or minimize further delay, and the anticipated length of the delay. The Respondents shall adopt all measures to avoid or minimize such delay. To the extent a delay is caused by circumstances beyond the control of the Respondents, or those resulting from delays caused by KDHE or any third party not under the control or employment of any of the signatories hereto, the schedule shall be extended for a period equal to the delay resulting from such circumstances. Such an extension does not alter the schedule for performance or completion of other tasks required by this Consent Order which are unaffected by such unexpected delay events, unless also specifically altered by amendment of this Consent Order. Failure to comply with the notice provision of this section may be grounds for KDHE to deny the Respondents an extension of time for performance. Unexpected delay events do not include unanticipated or increased costs of performance, changed economic circumstances, or normal precipitation events (having due regard for seasonal fluctuations). If KDHE determines that the delay as stated in the Respondents' written notice to KDHE was not due to unexpected delay events, an administrative penalty may be assessed as provided in Paragraph 59.

EFFECTIVE DATE AND SUBSEQUENT MODIFICATION

75. This Consent Order shall become effective when signed by the Secretary of the Department of Health and Environment. This Consent Order may be signed in any number of counterparts, each of which shall be an original, and all of which taken together shall constitute a single instrument, with the same effect as if the signatures thereto were upon the same instrument.

76. This Consent Order may be amended by mutual agreement of KDHE and Respondents. Such amendments shall be in writing, shall have as their effective date the date on which they are signed by all parties, and shall be incorporated into this Consent Order. Nothing herein shall limit KDHE's ability to require additional tasks as set forth in Paragraph 44 herein.

77. Following completion of the activities contemplated herein and final issuance of the KDHE Removal Action Decision, the Respondents shall negotiate in good faith with KDHE concerning a Removal Action (RA) Consent Order, or an Amendment to this Consent Order to address implementation of removal action activities. If either an Amendment or RA Order is not agreed to by the Respondents within sixty (60) days of KDHE approval of the Final RA Work Plan, the KDHE reserves the right to issue a unilateral administrative order to Respondents. In the event such a unilateral administrative order is issued by KDHE, Respondents reserve all legal and/or factual rights, privileges and defenses available to them to defend against said unilateral administrative order.

TERMINATION

78. The provisions of this Consent Order shall terminate upon Respondents' receipt of written notice from KDHE that Respondents have demonstrated that the terms of this Consent Order, including any additional tasks which KDHE has determined to be necessary have been satisfactorily completed.

IN WITNESS WHEREOF, the parties have affixed their signatures below:

UNITED STATES STEEL CORPORATION:

By: James David Moniot

Title: General Manager, Environmental Affairs

Date: 3-18-03

SALOMON SMITH BARNEY HOLDINGS, INC.:

Ellen T. O'Brien

By: Ellen T. O'Brien
Title: Counsel

Date: March 18, 2003

STATE OF KANSAS:

Date: 4-7-03

Roderick L. Bremby, Secretary
Kansas Department of Health &
Environment

CERTIFICATE OF MAILING

I hereby certify that on this 7th day of April, 2003, I deposited a true and correct copy of the above and foregoing Consent Order in the United States Mail, postage prepaid, and addressed to:

William C. Anderson
Doerner, Saunders, Daniel & Anderson, LLP
Suite 500
320 South Boston Avenue
Tulsa, Oklahoma 74103-3725

David L. Smiga
General Attorney
US Steel
600 Grant Street, Rm 1500
Pittsburgh, PA 15219-2800

Karna J. Marinka
KDHE Staff Person

EXHIBITS

SCOPE OF WORK	1
SITE MAP	2
DELIVERABLE SCHEDULE	3
REVISED PLAN	4
REMEDIAL ACTION DESIGN REPORT	5
REMEDIAL ACTION PLAN	6

REVISED PLAN
for
FORMER NATIONAL ZINC SITE
CHERRYVALE, MONTGOMERY COUNTY, KANSAS

September 16, 2002

Presented to:

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT

1000 Southwest Jackson, Suite 410
Topeka, Kansas 66612-1367

RECEIVED
SEP 17 2002
BUREAU OF
ENVIRONMENTAL REMEDIATION

Prepared by:

SALOMON SMITH BARNEY HOLDINGS, INC.
UNITED STATES STEEL CORPORATION

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Section I

Introduction

I. INTRODUCTION

Salomon Smith Barney Holdings, Inc. and United States Steel Corporation (Respondents) proposed a Plan (The Plan) for the former National Zinc site (Site) in Cherryvale, Kansas. The Plan consisted of Parts 1 through 7, and was submitted to Kansas Department of Health and Environment (KDHE) on or around April 3, 2002 for review and comment.

In preparing the Plan, the Respondents and their consultant, A & M Engineering and Environmental Services, Inc. (A & M Engineering) reviewed the available reports and correspondence listed below and relied on the information included in these documents.

a. The Expanded Site Inspection (ESI) Report (EPA I.D. KSD980-40698) and its appendices.

b. The Brownfields Targeted Assessment (BTA) Report prepared by KDHE in December 1999.

Respondents and their consultant also visited the Site on March 12, 2002 and met with KDHE at the Site and at the Cherryvale Library. The information obtained from discussions with the KDHE prior to, during, and after the Site visit was utilized in preparing the Plan.

In a letter dated August 2, 2002, KDHE related to Respondents their concerns and comments concerning the Plan and stated that they must be addressed to the Agency's satisfaction before KDHE will endorse the conceptual proposal. In Section II of this document, Respondents have set forth a response to KDHE's concerns and comments, and have addressed each comment separately.

The Revised Plan consists of five (5) phases, set forth in Sections IV through VIII hereof respectively. Phase 1 (Section IV) lists and presents the framework activities required for planning the initial field activities, which are presented in the Phase 2 Work Plan for Field Sampling and Construction for an interim Drainage System, hereinafter referred to as the "Phase 2 Work Plan" (Section V); Phase 3 (Section VI) provides for developing a Corrective Action Plan; Phase 4 (Section VII) provides for developing a Work Plan for Construction Activities; and Phase 5 (Section VIII) is to execute the Construction Activities Work Plan.

Respondents are seeking the approval by KDHE of the Phase 2 Work Plan (Section V) at this time. Phases 3, 4 and 5 are presented only to provide the framework for the full Revised Plan required to complete the project. Upon completion of the Phase 2 Work Plan, the Work Plans for other phases will be developed in their proper sequence and KDHE approvals will be obtained prior to their implementation.

The Phase 2 Work Plan (Section V) has been developed to implement the initial soil, sediment, surface water sampling and also the proposed Hydrogeological Investigation Work Plan. In the Phase 2 Work Plan, Respondents are also proposing to implement an interim Drainage Plan to limit the storm runoff water that enters the previously closed pond surface.

The information and data collected at the completion of the Phase 2 Work Plan will assist the Respondents in finalizing the Phase 3 Corrective Action Plan (Section VI) and obtaining KDHE

approval before proceeding with final development of the Phase 4 Work Plan for Construction Activities (Section VII).

As noted above, Respondents at this time request KDHE approval to proceed with the Phase 2 Work Plan (Section V). However, before moving to Section II of this Revised Plan and setting forth Respondents' responses to KDHE's August 2 Comment Letter, Respondents deem it important to bring one matter to KDHE's attention at the outset: the values for lead, arsenic and cadmium parameters included in the consensus-based TECs listed in Table 2 of the paper provided by KDHE as an attachment to its August 2 comment letter are well below the background levels at the site as measured by KDHE. Therefore, as is set forth more fully later in this document, Respondents believe that it is not feasible to use the consensus-based TECs as cleanup levels for stream sediments. Respondents believe that cleanup levels that are fully adequate and protective of the environment can be developed without reliance on the Table 2 TECs, and a framework for developing those cleanup levels is provided for herein.

Section II

Response to KDHE Concerns and Comments Included in August 2, 2002 Letter

II. RESPONSE TO KDHE CONCERNS AND COMMENTS INCLUDED IN AUGUST 2, 2002 LETTER

The following presents the Respondents response to each KDHE comment.

Comment 1: Section II-7-d, Page 4 – The text indicates that ground water contamination is likely not migrating offsite. This contention must be definitively established through ground water exploration and testing. In order to achieve finality for the site through the proposed remedy, this issue must be evaluated and resolved to KDHE's satisfaction. While KDHE ha agreed that the soil data generated during the 2001 Expanded Site Inspection (ESI) may be sufficient to guide the initial stages of contaminated soil consolidation and encapsulation at the site, the ground water exploration completed during that investigation was not sufficient to support conclusions concerning the nature, extent, or potential for exposure or ecological impacts posed by that contaminated medium. KDHE deems it necessary to determine the impacts to ground water, their extent off site, if any, and the relationship between ground water and surface water and the contamination therein. This investigative element was discussed during our on-site meeting. If, as the Work Plan suggests, the contamination is relatively immobile, the evaluation of its off-site impact should not be overly complex or burdensome. KDHE must consider both current and future use and identify the extent of contamination in ground water in order to evaluate remedial options and/or preclude any future potential for exposure through the implementation of meaningful and effective environmental use controls on affected properties on and off site.

Response: Respondents have prepared and are proposing a Hydrogeological Investigation Work Plan which is presented in Appendix A. The Phase 2 Work Plan also proposes to implement the Hydrogeological Investigation Work Plan. Following the completion of the proposed monitoring wells, Respondents will collect three monthly water quality and water level samples, as outlined in the Hydrogeological Investigation Work Plan and prepare a Phase 2 report which will present the information and data collected and also list the findings of the study and, if necessary, will also identify the applicable remedial options. All of the KDHE concerns listed in this comment will be addressed as part of the Phase 2 Work Plan and in the Phase 2 report.

Comment 2: Section II-4- To enhance the effectiveness and permanence of the remedy, consider using fly ash or hydrated lime to stabilize the waste and reduce the mobility of the inorganic constituents of concern.

Response: The contaminated soils and sediments will be removed in 6" layers, transported to the disposal area and spread with a dozer prior to compaction. Respondents note that during this process the contaminated soils will be well mixed and, under the proposed clay cap, will not leach any metal constituents. Therefore, Respondents believe that there is no need for additional stabilization of the removed soils and sediments by mixing with fly ash, hydrated lime or any other agent. Additionally, the disposal areas will be subject to deed restrictions where their future disturbance will be eliminated. Further, Respondents propose to construct an effective surface drainage system and cap for these areas.

Comment 3: Section II-4 – Before finalizing the remedial approach for the site, KDHE recommends the Respondents discuss the proposed remedy with the current landowner (the City of Cherryvale) to evaluate their future use plans for the site and evaluate whether the remedy could be reasonably modified to accommodate those future uses. In addition, it may be appropriate at the conclusion of the project to revise the site deed restriction to accommodate unrestricted or non-residential land use, as appropriate, in those portions of the site deemed free of soil and ground water contamination in excess of the Risk-Based Standards for Kansas (RSK) goals.

Response: Respondents are in the process of scheduling a meeting with the City to discuss this Revised Plan and to learn more about the City's plans for future usage of the site so they may be considered in the planning and execution phases of the project. Respondents' attorneys have also established contact with the City Attorney and, in principle, have discussed using property owned by the City as a source of clay and topsoil needed for the project. This borrow area is the same one utilized by the EPA during the residential soil removal project.

Comment 4: Section III, general comment – The Work Plan does not address the topic of long-term inspection and maintenance of the completed cap. This aspect of the remedy should be discussed; inadequate inspection and maintenance of the previous capping effort at the site led to failure of that remedy.

Response: A site inspection and maintenance plan will be developed under the requirements of the Phase 4 Construction Activities Work Plan and as a section of the Post Closure Care and Monitoring Plan. Respondents and their attorneys will discuss the site maintenance issues with the City of Cherryvale since it owns the property.

Comment 5: Section III, general comment – The United States Environmental Protection Agency (EPA) constructed a temporary cap over the soil repository for material excavated from residential yards and the Rodeo Grounds during their recent removal action, allowing the Respondents greater control over the ultimate cost of final capping. The Work Plan should address necessary improvements to that portion of the site to ensure the cap over those materials achieves the minimum construction standards and site remediation goals.

Response: The Respondents are in contact with the EPA's Project Manager. EPA was planning to start the Land Survey of the disposal area where they placed the soil material excavated from the residential yards. EPA also informed the engineer that they placed a minimum of 6" of soil cover over the disposal area. Respondents are planning the following regarding the EPA's disposal area:

1. Inspect the condition of the disposal area used by EPA.
2. Obtain the land survey report and plot the data from that report on the site map to be used by Respondents.
3. Conduct a Sampling Plan of the EPA disposal area as part of Phase 2 and as outlined in Appendix B.

4. Based on the findings of items 1 through 3 listed above, develop an activity in Phase 4 to grade and cap this area.

Comment 6: Section III-4-A, Page 7 – The Work Plan does not include a protocol for collection of confirmation samples following excavation of soil lifts. The plan should specify the spatial frequency, location, and method for collection and analysis of the confirmation samples. The text suggests that lead will be used as an indicator in determining the contaminated soil removal areas. Note that while the ESI findings indicated that arsenic contamination in excess of the KDHE non-residential RSK was largely co-located with lead contamination, this was not universally true; consequently, some areas may need to be addressed based on arsenic concentration. The constituents of concern, arsenic, cadmium and lead, should be included in confirmation sampling to verify the effectiveness of the soil removal.

Response: Under the Phase 3 Corrective Action Plan, Respondents will develop and submit a Sampling Plan to KDHE for review and approval which will include a protocol for confirmatory sampling of the excavated areas for soil and sediment removal and also for verification of the surface areas surrounding the identified excavation areas. The sampling protocol will require analysis of lead, arsenic and cadmium constituents in all samples.

The arsenic and cadmium results of KDHE sampling at the site were plotted on Figures 3-1 and 3-2. None of the cadmium samples exceeded the RSK value of 1000 mg/Kg.

Figure 3-3 shows the areas exceeding the RSK values for lead and arsenic at the site. Figures 3, 3-1, 3-2 and 3-3 are included at the end of the text.

Comment 7: Section III-4-A, Page 7- The text suggests that any area exceeding the RSK goal for lead after excavation of 18 inches of waste will be capped in place. It may be more economical and appropriate to determine the depth of soil exceeding the RSK goal before beginning any excavation. KDHE defers to the preference of the Respondents on this matter.

Response: Respondents will defer the decision whether to collect and analyze additional subsurface samples until after they meet with the City representatives and learn more about the City's plans for future usage of the site. If necessary, Respondents will either prepare an amendment to the Phase 2 Work Plan or include this sampling program in the Phase 3 Corrective Action Plan.

Comment 8: Section III-4-A, Page 7 – The goals for a stabilization/encapsulation remedy of this sort are specifically to minimize infiltration of precipitation into the waste, promote good surface drainage, resist erosion, improve aesthetics, minimize long-term maintenance, protect human health and the environment, and consider final use. The Work Plan for capping does not include specific performance standards to ensure these goals are attained by the remedy. The proposed 18-inch infiltration layer should have a hydraulic conductivity less than or equal to the hydraulic conductivity of any bottom liner system or natural subsoils. Where underlying soils possess hydraulic conductivities

greater than 1 x 10^{-5} centimeters per second, the infiltration layer should achieve 1 x 10^{-5} as a maximum permeability. The material used for the infiltration layer should, to the extent practicable, be free of rocks, clods, debris, cobbles, rubbish, and roots that may increase the hydraulic conductivity. The proposed cap should be adequate to withstand the local freeze-thaw conditions, which can be obtained from the Soil Conservation Service, local utilities, construction companies, and local universities. While six inches of soil dressing to support vegetations is an appropriate minimum, that layer should be matched to the rot zone needs of the proposed final vegetation, which has not been specified in this preliminary work proposal. Please include these or alternative proposals for performance criteria for the contemplated cap.

Response: Under the Phase 4 Construction Activities Work Plan, a Quality Assurance/Quality Control (QA/QC) Plan will be prepared and submitted to KDHE for approval. The QA/QC Plan will include procedures and specifications for selecting suitable clay and top soil material for construction of all the earthen components of the project. For clay material to be used for constructing the cap, permeability analysis will be performed along with development of windows information and, during the construction, compaction and moisture levels will be measured in order to assure that the compacted clay layers will meet the permeability requirements, which will be no greater than 1 x 10^{-7} centimeters per second.

The QA/QC Plan will meet the KDHE specifications for constructing clay cap, placement of vegetative and top soil (see Phase 3, (Section VI), paragraph 1)), and proper selection and placement of seeding.

Comment 9: Section III-4-B, Page 9 – The Work Plan proposes to use three times the arithmetic mean of the KDHE background sampling results to assess sediment impacts. This value is valid for assessment purposes at the CERCLA site screening phase but does not constitute an appropriate remedial goal. KDHE and the United States Fish and Wildlife Service (USFWS) are in the process of developing a sediment management strategy for the protection of freshwater ecosystems in Kansas. That strategy includes the use of consensus-based threshold effect concentrations (TECs), a composite goal that reflects current understanding of the contaminant level below which toxic effects are unlikely to be observed in the ecosystem. A copy of the Archives of Environmental Contamination and Toxicology article "Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems" is enclosed; the consensus-based TECs are listed in Table 2. These numbers are appropriate for assessment of the site and as remedial goals for dredging; however, before commencing any dredging operations, the KDHE/Bureau of Environmental Remediation must coordinate those activities with and obtain the concurrence of the KDHE Bureau of Environmental Field Services (BEFS), the Kansas Department of Agriculture Division of Water Resources (KDA/DWR) and USFWS. Those groups are tasked with evaluating the affected stream reaches to determine whether dredging to remove contaminants will be beneficial or harmful to the local ecological communities, and determining whether any

dredging management measures or post-dredging restorative measures are warranted. Once the Respondents have completed the sediment/surface water impact assessment phase described in the Work Plan and prepared a formal work proposal to address the affected stream reach(es), KDHE will review that proposal and site conditions with those stakeholders. Please revise the plan to include this sediment impact assessment and remediation strategy.

Response: Respondents have reviewed the paper titled "Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems" provided by KDHE as an attachment to the August 2, 2002 letter. The consensus-based TECs recommended in this paper are far below the background levels for constituents of concern in Drum Creek sediments as measured by KDHE. The following presents a comparison of TECs with KDHE sample results for sediment background concentrations for lead, cadmium and arsenic:

	Consensus Based TEC Mg/Kg	Sediment Background in Drum Creek Mg/Kg
Lead	35.8	36.11
Arsenic	9.79	27.79
Cadmium	0.99	3.76

Respondents propose, as part of Phase 2, to conduct the sediment and surface water sampling plan presented in Appendix B in order to gather additional sediment and surface water quality data to determine the following:

1. Further define the background levels of parameters of concern. Sediment samples including the background samples taken from Drum Creek will be analyzed for lead, arsenic, cadmium, mercury, chromium and zinc.

2. Collect a sufficient number of discreet sediment samples downstream from the point where the Unnamed Creek joins Drum Creek in order to study the level of environmental impact in Drum Creek and also to assist in developing cleanup levels for the parameters of concern.

3. Collect sufficient number of sediment samples from Unnamed Creek in order to prepare an inventory of the location and volume of sediments to be removed.

4. Surface water samples will be collected from approximately the same locations as the sediment samples in Drum Creek which will provide an indication as to the solubility of the parameters of concern in the sediments.

5. When standing water or water flow in the Unnamed Creek is encountered, a sufficient number of surface water samples will be collected to determine the level of impact and also to compare with ground water samples to determine if there is any interaction between groundwater and surface water.

6. By studying the data to be collected by the implementation of the Sampling Plan

proposed by the Respondents and the data previously collected by KDHE, Respondents will develop and propose cleanup levels for parameters of concern for sediments in Drum Creek and also the Unnamed Creek.

7. Respondents will also utilize data from the Phase 2 report to make recommendations as to which areas, if any, in Drum Creek would sediment removal be warranted and of benefit to the environment.

The surface water samples collected from Unnamed Creek and Drum Creek will be analyzed for lead, arsenic, cadmium, mercury, chromium and zinc.

In addition, the following information will be collected from the flowing surface water samples in both creeks: specific conductance by EPA Method 120.1, field temperature, total hardness as $CaCO_3$ and total suspended solids by EPA Method 160.2.

Comment 10: Section III-4-B, Page 9 – The Work Plan suggests that "Respondents do not anticipate removing any sediments from Drum Creek at this time." This may need to be re-evaluated in light of KDHE comment 8 above. Please review the KDHE findings for Drum Creek relative to the TECs or site-specific background concentrations for the inorganic constituents of concern.

Response: As stated in the response to Comment 9, at the completion of the Phase 2 Work Plan and Phase 2 report, sufficient data will be collected to examine if and where sediment removal from Drum Creek would be warranted and whether sediment removal would benefit short-term and long-term environmental quality in that stream.

Comment 11: Section III-4-C, Page 9 – See comment 7 above regarding capping goals and minimum performance requirements.

Response: See the response to Comment 8.

Comment 12: Section III-4-F, Page 10 – See comment 1 above regarding ground water contamination.

Response: See the response to Comment 1.

Comment 13: Section IV-Part 8, Task 3, Page 12 – See comment 8 (9) above regarding sediment remediation goals.

Response: See the response to Comment 9.

Comment 14: Site figures – Please include the EPA soil repository from the residential yards/rodeo ground removal action on the site figures. Also, it would be helpful to include the concentrations of site contaminants other than lead that were detected in

surface soil during the KDHE ESI, where the extent of contamination in excess of remediation goals extended beyond the lead impact shown on Figure No. 3.

Response: When the land survey information is provided by the EPA, Respondents will plot the soil repository site on the appropriate drawings. Respondents are also planning to conduct a soil testing program of the EPA disposal area as part of Phase 2 for measuring the lead, arsenic and cadmium levels in the contaminated soils placed in the repository site, as outlined in Appendix B.

The arsenic and cadmium sampling results are plotted on Figures 3-1 and 3-2. Figure 3-3 shows the areas exceeding the RSK values for lead and arsenic which generally coincide, with the exception of a small area north of the closed lagoon. Figures 3, 3-1, 3-2 and 3-3 are included at the end of the text.

Comment 15: Sampling and Analysis Plan, general – See comment 6 above.

Response: See the response to Comment 6.

Comment 16: Sampling and Analysis Plan, Sediment Sample Collection, Page 1 – Explain how composite results will be interpreted and how those interpretations will be applied for any remedial action deemed necessary, i.e., if a composite sample of 10 aliquots exceeds one tenth of the sediment action goal, will the entire sampled reach be considered for dredging? Also, it is unclear why so many samples are being dedicated to

the unnamed tributary segment when KDHE results indicated a significant impact throughout that stretch and beyond the confluence with Drum Creek. More useful information might be obtained by focusing sediment and surface water characterization efforts further downstream where the limits of impact might be reached and defined.

Response: The Revised Sampling and Analysis Plan presented in Appendix B requires that only discrete sediment samples be taken on the Unnamed Creek's drainage pathway for determining the location and the volume of sediments that will require removal. Discrete sediment sampling locations and the number of samples to be taken in the Unnamed Creek bed will be determined in the field.

Respondents are also proposing to take discrete sediment samples from the Drum Creek channel at locations shown in Figure 1 in Appendix B. The Respondents' objective is to take samples where sediments are concentrated. The sampling locations shown on Figure 1 may be adjusted in the field in order to take samples from locations where the sediments are concentrated.

Comment 17: Sampling and Analysis Plan, Sediment Sample Collection, Page 1 – The text indicates that KDHE background sample result values will be used, yet background samples are included in the sampling protocol and figure. The locations designated as background on the figure appear to be within an agricultural field. It is unclear how the Respondents propose to use results from these locations.

Response: The Revised Sampling and Analysis Plan presented in Appendix B eliminates background sampling locations for the Unnamed Creek. The previously proposed background samples in the drainage area feeding the Unnamed Creek are also eliminated.

Respondents are proposing to take additional sediment background samples for Drum Creek in order to establish a better data base to be used in determining a reasonable set of clean-up levels for the contaminants of concern. Respondents are also of the opinion that background sediment levels determined to represent Drum Creek should also be utilized for the Unnamed Creek since it feeds Drum Creek. Respondents are also preparing to utilize the KDHE background data along with the new data.

Comment 18: Sampling and Analysis Plan, Water Sampling, Page 7 – Surface water sampling is not included as a task element in the main work plan; however, KDHE deems that sampling appropriate. The Sampling and Analysis Plan initially indicates surface water samples will be collected along Drum Creek, and later that they will be collected along the unnamed drainage channel and Drum Creek. Surface water in the unnamed drainage, if present, should be collected to characterize the relationship between contaminated ground water and surface water. Surface water level gauging may also be a meaningful aspect of that effort.

Response: The Revised Sampling and Analysis Plan presented in Appendix B requires sampling the standing surface water and if flowing surface water exists, it will be

sampled and all surface water samples will be analyzed for the parameters of concern (lead, cadmium, chromium, mercury, arsenic and zinc).

At this time, Respondents do not believe that gauging on the Unnamed Creek or Drum Creek will be necessary.

Comment 19: Sampling and Analysis Plan, Water Sampling, Decontamination Procedures, Page 8 – After cleaning sampling equipment with Alconox and prior to collecting any samples, the equipment should be thoroughly washed with deionized water.

Response: The Revised Sampling and Analysis Plan includes a procedure to thoroughly wash the sampling equipment with deionized water prior to its use.

Comment 20: Sampling and Analysis Plan, Analytical Parameters, Page 9 – KDHE/BEFS has indicated that some additional surface water sample parameter analyses need to be conducted in order to assess and interpret surface water and sediment contamination meaningfully. Those parameters include: specific conductance by EPA 120.1, field temperature, total hardness as $CaCO_3$, and total suspended solids by EPA 160.2. Again, KDHE/BER will need to be coordinated with KDHE/BEFS, KDA/DWR, and USFWS after performing the initial sediment/surface water characterization activities and prior to initiating any stream remediation activities.

Response: The Revised Sampling and Analysis Plan includes procedures to measure the specific conductance by EPA Method 120.1, field temperature, total hardness as $CaCO_3$ and total suspended solids by EPA Method 160.2.

Comment 21: Sampling and Analysis Plan, Quality Control and Quality Assurance, Page 9 – The frequency of duplicate samples must be specified. Where reusable sampling equipment is employed to collect samples, equipment rinsate blanks should be collected at a rate of one per twenty investigation samples per medium or one per day per medium, whichever is less, to demonstrate that decontamination procedures are effective in preventing cross-contamination.

Response: The Revised Sampling and Analysis Plan, Quality Control and Quality Assurance, Page 9, has been revised to specify a duplicate sample frequency of one duplicate per 20 field samples collected.

The Revised Sampling and Analysis Plan also requires the following: where reusable sampling equipment is employed to collect samples, equipment rinsate blanks will be collected at a rate of one per twenty investigation samples per medium or one per day per medium, whichever is less, to demonstrate that decontamination procedures are effective in preventing cross-contamination.

Section III

Background Information

III. BACKGROUND INFORMATION

The key Site-specific information obtained from the documents above and considered in preparing the Plan and this Revised Plan is listed as follows:

1. The Site consists of approximately 360 acres containing the former National Zinc smelter facility on the northern edge of Cherryvale, Kansas.

2. At the request of KDHE, limited response actions were initiated at the site by National Zinc Company in October 1977. Beginning in 1979, contaminated water from the lagoon was treated and discharged into the adjacent Drum Creek. Ore and sludge were removed from the Site. Some of the remaining sludge was treated with lime and encapsulated on Site. The lagoon on the west side of the Site was filled with dirt and top soil and planted with grass. Five monitoring wells were installed on the western and southern edges of the lagoon. Analytical results of ground water samples collected in 1982, 1983 and 1984 showed high concentration levels of cadmium and lead. In an April 5, 1983 letter from KDHE to National Zinc, the cleanup and closure of the surface impoundments were found to be satisfactory and, at the same time, KDHE instructed National Zinc Company to perform some repair work of eroded areas and to continue ground water monitoring on a quarterly basis. Restrictive covenants limiting use of the Site were issued in 1983 and are still in effect.

3. In 1988, the City of Cherryvale purchased the Site property.

4. KDHE inspected the Site in May 1995 following a City of Cherryvale inquiry into possible restrictive covenant termination and re-development of the Site property. Surface water, soil, sediment and sludge/waste samples were obtained by KDHE. As a result of this sampling, Lead was detected at a maximum of 176,750 mg/Kg, above the non-residential Risk-Based Standard for Kansas (RSK) level of 1,000 mg/Kg. Cadmium was detected at 2,816 mg/Kg, above the Kansas non-residential RSK level of 1000 mg/Kg. The surface water and groundwater sampling results on Site exceeded Maximum Contaminant Levels (MCL) for Lead and Cadmium.

5. Cadmium was detected in surface and ground water up to 0.111 mg/L, which is above the MCL of 0.005 mg/L. In July 1996, sediment/sludge sampling indicated Lead of 1,786 mg/Kg, which is above the non-residential RSK level of 1,000 mg/Kg, and Cadmium in surface water up to 0.347 mg/L in standing water on Site.

6. On March 25, 1999, the City of Cherryvale submitted an application for KDHE to conduct a Brownfields Targeted Assessment (BTA) on the Site. The application was accepted by KDHE in April of 1999. The chemical and physical data collected during the BTA assessment were also used in preparing the ESI Report and, therefore, the conclusions included in the ESI Report are similar to those in the BTA Report. Following are the statements included among the conclusions of the BTA report.

   a. The BTA identified a significant area of Lead contamination in surficial soils at

the Site in excess of the Kansas RSK value of 1,000 mg/Kg for Lead in non-residential soils. The area of Lead contamination is generally in the immediate area of the intersecting railway and former production areas in the southeast portion of the Site, and lies to the northeast and southwest of the railway in this southeast area.

b. A large area, approximately the northeast ¼ of the site, was identified not to be significantly impacted by heavy metals constituents from the former National Zinc facility.

c. Surface water was identified to be impacted by several heavy metals constituents, primarily Cadmium, across the Site.

d. Elevated levels of Cadmium in ground water were also observed, primarily in areas underlain by the former lagoons, which were subsequently used as a waste disposal unit and covered. It does not appear that the ground water contamination is mobile and, thus, is likely not migrating off Site. Human exposure to contaminated ground water is minimal, although migration of impacted ground water in former lagoon to surface water via base flow is a probability.

7. In March 2001, KDHE completed an Expanded Site Inspection (ESI) Report for the Site. In preparing this report, KDHE conducted an extensive investigation and collected additional soil and water samples in order to fill data gaps. The following are among the conclusions of the ESI Report.

a. The pathways of greatest concern at the Site are the soil and surface water pathways. Observed release criteria for Hazard Ranking System (HRS) purposes appear to be met for both pathways as documented in the ESI.

b. Elevated Lead, Chromium and Silver concentrations were detected in the ground water. The area of elevated Lead, Chromium and Silver concentrations in ground water appears to be limited to within the former lagoon area.

c. In determining which surface water and soil samples were elevated, the laboratory results for off-Site samples for each type of constituent were compared with a concentration that was equal to or greater than three times (3X) the arithmetic mean of the background concentration.

Section IV

Phase 1—Develop Framework for Revised Plan

IV. PHASE 1 – DEVELOP FRAMEWORK FOR THE REVISED PLAN

The framework for developing the Revised Plan consists of Parts 1 through 5 set forth below:

Part 1: Identify any data gaps and prepare a sampling plan and quality control/quality assurance plan for any additional sampling:

Respondents believe that the chemical data gathered on the surface soil contamination at the Site is sufficient. Respondents are proposing additional sampling for two purposes.

1. Collection of additional sediment and surface water samples from within the Unnamed Creek and Drum Creek to assess the extent of contamination in the surface water pathway and to establish background levels.

2. Collect soil samples at EPA's disposal area to document the level of contamination in soils brought from off-site excavation.

Appendix B presents the proposed sampling plan and quality control/quality assurance plan for additional chemical soil, sediment and surface water sampling. Figure 1 shows the Site contour map and grid system, which is the same grid system used by KDHE in its investigations.

Part 2: Prepare a safety plan to be used during additional Site sampling:

The safety plan presented in Appendix C will be implemented during Site sampling activities. It will also be applicable to other field activities conducted at the Site.

Part 3: Develop an interim drainage plan:

Respondents believe that run-on storm runoff should be diverted from entering the previously closed lagoon surface area. An interim drainage plan has been developed to prevent surface water from entering the capped surface area of the previously closed lagoon, which will enhance the stability of the subsurface condition of this area and improving its ability to support the construction equipment and additional load from fill and capping material. Figure 2 presents the interim drainage plan in preliminary engineering design format. A shallow subsurface drain system will be added to the drainage system shown on Figure 2 in the field during construction.

Part 4: Develop a Hydrogeological Investigation Work Plan

Respondents developed and are presenting a Hydrogeological Investigation Work Plan in Appendix A to determine the impact of on-site conditions to groundwater

and determine if a relationship between groundwater and surface water exists.

Part 5: Submit the Revised Plan to KDHE for approval prior to implementation of Phase 2 (Section V):

Section V

Phase 2—Plan for Field Sampling and Construction of Interim Drainage System

V. PHASE 2 PLAN FOR FIELD SAMPLING AND CONSTRUCTION OF AN INTERIM DRAINAGE SYSTEM

Respondents propose that they be authorized by KDHE to proceed with the Phase 2 Work Plan outlined below in parts 6 through 9. They plan to schedule the field work as soon as KDHE approval is received.

Part 6: Implement the Soil, Sediment and Surface Water Sampling Plan presented in Appendix B.

Develop a report presenting the sampling results.

Part 7: Implement the interim Drainage Plan.

Following the construction of the storm runoff diversion dike around the closed pond, the water levels in the area will be measured on a monthly basis for a period of no less than three months in order to study and document the effects of the constructed dike.

Part 8. Implement the Hydrogeological Investigation Work Plan.

The Hydrogeological Investigation Work Plan presented in Appendix A will be implemented and the water quality sampling and water level measurements listed

in the Plan will be conducted. Also a report will be prepared to present the data collected and the findings of the study.

Part 9. Prepare a report to summarize the Phase 2 field work results.

In addition to the matters discussed in Parts 6, 7 and 8 above, this report will also include the following:

1. Develop and propose to KDHE clean-up levels to be used in determining areas where sediment removal will be warranted.

   The sediment samples previously obtained by KDHE showed background concentrations for lead, cadmium and arsenic well above the consensus-based TECs listed in the paper (Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems by D.D. McDonald, C.G. Ingersoll and T.A. Berger) provided by KDHE as an attachment to their August 2, 2002 letter.

   Also, the downstream sediment samples obtained by KDHE showed unexpected fluctuations. Respondents are proposing to take sufficient number of samples from both the Unnamed Creek and Drum Creek in upgradient and downgradient positions in order to prepare an effective sediment/surface water impact assessment report and to develop more

meaningful clean-up levels.

2. Study the impact of sediment removal from Drum Creek, evaluate the consequences of any removal, and quantify the volume of sediment to be removed from Drum Creek, if any, and from Unnamed Creek.

3. Evaluate the Hydrogeological Investigation Work Plan results and determine if there is any migration of on-site groundwater and, if any, what is the impact.

4. Identify and evaluate the corrective measures, if any, required for groundwater.

Respondents anticipate completing the implementation of Phase 2 Work Plan and submission of the Phase 2 report no later than 6 months from the date of receipt of approval from KDHE to proceed with Phase 2.

Section VI

Develop Corrective Action Plan

VI. PHASE 3 DEVELOP A CORRECTIVE ACTION PLAN

The Phase 3 Corrective Action Work Plan will be directed toward development of a Corrective Action Plan for the entire site. The Corrective Action Plan will be developed after completion of the Phase 2 Work Plan and report, and cover the following:

1. Consolidation of contaminated soils on the site.

   The following presents a brief description of the Respondents' present thoughts on the development of the Corrective Action Plan. Most of the information listed below was also included in the previous Plan dated April 3, 2002.

   Respondents propose to use Kansas non-residential RSKs to determine the areas and volume of contaminated soils to be removed and consolidated at the Site. These are 1000 mg/Kg for Lead, 1000 mg/Kg for Cadmium, and 38 mg/Kg for Arsenic.

   Surface areas where soil removal will be warranted will be determined using the chemical data previously gathered by KDHE. The lead, arsenic and cadmium concentrations will be utilized in determining the areas and volume of soil removal. Figures 3, 3-1, 3-2 and 3-3 show the analytical results and the areas exceeding the RSK values. The figures are included

at the end of the text.

Surface areas within the Site boundary with a total contaminant level equal to or above any of the following parameters, 1000 mg/Kg lead, 1000 mg/Kg cadmium and 38 mg/Kg arsenic will be excavated and transported to the previously closed lagoon area for placement. Figures 3, 3-1, 3-2 and 3-3 (figures are included at the end of the text) show the KDHE chemical sampling results and the areas where lead, cadmium and arsenic levels are equal to or exceed the RSK levels and, therefore, will require removal of contaminated soils in accordance with the following: an initial 6" thick layer of soil will be removed, and the excavated area retested. A confirmatory sampling will be performed based on a Sampling Plan that will be submitted to KDHE in the Phase 4 Construction Activities Work Plan to determine where additional soil removal is needed. If the RSK levels for any one of the contaminants of concern are still exceeded, an additional 6" layer of soil will be removed. Any excavated area that exceeds the RSK level for any of the contaminants of concern after removal of 18" of soil will be capped with a minimum of 18" thick compacted clay followed with 6" of vegetative soil followed by a 6" thick layer of topsoil and proper seeding. All other excavated areas will be covered with a minimum of 6" of soil and properly seeded.

The area utilized by EPA for placement of the excavated soils from residential areas will be evaluated. Respondents have been informed by EPA's Project Manager that the area utilized by EPA was properly graded and capped with a minimum of 6" thick clean soil. Respondents included an activity in the Phase 2 Work Plan to sample the contaminated soils in EPA's disposal site to determine if deed restriction will be required for this area and also if the cap placed by EPA will satisfy the KDHE requirements.

The excavated soil material will be placed on the surface of the previously closed lagoon area and graded prior to placing a new cap at the receiving areas which will contain a minimum of 18" of compacted clay followed with 6" of vegetative soil and 6" of topsoil and proper seeding.

2. Removal of sediments from Unnamed Creek and Drum Creek.

3. Repair of existing closed lagoon area.

4. A final surface drainage plan.

5. Groundwater remediation, if warranted

Section VII

Phase 4—Develop a Work Plan for Construction Activities

VII. PHASE 4 DEVELOP A WORK PLAN FOR CONSTRUCTION ACTIVITIES

As a result of Phase 3, a Corrective Action Plan will be developed for the site. The objective of the Phase 4 Construction Activities Work Plan is to develop a Corrective Action Construction Work Plan that will provide guidelines for the implementation of the Corrective Action Plan. The following will be included in this Construction Activity Work Plan:

- Engineering drawings to assist construction
- Volume calculations
- A Sampling Plan to collect and analyze confirmation sampling during the removal of contaminated soils an sediments from the surface water pathway
- Construction schedule
- QA/QC Plan for selection of suitable clay soil and the installation of the clay cap and other earthen components of the project
- Storm Runoff Management and Pollution Prevention Plan
- Post Closure Inspection and Maintenance Plan
- Plan for sediment control
- A Safety Plan covering the construction activities
- Dust Control and Air Pollution Prevention and Monitoring Plan
- Any other plans or procedures that may be determined later.

The Construction Work Plan will be submitted to KDHE for approval prior to startup of construction activities.

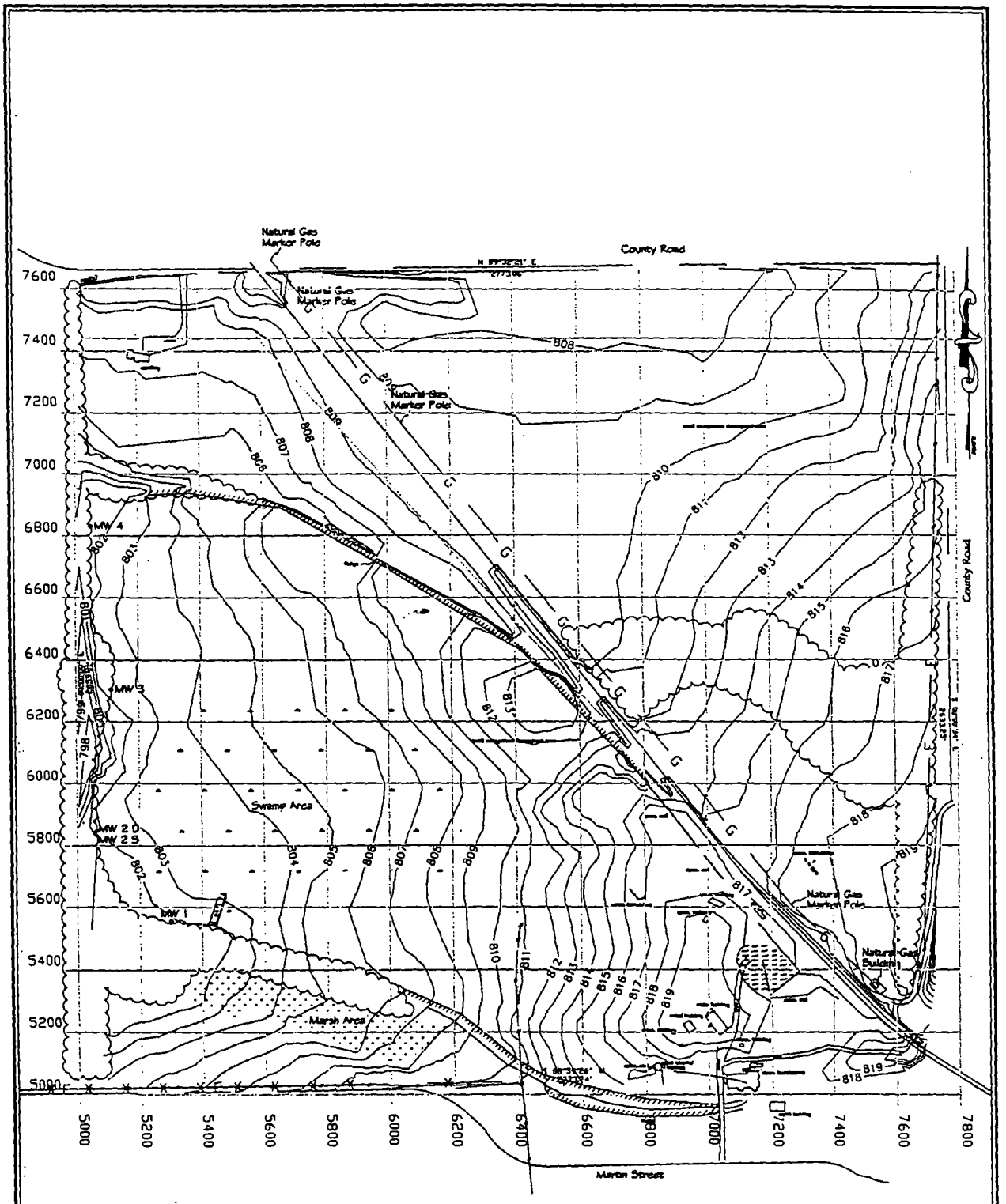
Section VIII

Phase 5—Execute the Construction Work Plan

VIII. PHASE 5 EXECUTE THE CONSTRUCTION WORK PLAN

Following are the work items to be included in this Plan:

- Conduct and complete construction activities
- Perform all QA/QC activities
- Prepare as-built drawings
- Prepare certification document
- Conduct land survey and prepare deed restrictions, as necessary.



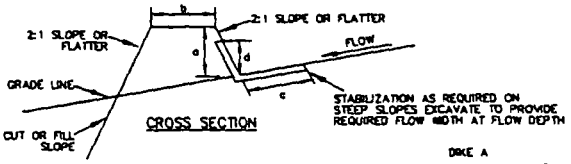
A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

BASE MAP
NATIONAL ZINC SITE, CHERRYVALE, KANSAS

SCALE:	DATE:	FIGURE NO.
1" = 300'	3-26-2002	1
APPROVED BY: AMF	DRAWN BY: ALB	PROJECT NO.

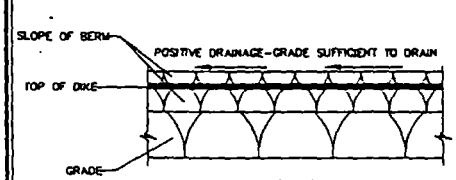
DETAIL–EARTH DIKE (DIVERSION DIKE)

NTS



CROSS SECTION

DIKE A	
a–DIKE HEIGHT	24"
b–DIKE WIDTH	24"
c–FLOW WIDTH	2'
d–FLOW DEPTH	12"



PLAN

STANDARD SYMBOL

A–1

CONSTRUCTION SPECIFICATIONS

1. ALL DIKES SHALL BE COMPACTED BY EARTH–MOVING EQUIPMENT.
2. ALL DIKES SHALL HAVE POSITIVE DRAINAGE TO AN OUTLET.
3. TOP WIDTH MAY BE WIDER AND SIDE SLOPES MAY BE FLATTER IF DESIRED TO FACILITATE CROSSING BY CONSTRUCTION TRAFFIC.
4. FIELD LOCATION SHOULD BE ADJUSTED AS NEEDED TO UTILIZE A STABILIZED SAFE OUTLET.
5. EARTH DIKES SHALL HAVE AN OUTLET THAT FUNCTIONS WITH A MINIMUM OF EROSION.
6. FLOW CHANNEL STABILIZATION SHALL BE PER THE CHART BELOW:

FLOW CHANNEL STABILIZATION

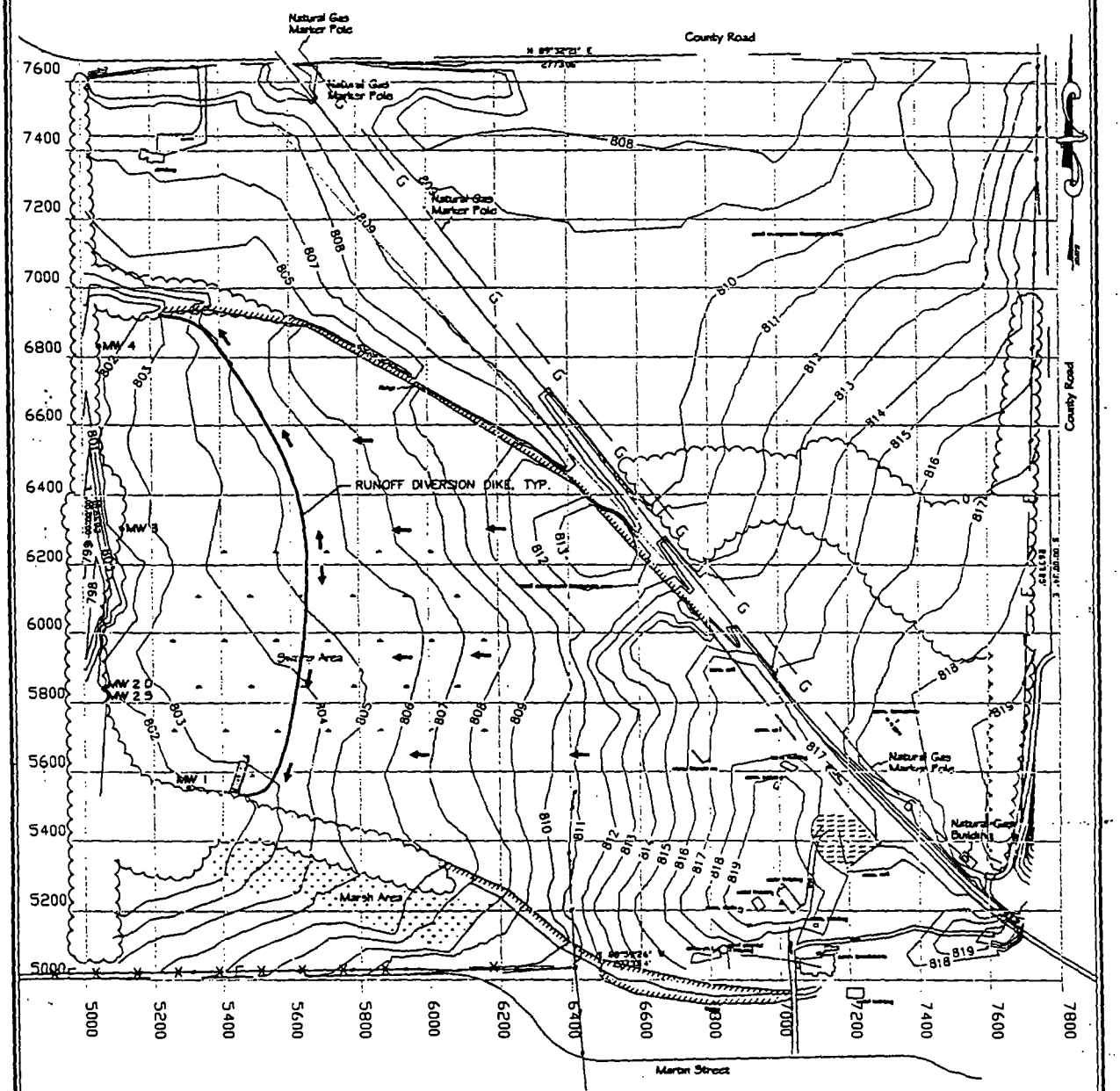
TYPE OF TREATMENT	CHANNEL GRADE	DIKE A
1	0.5–3.0%	SEED AND STRAW MULCH
2	3.1–5.0%	SEED AND STRAW MULCH
3	5.1–8.0%	SEED WITH JUTE, OR SOD; 2" STONE
4	8.1–20%	LINED RIP–RAP 4–6"

A. STONE TO BE 2 INCH STONE, OR RECYCLED CONCRETE EQUIVALENT, IN A LAYER AT LEAST 3 INCHES IN THICKNESS AND BE PRESSED INTO THE SOIL WITH CONSTRUCTION EQUIPMENT.

B. RIP–RAP TO BE 4–8 INCHES IN A LAYER AT LEAST 8 INCHES THICKNESS AND PRESSED INTO THE SOIL.

C. APPROVED EQUIVALENTS CAN BE SUBSTITUTED FOR ANY OF THE ABOVE MATERIALS.

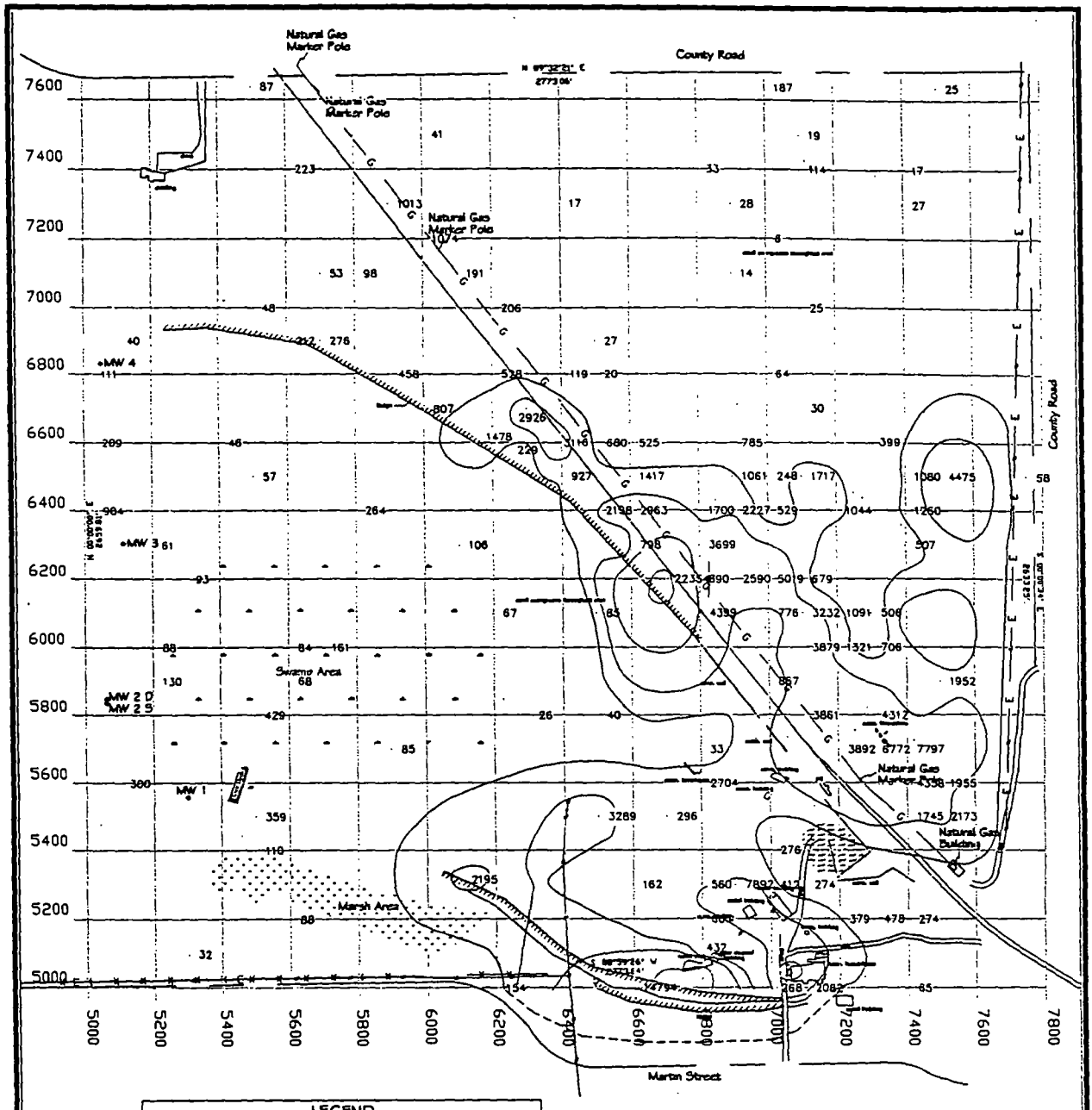
7. PERIODIC INSPECTION AND REQUIRED MAINTENANCE MUST BE PROVIDED AFTER EACH RAIN EVENT.



A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

RUNOFF DIVERSION DIKE
NATIONAL ZINC SITE, CHERRYVALE, KANSAS

SCALE:	DATE:	FIGURE NO.
1" = 300'	3–26–2002	2
APPROVED BY: AME	DRAWN BY: ALB	PROJECT NO.



LEGEND

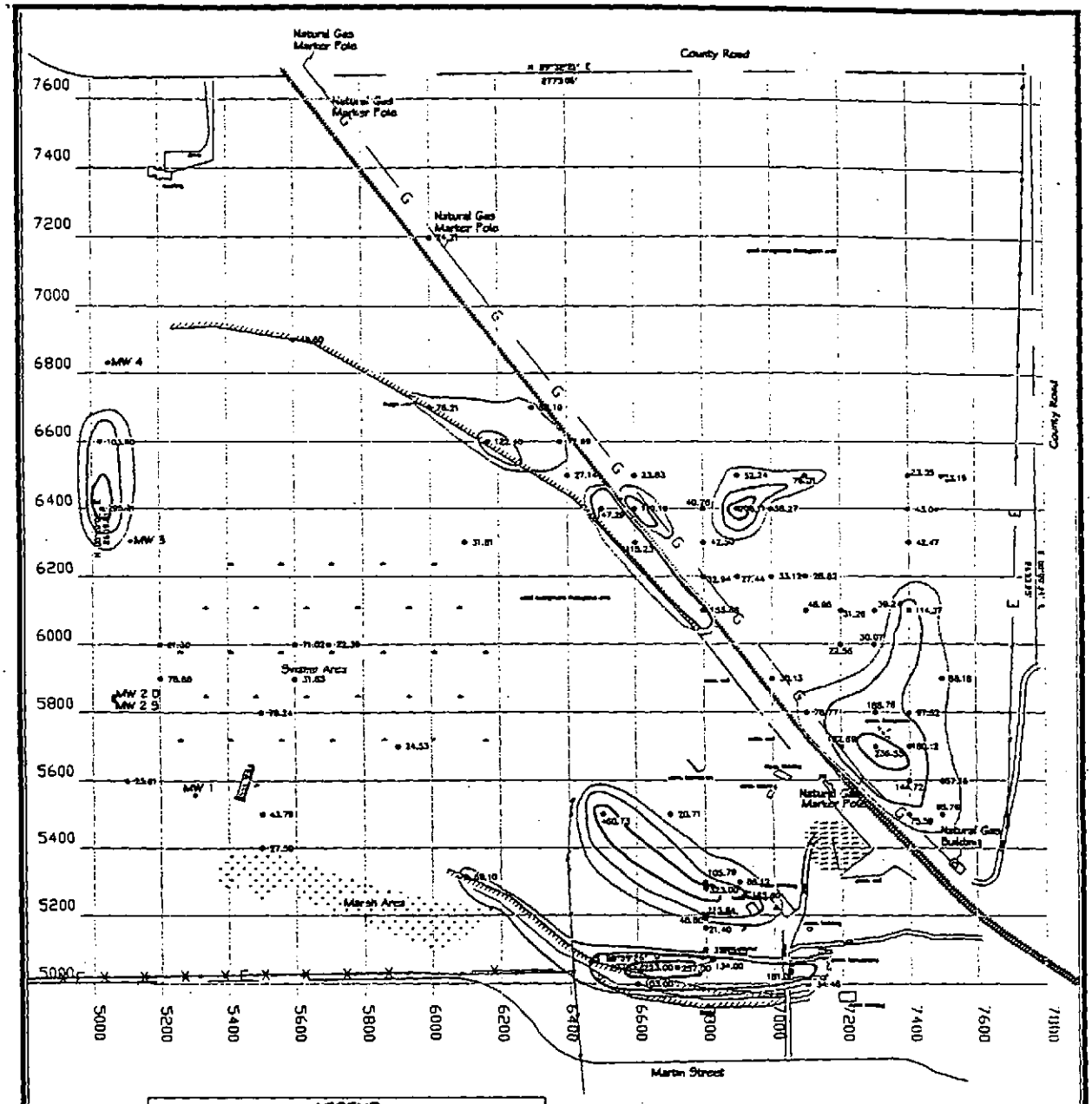
- 14794 = Sample Location & Concentration (mg/kg)
- = 1000 mg/kg Isocontour
- = 2000 mg/kg Isocontour
- = 5000 mg/kg Isocontour
- = 20000 mg/kg or greater Isocontour
- = Lath Set
- Power Pole
- Tree Line
- Water
- Railroad
- E — Overhead Electric
- G — Underground Natural Gas

LEAD
RSK = 1000 mg/Kg
RSK = RISK BASED STANDARD FOR KANSAS

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

KDHE LABORATORY RESULTS & ISOCONCENTRATIONS FOR LEAD
NATIONAL ZINC SITE, CHERRYVALE, KANSAS

SCALE:	DATE:	FIGURE NO.
1" = 300'	3-27-2002	3
APPROVED BY: AME	DRAWN BY: JDA	PROJECT NO.



LEGEND

- = Sample Location & Concentration (mg/kg)
- = 50 mg/kg Isocontour
- = 100 mg/kg Isocontour
- = 200 mg/kg Isocontour
- = Lath Set
- Power Pole
- Tree Line
- Water
- Railroad
- E — Overhead Electric
- G — Underground Natural Gas

CADMIUM

RSK = 1000 mg/Kg

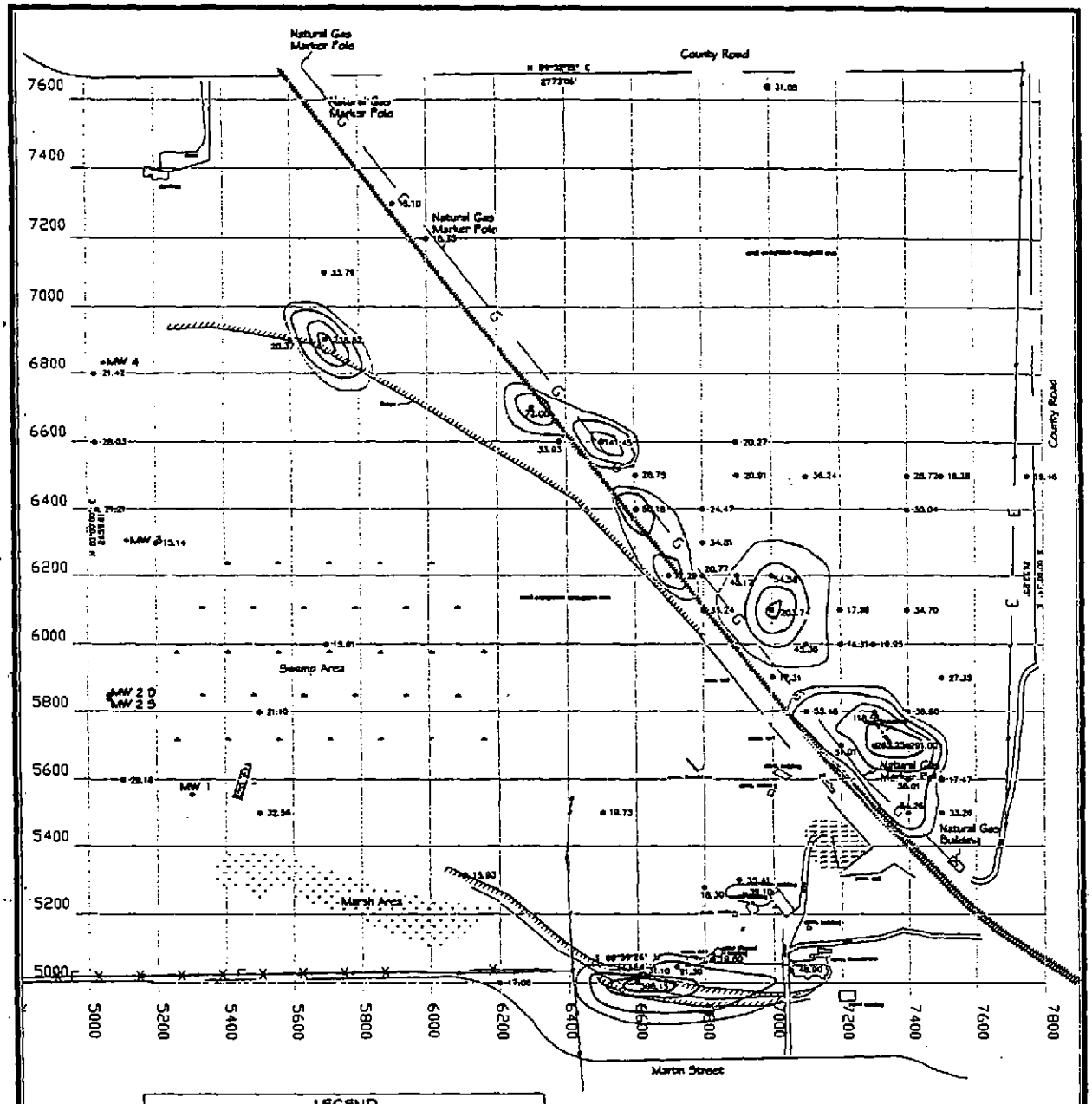
RSK = RISK BASED STANDARD FOR KANSAS

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

KOHE LABORATORY RESULTS & ISOCONCENTRATIONS OF CADMIUM
NATIONAL ZINC SITE, CHERRYVALE, KANSAS

SCALE:	DATE:	FIGURE NO.
1" = 300'	3-27-2002	3-1
APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.



LEGEND

- 17.09 = Sample Location & Concentration (mg/kg)
- 38 mg/kg Isocontour
- 50 mg/kg Isocontour
- 100 mg/kg Isocontour
- 200 mg/kg Isocontour
- Lath Set
- Power Pole
- Tree Line
- Water
- Railroad
- E — Overhead Electric
- G — Underground Natural Gas

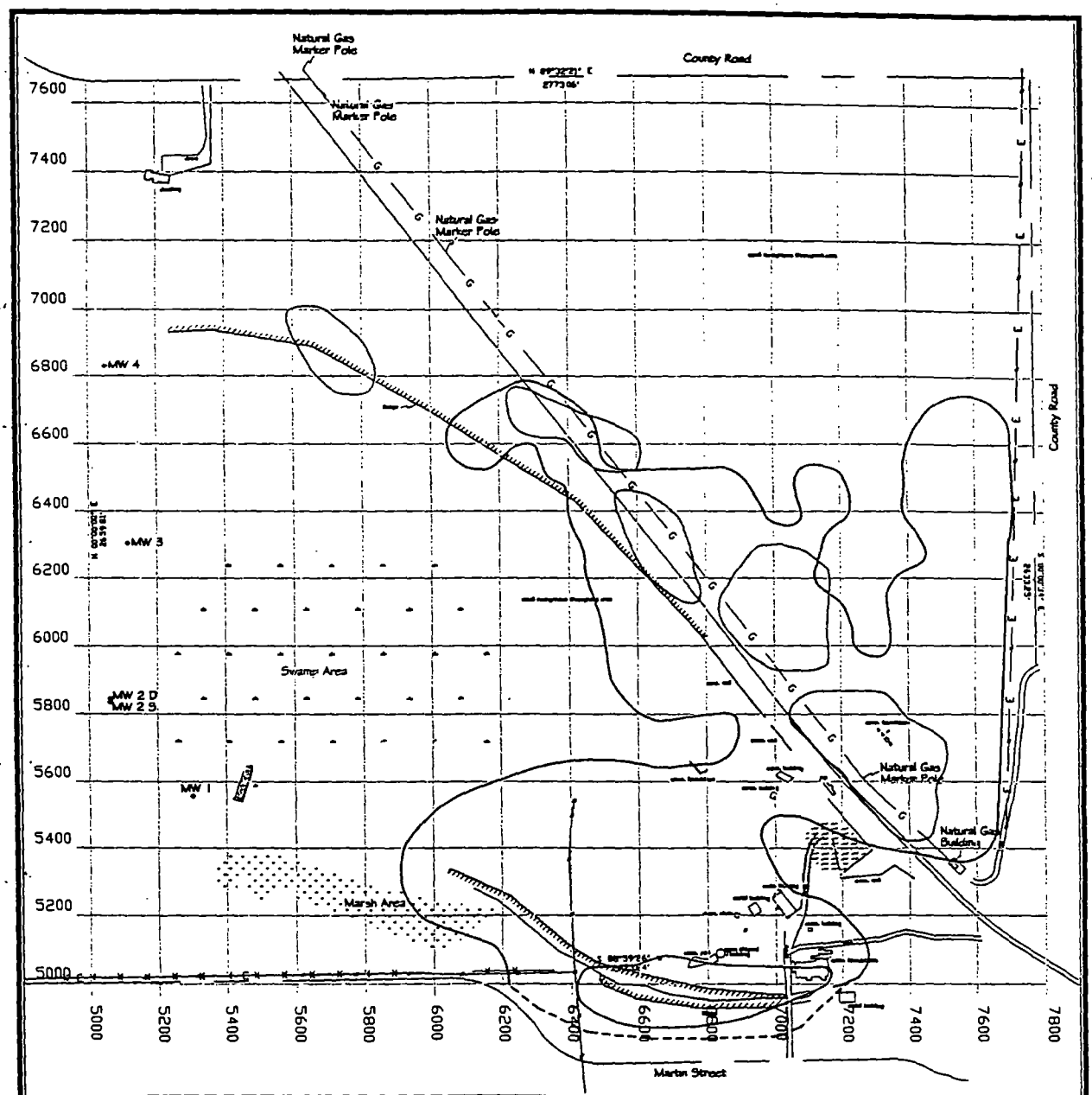
ARSENIC
RSK = 38 mg/Kg
RSK = RISK BASED STANDARD FOR KANSAS

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

KDHE LABORATORY RESULTS & ISOCONCENTRATIONS OF ARSENIC
NATIONAL ZINC SITE, CHERRYVALE, KANSAS

SCALE:	DATE:	FIGURE NO.
1" = 300'	9/10/2002	3-2
APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.



LEGEND

- = 1000 mg/kg or greater Lead Isocontour
- = 38 mg/kg or greater Arsenic Isocontour
- = Lath Set
- Power Pole
- Tree Line
- Water
- Railroad
- E — Overhead Electric
- G — Underground Natural Gas

LEAD
RSK = 1000 mg/Kg
ARSENIC
RSK = 38 mg/Kg
RSK = RISK BASED STANDARD FOR KANSAS
(NONE OF THE SAMPLES EXCEEDED RSK 1000 mg/Kg FOR CADMIUM)

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

IMPACTED AREAS ABOVE THE RSK VALUES
NATIONAL ZINC SITE, CHERRYVALE, KANSAS

SCALE:	DATE:	FIGURE NO.
1" = 300'	9-11-02	3-3
APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.

APPENDIX A

Hydrogeological Investigation Work Plan

CHERRYVALE NATIONAL ZINC SITE
HYDROGEOLOGICAL INVESTIGATION
WORK PLAN
CHERRYVALE, KANSAS

August 27, 2002

Prepared for

Salomon Smith Barney Holdings, Inc.

U.S. Steel Corporation

Prepared by

A & M Engineering and Environmental Services, Inc.
10010 East 16th Street
Tulsa, Oklahoma 74128
(918) 665-6575

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CHERRYVALE
NATIONAL ZINC SITE
HYDROGEOLOGICAL INVESTIGATION
WORK PLAN

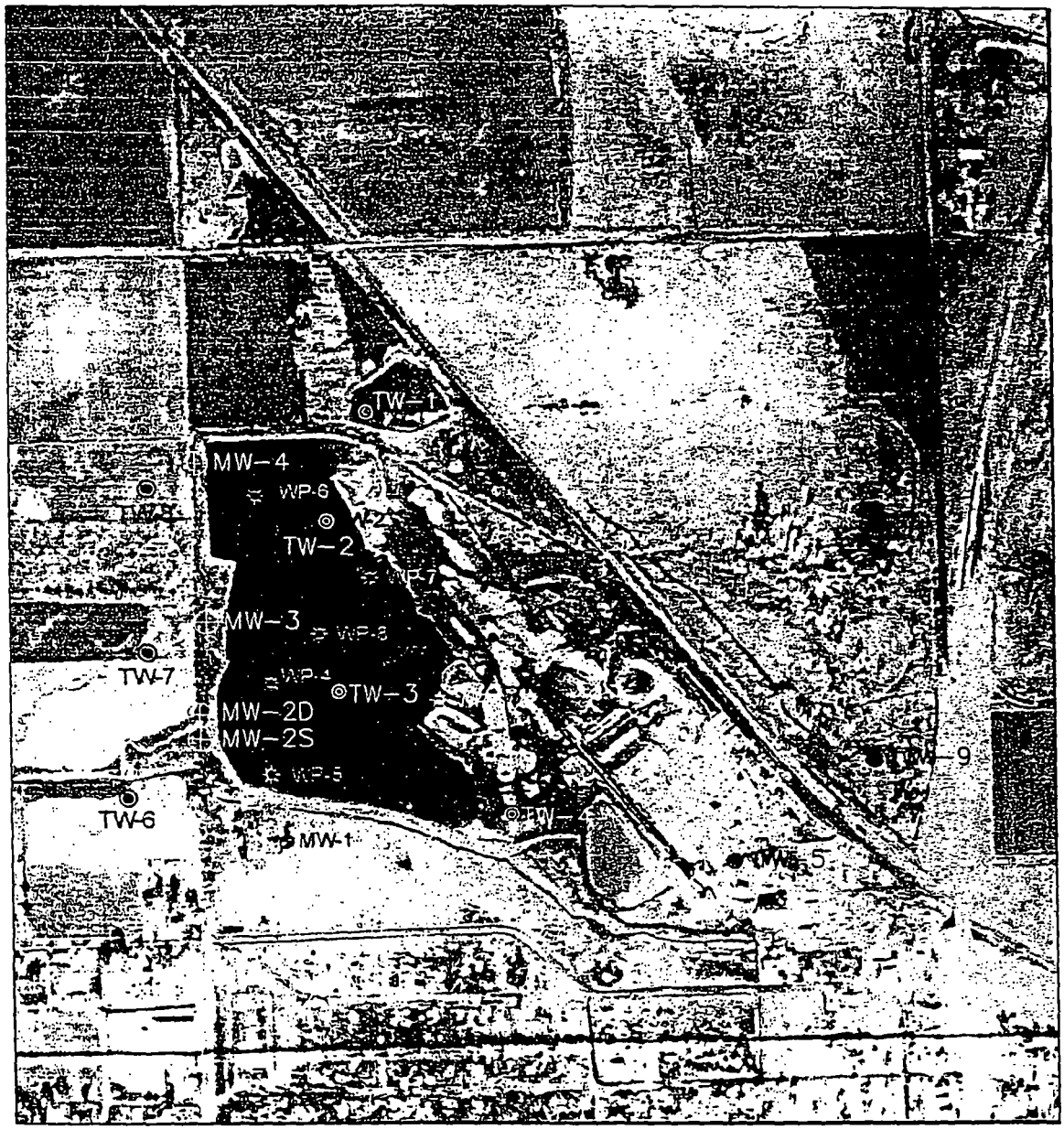
INTRODUCTION

Groundwater conditions at the former National Zinc site in Cherryvale, Kansas, are to be investigated to verify that groundwater contamination is not migrating off site. The proposed hydrogeologic investigation will address the groundwater flow and quality on site as well as off site and establish verifiable boundaries for contaminated groundwater. Data utilized in this investigation will include existing data in files and reports as well as new data.

BACKGROUND INFORMATION

The first series of soil tests and water levels was accomplished by Wichita Testing Laboratories as a lagoon embankment evaluation. These tests consisting of nine borings were completed in 1978. Data show a wet zone in silty clay at 7 to 12 feet, which overlies a limestone about 15 feet thick. Also in 1978, five monitor wells were drilled and completed. Each of these wells was drilled through the embankment and finished at depths from 12 to 19 feet, presumably at the base of the embankment fill. Three of these five wells (MW#2S, MW#2D and MW#4) were dry when measured on August 19, 1999. In August 1999, Kansas Department of Health and Environment (KDHE) drilled and completed nine test borings to obtain water quality data. The borings completed downgradient from the lagoon (TW-6, TW-7 and TW-8), as shown on Figure 1, were drilled to auger refusal and did not encounter the existing water table.

KDHE plugged TW-5, TW-6, TW-7 and TW-8 monitoring wells. TW-1, TW-2, TW-3, TW-4 and TW-9 are in place and in usable condition.



⊕ MW-1 MONITORING WELLS DRILLED IN 1978
◉ TW-6 TEMPORARY WELLS DRILLED BY KDHE IN 1999
☼ WP-5 WASTE PROFILE BORINGS DRILLED BY KDHE IN 1999

NOTE: TW-5,6,7,8 AND WP WELLS HAVE ALREADY BEEN PLUGGED

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

PREVIOUSLY DRILLED MONITORING WELLS AND BORINGS

NATIONAL ZINC FACILITY
CHERRYVALE, KANSAS

SCALE:	DATE:	FIGURE NO.
NOT TO SCALE	8/26/02	FIGURE 1
APPROVED BY: IT	DRAWN BY: GJJ	PROJECT NO.

OBJECTIVE

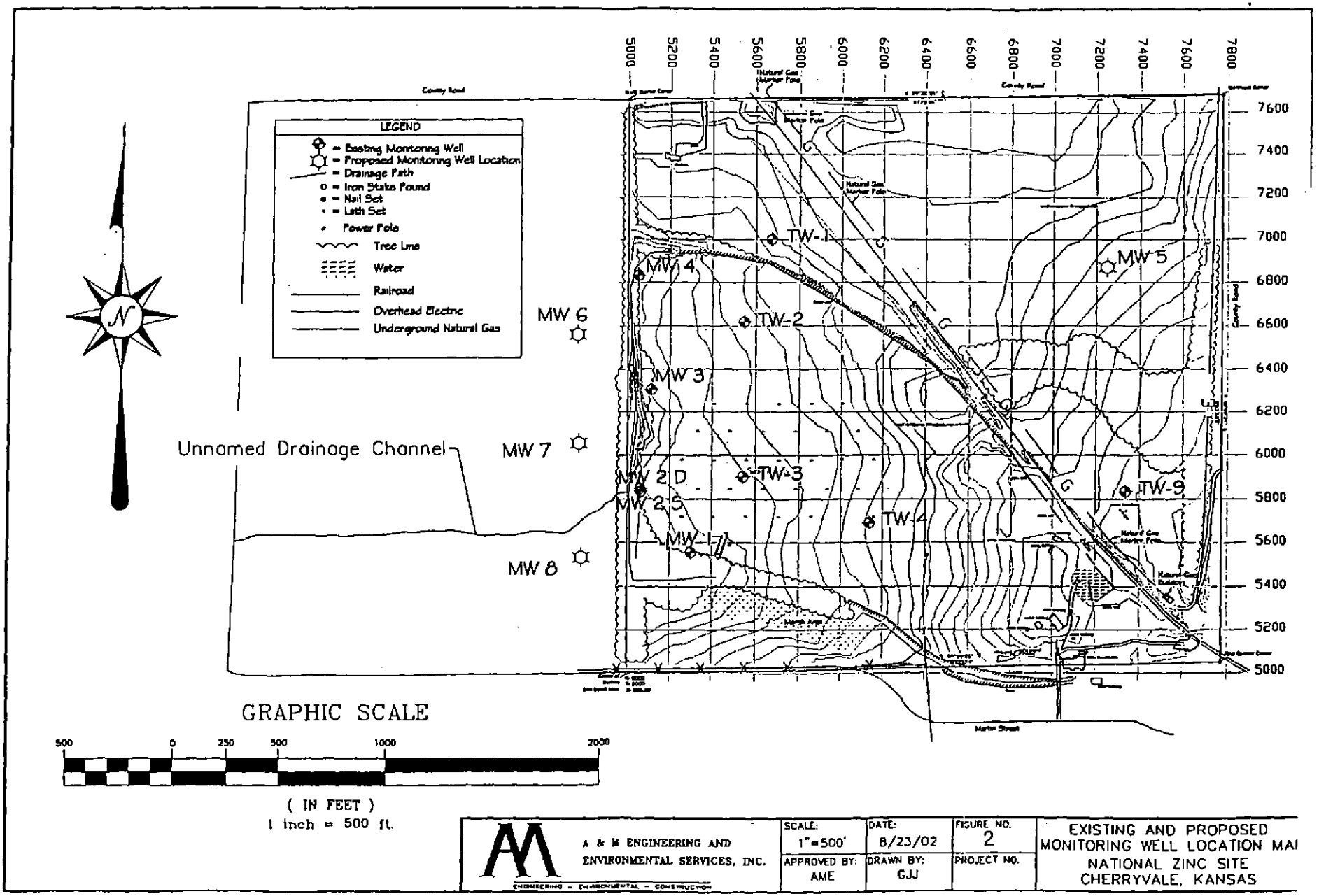
Based on existing data, it is believed that groundwater from the lagoon is not migrating off site. The purpose of this Work Plan is to confirm whether the groundwater indicated in on-site test borings is migrating and what contaminants, if any, are present in that water. To accomplish these tasks a series of monitor wells will be drilled and completed in the uppermost permeable water-bearing zone.

PROPOSED PLAN - MONITOR WELL LOCATIONS

The 1978 test borings for the embankment indicated a permeable zone in silty clay immediately overlying the weathered limestone. No borings in 1978 or 1999 have been finished in the limestone. The limestone at 15 to 20 feet is most likely the uppermost continuous permeable zone. The 1978 data indicated that this zone does contain water. Contaminated water in the lagoon area migrates downward through the silty clay to enter the limestone. If contaminated water migrates off site, most likely it does so through the limestone.

The hydrogeologic investigation will be accomplished by drilling and completing three monitor wells in the limestone downgradient (west) from the embankment. The locations for these three downgradient wells are shown on Figure 2.

Four wells (TW-1, TW-2, TW-3 and TW-4) were drilled and completed east of the berm in the general area of the fill and closed lagoon by KDHE. These wells were drilled to the top of the silty-clay, sandstone-rubble zone which is above the weathered limestone. These four wells will have water levels representative of the trapped water in the lagoon area. The chemical quality of this water was determined in 1999 by KDHE. This water was shown to be contaminated with certain toxic metals. These four wells will not be sampled and tested for the toxic metal contaminants of concern, but they will be measured for groundwater levels.



A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.	SCALE: 1"=500'	DATE: 8/23/02	FIGURE NO. 2	EXISTING AND PROPOSED MONITORING WELL LOCATION MAI NATIONAL ZINC SITE CHERRYVALE, KANSAS
ENGINEERING - ENVIRONMENTAL - CONSTRUCTION	APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.	

One new well will be drilled and completed east of the railroad tracks as shown on Figure 2. This upgradient well will be completed in the weathered limestone unit, as are the three downgradient wells.

The protocol of drilling and installation procedures for monitor wells is included in Appendix 1.

MONITOR WELL SAMPLING

All of the new and old monitor wells will provide water level elevations to be used to verify groundwater flow direction. Well water-level measurements will be taken monthly for a minimum of three months. Depending on evaluation of data from samples for those three months, further monthly sampling may be indicated for several additional months.

Chemical water quality samples will be taken from the four new wells monthly for three months. Each water sample will be tested for pH, Specific Conductivity, cadmium, lead, mercury, chromium, arsenic and silver. The KDHE tested the ten old wells, MW-1 through MW-4 on May 26, 1999, and TW-1 through TW-5 and TW-9 on August 25, 1999. At that time all wells had sufficient water for a sample. These data will be used for comparison with the new wells.

The Groundwater Sampling and Analysis Plan is included in Appendix 2.

PROPOSED DATA DISCUSSION

With the new water level data, an accurate groundwater flow may well be drawn. Hydraulic conductivity tests will be performed on the downgradient and upgradient limestone wells. No testing will be done on the in-lagoon wells as these wells will not penetrate the limestone, thus assuring no loss of low conductivity integrity of the clay layer over the limestone. With these data, rate and direction of flow will be established.

The water quality data will illustrate whether, as currently believed, water from the lagoon is not currently migrating off site, or if it is found to be migrating, where it is moving and what its chemical quality is.

APPENDIX 1

DRILLING AND INSTALLATION PROCEDURES FOR MONITOR WELLS

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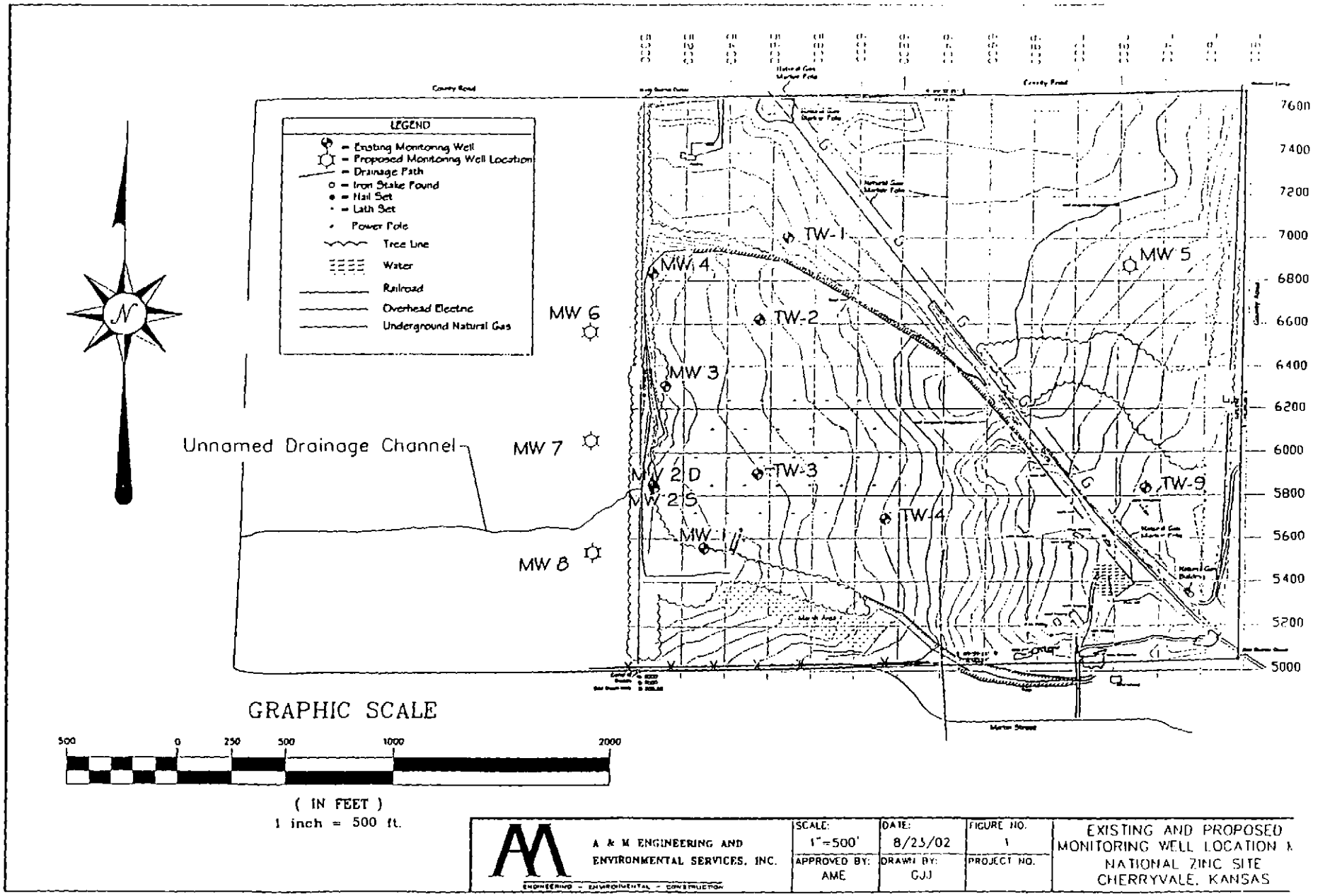
Monitoring Well Locations

For this project, four (4) new monitor wells will be installed. The first monitor well, designated MW-5, will be placed upgradient of the lagoon (northeast of the lagoon). Monitor wells MW-6, 7 and 8 will be located downgradient, west of the lagoon. Figure 1 depicts the approximate locations of the monitoring wells.

Monitoring Well Drilling

Monitor wells will be drilled using an auger or air rotary drill rig. The drilling auger will be used for boring the holes and removing encountered materials. The limestone section may require air rotary drilling. Each Monitor Well will be drilled into the uppermost aquifer to a depth of approximately 10-25 feet. The driller used for this project will be a Kansas certified monitoring well driller. Boring logs will be recorded for each Monitor Well location at the time of drilling by a Kansas Professional Geologist. At a minimum, boring logs will include:

- Project name and number
- Monitor well name/number
- Date and time of start and finish
- Weather conditions
- Geologist's name
- Driller's name
- Monitor well location
- Rig type bit size/auger size
- Depth to water
- Completion depth of monitor well
- Narrative description of encountered materials including:
    - Soil/rock type
    - Color and stain
    - Moisture content



A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.	SCALE: 1"=500'	DATE: 8/23/02	FIGURE NO. 1	EXISTING AND PROPOSED MONITORING WELL LOCATION NATIONAL ZINC SITE CHERRYVALE, KANSAS
	APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.	

    - Odor
    - Suspect contaminant
- Drilling observations including
    - Hole stability/caving
    - Advance rates
    - Drilling difficulties
- Equipment failures or other deviations from the drilling plan

Monitor Well Construction

After drilling, each well will be completed with 5 or 10 foot screen depending on uppermost groundwater depth. At least two feet of screen will be above the saturated zone (aquifer). The well casing for each monitor well will be PVC (Schedule 40) placed at least one foot above ground surface. The PVC casing and screen will have threaded joints with gasket seals. The filter pack will extend no more than three feet above the top of the well screen. The filter pack will be placed with a tremie pipe. Filter pack will be washed river sand with less than ten percent limestone, shale or sandstone. To seal the filter pack, bentonite pellets will be used. A minimum of two feet of certified sodium bentonite will be placed on top of the filter pack. Bentonite may be used to the surface. Cement with five percent bentonite will be prepared as a grout and placed over the bentonite seal with a tremie pipe up to ground surface. The monitoring wells will have locking caps. Since these wells are temporary monitor wells, no surface protector pipe and pad will be installed.

Monitoring Well Development

Well development will be accomplished by pumping or bailing each well. Before pumping or bailing, the pump or bailer will be thoroughly cleaned with a distilled water and Alconox mix and rinsed with distilled water, unless pre-cleaned disposable bailers

are used. The wells will be pumped or bailed until the water in each well is silt free. This determination will be a judgment decision by the well-site geologist.

Documentation of Monitor Well Construction and Completion

Each well will be surveyed for relative vertical elevation. A well completion log will be recorded for each monitoring well. Additionally, the driller will be required to complete and submit a monitoring well record form for each well and assign a number and submit to Kansas State Agency. An example of a typical well completion log form is provided as Figure 2.

COMPLETION LOG

A. M. K. ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

SITE NAME AND LOCATION	DRILLING METHOD:	PIEZOMETER NO.	
SEC T R	SAMPLING METHOD:	SHEET OF	
		DRILLING	
		START	FINISH
	WATER LEVEL / TIME	TIME	TIME
G.L. ELEV.	DATE	DATE	DATE
DATUM / TOC ELEV.	CASING DEPTH		
DRILL RIG	SURFACE CONDITIONS	CASING DIA 2"	SCREEN DIA 2"
ANGLE / BEARING			SLOT SIZE: .010
SAMPLE HAMMER TORQUE FT.-LBS			

DEPTH IN FEET (ELEVATION)	BLOWS/6 IN OR SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING SIZE	BLOWS/FOOT OR CASING	WELL CONSTRUCTION	NOTES
5								
0								
5								
10								
15								
20								
25								
30								
35								
40								
45								
50								

DRILLING CONTR.

LOGGED BY

CHK'D BY

DATE

FIGURE 2

APPENDIX 2

GROUNDWATER SAMPLING

AND

ANALYSIS PLAN

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PURPOSE

The purpose of the groundwater sampling and analysis is to ascertain the geochemistry of groundwater upgradient and downgradient of the former National Zinc facility, referred to as the "Site". Samples will be collected and analyzed for inorganic parameters.

QUALIFICATIONS OF SAMPLING PERSONNEL

The sampling will be directed by:

A & M Engineering and Environmental Services, Inc.
10010 East 16th Street
Tulsa, Oklahoma 74128
918-665-6575

Sampling personnel will consist of a Technician, Project Geologist, Health and Safety Officer and Project Manager. All on-site personnel, experienced in safety procedures and sampling of hazardous and non-hazardous materials, are trained under criteria set by 29 CFR 1910.120. This program instructs employees on general health and safety principles, proper operation of monitoring instruments, and the use of Personal Protective Equipment (PPE). Each employee also receives an eight hour annual update. The team consists of the personnel listed in Table 1, and will be assisted by field technician(s) under the supervision of a qualified team leader.

Table 1 : Field Sampling Personnel

NAME	AFFILIATION	TITLE
Irfan Taner PG	A & M Engineering	Project Geologist/Manager
Tony Mummolo	A & M Engineering	Chemist
David Anderson	A & M Engineering	Environmental Specialist
Jeff Elbert	A & M Engineering	Environmental Health & Safety
Jon Kuhn	A & M Engineering	Project Technician
Scott McReynolds	A & M Engineering	Project Technician
Ty Ertugrul	A & M Engineering	Environmental Specialist
Abby LaZar	A & M Engineering	Environmental Specialist

GROUNDWATER MONITORING SYSTEM

The former National Zinc facility (closed lagoon) has existing monitoring wells. The existing monitor wells are MW-1 through MW-4, TW-1 through TW-4 and TW-9. MW-1 through MW-4 wells are located on the western dike of the closed lagoon. TW-1 through TW-4 monitoring

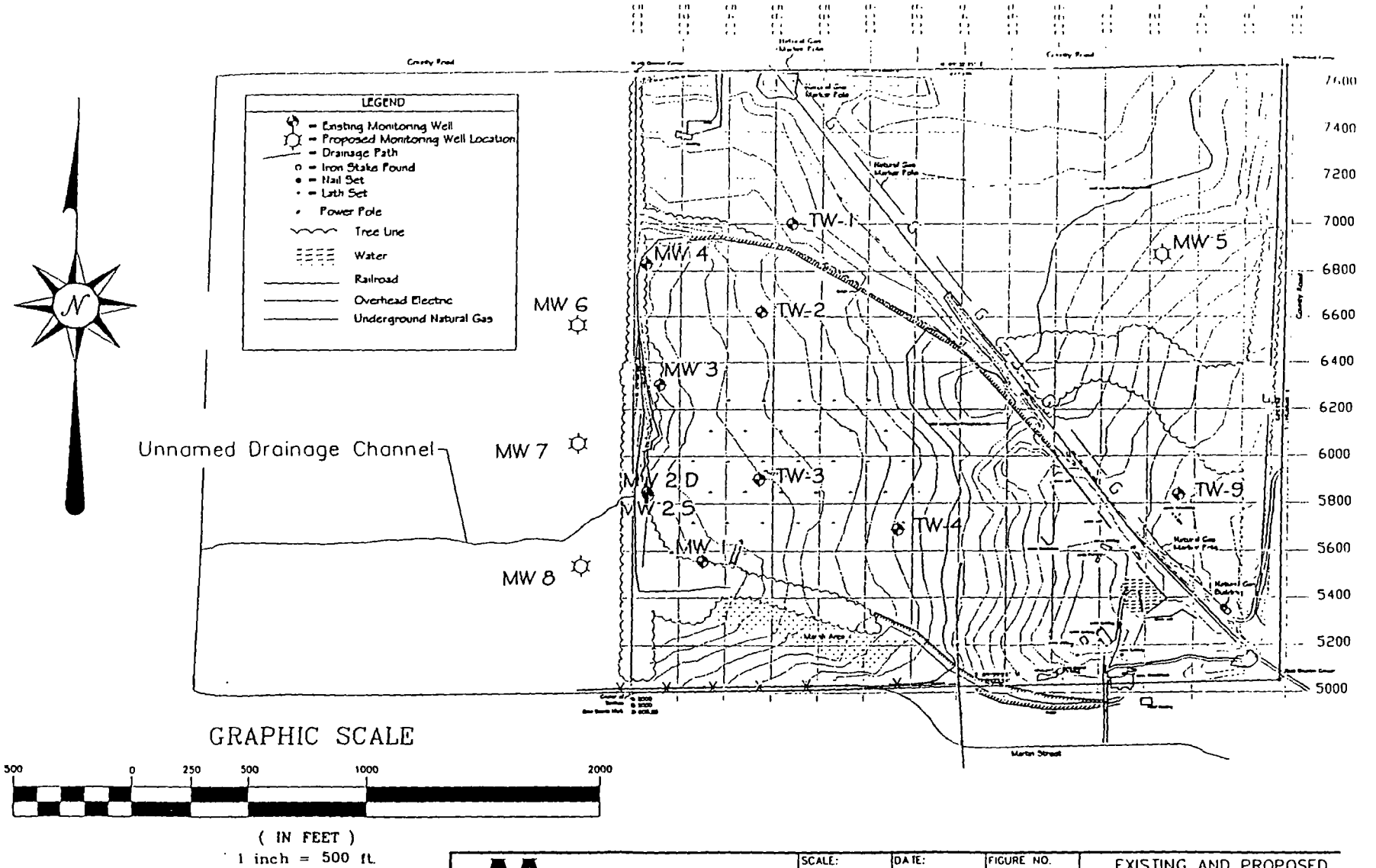
wells are located inside the former lagoon area. Also, there are four new proposed wells for the site. Figure 1 shows all the existing and the proposed monitor wells.

PARAMETERS

For each sampling event, the chemical constituents listed in Table 2 will be analyzed for each groundwater sample collected.

Table 2 : List of Parameters and Analytical Methods

PARAMETER	ANALYTICAL METHOD	PRACTICAL QUANTITATION LIMIT (PQL)(µg/l)
Specific Conductivity	EPA 120.1	N/A
pH	EPA 150.1	N/A
Arsenic	SW-846-6010	10
Cadmium	SW-846-6010	10
Lead	SW-846-6010	10
Chromium	SW-846-6010	10
Silver	SW-846-6010	10
Mercury	SW-846-7470-71	2



GRAPHIC SCALE

500 0 250 500 1000 2000

(IN FEET)
1 inch = 500 ft.

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC. ENGINEERING - ENVIRONMENTAL - CONSTRUCTION	SCALE: 1"=500'	DATE: 8/23/02	FIGURE NO. 1	EXISTING AND PROPOSED MONITORING WELL LOCATION M NATIONAL ZINC SITE CHERRYVALE, KANSAS
	APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.	

ORDER OF WELL VISITATION

To avoid cross contamination, well measurements will be taken starting with those wells with the least potential for contamination and proceeding to those wells with the highest potential for contamination. Well measurements will be taken at upgradient wells first, then downgradient wells, and finally the wells located inside the former lagoon area. Table 3 shows the proposed order of sampling.

Table 3 : Monitor Well Sampling Order

Sample Point Designation	Sample Point Identification
Upgradient Monitoring Well (MW)	MW-5, TW-9
Downgradient Monitoring Wells	MW-6, MW-7, MW-8
Existing Monitoring Wells	MW-1, MW-2S,D, MW-3, MW-4
Monitoring Wells in former Lagoon Area	TW-1, TW-2, TW-3, TW-4

RECORDKEEPING

The Field Sampling Team will maintain a compendium of Field Data Sheets. The Field Data Sheet shown in Figure 2 provide a permanent record of information about monitoring activities at each sample point.

After entering the general information the team recordkeeper will note the condition of the well, including whether or not the lock was in place, any evidence of tampering, if there is any water standing near the well, and the condition of the concrete well pad.

Upon arrival at each well on the schedule, the team recordkeeper will record the following on the Field Data Sheets:

- Date and time of water level measurements, temperature and weather data
- Persons present
- Well ID and condition of well
- Depth to water and technique used to measure
- Presence of immiscible layer and detection method
- Total Well depth
- Time well purged
- Well evacuation procedure/equipment, if different from plan
- Purge volume
- Time well sampled
- Sample withdrawal procedure/equipment, if different from plan
- Sampling sequence
- Preservatives used (if any)
- Field observations

Figure 2: Field Data Sheet

FIELD WATER QUALITY SAMPLING AND ANAYLSIS DATA SHEET

PROJECT NAME:_____ PROJECT NO:_____

SAMPLER NAME:_____ PERSON PRESENT:_____

WEATHER:_____ AIR TEMP:_____ LAST PRECIPT._____

LOCATION (STATION NO.)				
DATE AND TIME WATER LEVEL MEASURED				
DATE AND TIME PURGED				
DATE AND TIME SAMPLED				
SAMPLING METHOD				
TOP OF CASING ELEV.				
DEPTH TO WATER (DTW)				
TOTAL DEPTH (TD)				
REQUIRED PURGE VOLUME				
VOLUME PURGED				
THICKNESS OF NAPL/DNAPL				
SUBSTANCE ON WATER				
SAMPLING TEMP.				
SAMPLING PH (INST. NAME)				
SAMPLING SPEC. COND (INST. NAME)				
COLOR				
COOR				
SEDIMENT				
FIELD TREATMENT PRESERVATION				
PURGING/SAMPLING PLAN AND PROCEDURES FOLLOWED?				

NOTE:_____

Volume calculation: 2" – 0.163 gal/ft, 3" – 0.367 gal/ft, 4" – 0.653 gal/ft {[(TD-DTW) x gal/ft] x 3} + 3.5 gal = volume to evac.

FIELD ACTIVITIES

General Procedural Outline For Sampling

1) Decontaminate all field sampling equipment
2) Arrive on location, Prepare well location for sampling
3) Measure water level
4) Measure total well depth
5) Purge three well volumes testing pH and Specific Conductance
6) Collect samples testing pH and Specific Conductance
7) Decontaminate all equipment
8) Collect field blank and equipment blank samples
9) Preserve and label samples
10) Decontaminate all equipment
11) Prepare chain-of-custody
12) Transport or ship to laboratory
13) Sign chain-of-custody with laboratory

Decontamination

With the exception of disposable polyethylene bailers, all equipment used to collect groundwater samples, whether new or previously used, is assumed to be contaminated and undergoes the level of decontamination appropriate to its intended use and construction.

Prior to each sampling event, all equipment to be used during the sampling of groundwater and surface water and sediments will be decontaminated under laboratory conditions to ensure that no contaminants are inadvertently introduced into the samples collected.

Once field sampling begins, sampling equipment will be decontaminated between each sampling point by thorough washing in a non-phosphate detergent followed by triple rinse in distilled or de-ionized water. All rinsate will be collected and disposed properly.

The analytical laboratory will provide pre-cleaned sample containers which have been pre-preserved for monitor well groundwater samples.

Disposable polyethylene bailers may be used for collection of groundwater sampling. Sampling bailers will be factory decontaminated and sealed in plastic until opened for use in sample collection. Used bailers and disposable ancillary sampling equipment will be collected and stored for proper disposal.

Prevention of Contamination Release

To avoid a release of potentially contaminated groundwater, a protective layer of 6 mil polyethylene sheeting will be spread around the monitor well to collect any spillage during purging and sampling. Five gallon capacity plastic buckets will be used to collect rinse and decontamination water during field measurement and sampling. At each groundwater monitoring well in the former lagoon monitor wells, a 55 gallon capacity drum will be used to store rinse water, decontamination water and purge water from the well. Purge water and excess sampled water will be disposed in the groundwater treatment system of the City of Cherryvale.

Water Level and Total Depth Readings

Water level and total depth readings for each well will be taken at each sampling event. The designated team member will put on clean nitrile gloves and proceed as follows:

a. Grasp the monitor well cap with both hands and gently remove. Care must be taken to not let the lid (cap) touch anything while being placed on a clean sheet of polyethylene out of the sampler's work area.

b. The team leader will rinse the cable and probe of the depth meter with de-ionized (DI) or distilled water and collect the rinse water in a five gallon plastic bucket. Slowly the team leader will lower the depth indicator probe into the well until the meter indicates that water has been reached. Using the permanent measuring point designated on the casing, the depth at which the water was encountered will be mentally noted (the meter will be read to the nearest 0.01 ft.). Raise the probe until it is no longer in the water and lower the probe again until the meter indicates that water has been reached and mentally note the second value. If the values do not agree within 0.01 ft., repeat the steps as above until the two readings agree within 0.01 ft.. Once a stable depth to water reading has been confirmed, the depth-to-water value will be recorded on the Field Data Sheet.

c. Slowly lower the depth sounder into the well until it hits the bottom of the well. Read and mentally note the depth when tension in the cable is relieved as the weighted end touches the bottom of the well. Raise the probe above the bottom and then lower it again to the bottom to take an independent reading. If both readings are the same, record the value; if not, take an additional reading. Readings will be recorded to the nearest 0.01 ft. as measured from the permanent measuring point designated on the casing.

d. Slowly remove the probe from the well and decontaminate using a triple rinse with the DI water as it is removed. If organic contamination is suspected in the monitor well, decontamination of the water level indicator will include thorough washing with an Alconox soap solution before rinsing with DI water. During decontamination, the sampler will be careful to collect all rinsate water while not to allowing any rinse water to run down the well. The sampling team should be

absolutely sure the wire or probe never touches the ground or anything other than the water in the well.

e. Prior to covering the well, the well lid (cap) should be rinsed with distilled water. Then place the cap securely back onto the well stem.

f. Secure the locking protective well cover and proceed to the next monitor well in the circuit.

g. Transfer rinse water from the five gallon buckets to the 55 gallon drum for disposal in the groundwater treatment system equalization tank.

Purging

Three well volumes of water will be pumped from each well prior to sampling. The designated well pump is a Grundfos BMI / MP-1-115V. One well volume is equal to the amount of water held in the well bore and in the filter pack. A 10-foot filter pack will contain approximately 3.0 gallons of water (considering 20 percent specific yield of filter pack). The factor for 2-inch diameter pipe is 0.163 gallons per foot of water in the well. The amount of water in the filter pack is added to the amount of water in three times the casing volume for total amount of purgate.

The purge volume will be calculated in the field for each well by the following method:

Measure depth to water (static water level - SWL)
Measure depth to bottom of hole (total depth - TD)
[(TD-SWL) X 0.163 gal/foot X 3] + gravel pack H_2O = purge volume

Purging the well will be accomplished using a pump or bailer for removing the required quantity of water. Groundwater purged from the well prior to sampling will be placed in a 55 gallon drum. Stored purge and decontamination water will be properly disposed in the approved groundwater treatment system equalization tank.

Field Testing

Field analyses consisting of Temperature, Specific Conductance and pH will be conducted before the well is purged and at intervals (at least 3 times) during purging to ensure the water to be sampled is representative of the formation water and not impacted by static conditions in the well casing or gravel pack. Regardless of the number of well volumes removed, the purging will continue until field analyses are stable, or the well is "pumped dry". All field measurements will be recorded on the Field Data Sheet.

After purging, field measurements of temperature, pH and Specific Conductance will be made. Then as laboratory samples are collected, additional replicate samples will be collected and tested for temperature, pH and Specific Conductivity. A total of four replicate field measurements will be

made at the surface during laboratory sample collection Replicates will be tested in glass containers which are rinsed thoroughly between replicate tests.

Sample Collection

Groundwater samples will be collected using disposable polyethylene bailers and disposable nylon cord. Two field technicians will be responsible for sample collection and a third will complete the recordkeeping and labeling requirements. The two samplers will don clean nitrile examination gloves before removing the bailer from the protective plastic bag. The top of the bag will be opened to allow attachment of the disposable nylon cord to the bailer. Once the cord is securely attached the bailer will be removed from it's protective cover and slowly lowered into the well casing. As the bailer slowly contacts the water surface, it will be lowered very slowly approximately twelve inches and then withdrawn from the well casing. The water column in the bailer will be checked for indications of an immiscible layer of light non-aqueous phase liquid (LNAPL) on the water surface.

If LNAPL's are indicated, the bailer will be carefully discharged into a 40 ml Volatile Organics and Aromatics (VOA) vial with a Teflon septum designed for collection of volatile organic samples in water. The VOA vial would then be immediately labeled and place in the pre-chilled ice chest to be delivered to the analytical laboratory.

If there is no indication of LNAPL's, the contents of the bailer would be used for the first replicate sample for field Measurement of Temperature, pH and Specific Conductivity. Following bailer discharge, the bailer would then be lowered slowly down into the well casing to the water surface. The bailer will be very slowly lowered into the water completely to the bottom of the well casing. once on the bottom of the well, the bailer will be slowly withdrawn and the water column checked for indications of a dense non-aqueous phase liquid (DNAPL) which would accumulate on the bottom of the water table just above the aquifer confining bed or zone.

If there is no indication of DNAPLs, the bailer would be used for the fourth replicate sample for field measurement of temperature, pH and specific conductivity. Following bailer discharge, the bailer will then be lowered down into the well casing and filled with water for laboratory samples.

The samples from each well will be collected in the order and quantity shown in Table 3:

Table 4 : Order of Sample Collection

Parameter	Container	Quantity
Metals	Glass with acid preservative	1000 ml
pH and specific conductance	Glass	250 ml

Note: At least one duplicate and one equipment blank per sampling event will be included with the samples.

In accordance with the above, two separate containers will be used for each well. At the conclusion of taking the designated samples for the laboratory, the fourth and final replicate pH, temperature and Specific Conductance will again be analyzed at the well and recorded on the Field Data Sheet.

Sample Preservation

Containers designed for each group of parameters to be analyzed will be provided by the analytical laboratory. These containers will have the appropriate preservative already in the container, and labeled with the type of preservative used. Once collected and labeled, the samples will be placed in an ice chest, pre-chilled to 4° Centigrade.

Sample Custody Documentation

The chain-of-custody requirements for groundwater sampling are outlined in the following sections. These sections include a description of the minimum information requirements for:

- Sample labels
- Sample seals
- Chain-of-custody record
- Sample transportation

Sample Labels

The primary function of the sample label is to prevent misidentification of samples. The sample label will be completed using a waterproof ink marker. It will be firmly affixed to the sample container. Even if the label has a self-adhesive back, it is recommended that transparent cellophane tape be applied over the label to ensure it is not dislodged during shipping and handling.

Sample Seal

If a common carrier will be used to transport samples to the contract laboratory, seals will be used to ensure that samples have not been disturbed during transportation. Two-inch nylon reinforced packing tape will be used to seal individual sample containers. As a further precaution, a custody seal, signed and dated by the designated recordkeeper, may be affixed over the tape and/or to the sealed ice chest.

Chain-of-Custody Record

All samples must be accompanied by chain-of-custody forms. The chain-of-custody record provides the necessary documentation to track sample possession from time of collection through analysis. Figure 3 illustrates the chain-of-custody form to be utilized by the field sampling team.

The chain-of-custody documentation will include, at a minimum, the date, time and conditions under which the samples were collected along with the preservation techniques and the shipping data. The original chain-of-custody record will be sealed in a watertight pouch and placed in one of the sample coolers just before it is closed and sealed. A copy of the chain-of-custody report will be placed in the sampling logbook.

Sample Transportation

After collection of groundwater samples, the sample containers will be packed into plastic coolers lined with plastic bags. Sample bottles will be suitably packed to avoid breakage. The temperature in each cooler will be maintained at 4 degrees C by ice or two large, frozen "blue ice" packs. After packing, the shipping coolers shall be secured closed and may be sealed with custody seals. The groundwater samples shall be delivered the day of collection to the laboratory for analysis.

FIGURE 3

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

TULSA, OKLAHOMA

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

10010 E 16th Street - TULSA, OKLAHOMA 74128-4813

TEL. (918)665-6575 FAX. (918)665-6576 E-MAIL. aandm@aandmengineering.com

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER

PROJECT NUMBER	PROJECT NAME

SAMPLERS (Signature)

ANALYTICAL TESTS REQUIRED

STA NO	DATE	TIME	COMP	GRAB	STATION LOCATION	MATRIX	NO OF CONTAINERS	RUSH ? YES	RUSH ? NO													REMARKS

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

CHAIN DOC

QUALITY ASSURANCE/QUALITY CONTROL

Field and Sampling

The field quality control program is the responsibility of the sampling company and the laboratory. The laboratory will supply a sufficient number of containers for each group of parameters to be analyzed. One set of bottles of each type will be filled with reagent grade deionized water and transported to the field sampling location and returned to the laboratory.

The field equipment, such as pH meter and Specific Conductance meter, will be calibrated prior to transport to the field, and once in the field, instruments will be calibrated at a minimum of once per day. The pH meter is calibrated with prepared solutions as is the Specific Conductance meter. An equipment blank will be collected to ensure that any non-dedicated sampling equipment has been cleaned. To collect, run reagent-grade water through all equipment and transfer water to sample bottles. Samples will be subjected to same analyses as well samples.

Laboratory QA/QC Procedures

The laboratory has the responsibility of providing quality control within the laboratory. The laboratory has presented a QA/QC program prior to initiation of implementation of sampling and analysis. The plan provides for the use of standard, laboratory blanks, duplicates and spiked samples for calibration and identification of potential matrix interferences.

Laboratory control requirements for this project will include:

1) System performance checks
2) Continuing calibration checks
3) Method blank analysis
4) Interval standard area and retention time monitoring
5) Matrix spike/duplicates
6) Surrogate spikes
7) Criteria for qualitative identification

Specifically, the above are described by Fisk (1986) in ASTM STO 925. Data form QC samples will be used as a measure of performance and as an indicator of possible cross-contamination.

APPENDIX B

Soil, Sediment, and Water Sampling and Analysis Plan

Introduction

Relevant sections of the following sampling plan will be implemented for soil, sediment and water samples collected throughout the completion of field activities associated with site assessment performed at the National Zinc Site, Cherryvale Kansas. At the completion of sampling and analyses associated with this plan, a complete report of findings will be issued.

The Phase 1 work plan includes the following sampling events:

1. Soil samples to be collected at EPA's disposal site.
2. Sediment samples to be collected along the unnamed creek (discrete samples to be collected) and in Drum Creek (composite samples to be collected).
3. Surface water samples will be collected from the unnamed creek and in Drum Creek (when standing water or surface water is encountered).

This Plan outlines the methods and procedures that will be used by A & M Engineering for collection, preservation, transportation and analysis of the samples collected during the implementation of the Phase 1 work plan.

Soil Sample Collection

Introduction

The contaminated soils removed by the EPA from residential areas impacted by the National Zinc site operations in Cherryvale, Kansas were brought and disposed at the plant site. This site is referred to in this plan as EPA's disposal site. EPA was scheduled to survey the site on August 27, 2002 and supply the land survey and information to the respondents (Salomon Smith Barney and U.S. Steel) when available. When the respondents receive this information, A & M Engineering will plot the location of EPA's disposal site on existing site base maps and samples will be collected from the EPA disposal site area. The purpose of the sampling to be conducted by A & M Engineering is to obtain sufficient information on the Lead, Arsenic and Cadmium levels in the contaminated soils within EPA's disposal site to determine if deed restrictions will be warranted and to aid in the design of an appropriate clay cap for the disposal site.

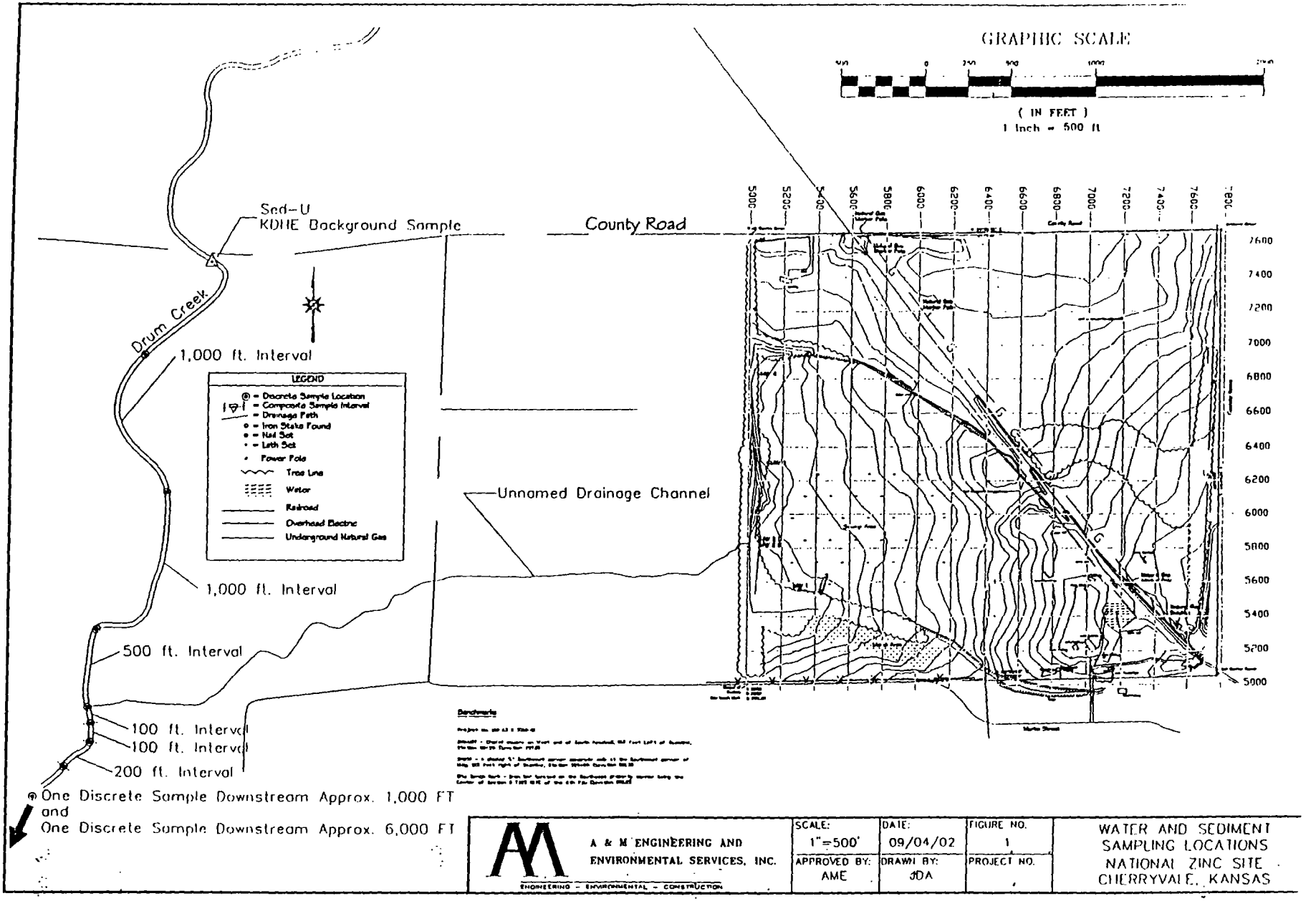
Sample Locations

The EPA's disposal site will be divided into grids with 50 foot intervals. The grid system to be developed for the EPA's disposal site will be coordinated very closely with the grid system shown in Figure 1 which is based on 100 foot intervals. From each 50' x 50' grid, two samples will be taken and composited into one sample. When the land survey information to be developed by the EPA is made available to A & M Engineering, that data will be plotted to show the location of the EPA disposal site on Figure 1 along with the proposed grid system for sampling.

The following describes the protocol which will be followed during sediment sample collection.

Sample Depth

At each sampling point (two samples from each 50' x 50' grid) soil will be collected from 8" below the surface to 36" below the surface. This sample interval will represent the top 28" segment of the disposed contaminated soil. The total depth of contaminated soil is anticipated to be around 3 feet.



A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.	SCALE: 1"=500'	DATE: 09/04/02	FIGURE NO. 1	WATER AND SEDIMENT SAMPLING LOCATIONS NATIONAL ZINC SITE CHERRYVALE, KANSAS
ENGINEERING - ENVIRONMENTAL - CONSTRUCTION	APPROVED BY: AME	DRAWN BY: JDA	PROJECT NO.	

Sampling Tools

1. Sediment sampling device may be any of the following:
   a. Tube-type soil sampler(s) fitted with a 6-inch to 12-inch sampling tube
   b. Stainless steel or plastic spoon or trowel
   c. Sharpshooter type shovel
2. Nitrile or vinyl gloves to be worn by samplers during any activities which involve contact with the sediment samples.
3. Plastic or stainless steel tools and tubs for sample compositing.
4. Pre-cleaned wide-mouth 500ml glass containers with Teflon lined lids for composite sample retention.
5. Distilled or de-ionized water for decontamination of equipment.
6. Alconox soap for decontamination of equipment.

Personal Protective Equipment

Field personnel will be equipped with the following personal protective equipment:

1. Hard hat
2. Safety glasses
3. Rubber boots
4. Nitrile or Vinyl gloves

Nitrile or Vinyl gloves and disposable sampling tools will be placed in a plastic trash bag for disposal after use. At the conclusion of sampling, liquid wastes (Alconox solution, rinse water) will be transported to the site for disposal.

Sampling Protocol

Sampling of soil within the EPA's disposal site will be conducted using the following protocol:

1. Grab sample locations based upon two grabs per 50' x 50' grid will be identified on the site base map by North and East coordinates from the survey grid provided by EPA. The locations will be transferred to the EPA's disposal site for sampling by field survey.
2. Sampling staff will don clean Nitrile or vinyl gloves. Thoroughly clean the soil sampler (particularly the sampling tube) and plastic wash tubs with Alconox/distilled or de-ionized water mixture and rinse with distilled or de-ionized water.
3. At each grab sample location, the soil surface will be penetrated approximately 8-inches deep with the tube type soil sampler. This top 8-inch segment will be discarded as clean cover soil. The tube type soil sampler will reenter the original hole and a grab sample will be obtained from the 8-inch to 36-inch zone. This process will be repeated within a two foot radius of the original location until a sample about 500 ml in volume has been recovered from the location. The 500 ml grab sample will be placed in a clean mixing tub. A second grab sample will be collected from the other previously marked location within that sample grid and placed in the clean mixing tub

   When both grab samples from a 50' x 50' grid have been obtained, the grab samples will be mixed in a tub to form a composite sample. The composite sample will be split two (2) ways with one split sent to the laboratory for analysis while one split will be retained for archive. The sample splits will be placed in separate labeled glass 500-ml capacity jars and placed in coolers for shipment to the laboratory and one set of split samples will be maintained in the samplers custody.

A soil sampling log will be maintained by the sampling team for future reference (Figure 2) and entries will be made in the Field Notebook.

4. Sampling team members will then clean the soil sampler(s), plastic tubs and plastic tools with Alconox and distilled or de-ionized water. Sampling team members will don clean Nitrile gloves prior to continuing with sampling.
5. The above sampling sequence will be followed for each of the remaining sample grids of the EPA's disposal site.
6. At conclusion of sampling, conduct final decontamination of sampling equipment and reusable personal protective equipment.

Decontamination Procedures

Decontamination procedures will consist of the following:

1. Sampling team members will don clean Nitrile gloves prior to initiating sampling and after each composite sample has been obtained.
2. The soil sampling tool will be cleaned with a brush and a solution of Alconox prior to beginning sampling and after each composite sample has been obtained. Particular attention will be paid to any portion of the sampling tool with cracks, crevices or an irregular surface which might trap contaminated material. The sampling tool will then be rinsed with distilled or de-ionized water and, if necessary, dried with a clean paper towel.
3. After sampling is complete, reusable personal protective equipment (i.e. boots) will be washed with an Alconox soap solution and scrub brush, followed by thorough rinsing with de-ionized water.

Preservation Procedures

Since the only constituents of concern associated with this sampling effort are metals, no preservatives are required. The samples will be placed in the glass 500-ml sample jars in coolers while in transit to the laboratory. One set of split samples will be retained by the sampling team for additional analyses should it be deemed necessary or desirable at a later date.

Labeling; Chain of Custody

A label with the following information will be affixed to each sample jar:

- Name of Sampling Firm
- Initials of Sampler
- Client/Source
- Site Name
- Sample Identification
- Identified as Grab (Discrete) or Composite
- Date of Sample Collection
- Time of Sample Collection
- Preservatives (if used)
- Analyses requested to be performed by Laboratory

The chain of custody form (Figure 3) will be completed and submitted with the samples and procedures outlined in EPA SW-846 followed throughout delivery of samples to the analytical laboratory.

Figure 2 Soil Sampling Log

A & M Engineering
10010 East 16th Street
Tulsa, OK 74128

SAMPLING LOG

Project Name:		Sampling Date:	
Site Location:		Sampler Name:	
Project Number:		Doc. Control No:	

SAMPLE NUMBER	SAMPLE LOCATION	MATERIAL DESCRIPTION (include color, odor ect.)	NO.OF GRABS & VOLUME	TOTAL VOLUME

Chain of Custody #:	
Grid Cell Cross Section #:	
Site Sampling Plan Dwg. #:	

Signature

Date:

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

TULSA, OKLAHOMA

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

10010 E. 16th Street - TULSA, OKLAHOMA 74128-4813
TEL: (918)665-6575 FAX: (918)665-6576 E-Mail: aandm@galstar.com

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
A & M Engineering	Irfan Tuner	918-665-6575

PROJECT NUMBER	PROJECT NAME
1294-129	A & M Engineering

SAMPLERS: (Signature)

ANALYTICAL TESTS REQUIRED

STA. NO	DATE	TIME	COMP	GRAB	STATION LOCATION	MATRIX	NO. OF CONTAINERS	RUSH ? YES	RUSH ? NO													REMARKS

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

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

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

CHARLEDAI

Sediment Sample Collection

Introduction

As part of the National Zinc Site characterization, the unnamed creek downgradient of the former lagoon area and Drum Creek will be tested and analyzed to determine the extent and magnitude of offsite migration of contaminants. To provide credible and defensible results, a defined plan for sample collection and analysis has been developed.

Review of the previously conducted site assessments indicated that the unnamed creek contained sediments contaminated with Lead, Cadmium and Arsenic. The previously conducted sampling on Drum Creek showed contamination at the confluence of the unnamed creek with Drum Creek. Respondents are proposing to collect sediment and water samples from both creeks.

Sample Locations

Sediment Sample Collection in the Unnamed Creek

A & M Engineering will conduct a thorough survey of the sediments in the unnamed creek in order to develop a map of sediments and volume information on the sediments requiring removal from the drainage path. Information to be gathered will be recorded per 100 ft. segment of the creek. The information will include sediment thickness, texture, color, aerial extent and differences from native soil. Discrete sediment samples will be collected from the unnamed creek during the performance of the sediment survey where it is determined to be necessary to separate the sediments from the native soil. During this survey, if standing water or water flow is encountered in the unnamed creek, a sufficient number of surface water samples will be collected to determine the impact of the sediments on surface water and also to compare the surface water quality with groundwater quality. The sediment samples from the unnamed creek will be analyzed for Lead, Cadmium, Arsenic, Mercury, Chromium and Zinc.

Sediment Sample Collection in Drum Creek

Discrete sediment samples will be collected from Drum Creek at the locations shown on Figure 1. The sediment samples obtained from Drum Creek will be analyzed for Lead, Cadmium, Arsenic, Mercury, Chromium and Zinc. The following describes the protocol which will be followed during sediment sample collection.

Sample Depth

The discrete sediment samples from Drum Creek will be taken from the top 6 inches of the accumulated sediments.

Sampling Tools

1. Sediment sampling device may be any of the following:
   a. Tube-type soil sampler(s) fitted with a 6-inch to 12-inch sampling tube
   b. Stainless steel or plastic spoon or trowel
   c. Sharpshooter type shovel
2. Nitrile or vinyl gloves to be worn by samplers during any activities which involve contact with the sediment samples.
3. Pre-cleaned wide-mouth 500ml glass containers with Teflon lined lids for composite sample retention.

4. Distilled or de-ionized water for decontamination of equipment.
5. Alconox soap for decontamination of equipment.

Personal Protective Equipment

Field personnel will be equipped with the following personal protective equipment:

5. Hard hat
6. Safety glasses
7. Rubber boots
8. Nitrile or Vinyl gloves

Nitrile or Vinyl gloves and disposable sampling tools will be placed in a plastic trash bag for disposal after use. At the conclusion of sampling, liquid wastes (Alconox solution, rinse water) will be transported to the site for disposal.

Sampling Protocol

Sampling of sediments along the unnamed drainage channel and Drum Creek will be conducted using the following protocol:

1. Sampling staff will don clean Nitrile gloves. Thoroughly clean the soil sampler (particularly the sampling tube) with Alconox/distilled or de-ionized water mixture and rinse with distilled or de-ionized water.
2. Beginning at the background sampling locations within Drum Creek samplers will establish grab sample locations by measuring along the channel or Drum Creek with either a tape measure or measuring wheel.
3. At each sample location, the sediments will be penetrated approximately 6-inches deep with the tube type soil sampler or other appropriate pre-cleaned tool and two (2) samples about 500 ml in volume each removed. The 500 ml samples will be placed in separate labeled glass 500-ml capacity jars and placed in coolers for shipment to the laboratory and one set of split samples will be maintained in the samplers custody.

   A soil sampling log will be maintained by the sampling team for future reference (Figure 2) and entries will be made in the Field Notebook.
4. Sampling team members will then clean the soil sampler(s) and other tools with Alconox and distilled or de-ionized water followed by a thorough rinse with distilled or de-ionized water. Sampling team members will don clean Nitrile gloves prior to continuing with sampling.
5. The above sampling sequence will be followed for each of the remaining sediment samples.
6. At conclusion of sampling, conduct final decontamination of sampling equipment and reusable personal protective equipment.

Decontamination Procedures

Decontamination procedures will consist of the following:

1. Sampling team members will don clean Nitrile gloves prior to initiating sampling and after each discrete sample has been obtained.
2. The soil sampling tool or other appropriate sampling tool will be cleaned with a brush and a solution of Alconox prior to beginning sampling and after each composite sample has been obtained. Particular attention will be paid to any portion of the sampling tool with cracks, crevices or an irregular surface which might trap contaminated material. The sampling tool will then be rinsed with distilled or de-ionized water and, if necessary, dried with a clean paper towel.

3. After sampling is complete, reusable personal protective equipment (i.e. boots) will be washed with an Alconox soap solution and scrub brush, followed by thorough rinsing with distilled or de-ionized water.

Preservation Procedures

Since the only constituents of concern associated with this sampling effort are metals, no preservatives are required. The samples will be placed in the glass 500-ml sample jars in coolers while in transit to the laboratory. One set of split samples will be retained by the sampling team for additional analyses should it be deemed necessary or desirable at a later date.

Labeling; Chain of Custody

A label with the following information will be affixed to each sample jar:

- Name of Sampling Firm
- Initials of Sampler
- Client/Source
- Site Name
- Sample Identification
- Identified as Grab (Discrete) or Composite
- Date of Sample Collection
- Time of Sample Collection
- Preservatives (if used)
- Analyses requested to be performed by Laboratory

The chain of custody form (Figure 3) will be completed and submitted with the samples and procedures outlined in EPA SW-846 followed throughout delivery of samples to the analytical laboratory.

Water Sample Collection

Introduction

Surface water samples will be collected from the unnamed creek and Drum Creek. Locations of any water samples collected will be noted in the field notebook and on the sample location map. As discrete sediment samples are collected along Drum Creek, a discrete water sample will be collected from each sediment sample location.

Sampling Tools

1. Disposable Polyethylene bailer, dipper or bottle
2. Nitrile or vinyl gloves to be worn by samplers during any activities which involve contact with the soil samples.
3. Pre-cleaned wide-mouth 500ml plastic containers with nitric acid preservative and plastic lids for sample retention.
4. Distilled or de-ionized water for decontamination of equipment.
5. Alconox soap for decontamination of equipment.

Personal Protective Equipment

Field personnel will be equipped with the following personal protective equipment:

1. Hard hat
2. Safety glasses
3. Rubber boots
4. Nitrile or Vinyl gloves

Nitrile or Vinyl gloves and disposable sampling tools will be placed in a plastic trash bag for disposal after use. At the conclusion of sampling, liquid wastes (Alconox solution, rinse water) will be transported to the site for disposal.

Sampling Protocol

Sampling of water will be conducted using the following protocol:

1. Sampling staff will don clean Nitrile gloves.
2. Using a disposable bailer, immerse the bailer in the standing water to be sampled and withdraw the collected sample.
3. The sampler(s) will discharge the collected sample into the proper containers for transport to the analytical laboratory. Two (2) containers will be required for each water sample collected. One container will contain preservative (nitric acid) while the second container has no preservative. Both containers will be properly labeled and placed in a prechilled cooler at 4° C for storage and transport.

   A sampling log will be maintained by the sampling team for future reference (Figure 2) and entries will be made in the Field Notebook.

4. Sampling team members will then don clean Nitrile gloves prior to continuing with sampling.
5. The above sampling sequence will be followed for each water sample collected.
6. At conclusion of sampling, conduct final decontamination of sampling equipment and reusable personal protective equipment.

Decontamination Procedures

Decontamination procedures will consist of the following:

1. Sampling team members will don clean Nitrile gloves prior to initiating sampling and after each composite sample has been obtained.
2. The reusable sampling equipment will be cleaned with a brush and a solution of Alconox prior to beginning sampling and after each sample has been obtained.
3. After sampling is complete, reusable personal protective equipment (i.e. boots) will be washed with an Alconox soap solution and scrub brush, followed by thorough rinsing with de-ionized water.

Number of Samples

The total number of water samples obtained during the field sampling program will be determined by the amount of water encountered in the unnamed drainage channel and Drum Creek.

Preservation Procedures

Since the only constituents of concern associated with this sampling effort are metals, nitric acid preservative is required. The samples for metals analysis will be placed in the prepreserved plastic 500-ml sample jars and maintained at 4°C in coolers while in transit to the laboratory.

Labeling; Chain of Custody

A label with the following information will be affixed to each sample container:

- Name of Sampling Firm
- Initials of Sampler
- Client/Source
- Site Name
- Sample Identification
- Identified as Grab or Composite
- Date of Sample Collection
- Time of Sample Compositing
- Preservatives (if used)
- Analyses requested to be performed by Laboratory

The chain of custody form (Figure 3) will be completed and submitted with the samples and procedures outlined in EPA SW-846 followed throughout delivery of samples to the analytical laboratory.

Field Notebooks

Each field and sampling activity at the site will be documented to ensure proper identification and tracking of samples. Field notebooks will be used to document the activities performed at the site. Entries will be written with as much detail as possible. At the beginning of each entry, the date, start time, weather, names of all sampling team members present, level of personal protection being used, the signature of the person making the entry will be noted. The items that will be recorded daily in the field notebooks include the following:

- The methodology used for identifying sampling locations and depth, and the corresponding sample designations.
- Detailed information on all samples collected and results of field descriptions.
- Descriptions of sampling equipment used, including decontamination procedures.

All entries will be made in ink or pencil, and no erasures will be permitted. If an incorrect entry is made, the information will be crossed out with a single strike mark. Any such corrections, strikeouts, and/or additions made in the field notebook will be clearly identified as such, and initialed by the person making such corrections and the date of the corrections noted next to the initials.

Analytical Parameters

Soil and Sediment Samples

Parameters, methods and detection limits for soil and sediment samples analyses may include the following:

	Parameter	Analytical Method	Detection Limit Soil
1.	Total Lead	Method SW846-6010	0.5 mg/kg
2.	Total Cadmium	Method SW846-6010	0.5 mg/kg
3.	Total Arsenic	Method SW846-6010	0.5 mg/kg
4.	Total Chromium	Method SW846-6010	0.5 mg/kg
5.	Total Zinc	Method SW846-6010	0.5 mg/kg
6.	Total Mercury	Method SW846-7470/7471	0.2 mg/kg
7.	pH	Method SW846-9045	-- SU

Water Samples

Parameters, methods and detection limits for water samples analyses may include the following:

	Parameter	Analytical Method	Detection Limit Water
1.	Total Lead	Method SW846-6010	0.005 mg/L
2.	Total Cadmium	Method SW846-6010	0.005 mg/L
3.	Total Arsenic	Method SW846-6010	0.005 mg/L
4.	Total Chromium	Method SW846-6010	0.005 mg/L
5.	Total Zinc	Method SW846-6010	0.005 mg/L
6.	Total Mercury	Method SW846-7470/7471	0.0002 mg/L
7.	Specific Conductance	EPA 120.1	
8.	Total Hardness ($CaCO_3$)	EPA 130.2	
9.	Total Suspended Solids	EPA 160.2	
10.	Field Temperature		
11.	Field pH	Method SW846-9045/EPA 150.1	-- SU

Analytical Laboratories

The following laboratory will be used for sample analysis:

1. Sherry Laboratory of Oklahoma, Tulsa, Oklahoma (certified in the State of Kansas)
2. If deemed necessary or desirable, additional laboratories will be selected at a later date. In such case, KDHE will be contacted and all necessary information related to the laboratory will be submitted for KDHE review and approval. After KDHE approval, that particular laboratory will be contracted.

Quality Control and Quality Assurance (QC/QA)

Field QC/QA

Prior to conducting any field testing, the instrument to be used will have the calibration checked against the appropriate standards, and if required, recalibrated according to the manufacturer's recommendations. Calibration logs will be maintained on the project site for each instrument which may be used for field analysis.

Field samples collected will be a soil matrix, thus disallowing the use of a "Trip Blank" or "Field Blank. For soil samples collected in the field, and transported to a contract laboratory for analysis, quality control will be limited to sample duplicates. Duplicate samples will be collected at a rate of one duplicate sample per each twenty field samples collected. To prevent bias on the part of the laboratory when analyzing samples, the duplicates will be labeled with the same identification information as other samples, and no distinction noted that the sample is a QC duplicate. A record will be made in the field notebook and on the soil sampling log, which will provide field personnel relevant information about the correlating sample number.

When reusable sampling equipment is used to collect field samples, equipment rinsate blanks will be collected at a rate of one per twenty investigation samples per sample medium or one per day per sample medium, whichever is less, to demonstrate that decontamination procedures are effective in preventing cross-contamination.

Laboratory QC/QA

The analytical laboratory will be analyzing matrix spikes, matrix spike duplicates, surrogate spikes and surrogate spike duplicates as part of its quality control procedures. To ensure the integrity and validity of data generated during the analysis of samples, the analytical laboratory will follow it's standard Quality Control/Quality Assurance (QC/QA) Program throughout its involvement in this project.

QUALITY ASSURANCE PROJECT PLAN

TABLE OF CONTENTS

1.0 INTRODUCTION

2.0 QUALITY CONTROL PERSONNEL

3.0 REQUIRED QC DOCUMENTATION

4.0 LABORATORY QUALIFICATION PACKAGE

5.0 IDENTIFICATION AND CONTROL OF SAMPLES

SECTION 1.0 INTRODUCTION

The Quality Assurance Project Plan (QAPP) presented herein is structured to implement the procedures necessary to achieve and maintain a consistently high level of quality in environmental site investigation activities performed at the National Zinc Company Site, Cherryvale, Kansas. This consistency will be accomplished through the standardization and thorough documentation of field techniques and activities. This QAPP is presented in a format that provides the structure for achieving a high level of confidence in the quality of work performed.

Definable Features of Work

This QAPP is generated to address the Cherryvale site investigation activities specified in the Sediment and Water Sampling and Analysis Plan.

Analytical Sampling

The objective of field sampling and laboratory analytical procedures is to obtain defensible data using the data quality objective (DQO) process for data collection. Data quality requirements for precision, accuracy, representativeness, comparability and completeness are defined for a site and must be achieved in order to satisfy DQOs.

A major required component of all field investigation sampling plans is maintaining sample integrity from collection to data reporting. To maintain and document sample possession, chain-of-custody procedures must be implemented. Elements of the chain include, at a minimum:

- Sample seals
- Labels with identification numbers to allow for sample tracking
- Field log books
- Field data record forms

- Chain-of-custody records
- Sample analysis request sheets
- Bills of lading and air bills
- Field and laboratory tracking forms.

Field and laboratory sample custodians or their designated representatives are responsible for maintaining custody of samples. A sample is considered to be under a person's custody if one or more of the following conditions are met:

- It is in the person's physical possession.
- It is in view of the person.
- It is secured by the person so that no one can tamper with the sample without being detected.
- It is secured by the person in an area that is restricted to authorized personnel.

Chain-of-custody will be maintained in the field through use of field log books, chain-of-custody records, sample labels, custody seals and airbills/bills of lading. Once the samples have arrived in the laboratory, the chain-of-custody is continued through use of an internal sample tracking system and locked or limited access sample storage areas. All records which are generated through the field and laboratory efforts are part of the Quality Assurance records kept in the project file. Each of the three steps which comprise the chain-of-custody process are described below.

Field Sample Custody

The sample custody program includes procedures for the preservation of samples, sample identification, recording sample collection locations and specific considerations associated with sample acquisition. The chain-of-custody requires, at a minimum, the following:

- Appropriate project identification information,

- Sample identification,
- Sample location,
- Sample date and time,
- Sample matrix,
- Number of containers per sample,
- Analysis required,
- Sampler's name,
- Release and acceptance information: i.e., date, location and technician's signature.

In-situ or field measurements (e.g. pH measurements, temperature, conductivity, flow measurements, compaction and air monitoring data) are recorded in field log books or on field data record forms. Sample containers are labeled or tagged appropriately according to applicable implementing procedures and plans. Labels or tags contain the following information:

- Organization and site name,
- Location of sample collection,
- Date and time of sample collection,
- Preservation,
- Sample identification number,
- Name(s) of sampler(s).

Custody seals will be affixed to all shipping containers. Samples are accompanied by chain-of-custody records. Completed chain-of-custody documents are retained as quality assurance records and maintained in accordance with the Quality Assurance Program.

Laboratory Sample Custody

Samples are packaged and delivered personally or shipped to the laboratory in accordance with U.S. Department of Transportation requirements with a separate custody record accompanying each shipment. Authorized sample custodians at the laboratories sign for incoming field

samples, obtain documents of shipment and verify data entered onto the sample custody records. The laboratories are required to inform A & M Engineering and Environmental Services, Inc. (A & M Engineering) of receipt of samples within one working day. If any damage or shipping discrepancy is noted upon receipt of samples, the laboratories are required to inform A & M Engineering. The Project Quality Control Manager and Project Manager will be notified. The samples are then entered into an internal tracking system and placed in locked or limited access storage in order to maintain internal chain-of-custody. Contract laboratories are required to maintain custody of samples to assure sample integrity.

Quality Assurance Records

Records generated as a result of analytical sampling activities are Quality Assurance Records and will be processed in accordance with the requirements of this QAP Plan. Documents such as Chain-of-Custody Records, analytical testing results and other required laboratory deliverables are essential documents necessary to ensure the integrity and defensibility of data used to make decisions in the remediation process. Further, Quality Assurance Records provide the record of events that have occurred for all features of the remedial work and their adequate generation, review, protection and submittal is essential to the success of the project.

Data Quality Objective

The objective is to establish the precision, accuracy, representativeness, completeness and comparability requirements of environmental sampling, analysis and measurement data. The parameters to be analyzed and associated detection limits are outlined in the Sediment and Water Sampling and Analysis Plan (Sampling and Analysis Plan). The Sampling and Analysis Plan also provides requirements for field sampling and testing. Samples will be collected in the field according to the Sampling and Analysis Plan which provides the details for decontamination of sampling equipment, sample packaging and preservation, transportation, sample numbering, chain-of-custody and documentation requirements. Samples will be collected in the field and sent to laboratories certified to perform the required analyses. Spiked and duplicate samples will

be used to develop estimates of the accuracy and precision of the analytical data. Field surveillance of sampling, field measurements and chain-of-custody procedures will be used to verify that proper techniques are being followed.

Preconstruction-Remediation Quality Control Meetings

To ensure that all parties performing work at the National Zinc Company Site, Cherryvale, Kansas fully understand the Quality requirements established for this project, a Pre-Investigation Meeting will be held prior to the start of site investigation activities. Attendees at the meeting include the Contracting Officer, or designee; the A & M Engineering Project Manager; the A & M Engineering Project Quality Control Manager; the A & M Engineering Project Superintendent; and KDHE personnel. Minutes of the meeting shall be prepared by the A & M Engineering Project Superintendent and signed by all meeting attendees. A copy of the minutes of the meeting will then be provided to the contracting officer and KDHE personnel.

SECTION 2.0 QUALITY CONTROL PERSONNEL

Quality Control Manager (QCM)

All project activities will be monitored by QCM to ensure that they are consistent with the procedures described in the Work Plan and are capable of providing data of sufficient quality to achieve the project objectives. QCM is responsible for the following activities:

- Implement Quality Assurance Project Plan (QAPP).
- Maintain communication with Project Manager and Sampling Personnel to ensure that all field activities are performed in accordance with the Sampling and Analysis Plan and achieve the Quality Standards required.
- Conduct field audits during sampling activities to determine if proper procedures are being followed.
- Review field and analytical data for completeness and accuracy.
- Report on a regular and timely basis inspection/test results.
- Maintain a Quality Assurance file of all data and other project records.

Laboratory QA/QC Officer

Sherry Laboratory of Oklahoma will analyze samples and laboratory QA/QC will be the responsibility of the laboratory QA/QC Officer. Also, the Laboratory Manager is responsible for QA/QC requirements. A Quality Assurance Manual for Sherry Laboratory of Oklahoma is included in the Sampling and Analysis Plan as an appendix.

The QA/QC Officer will report to the Quality Control Manager.

SECTION 3.0 REQUIRED QC DOCUMENTATION

This section of the Quality Assurance Project Plan delineates the required Quality Control documentation that is to be completed to support the National Zinc Company Project. Table 3-1 provides a listing of required checklists to be completed when performing inspections and specific forms to be used for activities such as sample chain-of-custody. Samples of these forms are included as attachments to this section.

TABLE 3-1:*Required Documentation*

Document Name	Document Number	Completed By
Contractor Daily Report		A & M Site Supervisor
Soil Sampling Log		Quality Control/Sampling Technician
Chain-of-Custody Form		Quality Control/Sampling Technician

SECTION 4.0 LABORATORY QUALIFICATION PACKAGE

Laboratory services will be conducted by Sherry Laboratories of Oklahoma.

For analytical sample testing, the selected laboratory must meet, as a minimum, U.S. EPA and State of Kansas DHE requirements. The laboratory will be required to submit their laboratory QAPP to A & M Engineering. Additionally, the selected analytical laboratory will be required to submit deliverables to support the data validation process. The laboratory will have Quality Control measures meeting the criteria stated in Tables of Internal (Laboratory) QC Samples, Quality Assurance Goals - Precision, Quality Assurance Goals - Accuracy, Percent Recovery, and Calibration Procedures. These tables are included at the end of this section.

SECTION 5.0 IDENTIFICATION AND CONTROL OF SAMPLES

This procedure describes standard procedures for sampling during the site remediation activities, including decontamination, packaging, transport and sample custody. Sample documentation is described and examples of types of documentation forms are provided.

Responsibilities

Quality Control Manager (QCM)

The QCM is responsible for performance of preparatory, initial and follow-up inspections of analytical sampling activities to ensure compliance with the requirements of this procedure and the Quality Assurance Project Plan. Additionally, the QCM is responsible for maintaining the status of sampling activities on the Remediation Plan provided in the Quality Assurance Project Plan.

Sample Technician

The Sample Technician is responsible for the physical collection of samples in accordance with the requirements of this procedure, and for ensuring proper chain-of-custody of collected samples.

Definitions

Sampling Event

A sampling event is considered to be from the time the sampling personnel arrive at the site until the personnel leave for more than a day. An example of two sampling events would occur if sampling personnel went to a site for three weeks, collected surface samples, drilled borings and put groundwater wells in place. During this visit, soil and water samples were collected. The sampling crew then left the site for two months, thus concluding the first sampling event. The

crew later returned to collect another set of samples over a three-day period. The second visit would constitute the second sampling event.

Trip Blank

Trip Blanks are QC samples which originate from analyte-free water taken from the laboratory to the sampling site and returned to the laboratory with the volatile organic (VOA) samples. One trip blank should accompany each cooler containing VOAs, should be stored at the laboratory with the samples and analyzed by the laboratory. Trip blanks are only analyzed for VOAs. No VOAs are planned for this project.

Equipment Rinsate

Equipment rinsate is a type of QC sample and are the final analyte-free water rinse collected after equipment decontamination and during a sampling event. Equipment rinsate will be taken once each sampling event. If analytes pertinent to the project are found in the rinsate, the field decontamination procedure will be evaluated and improved. The rinsate is analyzed for the same parameters as the related samples.

Field Blanks

Field blanks are a type of QC sample that consists of the source water used in decontamination. At a minimum, one field blank from each event and each source of water must be collected and analyzed for the same parameters as the related samples.

Field Duplicates/Splits

Field Duplicates (or splits) for soil samples will be collected in the field and prepared by homogenizing the soil sample and splitting into two samples. All samples except those designated for VOA analysis will be homogenized and split. For VOA analysis, select segments of soil will be taken from the length of the core and placed into 40 ml glass vials. Cores may be sealed and shipped to the laboratory for subsampling if the project deems this appropriate. The

field duplicates for water samples should be collected simultaneously. Field duplicates should be collected at a frequency of 5% per sample matrix. All the duplicates should be sent to the primary laboratory responsible for analysis. The same
samples used for field duplicates shall be split by the laboratory and be used as the laboratory duplicate or matrix spike and a matrix spike duplicated (MS/MSD). This means that for the duplicate sample, there will be analyses of the normal sample, the field duplicate and the laboratory MS/MSD. A separate MS/MSD will not be collected in the field, but will be obtained from the field duplicate by splitting the sample in the laboratory.

Sampling Requirements

Decontamination

Equipment that may come in contact with potentially contaminated soil, sediment, waste, or water will be decontaminated prior to and after use. Decontamination consists of phosphate-free detergent wash, and distilled, deionized (DI), or clean water rinse, as appropriate.

Sampling equipment will be decontaminated utilizing EPA guidelines. Summary decontamination steps are as follows:

Water Sampling Equipment

Prior to collecting a water sample, non-dedicated sampling equipment must be decontaminated according to the following procedure.

1. *Equipment.* Remove all visible contamination with clean tap water and an Alconox™ solution. If this is not effective, use a clean soft cloth or sponge or use pressurized water to clean equipment. If required, a brush may be used to clean stainless steel or metal equipment but not plastic equipment, which may be scratched by the brush. After cleaning equipment with tap water, triple rinse equipment with distilled or de-ionized water.

2. *Hoses*. Clean outside of hoses with high pressure hot water. Pump 3 volumes of clean tap water through hoses. If possible, use pressurized tap water. After cleaning hoses with tap water, pump 3 volumes of distilled or de-ionized water through hoses.
3. *Probe tips and meters*. Triple rinse with distilled or de-ionized water.
4. Collect sample according to the specific procedure for the sample type.
5. Rinse all sample collection equipment with clean tap water followed by distilled or de-ionized water. Store equipment in clean containers.

Soil and Sediment Sampling Equipment

Equipment used to collect samples for chemical analysis requires thorough decontamination, as described below:

1. Wash equipment (augers, split spoons, utensils, etc.) with distilled or de-ionized water, an Alconox™ solution, and/or a high-pressure washer. **If visible contamination remains, steam clean the equipment.**
2. A solvent rinse (Isopropanol) may be required to remove organic contamination that is not removed by washing and/or steam cleaning.
3. Rinse with clean tap water.
4. Triple rinse all equipment with distilled or de-ionized water and allow to air dry.
5. Collect sample according to the specific procedure for the sample type.
6. Rinse all sample collection equipment with clean tap water followed by distilled or de-ionized water. Store equipment in clean containers.

<u>QA Sample Codes:</u>

F - Field Blank

E - Equipment Rinsate

T - Trip Blank

The sample code will be followed by a four-digit date where the first two digits indicate

crew later returned to collect another set of samples over a three-day period. The second visit would constitute the second sampling event.

Trip Blank

Trip Blanks are QC samples which originate from analyte-free water taken from the laboratory to the sampling site and returned to the laboratory with the volatile organic (VOA) samples. One trip blank should accompany each cooler containing VOAs, should be stored at the laboratory with the samples and analyzed by the laboratory. Trip blanks are only analyzed for VOAs. No VOAs are planned for this project.

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Equipment rinsate is a type of QC sample and are the final analyte-free water rinse collected after equipment decontamination and during a sampling event. Equipment rinsate will be taken once each sampling event. If analytes pertinent to the project are found in the rinsate, the field decontamination procedure will be evaluated and improved. The rinsate is analyzed for the same parameters as the related samples.

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Sampling equipment will be decontaminated utilizing EPA guidelines. Summary decontamination steps are as follows:

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Prior to collecting a water sample, non-dedicated sampling equipment must be decontaminated according to the following procedure.

1. *Equipment.* Remove all visible contamination with clean tap water and an Alconox™ solution. If this is not effective, use a clean soft cloth or sponge or use pressurized water to clean equipment. If required, a brush may be used to clean stainless steel or metal equipment but not plastic equipment, which may be scratched by the brush. After cleaning equipment with tap water, triple rinse equipment with distilled or de-ionized water.

2. *Hoses*. Clean outside of hoses with high pressure hot water. Pump 3 volumes of clean tap water through hoses. If possible, use pressurized tap water. After cleaning hoses with tap water, pump 3 volumes of distilled or de-ionized water through hoses.
3. *Probe tips and meters*. Triple rinse with distilled or de-ionized water.
4. Collect sample according to the specific procedure for the sample type.
5. Rinse all sample collection equipment with clean tap water followed by distilled or de-ionized water. Store equipment in clean containers.

Soil and Sediment Sampling Equipment

Equipment used to collect samples for chemical analysis requires thorough decontamination, as described below:

1. Wash equipment (augers, split spoons, utensils, etc.) with distilled or de-ionized water, an Alconox™ solution, and/or a high-pressure washer. **If visible contamination remains, steam clean the equipment.**
2. A solvent rinse (Isopropanol) may be required to remove organic contamination that is not removed by washing and/or steam cleaning.
3. Rinse with clean tap water.
4. Triple rinse all equipment with distilled or de-ionized water and allow to air dry.
5. Collect sample according to the specific procedure for the sample type.
6. Rinse all sample collection equipment with clean tap water followed by distilled or de-ionized water. Store equipment in clean containers.

<u>QA Sample Codes:</u>

F - Field Blank

E - Equipment Rinsate

T - Trip Blank

The sample code will be followed by a four-digit date where the first two digits indicate

the month and the second two digits indicate the day, (ex: August 14 would be written as 0814). As an example, XXX-W06-F1025 is the sample identifier for the field blank collected at SWMU 6 on October 25.

Sample Packaging and Transport

Each sample will be packaged and transported appropriately as described in the following protocol:

- Collect samples in appropriate containers and add preservatives, as needed (Table 1).
- Print the following information clearly in waterproof ink on the label for each sample container: the preservative that has been added to each sample container, the sample number, the project number, the initials of the sample collector, and the date and time the sample was collected. For water samples, package sets together if appropriate.
- Fill out field sample log and chain-of-custody record.
- Separate and place samples in coolers according to laboratory destination and according to expected concentrations (e.g., lowest concentration samples together). Each cooler must weigh less than 70 pounds including ice. Package samples well to protect from shipping damage.
- Place samples on ice, as necessary (Table 1).
- Seal the top two copies of each chain-of-custody form inside a ziplock bag. Use strapping tape to attach the packet to the inside of the cooler lid. Samples will always be accompanied by a chain-of-custody record. When transferring samples, both the individuals relinquishing and receiving the samples will sign and date the chain-of-custody record. Samples will be packaged properly for shipment, including isolation of samples thought to have high chemical concentrations and dispatched to the appropriate laboratory for analysis.
- Secure cooler with custody seal.

- Field observations and comments,
- Any modifications to or deviation from the site specific Sampling and Analysis Plan.

Chain-of-Custodv Record

A chain-of-custody record will be filled out for and will accompany every sample to the analytical laboratory to establish the documentation necessary to track sample possession from the time of collection. A copy of the chain-of-custody form will be retained in the investigation files according to project number. The record will contain the following information:

- Sample number or identification,
- Names of samplers,
- Signature of collector, sampler or recorder,
- Location of project,
- Project manager's name,
- Date of collection,
- Place of collection (site location),
- Sample type,
- Analyses requested,
- Inclusive dates of possession
- Signature of person relinquishing or receiving sample,
- Laboratory sample number, where applicable,
- Date and time of sample receipt,
- Method of shipment and courier name.

Corrections to Sample Documentation

Original data recorded in field investigation daily reports, chain-of-custody records, and

other forms will be written in waterproof ink. None of these documents will be altered, destroyed or discarded, even if they are illegible or contain inaccuracies that require a replacement document.

If an error is made on a document compiled by one individual, that individual will make the necessary correction by crossing a single line through the error, entering the correct information and initialing and dating the change. The erroneous information will not be obliterated. Any subsequent error(s) discovered on a document will be corrected by the person discovering the error. All corrections will be initialed and dated. Site-specific documentation will be reviewed by site managers on a daily basis.

REFERENCED FORMS

Chain-of-Custody Form,

Tables on Sample Preservation and Storage Requirements.

APPENDIX C

Site Specific Health and Safety Plan

SITE SPECIFIC HEALTH & SAFETY PLAN ADDENDUM
(FIELD SAMPLING ACTIVITIES)

FOR

National Zinc Site
Cherryvale, Montgomery County, Kansas

March 28, 2002

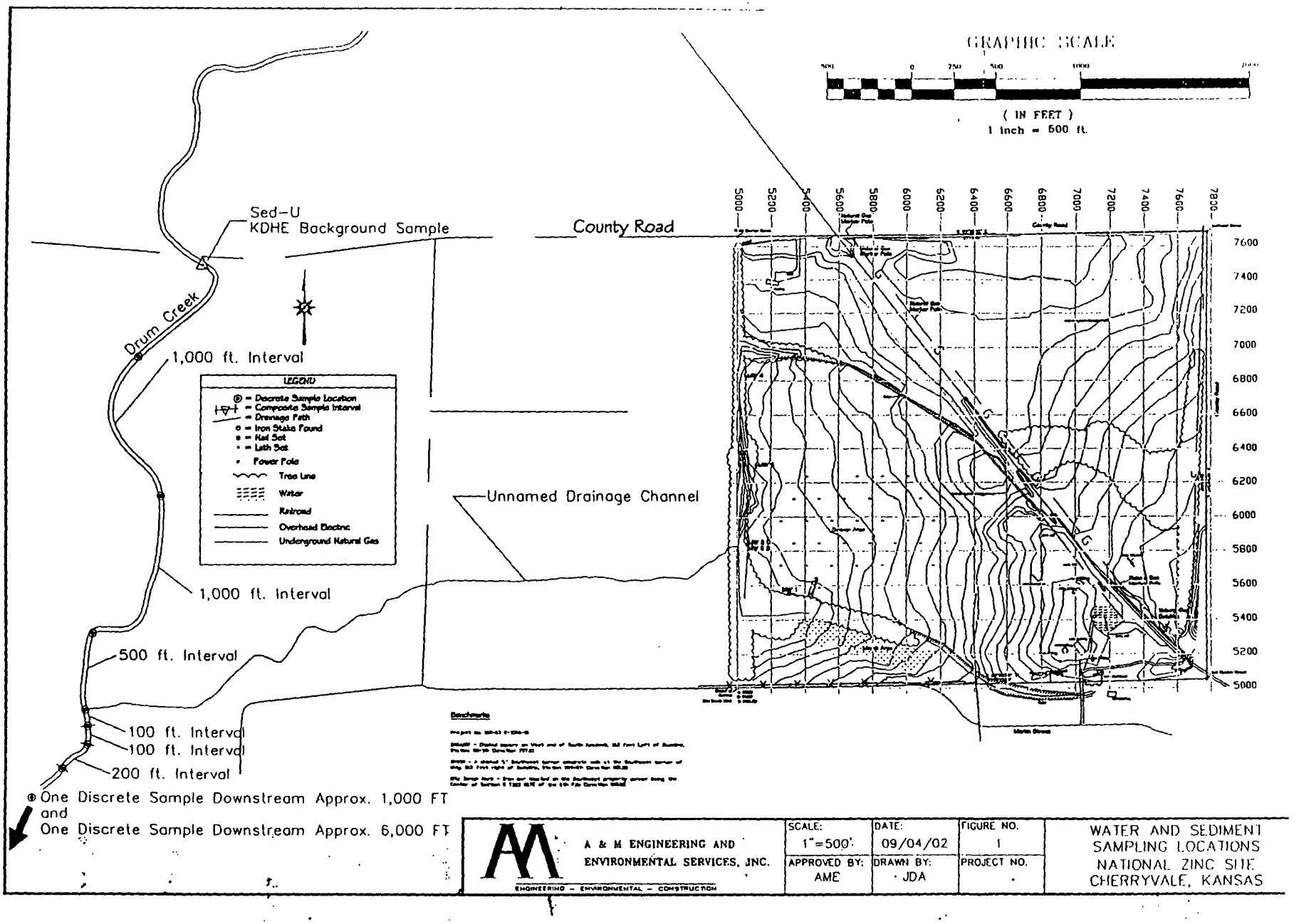
Project Summary:

A & M Engineering and Environmental Services, Inc. (A & M Engineering) has been contracted by Salomon Smith Barney Holdings, Inc. and the United Steel Corporation to conduct soil, sediment and water sampling activities as part of the overall characterization to be conducted at the National Zinc Site located in Cherryvale, Montgomery County, Kansas. Samples of sediment and water will be collected primarily from the unnamed drainage channel, Drum Creek, and background locations. Figure 1 (Water and Sediment Sampling Locations) shows the sample locations.

The primary contaminants of concern are lead, cadmium, zinc, chromium, and silver; all of which have been detected on-site at elevated levels as a result of the former smelter facility. These heavy metal contaminants are present on-site in concentrations that could potentially pose a health hazard from dermal contact/ingestion and/or associated dust inhalation. Therefore, all workers on-site will be 40-hour HAZWOPER trained.

Corporate Health & Safety Plan:

A & M Engineering has a Corporate Health & Safety Plan (CHSP) in place that addresses all aspects of health and safety encountered on typical project sites. However, specific project needs are addressed in the following addendum. A copy of the CHSP is available for Kansas Department of Health & Environment (KDHE) and client representatives upon request. A copy of this addendum and the CHSP will be kept on-site at all times during field sampling activities.



A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.	SCALE: 1"=500'	DATE: 09/04/02	FIGURE NO. 1	WATER AND SEDIMENT SAMPLING LOCATIONS NATIONAL ZINC SITE CHERRYVALE, KANSAS
ENGINEERING – ENVIRONMENTAL – CONSTRUCTION	APPROVED BY: AME	DRAWN BY: JDA	PROJECT NO.	

Emergency Contingency:

Prior to commencement of construction activities an assembly point will be designated for emergency situations. At least one (1) cellular phone will be available on-site during all field sampling activities. The closest emergency response entities are shown below:

Mercy Hospital (11.3 miles southwest) – DIRECTIONS SEE ATTACHMENT 1 (MAP)
800 West Myrtle Street
Independence, Kansas 67301
(620) 331-2200

Cherryvale **Fire Department** - DIRECTIONS SEE ATTACHMENT 1 (MAP)
116 South Neosha Street
Cherryvale, Kansas
(620) 336-2121

Cherryvale **Police Department** (620) 336-2400

Montgomery County Local Emergency Planning Commission (L.E.P.C)
County Judicial Court Basement
300 East Main Street
Independence, Kansas 67301-3762
(620) 252-4614

ALL EMERGENCIES 911

Pre-Construction Activities:

Prior to commencement of field sampling activities a Preliminary Site Entry Evaluation Form (Attachment 2) will be completed by either the Site Project Manager (SPM) or Site Construction Supervisor (SCS) with the assistance of the Corporate Health & Safety Officer (CHSO) or his designee as deemed necessary by Corporate Management (CM).

Relative to the information compiled on the Preliminary Site Entry Evaluation Form and in reference to the health and safety requirements included herein a Pre-Construction Health & Safety Meeting will be conducted for all A & M Engineering personnel and subcontractors to be involved in the on-site field sampling activities. The meeting will be conducted by either of the following individuals:

Site Project Manager (SPM)	Altay Ertugrul
Site Construction Supervisor (SCS)	David Anderson
Corporate Health & Safety Officer (CHSE)	Jeff Elbert

Assistant Health & Safety Officer (AHSO)	Joe Kennedy
Site Health & Safety Officer (SHSO)	Jon Kuhn

Attendees will be required to sign the Pre-Job Safety Orientation Signature Sheet included as Attachment 3.

Facility Access/Egress:

Workers will enter and exit the facility at designated locations. All workers are restricted to the areas where they are performing work and wandering will not be permitted. The general on-site roadway speed limit is 15 MPH unless otherwise posted.
All vehicles will travel on designated roads. Roadways will not be blocked without prior approval. Vehicles and equipment will not be left running unattended.

No weapons, firearms, or explosives will be allowed on any worker or within any vehicle/equipment entering the site.

Specific Environmental Standards:

Provisions will be made to ensure that all work is done in compliance with all environmental laws, rules, and regulations in a way that minimizes potential releases to the environment.

Hygiene & Personnel Protective Equipment:

All workers required to work within areas that may require the use of respirators will be clean shaven, except for mustaches which do not exceed the corners of the upper lip and sideburns which do not extend below the earlobes. Bottled drinking water and toilet facilities will be provided, as appropriate in designated areas. Smoking and other tobacco use will be limited to restricted areas.

Personal Protective Equipment (PPE) will be provided to all workers (at no cost) and include the following at a minimum:

Hard Hat (ANSI Z89.1 approved)
Safety Glasses (ANSI Z87.1 approved)
Steel Toed Rubber Boots with minimum six inch uppers
Nitrile or vinyl gloves

ATTACHMENT 1

(Maps To Nearest Hospital & Fire Department)

#1 Insurance Site
for Ease of Use-
Progressive.com

Coupons - Print FREE Coupons from your computer!

Grocery Coupons	Store Coupons	Online Coupons	Free Stuff	coolsavings.com

Welcome, Guest User

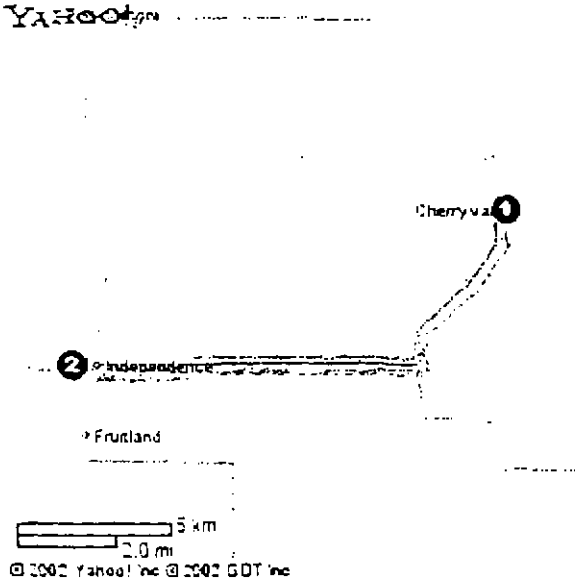
Yahoo! Yellow Pages

Starting from: Cherryvale, KS

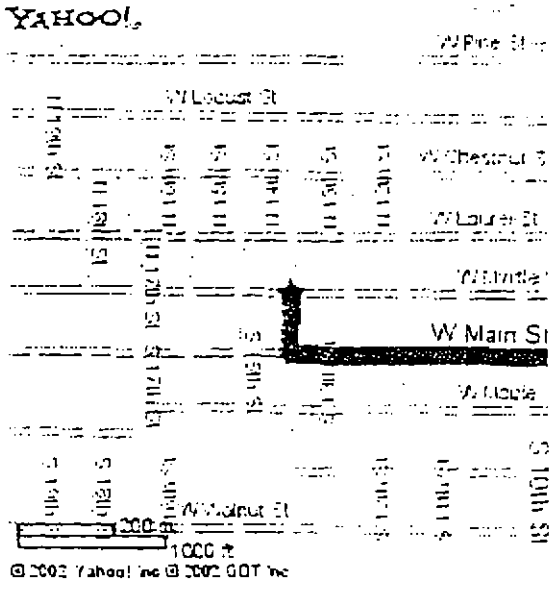
Arriving at: ★Mercy Hospital
800 W Myrtle St, Independence, KS 67301-3240
(620) 331-2200

Distance: 11.3 miles Approximate Travel Time: 19 mins

- Email Directions
- Get Reverse Directions
- Text Only Driving Direc



Full Route



Destination

	Directions	Miles
1.	Start on W 3RD ST going towards US-160	0.3
2.	Turn Left on US-160	11.0
3.	Turn Right on N 14TH ST	0.1
4.	Arrive at destination	

When using any driving directions or map, it's a good idea to do a reality check and make sure the road exists, watch out for construction, and follow all traffic safety precautions. This is only to be used as an in planning.

YAHOO! Yellow Pages

Home - Yahoo! - Maps - Address Book - He

Flights
Find great fares that are available when you are.
Go!
Travelocity.com

Welcome, Guest User

Create My Favorite Locations - Sign

Yahoo! Yellow Pages

Top > Community > Government > Fire Protection

Search

Search Public Records on Cherryvale Fire Chief Before You Call

Cherryvale Fire Chief

116 S Neosho St, Cherryvale, KS 67335
Phone: (620) 336-2121

Email this Business Listing

Save to Yahoo! Address Book

Find Nearby

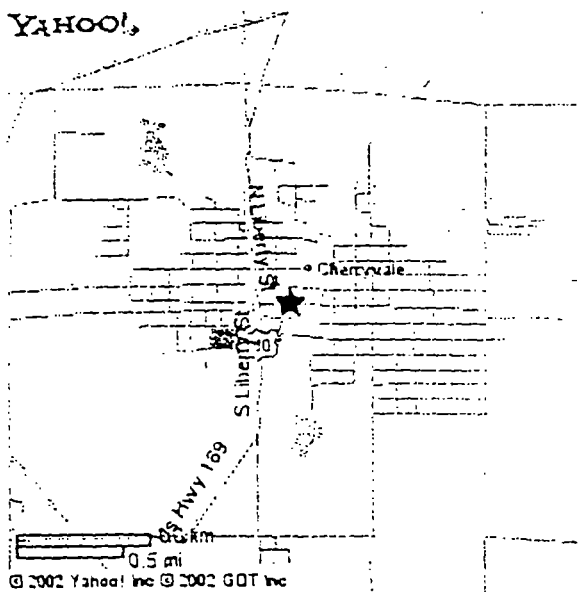
Related Categories:

- Fire Departments

Popular Categories:

- Restaurants
- Department Stores
- Entertainment & Arts
- Hotels
- Find Nearby

Map and Directions



Interactive Map

Driving Directions

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ID# 70729

ATTACHMENT 2
(Preliminary Site Entry Evaluation Form)

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
10010 east 16th Street
TULSA, OK 74128
ENGINEERING - ENVIRONMENTAL - CONSTRUCTION
(918) 665-6575 - FAX(918) 665-6576

PRELIMINARY SITE ENTRY EVALUATION FORM

SITE NAME: _____ PROJECT NUMBER: _____

CONDUCTED BY: _____ DATE: _____

BRIEF PROJECT DESCRIPTION: _____

DESIGNATED SPM: _____ DESIGNATED SCS: _____

PHYSICAL HAZARDS (INCLUDE TRIPS, FALLS, EXCAVATION HAZARDS, ETC.): _____

EXPOSURE HAZARDS (INCLUDE ACM, LBP, VOLATILES, ETC.): _____

IS PRELIMINARY MONITORING OR MATERIAL CHARACTERIZATION NEEDED? DESCRIBE: _____

IS MONITORING RECOMMENDED DURING PROJECT ACTIVITIES? DESCRIBE: _____

PPE REQUIRED (INCLUDE ROUTES OF ENTRY): _____

ARE SAFETY FEATURES OPERATIONAL ON EQUIPMENT TO BE USED? FIRE EXTINGUISHERS IN PLACE? DESCRIBE: _____

*Completed Preliminary Site Entry Evaluation Forms are kept in Appendix H

FIGURE 5

ATTACHMENT 3
(Pre-Job Safety Orientation Signature Sheet)

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
1001 N east 10th Street
TULSA OK 74123
ENGINEERING • ENVIRONMENTAL • CONSTRUCTION
(918) 665-6575 • FAX(918) 665-6576

WEEKLY SAFETY MEETING FORM

TRAINING CONDUCTED BY: _____
DATE OF TRAINING: _____
SUBJECT: _____

NAME (PRINT)	TITLE / POSITION	SIGNATURE	DATE
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			

*Completed Weekly Safety Meeting Forms are kept in Appendix L

FIGURE 8

DOERNER, SAUNDERS, DANIEL & ANDERSON, L.L.P.

ATTORNEYS AT LAW

SAM P. DANIEL
WILLIAM C. ANDERSON
VARLEY H. TAYLOR, JR.
G. MICHAEL LEWIS
LAWRENCE T. CHAMBERS, JR.
DALLAS B. FERGUSON
SAM G. BRATTON II
GARY M. MCDONALD
H. WAYNE COOPER
KEVIN C. COUTANT
RICHARD P. HIX
LYNN PAUL MATTSON
WILLIAM F. RIGGS
LEWIS N. CARTER
LINDA C. MARTIN
JAMES P. MCCANN
RICHARD H. FOSTER
CHARLES S. PLUMB
LEONARD I. PATAKI
S. DOUGLAS DOOD
ELISE DUNITZ BRENNAN
JON E. BRIGHTMIRE
TOM G. FERGUSON
RICHARD J. EAGLETON
REBECCA M. FOWLER

320 SOUTH BOSTON AVENUE, SUITE 500
TULSA, OKLAHOMA 74103-3725
TELEPHONE (918) 582-1211
FACSIMILE (918) 591-5360

ONE LEADERSHIP SQUARE, SUITE 501
211 NORTH ROBINSON
OKLAHOMA CITY, OKLAHOMA 73102-7112
TELEPHONE (405) 319-3500
FACSIMILE (405) 319-3509
www.dsda.com

MICHAEL C. REDMAN
STEVEN E. METCALF
JACQUE J. BRAWNER
SHELLY L. DALRYMPLE
RUSSELL W. KROLL
ROBERT A. BURK
S. GREGORY FROGGE
RACHEL BLUE
JAMES C. MILTON
AUDRA K. HAMILTON
JAMES J. ROBERTSON
R. CHARLES WILKIN III
KELLY S. ENOPP
WILLIAM H. SPITLER
YOUNG PEI
CHAD M. HINRICHS
ALEX L. HAMMACK
P. BRADLEY BENDURE
PATRICIA L. MARTIN
JONNATHAN D. HORTON
SHAWNA S. BAKER
LESLEY R. FORD
DAVID L. IANDIORIO

E. J. DOERNER (1897-1980)
DICKSON M. SAUNDERS (1920-2001)

Kurt

11/26

November 22, 2002

VIA FEDERAL EXPRESS
Rick L. Bean, LG
Chief, Remedial Section
Bureau of Environmental Remediation
Kansas Department of Health & Environment
1000 Southwest Jackson, Suite 410
Topeka, KS 66612-1367

RECEIVED
NOV 2 5 2002
BUREAU OF
ENVIRONMENTAL REMEDIATION

RE: Former National Zinc Site, Cherryvale, Kansas

Dear Mr. Bean:

Enclosed are three copies of Amendment No. 1 to the Revised Plan for the former National Zinc Site at Cherryvale which was submitted September 16, 2002. The enclosed Amendment No. 1 to Revised Plan is submitted on behalf of Respondents Salomon Smith Barney Holdings, Inc. (Salomon) and United States Steel Corporation (USS). As was the case with the Revised Plan itself, Amendment No. 1 is submitted under the conditions set forth in my letter to you dated March 15, 2002 (fourth paragraph) and Mr. Smiga's letter to you dated March 18, 2002.

Amendment No. 1 contains the responses of Respondents to KDHE's comment letter dated October 30, 2002. The Respondents believe that these responses are consistent with the discussion which took place in the telephone conference held between Messrs. Limesand, Wentz and Ertugrul on November 14, 2002. Also, consistent with that telephone discussion, this will confirm that after the RSE Phase I Work Plan has been completed and the data collected in that process has been evaluated, the Respondents will be open to conducting additional sampling or testing where necessary to enable KDHE to promptly select a remedial alternative, as envisioned by paragraph 43 of the revised Consent Order I transmitted by email to Erika Bessey on October 24, 2002.

After reviewing Amendment No. 1, please advise if KDHE has any further comments on the Revised Plan as amended. If not, we are available at Erika's convenience to work on finalizing the Revised Consent Order referenced above.

If you have any questions, please give me a call.

Sincerely,

William C. Anderson of
DOERNER, SAUNDERS, DANIEL & ANDERSON, L.L.P.

WCA/sm
Enclosure
cc: Ellen O'Brien, Esq. (w/encl.) – Via Federal Express
David Moniot, Esq. (w/encl.) – Via Federal Express
David L. Smiga, Esq. (w/encl.) – Via Federal Express
Charles N. Wentz (w/encl.) – Via Federal Express
Erika Bessey, Esq. (w/encl.) – Via Federal Express
Altay Ertugrul, A&M Engineering (w/o encl.) – Via Facsimile

AMENDMENT NO. 1 TO
REVISED PLAN FOR
FORMER NATIONAL ZINC SITE
CHERRYVALE, MONTGOMERY COUNTY, KANSAS

November 22, 2002

RECEIVED
NOV 2 5 2002
BUREAU OF
ENVIRONMENTAL REMEDIATION

Presented to:

KANSAS DEPARTMENT OF HEALTH
AND ENVIRONMENT
1000 SOUTHWEST JACKSON, SUITE 410
TOPEKA, KANSAS 66612-1367

Prepared by:

SALOMON SMITH BARNEY HOLDINGS, INC.
UNITED STATES STEEL CORPORATION

AMENDMENT NO. 1 TO REVISED PLAN FOR FORMER NATIONAL ZINC SITE, CHERRYVALE, KANSAS

Respondents have reviewed Kansas Department of Health and Environment's (KDHE) comments contained in its October 30, 2002 letter and, in response, have prepared this amendment to the Revised Plan dated September 16, 2002. The following presents the Respondents' responses to each KDHE comment.

Response to KDHE Comment No. 1

The respondents concur with the KDHE comment, and the evaluation of sediment quality will be completed as stated in the revised work plan prior to determination of remediation goals.

Response to KDHE Comment No. 2

The respondents will be conducting a hydrogeologic investigation at the site in addition to the surface water and sediment sampling. During hydrogeologic investigation, the groundwater and surface water interaction will be investigated as well. The surface water, if present during sampling, will be surveyed for elevation and compared with the groundwater elevations in the new monitoring wells.

Response to KDHE Comment No. 3

After discussion with KDHE regarding the lack of representative clean background locations on Unnamed Creek, it was decided that, at this time, no background sample will be taken from the Unnamed Creek watershed.

Response to KDHE Comment No. 4

See response to Comment No. 2 above.

Response to KDHE Comment No. 5

Blind duplicate samples will be collected at a frequency of one duplicate sample per twenty field samples per sampling medium, or one per sampling day, whichever is less.

Response to KDHE Comment No. 6

At this time the respondents intend to use the existing wells TW-1, TWE-2, TW-3, TW-4 and TW-9 for groundwater elevation measurement only. Should it be determined that

redevelopment of these wells is necessary to provide accurate water elevation data, the wells will be developed to minimize sediments in the well casing. Should surging be determined necessary by the field geologist, the wells will be surged with clean water which has been analyzed in the field for indicator parameters.

Response to KDHE Comment No. 7

The respondents intend to utilize a ten foot (10 ft.) screen which will be set into the first limestone formation and will extend upward across the unconsolidated permeable layer on top of the weathered limestone.

Response to KDHE Comment No. 8

At this time the respondents intend to use the existing wells TW-1, TWE-2, TW-3 and TW-4 for groundwater elevation measurement only. If the hydrogeologic investigation shows a direct hydraulic connection to downgradient wells, and the downgradient wells detect contamination, then wells T-1, TWE-2, TW-3 and TW-4 will be sampled together with the other wells.

Response to KDHE Comment No. 9

At this time the respondents intend to use the existing wells TW-1, TWE-2, TW-3 and TW-4 for groundwater elevation measurement only. After hydrogeologic evaluation and groundwater analysis from the proposed new wells is obtained, an assessment will be made and then, if appropriate, the existing wells in the pond (TW-1 through TW-4) will be sampled and analyzed together with the others.

Response to KDHE Comment No. 10

Newly completed wells will be developed to minimize sediments in the well casing. Should surging be determined necessary by the field geologist, the wells will be surged with clean water which has been analyzed in the field for indicator parameters. Throughout the well development process, indicator parameters will be measured in the field as an indication of the formation water stabilization. Also, surged water volume and purged water volumes will be recorded.

Indicator parameters will include pH, Specific Conductivity, and Dissolved Oxygen. Stabilization will be achieved after all indicator parameters have stabilized for three successive readings. The stabilized indicator parameter readings should be within:

- ± 0.2 SU for pH
- ± 5 % for Specific Conductivity
- ± 10 % for Dissolved Oxygen

Response to KDHE Comment No. 11

Field blanks will not be collected for metals analysis. However, blind duplicate samples will be collected at a frequency of one duplicate sample per twenty field samples per sampling medium, or one per sampling day, whichever is less.

Response to KDHE Comment No. 12

Throughout the purging process, indicator parameters will be measured in the field as an indication of the formation water stabilization or purging each well three water column volumes.

Indicator parameters will include pH, Specific Conductivity, and Dissolved Oxygen. Stabilization will be achieved after all indicator parameters have stabilized for three successive readings. The stabilized indicator parameter readings should be within:

- ± 0.2 SU for pH
- ± 5 % for Specific Conductivity
- ± 10 % for Dissolved Oxygen

Response to KDHE Comment No. 13

A Data Quality Assessment (DQA) will be conducted on generated field and laboratory data to ensure data quality and usability. The DQA process will follow the recommended practices as described in the EPA document, "Guidance for Data Quality Assessment: Practical Methods for Data Analysis, EPA QA/G-9, QA00 Update." A detailed data validation summary will be provided which will describe QA/QC methods employed, the relationship between QA/QC samples and collected environmental samples, any deviations in the execution of the sampling plan which could affect data usability, and a discussion of any deviations from predetermined QA/QC limits and the effects on generated environmental data. Statistical evaluation of generated environmental data will be conducted using either the EPA's Data Quality Evaluation Statistical Toolbox (DataQUEST) software, or a more advanced commercial statistical software package.

Response to KDHE Comment No. 14

The Respondents will collect a single grab sample from each 50' x 50' grid cell which will be considered indicative of and an average value for that particular 2500 sq. ft. area.

Each grab sample will be collected following the protocol outlined in the work plan without compositing. Analytical results from each grab sample will be compared to the non-residential action level for each parameter of concern to determine if further action is warranted at the on-site EPA soil repository area.

APPENDIX B

HYDROGEOLOGICAL INVESTIGATION REPORT

(DECEMBER 2003)

HYDROGEOLOGICAL INVESTIGATION REPORT OF THE FORMER NATIONAL ZINC SITE

CHERRYVALE, MONTGOMERY COUNTY, KANSAS

December 2003

for:

Salomon Smith Barney Holdings, Inc.
United States Steel Corporation

Prepared by:
A & M Engineering and Environmental Services
10010 East 16th Street
Tulsa, Oklahoma
Phone: (918) 665-6575
Fax: (918) 665-6576
e-mail: aandm@aandmengineering.com

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INTRODUCTION

Respondents, Salomon Smith Barney Holdings, Inc. (Salomon) and U.S. Steel Corporation (U.S. Steel), directed A & M Engineering and Environmental Services, Inc. (A & M Engineering) to conduct a hydrogeological investigation at the National Zinc Site located in Cherryvale, Kansas. The investigation was conducted in accordance with Hydrological Investigation Work Plan ("Work Plan") dated 8/27/02, as amended and approved by Kansas Department of Health and Environment ("KDHE") Consent Order 3-E-002 signed between Respondents and KDHE.

The Work Plan required the drilling and installing of four new monitor wells at the site and procedures for testing, sampling and analysis of the new and existing wells. The investigation followed those requirements and the details and results are included in this Report.

SITE CHARACTERIZATION

Location:

The National Zinc Site ("Site") is located on the northwestern city limits of the City of Cherryvale, Montgomery County, Kansas. The legal description of the Site is the NE/4, Section 8, Township 32 South, Range 17 East in Montgomery County. The geographic coordinates of the site are 39° 42' 30" North Latitude and 96° 25' 00" West Longitude. Figure 1 shows the topographic map of the Site and the surrounding areas.

Climate:

The climate of Montgomery County is characterized as a continental climate that is typically warm to hot in the summer and cold in the winter with the majority of precipitation events occurring in the spring and early summer. The average annual precipitation is 37 inches per year. The average winter temperature is 36.8°F and the average summer temperature is 78.4°F. The maximum 24-hour precipitation event recorded for Montgomery County is 6.38 inches.

Site Description

The Site is the former location of the National Zinc smelter facility and currently is unoccupied grassland with minor remnants of the former facility. The Site covers approximately 160 acres. The Site is bounded by Martin Street on the south, County Road 5200 on the north, County Road 5400 on the east, and a tree line to the west. The South Kansas and Oklahoma Railroad transects the site from southeast to northwest and a gas pipeline (Williams Pipeline Company) runs parallel to the railroad.
An unnamed creek starts in the middle portion of the Site and runs northwestward to the west edge of the Site and turns southward toward the southeast corner of the Site. It then turns west and joins Drum Creek approximately one-mile west. Another stream runs east to west along the southern edge of the Site and joins the unnamed creek at the western property line. These streams are intermittent type streams.

The Site slopes gently westward with approximately 20 feet of relief across the Site. The Site is generally grassland with the exception of a few buildings and structures in the

southeast part of the Site, which are remnants of the former smelter. The Site is bordered with residential areas to the south and with agriculture properties to the north, east, and west. Figure 2 is a detailed topographic map of the Site.

SITE BACKGROUND

The Site was the location of the former National Zinc smelter facility. The facility was constructed in 1898 and expanded over time.

During its operational history, the facility had large settling ponds covering approximately 23 acres. The major lagoon was located at the west central part of the Site in-between the two unnamed creeks (see Figure 1).

The smelter structures were mostly demolished with exception of the two buildings located in the southeastern part of the Site.

Recently (2000-2002), U.S. EPA conducted yard soil remediation in residential areas to the south of the Site and all the excavated soil was brought to the Site and deposited in the southeastern portion of the Site, adjacent to the existing buildings.

PREVIOUS SITE INVESTIGATIONS

The National Zinc smelter facility operated until 1976. KDHE conducted several investigations of the Surface Lagoon which was closed in 1977. The major investigations are described below:

The1978 Investigation:

The first investigation was conducted in April-June 1978 by Wichita Testing Laboratories on behalf of National Zinc Company. The study was directed to investigate the lagoon embankment and its stability. A copy of this report is included in Appendix 1.

During the 1978 investigation, nine (9) borings were drilled and logged. Soil samples were collected and tested for geotechnical evaluation. Also, the existing five monitoring wells along the embankment (MW-1, MW-2S, MW-2D, MW-3, and MW-4) were completed during this study.

This study concluded that the lagoon embankment was safe.

1999-2000 Site Investigation:

KDHE conducted Phase I and Phase II investigations and a Brownfields Targeted Assessment (BTA) at the Site. These included file review of all available data, Site topographic survey, Site geophysical surveys, soil sampling using X-ray fluorescence (XRF) unit for surface and subsurface samples, surface water and sediment sampling, test boring for waste characterization, test boring for groundwater characterization, groundwater sampling and data integration evaluation and reporting.

The 1999-2000 Site investigation report reached the following conclusions and recommendations:

1. Surficial soils at the Site's southeast, south and central portions are impacted mainly with lead and cadmium and to a lesser extent, with arsenic, above non-residential Kansas RSK (NRRSK) levels.
2. Surface water and sediments in the on-Site stream and ditches are impacted, mainly with cadmium.
3. The previously closed lagoon area contained some treated waste.
4. Groundwater samples from the monitor wells located in the former lagoon area and on the west embankment had elevated cadmium levels.
5. These reports expressed concern about the groundwater-surface water interface at the west edge of the former lagoon area.
6. These studies concluded that off-Site groundwater was not impacted.
7. The reports recommended further investigations of off-Site areas for soil, surface water and groundwater.

FIELD ACTIVITIES

The Work Plan specified the following tasks:

1. Drilling and completion of four monitor wells in the uppermost aquifer, one upgradient in the northeast quadrant of the Site for background purposes, and three downgradient wells to the west of the Site on adjacent properties.
2. Develop and sample the new four wells for three consecutive months for groundwater quality and measure water levels in all wells during these sampling events.
3. Address the potential for groundwater-surface water interface.

4. Evaluate all existing and new data and prepare this Report of the findings.

Monitor Well Drilling and Completion:

Drilling equipment and personnel were mobilized on July 21st, 2003 to the Site and drilling was started on July 22, 2003. The drilling subcontractor was Mohawk Drilling, Inc. of Tulsa, Oklahoma. The drilling method was air rotary with a 6 ¼" diameter air hammer. Drilling and well installation were completed on July 24, 2003.

Four monitor wells were completed, one upgradient (MW-5) in the northeast part of the Site and three downgradient wells (MW-6, MW-7, MW-8) west of the Site on the adjacent properties. Appendix 2 includes the lithologic and completion logs for the new wells and Appendix 3 includes the logs of the previously drilled and completed wells. Figure 2 shows the location of all the wells.

Monitor Well Survey:

The new monitor wells (MW-5, MW-6, MW-7 and MW-8) were surveyed utilizing the existing wells vertical and horizontal data. The survey established control points from MW-2 and MW-3. The survey data with other well information are shown on Table 1 for all the new and existing wells.

Monitor Well Hydraulic Testing:

The new monitor wells were purged and developed after completion. On August 4, 2003 upgradient MW-5 and downgradient MW-8 were chosen for hydraulic conductivity

testing. The slug testing data were collected using a data logger that was later downloaded to a computer for analysis.

The Hvorslev Graphs for the two wells are included in Appendix 4. The hydraulic testing results show that the uppermost aquifer has a hydraulic conductivity of 2.25×10^{-5} cm/sec in MW-5 and 1.21×10^{-5} cm/sec in MW-8.

During the 1978 Site investigation, undisturbed samples were collected from MW-1 (8-9.5 ft.), MW-3 (5-6.5 and 12-13.5 ft.) and MW-4 (7-8.5 ft.). These samples were tested by falling head for permeability and the results were 3.4×10^{-5}, 4.6×10^{-8}, 2.1×10^{-4}, and 5.3×10^{-8} cm/sec, respectively.

Water Level Measurements:

The water levels in the new and existing monitor wells were measured monthly beginning August 2003. The water levels and calculated groundwater elevations in each well are shown in Table 2.

The water levels in MW-2D and MW-2S were unreliable and in these two wells the screens are suspected to be plugged. Thus the water levels or groundwater elevations of these two wells were not utilized in the potentiometric maps or evaluation.

Groundwater Sampling and Analysis:

In accordance with the Work Plan, the groundwater in the new monitor wells (MW-5, MW-6, MW-7, and MW-8) was sampled and analyzed for three consecutive months (August, September, and October 2003). The groundwater samples were analyzed for pH, Specific Conductance, Mercury, Arsenic, Cadmium, Chromium, Lead and Silver. The field data sheets and laboratory analytical reports for these three sampling events are included in Appendix 5. The analytical data for these sampling events are tabulated in Table 3.

SITE GEOLOGY

The Site is located within the Osage Cuestas part of the Osage Plains physiographic province, which is characterized by rolling hills, and steep-sided hills that are dissected by intermittent streams with flat alluvial valleys.

Soils/Unconsolidated Materials:

Undisturbed areas of the Site, especially the northeast part, are underlain by the Kenoma Series soils. The Kenoma Soils are generally deep, moderately well drained, very slow permeable soils on uplands, of 0 to 2 percent slopes. The surface layer typically consists of dark grayish brown silt loam about 6 to 12 inches thick. The lower part consists of dark brown, grayish brown, yellowish brown, light gray to reddish brown silty clay with 4 to 6 feet thickness. This undisturbed soil section is encountered in MW-5, MW-6, MW-7 MW-8, TW-9, TW-2 and TW-1.

Fill clay generally grayish brown to dark brown with varying thickness is encountered in MW-1, MW-2, MW-3, MW-4, BH-5, and BH-6.

Bedrock:

The underlying bedrock is Pennsylvanian age Dennis Limestone of the Kansas City Group. Figure 3 shows the stratigraphic column of Montgomery County.

Dennis Limestone underlies the soil and unconsolidated materials at the Site and consists of light gray to bluish gray limestone, sandy, oolitic in the upper portion. Gray shale and black fissile shale are present in the lower part of the formation and locally contains 1 to 4 feet thick limestone at the base. The thickness of Dennis Limestone ranges from 10 to 70 feet. The Dennis Limestone is underlain by the Coffeyville Formation which is mainly shale with coal and sandstone interbeds.

The above-described typical Dennis Limestone section was penetrated in the new MW-6 well. The limestone is also exposed at the bottom of the unnamed creek adjacent to MW-8. The exposed limestone at the bottom of the creek is fractured. To depict the vertical and horizontal changes several geologic cross sections are constructed. Figure 4 shows the cross-section locations and Figures 5, 6, 7, 8, and 9 show the geologic cross-sections.

The cross-sections show the soil section and the underlying limestone. The limestone gently slopes westward. The cross-sections also show the treated waste material

encapsulated in the former lagoon area. (Cross-section E, Figure 9 and Cross-section D, Figure 8 respectively)

SITE HYDROGEOLOGY

The Site is located in the Osage Plains physiographic province which is characterized by rolling, steep-sided hills that are dissected by intermittent streams with alluvial valleys. The Site is on a drainage tributary of Drum Creek, which is in turn a tributary of the Verdigris River. Drum Creek is about 0.75 mile west of the Site and the Verdigris River is about 7 miles south of the Site.

The Site is drained by an intermittent stream which runs from the center of the Site westward to the western edge of the Site and turns south behind the dike and then westward to Drum Creek. Another intermittent stream runs along the southern boundary of the Site and merges with the other intermittent stream near MW-2. These 2 intermittent streams are collectively called Unnamed Creek.

The uppermost aquifer underneath of the Site is the fractured Dennis Limestone/Shale and the unconsolidated silty clay overlying the bedrock. During drilling in August 2003, moisture zones were encountered in the fractured Dennis Limestone and the underlying shale section at a depth of 5 to 25 feet. During previous drillings (1978 and 1999) saturated zones were reported just above the Limestone bedrock in the unconsolidated section.

Groundwater is encountered in all the monitor wells. Some of the wells were completed in unconsolidated sediments, others in the bedrock section (limestone/shale).

Groundwater levels in the monitor wells were measured monthly beginning August 2003 and are shown on Table 2. The groundwater levels in the monitor wells fluctuate 1 to 7 feet in the last four monthly measurements and these water level fluctuations are expected to be greater in the spring season.

Groundwater Flow:

Groundwater Potentiometric Maps are constructed using the monthly water levels (August, September, October and November 2003). Figures 10, 11, 12, and 13 show the potentiometric maps.

Groundwater flows from east to west. The contours show the intermittent stream effect on Site. Also the contours show a mounding at the location of the former lagoon in the vicinity of TW-3 and TW-4.

The August 2003 data plotted on Figure 10 show the intermittent stream was a gaining stream during low water levels. However, as some precipitation occurred during September and October 2003, the stream became a losing stream.

The potentiometric maps also show the effect of the western dike of the former lagoon. The groundwater contours gradient increases at the location of the dike due to hydraulic

conductivity changes. The dike was constructed over the native soil with compacted clay. The sampling and testing during 1978 showed the hydraulic conductivity difference between the native material with 8 x 10^{-5} cm/sec conductivity and the compacted clay material with a 5 x 10^{-8} cm/sec conductivity. Thus during heavy precipitation events the groundwater builds up east of the dike and rises to the surface (See Figure 5 Cross-section A-A').

Groundwater Velocity:

The groundwater velocity can be calculated using the following formula:

$$v = \frac{Kxi}{n}$$

where

v = groundwater velocity
K = hydraulic conductivity
i = hydraulic gradient
n = porosity

Groundwater in the uppermost aquifer flows from east to west. Using groundwater measurements from October 2003, the groundwater flow gradient was calculated between MW-5 and TW-3 and it is 0.0038 ft/ft.

For rate calculation, the hydraulic conductivity value is 2.252 x 10^{-5} cm/sec. The effective porosity is estimated to be 0.2 (20 percent). The groundwater velocity between the two wells is:

$$v = \frac{Kxi}{n} = \frac{2.252x10^{-5}x0.0038}{0.2} = 4.78x10^{-7} cm/\sec$$

$$or\ 0.04\ cm/day$$

The groundwater flow gradient was also calculated between TW-3 (at 803.45' MSL) and MW-8 (at 793.74' MSL) to be 0.011 ft/ft.

For velocity calculation, the hydraulic conductivity value for MW-8 was used and is $1.212x\ 10^{-5}$ cm/sec. The effective porosity is estimated to be 0.2 (20 percent). The groundwater velocity between these two wells is:

$$v = \frac{Kxi}{n} = \frac{1.212x10^{-5}x0.011}{0.2} = 6.66x10^{-7} cm/\sec$$

$$or\ 0.057\ cm/day$$

GROUNDWATER QUALITY / SUPPLY

In Montgomery County groundwater is present in unconsolidated sediments and Pennsylvanian bedrock formations (weathered and/or fractured shale limestone, sandstone). The groundwater in these units of the county is limited in yield and poor in quality. The well water in the Cherryvale area is reportedly marginal due to sulfates and excessive hardness. Also, oil field intrusion of brines from oil production dating back to the early 1900's has impacted shallow groundwater quality regionally in this portion of Southeast Kansas.

The City of Cherryvale and Montgomery County Rural Water District #12 supply water to private residences in this area. The City of Cherryvale receives water from Big Hill Lake located approximately five (5) miles east of Cherryvale. Montgomery County Rural Water District #12 receives water from the Verdigris River near Neodesha. approximately 20-25 miles northwest of Cherryvale. Both of these surface water intake locations are upgradient from the National Zinc facility. Thus there is no concern for water supply in relation to the Site.

KDHE Brownfields Targeted Assessment reviewed all available water well records within four (4) miles of the National Zinc facility and located seventeen (17) wells serving forty-one (41) persons. However, none of these wells are down gradient of the Site, specifically between the Site and Drum Creek. Therefore there is no concern for impact to any water well with regard to the subject site.

SITE SPECIFIC GROUNDWATER QUALITY

Groundwater at the Site was sampled by KDHE prior to 2002. The analytical results indicated that the groundwater in the wells inside the previously closed lagoon area and on the western dike had elevated concentrations of cadmium, chromium, lead and silver.

The new monitor wells were installed specifically to sample and analyze groundwater downgradient of the Site. The new monitor wells (MW-5 upgradient and MW-6, MW-7, MW-8 downgradient) were sampled and analyzed for three consecutive months (August,

September. and October 2003). The analytical reports are included in Appendix 5 and the data is tabulated on Table 3.

The groundwater samples of the downgradient wells did not detect any of the metals of concern above laboratory detection levels. The pH of upgradient groundwater samples is comparable to the downgradient groundwater samples. all in the range of 6.5 to 7.8 S.U. The specific conductance shows difference between the upgradient and downgradient groundwater samples. Specific conductance of upgradient water samples range from 640 to 1085 umhos/cm. and the specific conductance of downgradient well water samples range from 2175 to 4695 umhos/cm. The increase in specific conductivity across the Site indicates some soluble material (e.g. chloride, sulfate, carbonate) is impacting the groundwater. However, no metals of concern have been detected in the off-Site groundwater.

GROUND AND SURFACE WATER INTERACTIONS

The two intermittent streams and Unnamed Creek drain the surface water at the Site. The streams receive water from groundwater during low precipitation, however during higher precipitation the streams lose water to the uppermost groundwater aquifer.

Although KDHE previously expressed concerns regarding shallow seeps along the western side of the former lagoon, several inspections have been made by A & M Engineering, some jointly with KDHE, and no seeps detected. The most recent

inspections were conducted by A & M Engineering on 12-12-03 during high groundwater elevations, and again no seepage was observed.

The uppermost groundwater aquifer water levels fluctuate several feet. During September and October moderate precipitation caused groundwater levels to rise up to 6-7 feet and this fluctuation will definitely increase more during the spring season. The groundwater levels in MW-3 and TW-3 were almost at the surface elevation during the October and November 2003 measurements. This observation correlates with the swampy surface condition previously observed in the vicinity of TW-3. This observation indicates that the swampy area on top of the closed lagoon is primarily caused by the high groundwater fluctuations. Additionally, the surface berm on top of the dike along the western edge restricts surface runoff and, together with the flat topography of the lagoon cap, also contributes to the swampy conditions.

CONCLUSIONS

The following conclusions are drawn from this hydrogeologic investigation:

1. The uppermost groundwater aquifer at the site is the unconsolidated sediment / fractured limestone and shale of the Dennis Formation at a depth of 5 to 20 feet.

2. The Site groundwater flows westward.

3. The groundwater fluctuates as much as 6-7 feet at the Site.

4. The swampy area on top of the closed lagoon is caused by the condition of poor surface drainage and groundwater fluctuation. This is caused by the compacted dike along the western edge of the Site which impedes groundwater flow, and the surface berm on top of the dike along the western edge that contributes to this condition by preventing surface water runoff.

5. Groundwater quality is impacted by metals (cadmium, lead, and chromium) inside the closed lagoon area, but the metal impact is not detected downgradient of the Site. This confirms KDHE's previous conclusion, and undoubtedly is related to the presence of limestone.

6. Groundwater quality and yield is limited in this entire area and there is no water supply source impacted by the Site past or present activities.

RECOMMENDATIONS

The following recommendations are made considering groundwater quality and the conditions observed on the Site:

1. Based on the KDHE data from the Former National Zinc Site BTA (February, 2000), the groundwater in the previously closed lagoon area is contaminated with metals of concern (cadmium, lead, and chromium). Therefore, the clay

cap elevation in the vicinity of TW-3 and MW-3 should be raised to prevent groundwater and surface water interaction. The entire surface of the previously closed lagoon area should be raised a minimum of at least three (3) feet (the thickness of the proposed cap) in order to prevent interfacing between the groundwater and surface water.

2. Provide good storm water run-off systems around and over the closed lagoon site to provide good drainage and control erosion.

3. No additional sampling of groundwater monitor well quality is required.

4. Continue monthly water level measurements to obtain more data to utilize in the design phase.

Tables

Table 1

MONITORING WELL INFORMATION

Well No.	Date of Completion	Ground Elevation	T.O.C. Elevation	Total Depth	Screen Interval (From Ground Level)	Casing	Stick Up
MW-1	1978	802.85'	805.52'	*12.2'	9-17' **	0-9'	2.67'
MW-2S	1978	803.10'	806.20'	*4.56	7-12' **	0-7'	3.10'
MW-2D	1978	803.16'	806.08'	*11.0	16-19' **	0-16'	2.92'
MW-3	1978	802.22'	805.15'	*8.7'	8-14.0' **	0-8'	2.93'
MW-4	1978	803.02'	804.47'	*8.6'	8.5-16' **	0-8.5	1.45'
MW-5	7/22/03	813.06'	815.85'	16.50'	6.5-16.5'	0-6.5'	2.79'
MW-6	7/22/03	798.43'	802.15'	30.00'	10-30'	0-10'	3.72'
MW-7	7/22/03	796.09'	799.81'	22.50'	7.5-22.5'	0-7.5'	3.72'
MW-8	7/22/03	793.90'	797.07'	22.50'	7.5-22.5'	0-7.5'	3.17'
TW-1	8/16/99	806.76'	810.08'	. 14.00'	9-14'	0-9'	3.32'
TW-2	8/16/99	805.82'	809.48'	11.10'	6.1-11.1'	0-6.1	3.66'
TW-3	8/17/99	805.24'	808.80'	10.20'	5.2-10.2'	0-5.2'	3.56'
TW-4	8/17/99	805.75'	808.96'	7.50'	2.5-7.5'	0-2.5'	3.21'
TW-5	8/17/99	813.24'	815.36'	13.00'	8.0-13'	0-8.0'	2.12'
TW-9	8/19/99	818.03'	821.67'	9.00'	4-9'	0-4'	3.64'

* Total Depth measured in the field on October 20, 2003, completion logs (1978) showed deeper wells.

** Total Depth from the log records.

Table 2

MONITOR WELLS WATER LEVEL MEASUREMENTS
National Zinc Site
Cherryvale, Kansas

Well No.	TOC El. MSL Ft.	August, 2003		September, 2003		October, 2003		November, 2003	
		Water Depth Ft.	Groundwater Elevation MSL Ft.	Water Depth Ft.	Groundwater Elevation MSL Ft.	Water Depth Ft.	Groundwater Elevation MSL Ft.	Water Depth Ft.	Groundwater Elevation MSL Ft.
MW-1	805.52	8.65	796.87	6.0	799.52	5.65	799.87	4.14	801.38
MW-2D	806.08	DRY	NA	10.6	795.48	10.4	795.68	10.73	795.35
MW-2S	806.20	DRY	NA	DRY	NA	DRY	NA	DRY	NA
MW-3	805.15	8.5	796.65	7.55	797.6	3.38	801.77	3.23	801.92
MW-4	804.47	DRY	NA	5.8	798.67	4.6	799.87	4.41	800.06
MW-5	815.845	9.11	806.735	7	808.845	5	810.845	3.82	812.025
MW-6	802.150	11.64	790.51	11.2	790.95	11.01	791.14	10.92	791.23
MW-7	799.805	11.33	788.475	7.1	792.705	6.52	793.285	8.82	790.985
MW-8	797.07	10.33	786.74	3.3	793.77	3.33	793.74	3.75	793.32
TH-1	810.08	11.66	798.42	9.75	800.33	7.87	802.21	7.62	802.46
TH-2	809.48	8.36	801.12	7.68	801.8	6.38	803.1	6.55	802.93
TH-3	808.80	6.25	802.55	5.8	803.00	5.35	803.45	5.25	803.55
TH-9	821.67	DRY	NA	8.85	812.82	6.91	814.76	8.09	813.58

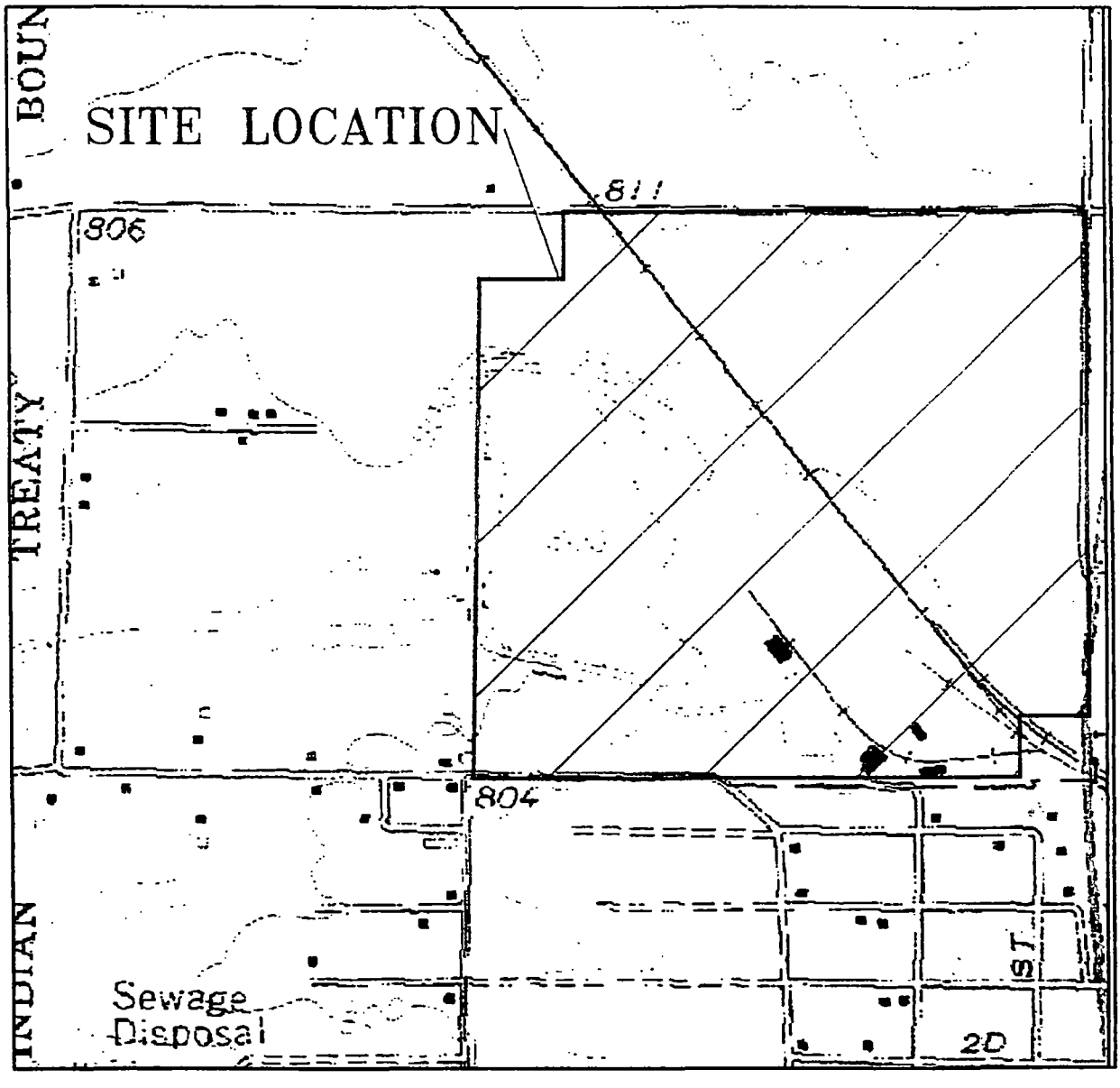
Table 3

ANALYTICAL RESULTS OF GROUND WATER SAMPLES

National Zinc Site
Cherryvale, Kansas

PARAMETERS	MW-5	MW-6	MW-7	MW-8
August, 2003				
PH (Field)	7.23	7.24	7.28	6.51
Specific Conductance. (Field)	640	2550	2300	2175
Mercury (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100
Arsenic (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500
Cadmium (mg/L)	<0.00100	<0.00100	<0.00100	<0.00100
Chromium (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100
Lead (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500
Silver (mg/L)	<0.00200	<0.00200	<0.00200	<0.00200
September, 2003				
PH (Field)	7.39	7.73	7.65	7.65
Specific Conductance. (Field)	960	2800	3215	4695
Mercury (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100
Arsenic (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500
Cadmium (mg/L)	<0.00100	<0.00100	<0.00100	<0.00100
Chromium (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100
Lead (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500
Silver (mg/L)	<0.00200	<0.00200	<0.00200	<0.00200
October, 2003				
PH (Field)	7.24	7.48	7.54	7.50
Specific Conductance. (Field)	1085	4560	3330	2855
Mercury (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100
Arsenic (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500
Cadmium (mg/L)	<0.00100	<0.00100	<0.00100	<0.00100
Chromium (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100
Lead (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500
Silver (mg/L)	<0.00200	<0.00200	<0.00200	<0.00200

Figures



CHERRYVALE QUANDRANGLE
MONTGOMERY COUNTY, KANSAS

1/2 1/4 0 0.5 MILE

500 0 500 1000 1500 2000 2500 3000 3500 FEET

0.5 .25 0 0.5 KILOMETER

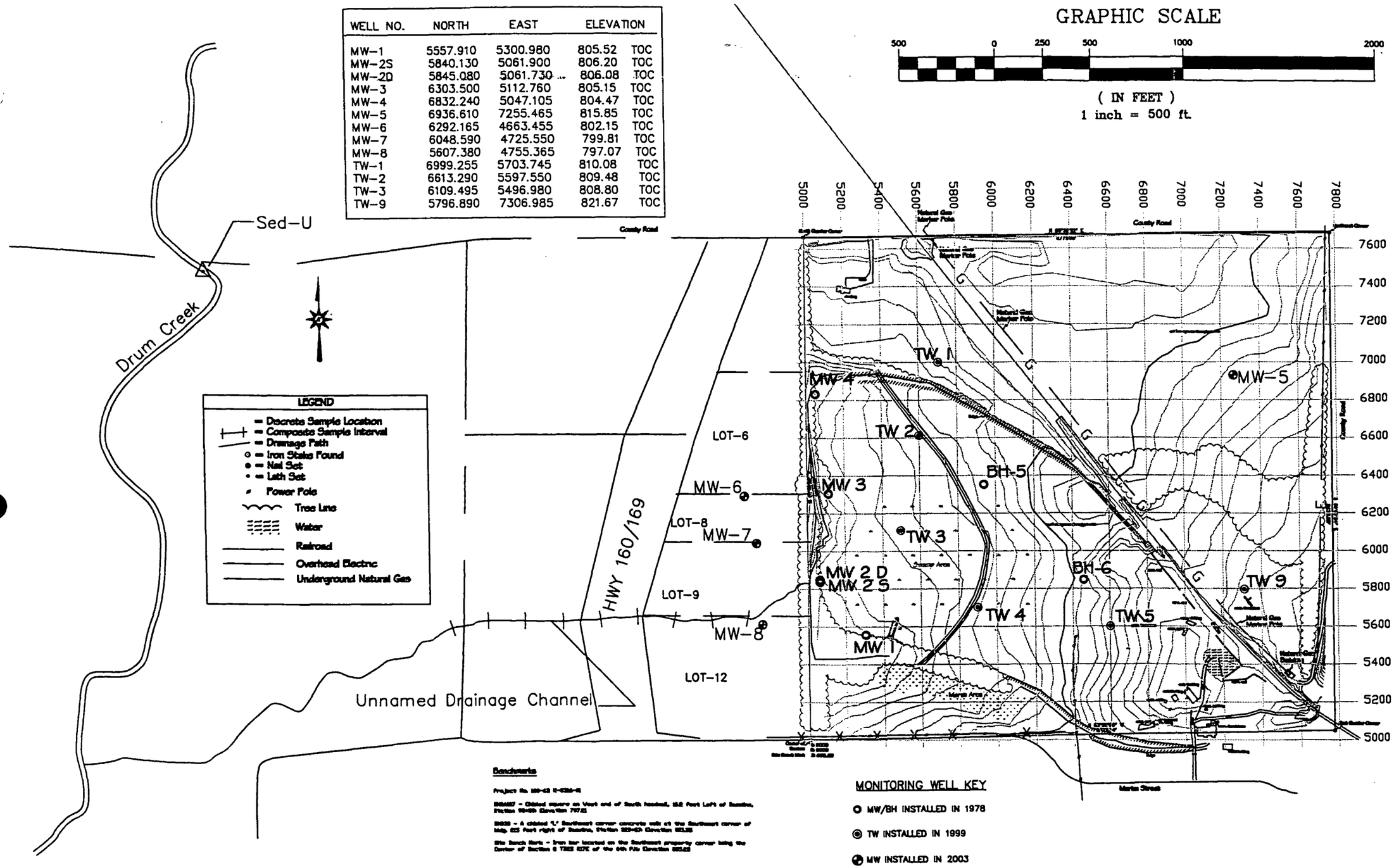
A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

TOPOGRAPHIC LOCATION MAP

SCALE:	DATE:	FIGURE NO.
AS	11/17/03	FIGURE 1
APPROVED BY:	DRAWN BY:	PROJECT NO.
IT	GJJ	1804–002

WELL NO.	NORTH	EAST	ELEVATION	
MW-1	5557.910	5300.980	805.52	TOC
MW-2S	5840.130	5061.900	806.20	TOC
MW-2D	5845.080	5061.730	806.08	TOC
MW-3	6303.500	5112.760	805.15	TOC
MW-4	6832.240	5047.105	804.47	TOC
MW-5	6936.610	7255.465	815.85	TOC
MW-6	6292.165	4663.455	802.15	TOC
MW-7	6048.590	4725.550	799.81	TOC
MW-8	5607.380	4755.365	797.07	TOC
TW-1	6999.255	5703.745	810.08	TOC
TW-2	6613.290	5597.550	809.48	TOC
TW-3	6109.495	5496.980	808.80	TOC
TW-9	5796.890	7306.985	821.67	TOC



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ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

SCALE:	DATE:	FIGURE NO.
1"=500'	11/20/03	2
APPROVED BY: IT	DRAWN BY: GJJ	PROJECT NO. 1804-002

SITE MAP

NATIONAL ZINC SITE
CHERRYVALE, KANSAS

System	Series	Stage	Group	Formation or rock unit	Thickness, in feet	Lithology	Water supply[1]
Quaternary	Pleistocene			Alluvium	0-60	Unconsolidated clay, silt, sand, and gravel. Basal part contains 0 to 14 feet of sand and gravel.	Yields moderate supplies of water to wells in parts of the Verdigris River valley and in major tributary valleys.
				Terrace deposits	0-38		Yields moderate supplies of water to wells in low terrace deposits. Intermediate and high terrace deposits yield lesser amounts to wells or may be above water table.
Pennsylvanian	Upper Pennsylvanian	Virgilian	Douglas	Lawrence Formation	140	Chiefly olive-gray shale. As much as 20 feet of sandstone in upper part. Thin bed of Haskell Limestone Member at base.	Yields very small supplies of water to shallow wells in weathered zones. Sandstone beds generally above water table.
				Stranger Formation	100-175	Gray shale and siltstone, and gray fine-grained sandstone. Thin bed of Westphalia Limestone Member in upper part.	Generally yields small to moderate supplies of water to wells in areas underlain by mudstone. Where sandstone beds are absent, yields very small to small supplies to shallow wells in weathered zone.
		Missourian	Lansing	Stanton Limestone	70-120	Consists of three limestone and two shale members. Limestones include fine-grained dense limestone, oolitic and sandy limestone, and fine-grained to coarsely crystalline limestone. Lower shale member locally includes a black fissile shale. Upper shale contains sandstone beds in outcrops in southern part of county.	Generally yields very small supplies of water to wells. Yields very small to small supplies of water to wells in areas underlain by thick limestone beds or shale. In southwestern part of county, yields very small to moderate supplies of water to wells in sandstone.
				Vilas Shale	50-120	Chiefly medium-gray shale.	Generally yields little or no water to wells except in the shallow zone of weathering.
				Plattsburg Limestone	0-70	Thick gray fine-grained to crystalline limestone in northern part of county. Thin or absent south of Elk River.	
			Kansas City	Bonner Springs Shale and Lane Shale	35-150	Gray silty to argillaceous shale.	
				Iola Limestone	2-10	Consists of two limestones separated by a black fissile shale containing phosphatic concretions. Lower limestone locally sandy or may be absent.	Generally yields little or no water to wells except in the shallow zone of weathering. Yields small supplies to wells locally from black shale.
				Chanute Shale	80-200	Chiefly gray shale and fine-grained sandstone. The Noxie Sandstone Member occurs extensively in the lower part and the Cottage Grove Sandstone Member in the upper part. The middle part contains the Thayer coal bed, one to three thin limestones, and gray shale.	Widespread aquifer. Generally yields small to moderate supplies of water to wells from sandstone beds at depths of as much as 400 feet.
				Drum Limestone	0-60	Light-gray fine-grained limestone and light-gray crossbedded very fossiliferous oolitic limestone.	Generally yields little or no water to wells except in the shallow zone of weathering.
				Cherryvale Shale	0-90	Chiefly bluish-gray shale with flagstones at top in outcrops in northern part of county. Flags increase in abundance southward.	
				Dennis Limestone	10-70	Light-gray to bluish-gray limestone, locally sandy or oolitic in upper part. Gray shale and black fissile shale in lower part. Locally contains a 1- to 4-foot thick limestone at base.	In northeast area, yields very small to small supplies of water to wells at depths of as much as 200 feet. Elsewhere, generally yields little or no water except in the shallow zone of weathering.
			Pleasanton	Coffeyville Formation	200	Chiefly medium-gray shale and siltstone. Upper part locally contains much fine-grained sandstone and several thin coals. Lower beds contain medium- to dark-gray and black shale. The Swope Limestone, 1 to 8 feet of gray limestone, occurs near the middle.	Generally yields little or no water to wells from the gray shales, siltstones, and thin limestones. Beds of sandstone and black shales locally yield small supplies of water to wells.
				Checkerboard Limestone	1-14	Consists of two thin limestones separated by gray shale where thickest. Lower limestone is brown-weathering crossbedded coquina.	
				Seminole Formation	5-10	Chiefly medium- to dark-gray shale. Locally contains a thin fine-grained sandstone at base.	
	Middle Pennsylvanian	Desmoinesian	Marmaton	Holdenville Shale	5-25	Gray and bluish-green fossiliferous shale.	Generally yields little or no water to wells.
				Lenapah Limestone	7-18	Upper massive limestone and lower nodular bedded limestone separated by a thin gray shale.	Yields very small to small supplies of water to wells generally less than 50 feet deep.
				Nowata Shale	3-30	Medium- to light-gray shale, locally contains some fine-grained sandstone.	
				Altamont Limestone	15-20	Upper and lower light-gray limestone members separated by gray and black fissile shale.	
				Bandera Shale	60-150	Gray shale and sandstone.	

[1] In this report, very small supplies refers to yields generally less than 1 gpm, small supplies to 1 to 5 gpm, and moderate supplies to 5 to 100 gpm.

FIGURE 3
GEOLOGIC PROFILE OF
MONTGOMERY COUNTY
National Zinc Site
Expanded Site Inspection
Cherryvale, Kansas
March, 2001

Source: "Geology and Ground-Water Resources of Montgomery County, Southeastern Kansas." *Kansas Geol. Survey Ground-Water Ser.* No. 1, 1974.

WELL NO.	NORTH	EAST	ELEVATION	
MW-1	5557.910	5300.980	805.52	TOC
MW-2S	5840.130	5061.900	806.20	TOC
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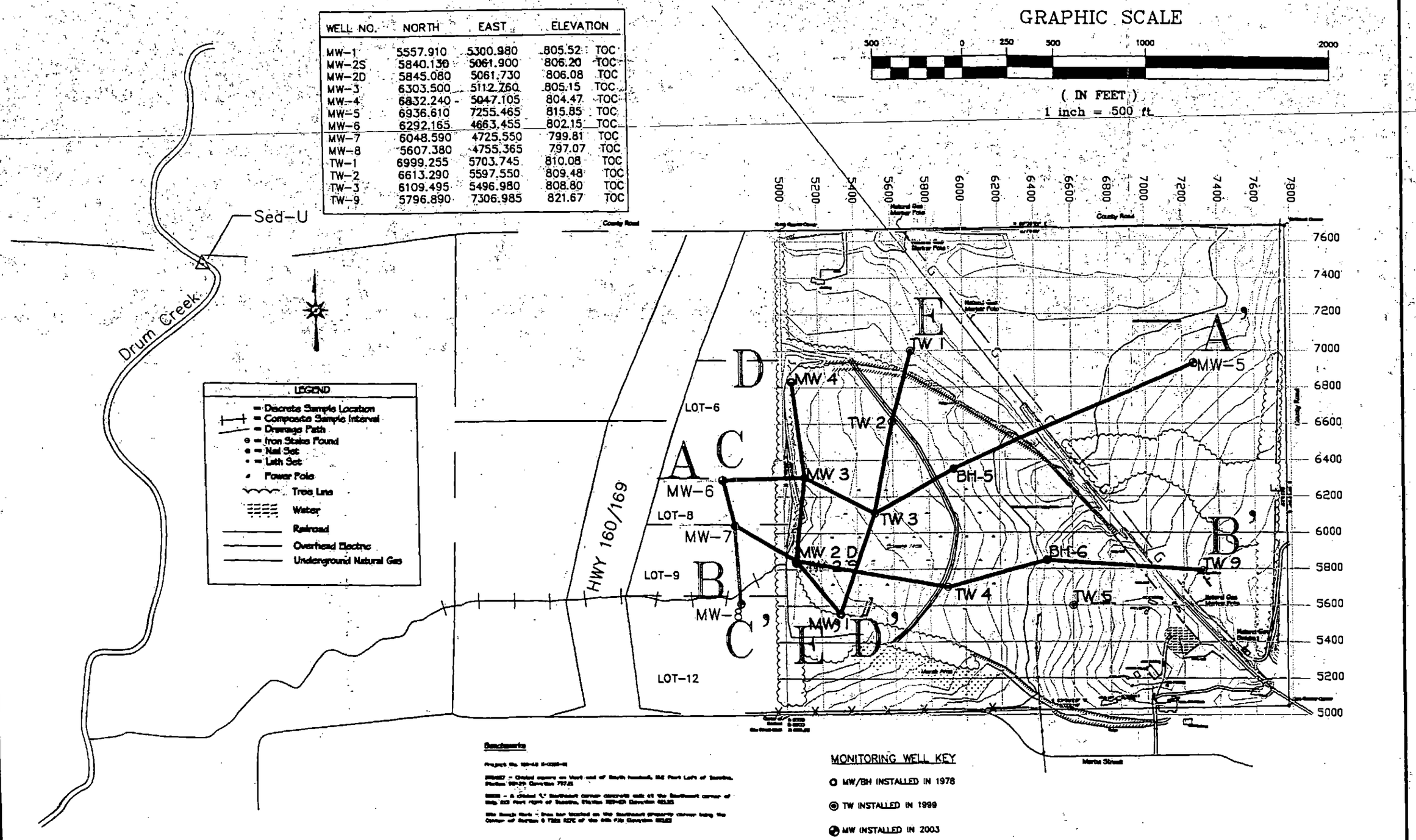

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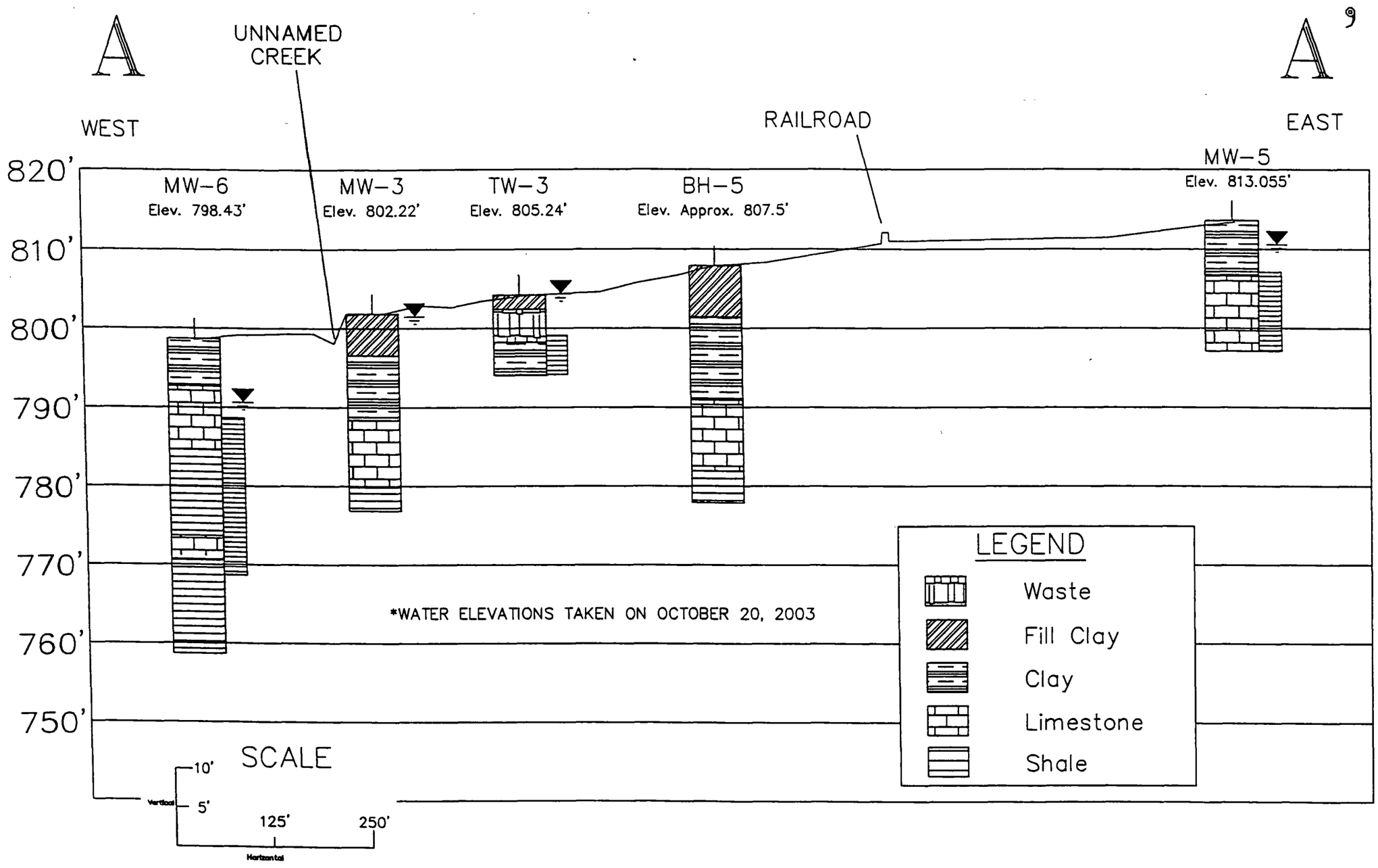
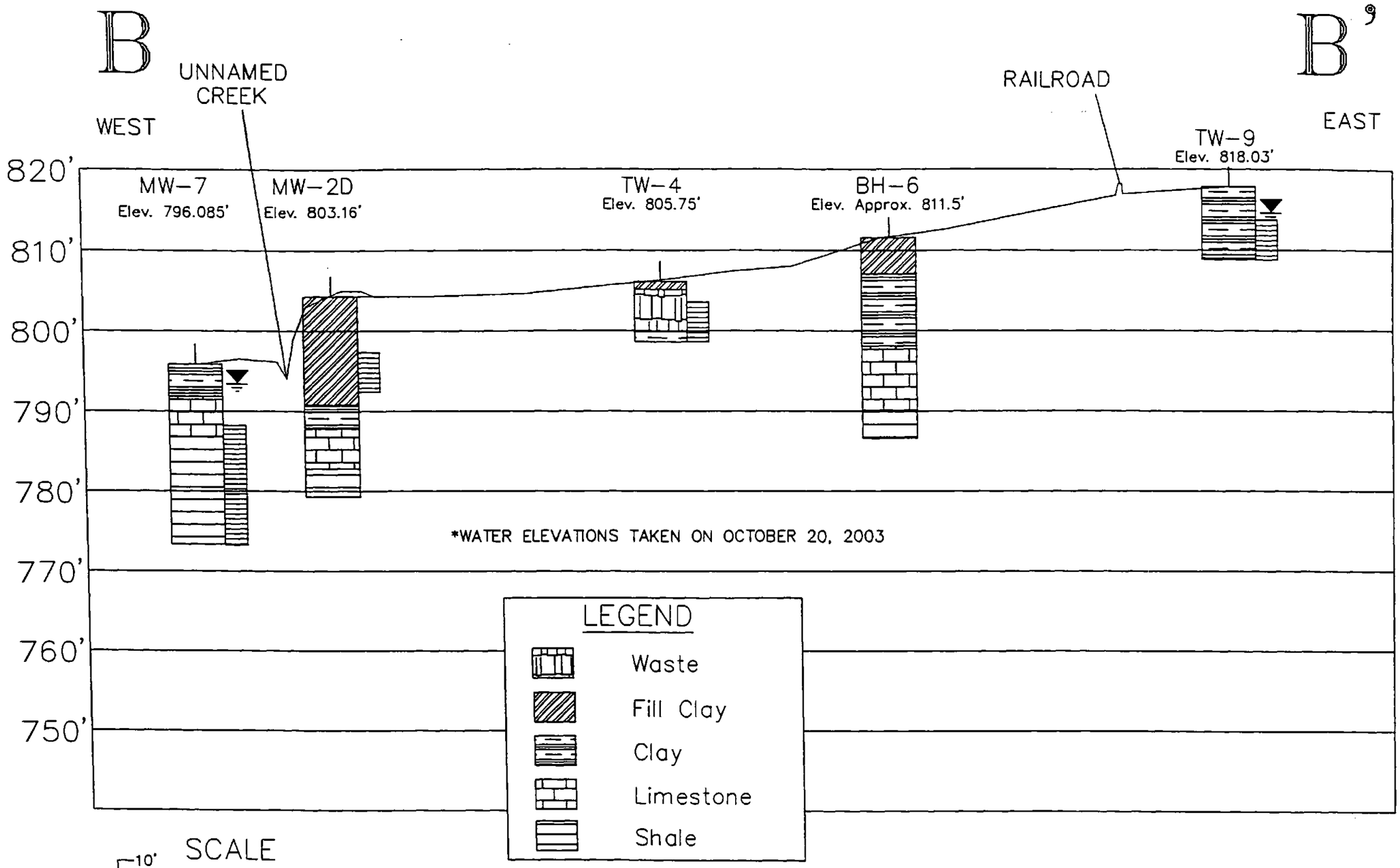
ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

SCALE:	DATE:	FIGURE NO.	CROSS-SECTION LOCATIONS
1"=500'	11/20/03	FIGURE 4	NATIONAL ZINC SITE CHERRYVALE, KANSAS
APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.	

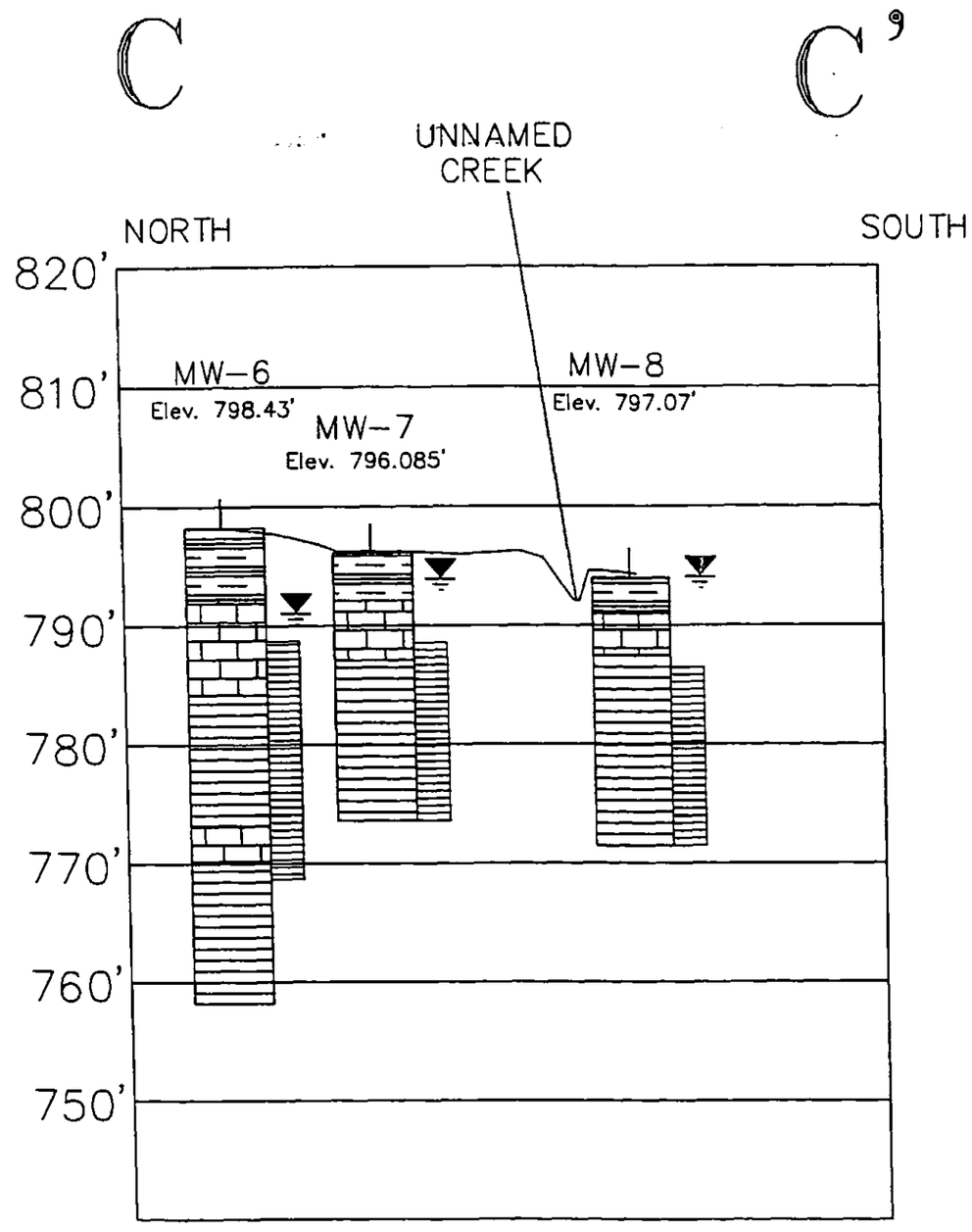


A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

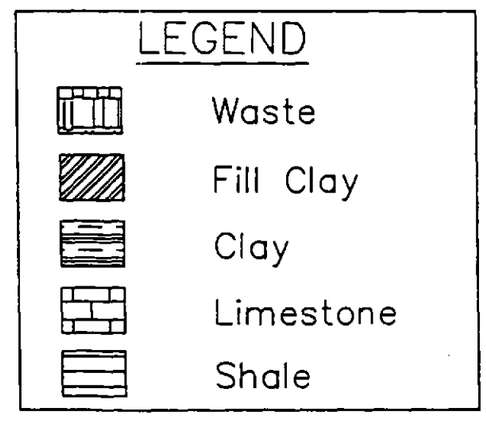
SCALE: AS	DATE: 11/20/03	FIGURE NO. FIGURE 5	CROSS-SECTION A-A'
APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.	NATIONAL ZINC SITE CHERRYVALE, KANSAS

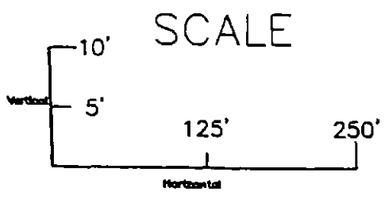


A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC. ENGINEERING – ENVIRONMENTAL – CONSTRUCTION	SCALE: AS	DATE: 11/20/03	FIGURE NO. FIGURE 6	CROSS-SECTION B-B'
	APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.	NATIONAL ZINC SITE CHERRYVALE, KANSAS



*WATER ELEVATIONS TAKEN ON OCTOBER 20, 2003

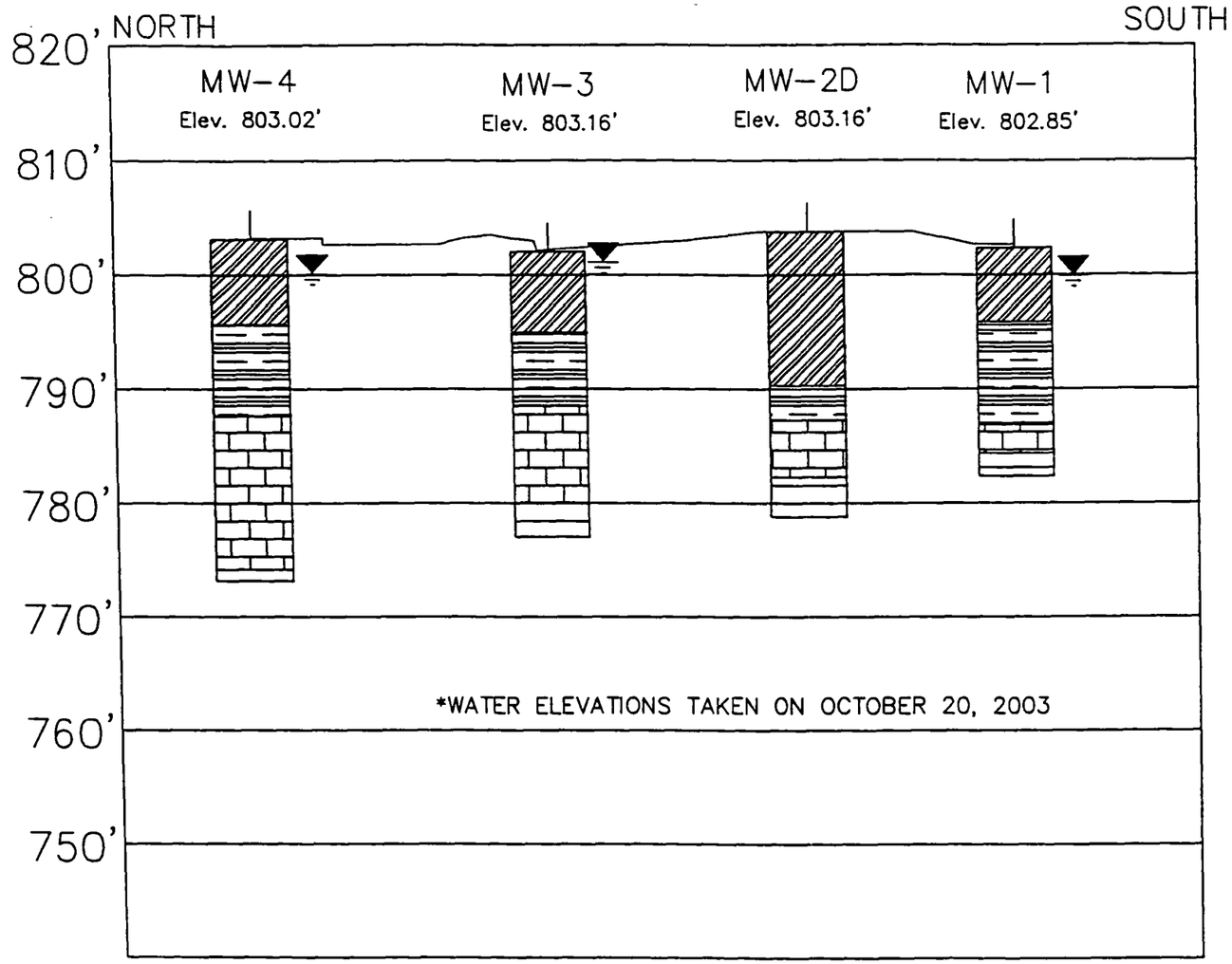


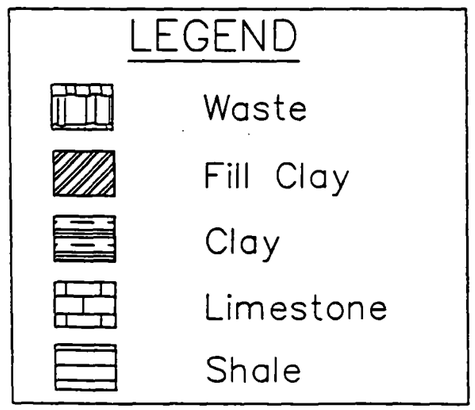


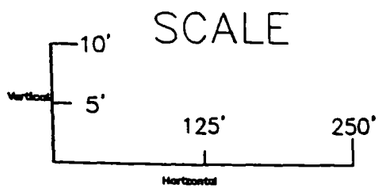
Vertical Exageration 10x

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC. ENGINEERING – ENVIRONMENTAL – CONSTRUCTION	SCALE: AS	DATE: 11/20/03	FIGURE NO. FIGURE 7	CROSS-SECTION C-C'
	APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.	NATIONAL ZINC SITE CHERRYVALE, KANSAS

D — D'

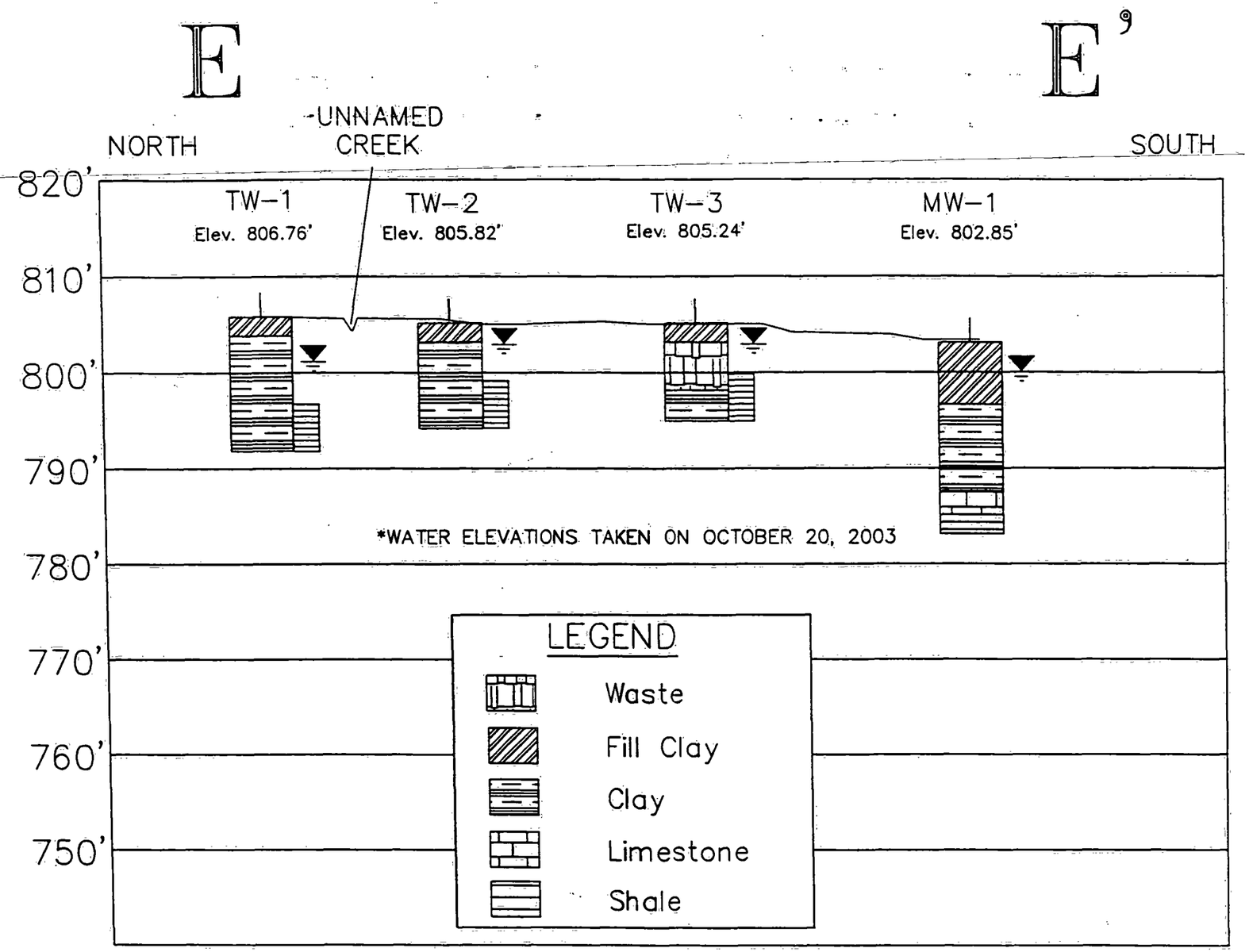






Vertical Exageration 10x

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC. (ENGINEERING – ENVIRONMENTAL – CONSTRUCTION)	SCALE: AS	DATE: 11/20/03	FIGURE NO. FIGURE 8	CROSS-SECTION D-D'
	APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.	NATIONAL ZINC SITE CHERRYVALE, KANSAS



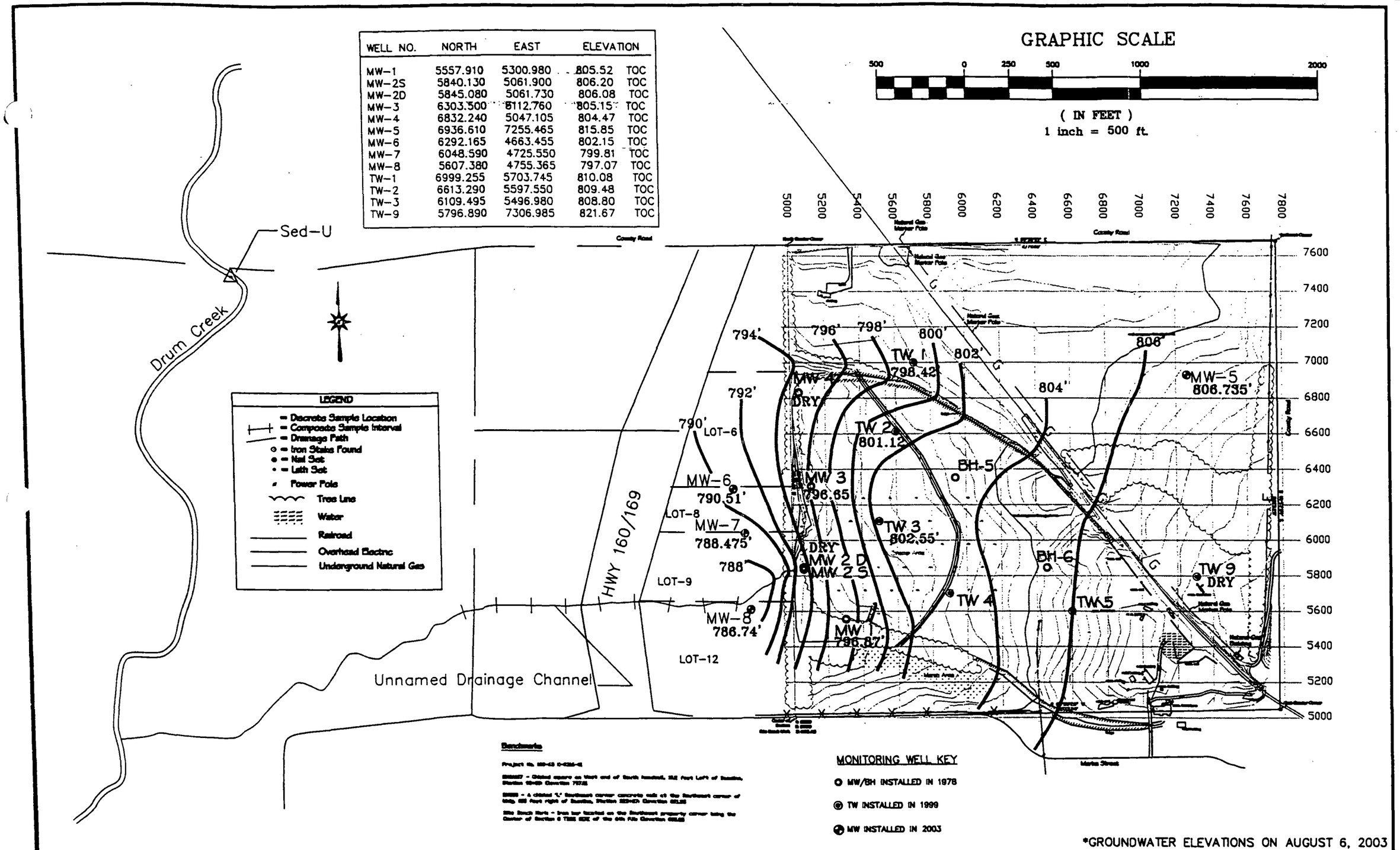
SCALE

10'
Vertical
5'
125'
250'
Horizontal

Vertical Exageration 10x

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC. ENGINEERING – ENVIRONMENTAL – CONSTRUCTION	SCALE: AS	DATE: 11/20/03	FIGURE NO. FIGURE 9	CROSS-SECTION E-E'
	APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.	NATIONAL ZINC SITE CHERRYVALE, KANSAS

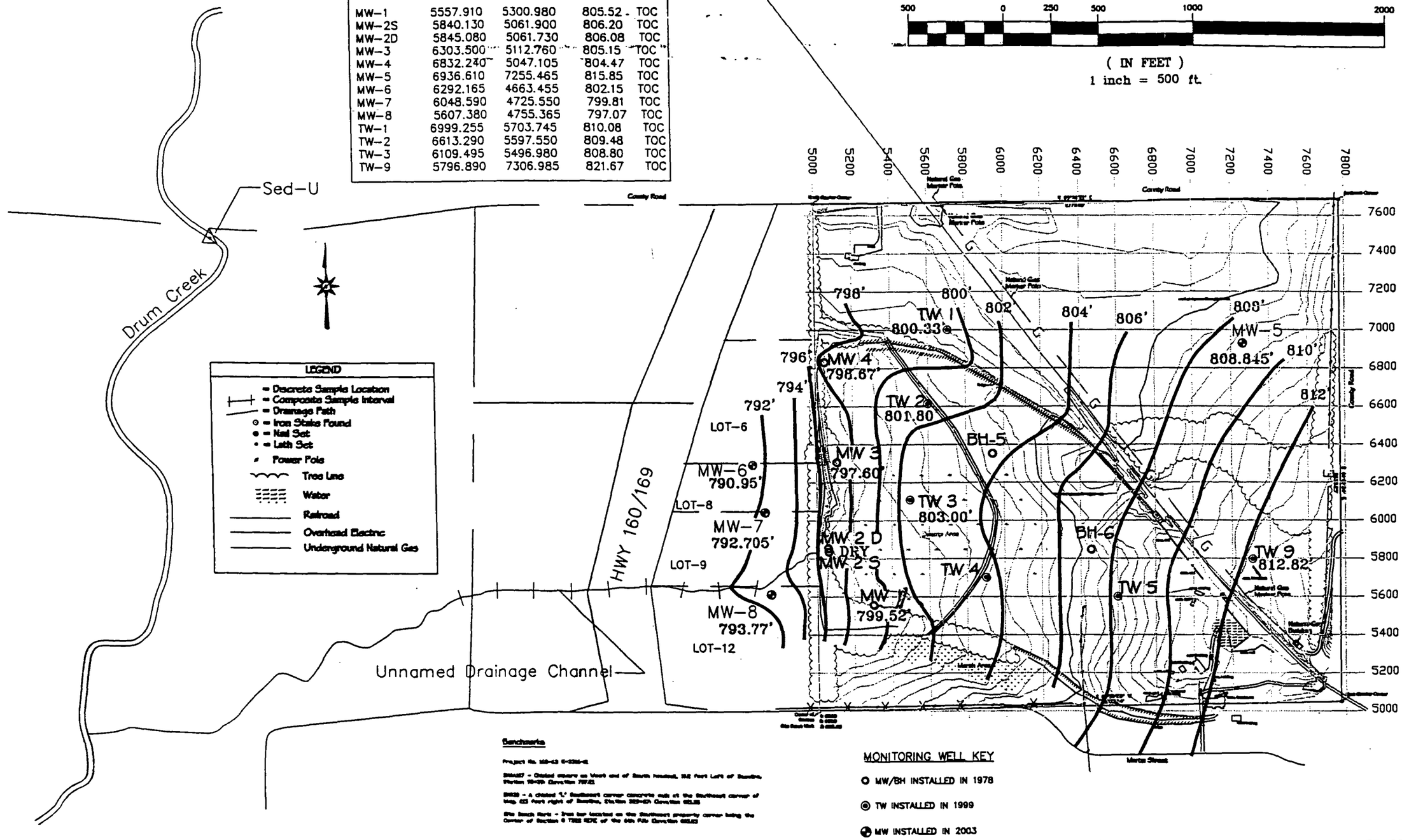
WELL NO.	NORTH	EAST	ELEVATION	
MW-1	5557.910	5300.980	805.52	TOC
MW-2S	5840.130	5061.900	806.20	TOC
MW-2D	5845.080	5061.730	806.08	TOC
MW-3	6303.500	5112.760	805.15	TOC
MW-4	6832.240	5047.105	804.47	TOC
MW-5	6936.610	7255.465	815.85	TOC
MW-6	6292.165	4663.455	802.15	TOC
MW-7	6048.590	4725.550	799.81	TOC
MW-8	5607.380	4755.365	797.07	TOC
TW-1	6999.255	5703.745	810.08	TOC
TW-2	6613.290	5597.550	809.48	TOC
TW-3	6109.495	5496.980	808.80	TOC
TW-9	5796.890	7306.985	821.67	TOC



*GROUNDWATER ELEVATIONS ON AUGUST 6, 2003

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.	SCALE: 1"=500'	DATE: 11/20/03	FIGURE NO. FIGURE 10	GROUNDWATER CONTOUR MAP
ENGINEERING – ENVIRONMENTAL – CONSTRUCTION	APPROVED BY: IT	DRAWN BY: GJJ	PROJECT NO. 1804-002	NATIONAL ZINC SITE CHERRYVALE, KANSAS

WELL NO.	NORTH	EAST	ELEVATION	
MW-1	5557.910	5300.980	805.52	TOC
MW-2S	5840.130	5061.900	806.20	TOC
MW-2D	5845.080	5061.730	806.08	TOC
MW-3	6303.500	5112.760	805.15	TOC
MW-4	6832.240	5047.105	804.47	TOC
MW-5	6936.610	7255.465	815.85	TOC
MW-6	6292.165	4663.455	802.15	TOC
MW-7	6048.590	4725.550	799.81	TOC
MW-8	5607.380	4755.365	797.07	TOC
TW-1	6999.255	5703.745	810.08	TOC
TW-2	6613.290	5597.550	809.48	TOC
TW-3	6109.495	5496.980	808.80	TOC
TW-9	5796.890	7306.985	821.67	TOC

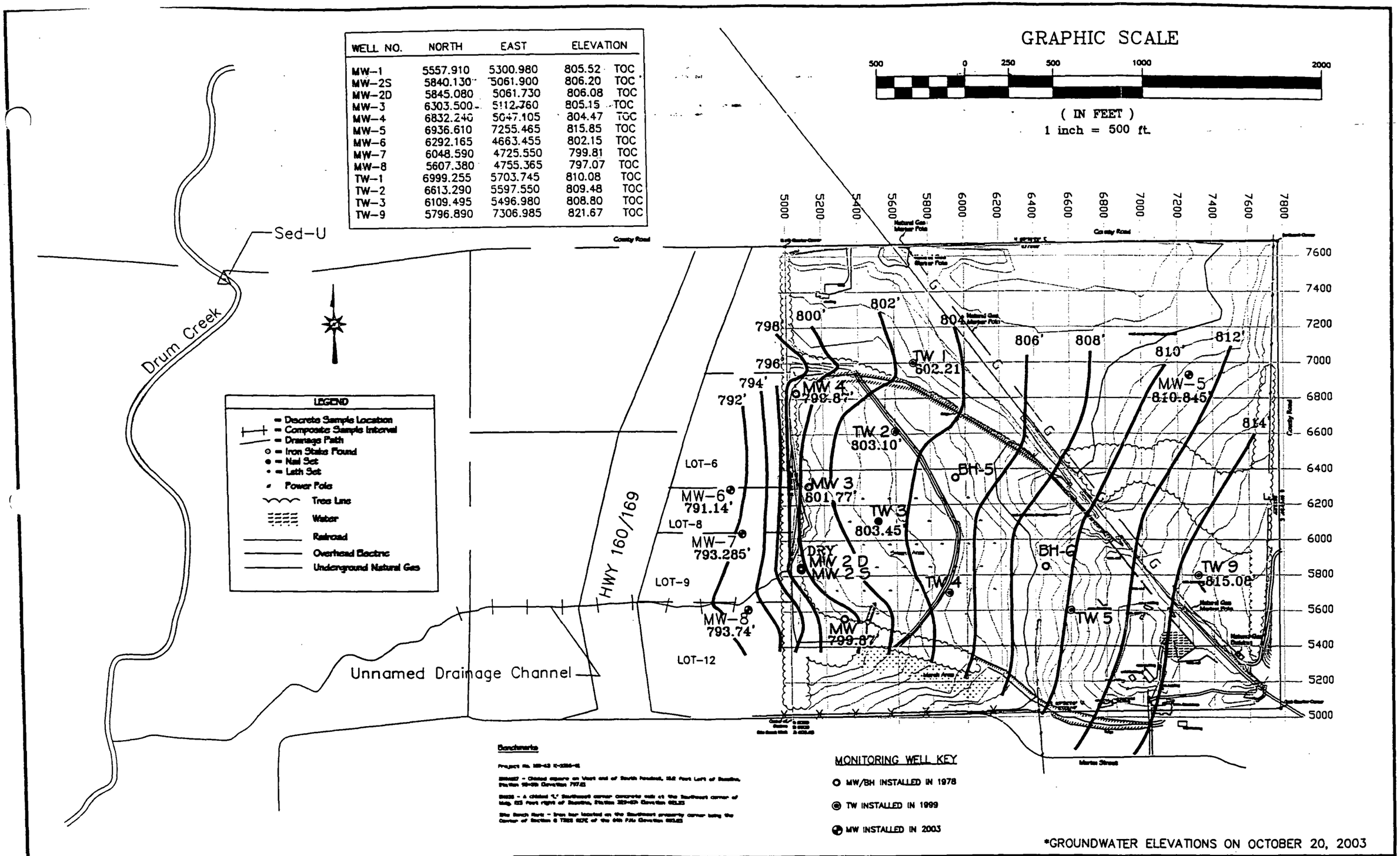


*GROUNDWATER ELEVATIONS ON SEPTEMBER 23, 2003

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

SCALE:	DATE:	FIGURE NO.	GROUNDWATER CONTOUR MAP
1"=500'	11/20/03	FIGURE 11	NATIONAL ZINC SITE
APPROVED BY: IT	DRAWN BY: GJJ	PROJECT NO. 1804-002	CHERRYVALE, KANSAS

WELL NO.	NORTH	EAST	ELEVATION	
MW-1	5557.910	5300.980	805.52	TOC
MW-2S	5840.130	5061.900	806.20	TOC
MW-2D	5845.080	5061.730	806.08	TOC
MW-3	6303.500	5112.760	805.15	TOC
MW-4	6832.240	5047.105	804.47	TOC
MW-5	6936.610	7255.465	815.85	TOC
MW-6	6292.165	4663.455	802.15	TOC
MW-7	6048.590	4725.550	799.81	TOC
MW-8	5607.380	4755.365	797.07	TOC
TW-1	6999.255	5703.745	810.08	TOC
TW-2	6613.290	5597.550	809.48	TOC
TW-3	6109.495	5496.980	808.80	TOC
TW-9	5796.890	7306.985	821.67	TOC

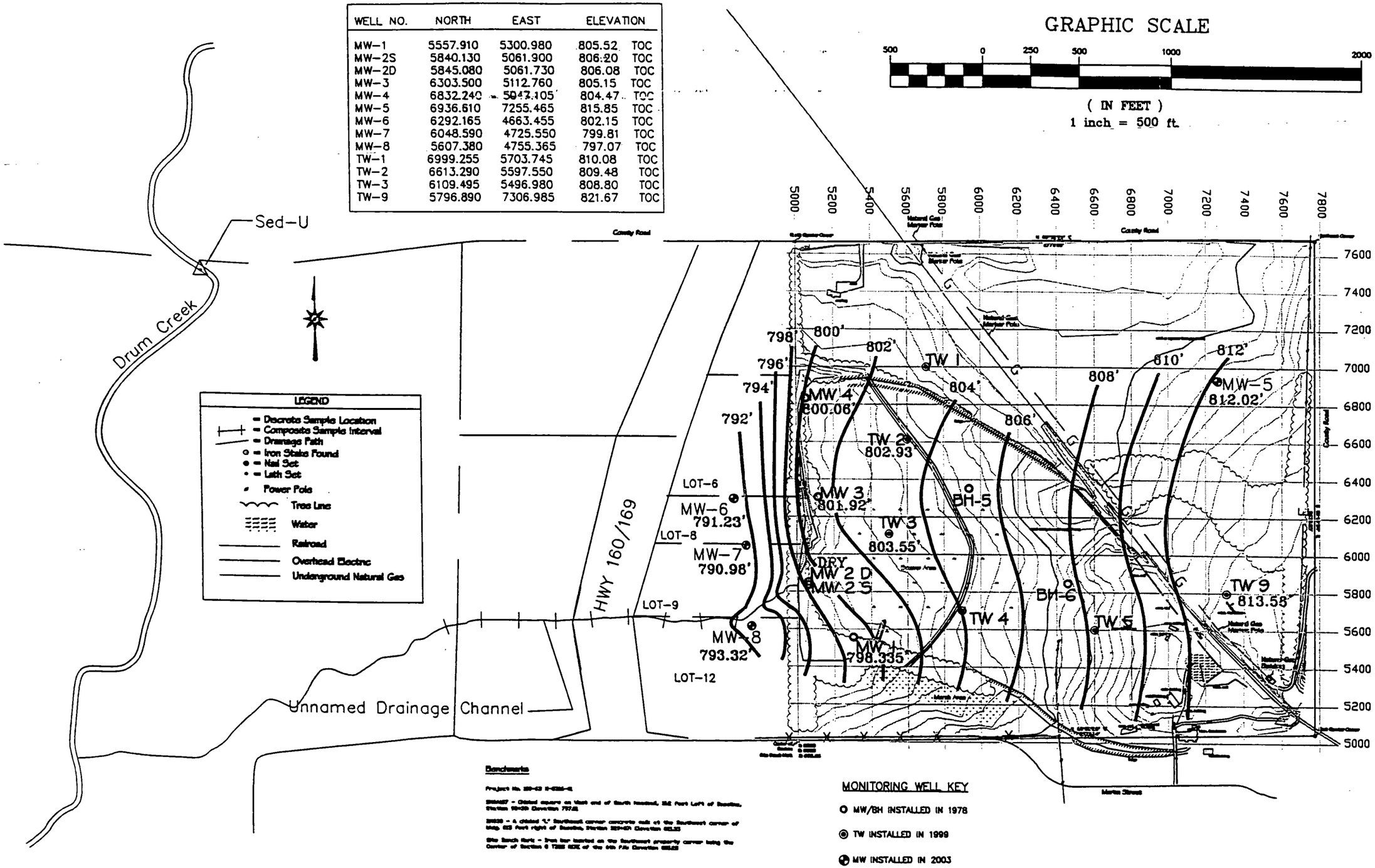


*GROUNDWATER ELEVATIONS ON OCTOBER 20, 2003

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

SCALE:	DATE:	FIGURE NO.	GROUNDWATER CONTOUR MAP
1"=500'	11/20/03	FIGURE 12	NATIONAL ZINC SITE
APPROVED BY: IT	DRAWN BY: GJJ	PROJECT NO. 1804-002	CHERRYVALE, KANSAS

WELL NO.	NORTH	EAST	ELEVATION	
MW-1	5557.910	5300.980	805.52	TOC
MW-2S	5840.130	5061.900	806.20	TOC
MW-2D	5845.080	5061.730	806.08	TOC
MW-3	6303.500	5112.760	805.15	TOC
MW-4	6832.240	5047.105	804.47	TOC
MW-5	6936.610	7255.465	815.85	TOC
MW-6	6292.165	4663.455	802.15	TOC
MW-7	6048.590	4725.550	799.81	TOC
MW-8	5607.380	4755.365	797.07	TOC
TW-1	6999.255	5703.745	810.08	TOC
TW-2	6613.290	5597.550	809.48	TOC
TW-3	6109.495	5496.980	808.80	TOC
TW-9	5796.890	7306.985	821.67	TOC



*GROUNDWATER ELEVATIONS ON NOVEMBER 18, 2003

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

SCALE:	DATE:	FIGURE NO.	GROUNDWATER CONTOUR MAP
1"=500'	11/20/03	FIGURE 13	NATIONAL ZINC SITE
APPROVED BY: IT	DRAWN BY: GJJ	PROJECT NO. 1840-002	CHERRYVALE, KANSAS

Appendix 1

Report of 1978-79 Site Investigation

JOB NO. 78/5041

GEOLOGIC AND SOIL ENGINEERING REPORT
LAGOON EMBANKMENT EVALUATION
CHERRYVALE, KANSAS

6-98

PREPARED FOR

NATIONAL ZINC COMPANY
BARTLESVILLE, OKLAHOMA 74003

June 9, 1978

PREPARED BY

WICHITA TESTING LABORATORIES
810 EAST MURDOCK
WICHITA, KANSAS 67214

(316) 264-4328

LAGOON EMBANKMENT EVALUATION
CHERRYVALE, KANSAS
GEOLOGY AND SITE CONDITIONS

The site of existing lagoon is located near the northwest limits of Cherryvale, Kansas in the N 1/2, Sec. 8, T32S, R17E.

The lagoon embankment, which has a maximum height of about 15 feet, presently ponds approximately 20± surface acres of water. This embankment was originally constructed in the late 1940's to entrap and pond contaminated surface runoff from the zinc plant property. The impoundment was designed to be an evaporating lagoon; however, to satisfactorily perform this function the embankment was subsequently modified several times by both increasing the height and constructing a new dike to enlarge the storage area. We were informed by personnel from the National Zinc Company that the existing impoundment has performed satisfactorily as an evaporating lagoon. We were also informed that several areas of seepage noted in the lower portion of the dike along the west downstream side have occurred since the embankment first impounded water.

The subject site is located within the Osage Cuestas section of the Osage Plains physiographic province, which is characterized by rolling, steep-sided hills that are dissected by intermittent streams with flat alluvial valleys. Specifically this site is on a drainage tributary

of Drum Creek which is in turn a tributary of the Verdigris River. The upper bedrock in this area is composed of limestones and shales of the Dennis Limestone formation of upper Pennsylvanian geologic age. In Borings 1 through 6 the Winterset limestone and Stark shale members of the Dennis Limestone formation were encountered. In each of these borings the upper portion of the Winterset limestone (surface bedrock) was found to be broken, weathered and containing seepage water perched above the underlying hard and relatively unweathered bedrock materials. The Winterset was encountered as high as elevation 80.6 feet (datum this survey) in Boring 6 to as low as elevation 75.6 feet (datum this survey) in Boring 2. Where penetrated, the thickness of the Winterset varied from 2.5 to 9.0 feet.

The soils encountered in the embankment portion of this site consist of medium and high plasticity (CL & CH) silty clay fill overlying the natural silty clay and sandy clay mantle soils which occur above the Winterset limestone. A thin topsoil zone was encountered below the fill in most borings and the entire embankment is capped with approximately one foot of cinder and brick used as a road bed. At the test hole locations the natural mantle soils, including topsoil zone, vary in thickness from 3 to 10 feet above bedrock. Geologic and Surface Profiles at the locations of Borings 1 through 4 are shown on the enclosed Figure Numbers 11 through 14 respectively.

The boring locations are shown on the enclosed Figure No. 1. The boring logs (Figures 2 through 10) present data obtained in this exploration. The logs include the surface elevation; depths and elevations of major changes in the character of the subsurface materials; visual descriptions of the materials in accordance with the Unified Soil Classification System; groundwater data; penetration resistance recorded in 0.5 ft. increments of depth; and the location of undisturbed soil samples.

The elevations shown on the Boring Logs were referenced to the floor level at the west entrance to the Filter House Building. This benchmark was assigned an elevation of 100.00 feet.

Observation wells were constructed by a licensed well driller at the location of Borings 1 through 4. The well driller was instructed to place one well point using PVC plastic pipe, through the embankment soils and into the underlying bedrock at each of these locations. In addition, near the location of Boring 2, one observation well was to be placed in the embankment fill above natural soils approximately 12 feet below grade. It is our understanding that the purpose of these observation wells is for National Zinc Company and/or the Kansas State Department of Health and Environment to monitor the seepage water level and quality.

Submitted By:

WICHITA TESTING LABORATORIES

By

Richard L. Luke
Engineering Geologist

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 1
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 1
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot	Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
91.7	0		Fill: cinders, brick, tile, etc.; loose.			
90.7	1	CH	Fill: silty clay; dark yellowish brown mottled with very dark brown and grayish brown; wet; med. plasticity; stiff.	1	6 7 6	W=23.6 D=101.5 N=13
86.2	5.5		As above but saturated in seams.			
85.2	6.5	CH	Silty Clay: very dark gray and dark grayish brown; wet to saturated in seams; high plasticity; medium stiff to stiff. (possible fill)			Water Level @ 8.0' (Elev. 83.7) After 24 Hours
84.2	7.5	CL				
82.7	9	CH	Silty Clay: very dark gray; minor organics; saturated; med. plasticity; medium stiff. (old topsoil zone)	2	2 2 5	W=27.1 D=94.5 N=7
			Silty Clay: dark yellowish brown; saturated; high plasticity; medium stiff.			
79.2	12.5		As above but some limestone gravel.	3		W=33.4 D=87.6
76.2	15.5		Limestone: broken and weathered.			
75.2	16.5		Limestone: light gray and hard. (possible Winterset Limestone)			
73.7	18		Shale: dark gray to gray; hard. (possible Stark Shale)			
			Coal Seam			
71.7	20					

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 2
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
92.1	0		Fill: cinders, brick, tile, etc.; loose.			
91.1	1	CH & CL	Fill: silty clay; very dark grayish brown, dark yellowish brown and reddish brown; wet; medium and high plasticity; stiff.	4		W=25.5 D=98.6
89.1	3		As above but saturated in seams.		3 4 5	N=9
				5		Water Level @ 7.7' (Elev. 84.4) After 24 Hours
84.1	8	▽	Very wet to saturated.		2 4 5	W=32.1 D=90.3 N=9
				6		W=30.2 D=94.9
78.6	13.5	CL	Silty Clay: some organics; very dark gray; very wet to saturated; medium plasticity; medium stiff. (old topsoil)		1 2 3	N=5
77.1	15	CH	Silty Clay: dark yellowish brown; saturated; high plasticity; medium stiff.	7		W=27.3 D=94.9
75.6	16.5		Limestone: weathered and broken.			
73.1	19		Limestone: hard; light yellowish brown. (possible Winterset Limestone)			

WICHITA TESTING LABORATORIES
Materials Engineers
Wichita, Kansas

BORING LOG

PROJECT
Lagoon Embankment Evaluation
National Zinc Company
Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 2
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 2
w = Moisture Content, %	D = Dry Density, pcf	Penetration Resistance: N = Blows per foot	Date: 4-18-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No	Blows	Remarks
72.1	20		Limestone: as before; but shaley; dark gray and hard.			
70.6	21.5		Shale: dark gray with thin limestone stringers. (possible Stark Shale)			
67.1	25					

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas	
Boring Method: 6-in. continuous flight auger	Standard Penetration Test	Boring No. 3
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer / 30-in. Fall / 2-in. o.d. Split-barrel Sampler	Sheet 1 of 2
w = Moisture Content, % / D = Dry Density, pcf	Penetration Resistance: N = Blows per foot	Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
91.3	0		Fill: cinders, brick, clay tile, etc.			
90.3	1	CH	Fill: silty clay; dark yellowish brown, grayish brown, reddish brown and gray; wet; high plasticity; stiff to medium stiff with depth.	8		W=25.5 D=94.8
87.3	4	CL	Fill: silty clay; very dark brown and yellowish brown; wet with saturated seams; medium plasticity; medium stiff.	9	2 2 3	N=5 W=28.5 D=95.5
						Water Level @ 7.7' (Elev. 83.6) After 24 Hours
83.8	7.5	CL	Silty Clay: very dark gray with some organics; wet; medium plasticity; med. stiff to stiff. (old topsoil zone)	10		W=24.3 D=98.0
83.3	8	CH				
82.3	9		Silty Clay: dark gray with lime concretions; wet; high plasticity; medium stiff to stiff.		3 4 4	N=8
80.3	11	CH	As above but dark yellowish brown.			
			Gravelly Clay: 20% fine to medium gravel (chert); dark yellowish brown; wet; high plasticity; stiff.	11		W=22.4 D=107.6
77.8	13.5		Limestone: dark yellowish brown; broken and weathered. (possible Winterset Limestone)			
74.8	16.5		Limestone: light yellowish brown; fossiliferous; medium hard. (Winterset Limestone)			

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method 6-in. continuous flight auger	Standard Penetration Test			Boring No. 3
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 2
w = Moisture Content, % / D = Dry Density, pcf	Penetration Resistance: N = Blows per foot			Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
71.3	20					
			Limestone: gray; hard.			
69.3	22					
			Shale: dark gray (possible Stark Shale)			
68.3	23		Calcareous			
67.8	23.5					
			Shale as before.			
66.3	25					

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 4
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, % / D=Dry Density, pcf	Penetration Resistance: N=Blows per foot			Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
92.1	0		Fill: cinders, brick, clay, tile, etc.			
91.1	1	CL	Fill: silty clay; dark yellowish brown, gray and reddish brown; wet; medium plasticity; medium stiff.	12		W=25.4 D=97.9
88.1	4	CH& CL	Fill: silty clay; very dark gray and dark gray; wet to saturated in seams; high and medium plasticity; medium stiff.		2 3 5	N=8
84.6	7.5	CH w/ CL ▽	Silty Clay: dark yellowish brown with iron stains; wet to very wet; high plasticity; with medium plasticity zones; medium stiff.	13		W=25.7 D=96.9
					2 3 4	Water Level @ 9.5' (Elev. 82.6') After 24 Hours N=7
				14		W=27.1 D=92.8
80.1	12	CH	Gravelly Clay: 20 to 25% fine to medium gravel; dark yellowish brown; very wet; high plasticity; stiff.		4 5 5	N=10
77.6	14.5		As above but saturated.			
76.6	15.5		Limestone: broken and weathered.			
75.1	17		Limestone: light gray; hard. (possible Winterset Limestone)			
72.1	20					

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 4
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 2
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
72.1	20		As before.			
71.1	21		Limestone: sandy and shaley; dark gray.			
63.1	29		Shale: fissile; black; hard. (possible Stark Shale)			
62.1	30					

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 5
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot			Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
94.1	0		Fill: Cinders.			
90.1	4	▽	As above but saturated.			Water @ 4.0' After Drilling. (perched in cinders above silty clay)
87.6	6.5	CL	Silty Clay: very dark grayish brown; very wet; low to medium plasticity; medium stiff.			
86.1	8	CH	Silty Clay: brownish gray with olive yellow and iron staining; very wet; medium to high plasticity; medium stiff.			
82.1	12		As above but yellowish brown with light gray to gray mottling; iron stain; 10 to 15% coarse sand; stiff.			
78.1	16		As above but with 15 to 25% gravel.			
77.1	17		Limestone: yellowish brown; weathered medium hard.			
75.1	19		Limestone: yellowish brown to light gray; hard.			

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method 6-in. continuous flight auger	Standard Penetration Test			Boring No. 5
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 2
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot			Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No	Blows	Remarks
74.1	20		Limestone: as before.			
72.6	21.5		Limestone: shaley; medium hard.			
71.1	23		Limestone: hard.			
68.1	26		Shale: dark gray; hard.			
			Calcareous			
64.1	30					

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in continuous flight auger	Standard Penetration Test			Boring No. 6
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in Fall	2-in. o.d Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, % / D=Dry Density, pcf	Penetration Resistance: N=Blows per foot			Date: 4-12-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
94.1	0		Fill: cinders and ash with brick and tile rubble; saturated @ 3.0'; loose.			Water @ 3.9' After Drilling (Perched above silty clay)
89.6	4.5	CH	Silty Clay: very dark gray; traces of fine sand; very wet; medium to high plasticity; medium stiff.			
88.1	6		As above but olive gray, gray and yellowish brown mottled.			
85.6	8.5	CH	Silty Clay: yellowish brown mottled with light gray to gray; very wet; high plasticity; medium stiff to stiff.			
82.1	12		As above with 20 to 25% limestone gravel; stiff.			
80.6	13.5		Limestone: yellowish brown; broken and weathered. (possible Winterset Limestone)			
78.6	15.5		Limestone: light gray; hard. (Winterset Limestone)			
77.6	16.5		As above but broken in part.			
74.6	19.5		Limestone: hard. (Winterset Limestone)			

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

ing Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 6
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 2
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-12-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
74.1	20		Limestone: as before.			
72.6	21.5		Shale: gray and light gray; sandy; high plasticity; hard. (possible Stark Shale)			
69.1	25					

Figure 7a

Drilled By: William R. Giesal

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No 8
Undisturbed Soil Sampler. 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 1
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-12-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
92.0	0		Fill: cinders.			
91.0	1	CH	Fill: silty clay; dark brown mottled with dark yellowish brown and reddish brown; wet; high plasticity; stiff.			
88.0	4	CH	Fill: silty clay; gray; yellowish brown and dark gray; very wet; high plasticity; stiff.			
85.0	7	CL	Silty Clay: very dark gray; very wet; medium to high plasticity; medium stiff. (old topsoil zone)			
84.0	8	CH	Silty Clay: dark gray; very wet; high plasticity; medium stiff to stiff.			
85.0	9	CH	Silty Clay: dark yellowish brown; very wet; high plasticity; stiff.			
78.5	13.5		Weathered Limestone.			
78.0	14					

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 9
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 1
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance, N=Blows per foot			Date: 4-12-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
st. 92.0	0		Fill: cinders, brick, tile, etc.; loose.			
91.0	1	CH	Fill: silty clay; dark yellowish brown, brown and grayish brown; wet; high plasticity; stiff.			
88.0	4	CL	Silty Clay: very dark gray to dark gray with some organics; saturated; medium plasticity; soft to medium stiff. (old topsoil zone)	15		W=30.5 D=90.6
87.0	5	CH	Silty Clay: dark gray; very wet; high plasticity; medium stiff.			
85.5	6.5		As above but dark yellowish brown and stiff.			
77.0	15		Saturated.			
76.5	15.5		Weathered Limestone.			
76.0	16					

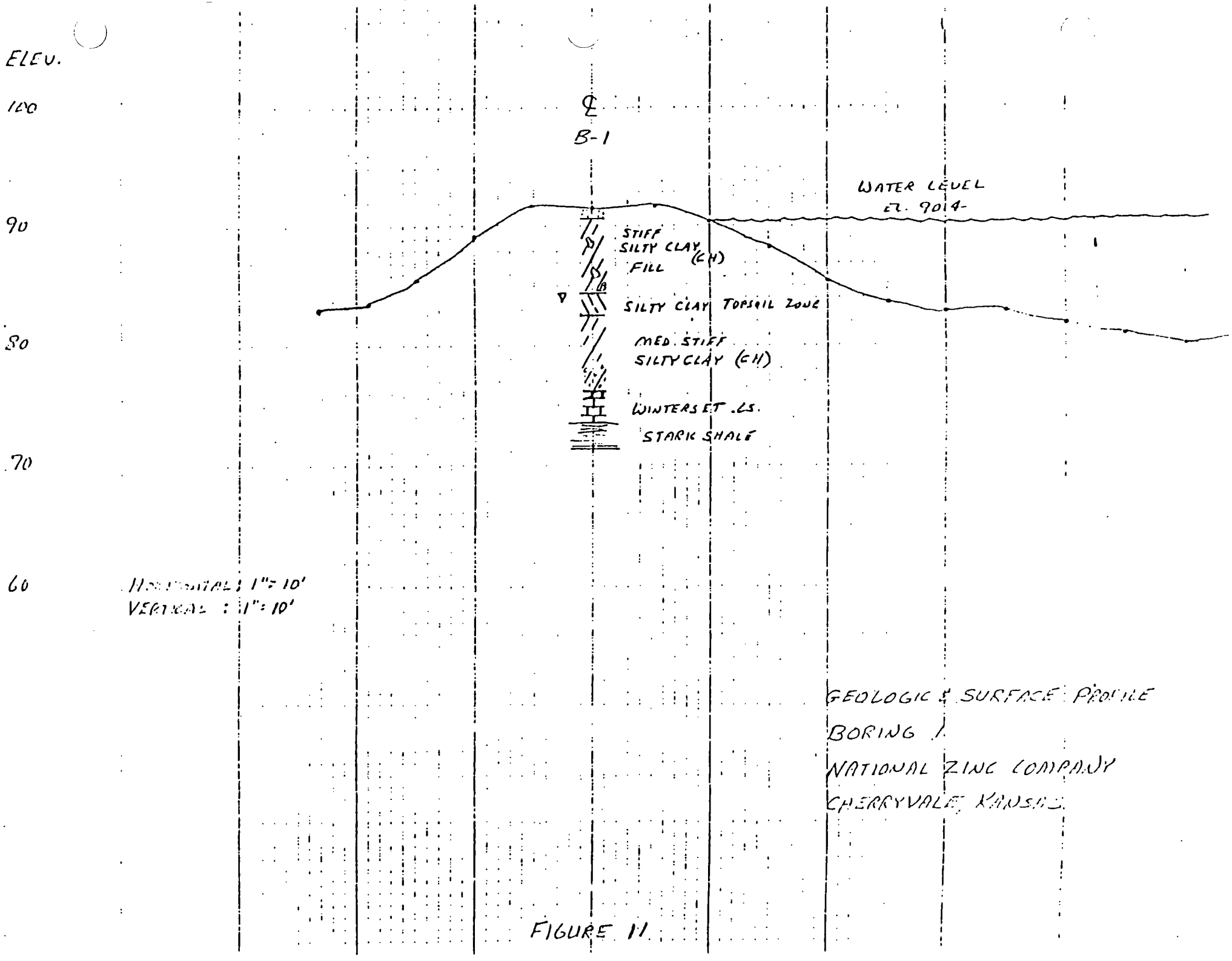

ELEV.
100
90
80
70
60
℄
B-1
WATER LEVEL
EL. 901.4
STIFF
SILTY CLAY (CH)
FILL
SILTY CLAY TOPSOIL ZONE
MED. STIFF
SILTY CLAY (CH)
WINTERSET LS.
STARK SHALE
HORIZONTAL: 1" = 10'
VERTICAL : 1" = 10'
GEOLOGIC & SURFACE PROFILE
BORING 1
NATIONAL ZINC COMPANY
CHERRYVALE, KANSAS

FIGURE 11

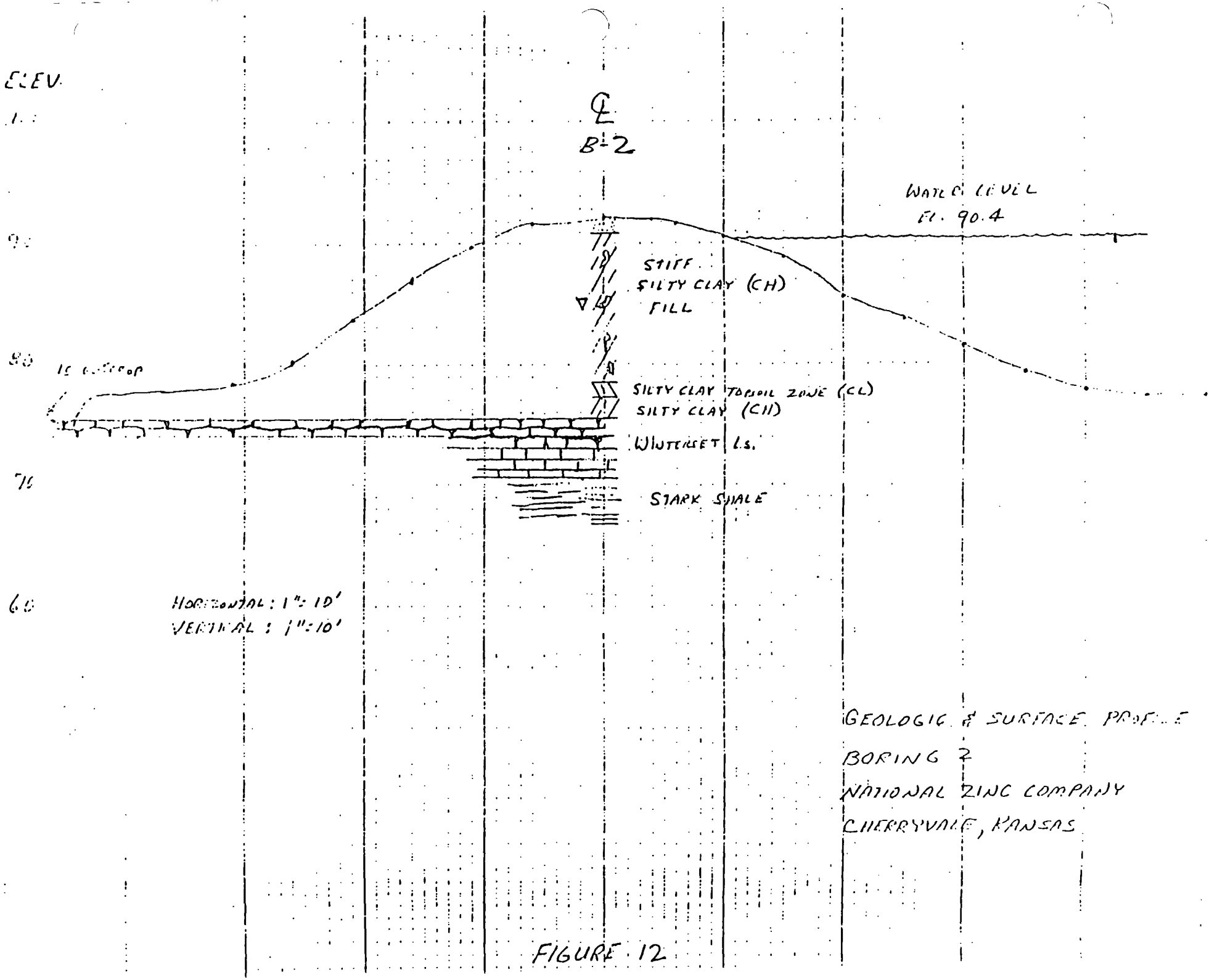
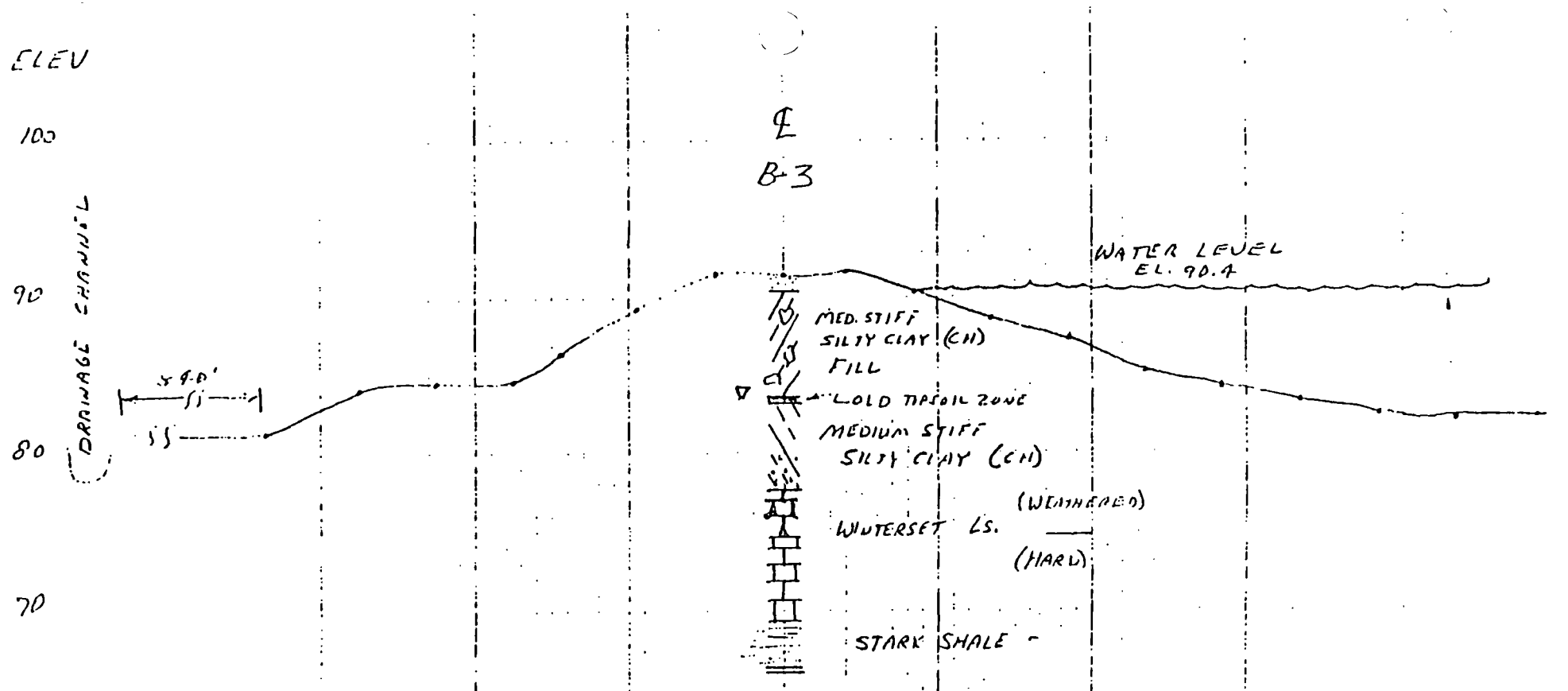
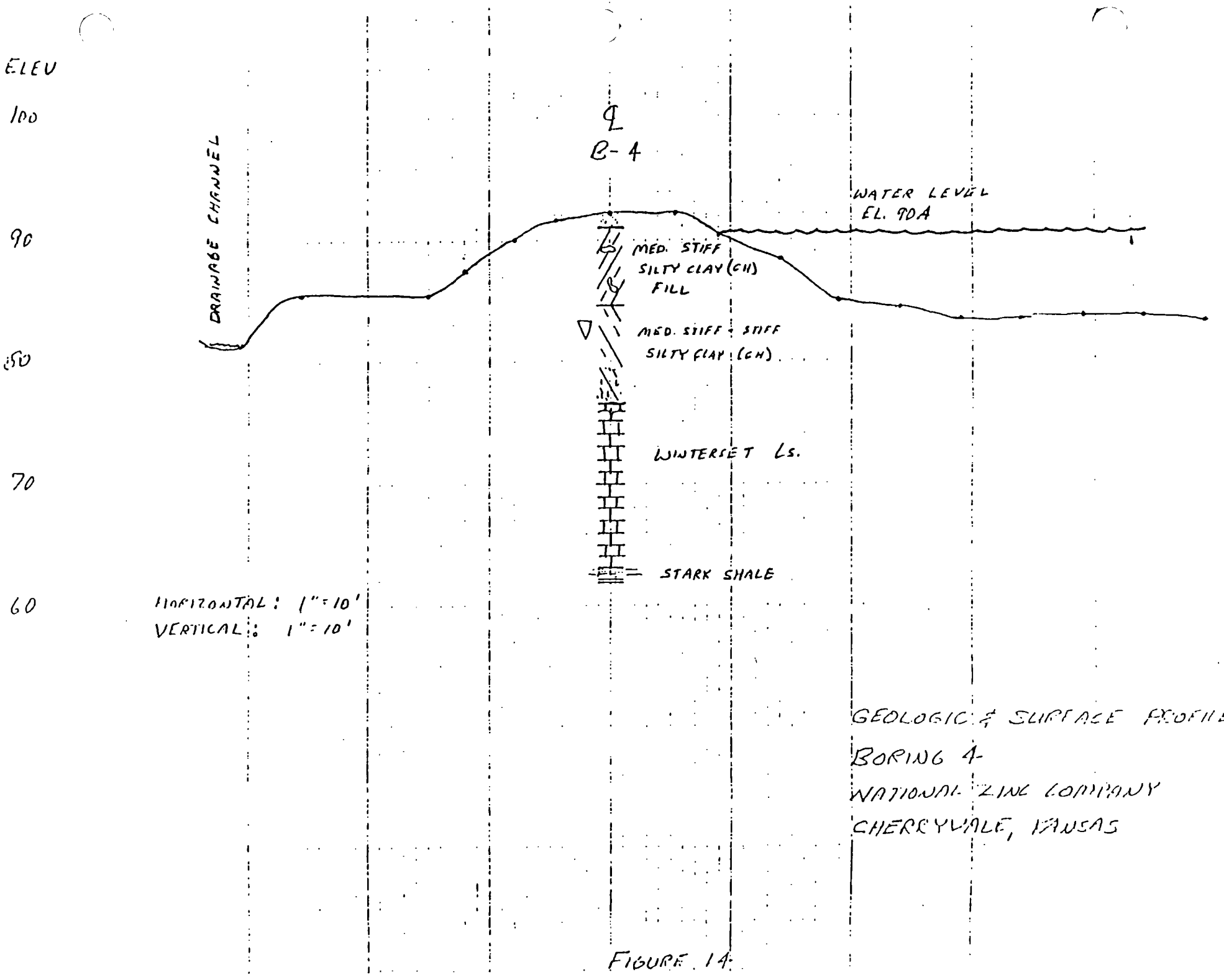

ELEV.
℄
B-2
WATER LEVEL
EL. 90.4
STIFF
SILTY CLAY (CH)
FILL
SILTY CLAY TOPSOIL ZONE (CL)
SILTY CLAY (CH)
WINTERSET LS.
STARK SHALE
HORIZONTAL: 1" = 10'
VERTICAL: 1" = 10'
GEOLOGIC & SURFACE PROFILE
BORING 7
NATIONAL ZINC COMPANY
CHERRYVALE, KANSAS

FIGURE 12



GEOLOGIC & SURFACE PROFILE
BORING 3
NATIONAL ZINC COMPANY
CHERRYVALE, KANSAS

FIGURE 13



GEOLOGIC & SURFACE PROFILE
BORING 4
NATIONAL ZINC COMPANY
CHERRYVALE, KANSAS

FIGURE 14

SOILS ENGINEERING REPORT
LAGOON EMBANKMENT EVALUATION
CHERRYVALE, KANSAS

I. INTRODUCTION

This is a report of subsurface and soil conditions for the existing wastewater lagoon at National Zinc Company plant near Cherryvale, Kansas. The lagoon has been used as a sedimentation basin to collect contaminated surface runoff from the plant area. The wastewater lake was designed as an evaporating lagoon. Numerous height and area additions have been constructed subsequent to initial construction to provide adequate storage.

This investigation was authorized by a contract between National Zinc Company and Wichita Testing Laboratories, dated April 3, 1978.

The purpose of this investigation was to provide an evaluation of the stability of the lagoon embankment as it exists.

Since no guidelines were designated for evaluating the existing embankment we used Soil Conservation Service criteria (Earth Dams and Reservoirs, SCS Technical Release No. 60) in our stability analysis. The embankment stability analysis was made utilizing Class (a) dam criteria. It should be noted that our investigation does not include a flood routing study.

II. FOUNDATION CHARACTERISTICS

1. Bedrock. Limestones and shales of upper Pennsylvanian geologic age underlie the lagoon. The bedrock is believed to be the upper portion of the Dennis Limestone, a member of the Kansas City group. The upper few feet of the limestone bedrock was generally weathered and broken at the boring locations. Residual gravelly clays and silty clay colluvium mantle the bedrock beneath the lagoon embankment. Some seepage was noted at the toe of the embankment at various locations along the west and southwest sides of the wastewater lagoon.

2. Classification. The naturally occuring soils above the bedrock have medium to high plasticity and medium stiff to stiff consistency. Liquid limit (ASTM: D-423) values of 40, 47, 53 and 45 and plasticity indices (ASTM: D-424) of 20, 28, 31 and 26 were obtained for Lab.Sample Nos. 2, 10, 11 and 13 respectively. Based on laboratory tests a visual inspection of the natural soils were classified as gravelly and silty clay (CL and/or CH) according to the Unified Classification System.

3. Density. Six undisturbed samples of the natural foundation soil above the bedrock were obtained using 3 and 5 inch diameter shelby tube samplers. The in situ dry densities varied from 1.49 to 1.72 gm/cc and the soil moisture contents varied from 22.4 to 27.3 percent.

4. Shear Strength. Consolidated-undrained (CU and $\overline{CU}$) triaxial tests were made on 1.4 inch diameter test specimens trimmed from Lab. Sample No. 7. The test specimens were saturated by backpressure prior to consolidation and shearing. Measurement of pore pressure response gave B parameters of 0.98 to 1.00. The total stress shear parameters interpreted from the test data for Lab. Sample No. 7 are $\phi = 13.8^{\circ}$ with c = 540 psf. The effective stress parameters are interpreted to be $\phi = 32.0$ and c = 0 psf.

5. Permeability. Falling head permeability tests were made on four undisturbed samples of the natural foundation soils beneath the embankment. The permeability rate was determined for each sample at a confining pressure of 0.5 KSF. Permeability rates of 3.4×10^{-5}, 4.6×10^{-8}, 2.1×10^{-4} and 5.3×10^{-8} cm/sec were obtained for Lab. Sample Nos. 2, 10, 11 and 13 respectively. Using an average permeability value of 6×10^{-5}, the seepage beneath the maximum section of the embankment (near Boring No. 2) was calculated to be about 0.14 cubic feet per day per lineal foot of embankment. Using the dimensions of this maximum section for the effective length of the embankment (assumed to be 2000 feet), the total quantity of seepage beneath the embankment is calculated to be about 280 cubic feet per day.

As can be seen from the laboratory test data, the permeability rates of the foundation soils can vary greatly. The weathered, broken portions of the limestone can also be highly pervious. The seepage rates will differ greatly at various locations beneath the embankment. The actual total quantity of seepage beneath the embankment may be from 200 to possibly 500 cubic feet per day.

6. Dispersion. The results of the dispersion tests on Lab. Sample Nos. 2, 10, 11 and 13 indicated dispersions of 33, 30, 6 and 37 respectively. These values indicate the foundation soils are low to non-dispersive.

III. EXISTING EMBANKMENT MATERIALS

1. Classification. Seven samples of material from the existing embankment were tested in the laboratory for classification in accordance with the Unified Soil Classification System. The liquid limits ranged from 39 to 60 and the plasticity indices varied from 19 to 42 for the embankment samples. The embankment materials were classified as silty clay and as CL and/or CH.

2. Density. Seven relatively undisturbed samples of the embankment material were obtained for inspection and laboratory testing. The insitu dry densities of these samples ranged from 1.45 to 1.63 gm/cc and their moisture contents varied from 23.6 to 32.1%

3. Shear Strength. A triaxial shear test (CU and $\overline{CU}$) was performed on specimens trimmed from Lab. Sample No. 6. The test specimen was saturated by backpressure prior to consolidation and shearing. Measurement of pore pressure response gave B parameters of 0.97 to 0.99. The total stress shear parameters interpreted from the test data are $\phi = 22.7^{\circ}$ with c = 330 psf. The effective stress parameters for the sample are interpreted to be $\phi = 28.0^{\circ}$ and c = 300 psf.

IV. SLOPE STABILITY ANALYSIS

Computer analyses of slope stability were performed using the modified Swedish circle method for steady seepage conditions at the maximum section of the lagoon embankment (near Boring No. 2). In our analyses we assumed a downstream slope of 1.7 from the top of the embankment (about elevation 92.0) to the top of the natural ground surface (about elevation 79.6). The embankment section used in our analyses had a top width of 12 feet. We also used a 2:1 slope for the upstream slope (the side facing the lagoon). We made our analyses assuming that a theoretical phreatic surface would develop at the water level in the lagoon (at elevation 90.4 resulting in 1.6 feet of freeboard) and would extend to the toe of the downstream slope (about elevation 79.6). Effective stress shear parameters ($\overline{CU}$) were used for steady seepage analysis.

The safety factors for both normal and earthquake conditions were determined for the maximum section as described above. A safety factor of 1.46 was obtained for static conditions using a total of 184 trial arcs. This factor of safety met the 1.4 minimum requirement (SCS, TR-60). A factor of safety of 1.16 was obtained for earthquake conditions in a static analysis, assuming a horizontal acceleration of 0.10 g. This met the 1.0 minimum factor of safety requirement (SCS, TR-60).

V. CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Based on the field and laboratory test data obtained from this investigation and on current Soil Conservation Service criteria, we conclude that the National Zinc Company waste water lagoon has adequate slope stability for the existing slope configurations and lake level. As stated in the introduction to this report, we did not conduct a flood routing study.

RECOMMENDATIONS

(1) We recommend an in-depth hydrology study made to determine the potential for overtopping the lagoon embankment.

(2) At the time of this investigation the lagoon water level was at elevation 90.4 which provides only 1.6 feet of freeboard at the maximum section. We concur with the State of Kansas Department of Health and Environment suggestion in their letter to National Zinc Company dated January 31, 1978 stating that the plant area be graded so as to divert all uncontaminated storm water runoff from entering the subject lagoon system.

(3) Seepage does not appear critical at the present time; however, timely observations, measurements, and analysis of data are recommended as a safeguard for future continued use of the lagoon. The seepage quantities could be determined economically by constructing weirs. The seepage quantities could then be monitored by studying the weir readings taken periodically. Tests of the dissolved and suspended solids in the seepage water could be monitored for indications of leaching or piping. The seepage water in the installed observation wells could be similarly tested and monitored. Pump-in or pump-out tests of the observation wells could also provide useful information.

If the quantity of seepage beneath the embankment is considered excessive at any time it may be controlled by pressure grouting through the embankment or possibly by application of bentonite to the reservoir surface. A cement grout appears preferable over other forms of chemical grout. Bentonite could be applied to those sections of the reservoir where seepage is to be controlled. This may be accomplished by broadcasting pelleted bentonite over the water surface.

If you have questions concerning this report, please give us a call at your convenience.

Submitted By:

WICHITA TESTING LABORATORIES

By Kent J. Schwieger

Kent J. Schwieger, P.E.

WESTERN LABORATORIES
Materials Engineers

Sample Number	Field Sample Number	Location and Description	Depth Feet	Field Classification	Mechanical Analysis — Grain Size Distribution Expressed as Percent Finer by Dry Weight: Fines					Sand						Gravel			
					0.001 0.005	0.005	0.01	0.05	#200 0.074	#100 0.149	#50 0.297	#40 0.42	#30 0.59	#16 1.19	#8 2.38	3/8" 9.525	1/2" 12.7	3/4" 19.05	1" 25.4
1	1	Boring No. 1	2.0-3.5	CL	23	32	62	86	92	96	97	98	99	100					
2	2	Boring No. 1	8.0-9.5	CL	16	29	57	87	96	98	99	100							
4	4	Boring No. 2	2.0-3.5	CH	16	31	63	84	89	93	96	97	98	100					
5	5	Boring No. 2	7.0-8.5	CL	22	39	63	91	96	99	99	100							
6	6	Boring No. 2	12.0-13.5	CH	10	54	76	90	94	98	100								
7	7	Boring No. 2	15.5-16.5	CH	15	38	60	72	76	82	87	89	95	99	100				
8	8	Boring No. 3	2.0-3.5	CH	18	37	63	83	88	92	95	96	98	100					
9	9	Boring No. 3	5.0-6.5	CH	36	52	73	87	92	96	99	100							
10	10	Boring No. 3	7.0-8.5	CL	27	37	63	88	95	98	99	100							
11	11	Boring No. 3	12.0-13.5	CH	25	45	65	77	81	87	90	92	95	100					
12	12	Boring No. 4	2.0-3.5	CL	10	34	61	90	94	98	99	99	100						
13	13	Boring No. 4	7.0-8.5	CL	21	43	64	89	95	99	99	100							
14	14	Boring No. 4	10.0-11.5	CH	21	43	66	85	91	97	98	99	99	100					

LABORATORY NO 6

MATERIALS TESTING REPORT	WESTERN LABORATORIES *Materials Engineers*	TRIAXIAL SHEAR TEST

PROJECT and STATE: NATIONAL ZINC Co.	SAMPLE LOCATION: ℄ Embankment @ B-2

FIELD SAMPLE NO	DEPTH	GEOLOGIC ORIGIN
6	12.8' - 13.2'	

TYPE OF SAMPLE	TESTED AT	APPROVED BY	DATE
UNDISTURBED	LINCOLN, NEBR		5-5-78

INDEX TEST DATA

USCS _____; LL _____; PI _____

% FINER (mm): 0.002 _____; 0.005 _____; 0.074 (#200) _____

G_s (-#4) _____; G_s (+#4) _____

STANDARD: γ_d MAX. _____ pcf; w_o _____ %

MODIFIED: γ_d MAX. _____ pcf; w_o _____ %

SPECIMEN DATA

HEIGHT 3.0 "; DIAMETER 1.4 "

MATERIALS TESTED PASSED _____ SIEVE

METHOD OF PREPARATION Trimmed from an undisturbed core

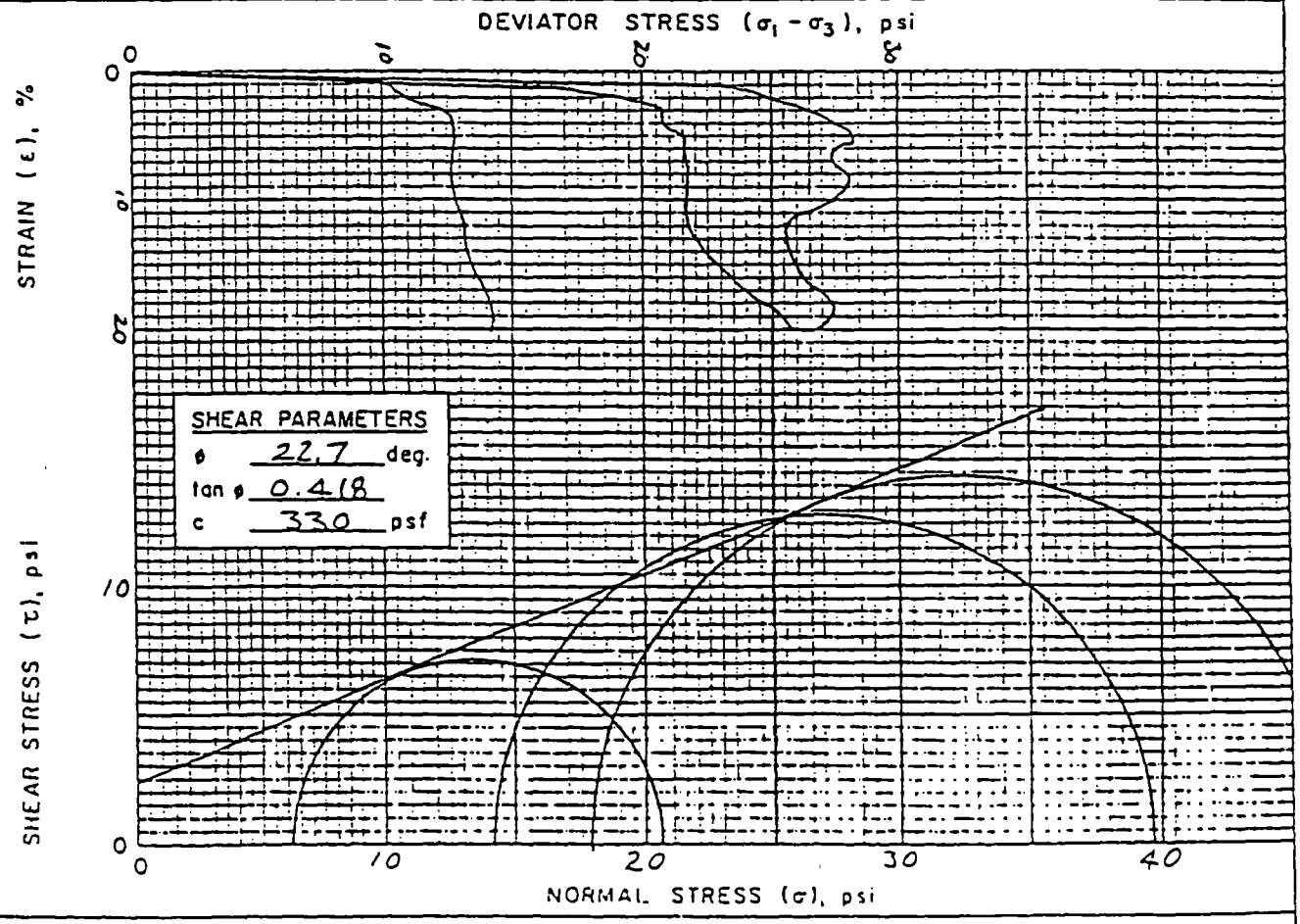
MOLDING MOISTURE _____ %

MOLDED AT _____ % OF γ_d MAXIMUM

TYPE OF TEST

UU ☐
CU ☐
$\overline{CU}$ ☒
CD ☐

DRY DENSITY INITIAL pcf ☒ g/cc ☐	DRY DENSITY CONSOLIDATED pcf ☒ g/cc ☐	$\bar{B}$ Brometer	MOISTURE CONTENT, % START OF TEST	MOISTURE CONTENT, % DEG. OF SAT. AT START OF TEST	MOISTURE CONTENT, % END OF TEST	TIME OF CONSOLIDATION (hrs.)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	AXIAL STRAIN AT FAILURE, ε (%)
89.9	93.2	.98	30.8	96.2	33.9	15	6.2	14.4	19.40
89.4	88.8	.99	30.8	95.2	34.1	15	14.1	25.7	20.14
92.3	96.9	.97	29.0	96.4	33.9	16	17.8	28.5	5.39



REMARKS

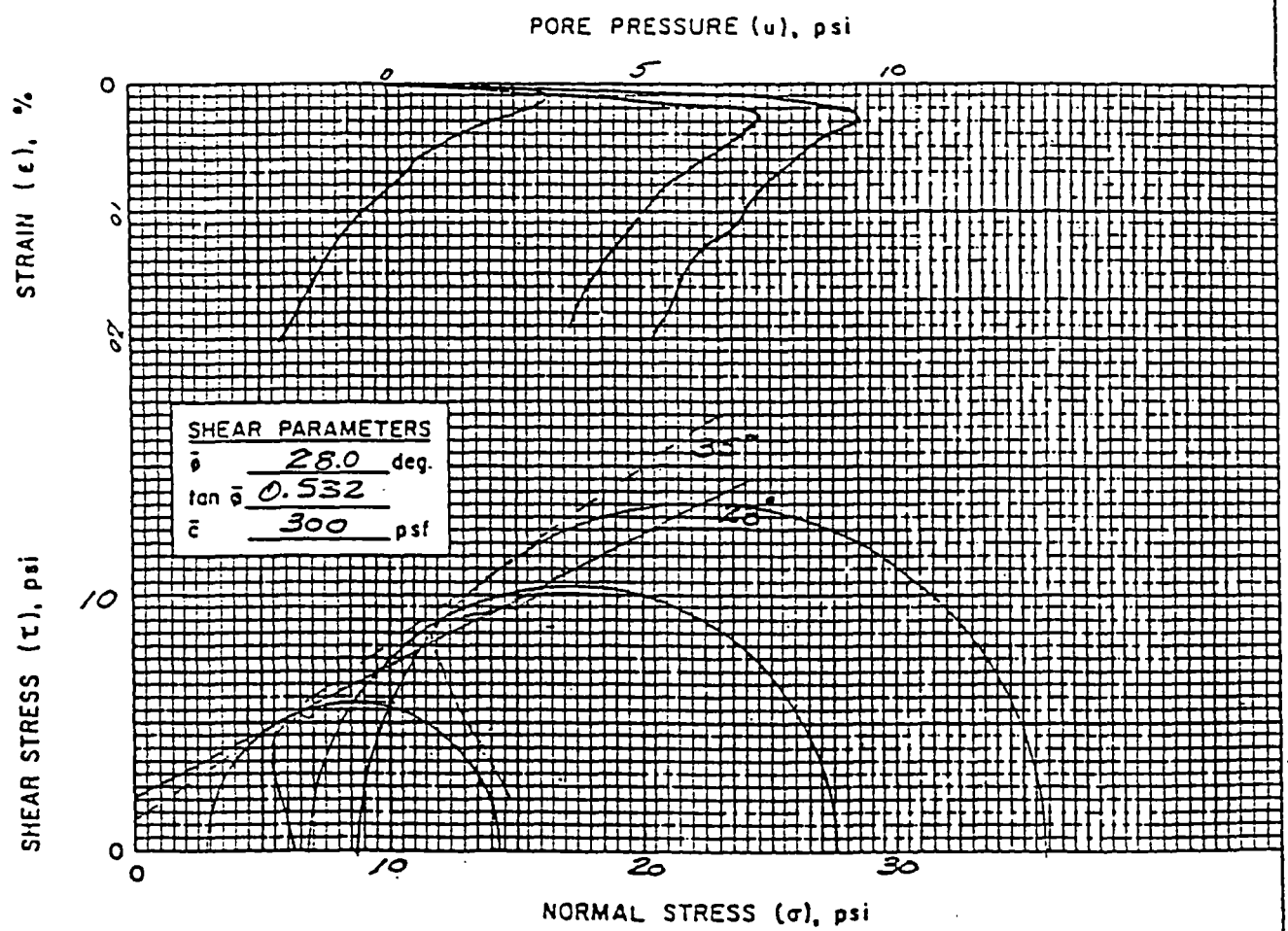
LABORATORY NO 6

MATERIALS TESTING REPORT	WESTERN LABORATORIES *Materials Engineers*	TRIAXIAL SHEAR TEST with pore pressure measured

PROJECT and STATE	SAMPLE LOCATION
National Line	℄ Embankment @ B-2

TYPE OF SAMPLE	TESTED AT	APPROVED BY	DATE
Undisturbed	Lincoln, NE		5/5/78

MINOR PRINCIPAL STRESS, σ_3 (psi)	PORE PRESSURE, u (psi)	EFFECTIVE MINOR PRINCIPAL STRESS, $\bar{\sigma}_3$ (psi)	DEVIATOR STRESS, $\sigma_1 - \sigma_3$ (psi)	FAILURE CRITERIA	AXIAL STRAIN AT FAILURE, ε (%)
6.2	3.3	2.9	11.3	$\bar{\sigma}_1$ / $\bar{\sigma}_3$	1.00
14.1	7.5	6.6	20.8		2.69
17.8	9.1	8.7	27.2		3.37



REMARKS Envelope based on vector curves

LABORATORY NO 7

MATERIALS TESTING REPORT	WESTERN LABORATORIES Materials Engineers	TRIAXIAL SHEAR TEST

PROJECT and STATE: NATIONAL - ZINC Co.			SAMPLE LOCATION: ℄ Embankment @ B-2
FIELD SAMPLE NO.: 7	DEPTH: 15.7'-16.4'	GEOLOGIC ORIGIN:	
TYPE OF SAMPLE: UNDISTURBED	TESTED AT: LINCOLN, NEBR	APPROVED BY:	DATE: 5-4-78

INDEX TEST DATA

USCS _____; LL _____; PI _____

% FINER (mm): 0.002 _____; 0.005 _____; 0.074 (#200) _____

G_s (-#4) _____; G_s (+#4) _____

STANDARD: γ_d MAX. _____ pcf; w_o _____ %

MODIFIED: γ_d MAX. _____ pcf; w_o _____ %

SPECIMEN DATA

HEIGHT 3.0 "; DIAMETER 1.4 "

MATERIALS TESTED PASSED _____ SIEVE

METHOD OF PREPARATION Trimmed from an undisturbed core

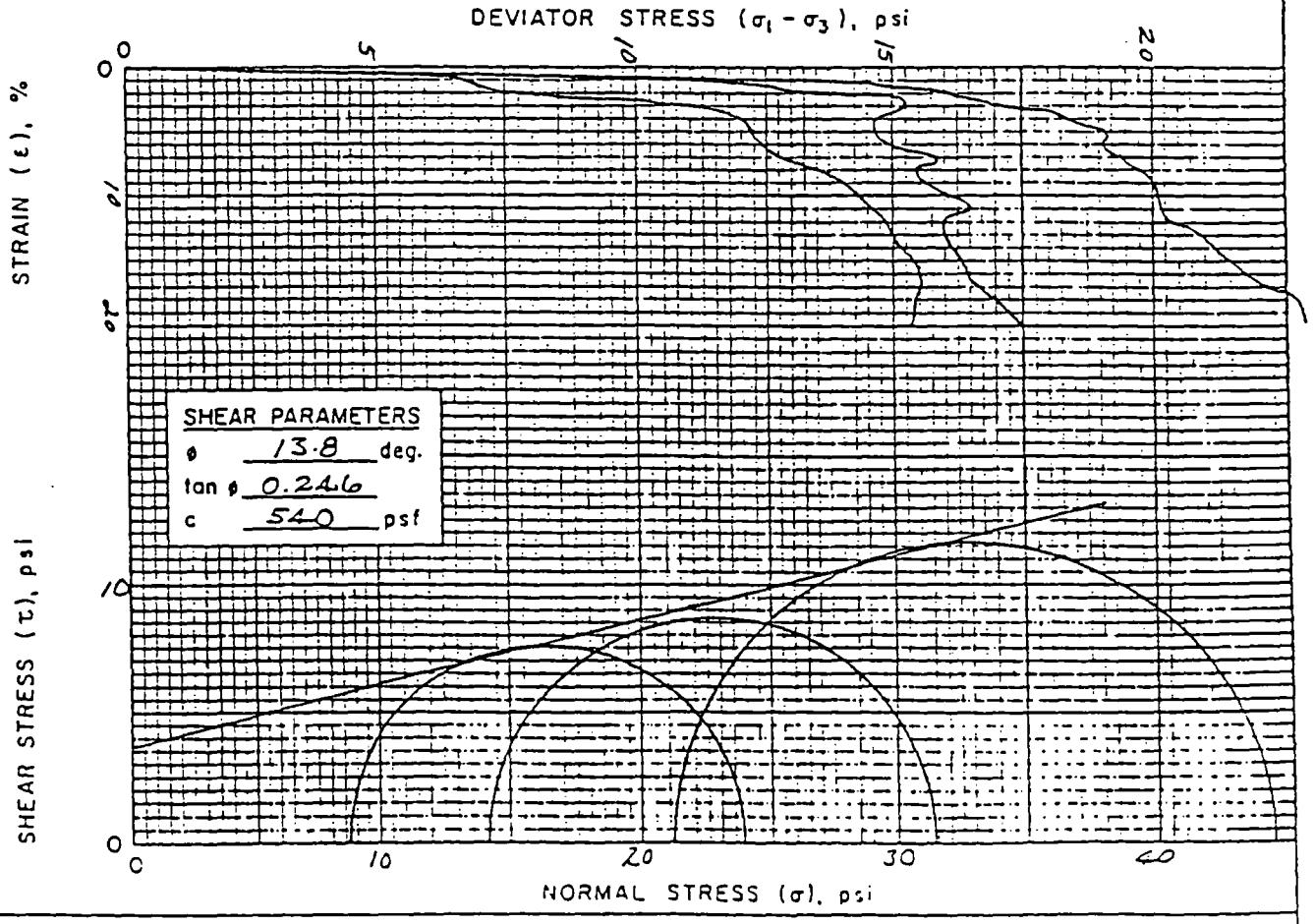
MOLDING MOISTURE _____ %

MOLDED AT _____ % OF γ_d MAXIMUM

TYPE OF TEST

- UU ☐
- CU ☐
- $\overline{CU}$ ☒
- CD ☐

DRY DENSITY INITIAL pcf ☒ g/cc ☐	DRY DENSITY CONSOLIDATED pcf ☒ g/cc ☐	B Parameter	MOISTURE CONTENT, % START OF TEST	MOISTURE CONTENT, % DEG. OF SAT. AT START OF TEST	MOISTURE CONTENT, % END OF TEST	TIME OF CONSOLIDATION (hrs.)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	AXIAL STRAIN AT FAILURE, ε (%)
96.7	103.0	.98	27.3	100.8	26.7	17	8.7	15.5	16.72
94.9	100.6	100	27.3	96.5	24.5	15	14.1	17.5	20.16
92.9	96.9	.99	27.3	91.9	27.0	17	21.1	23.1	20.44



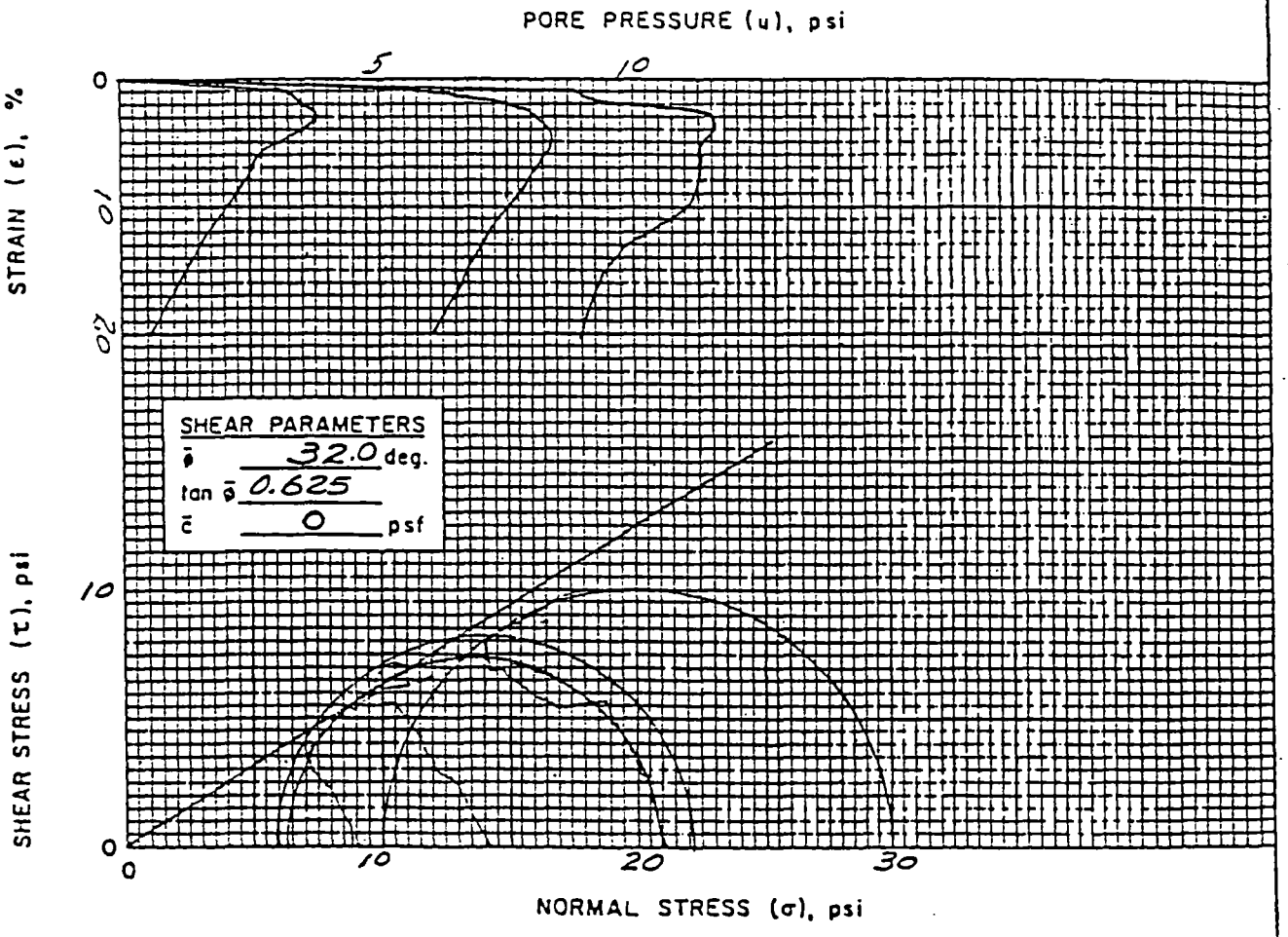
REMARKS

LABORATORY NO 7

MATERIALS TESTING REPORT	WESTERN LABORATORIES *Materials Engineers*	TRIAXIAL SHEAR TEST with pore pressure measured

PROJECT and STATE			SAMPLE LOCATION
[illegible]			℄ Embankment @ B-2
TYPE OF SAMPLE: Undisturbed	TESTED AT: Lincoln, NH	APPROVED BY	DATE: 7/4/78

MINOR PRINCIPAL STRESS, σ_3 (psi)	PORE PRESSURE, u (psi)	EFFECTIVE MINOR PRINCIPAL STRESS, $\bar{\sigma}_3$ (psi)	DEVIATOR STRESS, $\sigma_1 - \sigma_3$ (psi)	FAILURE CRITERIA	AXIAL STRAIN AT FAILURE, ε (%)
8.7	2.3	6.4	14.4	$\bar{\sigma}_1$ / $\bar{\sigma}_3$	9.36
14.1	8.2	5.9	16.1		6.40
21.1	11.1	10.0	19.9		8.06

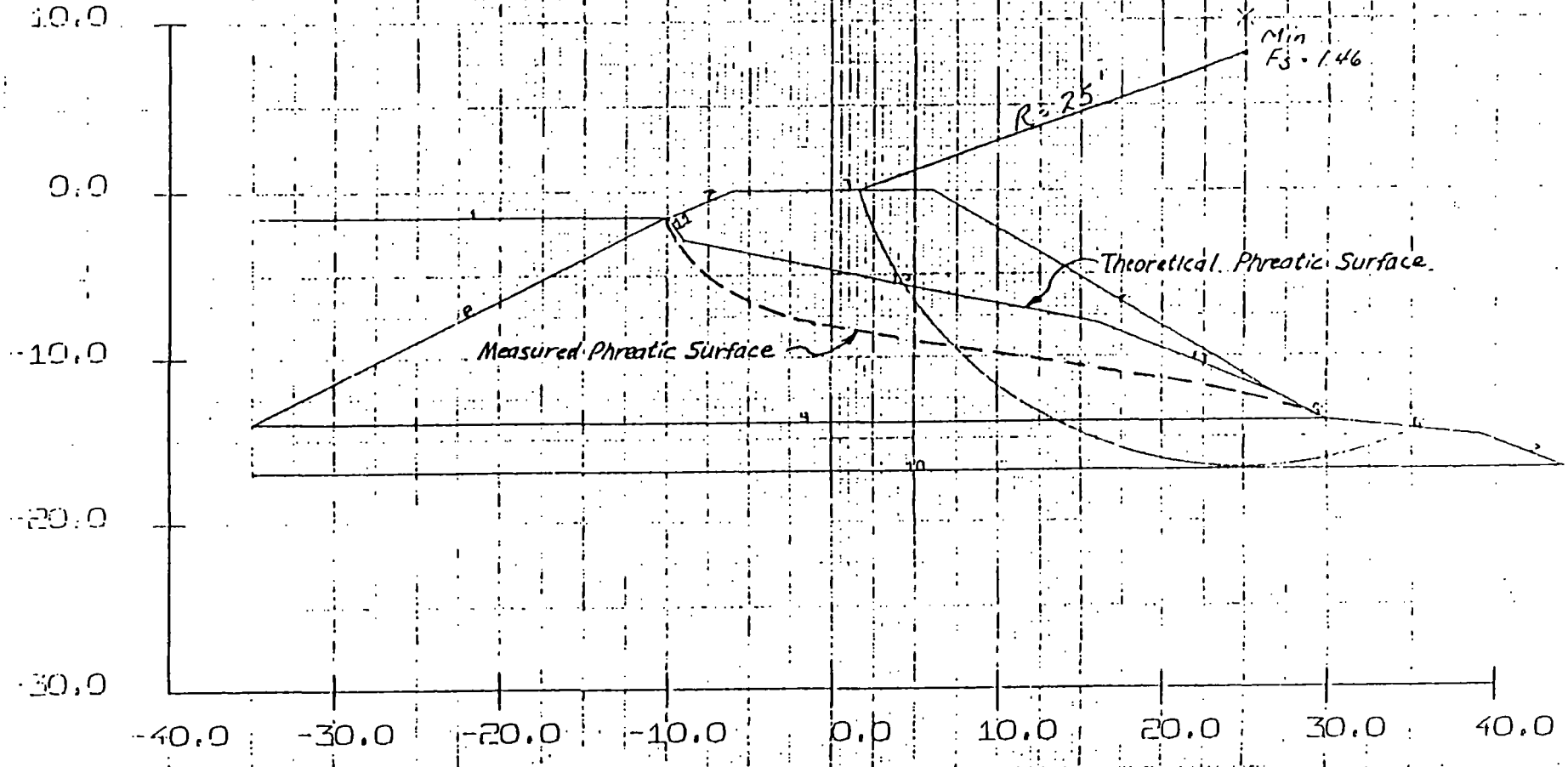


REMARKS Envelope based on vector curves

SLOPE STABILITY ANALYSIS
EMBANKMENT CROSS-SECTION

NATIONAL ZINC COMPANY - MAXIMUM SECTION JOB NO. 78/5041

Near Hole B-2



Appendix 2

Lithology and Completion Logs of New Monitor Wells

COMPLETION WELL LOG

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

SITE NAME AND LOCATION NATIONAL ZINC SITE CHERRYVALE, KANSAS	DRILLING METHOD: AIR ROTARY 6 1/4" AIR HAMMER	BORING NO. MV-5
	SAMPLING METHOD:	SHEET 1 OF 1
		DRILLING
		START / FINISH
WEATHER SUNNY TEMP 100 F	WATER LEVEL / TIME	TIME 1:30 PM / TIME 3:00 PM
G.L. ELEV.	DATE	DATE 7-22-03 / DATE 7-22-03
DATUM MSL / TOC ELEV.	CASING DEPTH	
DRILL RIG: ATV AIR HAMMER	TYPE GRAVEL: / CASING DIA: 2"	SCREEN DIA: 2"
ANGLE BEARING	TYPE BENTONITE: / SCHED.: 40 PVC	SLOT SIZE: 0.01
SAMPLE HAMMER TORQUE FT.-LBS		

DEPTH IN FEET	BLOW COUNT	SYMBOL	DESCRIPTION OF MATERIAL	WELL TYPICAL	WELL NOTES
			TOP SOIL, GRAY, SILTY, MOIST		CEMENT GROUT 0-2.5'
5			CLAY, BROWN, LIGHT BROWN, MOIST PLASTIC, STIFF		BENTONITE 2.5-4.5' CASING
10			LIMESTONE, BROWN, CREAM, FRACTURED WITH SHALE STREAKS, HARD, WET		SAND 4.5-16.5'
			LIMESTONE, BROWN, DARK BROWN, CRYSTALLINE, HARD, WET STREAKS TO 13'		SCREEN 6.5-16.5'
15			13'-16.5' DRY		
			TD-16.5'		
20					
25					
30					

DRILLING CONTR MOHAVK DRILLING, TULSA OK

DRILLER: ALLAN BRANTLEY

LOGGED BY ENIS TANER

DATE JULY 30, 2003 CHK'D BY IT

COMPLETION WELL LOG

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

SITE NAME AND LOCATION NATIONAL ZINC SITE CHERRYVALE, KANSAS	DRILLING METHOD: AIR ROTARY 6 1/4" AIR HAMMER	BORING NO. MW-7
	SAMPLING METHOD:	SHEET 1 OF 1
		DRILLING
		START / FINISH
WEATHER SUNNY TEMP 100 F	WATER LEVEL / TIME	TIME 7:30 AM / TIME 9:30 AM
G.L. ELEV.	DATE	DATE 7-23-03 / DATE 7-23-03
DATUM MSL / TOC ELEV.	CASING DEPTH	
DRILL RIG: ATV AIR HAMMER	TYPE GRAVEL: / CASING DIA: 2"	SCREEN DIA: 2"
ANGLE BEARING	TYPE BENTONITE: / SCHED.: 40 PVC	SLOT SIZE: 0.01
SAMPLE HAMMER TORQUE FT.-LBS		

DRILLING CONTR MOHAWK DRILLING, TULSA OK

DRILLER: ALLAN BRANTLEY

DEPTH IN FEET	BLOW COUNT	SYMBOL	DESCRIPTION OF MATERIAL	WELL TYPICAL	WELL NOTES
			TOP SOIL, GRAY, MOIST, STIFF		
			CLAY, GRAY, DARK GRAY, MOIST, STIFF, PLASTIC		CEMENT GROUT 0-3.5'
5					BENTONITE 3.5-5.5'
			LIMESTONE, BROWN, CREAM, WITH SHALE STREAKS		CASING
10			SHALE, GRAY, WITH THIN LIMESTONE STREAKS		
			SHALE, BLACK, FISSILE		SAND 5.5-22.5'
15					SCREEN 7.5-22.5'
			SHALE, GRAY, BLUISH GRAY, SLIGHTLY MOIST, MEDIUM SOFT		
20					
			TD-22.5'		
25					
30					

LOGGED BY ENIS TANER

DATE JULY 29, 2003 CHK'D BY IT

COMPLETION WELL LOG

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

SITE NAME AND LOCATION LANDFILL EXPANSION (ROONEY PROPERTY) QUARRY RECYCLING AND DISPOSAL FACILITY TULSA, OKLAHOMA	DRILLING METHOD: AIR ROTARY 6 1/4" AIR HAMMER	BORING NO. MW-6
	SAMPLING METHOD:	SHEET 1 OF 1
		DRILLING START / FINISH
	WATER LEVEL	TIME 10:15 AM / TIME 12:30 PM
WEATHER SUNNY TEMP 100 F	TIME	
G.L. ELEV.	DATE	DATE 7-23-03 / DATE 7-23-03
DATUM MSL / TOC ELEV.	CASING DEPTH	
DRILL RIG: ATV AIR HAMMER	TYPE GRAVEL: / CASING DIA: 2"	SCREEN DIA: 2"
ANGLE / BEARING	TYPE BENTONITE: / SCHED: 40 PVC	SLOT SIZE: 0.01
SAMPLE HAMMER TORQUE FT.-LBS		

DRILLING CONTR MOHAWK DRILLING, TULSA OK

DRILLER: ALLAN BRANTLEY

DEPTH IN FEET	BLOW COUNT	SYMBOL	DESCRIPTION OF MATERIAL	WELL TYPICAL	WELL NOTES
			SOIL, GRAY, MOIST		CEMENT GROUT 0-5'
			CLAY, BROWN, DARK BROWN, MOIST, PLASTIC, WITH GRAVEL LAYER AT 5.0'		BENTONITE 5-8'
10			LIMESTONE, LIGHT BROWN, CREAM, HARD, FRACTURED, PARTLY CRYSTALLINE		CASING
			SHALE, BLACK, FISSILE, HARD INTERBEDDED WITH GRAY SHALE		SAND 8-30'
20			SHALE, GRAY, BLUISH GRAY, SLIGHTLY MOIST, SOFT		SCREEN 10-30'
			LIMESTONE, BROWN, GRAY, HARD, DRY		
30			SHALE, GRAY, BLUISH GRAY, SOFT, MICACEOUS		
			SHALE, GRAY, DARK GRAY, FISSILE MEDIUM HARD		30 TO 40 FT PLUGGED BACK
40			TD-40'		
50					
60					

LOGGED BY EMIS TAMER

DATE JULY 30, 2003 CHK'D BY IT

COMPLETION WELL LOG

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.	DRILLING METHOD: AIR ROTARY 6 1/4" AIR HAMMER	BORING NO. MW-7	
SITE NAME AND LOCATION NATIONAL ZINC SITE CHERRYVALE, KANSAS	SAMPLING METHOD:	SHEET 1 OF 1	
		DRILLING	
		START	FINISH
	WATER LEVEL	TIME	TIME
WEATHER SUNNY TEMP 100 F	TIME	7:30 AM	9:30 AM
G.L. ELEV.	DATE	DATE	DATE
DATUM MSL TOC ELEV.	CASING DEPTH	7-23-03	7-23-03
DRILL RIG: ATV AIR HAMMER	TYPE GRAVEL:	CASING DIA: 2"	SCREEN DIA: 2"
ANGLE BEARING	TYPE BENTONITE:	SCHED: 40 PVC	SLOT SIZE: 0.01
SAMPLE HAMMER TORQUE FT.-LBS			

DEPTH IN FEET	BLOW COUNT	SYMBOL	DESCRIPTION OF MATERIAL	WELL TYPICAL	WELL NOTES
			TOP SOIL, GRAY, MOIST, STIFF		
			CLAY, GRAY, DARK GRAY, MOIST, STIFF, PLASTIC		CEMENT GROUT 0-3.5'
5					BENTONITE 3.5-5.5'
			LIMESTONE, BROWN, CREAM, WITH SHALE STREAKS		CASING
10			SHALE, GRAY, WITH THIN LIMESTONE STREAKS		
			SHALE, BLACK, FISSILE		SAND 5.5-22.5'
15					SCREEN 7.5-22.5'
			SHALE, GRAY, BLUISH GRAY, SLIGHTLY MOIST, MEDIUM SOFT		
20					
			TD-22.5'		
25					
30					

DRILLING CONTR MOHAWK DRILLING, TULSA OK

DRILLER: ALLAN BRANTLEY

LOGGED BY ENIS TANER

DATE JULY 30, 2003 CHK'D BY IT

COMPLETION WELL LOG

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

SITE NAME AND LOCATION NATIONAL ZINC SITE CHERRYVALE, KANSAS	DRILLING METHOD: AIR ROTARY 6 1/4" AIR HAMMER	BORING NO. MW-8
	SAMPLING METHOD:	SHEET 1 OF 1
		DRILLING
		START / FINISH
	WATER LEVEL	TIME / TIME
WEATHER SUNNY TEMP 100 F	TIME	4:15 PM / 6:30 PM
G.L. ELEV.	DATE	DATE / DATE
DATUM MSL TOC ELEV.	CASING DEPTH	7-22-03 / 7-22-03
DRILL RIG: ATV AIR HAMMER	TYPE GRAVEL: / CASING DIA: 2"	SCREEN DIA: 2"
ANGLE BEARING	TYPE BENTONITE: / SCHED: 40 PVC	SLOT SIZE: 0.01
SAMPLE HAMMER TORQUE FT.-LBS		

DRILLING CONTR MOHAWK DRILLING, TULSA OK

DRILLER: ALLAN BRANTLEY

DEPTH IN FEET	BLOW COUNT	SYMBOL	DESCRIPTION OF MATERIAL	WELL TYPICAL	WELL NOTES
			SOIL, GRAY, DARK GRAY, SILTY, MOIST		
			CLAY, GRAY, MOIST, STIFF, PLASTIC		CEMENT GROUT 0-3.5'
5			LIMESTONE, CREAM, BROWN, HARD, DARK BROWN, CRYSTALLINE		BENTONITE 3.5-5.5'
			SHALE, BLACK, DARK GRAY, FISSILE MEDIUM HARD, DRY		CASING
10			SHALE, GRAY, LIGHT GRAY, WITH FINE-GRAINED SANDSTONE STREAKS, MOIST		
					SAND 5.5-22.5'
15					
			SHALE, GRAY, LIGHT GRAY, WITH FINE-GRAINED SANDSTONE STREAKS, MOIST		SCREEN 7.5-22.5'
20					
			TD-22.5'		
25					
30					

LOGGED BY ENIS TANER

DATE JULY 30, 2003 CHK'D BY IT

Appendix 3

Lithology and Completion Logs of Existing Wells

OWNER: KDHE

GEOLOGIST: Randy Brown

SITE: National Zinc TW-1 N 7000 E 5700

PROJECT: Nat. Zinc BTA

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES: USCS SYMBOL	NUMBER	TYPE	RECOVERY	TESTS: SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS (PPM)	XRF (lead) average (mg/kg)
	TOP OF PROTECTOR PIPE: TOP OF CASING: GROUND SURFACE ELEV.:										
	0-1 Dark brown silty clay, dry (hard layer at 1')			CL-ML							
	1-4 Black clay trace cinders and slag, fat, slightly to moderately stiff, tr. moisture			CH							100.6
	4-8 Mottled dark gray to olive clay, trace of sandstone and shale inclusions			CH							89.4
	8-14 Tan to brown silty clay, wet, medium to high plasticity, moderately stiff			CH							97
	14- Sandstone refusal TD 14 5' .010 Schedule 40 Screen locked metal stick-up cover 1ft AGS Sand to 5.5 3' Bentonite chips (3/8")										94

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

BOREHOLE DIA.: 4 3/8

WELL DIA.: 2" PVC

WATER LEVEL OBSERVATIONS

WL	▽ 7.8 TOC	WD ▽ 6.8	SWL Abs
WL			
WL	TOC 1ft AGS TD 15.1 TOC		from

Kansas Department of Health and Environment
Division of Environment

BORING STARTED 08/16/99	
BORING COMPLETED 08/16/99	
RIG B-3300	FOREMAN Silvegan
APPROVED	JOB #

OWNER: KDHE

GEOLOGIST: Randy Brown

SITE: National Zinc TW-2 N6600 E5600

PROJECT: Nat. Zinc BTA

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES: USCS SYMBOL	NUMBER	TYPE	RECOVERY	TESTS: SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS (PPM)	XRF Lead (Pb) mg/kg
	TOP OF PROTECTOR PIPE: TOP OF CASING: GROUND SURFACE ELEV.:										
	0-2 Dk brown silty loam, roots		1	ML							<81.5
	2-4.5 Tan to reddish brown to brown silty clay, slightly fat, very stiff, mostly dry, low plasticity			CL							<64.3
	4.5-9.5 Same, but with trace moisture			CL							
	9.5-11.1 Same, wet with shale and sandstone residuum			CL							<70.7
	11.1 Refusal TD 11.1 5' .010 schedule 40 PVC screen, TOC 3.7' AGS, sand to 3.5', Bentonite (3/8 chips) to 0.5, steel locked protective cover										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

BOREHOLE DIA.: 4 1/4"
WELL DIA.: 2"

WATER LEVEL OBSERVATIONS

WL	8.12 TOC	WD	SWL
WL			
WL	TD 14.8 TOC		

Kansas Department of Health and Environment
Division of Environment

BORING STARTED 08/16/99
BORING COMPLETED 08/16/99
RIG B-3300 FOREMAN J. Logan
APPROVED JOB #

OWNER: KDHE

GEOLOGIST: Randy Braun

SITE: National Zinc N6100 E5500 TW3

PROJECT: Nat Zinc BTA

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY	TESTS: SPT - N BLOWS / FT.	TESTS: MOISTURE, %	TESTS: FIELD VAPOR TESTS (PPM)	NEF Cloud Ave. in ma/kg
	TOP OF PROTECTOR PIPE:										
	TOP OF CASING:										
	GROUND SURFACE ELEV.:										
	0-1 - Dark brown silty loam, roots			ML							866
	2-5 Black, gritty moist clay + cinders, high plasticity, very stiff			CH							451
	5-7 Same			CH							
	7-9 Dark brown silty clay, tr of sandstone residuum, very sm moderately moist, medium plas										100.7
	9-10.2 Same, more sa residuum										
	TD 10.2										
	5' 1010 Schedule 40 PVC Scr Sand to 5' BGS Bentonite to 0.6' Steel protective cover insulated, locked										
	Top of Casing 3.75' AGS TD										

0-2 Fill Clay
2-7 Waste
7-10.2 Clay

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

BOREHOLE DIA.: 4 7/8"
WELL DIA.: 2"

WATER LEVEL OBSERVATIONS

WL	▽ 17.06 TOC	WD	▽ 71.31 Abs	SWL
WL	TD 14.1 (TOC)			
WL				

Kansas Department of Health and Environment
Division of Environment

BORING STARTED 08/17/99
BORING COMPLETED 08/17/99
RIG B-3300 FOREMAN S. Lregan
APPROVED JOB #

OWNER: KOHE

GEOLOGIST: Randy Brown

SITE: National Zinc TW-4 N S 700 E S 900

PROJECT: Nat Zinc BTA

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES: USCS SYMBOL	NUMBER	TYPE	RECOVERY	TESTS: SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS (PPM)	XRF Cleed ave. (mg/kg)
	TOP OF PROTECTOR PIPE:										
	TOP OF CASING:										
	GROUND SURFACE ELEV.:										
	0-1.5 Dark brown silty clay loam, plant roots			ML							136.9
	1.5-4 Cinders, gritty w/clay black, wet at bottom			CH							1316.3
	4-7 Dark gray to black clay with cinders, wet			CH							
	7-7.5 Dark gray clay, Sandstone residuum										
	Refusal 7.5 TD 7.5										
	5' .010 Schedule 40 PVC Screen										
	Sand to 1" Bentonite to 6.5. 3/4										
	Completed w/ steel above ground cover locked										
	TOC 3.83' AGS										

0-2 Clay Fill

2-7.5 Waste

7.5 Limestone

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDAR BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY

WATER LEVEL OBSERVATIONS

WL	▽ 8.71 TOC WD	▽ 4.46 AGS SWL
WL		
WL	TD 10.74 from TOC	

Kansas Department of Health and Environment
Division of Environment

BORING COMPLETED	08/17/99
RIG B-3300	FOREMAN Silregan
APPROVED	JOB #

OWNER: KDHE

GEOLOGIST: Randy Brown

SITE: National Zinc N 5600 E 6600 TW-5

PROJECT: Nat'l Zinc BTA

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES: USCS SYMBOL	NUMBER	TYPE	RECOVERY	TESTS: SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS (PPM)	XRF Lead (Ave mg/kg)
	TOP OF PROTECTOR PIPE: TOP OF CASING: GROUND SURFACE ELEV.:										
	0-2 Dark brown silty loam			ML							86.3
	2-4.5 Dark brown silty clay, to olive, roots, trace of brick fragments			CL-CH							
	4.5-9 Dark brown to slightly Reddish brown silty clay, fat, moderately stiff, medium to high plasticity, trace of Sandstone residuum			CH							77.3 86.3
	9-13 Same, saturated TD 13			CH							
	5' @ 10 Schedule 40 PVC Screen Sand to 3.5' Bentonite to 0.5 AGS Completed with above ground steel protective cover TOC 2.13' AGS										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

BOREHOLE DIA.: 4 7/8"
WELL DIA.: 2"

WATER LEVEL OBSERVATIONS AGS

WL	▽ 5.00 TOC WD	▽ 2.87 SWL
WL	TD	
WL	TOC 15.00 from TOC	

Kansas Department of Health and Environment
Division of Environment

BORING STARTED	08/17/99
BORING COMPLETED	08/17/99
RIG B-3300	FOREMAN S. Grayan
APPROVED	JOB #

OWNER: National Zinc / KDHE

GEOLOGIST: Randy Brown

SITE: National Zinc TW-6

PROJECT: National Zinc BTA

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES: USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY	TESTS: SPT - N BLOWS / FT.	TESTS: MOISTURE, %	TESTS: FIELD VAPOR TESTS (PPM)	XRF Lead Ave (mg/kg)
	TOP OF PROTECTOR PIPE:										
	TOP OF CASING:										
	GROUND SURFACE ELEV.: 300' N of Martin Street										
	In Visible Right-of-Way, East Side										
	0-4 Dark brown silty loam, plant roots			ML CL							715
	4-7 Dark brown to reddish brown silty clay, dry, low plasticity, trace sandstone residuum			CL							7617
				CL							
	Refusal 7.0 Sandstone										
	5' .010 Schedule 40 PVC screen										
	Sand fo 1.5 Bentonite to ground surface Completed w/ locked steel protective cover										
	TOC 3.6' Abs Dry at completion										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

BOREHOLE DIA.: 4 7/8"

WELL DIA.: 2"

WATER LEVEL OBSERVATIONS

WL	Dry	WD	Dry SWL
WL			
WL	TD 10.1' from TOC		

Kansas Department of Health and Environment
Division of Environment

BORING STARTED	08/17/99
BORING COMPLETED	08/17/99
RIG	B-3300
FOREMAN	J. Kreger
APPROVED	
JOB #	

OWNER: KDHE

GEOLOGIST: Randy Brown

SITE: National Zinc TW-7

PROJECT: National Zinc BTA

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS (PPM)	XRF Lead Ave (mg/kg)
	TOP OF PROTECTOR PIPE:										
	TOP OF CASING:										
	GROUND SURFACE ELEV.:										
	In new visited Right-of-Way, ~~South~~ East side 600' of TW-6										
	0-1 Dark brown to reddish brown silty Aoum, plant roots			ML							
	1-3.5 Reddish brown Clayey silt w/ sandstone residuum			CL							<92.3
	TD 4.0 Refusal in sandstone										
	5' Screen .010 schedule 40 Sand to 1.0' Bentonite chips to ground surface 3/8" chips										
	TOC 3.48' Abs Completed w/ Steel protective cover, locked										
	Dry at completion										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

BOREHOLE DIA.: 4 7/8"

WELL DIA.: 2"

WATER LEVEL OBSERVATIONS

WL	Dry	WD	Dry SWL
WL			

TOC 3.48 Abs TOC 74 from TOC

Kansas Department of Health and Environment
Division of Environment

BORING STARTED 08/17/99

BORING COMPLETED 08/17/99

RIG B-3300

FOREMAN S. Keyan

APPROVED

JOB #

OWNER: KDHE

GEOLOGIST: Randy Brown

SITE: National Zinc TW-8

PROJECT: Nat Zinc BTA

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES: USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY	TESTS: SPT - N BLOWS / FT.	TESTS: MOISTURE, %	TESTS: FIELD VAPOR TESTS (PPM)	TESTS: XRF Lead Ave (mg/kg)
	TOP OF PROTECTOR PIPE: TOP OF CASING: GROUND SURFACE ELEV.:										
	In U.S. 166 Right of-way, East Side 500' South of Intersection Road 5200 and New U.S. 166										
	0-3.0 Reddish brown, clayey silty, abundant sandstone residum			ML-CL							
	3.0-3.5 light gray siltstone, weathered, friable			CP							<90
	3.5 Refusal Sandstone/siltstone										
	5' 0/0 Screen trimmed schedule 40										
	Sand to 1.5' Bentonite to surface										
	TOC 3.68' AGS Completed with above ground steel protective cover										
	Dry at completion										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

BOREHOLE DIA.: 4 7/8"
WELL DIA.: 2"

WATER LEVEL OBSERVATIONS

WL	Dry	WD	Dry SWL
WL			
WL	7.2' TD TOC		

Kansas Department of Health and Environment
Division of Environment

BORING STARTED 08/17/99
BORING COMPLETED 08/17/99
RIG B-3300 FOREMAN S. Grayson
APPROVED JOB #

LOG OF BORING NO.

OWNER: KDHE

GEOLOGIST: Randy Braun

SITE: National Zinc TW-9 N5800 E7300

PROJECT: Nat Zinc BTA

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES: USCS SYMBOL	NUMBER	TYPE	RECOVERY	TESTS: SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS (PPM)	Net Lead Ave (mg/kg)
	TOP OF PROTECTOR PIPE:										
	TOP OF CASING:										
	GROUND SURFACE ELEV.:										
	0-2 Dark brown silty clay loam, plant roots, dry			ML							<83
	2-4 Dark brown silty clay, mottled, w/reddish brown silty clay, dry, friable			CL							<85
	4-6 Orange to reddish brown clay, fat, high plasticity, very stiff			CH							<77
	6-9 Same but with increasing sandstone residuum with depth			CH / CP							<85
	Refusal 9'										
	5' .010 Schedule 40 PVC Screen Sand to 2.5 Bentonite to 0.5 (3/8" chips) TOC 3.82 Abs TD 13.80 Dry at completion, although water filling screen section slowly.										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

BOREHOLE DIA.: 4 7/8"

WELL DIA.: 2"

WATER LEVEL OBSERVATIONS

ATD 2	WD Dry	SWL
ATD		
TD 13.80 from TOC		

Kansas Department of Health and Environment
Division of Environment

BORING STARTED 08/19/99

BORING COMPLETED 08/19/99

RIG B-3300 FOREMAN Stregan

APPROVED JOB #

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 2
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
92.1	0		Fill: cinders, brick, tile, etc.; loose.			
91.1	1	CH & CL	Fill: silty clay; very dark grayish brown, dark yellowish brown and reddish brown; wet; medium and high plasticity; stiff.	4		W=25.5 D=98.6
89.1	3		As above but saturated in seams.		3 4 5	N=9
84.1	8	▽		5		Water Level @ 7.7' (Elev. 84.4) After 24 Hours
			Very wet to saturated.		2 4 5	W=32.1 D=90.3 N=9
				6		W=30.2 D=94.9
78.6	13.5	CL	Silty Clay: some organics; very dark gray; very wet to saturated; medium plasticity; medium stiff. (old topsoil)		1 2 3	N=5
77.1	15	CH	Silty Clay: dark yellowish brown; saturated; high plasticity; medium stiff.	7		W=27.3 D=94.9
75.6	16.5		Limestone: weathered and broken.			
73.1	19		Limestone: hard; light yellowish brown. (possible Winterset Limestone)			

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 2
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 2
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot			Date: 4-18-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
72.1	20		Limestone: as before; but shaley; dark gray and hard.			
70.6	21.5		Shale: dark gray with thin limestone stringers. (possible Stark Shale)			
67.1	25					

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 3
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
91.3	0		Fill: cinders, brick, clay tile, etc.			
90.3	1	CH	Fill: silty clay; dark yellowish brown, grayish brown, reddish brown and gray; wet; high plasticity; stiff to medium stiff with depth.	8		W=25.5 D=94.8
87.3	4	CL	Fill: silty clay; very dark brown and yellowish brown; wet with saturated seams; medium plasticity; medium stiff.	9	2 2 3	N=5 W=28.5 D=95.5 Water Level @ 7.7' (Elev. 83.6) After 24 Hours
83.8	7.5	CL	Silty Clay: very dark gray with some organics; wet; medium plasticity; med. stiff to stiff. (old topsoil zone)	10		W=24.3 D=98.0
83.3	8	CH				
82.3	9		Silty Clay: dark gray with lime concretions; wet; high plasticity; medium stiff to stiff.		3 4 4	N=8
80.3	11	CH	As above but dark yellowish brown.			
			Gravelly Clay: 20% fine to medium gravel (chert); dark yellowish brown; wet; high plasticity; stiff.	11		W=22.4 D=107.6
77.8	13.5		Limestone: dark yellowish brown; broken and weathered. (possible Winterset Limestone)			
74.8	16.5		Limestone: light yellowish brown; fossiliferous; medium hard. (Winterset Limestone)			

Figure 4 Drilled By: William R. Giesal

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Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 3
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 2
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot	Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
71.3	20		Limestone: gray; hard.			
69.3	22		Shale: dark gray (possible Stark Shale)			
68.3	23		Calcareous			
67.8	23.5		Shale as before.			
66.3	25					

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 4
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
92.1	0		Fill: cinders, brick, clay, tile, etc.			
91.1	1	CL	Fill: silty clay; dark yellowish brown, gray and reddish brown; wet; medium plasticity; medium stiff.	12		W=25.4 D=97.9
88.1	4	CH& CL	Fill: silty clay; very dark gray and dark gray; wet to saturated in seams; high and medium plasticity; medium stiff.		2 3 5	N=8
84.6	7.5	CH w/ CL ▽	Silty Clay: dark yellowish brown with iron stains; wet to very wet; high plasticity; with medium plasticity zones; medium stiff.	13		W=25.7 D=96.9
					2 3 4	Water Level @ 9.5' (Elev. 82.6') After 24 Hours N=7
				14		W=27.1 D=92.8
80.1	12	CH	Gravelly Clay: 20 to 25% fine to medium gravel; dark yellowish brown; very wet; high plasticity; stiff.		4 5 5	N=10
77.6	14.5		As above but saturated.			
76.6	15.5		Limestone: broken and weathered.			
75.1	17		Limestone: light gray; hard. (possible Winterset Limestone)			
72.1	20					

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas			
Boring Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 4
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 2
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot			Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
72.1	20		As before.			
71.1	21		Limestone: sandy and shaley; dark gray.			
63.1	29		Shale: fissile; black; hard. (possible Stark Shale)			
62.1	30					

Figure 5a

Drilled By: William R. Giessi

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger		Standard Penetration Test		Boring No. 1
Undisturbed Soil Sampler: 3-in.o.d. thin-walled tube		140-lb. Hammer	30-in. Fall	2-in.o.d. Split-barrel Sampler	Sheet 1 of 1
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
91.7	0		Fill: cinders, brick, tile, etc.; loose.			
90.7	1	CH	Fill: silty clay; dark yellowish brown mottled with very dark brown and grayish brown; wet; med. plasticity; stiff.	1	6 7 6	W=23.6 D=101.5 N=13
86.2	5.5		As above but saturated in seams.			
85.2	6.5	CH	Silty Clay: very dark gray and dark grayish brown; wet to saturated in seams; high plasticity; medium stiff to stiff. (possible fill)			Water Level @ 8.0' (Elev. 83.7) After 24 Hours
84.2	7.5	CL				
82.7	9	CH	Silty Clay: very dark gray; minor organics; saturated; med. plasticity; medium stiff. (old topsoil zone)	2	2 2 5	W=27.1 D=94.5 N=7
			Silty Clay: dark yellowish brown; saturated; high plasticity; medium stiff.			
79.2	12.5		As above but some limestone gravel.	3		W=33.4 D=87.6
76.2	15.5		Limestone: broken and weathered.			
75.2	16.5		Limestone: light gray and hard. (possible Winterset Limestone)			
73.7	18		Shale: dark gray to gray; hard. (possible Stark Shale)			
			Coal Seam			
71.7	20					

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 5
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, % / D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
94.1	0		Fill: Cinders.			
90.1	4	▽	As above but saturated.			Water @ 4.0' After Drilling. (perched in cinders above silty clay)
87.6	6.5	CL	Silty Clay: very dark grayish brown; very wet; low to medium plasticity; medium stiff.			
86.1	8	CH	Silty Clay: brownish gray with olive yellow and iron staining; very wet; medium to high plasticity; medium stiff.			
82.1	12		As above but yellowish brown with light gray to gray mottling; iron stain; 10 to 15% coarse sand; stiff.			
78.1	16		As above but with 15 to 25% gravel.			
77.1	17		Limestone: yellowish brown; weathered; medium hard.			
75.1	19		Limestone: yellowish brown to light gray; hard.			

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 5
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 2
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot	Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
74.1	20		Limestone: as before.			
72.6	21.5		Limestone: shaley; medium hard.			
71.1	23		Limestone: hard.			
68.1	26		Shale: dark gray; hard.			
			Calcareous			
64.1	30					

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 6
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot			Date: 4-12-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
94.1	0		Fill: cinders and ash with brick and tile rubble; saturated @ 3.0'; loose.			Water @ 3.9' After Drilling (Perched above silty clay)
89.6	4.5	CH	Silty Clay: very dark gray; traces of fine sand; very wet; medium to high plasticity; medium stiff.			
88.1	6		As above but olive gray, gray and yellowish brown mottled.			
85.6	8.5	CH	Silty Clay: yellowish brown mottled with light gray to gray; very wet; high plasticity; medium stiff to stiff.			
82.1	12		As above with 20 to 25% limestone gravel; stiff.			
80.6	13.5		Limestone: yellowish brown; broken and weathered. (possible Winterset Limestone)			
78.6	15.5		Limestone: light gray; hard. (Winterset Limestone)			
77.6	16.5		As above but broken in part.			
74.6	19.5		Limestone: hard. (Winterset Limestone)			

WICHITA TESTING LABORATORIES
Materials Engineers
Wichita, Kansas

BORING LOG

PROJECT
Lagoon Embankment Evaluation
National Zinc Company
Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 6
disturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 2
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-12-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
74.1	20		Limestone: as before.			
72.6	21.5		Shale: gray and light gray; sandy; high plasticity; hard. (possible Stark Shale)			
69.1	25					

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Figure 7a

Drilled By: William R. Giesel

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 8
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 1
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-12-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
st.) 92.0	0		Fill: cinders.			
91.0	1	CH	Fill: silty clay; dark brown mottled with dark yellowish brown and reddish brown; wet; high plasticity; stiff.			
88.0	4	CH	Fill: silty clay; gray; yellowish brown and dark gray; very wet; high plasticity; stiff.			
85.0	7	CL	Silty Clay: very dark gray; very wet; medium to high plasticity; medium stiff. (old topsoil zone)			
84.0	8	CH	Silty Clay: dark gray; very wet; high plasticity; medium stiff to stiff.			
85.0	9	CH	Silty Clay: dark yellowish brown; very wet; high plasticity; stiff.			
78.5	13.5		Weathered Limestone.			
78.0	14					

WICHITA TESTING LABORATORIES Materials Engineers Wichita, Kansas BORING LOG	PROJECT Lagoon Embankment Evaluation National Zinc Company Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 9
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 1
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot	Date: 4-12-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
st. 92.0	0		Fill: cinders, brick, tile, etc.; loose.			
91.0	1	CH	Fill: silty clay; dark yellowish brown, brown and grayish brown; wet; high plasticity; stiff.			
88.0	4	CL	Silty Clay: very dark gray to dark gray with some organics; saturated; medium plasticity; soft to medium stiff. (old topsoil zone)	15		W=30.5 D=90.6
87.0	5	CH	Silty Clay: dark gray; very wet; high plasticity; medium stiff.			
85.5	6.5		As above but dark yellowish brown and stiff.			
77.0	15		Saturated.			
76.5	15.5		Weathered Limestone.			
76.0	16					

Appendix 4

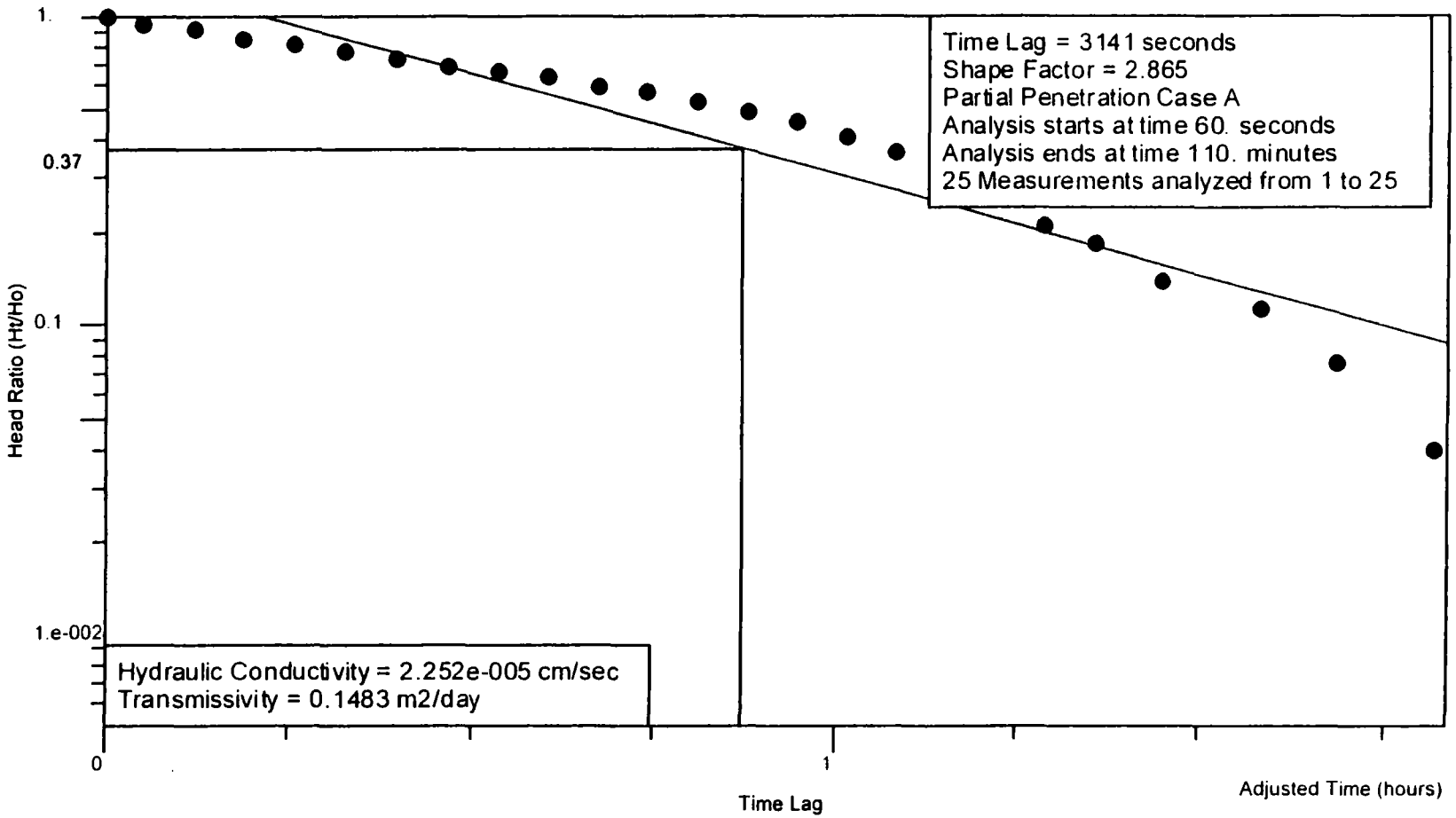
Slug Test Data and Graphs

Cherryvale, KS

8/4/2003

Hvorslev Graph

MW-5



Ho is 2.51 feet at 60. seconds

Project Number 1804-002

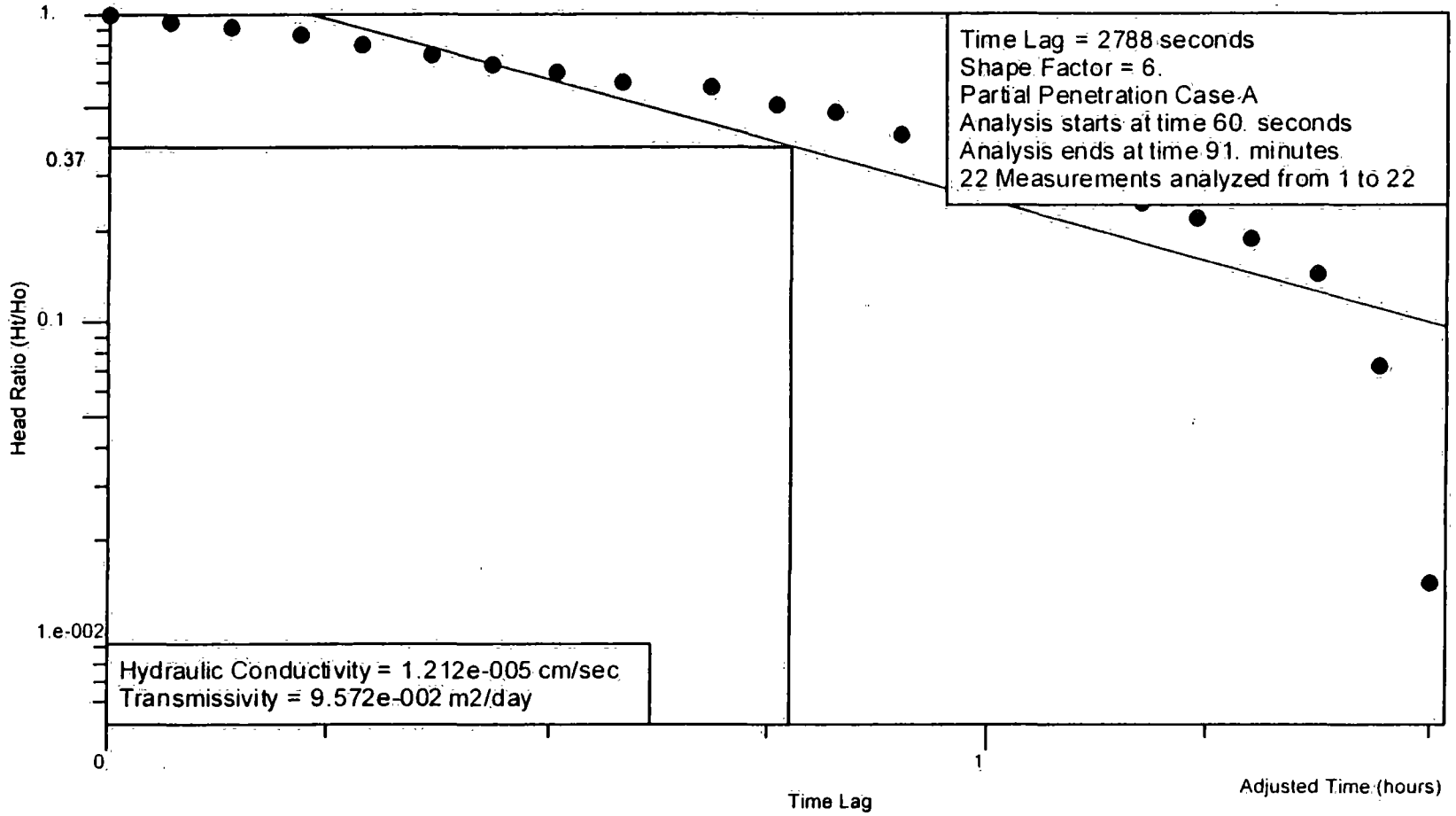
Analysis by Starpoint Software

Cherryvale, KS

8/4/2003

Hvorslev Graph

MW-8



Ho is 0.69 feet at 60. seconds

Project Number 1804-002

Analysis by Starpoint Software

Appendix 5

Groundwater Sampling Field Data Sheets and Laboratory Analytical Reports

FIELD WATER QUALITY SAMPLING AND ANAYLSIS DATA SHEET

PROJECT NAME: Cherryvale PROJECT NO: 1804-002-203

SAMPLER NAME: Jon Kuhn PERSON PRESENT:

WEATHER: Cloudy AIR TEMP: 83° F LAST PRECIPT.

				Duplicate
LOCATION (STATION NO.)	MW # 5	MW # 6	MW # 7	MW # 8
DATE AND TIME WATER LEVEL MEASURED	9/23/03 12:20	9/23/03 13:20	9/23/03 13:24	9/23/03
DATE AND TIME PURGED	9/23/03 13:45	9/23/03 14:30	9/23/03 14:05	9/23/03 15:00
DATE AND TIME SAMPLED	9/23/03 16:00	9/23/03 16:30	9/23/03 16:40	9/23/03 16:50
SAMPLING METHOD	Baler.	Baler	Baler.	Baler.
TOP OF CASING ELEV.				
DEPTH TO WATER (DTW)	7.0	11.2	7.1	3.3
TOTAL DEPTH (TD)	19.3	34.1	26.35	26.0
REQUIRED PURGE VOLUME	9.5	14.69	12.91	
VOLUME PURGED				
THICKNESS OF NAPL/DNAPL	None	None	None	None
SUBSTANCE ON WATER	None.	None	None	None
SAMPLING TEMP.	22.5 | 20.9	18.5 | 17.3	20.9 | 18.8	19.6 | 17.6
	18.7 | 19.6	16.8 | 16.5	17.7 | 17.9	16.5 | 16.1
SAMPLING PH	7.44 | 7.39	7.66 | 7.63	7.66 | 7.56	7.79 | 7.62
(INST. NAME)	7.38 | 7.36	7.81 | 7.82	7.60 | 7.77	7.60 | 7.58
SAMPLING SPEC. COND	1040 | 930	2600 | 2700	2810 | 3180	4020 | 4210
(INST. NAME)	930 | 930	2890 | 3000	3400 | 3460	5020 | 5520
COLOR	clear → murky.	clear → murky	clear → murky	clear → murky
ODOR	None	None	Salty surface	Salty surface
SEDIMENT	Slight	Some	Slight	Slight
FIELD TREATMENT PRESERVATION	Preservered	Preservered	Preservered	Preservered
PURGING/SAMPLING PLAN AND PROCEDURES FOLLOWED?	Yes	Yes	Yes	Yes

NOTE:

Volume calculation: 2" – 0.163 gal/ft, 3" – 0.367 gal/ft, 4" – 0.653 gal/ft {[(TD-DTW) x gal/ft] x 3} + 3.5 gal = volume to evac.

PROJECT NAME Cherryvale PROJECT NUMBER

SAMPLER NAME Jon PERSON PRESENT

WEATHER Clear AMBIENT AIR TEMP. 95 LAST PRECIP.

LOCATION (STATION NO.)	MW# 5		MW8		MW 7		MW 6	
CONDITION OF WELL	Good		Good		Good		Good	
WATER SOURCES	Ground		Ground		Ground		Ground	
DATE AND TIME WATER LEVEL MEASURED	8-6-03 12:00		8-6-03 12:31		8-6-03 1:00		8-6-03 1:26	
DATE AND TIME PURGED	8-6-03/12:02.		8-6-03 12:33		8-6-03 1:02		8-6-03 1:28	
DATE AND TIME SAMPLED	8-6-03 3:31		8-6-03 3:47		8-6-03 3:57		8-6-03 4:05	
SAMPLING METHOD	Bailer.		Bailer		Bailer		Bailer	
TOTAL WELL DEPTH TWD	19.45		26.01		26.28		33.63	
WATER DEPTH (GL) WD	9.11		10.33		11.33		11.64	
THICKNESS OF NAPL/DNAPL	none		none		none		none	
VOLUME TO EVACUATE	8.6		11.2		10.8		14.3	
PUMP RATE WHILE PURGING								
SUBSTANCE ON WATER	none		Slight		none		none	
SAMPLING TEMPERATURE	20.7	19.5	18.9	17.8	22.5	19.1	19.2	19.5
	19.1	18.9	16.7	16.7	18.5	17.7	18.6	17.6
SAMPLING pH	7.00	7.21	7.00	7.23	7.26	7.34	6.46	6.46
	7.30	7.39	7.33	7.39	7.28	7.24	6.55	6.57
SAMPLING SPECIFIC CONDUCTANCE	620	640	2000	2400	2000	2200	2000	2100
	690	670	2900	2900	2300	2700	2200	2400
COLOR	~~Clear~~ ~~Brown~~ Cloudy		Clear → murky		clear → murky		clear → murky	
ODOR	None		None		salty		none	
SEDIMENT	Medium		Medium		medium		medium → heavy	
FIELD TREATMENT PRESERVATION	Prepreserved.		Prepreserved		Prepreserved		Prepreserved	
PURGING/SAMPLING PLAN	yes		yes		yes		yes	

VOLUME CALCULATION: 2" – 0.163 GAL/FT. 3" – 0.367 GAL/FT. 4" – 0.653 GAL/FT

{((TWD-WD) x GAL/FT) x 3} ÷ 3.5 GAL = VOLUME TO EVAC.

ONE BAILER = 0.24 GAL.

FIELD WATER QUALITY SAMPLING AND ANAYLSIS DATA SHEET

PROJECT NAME: Cherryvale, KS **PROJECT NO:** 1804-002

SAMPLER NAME: Gavin James **PERSON PRESENT:** Okay Ertugrul

WEATHER: Cloudy **AIR TEMP:** 50°F **LAST PRECIPT.** 3hrs.

LOCATION (STATION NO.)	MW-4	MW-5	MW-6	MW-7
DATE AND TIME WATER LEVEL MEASURED	11/14/03 3:15	11/14/03 3:25	11/15/03 3:28	11/15/03 3:35
DATE AND TIME PURGED				
DATE AND TIME SAMPLED				
SAMPLING METHOD				
TOP OF CASING ELEV.				
DEPTH TO WATER (DTW)	4.41'	3.82'	10.92'	8.82'
TOTAL DEPTH (TD)				
REQUIRED PURGE VOLUME				
VOLUME PURGED				
THICKNESS OF NAPL/DNAPL				
SUBSTANCE ON WATER				
SAMPLING TEMP.				
SAMPLING PH (INST. NAME)				
SAMPLING SPEC. COND (INST. NAME)				
COLOR				
ODOR				
SEDIMENT				
FIELD TREATMENT PRESERVATION				
PURGING/SAMPLING PLAN AND PROCEDURES FOLLOWED?				
OTHER				

NOTE:

Volume calculation: 2" – 0.163 gal/ft, 3" – 0.367 gal/ft, 4" – 0.653 gal/ft {[(TD-DTW) x gal/ft] x 3} + 3.5 gal = volume to evac.

FIELD WATER QUALITY SAMPLING AND ANAYLSIS DATA SHEET

PROJECT NAME: Cherryvale, KS **PROJECT NO:** 1804-002

SAMPLER NAME: Gavin James **PERSON PRESENT:** Ctlay Ertugrul

WEATHER: Cloudy **AIR TEMP:** 50°F **LAST PRECIPT.** 3hrs.

LOCATION (STATION NO.)	MW-1		MW-2S		MW-2D		MW-3	
DATE AND TIME WATER LEVEL MEASURED	11/14/03 3:00pm		11/14/03 3:05pm		11/14/03 3:02pm		11/14/03 3:09	
DATE AND TIME PURGED								
DATE AND TIME SAMPLED								
SAMPLING METHOD								
TOP OF CASING ELEV.								
DEPTH TO WATER (DTW)	4.14'		4.55'		10.73'		3.23'	
TOTAL DEPTH (TD)								
REQUIRED PURGE VOLUME								
VOLUME PURGED								
THICKNESS OF NAPL/DNAPL								
SUBSTANCE ON WATER								
SAMPLING TEMP.								
SAMPLING PH								
(INST. NAME)								
SAMPLING SPEC. COND								
(INST. NAME)								
COLOR								
ODOR								
SEDIMENT								
FIELD TREATMENT PRESERVATION								
PURGING/SAMPLING PLAN AND PROCEDURES FOLLOWED?								
OTHER								

NOTE:

Volume calculation: 2" – 0.163 gal/ft, 3" – 0.367 gal/ft, 4" – 0.653 gal/ft {[(TD-DTW) x gal/ft] x 3} + 3.5 gal = volume to evac.

FIELD WATER QUALITY SAMPLING AND ANAYLSIS DATA SHEET

PROJECT NAME: Cherryvale, KS **PROJECT NO:** 1804-002

SAMPLER NAME: Gavin James **PERSON PRESENT:** O. Ertugrul

WEATHER: Cloudy **AIR TEMP:** 50°F **LAST PRECIPT.** 3 hrs

LOCATION (STATION NO.)	MW-4		TW-2		TW-3		TW-9	
DATE AND TIME WATER LEVEL MEASURED	11/18/03 3:39		11/18/03 4:03		11/18/03 4:05		11/18/03 4:36	
DATE AND TIME PURGED								
DATE AND TIME SAMPLED								
SAMPLING METHOD								
TOP OF CASING ELEV.								
DEPTH TO WATER (DTW)	3.75'		6.55'		5.25'		8.09'	
TOTAL DEPTH (TD)								
REQUIRED PURGE VOLUME								
VOLUME PURGED								
THICKNESS OF NAPL/DNAPL								
SUBSTANCE ON WATER								
SAMPLING TEMP.								
SAMPLING PH								
(INST. NAME)								
SAMPLING SPEC. COND								
(INST. NAME)								
COLOR								
ODOR								
SEDIMENT								
FIELD TREATMENT PRESERVATION								
PURGING/SAMPLING PLAN AND PROCEDURES FOLLOWED?								
OTHER								

NOTE:

Volume calculation: 2" – 0.163 gal/ft, 3" – 0.367 gal/ft, 4" – 0.653 gal/ft **{[(TD-DTW) x gal/ft] x 3} + 3.5 gal = volume to evac.**

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Tulsa, OK 74128-4813
TEL: (918)665-6574
FAX ( ) 665-6576

August 13, 2003
Order No.: T03080064

RE: Cherryvale

Dear Irfan Taner:

Sherry Laboratories received 6 samples on 8/7/2003 for the analyses presented in the following report.

In accordance with your instructions, Sherry Laboratories/Oklahoma conducted the analysis shown on the following pages on samples submitted by your company. The results related only to the items tested. Unless otherwise noted, all analysis was conducted using EPA approved methodologies. All relevant sampling information is on the attached chain-of-custody form. The initials SUB as the analyst designate any testing sub-contracted by SLO.

Certifications/Accreditation: OK - 7604
AR - ADEQ
KS - E-10232
LA - 4002

A scope of Certified/Accredited parameters is available upon request.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Tom Gilroy

Approved By: _____
Brian Duzan, Director
Environmental Services

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QA/QC REPORT
A & M Engineering
SAMPLE # T03080064
BATCH QC

PARAMETERS	LFB	MS % REC.	MSD % REC.	RPD
Arsenic	101	98	98	0.01
Cadmium	105	103	104	0.8
Chromium	104	103	104	1.2
Lead	102	104	105	0.4
Silver	102	101	102	1.0
Mercury	110	100	102	1.5

Approved by:

SHERRY LABORATORIES/OKLAHOMA

Brian Duzan
Laboratory Director

SHERRYLaboratories

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6825 E 38th Street
Tulsa OK 74145
(918)828-9977

Fax: (918)828-7756
(800)324-5757

CLIENT: A & M Engineering
Lab Order: T03080064 **Date Received:** 8/7/2003
Project: Cherryvale **Date Reported:** *13-Aug-03*

Lab ID: T03080064-01 Collection Date: 8/6/2003 3:31:00 PM Sample ID: MW #5

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	8/7/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	8/8/2003 11:27:52	
Cadmium	< 0.00100	0.00100	mg/L	8/8/2003 11:27:52	
Chromium	< 0.0100	0.0100	mg/L	8/8/2003 11:27:52	
Lead	< 0.00500	0.00500	mg/L	8/8/2003 11:27:52	
Silver	< 0.00200	0.00200	mg/L	8/8/2003 11:27:52	

Lab ID: T03080064-02 Collection Date: 8/6/2003 3:47:00 PM Sample ID: MW #8

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	8/7/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	8/8/2003 12:01:55	
Cadmium	< 0.00100	0.00100	mg/L	8/8/2003 12:01:55	
Chromium	< 0.0100	0.0100	mg/L	8/8/2003 12:01:55	
Lead	< 0.00500	0.00500	mg/L	8/8/2003 12:01:55	
Silver	< 0.00200	0.00200	mg/L	8/8/2003 12:01:55	

Lab ID: T03080064-03 Collection Date: 8/6/2003 3:57:00 PM Sample ID: MW #7

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	8/7/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	8/8/2003 12:06:50	
Cadmium	< 0.00100	0.00100	mg/L	8/8/2003 12:06:50	
Chromium	< 0.0100	0.0100	mg/L	8/8/2003 12:06:50	
Lead	< 0.00500	0.00500	mg/L	8/8/2003 12:06:50	
Silver	< 0.00200	0.00200	mg/L	8/8/2003 12:06:50	

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Tulsa OK 74145
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Fax: (918)828-7756
(800)324-5757

CLIENT: A & M Engineering
Lab Order: T03080064 **Date Received:** 8/7/2003
Project: Cherryvale **Date Reported:** 13-Aug-03

Lab ID: T03080064-04 Collection Date: 8/6/2003 4:05:00 PM Sample ID: MW #6

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	8/7/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	8/8/2003 12:11:46	
Cadmium	< 0.00100	0.00100	mg/L	8/8/2003 12:11:46	
Chromium	< 0.0100	0.0100	mg/L	8/8/2003 12:11:46	
Lead	< 0.00500	0.00500	mg/L	8/8/2003 12:11:46	
Silver	< 0.00200	0.00200	mg/L	8/8/2003 12:11:46	

Lab ID: T03080064-05 Collection Date: 8/6/2003 Sample ID: Duplicate

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	8/7/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	8/8/2003 12:16:43	
Cadmium	< 0.00100	0.00100	mg/L	8/8/2003 12:16:43	
Chromium	< 0.0100	0.0100	mg/L	8/8/2003 12:16:43	
Lead	< 0.00500	0.00500	mg/L	8/8/2003 12:16:43	
Silver	< 0.00200	0.00200	mg/L	8/8/2003 12:16:43	

Lab ID: T03080064-06 Collection Date: 8/6/2003 Sample ID: Equip. Blank

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	8/7/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	8/8/2003 12:21:40	
Cadmium	< 0.00100	0.00100	mg/L	8/8/2003 12:21:40	
Chromium	< 0.0100	0.0100	mg/L	8/8/2003 12:21:40	
Lead	< 0.00500	0.00500	mg/L	8/8/2003 12:21:40	
Silver	< 0.00200	0.00200	mg/L	8/8/2003 12:21:40	

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T08080006-1

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

TULSA, OKLAHOMA

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

10010 E. 16th Street - TULSA, OKLAHOMA 74128-4813
TEL: (918)665-6575 FAX: (918)665-6576 E-Mail: aandm@aandmengineering.com

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
A & M ENGINEERING	Irfan Tanck	(918) 665-6575

PROJECT NUMBER	PROJECT NAME
1804-002-203	Cherryvale

SAMPLERS: (Signature) [signature]

ANALYTICAL TESTS REQUIRED

STA. NO	DATE	TIME	COMP.	GRAB	STATION LOCATION	MATRIX	NO. OF CONTAINERS	RUSH ? YES	RUSH ? NO	Arsenic	Cadmium	Lead	Chromium	Silver	Mercury						REMARKS
	8-6-03	15:31			MW #5	Liq	1		X	X	X	X	X	X	X						
	8-6-03	15:47			MW #8	Liq	1		X	X	X	X	X	X	X						
	8-6-03	15:57			MW #7	Liq	1		X	X	X	X	X	X	X						Temp.
	8-6-03	16:05			MW #6	Liq	1		X	X	X	X	X	X	X						2.5°C
	8-6-03				Duplicate	Liq	1		X	X	X	X	X	X	X						
	8-6-03				Equip. Blank	Liq	1		X	X	X	X	X	X	X						

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
				[signature]	8-7-03	08:35	[signature]
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	REMARKS:			

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Tulsa OK 74145
(918)828-9977

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Fax: (918)828-7756
(800)324-5757

Altay Ertugrul
A & M Engineering
10010 E. 16th St.
Tulsa, OK 74128-4813
TEL: (918) 665-6574
FAX ( ) 665-6576

September 29, 2003
Order No.: T03090311

RE: Cherryvale

Dear Altay Ertugrul:

Sherry Laboratories received 6 samples on 9/24/2003 for the analyses presented in the following report.

In accordance with your instructions, Sherry Laboratories/Oklahoma conducted the analysis shown on the following pages on samples submitted by your company. The results related only to the items tested. Unless otherwise noted, all analysis was conducted using EPA approved methodologies. All relevant sampling information is on the attached chain-of-custody form. The initials SUB as the analyst designate any testing sub-contracted by SLO.

Certifications/Accreditation: OK - 7604
AR - ADEQ
KS - E-10232
LA - 4002

A scope of Certified/Accredited parameters is available upon request.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Approved By: Sharon Wedeki

Brian Duzan, Director
Environmental Services

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Tulsa OK 74145
(918)828-9977

Fax: (918)828-7756
(800)324-5757

CLIENT: A & M Engineering
Lab Order: T03090311 **Date Received:** 9/24/2003
Project: Cherryvale **Date Reported:** *29-Sep-03*

Lab ID: T03090311-01 Collection Date: 9/23/2003 4:00:00 PM Sample ID: MW 5

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	9/24/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	9/26/2003 1:59:31	
Cadmium	< 0.00100	0.00100	mg/L	9/26/2003 1:59:31	
Chromium	< 0.0100	0.0100	mg/L	9/26/2003 1:59:31	
Lead	< 0.00500	0.00500	mg/L	9/26/2003 1:59:31	
Silver	< 0.00200	0.00200	mg/L	9/26/2003 1:59:31	

Lab ID: T03090311-02 Collection Date: 9/23/2003 4:30:00 PM Sample ID: MW 6

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	9/24/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	9/26/2003 2:09:16	
Arsenic	< 0.00500	0.00500	mg/L	9/26/2003 11:24:0	
Cadmium	< 0.00100	0.00100	mg/L	9/26/2003 2:09:16	
Cadmium	< 0.00100	0.00100	mg/L	9/26/2003 11:24:0	
Chromium	< 0.0100	0.0100	mg/L	9/26/2003 2:09:16	
Chromium	< 0.0100	0.0100	mg/L	9/26/2003 11:24:0	
Lead	< 0.00500	0.00500	mg/L	9/26/2003 2:09:16	
Lead	< 0.00500	0.00500	mg/L	9/26/2003 11:24:0	
Silver	< 0.00200	0.00200	mg/L	9/26/2003 2:09:16	
Silver	< 0.00200	0.00200	mg/L	9/26/2003 11:24:0	

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CLIENT: A & M Engineering
Lab Order: T03090311 **Date Received:** 9/24/2003
Project: Cherryvale **Date Reported:** *29-Sep-03*

Lab ID: T03090311-03 Collection Date: 9/23/2003 4:40:00 PM Sample ID: MW 7

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	9/24/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	9/26/2003 2:18:55	
Cadmium	< 0.00100	0.00100	mg/L	9/26/2003 2:18:55	
Chromium	< 0.0100	0.0100	mg/L	9/26/2003 2:18:55	
Lead	< 0.00500	0.00500	mg/L	9/26/2003 2:18:55	
Silver	< 0.00200	0.00200	mg/L	9/26/2003 2:18:55	

Lab ID: T03090311-04 Collection Date: 9/23/2003 4:50:00 PM Sample ID: MW 8

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	9/24/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	9/26/2003 2:48:09	
Cadmium	< 0.00100	0.00100	mg/L	9/26/2003 2:48:09	
Chromium	< 0.0100	0.0100	mg/L	9/26/2003 2:48:09	
Lead	< 0.00500	0.00500	mg/L	9/26/2003 2:48:09	
Silver	< 0.00200	0.00200	mg/L	9/26/2003 2:48:09	

Lab ID: T03090311-05 Collection Date: 9/23/2003 Sample ID: Duplicate

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	9/24/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	9/26/2003 2:53:28	
Cadmium	< 0.00100	0.00100	mg/L	9/26/2003 2:53:28	
Chromium	< 0.0100	0.0100	mg/L	9/26/2003 2:53:28	
Lead	< 0.00500	0.00500	mg/L	9/26/2003 2:53:28	
Silver	< 0.00200	0.00200	mg/L	9/26/2003 2:53:28	

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(800)324-5757

CLIENT: A & M Engineering
Lab Order: T03090311 **Date Received:** 9/24/2003
Project: Cherryvale **Date Reported:** *29-Sep-03*

Lab ID: T03090311-06 **Collection Date: 9/23/2003** **Sample ID: Equipment Blank**

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	9/24/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	9/26/2003 2:59:14	
Cadmium	< 0.00100	0.00100	mg/L	9/26/2003 2:59:14	
Chromium	< 0.0100	0.0100	mg/L	9/26/2003 2:59:14	
Lead	< 0.00500	0.00500	mg/L	9/26/2003 2:59:14	
Silver	< 0.00200	0.00200	mg/L	9/26/2003 2:59:14	

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Sherry Laboratories

Date: *29-Sep-03*

CLIENT: A & M Engineering
Work Order: T03090311
Project: Cherryvale

QC SUMMARY REPORT

TestCode	Analyte	BatchID	QCType	Result	PQL	Units	%Rec	%RPD
HG_WW	Mercury	R15859	MBLK	< 0.00010	0.0001	mg/L		
	Mercury	R15859	LCS	0.001035	0.0001	mg/L	103	
	Mercury	R15859	MS	0.000937	0.0001	mg/L	93.7	
	Mercury	R15859	MS	0.001032	0.0001	mg/L	103	
	Mercury	R15859	MSD	0.000971	0.0001	mg/L	97.1	3.56
	Mercury	R15859	MSD	0.001003	0.0001	mg/L	100	2.85
met_ww_icpt	Arsenic	R15904	mblk	< 0.0050	0.005	mg/L		
	Cadmium	R15904	mblk	< 0.0010	0.001	mg/L		
	Chromium	R15904	mblk	< 0.010	0.01	mg/L		
	Lead	R15904	mblk	< 0.0050	0.005	mg/L		
	Silver	R15904	mblk	< 0.0020	0.002	mg/L		
	Arsenic	R15904	lcs	2.017	0.005	mg/L	101	
	Cadmium	R15904	lcs	1.995	0.001	mg/L	99.7	
	Chromium	R15904	lcs	1.977	0.01	mg/L	98.8	
	Lead	R15904	lcs	1.964	0.005	mg/L	98.2	
	Silver	R15904	lcs	0.2031	0.002	mg/L	102	
	Arsenic	R15904	ms	1.988	0.005	mg/L	99.4	
	Cadmium	R15904	ms	1.99	0.001	mg/L	99.5	
	Chromium	R15904	ms	2.008	0.01	mg/L	100	
	Lead	R15904	ms	2.105	0.005	mg/L	105	
	Silver	R15904	ms	0.1993	0.002	mg/L	99.7	
	Arsenic	R15904	msd	1.971	0.005	mg/L	98.6	0.824
	Cadmium	R15904	msd	1.985	0.001	mg/L	99.2	0.279
	Chromium	R15904	msd	2.004	0.01	mg/L	100	0.192
	Lead	R15904	msd	2.093	0.005	mg/L	105	0.589
	Silver	R15904	msd	0.2007	0.002	mg/L	100	0.67

T0309031

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

TULSA, OKLAHOMA

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10010 E. 16th Street - TULSA, OKLAHOMA 74128-4813
TEL: (918)665-6575 FAX: (918)665-6576 E-Mail: aandm@aandmengineering.com

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
A & M ENGINEERING	Irfan Taner	(918) 665-6575

PROJECT NUMBER	PROJECT NAME
1804-002-203	Cherryvale

SAMPLERS: (Signature) Jon Kuhn

ANALYTICAL TESTS REQUIRED

STA. NO	DATE	TIME	COMP	GRAB	STATION LOCATION	MATRIX	NO. OF CONTAINERS	RUSH ? YES	RUSH ? NO	Arsenic	Cadmium	Lead	Chromium	Silver	Mercury						REMARKS
	9/23/03	16:00			mw 5	Liq	1		X	X	X	X	X	X	X						
	9/23/03	16:30			mw 6	Liq	1		X	X	X	X	X	X	X						
	9/23/03	16:40			mw 7	Liq	1		X	X	X	X	X	X	X						
	9/23/03	16:50			mw 8	Liq	1		X	X	X	X	X	X	X						
	9/23/03				Duplicate	Liq	1		X	X	X	X	X	X	X						
	9/23/03				Equipment Blk	Liq	1		X	X	X	X	X	X	X						

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
Gary W. Gates	9/24/03	10:25	Amanda Andrews	Jon Kuhn	9/24/03	08:00	Gary W. Gates
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	REMARKS:			

CHAIN DWG

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(800)324-5757

Altay Ertugrul
A & M Engineering
10010 E. 16th St.
Tulsa, OK 74128-4813
TEL: (918) 665-6574
FAX ( ) 665-6576

October 29, 2003
Order No.: T03100263

RE: Cherryvale

Dear Altay Ertugrul:

Sherry Laboratories received 5 samples on 10/21/2003 for the analyses presented in the following report.

In accordance with your instructions, Sherry Laboratories/Oklahoma conducted the analysis shown on the following pages on samples submitted by your company. The results related only to the items tested. Unless otherwise noted, all analysis was conducted using EPA approved methodologies. Test reports meet all the NELAC requirements. All relevant sampling information is on the attached chain-of-custody form. The initials SUB as the analyst designate any testing sub-contracted by SLO.

Certifications/Accreditation: OK - 7604
AR - ADEQ
KS - E-10232
LA - 4002

A scope of Certified/Accredited parameters is available upon request. If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Approved By: _____
Brian Duzan, Director
Environmental Services

6825 E 38th Street
Tulsa OK 74145
(918)828-9977

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Fax: (918)828-7756
(800)324-5757

CLIENT: A & M Engineering
Lab Order: T03100263 **Date Received:** 10/21/2003
Project: Cherryvale **Date Reported:** *29-Oct-03*

Lab ID: T03100263-01 Collection Date: 10/20/2003 3:45:00 P Sample ID: MW #5

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	10/21/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	10/23/2003 3:55:5	
Cadmium	< 0.00100	0.00100	mg/L	10/23/2003 3:55:5	
Chromium	< 0.0100	0.0100	mg/L	10/23/2003 3:55:5	
Lead	< 0.00500	0.00500	mg/L	10/23/2003 3:55:5	
Silver	< 0.00200	0.00200	mg/L	10/23/2003 3:55:5	

Lab ID: T03100263-02 Collection Date: 10/20/2003 4:15:00 P Sample ID: MW #6

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	10/21/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	10/23/2003 4:00:4	
Cadmium	< 0.00100	0.00100	mg/L	10/23/2003 4:00:4	
Chromium	< 0.0100	0.0100	mg/L	10/23/2003 4:00:4	
Lead	< 0.00500	0.00500	mg/L	10/23/2003 4:00:4	
Silver	< 0.00200	0.00200	mg/L	10/23/2003 4:00:4	

Lab ID: T03100263-03 Collection Date: 10/20/2003 4:05:00 P Sample ID: MW #7

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	10/21/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	10/23/2003 4:05:4	
Cadmium	< 0.00100	0.00100	mg/L	10/23/2003 4:05:4	
Chromium	< 0.0100	0.0100	mg/L	10/23/2003 4:05:4	
Lead	< 0.00500	0.00500	mg/L	10/23/2003 4:05:4	
Silver	< 0.00200	0.00200	mg/L	10/23/2003 4:05:4	

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6825 E 38th Street
Tulsa OK 74145
(918)828-9977

SHERRYLaboratories

Testing Today – Protecting Tomorrow®

Fax: (918)828-7756
(800)324-5757

CLIENT: A & M Engineering
Lab Order: T03100263 **Date Received:** 10/21/2003
Project: Cherryvale **Date Reported:** *29-Oct-03*

Lab ID: T03100263-04 Collection Date: 10/20/2003 3:55:00 P Sample ID: MW #8

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	10/21/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	10/23/2003 4:10:4	
Cadmium	< 0.00100	0.00100	mg/L	10/23/2003 4:10:4	
Chromium	< 0.0100	0.0100	mg/L	10/23/2003 4:10:4	
Lead	< 0.00500	0.00500	mg/L	10/23/2003 4:10:4	
Silver	< 0.00200	0.00200	mg/L	10/23/2003 4:10:4	

Lab ID: T03100263-05 Collection Date: 10/20/2003 Sample ID: Duplicate

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	10/21/2003	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	10/23/2003 4:14:4	
Cadmium	< 0.00100	0.00100	mg/L	10/23/2003 4:14:4	
Chromium	< 0.0100	0.0100	mg/L	10/23/2003 4:14:4	
Lead	< 0.00500	0.00500	mg/L	10/23/2003 4:14:4	
Silver	< 0.00200	0.00200	mg/L	10/23/2003 4:14:4	

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Sherry Laboratories

Date: *29-Oct-03*

CLIENT: A & M Engineering
Work Order: T03100263
Project: Cherryvale

QC SUMMARY REPORT

estCode	Analyte	BatchID	QCType	Result	PQL	Units	%Rec	%RPD
HG_WW	Mercury	R16222	MBLK	< 0.00010	0.0001	mg/L		
	Mercury	R16222	LCS	0.001019	0.0001	mg/L	102	
	Mercury	R16222	MS	0.000935	0.0001	mg/L	93.5	
	Mercury	R16222	MSD	0.000966	0.0001	mg/L	96.6	3.26
met_ww_icpt	Arsenic	1628	mblk	< 0.0050	0.005	mg/L		
	Cadmium	1628	mblk	< 0.0010	0.001	mg/L		
	Chromium	1628	mblk	< 0.010	0.01	mg/L		
	Lead	1628	mblk	< 0.0050	0.005	mg/L		
	Silver	1628	mblk	< 0.0020	0.002	mg/L		
	Arsenic	1628	lcs	2.016	0.005	mg/L	101	
	Cadmium	1628	lcs	2.03	0.001	mg/L	101	
	Chromium	1628	lcs	2.027	0.01	mg/L	101	
	Lead	1628	lcs	2.015	0.005	mg/L	101	
	Silver	1628	lcs	0.2011	0.002	mg/L	101	
	Arsenic	1628	ms	2.023	0.005	mg/L	101	
	Cadmium	1628	ms	2.052	0.001	mg/L	103	
	Chromium	1628	ms	2.032	0.01	mg/L	102	
	Lead	1628	ms	2.069	0.005	mg/L	103	
	Silver	1628	ms	0.2041	0.002	mg/L	102	
	Arsenic	1628	msd	2.025	0.005	mg/L	101	0.0829
	Cadmium	1628	msd	2.052	0.001	mg/L	103	0.0301
	Chromium	1628	msd	2.028	0.01	mg/L	101	0.169
	Lead	1628	msd	2.071	0.005	mg/L	104	0.0795
	Silver	1628	msd	0.2041	0.002	mg/L	102	0.0199

T03100263

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

TULSA, OKLAHOMA

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

10010 E. 16th Street - TULSA, OKLAHOMA 74128-4813
TEL: (918)665-6575 FAX: (918)665-6576 E-Mail: aandm@aandmengineering.com

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
A & M ENGINEERING	Irfan Tunca	(918) 665-6575

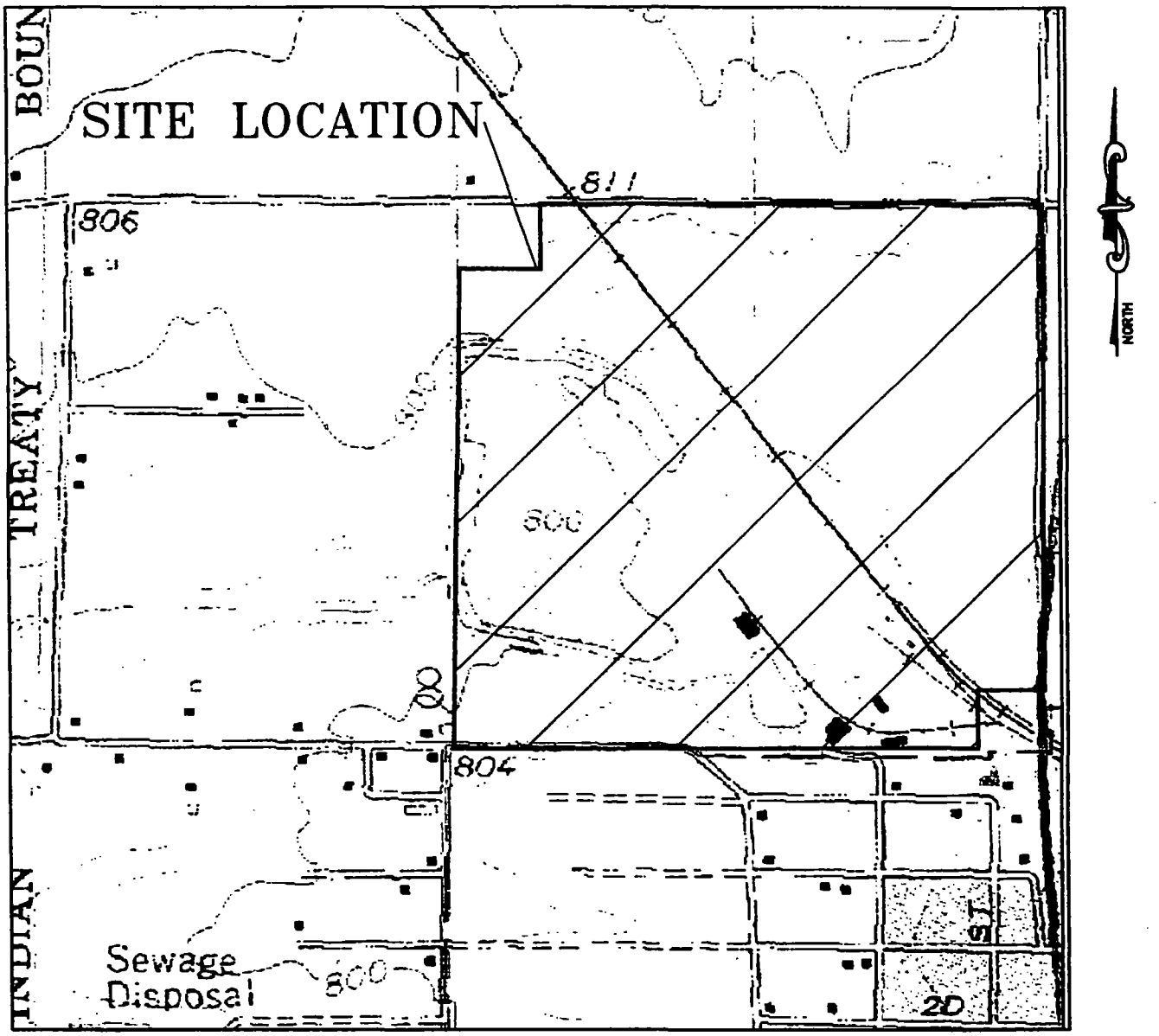
PROJECT NUMBER	PROJECT NAME
1804-002-203	Cherryvale

SAMPLERS: (Signature) Jon Rucka, [illegible]

ANALYTICAL TESTS REQUIRED

STA. NO	DATE	TIME	COMP	GRAB	STATION LOCATION	MATRIX	NO. OF CONTAINERS	RUSH ? YES	RUSH ? NO	Arsenic	Cadmium	Lead	Chromium	Silver	Mercury						REMARKS
	10/20/03	15:45			MW #5	Liq	1		X	X	X	X	X	X	X						
	10/20/03	16:15			MW #6	Liq	1		X	X	X	X	X	X	X						
	10/20/03	16:05			MW #7	Liq	1		X	X	X	X	X	X	X						
	10/20/03	15:55			MW #8	Liq	1		X	X	X	X	X	X	X						
	10/20/03				Duplicate	Liq	1		X	X	X	X	X	X	X						

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
				Jon Rucka	10/21/03	09:20	[illegible]
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	REMARKS:			



CHERRYVALE QUANDRANGLE
MONTGOMERY COUNTY, KANSAS

1/2 1/4 0 0.5 MILE

500 0 500 1000 1500 2000 2500 3000 3500 FEET

0.5 .25 0 0.5 KILOMETER

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

TOPOGRAPHIC LOCATION MAP		
SCALE: AS	DATE: 11/17/03	FIGURE NO. FIGURE 1
APPROVED BY: IT	DRAWN BY: GJJ	PROJECT NO. 1804–002

APPENDIX C

ANALYTICAL REPORT: SURFACE WATER, SEDIMENT AND EPA REPOSITORY SOIL SAMPLING

(OCTOBER 2003)

Analytical Report
Surface Water, Sediment, and EPA Repository Soil Sampling
For
Former National Zinc Site
Cherryvale, Montgomery County, Kansas

October 2003

Presented to:

Kansas Department of Health & Environment

Prepared By:

Salomon Smith Barney Holdings, Inc.
United States Steel Corporation
&
A & M Engineering and Environmental Services, Inc.

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Figure 6	14

APPENDICES

Appendix A Analyzed Parameters for Cadmium, Zinc, Arsenic & Lead (Figures 3A-3D)

Appendix B Sediment and Surface Water Analytical Data for Unnamed & Drum Creeks

Appendix C Sediment Sample Location Descriptions & Site Photos for Unnamed and Drum Creeks

Appendix D EPA Repository Analytical Data

Introduction:

The purpose of this report is for the presentation of the sediment and surface water sampling and the Environmental Protection Agency (EPA) Repository Sampling Data. This report is divided into two sections. Section I will cover the sediment and surface water sampling. Section II will deal with the EPA Repository area soil sampling. All sampling events were conducted according to the sampling and amended sampling plan outlined in the National Zinc Site (Site) Consent Agreement.

I. Sediment and Surface Water Sampling

Background Information:

A & M Engineering and Environmental Services, Inc. (A & M Engineering) of Tulsa Oklahoma conducted sediment and surface water testing on June 24, 25 and 26 of 2003. The purpose of the sampling event was to collect and analyze surface water and sediment samples as spelled out in the plan.

Sediment samples and background sediment sample locations are shown on Figure 1. Water samples and background water sample locations are shown in Figure 2.

The parameters analyzed for sediments were Lead, Cadmium, Arsenic, Chromium, Zinc, Mercury and pH. The sampling events were broken up into 2 categories: Unnamed Creek and Drum Creek. The sediment sampling parameters for Unnamed Creek are summarized in Table 1. The parameters analyzed for Drum Creek are summarized in Table 2.

The parameters analyzed for surface water samples were Hardness, Mercury, Arsenic, Cadmium, Chromium, Lead, Zinc and Suspended Solids. The sampling event covered two areas: Unnamed Creek and Drum Creek. The analytical parameters for Unnamed Creek are summarized in Table 3. The analytical parameters for Drum Creek are summarized in Table 4.

Figures 3A-3D present the four analyzed parameters, Cadmium, Zinc, Arsenic, and Lead plotted on the map for overlay references. These figures are included as Appendix A. Appendix B includes the Sediment and Surface Water Analytical Data for both Unnamed and Drum Creeks. Table 5 quantifies the sediment amounts between measuring points in Unnamed Creek and the total amount of sedimentation in Unnamed Creek.

Appendix C presents the Sediment Sample Descriptions and Site Photos for sample locations along Unnamed Creek and Drum Creek.

Table 1

Sediment Samples from Unnamed Creek near the National Zinc Site - Cherryvale, Kansas

Sample	Mercury (mg/Kg)	Arsenic (mg/Kg)	Cadmium (mg/Kg)	Chromium (mg/Kg)	Lead (mg/Kg)	Zinc (mg/Kg)	pH
S-1	0.059	21.20	20.60	11.20	163.00	1470.0	6.90
S-2	0.070	41.50	32.50	11.30	233.00	2150.0	6.81
S-3	0.086	15.80	44.80	11.00	189.00	3290.0	7.45
S-4	0.240	40.30	51.60	12.80	546.00	11900.0	7.22
S-22	0.098	23.20	333.00	17.40	606.00	14600.0	7.67
S-5	0.560	37.80	704.00	19.00	1190.00	16500.0	7.47
S-6	0.170	5.94	68.70	7.68	238.00	2850.0	7.45
S-19	0.046	18.00	511.00	15.60	368.00	32900.0	7.70
S-18	0.088	58.10	177.00	9.49	192.00	3600.0	7.38
S-9	0.160	15.20	79.30	13.20	145.00	2170.0	7.48
S-8	0.064	0.92	23.50	6.96	9.42	1010.0	7.38
S-7-D1	0.130	30.70	430.00	14.00	473.00	10300.0	7.43
S20-BG1	0.089	6.97	3.98	14.10	22.40	131.0	7.79
S21-BG2	<0.025	11.90	8.94	25.40	70.30	59.6	7.83

Table 2

Sediment Samples from Drum Creek near the National Zinc Site - Cherryvale, Kansas

Sample	Mercury (mg/Kg)	Arsenic (mg/Kg)	Cadmium (mg/Kg)	Chromium (mg/Kg)	Lead (mg/Kg)	Zinc (mg/Kg)	pH
S-15-D8	0.038	2.30	1.80	8.68	8.87	49.9	7.46
S-14-D7	0.052	1.81	1.70	8.20	16.00	81.2	7.06
S-14-D6	0.180	3.17	2.55	9.70	24.50	94.6	7.17
S-10-D2	0.086	7.16	4.63	13.90	20.60	78.8	6.40
S-11-D3	0.099	11.40	90.40	11.70	144.00	3680.0	7.16
S-12-D4	0.120	13.90	73.00	13.50	223.00	5950.0	7.50
S-13-D5	0.100	8.84	71.10	18.60	109.00	1520.0	7.36
S-16-D9	0.046	1.66	1.77	8.86	10.10	49.6	7.22
S-17-D10	0.051	18.50	14.30	11.60	48.20	517.0	7.03
S20-BG1	0.089	6.97	3.98	14.10	22.40	131.0	7.79
S21-BG2	<0.025	11.90	8.94	25.40	70.30	59.6	7.83

Table 3

Water Samples from Unnamed Creek near the National Zinc Site - Cherryvale, Kansas

Sample	Hardness (mg/L)	Mercury (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Zinc (mg/L)	Suspended Solids (mg/L)
W-1	1600	<0.000100	<0.00500	0.039	<0.0100	<0.00500	1.6300	10
W-2	910	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.7910	<5.00
W-17	470	0.0002	<0.00500	0.498	0.0365	0.585	35.9000	3780
W-3	280	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.6950	7
W-16	320	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.2860	18
W-6	300	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.3540	<5.00
W-5	310	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.2240	<5.00
W-4-D1	240	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.0322	10

Table 4

Water Samples from Drum Creek near the National Zinc Site - Cherryvale, Kansas

Sample	Hardness (mg/L)	Mercury (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Zinc (mg/L)	Suspended Solids (mg/L)
W-13-D8	220	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	<0.0100	79
W-12-D7	250	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	<0.0100	<5.00
W-11-D6	230	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	<0.0100	16
W-7-D2	240	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	<0.0100	7
W-8-D3	240	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	<0.0100	33
W-9-D4	230	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.1320	58
W-10-D5	240	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.0544	130
W-14-D9	250	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	<0.0100	60
W-15-D10	220	<0.000100	<0.00500	<0.00100	<0.0100	<0.00500	0.0204	189

Table 5

Unnamed Creek
Sediment Quantification

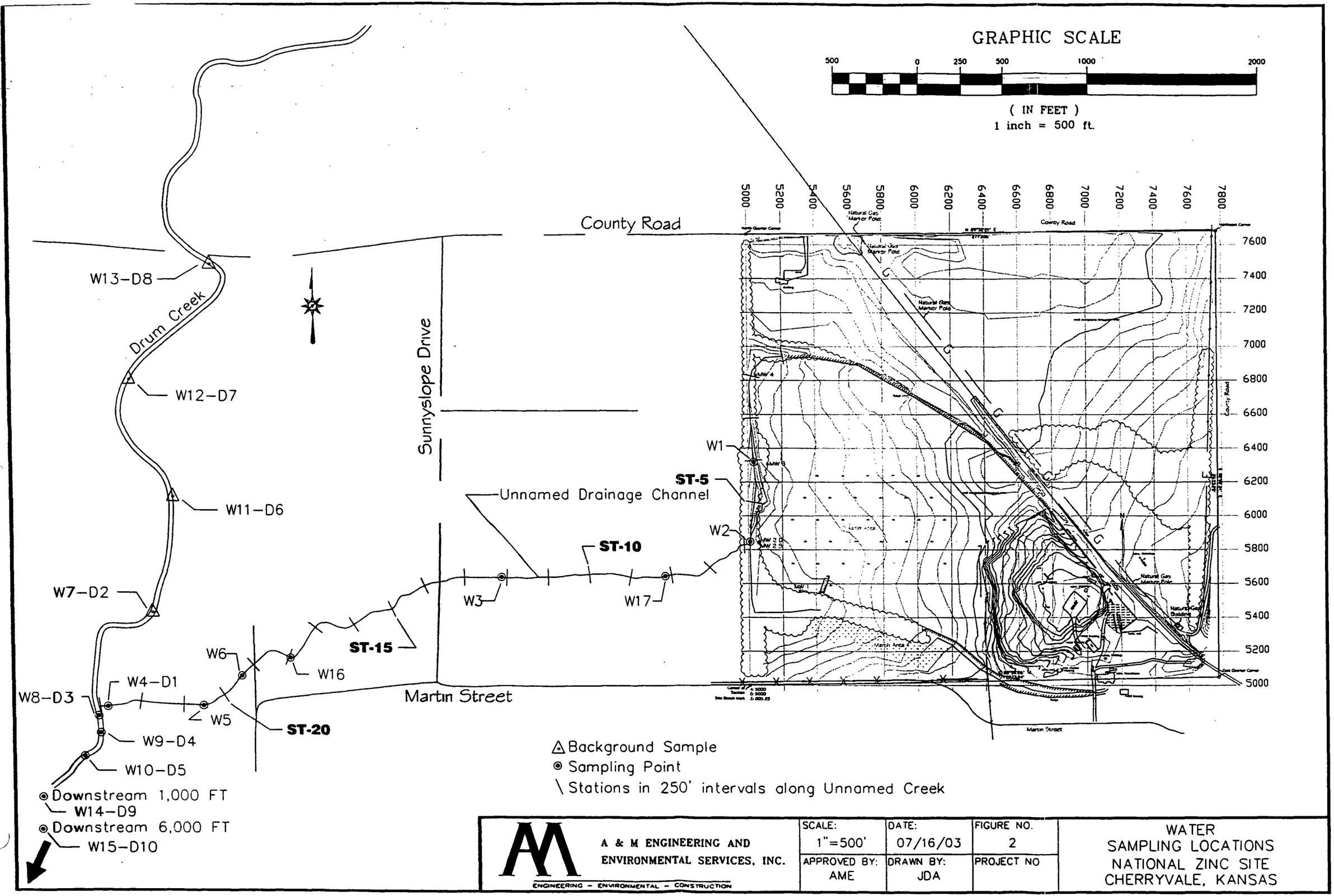
Station	Width (feet)	Depth (inches)	Length (feet)	Cubic Feet	Cubic Yards
1	14	4	250	1166.667	43.210
2	8	6	250	1000.000	37.037
3	14	12	250	3500.000	129.630
4	11	4	250	916.667	33.951
5	11	10	250	2291.667	84.876
6	6	8	250	1000.000	37.037
7	12	2	250	500.000	18.519
8	27	6	250	3375.000	125.000
9	14	10	250	2916.667	108.025
10	27	2	250	1125.000	41.667
11	40	6	250	5000.000	185.185
12	16	3	250	1000.000	37.037
13	20	4	250	1666.667	61.728
14	27	4	250	2250.000	83.333
15	27	6	250	3375.000	125.000
16	27	2	250	1125.000	41.667
17	19	16	250	6333.333	234.568
18	21	6	250	2625.000	97.222
19	19	8	250	3166.667	117.284
20	19	16	250	6333.333	234.568
21	16	16	250	5333.333	197.531
22	16	30	250	10000.000	370.370
Totals	411	181	5500	66000.000	2444.442

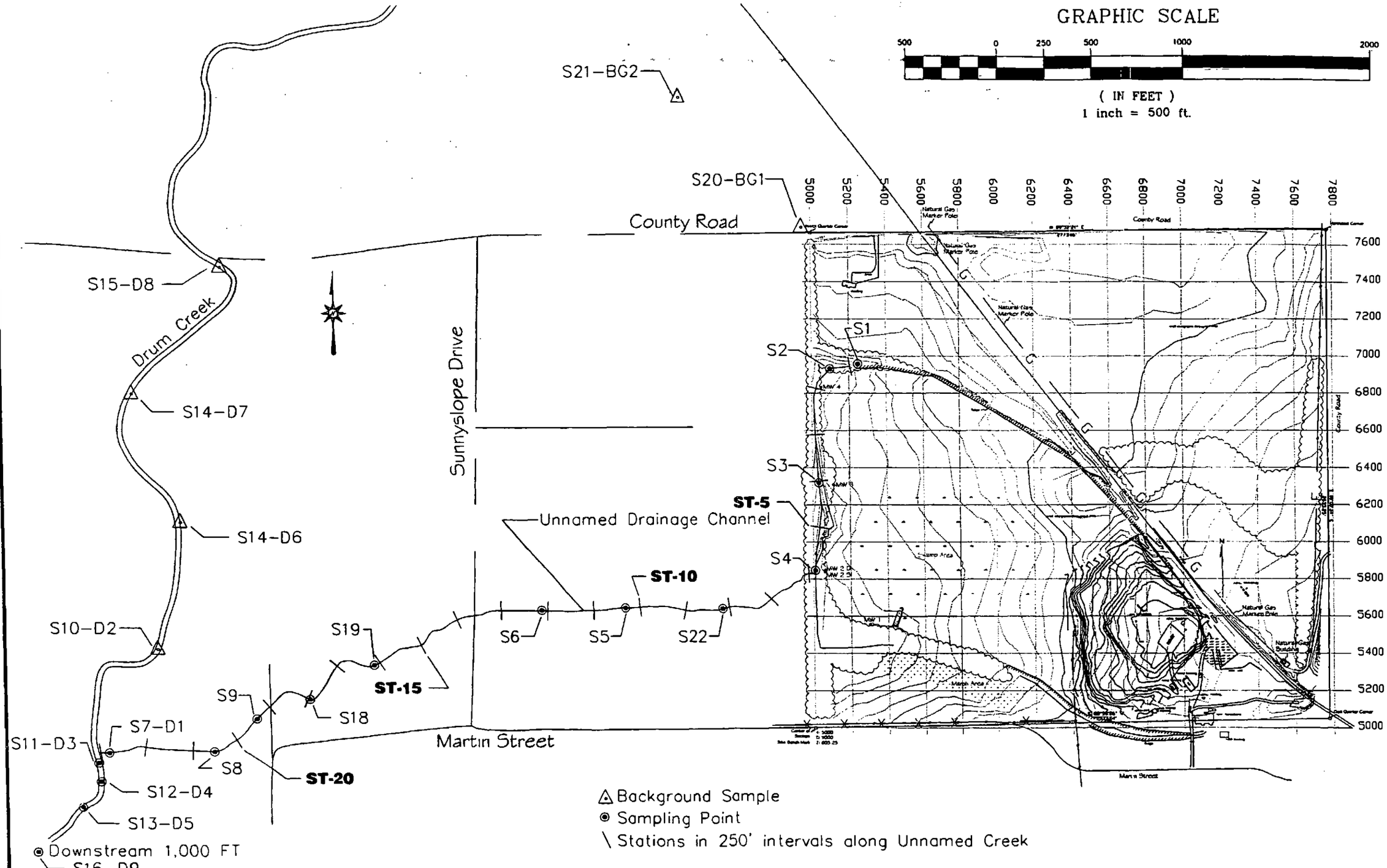
II. EPA Repository Sampling

Background Information:

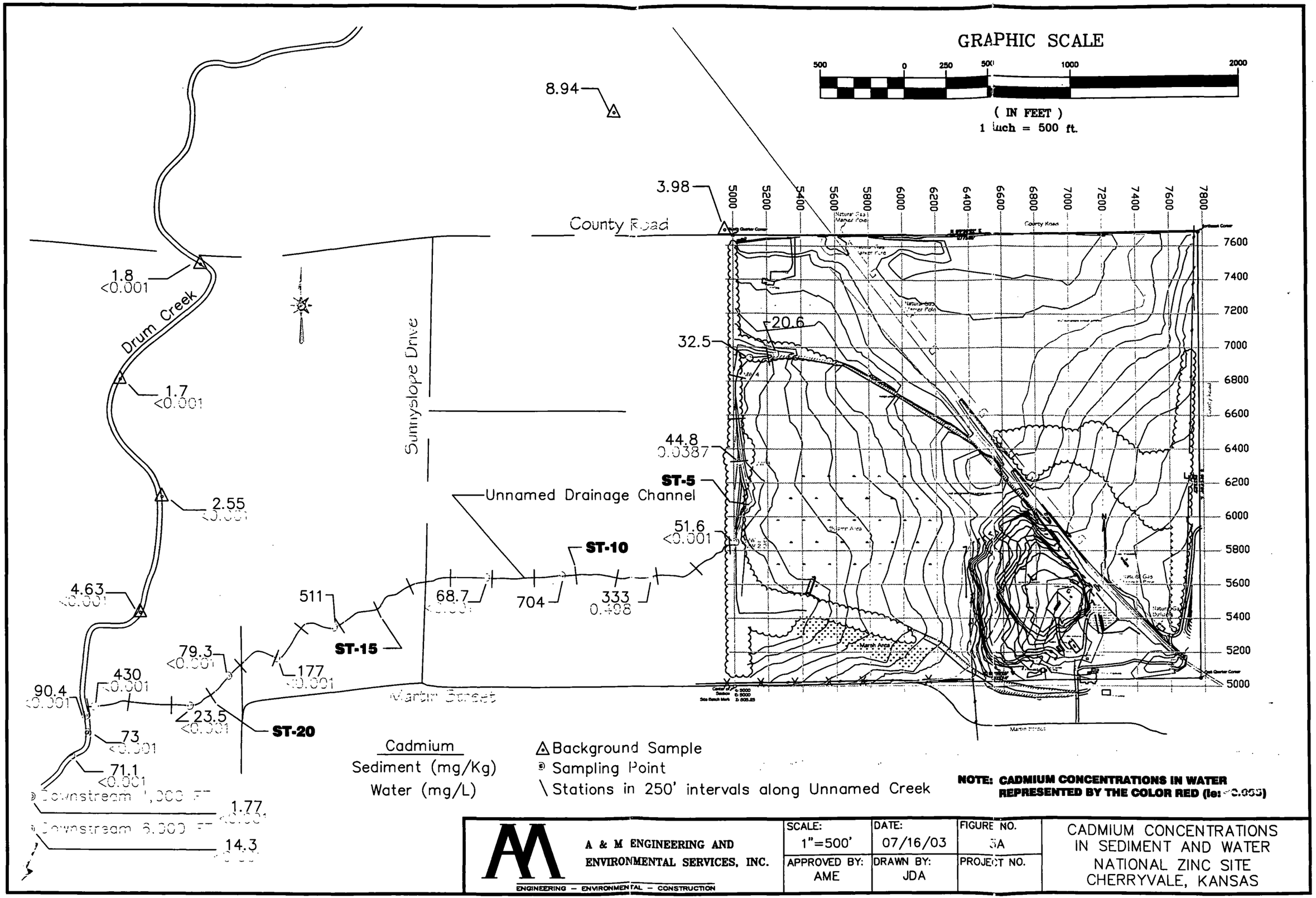
The EPA Repository area is the area where EPA placed the excavated contaminated soil from the residential areas. The purpose of sampling the EPA Repository area was to determine if the concentration levels in the repository area exceeded the non-residential area Risk-Based Standards for Kansas (RSK) and assess the need for placing a cap over this entire area. The collection and handling of the repository soil samples were conducted in accordance with the pre-approved and amended sampling plans of Kansas Department of Health and Environment (KDHE).

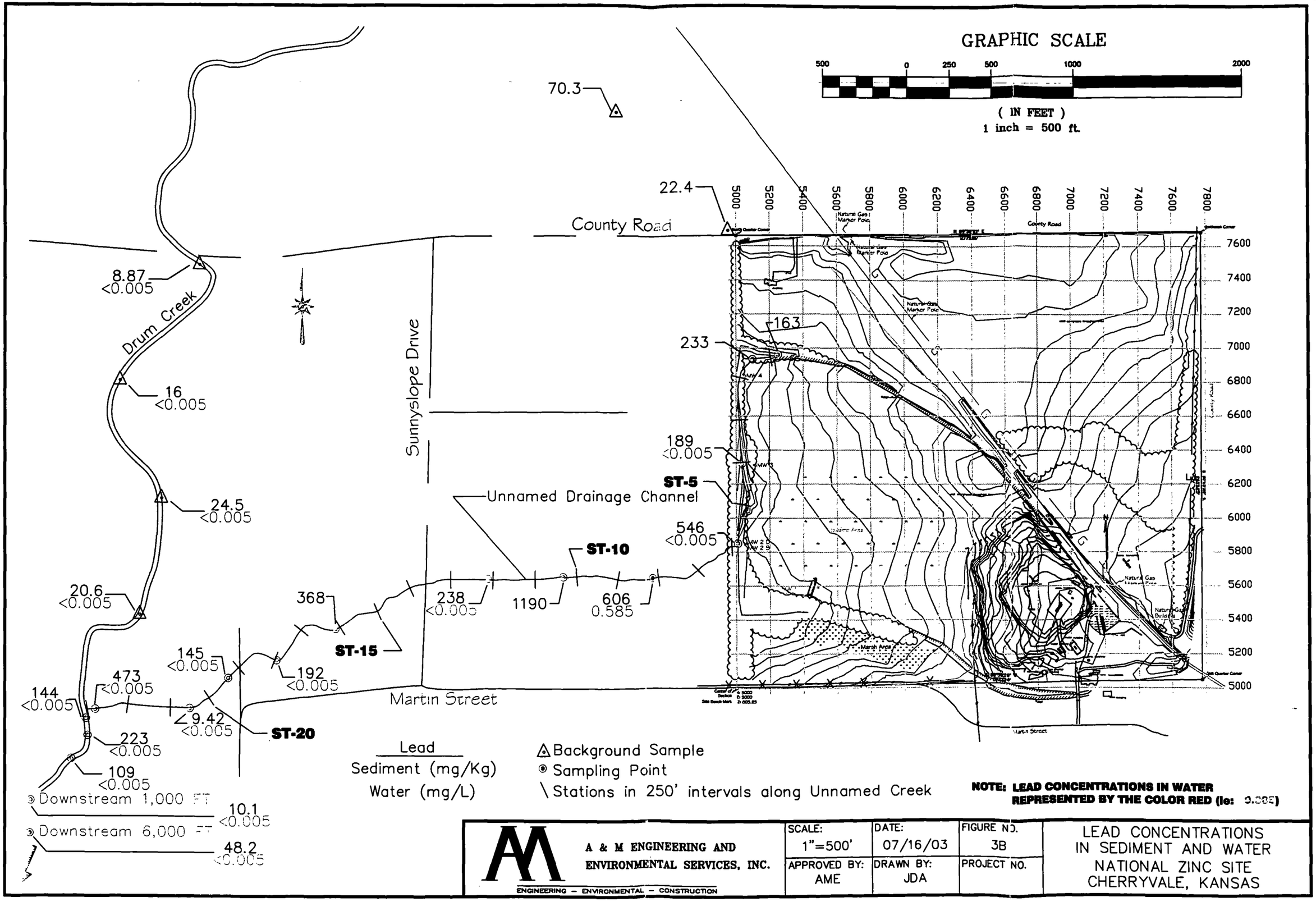
On May 15 and May 28, 2003 A & M Engineering collected soil samples on the EPA repository area. The samples were collected according to the grid map, see Figure 4. The samples were composited according to the sampling and amended sampling plan, and analyzed by Sherry Laboratories in Tulsa, Oklahoma for Total Lead, Arsenic and Cadmium. Sample points requiring a second composite sample, because of depth, are listed as A and B on the chain of custody for its respective grid number, Figure 5 shows the sampling points. There were no levels of Cadmium above the RSK, however one area described as sample point 18 exceeded the RSK for Arsenic and Lead. Table 6 summarizes the data for the analyzed parameters. Figure 6 shows the cross sectional view of the Repository Area. Appendix D presents the EPA Repository Laboratory Report.

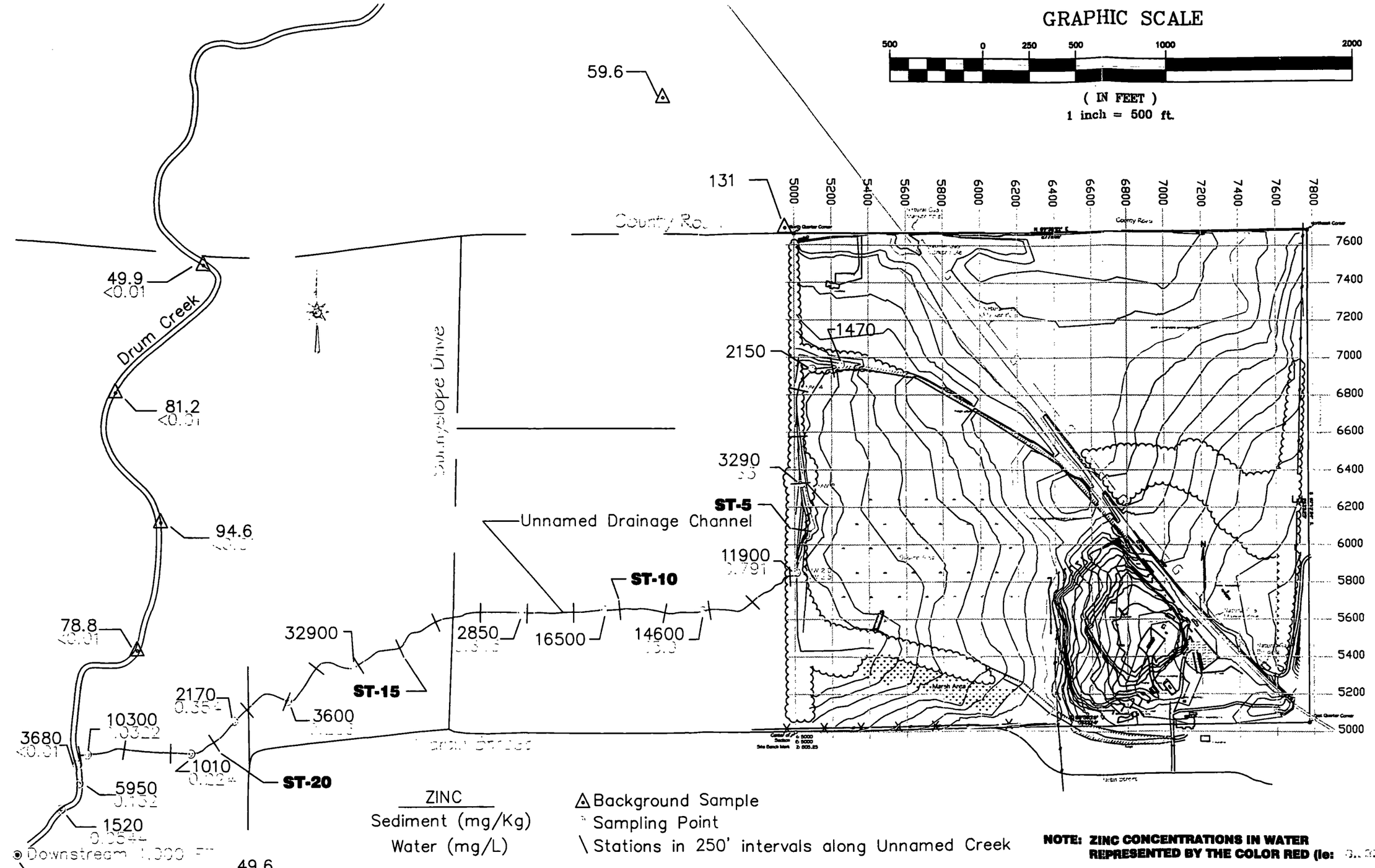

GRAPHIC SCALE
500 0 250 500 1000 2000
(IN FEET)
1 inch = 500 ft.
County Road
Sunnyslope Drive
Unnamed Drainage Channel
Martin Street
Drum Creek
W13-D8
W12-D7
W11-D6
W7-D2
W8-D3
W4-D1
W5
W6
W16
W9-D4
W10-D5
W14-D9
W15-D10
W1
W2
W3
W17
ST-5
ST-10
ST-15
ST-20
Downstream 1,000 FT
Downstream 6,000 FT
Background Sample
Sampling Point
Stations in 250' intervals along Unnamed Creek
A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
ENGINEERING - ENVIRONMENTAL - CONSTRUCTION
SCALE: 1"=500'
DATE: 07/16/03
FIGURE NO. 2
APPROVED BY: AME
DRAWN BY: JDA
PROJECT NO
WATER SAMPLING LOCATIONS
NATIONAL ZINC SITE
CHERRYVALE, KANSAS



A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.	SCALE: 1"=500'	DATE: 07/16/03	FIGURE NO. 1	SEDIMENT SAMPLING LOCATIONS NATIONAL ZINC SITE CHERRYVALE, KANSAS
ENGINEERING - ENVIRONMENTAL - CONSTRUCTION	APPROVED BY: AME	DRAWN BY: JDA	PROJECT NO.	


GRAPHIC SCALE
500 0 250 500 1000 2000
(IN FEET)
1 inch = 500 ft.
8.94
3.98
County Road
1.8
<0.001
Drum Creek
1.7
<0.001
Sunnyslope Drive
20.6
32.5
44.8
0.0387
ST-5
Unnamed Drainage Channel
51.6
<0.001
ST-10
2.55
4.63
511
68.7
704
333
0.498
ST-15
79.3
<0.001
177
<0.001
430
<0.001
90.4
<0.001
23.5
<0.001
ST-20
Martin Street
73
<0.001
71.1
<0.001
Downstream 1,000 FT
1.77
Downstream 6,000 FT
14.3
Cadmium
Sediment (mg/Kg)
Water (mg/L)
Background Sample
Sampling Point
Stations in 250' intervals along Unnamed Creek
NOTE: CADMIUM CONCENTRATIONS IN WATER REPRESENTED BY THE COLOR RED (le: <0.005)
A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
ENGINEERING – ENVIRONMENTAL – CONSTRUCTION
SCALE: 1"=500'
DATE: 07/16/03
FIGURE NO. 5A
APPROVED BY: AME
DRAWN BY: JDA
PROJECT NO.
CADMIUM CONCENTRATIONS IN SEDIMENT AND WATER
NATIONAL ZINC SITE
CHERRYVALE, KANSAS


GRAPHIC SCALE
500 0 250 500 1000 2000
(IN FEET)
1 inch = 500 ft.
70.3
22.4
County Road
8.87
<0.005
Drum Creek
16
<0.005
Sunnyslope Drive
163
233
189
<0.005
ST-5
Unnamed Drainage Channel
546
<0.005
ST-10
24.5
<0.005
20.6
<0.005
368
238
<0.005
1190
606
0.585
145
<0.005
ST-15
192
<0.005
473
<0.005
144
<0.005
9.42
<0.005
ST-20
Martin Street
223
<0.005
109
<0.005
Downstream 1,000 FT
10.1
<0.005
Downstream 6,000 FT
48.2
<0.005
Lead
Sediment (mg/Kg)
Water (mg/L)
Background Sample
Sampling Point
Stations in 250' intervals along Unnamed Creek
NOTE: LEAD CONCENTRATIONS IN WATER REPRESENTED BY THE COLOR RED (le: 0.005)
A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
ENGINEERING – ENVIRONMENTAL – CONSTRUCTION
SCALE: 1"=500'
DATE: 07/16/03
FIGURE NO. 3B
APPROVED BY: AME
DRAWN BY: JDA
PROJECT NO.
LEAD CONCENTRATIONS IN SEDIMENT AND WATER
NATIONAL ZINC SITE
CHERRYVALE, KANSAS

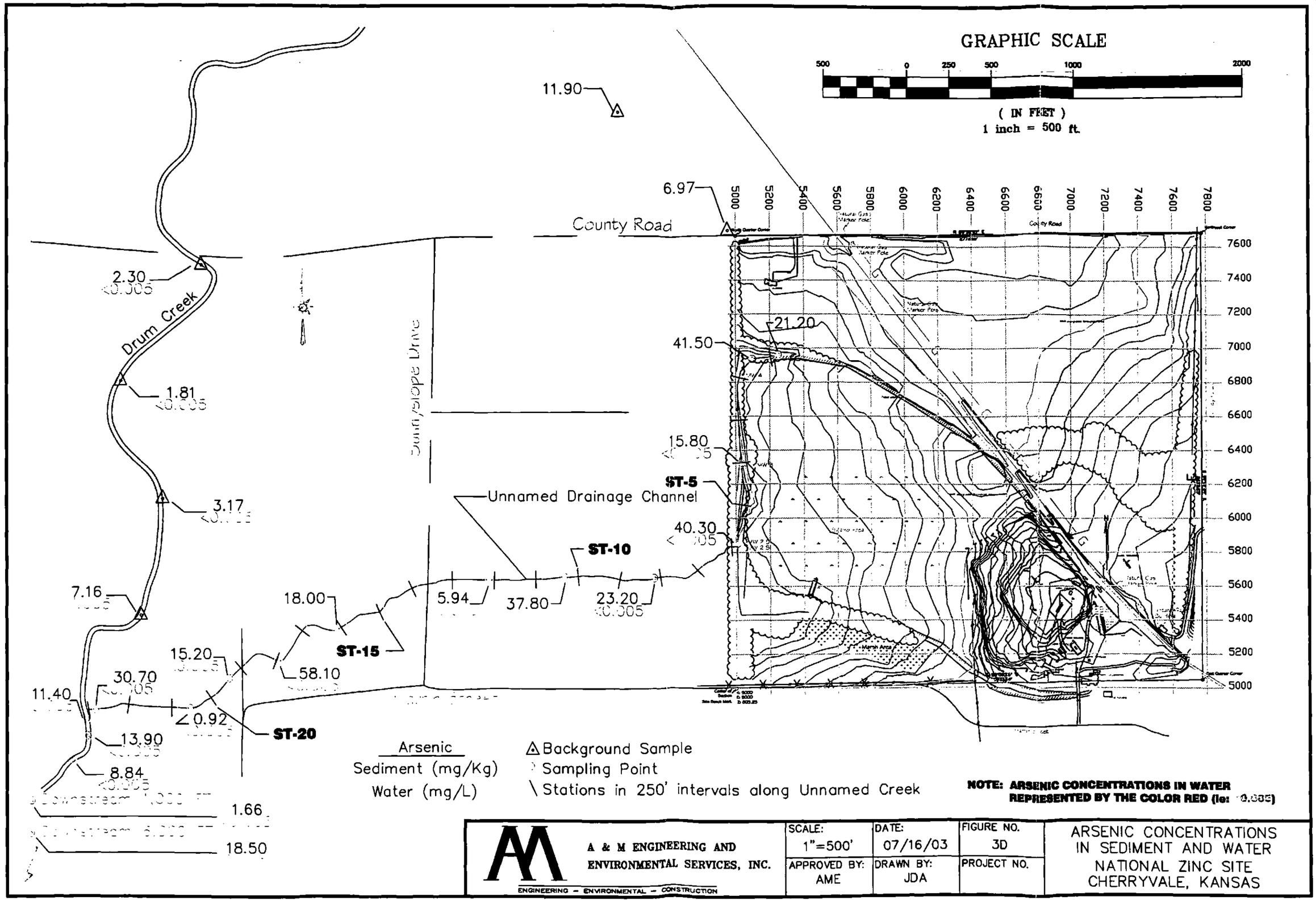


ZINC
Sediment (mg/Kg)
Water (mg/L)

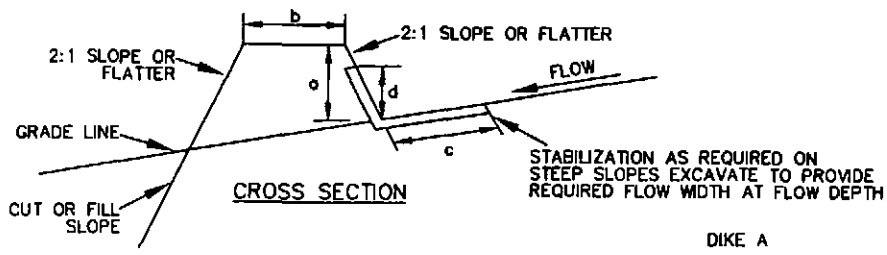
△ Background Sample
Sampling Point
\ Stations in 250' intervals along Unnamed Creek

NOTE: ZINC CONCENTRATIONS IN WATER REPRESENTED BY THE COLOR RED (ie: 0.[illegible])

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC. ENGINEERING – ENVIRONMENTAL – CONSTRUCTION	SCALE: 1"=500'	DATE: 07/16/03	FIGURE NO. 3C	ZINC CONCENTRATIONS IN SEDIMENT AND WATER NATIONAL ZINC SITE CHERRYVALE, KANSAS
	APPROVED BY: AME	DRAWN BY: JDA	PROJECT NO.	

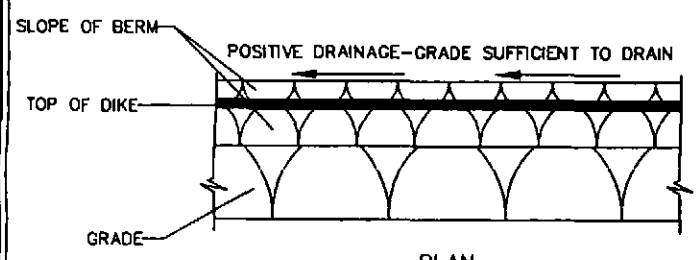

GRAPHIC SCALE
500 0 250 500 1000 2000
(IN FEET)
1 inch = 500 ft.
11.90
6.97
County Road
2.30
Drum Creek
1.81
3.17
7.16
11.40
13.90
8.84
1.66
18.50
30.70
15.20
0.92
ST-20
ST-15
18.00
58.10
5.94
37.80
23.20
ST-10
Unnamed Drainage Channel
40.30
ST-5
15.80
41.50
21.20
5000 5200 5400 5600 5800 6000 6200 6400 6600 6800 7000 7200 7400 7600 7800
7600 7400 7200 7000 6800 6600 6400 6200 6000 5800 5600 5400 5200 5000
Arsenic
Sediment (mg/Kg)
Water (mg/L)
Background Sample
Sampling Point
Stations in 250' intervals along Unnamed Creek
NOTE: ARSENIC CONCENTRATIONS IN WATER REPRESENTED BY THE COLOR RED (le: 0.005)
A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
ENGINEERING - ENVIRONMENTAL - CONSTRUCTION
SCALE: 1"=500'
DATE: 07/16/03
FIGURE NO. 3D
APPROVED BY: AME
DRAWN BY: JDA
PROJECT NO.
ARSENIC CONCENTRATIONS IN SEDIMENT AND WATER
NATIONAL ZINC SITE
CHERRYVALE, KANSAS

DETAIL–EARTH DIKE (DIVERSION DIKE)
NTS



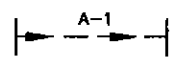
CROSS SECTION

DIKE A	
a–DIKE HEIGHT	24"
b–DIKE WIDTH	24"
c–FLOW WIDTH	2'
d–FLOW DEPTH	12"



PLAN

STANDARD SYMBOL



CONSTRUCTION SPECIFICATIONS

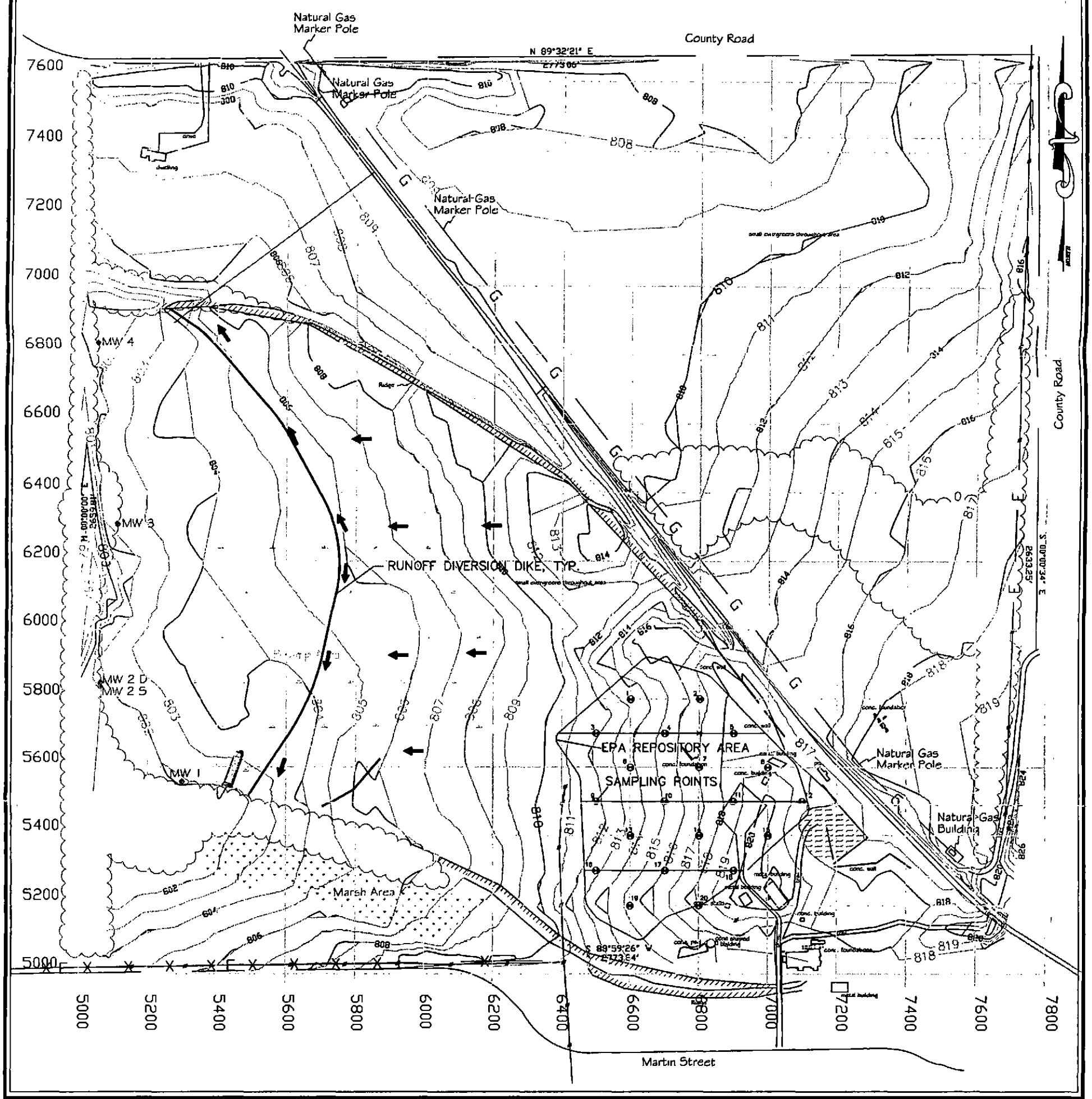
1. ALL DIKES SHALL BE COMPACTED BY EARTH–MOVING EQUIPMENT.
2. ALL DIKES SHALL HAVE POSITIVE DRAINAGE TO AN OUTLET.
3. TOP WIDTH MAY BE WIDER AND SIDE SLOPES MAY BE FLATTER IF DESIRED TO FACILITATE CROSSING BY CONSTRUCTION TRAFFIC.
4. FIELD LOCATION SHOULD BE ADJUSTED AS NEEDED TO UTILIZE A STABILIZED SAFE OUTLET.
5. EARTH DIKES SHALL HAVE AN OUTLET THAT FUNCTIONS WITH A MINIMUM OF EROSION.
6. FLOW CHANNEL STABILIZATION SHALL BE PER THE CHART BELOW:

FLOW CHANNEL STABILIZATION

TYPE OF TREATMENT	CHANNEL GRADE	DIKE A
1	0.5–3.0%	SEED AND STRAW MULCH
2	3.1–5.0%	SEED AND STRAW MULCH
3	5.1–8.0%	SEED WITH JUTE, OR SOD; 2" STONE
4	8.1–20%	LINED RIP–RAP 4–8"

A. STONE TO BE 2 INCH STONE, OR RECYCLED CONCRETE EQUIVALENT, IN A LAYER AT LEAST 3 INCHES IN THICKNESS AND BE PRESSED INTO THE SOIL WITH CONSTRUCTION EQUIPMENT.
B. RIP–RAP TO BE 4–8 INCHES IN A LAYER AT LEAST 8 INCHES THICKNESS AND PRESSED INTO THE SOIL.
C. APPROVED EQUIVALENTS CAN BE SUBSTITUTED FOR ANY OF THE ABOVE MATERIALS.

7. PERIODIC INSPECTION AND REQUIRED MAINTENANCE MUST BE PROVIDED AFTER EACH RAIN EVENT.



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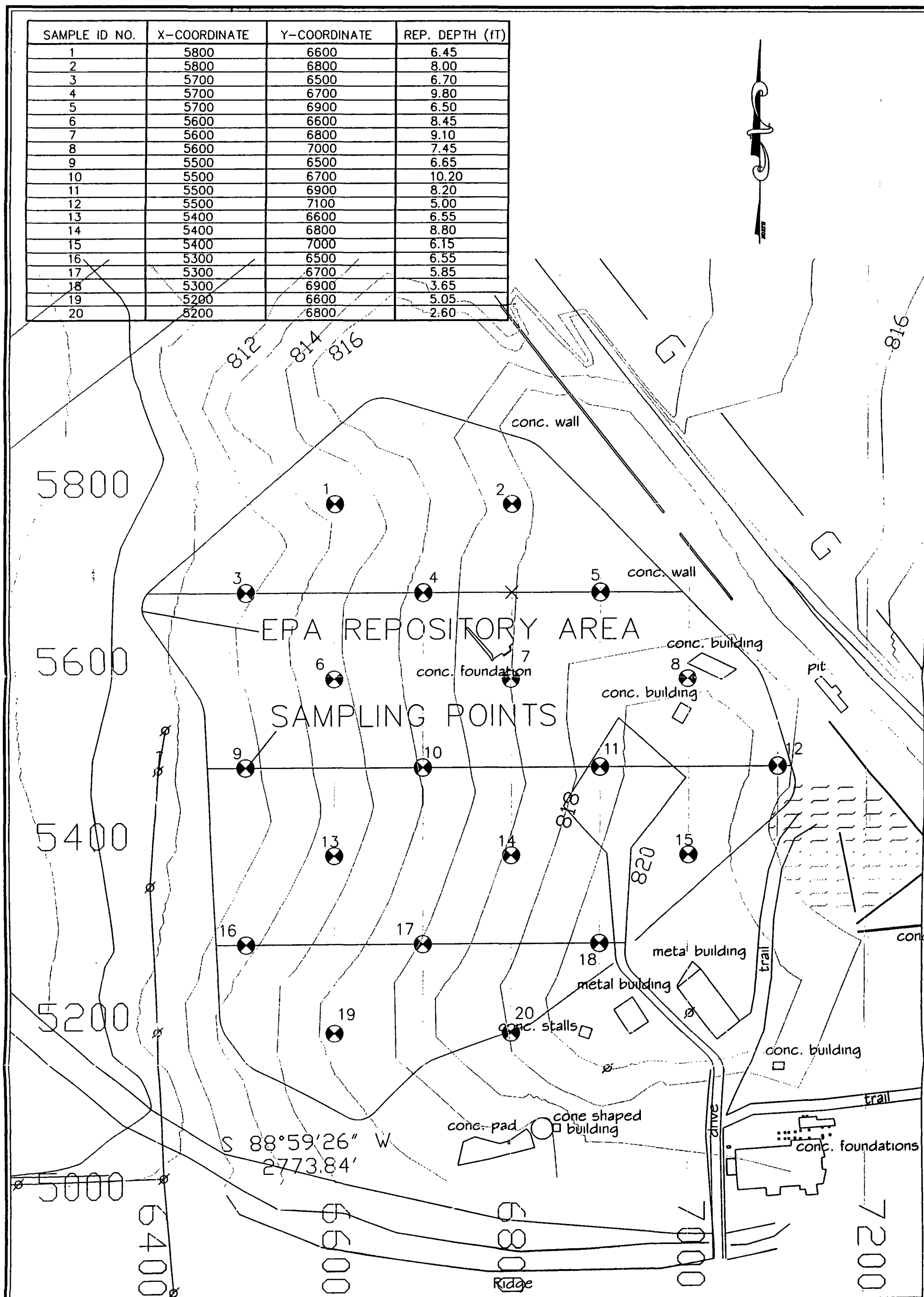
ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

EPA REPOSITORY AREA LOCATION
NATIONAL ZINC SITE, CHERRYVALE, KANSAS

SCALE:	DATE:	FIGURE NO.
1" = 300'	4–28–2003	4
APPROVED BY: AME	DRAWN BY: OME	PROJECT NO.

SAMPLE ID NO.	X-COORDINATE	Y-COORDINATE	REP. DEPTH (fT)
1	5800	6600	6.45
2	5800	6800	8.00
3	5700	6500	6.70
4	5700	6700	9.80
5	5700	6900	6.50
6	5600	6600	8.45
7	5600	6800	9.10
8	5600	7000	7.45
9	5500	6500	6.65
10	5500	6700	10.20
11	5500	6900	8.20
12	5500	7100	5.00
13	5400	6600	6.55
14	5400	6800	8.80
15	5400	7000	6.15
16	5300	6500	6.55
17	5300	6700	5.85
18	5300	6900	3.65
19	5200	6600	5.05
20	5200	6800	2.60



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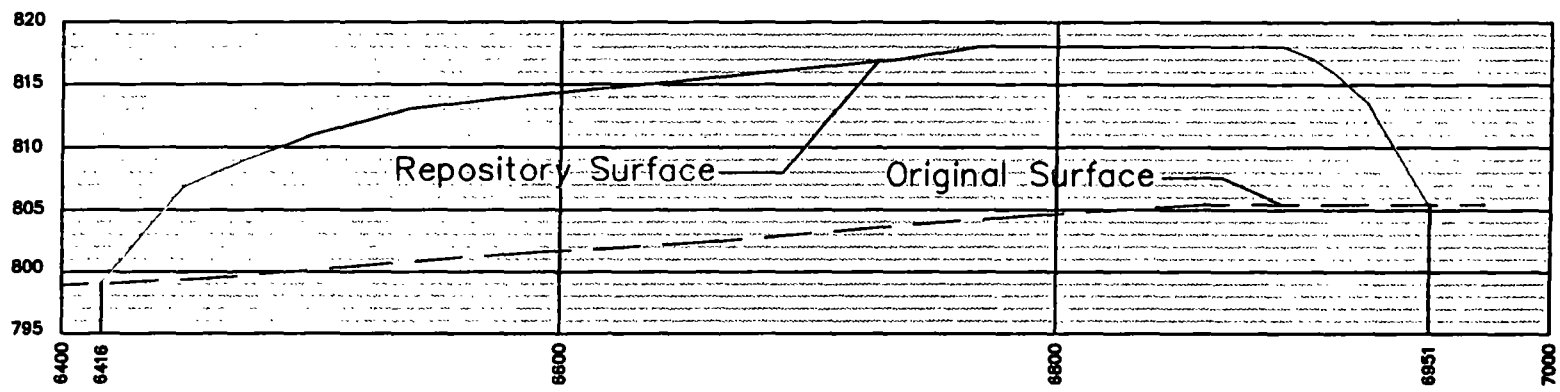
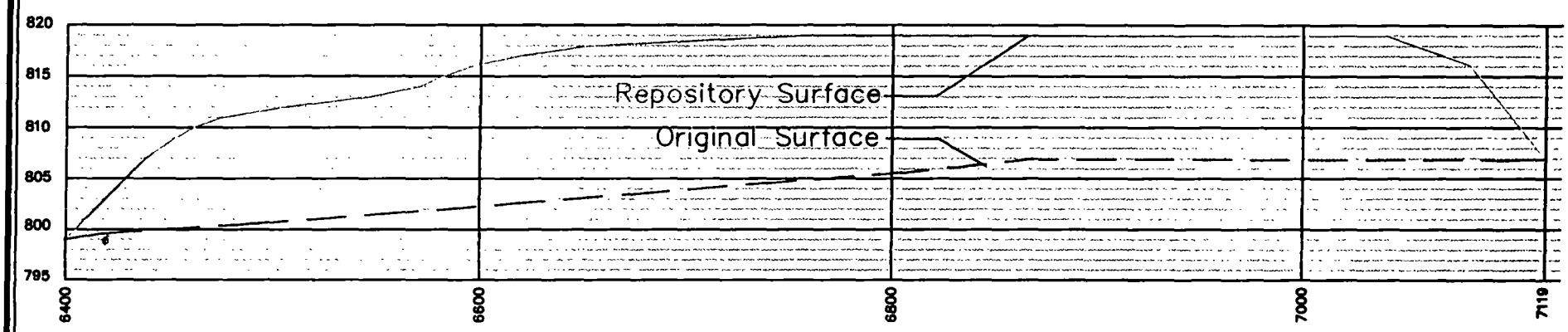
ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

EPA REPOSITORY AREA SAMPLING LOCATIONS
NATIONAL ZINC SITE, CHERRYVALE, KANSAS

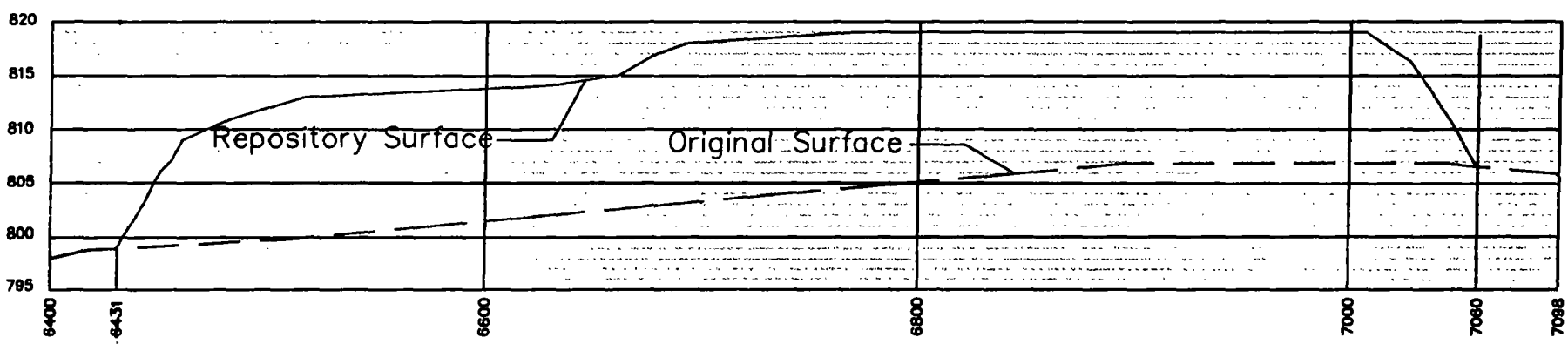
SCALE:	DATE:	FIGURE NO.
1" = 100'	4-28-2003	5
APPROVED BY: AME	DRAWN BY: OME	PROJECT NO.



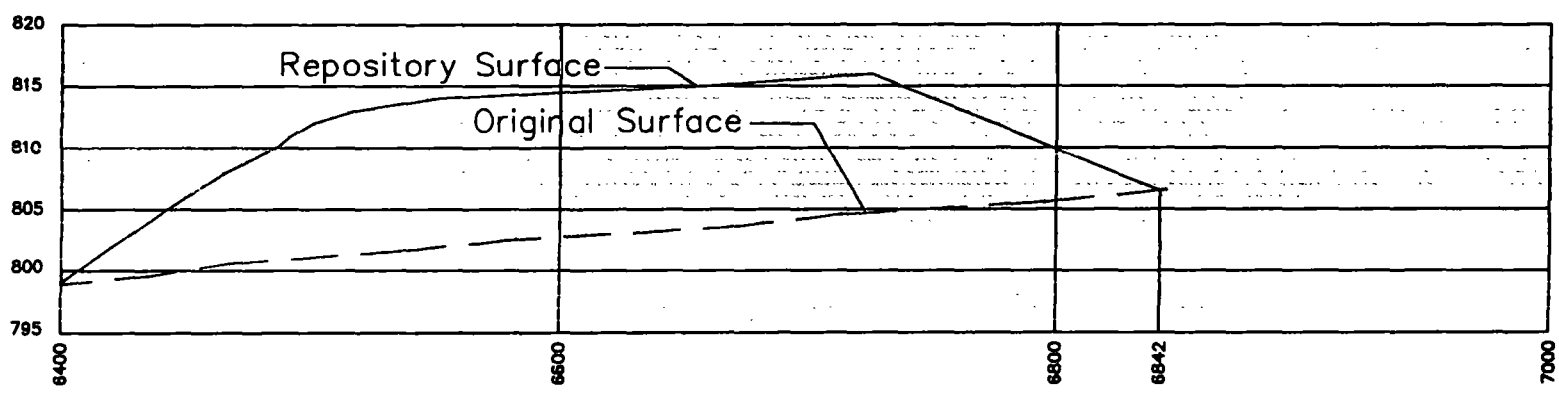
N 5800 CROSSECTION
scale as noted



N 5600 CROSSECTION
scale as noted



N 5400 CROSSECTION
scale as noted



N 5200 CROSSECTION
scale as noted

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ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

EPA REPOSITORY AREA CROSS SECTIONS
NATIONAL ZINC SITE, CHERRYVALE, KANSAS

SCALE:	DATE:	FIGURE NO.
AS NOTED	4-28-2003	6
APPROVED BY: AME	DRAWN BY: OME	PROJECT NO.

TABLE 6
EPA REPOSITORY SOIL SAMPLES
Parameters in mg/kg

National Zinc Site- Cherryvale, Kansas

Sampling Location	Arsenic	Cadmium	Lead
EPAR11A	3.53	6.42	95
EAPR15A	5.23	7.17	101
EPAR18A	41.3*	19.60	1050*
EPAR20A	9.19	15.8	529
EPAR19A	5.89	12.5	227
EPAR16A	6.1	12.7	226
EPAR09A	6.57	14.3	289
EPAR03A	4.14	12.7	270
EPAR01A	4.97	10.3	198
EPAR02A	3.75	5.89	108
EPARO5A	5.86	10.7	215
EPAR07A	5.33	11.7	414
EPAR10A	4.72	7.25	169
EPAR13A	5.76	4.18	49.8
EPAR06A	4.39	6.81	177
EPAR06B	9.82	22.3	569
EPAR04A	4.84	7.09	155
EPAR04B	7.2	9.84	210
EPAR08A	5.4	10.3	221
EPAR08B	5.15	35.2	160
EPAR012A	5.65	11.4	241
EPAR017A	12.7	35.3	707
EPAR014A	8.17	18.8	575
EPAR014BEB	7.11	17.4	243
EB (Equipment	<DL	<DL	<DL

*** Denotes sample locations that exceed RSK for indusrial area**

APPENDIX A
(Analyzed Parameters for Cadmium,
Arsenic, Zinc and Lead)
Note: Figures 3A-3D

APPENDIX B

(Sediment and Surface Water Analytical Data
for Unnamed and Drum Creeks)

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(800)324-5757

Altay Ertugrul
A & M Engineering
10010 E. 16th St.
Tulsa, OK 74128-4813
TEL: (918) 665-6574
FAX ( ) 665-6576

July 09, 2003
Order No.: T03060331

RE: Cherryvale

Dear Altay Ertugrul:

Sherry Laboratories received 23 samples on 6/27/03 for the analyses presented in the following report.

In accordance with your instructions, Sherry Laboratories/Oklahoma conducted the analysis shown on the following pages on samples submitted by your company. The results related only to the items tested. Unless otherwise noted, all analysis was conducted using EPA approved methodologies. All relevant sampling information is on the attached chain-of-custody form. The initials SUB as the analyst designate any testing sub-contracted by SLO.

Certifications/Accreditation: OK - 7604
AR - ADEQ
KS - E-10232
LA - 4002

A scope of Certified/Accredited parameters is available upon request.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Tom Gilroy

Approved By:

Brian Duzan, Director
Environmental Services

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QA/QC REPORT
A&M Eng.
SAMPLE # T03060331
BATCH QC

PARAMETERS	LFB	MS % REC.	MSD % REC.	RPD
Total Arsenic	97	99	121	20.1
Total Cadmium	101	88	89	2.0
Total Chromium	101	99	97	2.1
Total Mercury	112	128	130	1.4

Approved by:
SHERRY LABORATORIES/OKLAHOMA

Brian Duzan
Laboratory Director

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CLIENT: A & M Engineering
Lab Order: T03060331 **Date Received:** 6/27/03
Project: Cherryvale **Date Reported:** *09-Jul-03*

Lab ID: T03060331-01 Collection Date: 6/24/03 10:15:00 AM Sample ID: CVKS-1

Matrix SOIL

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		SW7471				KR
Mercury	0.059		0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP		SW6010A				KR
Arsenic	21.2		0.500	mg/Kg	7/1/03	
Cadmium	20.6		0.250	mg/Kg	7/1/03	
Chromium	11.2		0.250	mg/Kg	7/1/03	
Lead	163		0.125	mg/Kg	7/1/03	
Zinc	1,470		2.20	mg/Kg	7/1/03	
PH IN SOIL		SW9040				SN
pH	6.90		0.10	pH Units	7/8/03 2:52:00 PM	

Lab ID: T03060331-02 Collection Date: 6/24/03 11:00:00 AM Sample ID: CVKS-2

Matrix SOIL

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		SW7471				KR
Mercury	0.070		0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP		SW6010A				KR
Arsenic	41.5		0.500	mg/Kg	7/1/03	
Cadmium	32.5		0.250	mg/Kg	7/1/03	
Chromium	11.3		0.250	mg/Kg	7/1/03	
Lead	233		1.20	mg/Kg	7/1/03	
Zinc	2,150		21.0	mg/Kg	7/1/03	
PH IN SOIL		SW9040				SN
pH	6.81		0.10	pH Units	7/8/03 2:52:00 PM	

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CLIENT: A & M Engineering
Lab Order: T03060331 **Date Received:** 6/27/03
Project: Cherryvale **Date Reported:** *09-Jul-03*

Lab ID: T03060331-03 Collection Date: 6/24/03 12:00:00 PM Sample ID: CVKS-3

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE	SW7471				KR
Mercury	0.086	0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				KR
Arsenic	15.8	0.500	mg/Kg	7/1/03	
Cadmium	44.8	0.250	mg/Kg	7/1/03	
Chromium	11.0	0.250	mg/Kg	7/1/03	
Lead	189	0.125	mg/Kg	7/1/03	
Zinc	3,290	25.0	mg/Kg	7/1/03	
PH IN SOIL	SW9040				SN
pH	7.45	0.10	pH Units	7/8/03 2:52:00 PM	

Lab ID: T03060331-04 Collection Date: 6/24/03 12:20:00 PM Sample ID: CVKS-4

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE	SW7471				KR
Mercury	0.24	0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				KR
Arsenic	40.3	0.500	mg/Kg	7/1/03	
Cadmium	51.6	0.250	mg/Kg	7/1/03	
Chromium	12.8	0.250	mg/Kg	7/1/03	
Lead	546	1.00	mg/Kg	7/1/03	
Zinc	11,900	21.0	mg/Kg	7/1/03	
PH IN SOIL	SW9040				SN
pH	7.22	0.10	pH Units	7/8/03 2:52:00 PM	

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CLIENT: A & M Engineering
Lab Order: T03060331 **Date Received:** 6/27/03
Project: Cherryvale **Date Reported:** *09-Jul-03*

Lab ID: T03060331-05 Collection Date: 6/24/03 1:35:00 PM Sample ID: CVKS-5

Matrix SOIL

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		SW7471				KR
Mercury	0.56		0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP		SW6010A				KR
Arsenic	37.8		0.500	mg/Kg	7/1/03	
Cadmium	704		1.90	mg/Kg	7/1/03	
Chromium	19.0		0.250	mg/Kg	7/1/03	
Lead	1,190		1.00	mg/Kg	7/1/03	
Zinc	16,500		19.0	mg/Kg	7/1/03	
PH IN SOIL		SW9040				SN
pH	7.47		0.10	pH Units	7/8/03 2:52:00 PM	

Lab ID: T03060331-06 Collection Date: 6/24/03 3:00:00 PM Sample ID: CVKS-6

Matrix SOIL

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		SW7471				KR
Mercury	0.17		0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP		SW6010A				KR
Arsenic	5.94		0.500	mg/Kg	7/1/03	
Cadmium	68.7		0.250	mg/Kg	7/1/03	
Chromium	7.68		0.250	mg/Kg	7/1/03	
Lead	238		0.125	mg/Kg	7/1/03	
Zinc	2,850		22.0	mg/Kg	7/1/03	
PH IN SOIL		SW9040				SN
pH	7.45		0.10	pH Units	7/8/03 2:52:00 PM	

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CLIENT: A & M Engineering
Lab Order: T03060331 **Date Received:** 6/27/03
Project: Cherryvale **Date Reported:** *09-Jul-03*

Lab ID: T03060331-07 Collection Date: 6/25/03 11:00:00 AM Sample ID: CVKS-7-D-1

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		**SW7471**			**KR**
Mercury	0.13	0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP		**SW6010A**			**KR**
Arsenic	30.7	0.500	mg/Kg	7/1/03	
Cadmium	430	2.30	mg/Kg	7/1/03	
Chromium	14.0	0.250	mg/Kg	7/1/03	
Lead	473	1.20	mg/Kg	7/1/03	
Zinc	10,300	23.0	mg/Kg	7/1/03	
PH IN SOIL		**SW9040**			**SN**
pH	7.43	0.10	pH Units	7/8/03 2:52:00 PM	

Lab ID: T03060331-08 Collection Date: 6/25/03 11:15:00 AM Sample ID: CVKS-8

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		**SW7471**			**KR**
Mercury	0.064	0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP		**SW6010A**			**KR**
Arsenic	0.924	0.500	mg/Kg	7/1/03	
Cadmium	23.5	0.250	mg/Kg	7/1/03	
Chromium	6.96	0.250	mg/Kg	7/1/03	
Lead	9.42	0.125	mg/Kg	7/1/03	
Zinc	1,010	2.50	mg/Kg	7/1/03	
PH IN SOIL		**SW9040**			**SN**
pH	7.38	0.10	pH Units	7/8/03 2:52:00 PM	

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CLIENT: A & M Engineering
Lab Order: T03060331 **Date Received:** 6/27/03
Project: Cherryvale **Date Reported:** *09-Jul-03*

Lab ID: T03060331-09 Collection Date: 6/25/03 11:40:00 AM Sample ID: CVKS-9

Matrix SOIL

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		SW7471				KR
Mercury	0.16		0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP		SW6010A				KR
Arsenic	15.2		0.500	mg/Kg	7/1/03	
Cadmium	79.3		0.250	mg/Kg	7/1/03	
Chromium	13.2		0.250	mg/Kg	7/1/03	
Lead	145		0.125	mg/Kg	7/1/03	
Zinc	2,170		21.0	mg/Kg	7/1/03	
PH IN SOIL		SW9040				SN
pH	7.48		0.10	pH Units	7/8/03 2:52:00 PM	

Lab ID: T03060331-10 Collection Date: 6/25/03 12:30:00 PM Sample ID: CVKS-10-D-2

Matrix SOIL

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		SW7471				KR
Mercury	0.086		0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP		SW6010A				KR
Arsenic	7.16		0.500	mg/Kg	7/1/03	
Cadmium	4.63		0.250	mg/Kg	7/1/03	
Chromium	13.9		0.250	mg/Kg	7/1/03	
Lead	20.6		0.125	mg/Kg	7/1/03	
Zinc	78.8		0.250	mg/Kg	7/1/03	
PH IN SOIL		SW9040				SN
pH	6.40		0.10	pH Units	7/8/03 2:52:00 PM	

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CLIENT: A & M Engineering
Lab Order: T03060331 **Date Received:** 6/27/03
Project: Cherryvale **Date Reported:** *09-Jul-03*

Lab ID: T03060331-11 Collection Date: 6/25/03 1:30:00 PM Sample ID: CVKS-11-D-3

Matrix SOIL

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		SW7471				KR
Mercury	0.099		0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP		SW6010A				KR
Arsenic	11.4		0.500	mg/Kg	7/1/03	
Cadmium	90.4		0.250	mg/Kg	7/1/03	
Chromium	11.7		0.250	mg/Kg	7/1/03	
Lead	144		0.125	mg/Kg	7/1/03	
Zinc	3,680		24.0	mg/Kg	7/1/03	
PH IN SOIL		SW9040				SN
pH	7.16		0.10	pH Units	7/8/03 2:52:00 PM	

Lab ID: T03060331-12 Collection Date: 6/25/03 1:50:00 PM Sample ID: CVKS-12-D-4

Matrix SOIL

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		SW7471				KR
Mercury	0.12		0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP		SW6010A				KR
Arsenic	13.9		0.500	mg/Kg	7/1/03	
Cadmium	73.0		0.250	mg/Kg	7/1/03	
Chromium	13.5		0.250	mg/Kg	7/1/03	
Lead	223		0.950	mg/Kg	7/1/03	
Zinc	5,950		19.0	mg/Kg	7/1/03	
PH IN SOIL		SW9040				SN
pH	7.50		0.10	pH Units	7/8/03 2:52:00 PM	

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(800)324-5757

CLIENT: A & M Engineering
Lab Order: T03060331 **Date Received:** 6/27/03
Project: Cherryvale **Date Reported:** *09-Jul-03*

Lab ID: T03060331-13 Collection Date: 6/25/03 2:10:00 PM Sample ID: CVKS-13-D-5

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE	SW7471				KR
Mercury	0.10	0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				KR
Arsenic	8.84	0.500	mg/Kg	7/1/03	
Cadmium	71.1	0.250	mg/Kg	7/1/03	
Chromium	18.6	0.250	mg/Kg	7/1/03	
Lead	109	0.125	mg/Kg	7/1/03	
Zinc	1,520	2.00	mg/Kg	7/1/03	
PH IN SOIL	SW9040				SN
pH	7.36	0.10	pH Units	7/8/03 2:52:00 PM	

Lab ID: T03060331-14 Collection Date: 6/25/03 2:40:00 PM Sample ID: CVKS-14-D-6

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE	SW7471				KR
Mercury	0.18	0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				KR
Arsenic	3.17	0.500	mg/Kg	7/1/03	
Cadmium	2.55	0.250	mg/Kg	7/1/03	
Chromium	9.70	0.250	mg/Kg	7/1/03	
Lead	24.5	0.125	mg/Kg	7/1/03	
Zinc	94.6	0.250	mg/Kg	7/1/03	
PH IN SOIL	SW9040				SN
pH	7.17	0.10	pH Units	7/8/03 2:52:00 PM	

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CLIENT: A & M Engineering
Lab Order: T03060331 **Date Received:** 6/27/03
Project: Cherryvale **Date Reported:** *09-Jul-03*

Lab ID: T03060331-15 Collection Date: 6/25/03 3:30:00 PM Sample ID: CVKS-14-D-7

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE	**SW7471**				**KR**
Mercury	0.052	0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP	**SW6010A**				**KR**
Arsenic	1.81	0.500	mg/Kg	7/1/03	
Cadmium	1.70	0.250	mg/Kg	7/1/03	
Chromium	8.20	0.250	mg/Kg	7/1/03	
Lead	16.0	0.125	mg/Kg	7/1/03	
Zinc	81.2	0.250	mg/Kg	7/1/03	
PH IN SOIL	**SW9040**				**SN**
pH	7.06	0.10	pH Units	7/8/03 2:52:00 PM	

Lab ID: T03060331-16 Collection Date: 6/25/03 3:50:00 PM Sample ID: CVKS-15-D-8

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE	**SW7471**				**KR**
Mercury	0.038	0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP	**SW6010A**				**KR**
Arsenic	2.30	0.500	mg/Kg	7/1/03	
Cadmium	1.80	0.250	mg/Kg	7/1/03	
Chromium	8.68	0.250	mg/Kg	7/1/03	
Lead	8.87	0.125	mg/Kg	7/1/03	
Zinc	49.9	0.250	mg/Kg	7/1/03	
PH IN SOIL	**SW9040**				**SN**
pH	7.46	0.10	pH Units	7/8/03 2:52:00 PM	

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CLIENT: A & M Engineering
Lab Order: T03060331 **Date Received:** 6/27/03
Project: Cherryvale **Date Reported:** *09-Jul-03*

Lab ID: T03060331-17 Collection Date: 6/25/03 4:15:00 PM Sample ID: CVKS-16-D-9

Matrix SOIL

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		SW7471				KR
Mercury	0.046		0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP		SW6010A				KR
Arsenic	1.66		0.500	mg/Kg	7/1/03	
Cadmium	1.77		0.250	mg/Kg	7/1/03	
Chromium	8.86		0.250	mg/Kg	7/1/03	
Lead	10.1		0.125	mg/Kg	7/1/03	
Zinc	49.6		0.250	mg/Kg	7/1/03	
PH IN SOIL		SW9040				SN
pH	7.22		0.10	pH Units	7/8/03 2:52:00 PM	

Lab ID: T03060331-18 Collection Date: 6/25/03 4:40:00 PM Sample ID: CVKS-17-D-10

Matrix SOIL

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		SW7471				KR
Mercury	0.051		0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP		SW6010A				KR
Arsenic	18.5		0.500	mg/Kg	7/1/03	
Cadmium	14.3		0.250	mg/Kg	7/1/03	
Chromium	11.6		0.250	mg/Kg	7/1/03	
Lead	48.2		0.125	mg/Kg	7/1/03	
Zinc	517		2.30	mg/Kg	7/1/03	
PH IN SOIL		SW9040				SN
pH	7.03		0.10	pH Units	7/8/03 2:52:00 PM	

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CLIENT: A & M Engineering
Lab Order: T03060331 **Date Received:** 6/27/03
Project: Cherryvale **Date Reported:** *09-Jul-03*

Lab ID: T03060331-19 Collection Date: 6/25/03 5:00:00 PM Sample ID: CVKS-18

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE	SW7471				KR
Mercury	0.088	0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				KR
Arsenic	58.1	0.500	mg/Kg	7/1/03	
Cadmium	177	1.80	mg/Kg	7/1/03	
Chromium	9.49	0.250	mg/Kg	7/1/03	
Lead	192	0.900	mg/Kg	7/1/03	
Zinc	3,600	18.0	mg/Kg	7/1/03	
PH IN SOIL	SW9040				SN
pH	7.38	0.10	pH Units	7/8/03 2:52:00 PM	

Lab ID: T03060331-20 Collection Date: 6/25/03 5:20:00 PM Sample ID: CVKS-19

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE	SW7471				KR
Mercury	*0.046	0.025	mg/Kg	7/3/03	
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				KR
Arsenic	18.0	0.500	mg/Kg	7/1/03	
Cadmium	511	2.00	mg/Kg	7/1/03	
Chromium	15.6	0.250	mg/Kg	7/1/03	
Lead	368	1.00	mg/Kg	7/1/03	
Zinc	32,900	200	mg/Kg	7/1/03	
PH IN SOIL	SW9040				SN
pH	7.70	0.10	pH Units	7/8/03 2:52:00 PM	

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CLIENT: A & M Engineering
Lab Order: T03060331 **Date Received:** 6/27/03
Project: Cherryvale **Date Reported:** *09-Jul-03*

Lab ID: T03060331-21 Collection Date: 6/26/03 11:30:00 AM Sample ID: CVKS020-BG-1

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE	**SW7471**				**KR**
Mercury	0.089	0.025	mg/Kg	6/30/03	
METALS IN SOIL OR SLUDGE BY ICP	**SW6010A**				**KR**
Arsenic	6.97	0.500	mg/Kg	7/1/03	
Cadmium	3.98	0.250	mg/Kg	7/1/03	
Chromium	14.1	0.250	mg/Kg	7/1/03	
Lead	22.4	0.125	mg/Kg	7/1/03	
Zinc	131	0.250	mg/Kg	7/1/03	
PH IN SOIL	**SW9040**				**SN**
pH	7.79	0.10	pH Units	7/8/03 2:52:00 PM	

Lab ID: T03060331-22 Collection Date: 6/26/03 11:45:00 AM Sample ID: CVKS021-BG-2

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE	**SW7471**				**KR**
Mercury	*<0.025	0.025	mg/Kg	7/3/03	
METALS IN SOIL OR SLUDGE BY ICP	**SW6010A**				**KR**
Arsenic	11.9	0.500	mg/Kg	7/1/03	
Cadmium	8.94	0.250	mg/Kg	7/1/03	
Chromium	25.4	0.250	mg/Kg	7/1/03	
Lead	70.3	0.125	mg/Kg	7/1/03	
Zinc	59.6	0.250	mg/Kg	7/1/03	
PH IN SOIL	**SW9040**				**SN**
pH	7.83	0.10	pH Units	7/8/03 2:52:00 PM	

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CLIENT: A & M Engineering
Lab Order: T03060331 **Date Received:** 6/27/03
Project: Cherryvale **Date Reported:** *09-Jul-03*

Lab ID: T03060331-23 Collection Date: 6/26/03 12:30:00 PM Sample ID: CVKS-22

Matrix SOIL

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		**SW7471**				**KR**
Mercury	*0.098		0.025	mg/Kg	7/3/03	
METALS IN SOIL OR SLUDGE BY ICP		**SW6010A**				**KR**
Arsenic	23.2		0.500	mg/Kg	7/1/03	
Cadmium	333		2.40	mg/Kg	7/1/03	
Chromium	17.4		0.250	mg/Kg	7/1/03	
Lead	606		1.20	mg/Kg	7/1/03	
Zinc	14,600		24.0	mg/Kg	7/1/03	
PH IN SOIL		**SW9040**				**SN**
pH	7.67		0.10	pH Units	7/8/03 2:52:00 PM	

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T03060331

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

TULSA, OKLAHOMA
ENGINEERING - ENVIRONMENTAL - CONSTRUCTION
10010 E. 16th Street - TULSA, OKLAHOMA 74128-4813
TEL: (918)665-6575 FAX: (918)665-6576 E-Mail: aandm@aandmengineering.com

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
A & M ENGINEERING	Altay Ertugrul	(918) 665-6575

PROJECT NUMBER	PROJECT NAME
1804-002-301	Cherryvale

SAMPLERS: (Signature)

ANALYTICAL TESTS REQUIRED

STA. NO	DATE	TIME	COMP	GRAB	STATION LOCATION	MATRIX	NO. OF CONTAINERS	RUSH ? YES	RUSH ? NO	Total lead	Total Cadmium	Total Arsenic	Total Chromium	Total Zinc	Total Mercury	pH					REMARKS
	6/24/03	10:15			CVKS-1	Sol	1		X	X	X	X	X	X	X	X					
	6/24/03	11:00			CVKS-2	Sol	1		X	X	X	X	X	X	X	X					
	6/24/03	12:00			CVKS-3	Sol	1		X	X	X	X	X	X	X	X					
	6/24/03	12:20			CVKS-4	Sol	1		X	X	X	X	X	X	X	X					
	6/24/03	13:35			CVKS-5	Sol	1		X	X	X	X	X	X	X	X					
	6/24/03	15:00			CVKS-6	Sol	1		X	X	X	X	X	X	X	X					
	6/25/03	11:00			CVKS-7-D-1	Sol	1		X	X	X	X	X	X	X	X					
	6/25/03	11:15			CVKS-8	Sol	1		X	X	X	X	X	X	X	X					
	6/25/03	11:40			CVKS-9	Sol	1		X	X	X	X	X	X	X	X					
	6/25/03	12:30			CVKS-10-D-2	Sol	1		X	X	X	X	X	X	X	X					
	6/25/03	13:30			CVKS-11-D-3	Sol	1		X	X	X	X	X	X	X	X					
	6/25/03	13:50			CVKS-12-D-4	Sol	1		X	X	X	X	X	X	X	X					
	6/25/03	14:10			CVKS-13-D-5	Sol	1		X	X	X	X	X	X	X	X					

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
				Jon Kuhl	6/27/03	09:00	[illegible]
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
				A. Tam	6-27-03	9:20	[illegible]
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	REMARKS:			

T03060331

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

TULSA, OKLAHOMA
ENGINEERING - ENVIRONMENTAL - CONSTRUCTION
10010 E. 16th Street - TULSA, OKLAHOMA 74128-4813
TEL: (918)665-6575 FAX: (918)665-6576 E-Mail: aandm@aandmengineering.com

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
A & M ENGINEERING	Altay Ertugrul	(918) 665-6575

PROJECT NUMBER	PROJECT NAME
1804-002-301	Cherryvale

SAMPLERS: (Signature) Jon Kuba

ANALYTICAL TESTS REQUIRED

STA. NO	DATE	TIME	COMP	GRAB	STATION LOCATION	MATRIX	NO. OF CONTAINERS	RUSH ? YES	RUSH ? NO	Total lead	Total cadmium	Total Arsenic	Total Chromium	Total Zinc	Total Mercury	pH				REMARKS
	6/25/03	14:40			CVKS-14-D-6	Sol	1		X	X	X	X	X	X	X	X				
	6/25/03	15:30			CVKS-14-D-7	Sol	1		X	X	X	X	X	X	X	X				
	6/25/03	15:50			CVKS-15-D-8	Sol	1		X	X	X	X	X	X	X	X				
	6/25/03	16:15			CVKS-16-D-9	Sol	1		X	X	X	X	X	X	X	X				
	6/25/03	16:40			CVKS-17-D-10	Sol	1		X	X	X	X	X	X	X	X				
	6/25/03	17:00			CVKS-18	Sol	1		X	X	X	X	X	X	X	X				
	6/25/03	17:20			CVKS-19	Sol	1		X	X	X	X	X	X	X	X				
	6/26/03	11:30			CVKS020-BG-1	Sol	1		X	X	X	X	X	X	X	X				
	6/26/03	11:45			CVKS021-BG-2	Sol	1		X	X	X	X	X	X	X	X				
	6/26/03	12:30			CVKS-22	Sol	1		X	X	X	X	X	X	X	X				

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
				Jon Kuba	6/27/03	09:00	[illegible]
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
				[illegible]	6-D-03	9:20	[illegible]
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	REMARKS:			

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Altay Ertugrul
A & M Engineering
10010 E. 16th St.
Tulsa, OK 74128-4813
TEL: (918) 665-6574
FAX ( ) 665-6576

July 08, 2003
Order No.: T03060315

RE: Cherryvale

Dear Altay Ertugrul:

Sherry Laboratories received 16 samples on 6/26/03 for the analyses presented in the following report.

In accordance with your instructions, Sherry Laboratories/Oklahoma conducted the analysis shown on the following pages on samples submitted by your company. The results related only to the items tested. Unless otherwise noted, all analysis was conducted using EPA approved methodologies. All relevant sampling information is on the attached chain-of-custody form. The initials SUB as the analyst designate any testing sub-contracted by SLO.

Certifications/Accreditation: OK - 7604
AR - ADEQ
KS - E-10232
LA - 4002

A scope of Certified/Accredited parameters is available upon request.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Tom Gilroy

Approved By: _____
Brian Duzan, Director
Environmental Services

SHERRYLaboratories

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QA/QC REPORT
A & M Engineering
SAMPLE # 315
BATCH QC

PARAMETERS	LFB	MS %REC	MSD %REC	RPD
Hardness	99	90	90	0.0
Mercury	112	106	103	2.4
Arsenic	98	100	97	3.6
Cadmium	101	103	100	3.1
Chromium	102	104	102	2.0
Lead	99	104	101	2.6
Zinc	100	102	99	3.2
Total Suspended Solids	103	-	-	12.2

Approved by:

SHERRY LABORATORIES/OKLAHOMA

Brian Duzan
Laboratory Director

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CLIENT: A & M Engineering
Lab Order: T03060315 **Date Received:** 6/26/03
Project: Cherryvale **Date Reported:** *08-Jul-03*

Lab ID: T03060315-01 Collection Date: 6/24/03 12:00:00 PM Sample ID: CVKW-1

Matrix AQUEOUS

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
HARDNESS		E130.2				SM
Hardness (As CaCO3)	1,600		10	mg/L	7/1/03 2:15:00 PM	
MERCURY IN WATER, TOTAL		E245.2				KR
Mercury	< 0.000100		0.000100	mg/L	6/26/03	
METALS IN WATER BY ICP, TOTAL		E200.7				KR
Arsenic	< 0.00500		0.00500	mg/L	6/30/03 3:53:20 P	
Cadmium	0.0387		0.00100	mg/L	6/30/03 3:53:20 P	
Chromium	< 0.0100		0.0100	mg/L	6/30/03 3:53:20 P	
Lead	< 0.00500		0.00500	mg/L	6/30/03 3:53:20 P	
Zinc	1.63		0.0100	mg/L	6/30/03 3:53:20 P	
TOTAL SUSPENDED SOLIDS		E160.2				JF
Suspended Solids (Residue, Non-Filterable)	10.0		5.00	mg/L	6/26/03 12:00:00 P	

Lab ID: T03060315-02 Collection Date: 6/24/03 12:20:00 PM Sample ID: CVKW-2

Matrix AQUEOUS

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
HARDNESS		E130.2				SM
Hardness (As CaCO3)	910		10	mg/L	7/1/03 2:15:00 PM	
MERCURY IN WATER, TOTAL		E245.2				KR
Mercury	< 0.000100		0.000100	mg/L	6/26/03	
METALS IN WATER BY ICP, TOTAL		E200.7				KR
Arsenic	< 0.00500		0.00500	mg/L	6/30/03 4:16:53 P	
Cadmium	< 0.00100		0.00100	mg/L	6/30/03 4:16:53 P	
Chromium	< 0.0100		0.0100	mg/L	6/30/03 4:16:53 P	
Lead	< 0.00500		0.00500	mg/L	6/30/03 4:16:53 P	
Zinc	0.791		0.0100	mg/L	6/30/03 4:16:53 P	
TOTAL SUSPENDED SOLIDS		E160.2				JF
Suspended Solids (Residue, Non-Filterable)	< 5.00		5.00	mg/L	6/26/03 12:00:00 P	

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CLIENT: A & M Engineering
Lab Order: T03060315 **Date Received:** 6/26/03
Project: Cherryvale **Date Reported:** *08-Jul-03*

Lab ID: T03060315-03 Collection Date: 6/24/03 3:00:00 PM Sample ID: CVKW-3

Matrix AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
HARDNESS	E130.2				SM
Hardness (As CaCO3)	280	10	mg/L	7/1/03 2:15:00 PM	
MERCURY IN WATER, TOTAL	E245.2				KR
Mercury	< 0.000100	0.000100	mg/L	6/26/03	
METALS IN WATER BY ICP, TOTAL	E200.7				KR
Arsenic	< 0.00500	0.00500	mg/L	6/30/03 4:51:02 P	
Cadmium	< 0.00100	0.00100	mg/L	6/30/03 4:51:02 P	
Chromium	< 0.0100	0.0100	mg/L	6/30/03 4:51:02 P	
Lead	< 0.00500	0.00500	mg/L	6/30/03 4:51:02 P	
Zinc	0.695	0.0100	mg/L	6/30/03 4:51:02 P	
TOTAL SUSPENDED SOLIDS	E160.2				JF
Suspended Solids (Residue, Non-Filterable)	7.00	5.00	mg/L	6/26/03 12:00:00 P	

Lab ID: T03060315-04 Collection Date: 6/25/03 11:00:00 AM Sample ID: CVKW-4-D1

Matrix AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
HARDNESS	E130.2				SM
Hardness (As CaCO3)	240	10	mg/L	7/1/03 2:15:00 PM	
MERCURY IN WATER, TOTAL	E245.2				KR
Mercury	< 0.000100	0.000100	mg/L	6/26/03	
METALS IN WATER BY ICP, TOTAL	E200.7				KR
Arsenic	< 0.00500	0.00500	mg/L	6/30/03 4:55:57 P	
Cadmium	< 0.00100	0.00100	mg/L	6/30/03 4:55:57 P	
Chromium	< 0.0100	0.0100	mg/L	6/30/03 4:55:57 P	
Lead	< 0.00500	0.00500	mg/L	6/30/03 4:55:57 P	
Zinc	0.0322	0.0100	mg/L	6/30/03 4:55:57 P	
TOTAL SUSPENDED SOLIDS	E160.2				JF
Suspended Solids (Residue, Non-Filterable)	10.0	5.00	mg/L	6/26/03 12:00:00 P	

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Fax: (918)828-7756
(800)324-5757

CLIENT: A & M Engineering
Lab Order: T03060315 **Date Received:** 6/26/03
Project: Cherryvale **Date Reported:** *08-Jul-03*

Lab ID: T03060315-05 Collection Date: 6/25/03 11:15:00 AM Sample ID: CVKW-5

Matrix AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
HARDNESS	E130.2				SM
Hardness (As CaCO3)	310	10	mg/L	7/1/03 2:15:00 PM	
MERCURY IN WATER, TOTAL	E245.2				KR
Mercury	< 0.000100	0.000100	mg/L	6/26/03	
METALS IN WATER BY ICP, TOTAL	E200.7				KR
Arsenic	< 0.00500	0.00500	mg/L	6/30/03 5:00:52 P	
Cadmium	< 0.00100	0.00100	mg/L	6/30/03 5:00:52 P	
Chromium	< 0.0100	0.0100	mg/L	6/30/03 5:00:52 P	
Lead	< 0.00500	0.00500	mg/L	6/30/03 5:00:52 P	
Zinc	0.224	0.0100	mg/L	6/30/03 5:00:52 P	
TOTAL SUSPENDED SOLIDS	E160.2				JF
Suspended Solids (Residue, Non-Filterable)	< 5.00	5.00	mg/L	6/26/03 12:00:00 P	

Lab ID: T03060315-06 Collection Date: 6/25/03 11:40:00 AM Sample ID: CVKW-6

Matrix AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
HARDNESS	E130.2				SM
Hardness (As CaCO3)	300	10	mg/L	7/1/03 2:15:00 PM	
MERCURY IN WATER, TOTAL	E245.2				KR
Mercury	< 0.000100	0.000100	mg/L	6/26/03	
METALS IN WATER BY ICP, TOTAL	E200.7				KR
Arsenic	< 0.00500	0.00500	mg/L	6/30/03 5:24:16 P	
Cadmium	< 0.00100	0.00100	mg/L	6/30/03 5:24:16 P	
Chromium	< 0.0100	0.0100	mg/L	6/30/03 5:24:16 P	
Lead	< 0.00500	0.00500	mg/L	6/30/03 5:24:16 P	
Zinc	0.354	0.0100	mg/L	6/30/03 5:24:16 P	
TOTAL SUSPENDED SOLIDS	E160.2				JF
Suspended Solids (Residue, Non-Filterable)	< 5.00	5.00	mg/L	6/26/03 12:00:00 P	

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(800)324-5757

CLIENT: A & M Engineering
Lab Order: T03060315 **Date Received:** 6/26/03
Project: Cherryvale **Date Reported:** *08-Jul-03*

Lab ID: T03060315-07 Collection Date: 6/25/03 12:30:00 PM Sample ID: CVKW-7-D2

Matrix AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
HARDNESS	E130.2				SM
Hardness (As CaCO3)	240	10	mg/L	7/1/03 2:15:00 PM	
MERCURY IN WATER, TOTAL	E245.2				KR
Mercury	< 0.000100	0.000100	mg/L	6/26/03	
METALS IN WATER BY ICP, TOTAL	E200.7				KR
Arsenic	< 0.00500	0.00500	mg/L	6/30/03 5:29:12 P	
Cadmium	< 0.00100	0.00100	mg/L	6/30/03 5:29:12 P	
Chromium	< 0.0100	0.0100	mg/L	6/30/03 5:29:12 P	
Lead	< 0.00500	0.00500	mg/L	6/30/03 5:29:12 P	
Zinc	< 0.0100	0.0100	mg/L	6/30/03 5:29:12 P	
TOTAL SUSPENDED SOLIDS	E160.2				JF
Suspended Solids (Residue, Non-Filterable)	7.00	5.00	mg/L	6/26/03 12:00:00 P	

Lab ID: T03060315-08 Collection Date: 6/25/03 1:30:00 PM Sample ID: CVKW-8-D3

Matrix AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
HARDNESS	E130.2				KR
Hardness (As CaCO3)	240	10	mg/L	7/8/03 10:00:00 A	
MERCURY IN WATER, TOTAL	E245.2				KR
Mercury	< 0.000100	0.000100	mg/L	6/27/03	
METALS IN WATER BY ICP, TOTAL	E200.7				KR
Arsenic	< 0.00500	0.00500	mg/L	6/30/03 5:34:01 P	
Cadmium	< 0.00100	0.00100	mg/L	6/30/03 5:34:01 P	
Chromium	< 0.0100	0.0100	mg/L	6/30/03 5:34:01 P	
Lead	< 0.00500	0.00500	mg/L	6/30/03 5:34:01 P	
Zinc	< 0.0100	0.0100	mg/L	6/30/03 5:34:01 P	
TOTAL SUSPENDED SOLIDS	E160.2				JF
Suspended Solids (Residue, Non-Filterable)	33.0	5.00	mg/L	6/26/03 12:00:00 P	

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CLIENT: A & M Engineering
Lab Order: T03060315 **Date Received:** 6/26/03
Project: Cherryvale **Date Reported:** *08-Jul-03*

Lab ID: T03060315-09 Collection Date: 6/25/03 1:50:00 PM Sample ID: CVKW-9-D4

Matrix AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
HARDNESS	E130.2				KR
Hardness (As CaCO3)	230	10	mg/L	7/8/03 10:00:00 A	
MERCURY IN WATER, TOTAL	E245.2				KR
Mercury	< 0.000100	0.000100	mg/L	6/27/03	
METALS IN WATER BY ICP, TOTAL	E200.7				KR
Arsenic	< 0.00500	0.00500	mg/L	6/30/03 5:38:50 P	
Cadmium	< 0.00100	0.00100	mg/L	6/30/03 5:38:50 P	
Chromium	< 0.0100	0.0100	mg/L	6/30/03 5:38:50 P	
Lead	< 0.00500	0.00500	mg/L	6/30/03 5:38:50 P	
Zinc	0.132	0.0100	mg/L	6/30/03 5:38:50 P	
TOTAL SUSPENDED SOLIDS	E160.2				JF
Suspended Solids (Residue, Non-Filterable)	58.0	5.00	mg/L	6/26/03 12:00:00 P	

Lab ID: T03060315-10 Collection Date: 6/25/03 2:10:00 PM Sample ID: CVKW-10-D4

Matrix AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
HARDNESS	E130.2				KR
Hardness (As CaCO3)	240	10	mg/L	7/8/03 10:00:00 A	
MERCURY IN WATER, TOTAL	E245.2				KR
Mercury	< 0.000100	0.000100	mg/L	6/27/03	
METALS IN WATER BY ICP, TOTAL	E200.7				KR
Arsenic	< 0.00500	0.00500	mg/L	6/30/03 5:43:39 P	
Cadmium	< 0.00100	0.00100	mg/L	6/30/03 5:43:39 P	
Chromium	< 0.0100	0.0100	mg/L	6/30/03 5:43:39 P	
Lead	< 0.00500	0.00500	mg/L	6/30/03 5:43:39 P	
Zinc	0.0544	0.0100	mg/L	6/30/03 5:43:39 P	
TOTAL SUSPENDED SOLIDS	E160.2				JF
Suspended Solids (Residue, Non-Filterable)	130	5.00	mg/L	6/26/03 12:00:00 P	

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CLIENT: A & M Engineering
Lab Order: T03060315 **Date Received:** 6/26/03
Project: Cherryvale **Date Reported:** *08-Jul-03*

Lab ID: T03060315-11 Collection Date: 6/25/03 2:40:00 PM Sample ID: CVKW-11-D6

Matrix AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
HARDNESS	E130.2				KR
Hardness (As CaCO3)	230	10	mg/L	7/8/03 10:00:00 A	
MERCURY IN WATER, TOTAL	E245.2				KR
Mercury	< 0.000100	0.000100	mg/L	6/27/03	
METALS IN WATER BY ICP, TOTAL	E200.7				KR
Arsenic	< 0.00500	0.00500	mg/L	6/30/03 5:48:28 P	
Cadmium	< 0.00100	0.00100	mg/L	6/30/03 5:48:28 P	
Chromium	< 0.0100	0.0100	mg/L	6/30/03 5:48:28 P	
Lead	< 0.00500	0.00500	mg/L	6/30/03 5:48:28 P	
Zinc	< 0.0100	0.0100	mg/L	6/30/03 5:48:28 P	
TOTAL SUSPENDED SOLIDS	E160.2				JF
Suspended Solids (Residue, Non-Filterable)	16.0	5.00	mg/L	6/26/03 12:00:00 P	

Lab ID: T03060315-12 Collection Date: 6/25/03 3:20:00 PM Sample ID: CVKW-12-D7

Matrix AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
HARDNESS	E130.2				KR
Hardness (As CaCO3)	250	10	mg/L	7/8/03 10:00:00 A	
MERCURY IN WATER, TOTAL	E245.2				KR
Mercury	< 0.000100	0.000100	mg/L	6/27/03	
METALS IN WATER BY ICP, TOTAL	E200.7				KR
Arsenic	< 0.00500	0.00500	mg/L	6/30/03 5:53:17 P	
Cadmium	< 0.00100	0.00100	mg/L	6/30/03 5:53:17 P	
Chromium	< 0.0100	0.0100	mg/L	6/30/03 5:53:17 P	
Lead	< 0.00500	0.00500	mg/L	6/30/03 5:53:17 P	
Zinc	< 0.0100	0.0100	mg/L	6/30/03 5:53:17 P	
TOTAL SUSPENDED SOLIDS	E160.2				JF
Suspended Solids (Residue, Non-Filterable)	< 5.00	5.00	mg/L	6/26/03 12:00:00 P	

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CLIENT: A & M Engineering
Lab Order: T03060315 **Date Received:** 6/26/03
Project: Cherryvale **Date Reported:** *08-Jul-03*

Lab ID: T03060315-13 Collection Date: 6/25/03 3:50:00 PM Sample ID: CVKW-13-D8

Matrix AQUEOUS

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
HARDNESS		E130.2				KR
Hardness (As CaCO3)	220		10	mg/L	7/8/03 10:00:00 A	
MERCURY IN WATER, TOTAL		E245.2				KR
Mercury	< 0.000100		0.000100	mg/L	6/27/03	
METALS IN WATER BY ICP, TOTAL		E200.7				KR
Arsenic	< 0.00500		0.00500	mg/L	6/30/03 5:58:06 P	
Cadmium	< 0.00100		0.00100	mg/L	6/30/03 5:58:06 P	
Chromium	< 0.0100		0.0100	mg/L	6/30/03 5:58:06 P	
Lead	< 0.00500		0.00500	mg/L	6/30/03 5:58:06 P	
Zinc	< 0.0100		0.0100	mg/L	6/30/03 5:58:06 P	
TOTAL SUSPENDED SOLIDS		E160.2				JF
Suspended Solids (Residue, Non-Filterable)	79.0		5.00	mg/L	6/26/03 12:00:00 P	

Lab ID: T03060315-14 Collection Date: 6/25/03 4:15:00 PM Sample ID: CVKW-14-D9

Matrix AQUEOUS

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
HARDNESS		E130.2				KR
Hardness (As CaCO3)	250		10	mg/L	7/8/03 10:00:00 A	
MERCURY IN WATER, TOTAL		E245.2				KR
Mercury	< 0.000100		0.000100	mg/L	6/27/03	
METALS IN WATER BY ICP, TOTAL		E200.7				KR
Arsenic	< 0.00500		0.00500	mg/L	6/30/03 6:02:55 P	
Cadmium	< 0.00100		0.00100	mg/L	6/30/03 6:02:55 P	
Chromium	< 0.0100		0.0100	mg/L	6/30/03 6:02:55 P	
Lead	< 0.00500		0.00500	mg/L	6/30/03 6:02:55 P	
Zinc	< 0.0100		0.0100	mg/L	6/30/03 6:02:55 P	
TOTAL SUSPENDED SOLIDS		E160.2				JF
Suspended Solids (Residue, Non-Filterable)	60.0		5.00	mg/L	6/26/03 12:00:00 P	

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CLIENT: A & M Engineering
Lab Order: T03060315 **Date Received:** 6/26/03
Project: Cherryvale **Date Reported:** *08-Jul-03*

Lab ID: T03060315-15 Collection Date: 6/25/03 4:40:00 PM Sample ID: CVKW-15-D10

Matrix AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
HARDNESS		E130.2			KR
Hardness (As CaCO3)	220	10	mg/L	7/8/03 10:00:00 A	
MERCURY IN WATER, TOTAL		E245.2			KR
Mercury	< 0.000100	0.000100	mg/L	6/27/03	
METALS IN WATER BY ICP, TOTAL		E200.7			KR
Arsenic	< 0.00500	0.00500	mg/L	6/30/03 6:07:44 P	
Cadmium	< 0.00100	0.00100	mg/L	6/30/03 6:07:44 P	
Chromium	< 0.0100	0.0100	mg/L	6/30/03 6:07:44 P	
Lead	< 0.00500	0.00500	mg/L	6/30/03 6:07:44 P	
Zinc	0.0204	0.0100	mg/L	6/30/03 6:07:44 P	
TOTAL SUSPENDED SOLIDS		E160.2			JF
Suspended Solids (Residue, Non-Filterable)	189	5.00	mg/L	6/26/03 12:00:00 P	

Lab ID: T03060315-16 Collection Date: 6/25/03 5:00:00 PM Sample ID: CVKW-16

Matrix AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
HARDNESS		E130.2			KR
Hardness (As CaCO3)	320	10	mg/L	7/8/03 10:00:00 A	
MERCURY IN WATER, TOTAL		E245.2			KR
Mercury	< 0.000100	0.000100	mg/L	6/27/03	
METALS IN WATER BY ICP, TOTAL		E200.7			KR
Arsenic	< 0.00500	0.00500	mg/L	6/30/03 6:30:59 P	
Cadmium	< 0.00100	0.00100	mg/L	6/30/03 6:30:59 P	
Chromium	< 0.0100	0.0100	mg/L	6/30/03 6:30:59 P	
Lead	< 0.00500	0.00500	mg/L	6/30/03 6:30:59 P	
Zinc	0.286	0.0100	mg/L	6/30/03 6:30:59 P	
TOTAL SUSPENDED SOLIDS		E160.2			JF
Suspended Solids (Residue, Non-Filterable)	18.0	5.00	mg/L	6/26/03 12:00:00 P	

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T030620315

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

TULSA, OKLAHOMA

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

10010 E. 16th Street - TULSA, OKLAHOMA 74128-4813
TEL: (918)665-6575 FAX: (918)665-6576 E-Mail: aandm@aandmengineering.com

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
A & M ENGINEERING	Altay Entrgual	(918) 665-6575

PROJECT NUMBER	PROJECT NAME
1804-002-301	Cherryvale

SAMPLERS: (Signature) [signature]

ANALYTICAL TESTS REQUIRED

STA. NO	DATE	TIME	COMP	GRAB	STATION LOCATION	MATRIX	NO. OF CONTAINERS	RUSH ? YES	RUSH ? NO	Total Lead	Total Cadmium	Total Arsenic	Total Chromium	Total Zinc	Total Mercury	Total Hardness (CaCO3)	TSS				REMARKS
	6/24/03	12:00		✓	CVKW-1	Liq	2		X	X	X	X	X	X	X	X					
	6/24/03	12:20		✓	CVKW-2	Liq	2		X	X	X	X	X	X	X	X					
	6/24/03	15:00		✓	CVKW-3	Liq	2		X	X	X	X	X	X	X	X					
	6-25-03	11:00		✓	CVKW-4-D1	Liq	2		X	X	X	X	X	X	X	X					
	6-25-03	11:15		✓	CVKW-5	Liq	2		X	X	X	X	X	X	X	X					
	6-25-03	11:40		✓	CVKW-6	Liq	2		X	X	X	X	X	X	X	X					
	6-25-03	12:30		✓	CVKW-7-D2	Liq	2		X	X	X	X	X	X	X	X					
	6-25-03	13:30		✓	CVKW-8-D3	Liq	2		X	X	X	X	X	X	X	X					
	6/25/03	13:50		✓	CVKW-9-D4	Liq	2		X	X	X	X	X	X	X	X					
	6/25/03	14:10		✓	CVKW-10-D5	Liq	2		X	X	X	X	X	X	X	X					
	6/25/03	14:40		✓	CVKW-11-D6	Liq	2		X	X	X	X	X	X	X	X					
	6/25/03	15:20		✓	CVKW-12-D7	Liq	2		X	X	X	X	X	X	X	X					
	6/25/03	15:50		✓	CVKW-13-D8	Liq	2		X	X	X	X	X	X	X	X					

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
				[signature]	6/26/03	0930	[signature]
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	REMARKS:			

T03060315

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

TULSA, OKLAHOMA

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

10010 E. 16th Street - TULSA, OKLAHOMA 74128-4813
TEL: (918)665-6575 FAX: (918)665-6576 E-Mail: aandm@aandmengineering.com

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
A & M ENGINEERING	Altay Ertugrul	(918) 665-6575

PROJECT NUMBER	PROJECT NAME
1804-002-301	

SAMPLERS: (Signature)

STA. NO	DATE	TIME	COMP.	GRAB	STATION LOCATION	MATRIX	NO. OF CONTAINERS	RUSH ? YES	RUSH ? NO	Total Lead	Total Cadmium	Total Arsenic	Total Chromium	Total Zinc	Total Mercury	Total Nickel (Ni)	TSS				REMARKS
	6/25/03	16:15		/	CVKW-14-D9	Liq	2		X	X	X	X	X	X	X	X	X				
	6/25/03	16:40		/	CVKW-15-D10	Liq	2		X	X	X	X	X	X	X	X	X				
	6/25/03	17:00		/	CVKW-16	Liq	2		X	X	X	X	X	X	X	X	X				

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	6/26/03	0930	RECEIVED BY: (Signature)
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	REMARKS:			

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(918)828-9977

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(800)324-5757

Altay Ertugrul
A & M Engineering
10010 E. 16th St.
Tulsa, OK 74128-4813
TEL: (918) 665-6574
FAX ( ) 665-6576

July 02, 2003
Order No.: T03060333

RE: Cherryvale

Dear Altay Ertugrul:

Sherry Laboratories received 1 sample on 6/27/03 for the analyses presented in the following report.

In accordance with your instructions, Sherry Laboratories/Oklahoma conducted the analysis shown on the following pages on samples submitted by your company. The results related only to the items tested. Unless otherwise noted, all analysis was conducted using EPA approved methodologies. All relevant sampling information is on the attached chain-of-custody form. The initials SUB as the analyst designate any testing sub-contracted by SLO.

Certifications/Accreditation: OK - 7604
AR - ADEQ
KS - E-10232
LA - 4002

A scope of Certified/Accredited parameters is available upon request.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Tom Gilroy

Approved By: _____
Brian Duzan, Director
Environmental Services

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QA/QC REPORT
A & M Engineering
SAMPLE # T03060333
BATCH QC

PARAMETERS	LFB	MS % REC	MSD % REC	RPD
Total Hardness	99	90	90	0.0
Arsenic	99	98	99	1.1
Cadmium	101	100	102	1.6
Chromium	102	102	104	2.0
Lead	100	102	104	1.3
Zinc	100	98	100	1.3
Total Suspended Solids	108	-	-	2.1

Approved by:

SHERRY LABORATORIES/OKLAHOMA

Brian Duzan
Laboratory Director

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6825 E 38th Street
Tulsa OK 74145
(918)628-9977

Fax: (918)628-7758
(800)324-5757

CLIENT:	A & M Engineering	**Client Sample ID:**	CVKW-17
Lab Order:	T03060333	**Tag Number:**	
Project:	Cherryvale	**Collection Date:**	6/26/03 12:30:00 PM
Lab ID:	T03060333-01A	**Matrix:**	AQUEOUS
Date Received:	27-Jun-03	**Date Reported:**	02-Jul-03

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
HARDNESS		**E130.2**				**SM**
Hardness (As CaCO3)	470		20	mg/L	7/1/03 2:15:00 PM	
MERCURY IN WATER, TOTAL		**E245.2**				**KR**
Mercury	0.000200		0.000100	mg/L	6/27/03	
METALS IN WATER BY ICP, TOTAL		**E200.7**				**KR**
Arsenic	< 0.00500		0.00500	mg/L	6/30/03 6:45:37 P	
Cadmium	0.498		0.00100	mg/L	6/30/03 6:45:37 P	
Chromium	0.0365		0.0100	mg/L	6/30/03 6:45:37 P	
Lead	0.585		0.00500	mg/L	6/30/03 6:45:37 P	
Zinc	35.9		0.100	mg/L	6/30/03 6:45:37 P	
TOTAL SUSPENDED SOLIDS		**E160.2**				**SN**
Suspended Solids (Residue, Non-Filterable)	3,780		20.0	mg/L	6/27/03 2:15:00 P	

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TD3060333

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

TULSA, OKLAHOMA

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

10010 E. 16th Street - TULSA, OKLAHOMA 74128-4813
TEL: (918)665-6575 FAX: (918)665-6576 E-Mail: aandm@aandmengineering.com

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
A & M ENGINEERING	Altay Ertugral	(918) 665-6575

PROJECT NUMBER	PROJECT NAME
1804-602-301	Cherryvale

SAMPLERS: (Signature) Jon Kuhn

ANALYTICAL TESTS REQUIRED

STA. NO	DATE	TIME	COMP	GRAB	STATION LOCATION	MATRIX	NO. OF CONTAINERS	RUSH ? YES	RUSH ? NO	Total Lead	Total Cadmium	Total Arsenic	Total Chromium	Total Zinc	Total Mercury	Total Metals (Calcd.)	T-33				REMARKS
	6/26/03	12:30			CVKW-17	Liq	2		X	X	X	X	X	X	X	X	X				

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
				Jon Kuhn	6/27/03	09:00	[illegible]
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
				[illegible]	6-27-03	9:20	[illegible]
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	REMARKS:			

;1+918+828+7756 8 4/ 4
LABORATORIES

APPENDIX C

(Sediment Sample Location Descriptions & Site Photos
for Unnamed and Drum Creeks)

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Tulsa OK 74145
(918)828-9977

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(800)324-5757

Irfan Taner
A & M Engineering
10010 E. 16th St.
Tulsa, OK 74128-4813
TEL: (918)665-6574
FAX ( ) 665-6576

February 10, 2004
Order No.: T04010372

RE: Cherryvale

Dear Irfan Taner:

Sherry Laboratories received 7 samples on 1/30/2004 for the analyses presented in the following report.

In accordance with your instructions, Sherry Laboratories/Oklahoma conducted the analysis shown on the following pages on samples submitted by your company. The results related only to the items tested. Unless otherwise noted, all analysis was conducted using EPA approved methodologies. Test reports meet all the NELAC requirements. All relevant sampling information is on the attached chain-of-custody form. The initials SUB as the analyst designate any testing sub-contracted by SLO.

Certifications/Accreditation: OK - 7604
AR - ADEQ
KS - E-10232
LA - 4002

A scope of Certified/Accredited parameters is available upon request. If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Approved By: _____
Brian Duzan, Director
Environmental Services

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CLIENT: A & M Engineering
Lab Order: T04010372 **Date Received:** 1/30/2004
Project: Cherryvale **Date Reported:** *10-Feb-04*

Lab ID: T04010372-01 Collection Date: 1/30/2004 11:00:00 A Sample ID: Effluent

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL		**E245.2**			**KR**
Mercury	< 0.000100	0.000100	mg/L	2/2/2004	
METALS IN WATER BY ICP, TOTAL		**E200.7**			**KR**
Arsenic	< 0.00500	0.00500	mg/L	2/3/2004 3:27:10 P	
Cadmium	< 0.00100	0.00100	mg/L	2/3/2004 3:27:10 P	
Chromium	0.0240	0.0100	mg/L	2/3/2004 3:27:10 P	
Lead	0.00938	0.00500	mg/L	2/3/2004 3:27:10 P	
Silver	< 0.00200	0.00200	mg/L	2/3/2004 3:27:10 P	
Zinc	0.0340	0.0100	mg/L	2/3/2004 3:27:10 P	
TOTAL SUSPENDED SOLIDS		**E160.2**			**PB**
Suspended Solids (Residue, Non-Filterable)	34.0	10.0	mg/L	2/4/2004 9:55:00 A	

Lab ID: T04010372-02 Collection Date: 1/30/2004 1:30:00 PM Sample ID: Low Water Crossing

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL		**E245.2**			**KR**
Mercury	< 0.000100	0.000100	mg/L	2/2/2004	
METALS IN WATER BY ICP, TOTAL		**E200.7**			**KR**
Arsenic	< 0.00500	0.00500	mg/L	2/3/2004 3:32:05 P	
Cadmium	< 0.00100	0.00100	mg/L	2/3/2004 3:32:05 P	
Chromium	0.0280	0.0100	mg/L	2/3/2004 3:32:05 P	
Lead	< 0.00500	0.00500	mg/L	2/3/2004 3:32:05 P	
Silver	< 0.00200	0.00200	mg/L	2/3/2004 3:32:05 P	
Zinc	0.0205	0.0100	mg/L	2/3/2004 3:32:05 P	
TOTAL SUSPENDED SOLIDS		**E160.2**			**PB**
Suspended Solids (Residue, Non-Filterable)	8.00	5.00	mg/L	2/4/2004 9:55:00 A	

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CLIENT: A & M Engineering
Lab Order: T04010372 **Date Received:** 1/30/2004
Project: Cherryvale **Date Reported:** *10-Feb-04*

Lab ID: T04010372-03 Collection Date: 1/30/2004 1:50:00 PM Sample ID: Downstream

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL		**E245.2**			**KR**
Mercury	< 0.000100	0.000100	mg/L	2/2/2004	
METALS IN WATER BY ICP, TOTAL		**E200.7**			**KR**
Arsenic	< 0.00500	0.00500	mg/L	2/3/2004 3:37:00 P	
Cadmium	< 0.00100	0.00100	mg/L	2/3/2004 3:37:00 P	
Chromium	0.0280	0.0100	mg/L	2/3/2004 3:37:00 P	
Lead	< 0.00500	0.00500	mg/L	2/3/2004 3:37:00 P	
Silver	< 0.00200	0.00200	mg/L	2/3/2004 3:37:00 P	
Zinc	0.0360	0.0100	mg/L	2/3/2004 3:37:00 P	
TOTAL SUSPENDED SOLIDS		**E160.2**			**PB**
Suspended Solids (Residue, Non-Filterable)	39.0	5.00	mg/L	2/4/2004 9:55:00 A	

Lab ID: T04010372-04 Collection Date: 1/30/2004 11:45:00 A Sample ID: Upstream

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL		**E245.2**			**KR**
Mercury	< 0.000100	0.000100	mg/L	2/2/2004	
METALS IN WATER BY ICP, TOTAL		**E200.7**			**KR**
Arsenic	< 0.00500	0.00500	mg/L	2/3/2004 3:41:49 P	
Cadmium	< 0.00100	0.00100	mg/L	2/3/2004 3:41:49 P	
Chromium	0.0270	0.0100	mg/L	2/3/2004 3:41:49 P	
Lead	< 0.00500	0.00500	mg/L	2/3/2004 3:41:49 P	
Silver	< 0.00200	0.00200	mg/L	2/3/2004 3:41:49 P	
Zinc	< 0.0100	0.0100	mg/L	2/3/2004 3:41:49 P	
TOTAL SUSPENDED SOLIDS		**E160.2**			**PB**
Suspended Solids (Residue, Non-Filterable)	7.00	5.00	mg/L	2/4/2004 9:55:00 A	

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CLIENT: A & M Engineering
Lab Order: T04010372 **Date Received:** 1/30/2004
Project: Cherryvale **Date Reported:** *10-Feb-04*

Lab ID: T04010372-05 Collection Date: 1/30/2004 12:15:00 P Sample ID: Unnamed Creek

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL		**E245.2**			**KR**
Mercury	< 0.000100	0.000100	mg/L	2/2/2004	
METALS IN WATER BY ICP, TOTAL		**E200.7**			**KR**
Arsenic	< 0.00500	0.00500	mg/L	2/5/2004 11:45:03	
Cadmium	0.0112	0.00100	mg/L	2/5/2004 11:45:03	
Chromium	0.0961	0.0100	mg/L	2/5/2004 11:45:03	
Lead	0.0358	0.00500	mg/L	2/5/2004 11:45:03	
Silver	< 0.00200	0.00200	mg/L	2/5/2004 11:45:03	
Zinc	1.07	0.0100	mg/L	2/5/2004 11:45:03	

Lab ID: T04010372-06 Collection Date: 1/30/2004 12:05:00 P Sample ID: 75 Foot

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL		**E245.2**			**KR**
Mercury	< 0.000100	0.000100	mg/L	2/2/2004	
METALS IN WATER BY ICP, TOTAL		**E200.7**			**KR**
Arsenic	< 0.00500	0.00500	mg/L	2/5/2004 12:19:42	
Cadmium	< 0.00100	0.00100	mg/L	2/5/2004 12:19:42	
Chromium	0.0690	0.0100	mg/L	2/5/2004 12:19:42	
Lead	0.0251	0.00500	mg/L	2/5/2004 12:19:42	
Silver	< 0.00200	0.00200	mg/L	2/5/2004 12:19:42	
Zinc	0.0152	0.0100	mg/L	2/5/2004 12:19:42	
TOTAL SUSPENDED SOLIDS		**E160.2**			**PB**
Suspended Solids (Residue, Non-Filterable)	13.0	5.00	mg/L	2/4/2004 9:55:00 A	

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Fax: (918)828-7756
(800)324-5757

CLIENT: A & M Engineering
Lab Order: T04010372 **Date Received:** 1/30/2004
Project: Cherryvale **Date Reported:** *10-Feb-04*

Lab ID: T04010372-07 Collection Date: 1/30/2004 1:50:00 PM Sample ID: Downstream Solid

Matrix: SOLID

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		**SW7471**				**KR**
Mercury	< 0.025		0.025	mg/Kg	2/3/2004	
METALS IN SOIL OR SLUDGE BY ICP		**SW6010A**				**KR**
Arsenic	6.76		0.500	mg/Kg	2/9/2004	
Cadmium	2.99		0.250	mg/Kg	2/9/2004	
Chromium	14.6		0.250	mg/Kg	2/9/2004	
Lead	9.73		0.125	mg/Kg	2/9/2004	
Silver	< 0.0500		0.0500	mg/Kg	2/9/2004	
Zinc	24.9		0.250	mg/Kg	2/9/2004	
PH IN SOIL		**SW9045C**				**PB**
pH	7.09		0.10	pH Units	2/2/2004 2:16:00 P	

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Sherry Laboratories

Date: *10-Feb-04*

CLIENT: A & M Engineering
Work Order: T04010372
roject: Cherryvale

QC SUMMARY REPORT

TestCode	Analyte	BatchID	QCType	Result	PQL	Units	%Rec	%RPD
HG_S	Mercury	R17390	MBLK	< 0.025	0.025	mg/Kg		
	Mercury	R17390	LCS	0.2482	0.025	mg/Kg	99.3	
	Mercury	R17390	MS	0.2389	0.025	mg/Kg	95.6	
	Mercury	R17390	MSD	0.2618	0.025	mg/Kg	105	9.15
HG_WW	Mercury	R17380	MBLK	< 0.00010	0.0001	mg/L		
	Mercury	R17380	LCS	0.001057	0.0001	mg/L	106	
	Mercury	R17380	MS	0.00099	0.0001	mg/L	99	
	Mercury	R17380	MSD	0.000993	0.0001	mg/L	99.3	0.303
MET_S_ICP	Arsenic	R17461	MBLK	< 0.50	0.5	mg/Kg		
	Cadmium	R17461	MBLK	< 0.25	0.25	mg/Kg		
	Chromium	R17461	MBLK	< 0.25	0.25	mg/Kg		
	Lead	R17461	MBLK	< 0.12	0.125	mg/Kg		
	Silver	R17461	MBLK	< 0.050	0.05	mg/Kg		
	Zinc	R17461	MBLK	< 0.25	0.25	mg/Kg		
	Arsenic	R17461	LCS	1.939	0.5	mg/Kg	97	
	Arsenic	R17461	LCS	1.976	0.5	mg/Kg	98.8	1.89
	Cadmium	R17461	LCS	1.982	0.25	mg/Kg	99.1	
	Cadmium	R17461	LCS	2.019	0.25	mg/Kg	101	1.85
	Chromium	R17461	LCS	2.01	0.25	mg/Kg	100	2.16
	Chromium	R17461	LCS	1.967	0.25	mg/Kg	98.4	
	Lead	R17461	LCS	1.977	0.125	mg/Kg	98.8	
	Lead	R17461	LCS	2.017	0.125	mg/Kg	101	2
	Silver	R17461	LCS	0.199	0.05	mg/Kg	99.5	2.03
	Silver	R17461	LCS	0.195	0.05	mg/Kg	97.5	
	Zinc	R17461	LCS	2.006	0.25	mg/Kg	100	1.41
	Zinc	R17461	LCS	1.978	0.25	mg/Kg	98.9	
	Arsenic	R17461	MS	2.074	0.5	mg/Kg	104	
	Cadmium	R17461	MS	2.16	0.25	mg/Kg	108	
	Chromium	R17461	MS	2.116	0.25	mg/Kg	106	
	Lead	R17461	MS	2.15	0.125	mg/Kg	108	
	Silver	R17461	MS	0.208	0.05	mg/Kg	104	
	Zinc	R17461	MS	2.172	0.25	mg/Kg	109	
	Arsenic	R17461	MSD	2.08	0.5	mg/Kg	104	0.289
	Cadmium	R17461	MSD	2.181	0.25	mg/Kg	109	0.968
	Chromium	R17461	MSD	2.124	0.25	mg/Kg	106	0.377
	Lead	R17461	MSD	2.172	0.125	mg/Kg	109	1.02
	Silver	R17461	MSD	0.21	0.05	mg/Kg	105	0.957
	Zinc	R17461	MSD	2.191	0.25	mg/Kg	110	0.871
MET_WW_ICP	Arsenic	1759	mblk	< 0.0050	0.005	mg/L		
	Arsenic	1763	mblk	< 0.0050	0.005	mg/L		
	Cadmium	1759	mblk	< 0.0010	0.001	mg/L		
	Cadmium	1763	mblk	< 0.0010	0.001	mg/L		
	Chromium	1759	mblk	< 0.010	0.01	mg/L		
	Chromium	1763	mblk	< 0.010	0.01	mg/L		
	Lead	1759	mblk	< 0.0050	0.005	mg/L		
	Lead	1763	mblk	< 0.0050	0.005	mg/L		
	Silver	1759	mblk	< 0.0020	0.002	mg/L		
	Silver	1763	mblk	< 0.0020	0.002	mg/L		
	Zinc	1759	mblk	< 0.010	0.01	mg/L		

CLIENT: A & M Engineering
Work Order: T04010372
Project: Cherryvale

QC SUMMARY REPORT

estCode	Analyte	BatchID	QCType	Result	PQL	Units	%Rec	%RPD
	Zinc	1763	mblk	< 0.010	0.01	mg/L		
	Arsenic	1759	lcs	1.965	0.005	mg/L	98.3	
	Arsenic	1763	lcs	2.009	0.005	mg/L	100	
	Cadmium	1759	lcs	1.974	0.001	mg/L	98.7	
	Cadmium	1763	lcs	2.008	0.001	mg/L	100	
	Chromium	1759	lcs	1.992	0.01	mg/L	99.6	
	Chromium	1763	lcs	2.088	0.01	mg/L	104	
	Lead	1759	lcs	2.043	0.005	mg/L	102	
	Lead	1763	lcs	2.108	0.005	mg/L	105	
	Silver	1759	lcs	0.1999	0.002	mg/L	99.9	
	Silver	1763	lcs	0.2058	0.002	mg/L	103	
	Zinc	1759	lcs	1.978	0.01	mg/L	98.9	
	Zinc	1763	lcs	2.028	0.01	mg/L	101	
	Arsenic	1759	ms	2.004	0.005	mg/L	100	
	Arsenic	1763	ms	2.165	0.005	mg/L	108	
	Cadmium	1759	ms	1.991	0.001	mg/L	99.5	
	Cadmium	1763	ms	2.122	0.001	mg/L	106	
	Chromium	1759	ms	1.995	0.01	mg/L	98.8	
	Chromium	1763	ms	2.129	0.01	mg/L	102	
	Lead	1759	ms	1.984	0.005	mg/L	97.7	
	Lead	1763	ms	2.077	0.005	mg/L	102	
	Silver	1759	ms	0.202	0.002	mg/L	99.3	
	Silver	1763	ms	0.2107	0.002	mg/L	105	
	Zinc	1759	ms	2.046	0.01	mg/L	101	
	Zinc	1763	ms	3.138	0.01	mg/L	103	
	Arsenic	1759	msd	1.99	0.005	mg/L	99.5	0.702
	Arsenic	1763	msd	2.159	0.005	mg/L	108	0.303
	Cadmium	1759	msd	1.982	0.001	mg/L	99.1	0.416
	Cadmium	1763	msd	2.111	0.001	mg/L	105	0.508
	Chromium	1759	msd	1.983	0.01	mg/L	98.2	0.6
	Chromium	1763	msd	2.138	0.01	mg/L	102	0.427
	Lead	1759	msd	1.961	0.005	mg/L	96.6	1.13
	Lead	1763	msd	2.08	0.005	mg/L	102	0.119
	Silver	1759	msd	0.2004	0.002	mg/L	98.5	0.775
	Silver	1763	msd	0.2086	0.002	mg/L	104	1
	Zinc	1759	msd	2.033	0.01	mg/L	100	0.623
	Zinc	1763	msd	3.125	0.01	mg/L	103	0.42
PH_S	pH	R17376	DUP	7.09	0.1	pH Units	0	0
TSS	Suspended Solids (Residue, Non-Filt	R17429	MBLK	< 5.0	5	mg/L		
	Suspended Solids (Residue, Non-Filt	R17429	LCS	85	5	mg/L	96.3	
	Suspended Solids (Residue, Non-Filt	R17429	DUP	17	5	mg/L	0	6.06
	Suspended Solids (Residue, Non-Filt	R17429	DUP	164	10	mg/L	0	1.21

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812-375-0531 Fax 812-375-0731

☐ 5738 Industrial Rd., Fort Wayne, IN 46825
260-471-7000 Fax 260-471-7777

☐ 2417 W. Pinhook Rd, Lafayette, LA 70508
337-235-0483/800-737-2378
Fax 337-233-6540

☒ 3445 S Sheridan, Tulsa, OK 74145
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Page 1 of 1

Chain of Custody Record

Laboratory Number: T04010372

Client Name: CNM
Contact Name: Irfan Tanner
Phone/Fax:

Project Name: 1804-002 chemvale.
Project #: Jon Kuhn
Sampler's Signature:

Collection Date	Collection Time	Grab	Comp	Sample Identification / Description	Preservative	Number / Type of Container	Matrix Code	TSS	Mercury	Cadmium	Zinc	Arsenic	Chromium	Lead	Silver		Comments / Remarks
1-30/04	11:00	/		effluent		2	Liq	X	X	X	X	X	X	X	X		pH on sediment
1-30/04	13:30			low water crossing		2	Liq	X	X	X	X	X	X	X	X		
1-30/04	13:50			Downstream		3	Soil Liq	X	X	X	X	X	X	X	X		1 sediment.
1-30/04	11:45			upstream		2	Liq	X	X	X	X	X	X	X	X		
1-30/04	12:15			Unnamed Creek		2	Liq	X	X	X	X	X	X	X	X		Unnamed Creek was not large for TSS. Client was notified.
1-30/04	12:05			75 foot		2	Liq	X	X	X	X	X	X	X	X		

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Relinquished by: (Signature)	Received by: (Signature)	Date	Time	Relinquished by: (Signature) Jon Kuhn	Received by Laboratory: (Signature)	Date 1/30/04	Time 17:00

Matrix Codes
DW = Drinking Water MW = Monitoring Well
WW = Waste Water SL = Sludge
SO = Soil O Oil OT = Other

Container Types
G = Glass
P = Plastic

Shipping Conditions
☐ Iced
Temp. ____
☐ Ambient

Which Regulations Apply
☐ RCRA ☐ Drinking Water
☐ POTW ☐ Other ____
☐ NPDES

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CLIENT: A & M Engineering
Lab Order: T04010347 **Date Received:** 1/29/2004
Project: Cherryvale **Date Reported:** *10-Feb-04*

Lab ID: T04010347-01 Collection Date: 1/28/2004 5:30:00 PM Sample ID: Drum Creek

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL		**E245.2**			**KR**
Mercury	< 0.000100	0.000100	mg/L	2/2/2004	
METALS IN WATER BY ICP, TOTAL		**E200.7**			**KR**
Arsenic	< 0.00500	0.00500	mg/L	2/2/2004 8:57:28	P
Cadmium	< 0.00100	0.00100	mg/L	2/2/2004 8:57:28	P
Chromium	0.139	0.0100	mg/L	2/2/2004 8:57:28	P
Lead	< 0.00500	0.00500	mg/L	2/2/2004 8:57:28	P
Silver	< 0.00200	0.00200	mg/L	2/2/2004 8:57:28	P
Zinc	< 0.0100	0.0100	mg/L	2/2/2004 8:57:28	P
TOTAL SUSPENDED SOLIDS		**E160.2**			**PB**
Suspended Solids (Residue, Non-Filterable)	8.00	5.00	mg/L	2/2/2004 3:45:00	P

Lab ID: T04010347-02 Collection Date: 1/28/2004 5:30:00 PM Sample ID: Drum Creek

Matrix: SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		**SW7471**			**KR**
Mercury	< 0.025	0.025	mg/Kg	2/3/2004	
METALS IN SOIL OR SLUDGE BY ICP		**SW6010A**			**KR**
Arsenic	26.9	0.500	mg/Kg	2/2/2004	
Cadmium	15.7	0.250	mg/Kg	2/2/2004	
Chromium	19.3	0.250	mg/Kg	2/2/2004	
Lead	40.6	0.125	mg/Kg	2/2/2004	
Zinc	960	2.50	mg/Kg	2/2/2004	
PH IN SOIL		**SW9045C**			**PB**
pH	6.61	0.10	pH Units	1/30/2004 10:58:0	

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Sherry Laboratories

Date: *10-Feb-04*

CLIENT: A & M Engineering
Work Order: T04010347
Project: Cherryvale

QC SUMMARY REPORT

TestCode	Analyte	BatchID	QCType	Result	PQL	Units	%Rec	%RPD
HG_S	Mercury	R17390	MBLK	< 0.025	0.025	mg/Kg		
	Mercury	R17390	LCS	0.2482	0.025	mg/Kg	99.3	
	Mercury	R17390	MS	0.2389	0.025	mg/Kg	95.6	
	Mercury	R17390	MSD	0.2618	0.025	mg/Kg	105	9.15
HG_WW	Mercury	R17380	MBLK	< 0.00010	0.0001	mg/L		
	Mercury	R17380	LCS	0.001057	0.0001	mg/L	106	
	Mercury	R17380	MS	0.00099	0.0001	mg/L	99	
	Mercury	R17380	MSD	0.000993	0.0001	mg/L	99.3	0.303
MET_S_ICP	Arsenic	1756	MBLK	< 0.50	0.5	mg/Kg		
	Cadmium	1756	MBLK	< 0.25	0.25	mg/Kg		
	Chromium	1756	MBLK	< 0.25	0.25	mg/Kg		
	Lead	1756	MBLK	< 0.12	0.125	mg/Kg		
	Zinc	1756	MBLK	< 0.25	0.25	mg/Kg		
	Arsenic	1756	LCS	1.893	0.5	mg/Kg	94.6	
	Arsenic	1756	LCS	1.934	0.5	mg/Kg	96.7	2.14
	Cadmium	1756	LCS	1.951	0.25	mg/Kg	97.6	
	Cadmium	1756	LCS	1.986	0.25	mg/Kg	99.3	1.78
	Chromium	1756	LCS	2.132	0.25	mg/Kg	107	0.895
	Chromium	1756	LCS	2.113	0.25	mg/Kg	106	
	Lead	1756	LCS	1.916	0.125	mg/Kg	95.8	
	Lead	1756	LCS	1.962	0.125	mg/Kg	98.1	2.37
	Zinc	1756	LCS	1.959	0.25	mg/Kg	98	1.34
	Zinc	1756	LCS	1.933	0.25	mg/Kg	96.6	
	Arsenic	1756	MS	48.55	0.5	mg/Kg	97.1	
	Cadmium	1756	MS	52.14	0.25	mg/Kg	104	
	Chromium	1756	MS	60.91	0.25	mg/Kg	99.4	
	Lead	1756	MS	52.09	0.125	mg/Kg	104	
	Zinc	1756	MS	423.5	2.5	mg/Kg	82.6	
	Arsenic	1756	MSD	47.94	0.5	mg/Kg	95.9	1.26
	Cadmium	1756	MSD	51.42	0.25	mg/Kg	103	1.39
	Chromium	1756	MSD	58.48	0.25	mg/Kg	94.5	4.08
	Lead	1756	MSD	51.42	0.125	mg/Kg	103	1.29
	Zinc	1756	MSD	418.9	2.5	mg/Kg	73.3	1.1
MET_WW_ICP	Arsenic	1757	mblk	< 0.0050	0.005	mg/L		
	Cadmium	1757	mblk	< 0.0010	0.001	mg/L		
	Chromium	1757	mblk	< 0.010	0.01	mg/L		
	Lead	1757	mblk	< 0.0050	0.005	mg/L		
	Silver	1757	mblk	< 0.0020	0.002	mg/L		
	Zinc	1757	mblk	< 0.010	0.01	mg/L		
	Arsenic	1757	lcs	1.933	0.005	mg/L	96.6	
	Cadmium	1757	lcs	1.977	0.001	mg/L	98.8	
	Chromium	1757	lcs	2.289	0.01	mg/L	114	
	Lead	1757	lcs	1.971	0.005	mg/L	98.6	
	Silver	1757	lcs	0.1902	0.002	mg/L	95.1	
	Zinc	1757	lcs	1.971	0.01	mg/L	98.6	
	Arsenic	1757	ms	1.921	0.005	mg/L	96	
	Cadmium	1757	ms	1.942	0.001	mg/L	97.1	
	Chromium	1757	ms	2.273	0.01	mg/L	92.3	
	Lead	1757	ms	1.864	0.005	mg/L	93.2	

CLIENT: A & M Engineering
Work Order: T04010347
Project: Cherryvale

QC SUMMARY REPORT

TestCode	Analyte	BatchID	QCType	Result	PQL	Units	%Rec	%RPD
	Silver	1757	ms	0.1904	0.002	mg/L	95.2	
	Zinc	1757	ms	2.09	0.01	mg/L	101	
	Arsenic	1757	msd	1.952	0.005	mg/L	97.6	1.64
	Cadmium	1757	msd	1.963	0.001	mg/L	98.2	1.08
	Chromium	1757	msd	2.305	0.01	mg/L	93.8	1.39
	Lead	1757	msd	1.883	0.005	mg/L	94.2	1.01
	Silver	1757	msd	0.1937	0.002	mg/L	96.8	1.71
	Zinc	1757	msd	2.11	0.01	mg/L	102	0.934
PH_S	pH	R17349	DUP	6.6	0.1	pH Units	0	0.151
TSS	Suspended Solids (Residue, Non-Filt	R17387	MBLK	< 5.0	5	mg/L		
	Suspended Solids (Residue, Non-Filt	R17387	LCS	94	5	mg/L	106	
	Suspended Solids (Residue, Non-Filt	R17387	DUP	54	5	mg/L	0	3.64
	Suspended Solids (Residue, Non-Filt	R17387	DUP	78	10	mg/L	0	7.41

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Altay Ertugrul
A & M Engineering
10010 E. 16th St.
Tulsa, OK 74128-4813
TEL: (918) 665-6574
FAX ( ) 665-6576

March 05, 2004
Order No.: T04030012

RE: Cherryvale

Dear Altay Ertugrul:

Sherry Laboratories received 3 samples on 3/1/2004 for the analyses presented in the following report.

In accordance with your instructions, Sherry Laboratories/Oklahoma conducted the analysis shown on the following pages on samples submitted by your company. The results related only to the items tested. Unless otherwise noted, all analysis was conducted using EPA approved methodologies. Test reports meet all the NELAC requirements. All relevant sampling information is on the attached chain-of-custody form. The initials SUB as the analyst designate any testing sub-contracted by SLO.

Certifications/Accreditation: OK - 7604
AR - ADEQ
KS - E-10232
LA - 4002

A scope of Certified/Accredited parameters is available upon request. If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Approved By: _____
Brian Duzan, Director
Environmental Services

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CLIENT: A & M Engineering
Lab Order: T04030012 **Date Received:** 3/1/2004
Project: Cherryvale **Date Reported:** *05-Mar-04*

Lab ID: T04030012-01 Collection Date: 3/1/2004 12:00:00 PM Sample ID: Low Water Crossing

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	3/3/2004	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	3/4/2004 12:51:53	
Cadmium	< 0.00100	0.00100	mg/L	3/4/2004 12:51:53	
Chromium	< 0.0100	0.0100	mg/L	3/4/2004 12:51:53	
Lead	< 0.00500	0.00500	mg/L	3/4/2004 12:51:53	
Silver	< 0.00200	0.00200	mg/L	3/4/2004 12:51:53	
Zinc	< 0.0100	0.0100	mg/L	3/4/2004 12:51:53	

Lab ID: T04030012-02 Collection Date: 3/1/2004 12:10:00 PM Sample ID: Below Low Water Crossing

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	3/3/2004	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	3/4/2004 1:21:34 P	
Cadmium	< 0.00100	0.00100	mg/L	3/4/2004 1:21:34 P	
Chromium	< 0.0100	0.0100	mg/L	3/4/2004 1:21:34 P	
Lead	< 0.00500	0.00500	mg/L	3/4/2004 1:21:34 P	
Silver	< 0.00200	0.00200	mg/L	3/4/2004 1:21:34 P	
Zinc	< 0.0100	0.0100	mg/L	3/4/2004 1:21:34 P	

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CLIENT: A & M Engineering
Lab Order: T04030012 **Date Received:** 3/1/2004
Project: Cherryvale **Date Reported:** *05-Mar-04*

Lab ID: T04030012-03 Collection Date: 3/1/2004 2:10:00 PM Sample ID: Downstream

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	3/3/2004	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	3/4/2004 1:26:32	P
Cadmium	< 0.00100	0.00100	mg/L	3/4/2004 1:26:32	P
Chromium	< 0.0100	0.0100	mg/L	3/4/2004 1:26:32	P
Lead	< 0.00500	0.00500	mg/L	3/4/2004 1:26:32	P
Silver	< 0.00200	0.00200	mg/L	3/4/2004 1:26:32	P
Zinc	< 0.0100	0.0100	mg/L	3/4/2004 1:26:32	P

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Sherry Laboratories

Date: *05-Mar-04*

CLIENT: A & M Engineering
Work Order: T04030012
Project: Cherryvale

QC SUMMARY REPORT

TestCode	Analyte	BatchID	QCType	Result	PQL	Units	%Rec	%RPD
HG_WW	Mercury	R17711	MBLK	< 0.00010	0.0001	mg/L		
	Mercury	R17711	LCS	0.001029	0.0001	mg/L	103	
	Mercury	R17711	MS	0.001024	0.0001	mg/L	102	
	Mercury	R17711	MSD	0.001028	0.0001	mg/L	103	0.39
met_ww_icpt	Arsenic	1799	mblk	< 0.0050	0.005	mg/L		
	Cadmium	1799	mblk	< 0.0010	0.001	mg/L		
	Chromium	1799	mblk	< 0.010	0.01	mg/L		
	Lead	1799	mblk	< 0.0050	0.005	mg/L		
	Silver	1799	mblk	< 0.0020	0.002	mg/L		
	Zinc	1799	mblk	< 0.010	0.01	mg/L		
	Arsenic	1799	lcs	1.935	0.005	mg/L	96.8	
	Cadmium	1799	lcs	2.066	0.001	mg/L	103	
	Chromium	1799	lcs	1.963	0.01	mg/L	98.2	
	Lead	1799	lcs	1.944	0.005	mg/L	97.2	
	Silver	1799	lcs	0.1978	0.002	mg/L	98.9	
	Zinc	1799	lcs	1.926	0.01	mg/L	96.3	
	Arsenic	1799	ms	2.022	0.005	mg/L	101	
	Cadmium	1799	ms	2.061	0.001	mg/L	103	
	Chromium	1799	ms	1.962	0.01	mg/L	98.1	
	Lead	1799	ms	1.872	0.005	mg/L	93.6	
	Silver	1799	ms	0.1958	0.002	mg/L	97.9	
	Zinc	1799	ms	1.941	0.01	mg/L	97	
	Arsenic	1799	msd	2.015	0.005	mg/L	101	0.304
	Cadmium	1799	msd	2.06	0.001	mg/L	103	0.0674
	Chromium	1799	msd	1.964	0.01	mg/L	98.2	0.121
	Lead	1799	msd	1.874	0.005	mg/L	93.7	0.0889
	Silver	1799	msd	0.195	0.002	mg/L	97.5	0.417
	Zinc	1799	msd	1.933	0.01	mg/L	96.6	0.42

TO-1030012

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

TULSA, OKLAHOMA

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

10010 E. 16th Street - TULSA, OKLAHOMA 74128-4813
TEL: (918)665-6575 FAX: (918)665-6576 E-Mail: aandm@aandmengineering.com

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
A & M ENGINEERING	Alfay E.	(918) 665-6575

PROJECT NUMBER	PROJECT NAME
1804-002	Cherryvale

SAMPLERS: (Signature) Jim Kuhn

ANALYTICAL TESTS REQUIRED

STA. NO	DATE	TIME	COMP	GRAB	STATION LOCATION	MATRIX	NO. OF CONTAINERS	RUSH ? YES	RUSH ? NO	Cadmium	Arsenic	Lead	Zinc	Chromium	Mercury	Silver						REMARKS
	3-1-04	12:00		✓	Low water Crossing	Liq	1		X	X	X	X	X	X	X	X						
	3-1-04	12:10		✓	Below low water Crossing	Liq	1		X	X	X	X	X	X	X	X						
	3-1-04	14:10		✓	Downstream	Liq	1		X	X	X	X	X	X	X	X						

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature) Jim Kuhn	DATE 3/1/04	TIME 1612	RECEIVED BY: (Signature) A. Fowler
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	REMARKS:			

APPENDIX B

Table 1b. Formulae for calculation of hardness-dependent aquatic life support criteria for chromium III and total cadmium, total copper, total lead, total nickel, total silver and total zinc and pHdependent aquatic life support criteria for pentachlorophenol. A WER value of 1.0 is applied in the hardness-dependent equations for total metals unless a site-specific WER has been determined and adopted by the department in accordance with K.A.R. 28-16-28e(a) and K.A.R. 28-16-28f(f). Hardness values in metal formulae are entered in units of mg/L as CaCO3. Pentachlorophenol formulae apply only over the pH range 6.5-8.5.

"Water-effect ratio (WER)" means the numerical toxicity (median lethal concentration or no-observed-effect level) of a chemical pollutant diluted in water from a given stream, lake, or wetland divided by the numerical toxicity of the same pollutant diluted in laboratory water.

28-16-28b. Definitions.

(o) "Condition of acute toxicity" means any concentration of a toxic substance that exceeds the applicable acute criterion for aquatic life support presented in K.A.R. 28 -16-28e or, for substances not listed in K.A.R. 28 -16-28e or for mixtures of toxic substances, any concentration that exceeds 0.3 times the median lethal concentration. The concentration at which acute toxicity exists shall be determined through laboratory toxicity tests conducted in accordance with the United States environmental protection agency's "methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms," fourth edition, as published in August 1993, which is hereby adopted by reference.

(p) "Condition of chronic toxicity" means any concentration of a toxic substance that exceeds the applicable chronic criterion for aquatic life support presented in K.A.R. 28-16-28e or, for substances not listed in K.A.R. 28 -16-28e or for mixtures of toxic substances, any concentration that exceeds the no -observed-effect level. The concentration at which chronic toxicity exists shall be determined throug h laboratory toxicity tests conducted in accordance with the United States environmental protection agency's "short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms," third edition, as published in July 1994, which is hereby adopted by reference.

CADMIUM (ug/L):
acute criterion = WER[EXP[(1.1280*(LN(hardness)))-3.6867]]
chronic criterion = WER[EXP[(0.7852*(LN(hardness)))-2.715]]

CHROMIUM III (ug/L):
acute criterion = WER[EXP[(0.819*(LN(hardness)))+3.7256]]
chronic criterion = WER[EXP[(0.819*(LN(hardness)))+0.6848]]

LEAD (ug/L):
acute criterion = WER[EXP[(1.273*(LN(hardness)))-1.460]]
chronic criterion = WER[EXP[(1.273*(LN(hardness)))-4.705]]

ZINC (ug/L):
acute criterion = WER[EXP[(0.8473*(LN(hardness)))+0.884]]
chronic criterion = WER[EXP[(0.8473*(LN(hardness)))+0.884]]

TABLE 3

Aquatic Life Support Criteria Calculations Based on K.A.R. 28-16-28

			Cadmium			Chromium		
Sample ID	**WER**	**Hardness**	(µg/L)	Acute Criterion	Chronic Criterion	(µg/L)	Acute Criterion	Chronic Criterion
W7-D2	1	240		=1*EXP(1.128*(LN(C4))-3.6867)	=1*EXP(0.7852*(LN(C4))-2.715)		=1*EXP(0.819*(LN(C4))+3.7256)	=1*EXP(0.819*(LN(C4))+0.6848)
W7-D2 (H)	1	**240**		=1*EXP(1.128*(LN(C5))-3.6867)	=1*EXP(0.7852*(LN(C5))-2.715)	27	=1*EXP(0.819*(LN(C5))+3.7256)	=1*EXP(0.819*(LN(C5))+0.6848)
Effluent	1	***220***		=1*EXP(1.128*(LN(C6))-3.6867)	=1*EXP(0.7852*(LN(C6))-2.715)	24	=1*EXP(0.819*(LN(C6))+3.7256)	=1*EXP(0.819*(LN(C6))+0.6848)
W4-D1	1	240		=1*EXP(1.128*(LN(C7))-3.6867)	=1*EXP(0.7852*(LN(C7))-2.715)		=1*EXP(0.819*(LN(C7))+3.7256)	=1*EXP(0.819*(LN(C7))+0.6848)
W4-D1 (H)	1	**240**	11.2	=1*EXP(1.128*(LN(C8))-3.6867)	=1*EXP(0.7852*(LN(C8))-2.715)	96.1	=1*EXP(0.819*(LN(C8))+3.7256)	=1*EXP(0.819*(LN(C8))+0.6848)
W8-D3	1	240		=1*EXP(1.128*(LN(C9))-3.6867)	=1*EXP(0.7852*(LN(C9))-2.715)		=1*EXP(0.819*(LN(C9))+3.7256)	=1*EXP(0.819*(LN(C9))+0.6848)
W8-D3 (H)	1	**240**		=1*EXP(1.128*(LN(C10))-3.6867)	=1*EXP(0.7852*(LN(C10))-2.715)	69	=1*EXP(0.819*(LN(C10))+3.7256)	=1*EXP(0.819*(LN(C10))+0.6848)
W9-D4	1	230		=1*EXP(1.128*(LN(C11))-3.6867)	=1*EXP(0.7852*(LN(C11))-2.715)		=1*EXP(0.819*(LN(C11))+3.7256)	=1*EXP(0.819*(LN(C11))+0.6848)
W10-D5	1	240		=1*EXP(1.128*(LN(C12))-3.6867)	=1*EXP(0.7852*(LN(C12))-2.715)		=1*EXP(0.819*(LN(C12))+3.7256)	=1*EXP(0.819*(LN(C12))+0.6848)
W14-D9	1	250		=1*EXP(1.128*(LN(C13))-3.6867)	=1*EXP(0.7852*(LN(C13))-2.715)		=1*EXP(0.819*(LN(C13))+3.7256)	=1*EXP(0.819*(LN(C13))+0.6848)
W15-D10	1	220		=1*EXP(1.128*(LN(C14))-3.6867)	=1*EXP(0.7852*(LN(C14))-2.715)		=1*EXP(0.819*(LN(C14))+3.7256)	=1*EXP(0.819*(LN(C14))+0.6848)
W15-D10 (H)	1	**220**		=1*EXP(1.128*(LN(C15))-3.6867)	=1*EXP(0.7852*(LN(C15))-2.715)	28	=1*EXP(0.819*(LN(C15))+3.7256)	=1*EXP(0.819*(LN(C15))+0.6848)
LWC-300	1							

			Lead			Zinc		
Sample ID	**WER**	**Hardness**	(µg/L)	Acute Criterion	Chronic Criterion	(µg/L)	Acute Criterion	Chronic Criterion
W7-D2	1	240		=1*EXP(1.273*(LN(C22))-1.46)	=1*EXP(1.273*(LN(C22))-4.705)		=1*EXP(0.8473*(LN(C22))+0.884)	=1*EXP(0.8473*(LN(C22))+0.884)
W7-D2 (H)	1	**240**		=1*EXP(1.273*(LN(C23))-1.46)	=1*EXP(1.273*(LN(C23))-4.705)		=1*EXP(0.8473*(LN(C23))+0.884)	=1*EXP(0.8473*(LN(C23))+0.884)
Effluent	1	***220***	9.38	=1*EXP(1.273*(LN(C24))-1.46)	=1*EXP(1.273*(LN(C24))-4.705)	34	=1*EXP(0.8473*(LN(C24))+0.884)	=1*EXP(0.8473*(LN(C24))+0.884)
W4-D1	1	240		=1*EXP(1.273*(LN(C25))-1.46)	=1*EXP(1.273*(LN(C25))-4.705)	32.2	=1*EXP(0.8473*(LN(C25))+0.884)	=1*EXP(0.8473*(LN(C25))+0.884)
W4-D1 (H)	1	**240**	35.8	=1*EXP(1.273*(LN(C26))-1.46)	=1*EXP(1.273*(LN(C26))-4.705)	1070	=1*EXP(0.8473*(LN(C26))+0.884)	=1*EXP(0.8473*(LN(C26))+0.884)
W8-D3	1	240		=1*EXP(1.273*(LN(C27))-1.46)	=1*EXP(1.273*(LN(C27))-4.705)	132	=1*EXP(0.8473*(LN(C27))+0.884)	=1*EXP(0.8473*(LN(C27))+0.884)
W8-D3 (H)	1	**240**	25.1	=1*EXP(1.273*(LN(C28))-1.46)	=1*EXP(1.273*(LN(C28))-4.705)	15.2	=1*EXP(0.8473*(LN(C28))+0.884)	=1*EXP(0.8473*(LN(C28))+0.884)
W9-D4	1	230		=1*EXP(1.273*(LN(C29))-1.46)	=1*EXP(1.273*(LN(C29))-4.705)	132	=1*EXP(0.8473*(LN(C29))+0.884)	=1*EXP(0.8473*(LN(C29))+0.884)
W10-D5	1	240		=1*EXP(1.273*(LN(C30))-1.46)	=1*EXP(1.273*(LN(C30))-4.705)	54.4	=1*EXP(0.8473*(LN(C30))+0.884)	=1*EXP(0.8473*(LN(C30))+0.884)
W14-D9	1	250		=1*EXP(1.273*(LN(C31))-1.46)	=1*EXP(1.273*(LN(C31))-4.705)		=1*EXP(0.8473*(LN(C31))+0.884)	=1*EXP(0.8473*(LN(C31))+0.884)
W15-D10	1	220		=1*EXP(1.273*(LN(C32))-1.46)	=1*EXP(1.273*(LN(C32))-4.705)	20.4	=1*EXP(0.8473*(LN(C32))+0.884)	=1*EXP(0.8473*(LN(C32))+0.884)
W15-D10 (H)	1	**220**		=1*EXP(1.273*(LN(C33))-1.46)	=1*EXP(1.273*(LN(C33))-4.705)	20.5	=1*EXP(0.8473*(LN(C33))+0.884)	=1*EXP(0.8473*(LN(C33))+0.884)
LWC-300								

Table 2
Sediment Analytical Data
Drum Creek

Sampling point	Date	Mercury	Arsenic	Cadmium	Chromium	Lead	Zinc	Sampling location
1	6/24/03	0.038	2.3	1.8	8.68	8.87	49.9	S15-D8
2	6/24/03	0.052	1.81	1.7	8.2	16	81.2	S14-D7
3	6/24/03	0.18	3.17	2.55	9.7	24.5	94.6	S14-D6
4	6/24/03	0.086	7.16	4.63	13.9	20.6	78.8	S10-D2
5	6/24/03	0.13	30.7	430	14	473	10,300	(Confluence) S7-D1
6	6/24/03	0.099	11.4	90.4	11.7	144	3,680	S11-D3
7	6/24/03	0.12	13.9	73	13.5	223	5,950	S12-D4
8	6/24/03	0.1	8.84	71.1	18.6	109	1,520	300' downstream from #5 S13-D5
9	6/24/03	0.046	1.66	1.77	8.86	10.1	49.6	Main Street bridge S16-D9
10	6/24/03	0.051	18.5	14.3	11.6	48.2	517	Low water crossing S17-D10*
11	1/30/04	BDL	6.76	2.99	14.6	9.73	24.9	300' below low water crossing

Note: Parameters are in mg/L

Sediment Sample Descriptions – Unnamed Creek

S1:

Sampled on the National Zinc Site (project site) about 300' east of the western property line. The area was open and somewhat dry. The sediment area is 10' wide and 4" deep. The sediment was a tannish brown color with some silt and sand type gravel.

S2:

Sampled along the edge of the project site about 100' east of the western property line. At this point, unnamed creek is narrow and turns south and has varying pockets of sediment. There is a small tributary that connects from the north. The sample was taken east of the intersection point to prevent influence from tributary. Trees surrounded the area and the soil was moist. The sediment area is 6' wide and 16" deep. The sediment was dark in color with intermixed river sand the size of gravel at the point of accumulation.

S3:

Sampled on the project site about 650' south of S2 near MW3 along the western property line in the unnamed creek. The sediment area is 8' wide and 10" deep. Water was present at the sampling point so W1 was collected at the same point. Dense grass and cattails present where canopy was open. Wherever vegetation is present, sediments have washed clean from those areas. The drainage pipe originates from the flatlands of the site. The sediment was brown with very little gravel, more like silt.

Photo 1: Drainage pipe and area where sediment and water were sampled.
Photo 2: Slate rock that covers much of the creek between S3 and S4.

S4:

Sampled on the project site about 500' south of S3 near MW2 along the western property line in the unnamed creek. Water was present at the sampling point so W2 was collected at the same point. Trees covered the area and it was a low point where water had collected. Near this point, the creek turns and starts going west off of the project site and towards Highway 169. The sediment area is 16' wide and 2" deep. Area north of the sample point is heavy with cattails and the sample point is mainly dark silt with some gravel.

Photo 2: Slate rock that covers much of the creek between S3 and S4.
Photo 3: Looking west towards Highway 169 from MW2 near S4.
Photo 4: Looking east towards project site from Highway 169. S4 is located near the clearing in the tree line near the left-center portion of the photo.

S22:

Sampled along unnamed creek between the project site and Highway 169. The sample point was about 400' west of the western property line. Trees lined the creek at this point and there was standing water where W17 was collected. The creek had fairly heavy silt and dense grass and cattail vegetation. The sediment area is 8' wide and 8" deep. The sediment was mainly dark silt.

Photo 4: Looking east towards project site from Highway 169. S22 is located in the dry streambed seen in the top-right portion of the photo.

S5:

Sampled along unnamed creek between the project site and Highway 169 about 950' west of the western property line. The area has a shallow streambed with a rocky slate bottom and mixed vegetation. There is very little sediment and the sample collected was from a thin top layer. The sediment area is 20' wide and 1" deep.

Photo 4: Looking east towards project site from Highway 169. S22 is located in the dry streambed seen in the top-right portion of the photo.

S6:

Sampled on the west side of Highway 169 about 400' east of Sunnyslope Drive along unnamed creek. The sample was taken from the shallow streambed populated with mixed grasses and heavy in silt with little sediment. The creek is lined with hayfields on both sides and has standing water in many places because of equipment running down and making deep ruts. The sediment area is 15' wide and 1" deep. W3 was collected from this same area.

Photo 5: Looking west along unnamed creek towards Sunnyslope Drive from Highway 169. S6 is located in the center of the streambed.

S19:

Sampled along unnamed creek about 550' west of Sunnyslope Drive. The sample point is surrounded by very dense vegetation. The portion of the creek leading up to this point is mostly slate rock but at the sample point, the creek begins to include sediment. The sediment area is 12' wide and 2" deep.

S18:

Sampled along unnamed creek about 250' east of the Martin Street culvert. This area has very heavy sediments and brackish water in many places. The sediment was estimated as 12' across and at least 16" deep near this point. The vegetation is dense and there are

many aquatic creatures in this area. Gray colored buildup was noted on top of the organic matter in this stretch of the creek. The water has to be 3' deep to reach the culvert opening. The sediment was mixed gravel with silt, dark in color with some gray mix. W16 was collected at this sample point.

Photo 6: Looking northeast from Martin Street culvert up the unnamed creek. S18 is located near the top portion of the photo obscured by foliage.
Photo 7: Located right at the northeast base of the Martin Street culvert. Water must reach about 3' to flow through the drainage pipe.

S9:

Sampled along unnamed creek about 100' west of the Martin Street culvert. The sample area was estimated to have sediment that was 16' wide and 6" deep. The area was a lot drier than the previous portion of the creek due to the culvert. Dense vegetation was present in the area. W6 was collected at this sample point.

Photo 8: Looking southwest from Martin Street culvert down the unnamed creek. S9 is located near the top-center portion of the photo obscured by foliage.
Photo 9: Located between S8 and S9, this area is where a water line has been added.

S8:

Sampled about 600' east of the intersection point between unnamed creek and Drum creek. The creek deepens and widens considerably in this stretch and has mostly standing water. The vegetation is dense in the area. There is heavy sediment near the sample point with estimates of sediment as 14' wide and 8" deep. This portion of the creek from the Martin Street Culvert downstream to Drum Creek is all brick red brownish sediment. W5 was collected at this sample point.

Photo 9: Located between S8 and S9, this area is where a water line has been added.
Photo 10: Sediment piles that are typical of the turns along unnamed creek between Martin Street culvert and the end of unnamed creek.

S7-D1:

Sampled within 50' east of Drum creek along unnamed creek at about the intersection point. This area is very heavy in sediment with an estimated 12' width and 24" depth. The vegetation is dense in the area. W4-D1 was collected at this point.

Sediment Sample Descriptions – Drum Creek

S15-D8:

Sampled within 50' south of the new bridge. The county had disturbed the area during the installation of the new bridge although the amount of disturbance is uncertain. The creek is very wide and deep with steep sides. The area is relatively free of vegetation because of the construction although the rest of the creek is full of vegetation. W13-D8 was collected at this point.

Photo 11: Looking south down Drum creek from the new bridge located on the county road. S15-D8 is located to the bottom-right outside the scope of the photo.

S14-D7:

Sampled about 750' south of the county road at a major bend in Drum creek. Vegetation is present but not dense and the sides are steep with deep water in the creek. W12-D7 was collected at this point.

S14-D6:

Sampled along Drum creek about 1350' south of the county road. The creek conditions remain relatively constant at this point with moderate vegetation, steep banks, and deep water. W11-D6 was collected at this point.

Photo 12: Looking north along Drum creek from S10-D2 towards S14-D6. S14-D6 is farther upstream and is not visible in the photo.

S10-D2:

Sampled along Drum creek about 2100' south of the county road. The creek has moderate vegetation at this point. The sample area has shallow water and sediment piles. W7-D2 was collected at this point.

Photo 12: Looking north along Drum creek from S10-D2 towards S14-D6.
Photo 13: Looking west at the feeder creek. S10-D2 is located below scope of the photo.
Photo 14: Silt shelf located in the sampling area. S10-D2 was taken near in the vicinity of the silt shelf. Note fish in water.

S11-D3:

Sampled along Drum creek within 50' south of the intersection with unnamed creek. The sediment is very deep at this point while the creek is still wide with steep banks. The vegetation is moderate. W8-D3 was collected at this point.

S12-D4:

Sampled along Drum creek about 100' south of the intersection with unnamed creek. The sediment is very deep at this point while the creek is still wide with steep banks. The vegetation is moderate. W9-D4 was collected at this point.

S13-D5:

Sampled along Drum creek about 250' south of the intersection with unnamed creek. The creek is wide at this point but less than 4' deep. The vegetation remains moderate. W10-D5 was collected at this point.

S16-D9:

Sampled along Drum creek south of the next bridge crossing for the county road about 1 mile south of the first bridge (S15-D8). There is moderate vegetation, steep sides, and deep water in the sample area. W14-D9 was collected at this point.

Photo 15: Looking south along Drum creek from the second county road bridge. S16-D9 is located on the left bank of the creek on the left side of the photo obscured by foliage.

S17-D10:

Sampled along Drum creek at a low water crossing for the county road about 1 mile south of the second bridge (S16-D9). The water was no more than 6" above the crossing. The actual streambed is populated with vegetation and some sediment. W15-D10 was collected at this point.

Photo 16: Looking east across low water crossing on the third county road. S17-D10 was sampled from the streambed near the right edge of the low water crossing.

Sediment Sample Description – Background

S20-BG1:

Sampled within 100' of the northwest corner of the project site on the south side of the country road in a ditch area that fed into a drain. The area was relatively dry and surrounded by grass.

Photo 17: Ditch area on the south side of the country road. S20-BG1 can be seen in the bottom-right portion of the photo.

S21-BG2:

Sampled about 150' south of the railroad tracks on the west side of Highway 169 in a ditch just east of an area of cattails. The sample point was 100' south of the gas line to stay away from ground disturbance. The area was moist and surrounded by grass.

Photo 18: Looking north towards railroad tracks along Highway 169. S21-BG2 is located in the low area between the highway and cattails.

The quantity of sediment to be removed from Unnamed Creek was 2,444 cubic yards. The heaviest sediment accumulations were located in the areas where Unnamed Creek had slight bends and turns. The amount of sediments to be removed were measured in the field.

Water Sample Descriptions – Unnamed Creek

W1:

Sampled on the project site about 650' south of the county road. Located near MW3 along the western property line in the unnamed creek. The sediment in this area is 8' wide and 10" deep. The water was collected from the pool in Photo 1. Dense grass and cattails present where canopy was open. The drainage pipe originates from the flatlands of the site. S3 was collected at this point.

Photo 1: Drainage pipe and area where sediment and water were sampled.
Photo 2: Slate rock that covers much of the creek between W1 and W2.

W2:

Sampled on the project site about 500' south of W1 near MW2 along the western property line in the unnamed creek. Trees covered the area and it was a low point where water had collected. Near this point, the creek turns and starts going west off of the project site and towards Highway 169. The sediment in the area is 16' wide and 2" deep. S4 was collected in this area.

Photo 2: Slate rock that covers much of the creek between W1 and W2.
Photo 3: Looking west towards Highway 169 from MW2 near W2.
Photo 4: Looking east towards project site from Highway 169. W2 is located near the clearing in the tree line near the left-center portion of the photo.

W17:

Sampled along unnamed creek between the project site and Highway 169. The sample point was about 400' west of the western property line. Trees lined the creek at this point and there was standing water where W17 was collected. The creek had fairly heavy silt and dense grass and cattail vegetation. The sediment in the area is 8' wide and 8" deep. S22 was collected at this sample point.

Photo 4: Looking east towards project site from Highway 169. W17 is located in the dry streambed seen in the top-right portion of the photo.

W3:

Sampled on the west side of Highway 169 about 400' east of Sunnyslope Drive along unnamed creek. The sample was taken from the shallow streambed populated with mixed grasses and heavy in silt with little sediment. The creek is lined with hayfields on both sides and has standing water in many places because of equipment running down

and making deep ruts. The sediment area is 15' wide and 1" deep. S6 was collected from this same area.

Photo 5: Looking west along unnamed creek towards Sunnyslope Drive from Highway 169. W3 is located in the center of the streambed.

W16:

Sampled along unnamed creek about 250' east of the Martin Street culvert. This area has very heavy sediments and brackish water in many places. The sediment was estimated as 12' across and at least 16" deep near this point. The vegetation is dense and there are many aquatic creatures in this area. Gray colored buildup was noted on top of the organic matter in this stretch of the creek. The water has to be 3' deep to reach the culvert opening. S18 was collected at this sample point.

Photo 6: Looking northeast from Martin Street culvert up the unnamed creek. W16 is located near the top portion of the photo obscured by foliage.
Photo 7: Located right at the northeast base of the Martin Street culvert. Water must reach about 3' to flow through the drainage pipe.

W6:

Sampled along unnamed creek about 100' west of the Martin Street culvert. The sample area was estimated to have sediment that was 16' wide and 6" deep. The area was a lot drier than the previous portion of the creek due to the culvert. Dense vegetation was present in the area. S9 was collected at this sample point.

Photo 8: Looking southwest from Martin Street culvert down the unnamed creek. W6 is located near the top-center portion of the photo obscured by foliage.
Photo 9: Located between W5 and W6, this area is where a water line has been added.

W5:

Sampled about 600' east of the intersection point between unnamed creek and Drum creek. The creek deepens and widens considerably in this stretch and has mostly standing water. The vegetation is dense in the area. There is heavy sediment near the sample point with estimates of sediment as 14' wide and 8" deep. S8 was collected at this sample point.

Photo 9: Located between W5 and W6, this area is where a water line has been added.
Photo 10: Sediment piles that are typical of the turns along unnamed creek between Martin Street culvert and the end of unnamed creek.

W4-D1:

Sampled within 50' east of Drum creek along unnamed creek at about the intersection point. This area is very heavy in sediment with an estimated 12' width and 24" depth. The vegetation is dense in the area. S7-D1 was collected at this point.

Water Sample Descriptions – Drum Creek

W13-D8:

Sampled within 50' south of the new bridge. The county had disturbed the area during the installation of the new bridge although the amount of disturbance is uncertain. The creek is very wide and deep with steep sides. The area is relatively free of vegetation because of the construction although the rest of the creek is full of vegetation. S15-D8 was collected at this point.

Photo 11: Looking south down Drum creek from the new bridge located on the county road. W13-D8 is located to the bottom-right outside the scope of the photo.

W12-D7:

Sampled about 750' south of the county road at a major bend in Drum creek. Vegetation is present but not dense and the sides are steep with deep water in the creek. S14-D7 was collected at this point.

W11-D6:

Sampled along Drum creek about 1350' south of the county road. The creek conditions remain relatively constant at this point with moderate vegetation, steep banks, and deep water. S14-D6 was collected at this point.

Photo 12: Looking north along Drum creek from W7-D2 towards W11-D6. W11-D6 is farther upstream and is not visible in the photo.

W7-D2:

Sampled along Drum creek about 2100' south of the county road. The creek has moderate vegetation at this point. The sample area has shallow water and sediment piles. S10-D2 was collected at this point.

Photo 12: Looking north along Drum creek from W7-D2 towards W11-D6.
Photo 13: Looking west at the feeder creek. W7-D2 is located below scope of the photo.
Photo 14: Silt shelf located in the sampling area. W7-D2 was taken near in the vicinity of the silt shelf. Note fish in water.

W8-D3:

Sampled along Drum creek within 50' south of the intersection with unnamed creek. The sediment is very deep at this point while the creek is still wide with steep banks. The vegetation is moderate. S11-D3 was collected at this point.

W9-D4:

Sampled along Drum creek about 100' south of the intersection with unnamed creek. The sediment is very deep at this point while the creek is still wide with steep banks. The vegetation is moderate. S12-D4 was collected at this point.

W10-D5:

Sampled along Drum creek about 250' south of the intersection with unnamed creek. The creek is wide at this point but less than 4' deep. The vegetation remains moderate. S13-D5 was collected at this point.

W14-D9:

Sampled along Drum creek south of the next bridge crossing for the county road about 1 mile south of the first bridge (W13-D8). There is moderate vegetation, steep sides, and deep water in the sample area. S16-D9 was collected at this point.

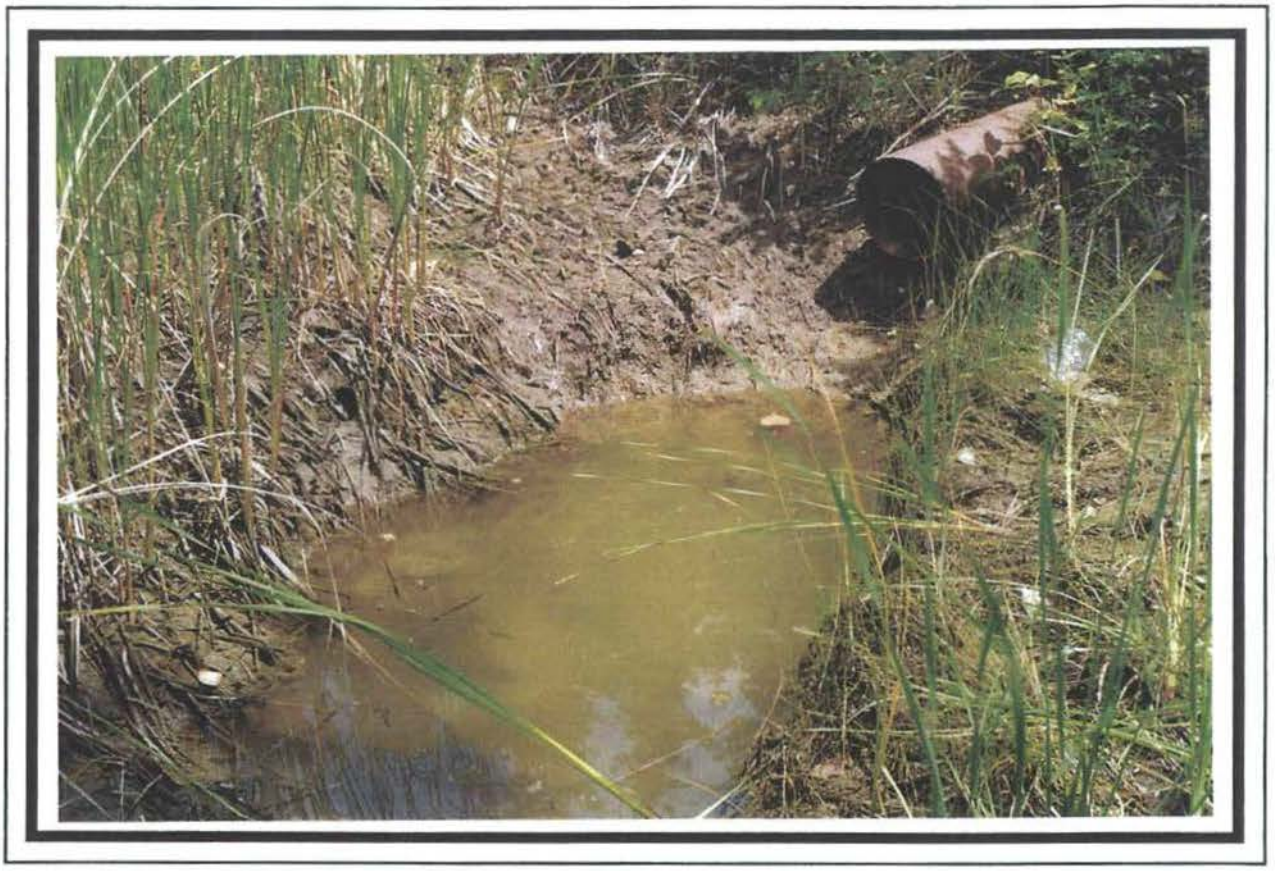
Photo 15: Looking south along Drum creek from the second county road bridge. S16-D9 is located on the left bank of the creek on the left side of the photo obscured by foliage.

W15-D10:

Sampled along Drum creek at a low water crossing for the county road about 1 mile south of the second bridge (W14-D9). The water was no more than 6" above the crossing. The actual streambed is populated with vegetation and some sediment. S17-D10 was collected at this point.

Photo 16: Looking east across low water crossing on the third county road. W15-D10 was sampled from the streambed near the right edge of the low water crossing.

#1



Drainage pipe and area where S3 and W1 were sampled.

#2

Slate rock that covers much of the creek between S3 and S4.

#3

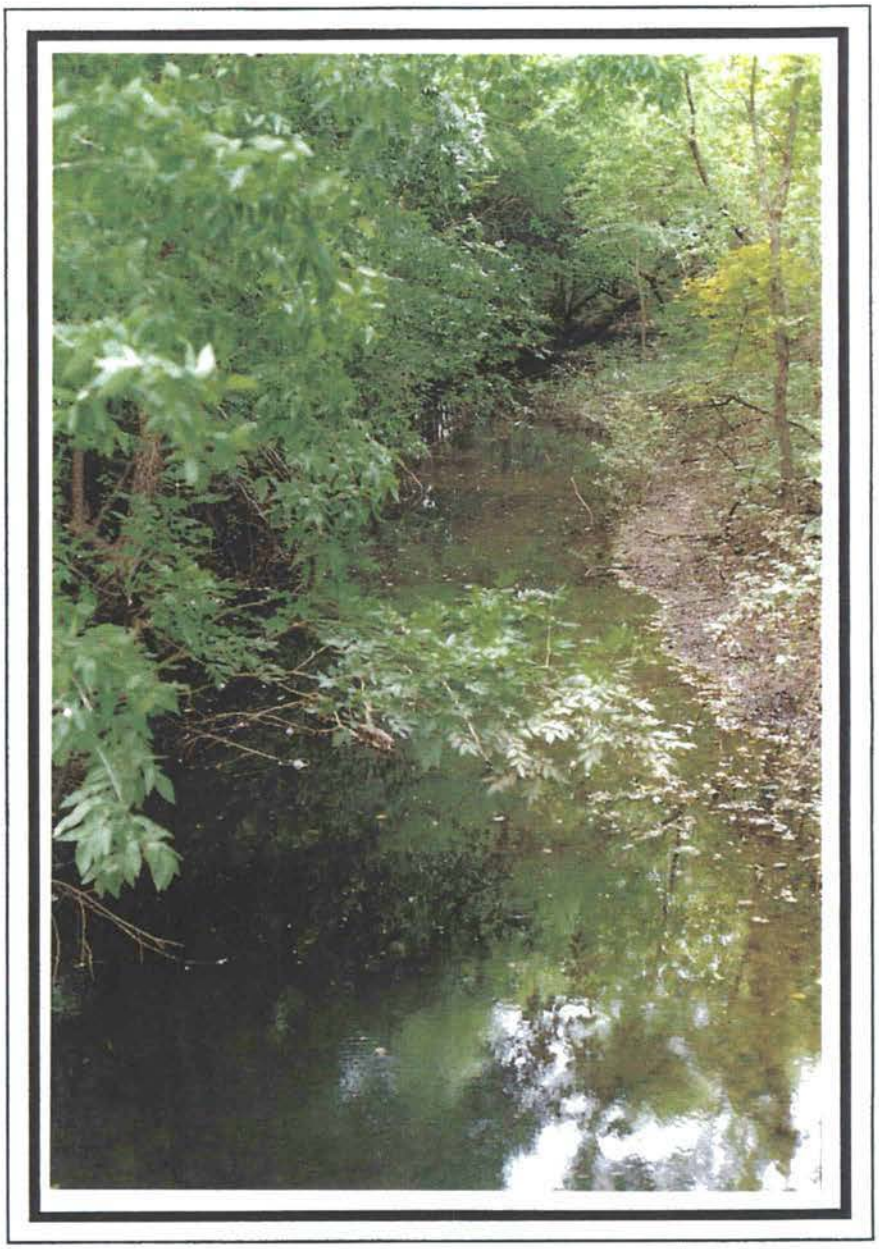
Looking west towards Highway 169 from MW2 near S4.

#4

Looking east towards project site from Highway 169. S4 is located near the clearing in the tree line at the back. S22 and S5 are located in the creek visible on the right.

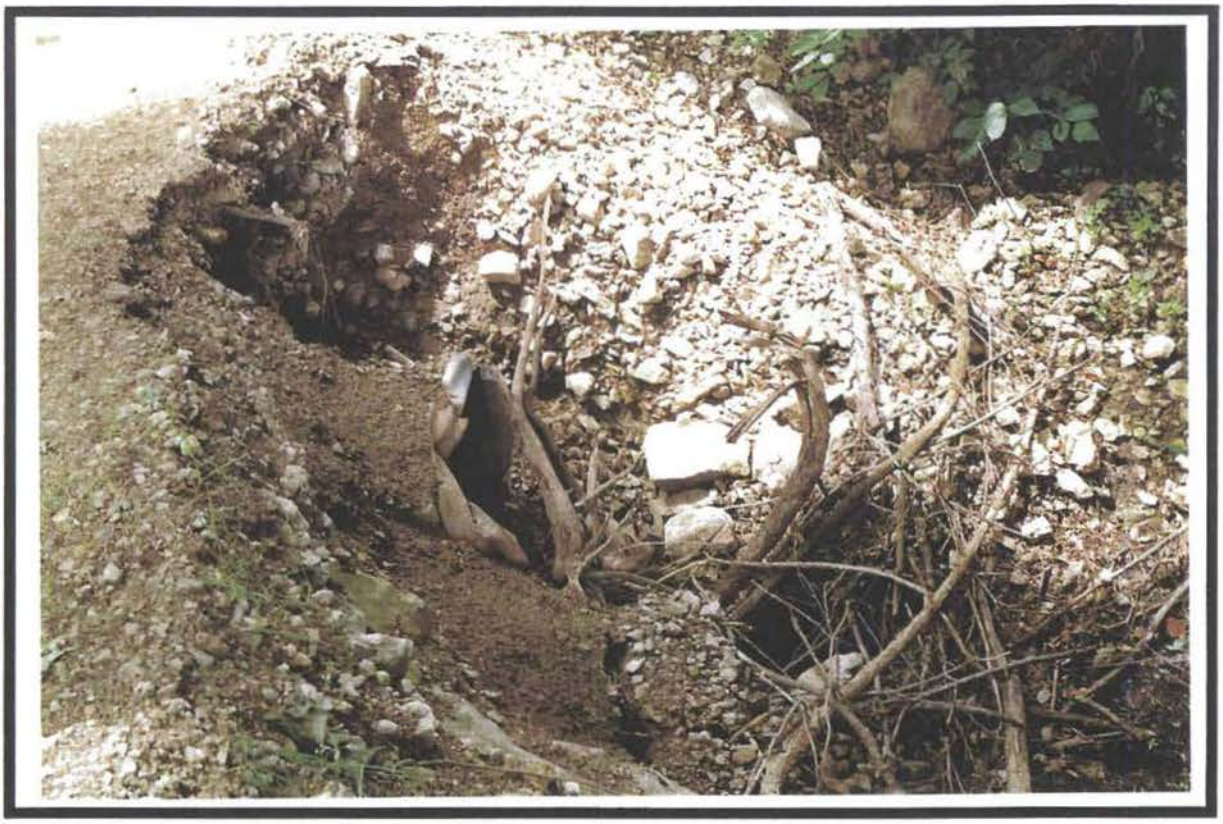
#5

Looking west along unnamed creek towards Sunnyslope Drive from Highway 169. S6 is located in the center of the creek.

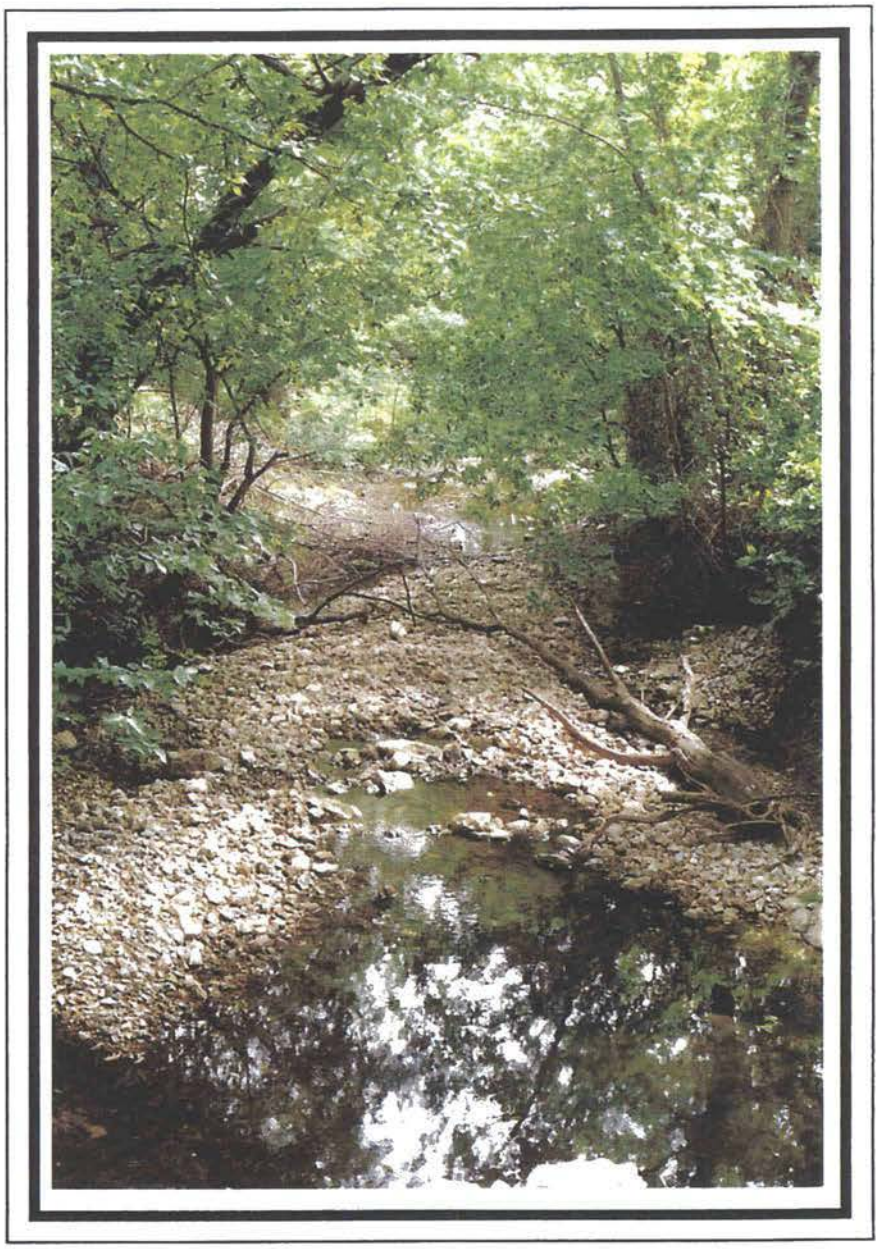


Looking northeast from Martin Street culvert up the unnamed creek. S18 is located near the top of the photo but obscured by foliage.

#7



Located right at the northeast base of the Martin Street culvert. Water must reach about 3′ to flow through the drainage pipe.



Looking southwest from Martin Street culvert down the unnamed creek. S9 is located near the top of the photo but obscured by foliage.

#9

Located between S8 and S9, this area is where a water line has been added.

#10

Sediment piles that are typical of the turns along unnamed creek between Martin Street culvert and the end of unnamed creek.

#11

Looking south down Drum creek from the new bridge located on the county road. S15 is located to the bottom-right outside the scope of the photo.

#12

Looking north along Drum creek from S10-D2 towards S14-D6.

#13

Looking west at the feeder creek. S10-D2 is located below scope of the photo.

#14

Silt shelf located in the sampling area. S10-D2 was taken near in the vicinity of the silt shelf. Note fish in water.

#15

Looking south along Drum creek from the second county road bridge. S16 is located on the left bank of the creek but obscured by foliage.

#16

Looking east across low water crossing on the third county road. S17 was sampled in the streambed near the right edge of the low water crossing.

#17

Ditch area on the south side of the county road. S20-BG1 can be seen in the bottom-right portion of the photo.

#18

Looking north towards railroad tracks along Highway 169.
S21-BG2 is located in the low area between the highway and cattails.

APPENDIX D
(EPA Repository Analytical Data)

6825 E 38th Street
Tulsa OK 74145
(918)828-9977

SHERRYLaboratories

Testing Today – Protecting Tomorrow

Fax: (918)828-7756
(800)324-5757

Altay Ertugrul
A & M Engineering
10010 E. 16th St.
Tulsa, OK 74128-4813
TEL: (918) 665-6574
FAX ( ) 665-6576

June 05, 2003
Order No.: T03050336

RE: Cherryvale Soils

Dear Altay Ertugrul:

Sherry Laboratories received 25 samples on 5/30/03 for the analyses presented in the following report.

In accordance with your instructions, Sherry Laboratories/Oklahoma conducted the analysis shown on the following pages on samples submitted by your company. The results related only to the items tested. Unless otherwise noted, all analysis was conducted using EPA approved methodologies. All relevant sampling information is on the attached chain-of-custody form. The initials SUB as the analyst designate any testing sub-contracted by SLO.

Certifications/Accreditation: OK - 7604
AR - ADEQ
KS - E-10232
LA - 4002

A scope of Certified/Accredited parameters is available upon request.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Tom Gilroy

Approved By: _____
Brian Duzan, Director
Environmental Services

SHERRYLaboratories

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Tulsa OK 74145
(918)828-9977

Fax: (918)828-7756
(800)324-5757

CLIENT: A & M Engineering
Lab Order: T03050336 **Date Received:** 5/30/03
Project: Cherryvale Soils **Date Reported:** *05-Jun-03*

Lab ID: T03050336-01 Collection Date: 5/28/03 Sample ID: EPAR11A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	**SW6010A**				**SW**
Arsenic	3.53	0.500	mg/Kg	6/2/03	
Cadmium	6.42	0.250	mg/Kg	6/2/03	
Lead	95.3	1.25	mg/Kg	6/2/03	

Lab ID: T03050336-02 Collection Date: 5/28/03 Sample ID: EPAR15A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	**SW6010A**				**SW**
Arsenic	5.23	0.500	mg/Kg	6/2/03	
Cadmium	7.17	0.250	mg/Kg	6/2/03	
Lead	101	0.125	mg/Kg	6/2/03	

Lab ID: T03050336-03 Collection Date: 5/28/03 Sample ID: EPAR18A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	**SW6010A**				**SW**
Arsenic	41.3	0.500	mg/Kg	6/2/03	
Cadmium	19.6	0.250	mg/Kg	6/2/03	
Lead	1,050	1.25	mg/Kg	6/2/03	

Lab ID: T03050336-04 Collection Date: 5/28/03 Sample ID: EPAR20A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	**SW6010A**				**SW**
Arsenic	9.19	0.500	mg/Kg	6/2/03	
Cadmium	15.8	0.250	mg/Kg	6/2/03	
Lead	529	1.25	mg/Kg	6/2/03	

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CLIENT: A & M Engineering
Lab Order: T03050336 **Date Received:** 5/30/03
Project: Cherryvale Soils **Date Reported:** *05-Jun-03*

Lab ID: T03050336-05 Collection Date: 5/28/03 Sample ID: EPAR19A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	5.89	0.500	mg/Kg	6/2/03	
Cadmium	12.5	0.250	mg/Kg	6/2/03	
Lead	227	1.25	mg/Kg	6/2/03	

Lab ID: T03050336-06 Collection Date: 5/28/03 Sample ID: EPAR16A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	6.10	0.500	mg/Kg	6/2/03	
Cadmium	12.7	0.250	mg/Kg	6/2/03	
Lead	226	1.25	mg/Kg	6/2/03	

Lab ID: T03050336-07 Collection Date: 5/28/03 Sample ID: EPAR09A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	6.57	0.500	mg/Kg	6/2/03	
Cadmium	14.3	0.250	mg/Kg	6/2/03	
Lead	289	1.25	mg/Kg	6/2/03	

Lab ID: T03050336-08 Collection Date: 5/28/03 Sample ID: EPAR03A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	4.14	0.500	mg/Kg	6/2/03	
Cadmium	12.7	0.250	mg/Kg	6/2/03	
Lead	270	1.25	mg/Kg	6/2/03	

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CLIENT: A & M Engineering
Lab Order: T03050336 **Date Received:** 5/30/03
Project: Cherryvale Soils **Date Reported:** *05-Jun-03*

Lab ID: T03050336-09 Collection Date: 5/28/03 Sample ID: EPAR1A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	**SW6010A**				**SW**
Arsenic	4.97	0.500	mg/Kg	6/2/03	
Cadmium	10.3	0.250	mg/Kg	6/2/03	
Lead	198	0.125	mg/Kg	6/2/03	

Lab ID: T03050336-10 Collection Date: 5/28/03 Sample ID: EPAR2A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	**SW6010A**				**SW**
Arsenic	3.75	0.500	mg/Kg	6/2/03	
Cadmium	5.89	0.250	mg/Kg	6/2/03	
Lead	108	0.125	mg/Kg	6/2/03	

Lab ID: T03050336-11 Collection Date: 5/28/03 Sample ID: EPAR5A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	**SW6010A**				**SW**
Arsenic	5.86	0.500	mg/Kg	6/2/03	
Cadmium	10.7	0.250	mg/Kg	6/2/03	
Lead	215	0.125	mg/Kg	6/2/03	

Lab ID: T03050336-12 Collection Date: 5/28/03 Sample ID: EPAR7A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	**SW6010A**				**SW**
Arsenic	5.33	0.500	mg/Kg	6/2/03	
Cadmium	11.7	0.250	mg/Kg	6/2/03	
Lead	414	1.25	mg/Kg	6/2/03	

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CLIENT: A & M Engineering
Lab Order: T03050336 **Date Received:** 5/30/03
Project: Cherryvale Soils **Date Reported:** *05-Jun-03*

Lab ID: T03050336-13 Collection Date: 5/28/03 Sample ID: EPAR10A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	4.72	0.500	mg/Kg	6/2/03	
Cadmium	7.25	0.250	mg/Kg	6/2/03	
Lead	169	0.125	mg/Kg	6/2/03	

Lab ID: T03050336-14 Collection Date: 5/28/03 Sample ID: EPAR13A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	5.76	0.500	mg/Kg	6/2/03	
Cadmium	4.18	0.250	mg/Kg	6/2/03	
Lead	49.8	0.125	mg/Kg	6/2/03	

Lab ID: T03050336-15 Collection Date: 5/28/03 Sample ID: EPAR06A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	4.39	0.500	mg/Kg	6/2/03	
Cadmium	6.81	0.250	mg/Kg	6/2/03	
Lead	177	0.125	mg/Kg	6/2/03	

Lab ID: T03050336-16 Collection Date: 5/28/03 Sample ID: EPAR06B

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	9.82	0.500	mg/Kg	6/2/03	
Cadmium	22.3	0.250	mg/Kg	6/2/03	
Lead	569	1.25	mg/Kg	6/2/03	

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CLIENT: A & M Engineering
Lab Order: T03050336 **Date Received:** 5/30/03
Project: Cherryvale Soils **Date Reported:** *05-Jun-03*

Lab ID: T03050336-17 Collection Date: 5/28/03 Sample ID: EPAR04A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	4.84	0.500	mg/Kg	6/2/03	
Cadmium	7.09	0.250	mg/Kg	6/2/03	
Lead	155	0.125	mg/Kg	6/2/03	

Lab ID: T03050336-18 Collection Date: 5/28/03 Sample ID: EPAR04B

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	7.20	0.500	mg/Kg	6/2/03	
Cadmium	9.84	0.250	mg/Kg	6/2/03	
Lead	210	1.25	mg/Kg	6/2/03	

Lab ID: T03050336-19 Collection Date: 5/28/03 Sample ID: EPAR08A

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	5.40	0.500	mg/Kg	6/2/03	
Cadmium	10.3	0.250	mg/Kg	6/2/03	
Lead	221	0.125	mg/Kg	6/2/03	

Lab ID: T03050336-20 Collection Date: 5/28/03 Sample ID: EPAR08B

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	5.15	0.500	mg/Kg	6/2/03	
Cadmium	35.2	0.250	mg/Kg	6/2/03	
Lead	160	0.125	mg/Kg	6/2/03	

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CLIENT: A & M Engineering
Lab Order: T03050336 **Date Received:** 5/30/03
Project: Cherryvale Soils **Date Reported:** *05-Jun-03*

Lab ID: T03050336-21 **Collection Date: 5/28/03** **Sample ID: EPAR12A**

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	5.65	0.500	mg/Kg	6/2/03	
Cadmium	11.4	0.250	mg/Kg	6/2/03	
Lead	241	0.125	mg/Kg	6/2/03	

Lab ID: T03050336-22 **Collection Date: 5/28/03** **Sample ID: EPAR17A**

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	12.7	0.500	mg/Kg	6/2/03	
Cadmium	35.3	0.250	mg/Kg	6/2/03	
Lead	707	1.25	mg/Kg	6/2/03	

Lab ID: T03050336-23 **Collection Date: 5/28/03** **Sample ID: EPAR14A**

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	8.17	0.500	mg/Kg	6/2/03	
Cadmium	18.8	0.250	mg/Kg	6/2/03	
Lead	575	1.25	mg/Kg	6/2/03	

Lab ID: T03050336-24 **Collection Date: 5/28/03** **Sample ID: EPAR14B**

Matrix SOIL

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN SOIL OR SLUDGE BY ICP	SW6010A				SW
Arsenic	7.11	0.500	mg/Kg	6/2/03	
Cadmium	17.4	0.250	mg/Kg	6/2/03	
Lead	243	1.25	mg/Kg	6/2/03	

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CLIENT: A & M Engineering
Lab Order: T03050336 **Date Received:** 5/30/03
Project: Cherryvale Soils **Date Reported:** *05-Jun-03*

Lab ID: T03050336-25 **Collection Date: 5/28/03** **Sample ID: Equipment Blank**

Matrix AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
METALS IN WATER BY ICP, TOTAL	**E200.7**				**SW**
Arsenic	< 0.00500	0.00500	mg/L	6/3/03	
Cadmium	< 0.00100	0.00100	mg/L	6/3/03	
Lead	< 0.00500	0.00500	mg/L	6/3/03	

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T03050336

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

TULSA, OKLAHOMA

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

10010 E. 16th Street - TULSA, OKLAHOMA 74128-4813
TEL: (918)665-6575 FAX: (918)665-6576 E-Mail: aandm@aandmengineering.com

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
A & M ENGINEERING	Altay Kurtugrul	(918) 665-6575

PROJECT NUMBER	PROJECT NAME
1804-002-201	Cherryvale

SAMPLERS: (Signature) Jon Kuehn

ANALYTICAL TESTS REQUIRED

STA. NO	DATE	TIME	COMP	GRAB	STATION LOCATION	MATRIX	NO. OF CONTAINERS	RUSH ? YES	RUSH ? NO	Total Lead	total Arsenic	total Cadmium									REMARKS
	5-15-03	10:55	X		EPAR11A	Soi	1		X	X	X	X									
	5-28-03	10:00	X		EPAR 15A	Soi	1		X	X	X	X									
	5-28/03	10:30	X		EPAR 18A	Soi	1		X	X	X	X									
	5-28/03	11:15	X		EPAR 20A	Soi	1		X	X	X	X									
	5-28/03	11:30	X		EPAR 19A	Soi	1		X	X	X	X									
	5-28/03	11:45	X		EPAR 16A	Soi	1		X	X	X	X									
	5-28/03	13:15	X		EPAR 09A	Soi	1		X	X	X	X									
	5-28/03	13:45	X		EPAR03A	Soi	1		X	X	X	X									
	5-28/03	14:10	X		EPAR 1A	Soi	1		X	X	X	X									
	5-28/03	14:50	X		EPAR 2A	Soi	1		X	X	X	X									
	5-28/03	15:05	X		EPAR 5A	Soi	1		X	X	X	X									
	5-28/03	15:30	X		EPA R 7A	Soi	1		X	X	X	X									
	5-28/03	16:15	X		EPA R 10A	Soi	1		X	X	X	X									

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
				Jon Kuehn	5/30/03	08:15	Matt Mize
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
				Matt Mize	5/30/03	09:00	Sharon Weddle
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	REMARKS:			

TD3050336

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

TULSA, OKLAHOMA

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

10010 E. 16th Street - TULSA, OKLAHOMA 74128-4813
TEL: (918)665-6575 FAX: (918)665-6576 E-Mail: aandm@aandmengineering.com

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
A & M ENGINEERING	Altay Ertugrul	(918) 665-6575

PROJECT NUMBER	PROJECT NAME
1804-002-201	Cherryvale

SAMPLERS: (Signature) Jon Kuhn

ANALYTICAL TESTS REQUIRED

STA. NO	DATE	TIME	COMP	GRAB	STATION LOCATION	MATRIX	NO. OF CONTAINERS	RUSH ? YES	RUSH ? NO	Total Lead	Total Arsenic	Total Cadmium									REMARKS
	5/28/03	16:40	X		EPAR13A	Sol	1		X	X	X	X									
	5/28/03	17:20	X		EPAR06A	Sol	1		X	X	X	X									
	5/28/03	17:35	X		EPAR06B	Sol	1		X	X	X	X									
	5/28/03	17:50	X		EPAR04A	Sol	1		X	X	X	X									
	5/28/03	18:00	X		EPAR04B	Sol	1		X	X	X	X									
	5/28/03	18:20	X		EPAR08A	Sol	1		X	X	X	X									
	5/28/03	18:30	X		EPAR08B	Sol	1		X	X	X	X									
	5/28/03	18:45	X		EPAR12A	Sol	1		X	X	X	X									
	5/28/03	19:05	X		EPAR17A	Sol	1		X	X	X	X									
	5/28/03	19:25	X		EPAR14A	Sol	1		X	X	X	X									
	5/28/03	19:40	X		EPAR14B	Sol	1		X	X	X	X									
	5/28/03				Equipment Blank	Liq	1		X	X	X	X									

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

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
Jon Kuhn	5/30/03	08:15	Matt Miz
Matt Miz	5/30/03	08:00	Sharon Weddle

REMARKS:

APPENDIX D

WATER QUALITY AND SEDIMENT SAMPLING REPORT

(APRIL 2004)

Water Quality and Sediment Sampling Report
For
Former National Zinc Site
Cherryvale, Montgomery County, Kansas

April 2004

Presented to:

Kansas Department of Health
& Environment

Prepared By:

Salomon Smith Barney Holdings, Inc.
United States Steel Corporation
&
A & M Engineering and Environmental Services, Inc.

INTRODUCTION

This analytical report presents a summary of the sediment and water quality samples collected by the Respondents (U.S. Steel Corporation and Salomon Smith Barney Holdings, Inc.) and their consultant, A & M Engineering and Environmental Services, Inc. (A & M Engineering) at three different times from Drum Creek in the vicinity of the former National Zinc site, Cherryvale, Kansas.

The three sampling events referenced above are:

1. The sediment and water quality sampling conducted by A & M Engineering during June 24, 25 and 26th of 2003. The objective of this sampling event was to comply with the Phase II Work Plan pursuant to Kansas Department of Health and Environment's (KDHE) Consent Order No. 03-E-0022 (Consent Order). The analytical data resulting from this sampling event was provided to KDHE in the report titled "Analytical Report Surface Water Sediment and EPA Repository Soil Sampling" (Analytical Report) which was dated October 2003.

2. The sediment and water quality sampling conducted January 30, 2004. The purpose of this sampling event was to gather water quality data during the high water flow conditions in Drum Creek and also to collect a sediment sample from sediment accumulation downstream from the low water crossing.

3. The water quality sampling conducted March 1, 2004. The purpose of this sampling was to gather water quality data from Drum Creek during normal water flow conditions.

The second and third sampling events were conducted following receipt of verbal comments from KDHE on the Analytical Report that the first sampling event represented the low water flow conditions in Drum Creek and KDHE would require additional sampling representing the high water flow and normal water flow conditions of Drum Creek.

KDHE's concern was that during the high water flow conditions the sediments in Drum Creek would impact the water quality at a greater degree than the low water flow conditions. Respondents authorized A & M Engineering to observe the flow conditions and collect water quality samples during the high and normal water flow conditions in order to address KDHE's concerns.

The laboratory reports for the first sampling event are included in the Analytical Report. The laboratory reports for the second and third sampling events listed above are included in Appendix A. Pictures taken during the January 2004 sampling event are also included in Appendix A.

ANALYTICAL DATA

1. Drinking Water Standards

The purpose of collecting the additional water samples was to study the fluctuation, if any, of metal concentrations in stream water under high and normal flow conditions.

The laboratory data shown in Table 1 is a summary of three separate sampling events collected at varying levels of water flow in Drum Creek. In Table 1 the items in blue represent low water flow conditions; the items in red represents high water flow conditions and the items in black represents normal water flow conditions. Some of the samples were taken in identical spots at varying water levels. These areas are identified in the far right column in Table 1. The Maximum Contaminant Levels (MCL), as outlined in the EPA's Standard for Safe Drinking Water, are shown at the bottom of the table.

The sample marked "effluent" is the effluent discharge from the new City lagoons. The City discharge is located upstream from the mouth of the Unnamed Creek and was not in place at the time of the sampling reported in the Analytical Report. In Table 1, samples 1 through 6 were taken upstream from where Unnamed Creek empties into Drum Creek. Samples 7 and 8

were taken at the confluence of Unnamed Creek and Drum Creek. Samples 9 through 19 are taken downstream from the confluence of Unnamed and Drum Creeks.

The samples taken in identical locations at different water levels are samples 4 and 5; 7 and 8; 9 and 10; 14, 15 and 16; and 17 and 18.

Mercury and Arsenic are all below detection limits in all samples. Cadmium levels are all below detection limits with the exception of one at the mouth of Drum Creek during high flow. Chromium showed non-detect in all low water and normal water levels. Chromium was detected in all samples during high water flows, but was below its MCL. Lead concentrations showed non-detect in all low and normal water level flows. During high water flows, lead showed traces in the City effluent discharge, at the stream confluence, and 75 feet downstream from the mouth of Unnamed Creek. Zinc showed up sporadically in multiple samples in low and high water level conditions, but showed non-detect during normal water levels. Zinc in all cases was far below its MCL. Figure 1 shows the water sampling locations in Drum Creek.

2. Sediments

There were 10 original sediment samples taken from visible sediment areas in June 2003 during low water levels and included in the Analytical Report. There was one additional sediment sample taken January 30, 2004, during high water flow, 300 feet below the low water crossing. Samples 1 through 4 are upstream of Unnamed Creek. Sample 5 is at the confluence of Drum Creek and Unnamed Creek. Samples 6 through 8 are within 300 feet downstream of the confluence. Samples 5 through 8 combined take into account the first 300 feet at and below the confluence of Unnamed and Drum Creeks. Sample 9 is at the Main Street Bridge, approximately 1,000 feet downstream of the confluence. Sample 10 is at the low water crossing, approximately 6,000 feet downstream, and Sample 11 is 300 feet below the low water crossing. The sediment laboratory results are summarized in Table 2.

In Table 2 the laboratory results of samples within the first 300 feet downstream from the confluence with Unnamed Creek are shaded in light gray. Except for the samples in this 300 foot area, the constituents in all other samples resemble the background levels. Figure 2 shows the sediment sampling locations in Drum Creek.

3. Kansas Surface Water Quality Standards - Aquatic Life Criteria (KAR 28-16-28)

The Respondents, addressing the issues of aquatic life criteria for Drum Creek (under the Kansas Surface Water Quality Standards as adopted by reference and outlined in Article 16 of the KDHE regulations), have conducted calculations using the criteria in Table 1b of the regulations referenced above. The calculations are set forth in Appendix B, and the results of those calculations are set forth in Table 3. Sampling locations listed on Table 1 that were below detection limits are excluded from Table 3.

Data presented in Table 3 show the following: Cadmium had one occurrence above the chronic criteria at the confluence of Unnamed Creek and Drum Creek during high flow conditions. Mercury, Arsenic and Chromium were all below the acute and chronic criteria at all flow conditions. Lead had two occurrences above the chronic criteria levels. Both were during high flow water conditions. One is at the confluence of Drum Creek and the other is 75 feet below the confluence of Drum Creek. Zinc had one occurrence that was above both the acute and chronic criteria. It occurred at the confluence of Drum Creek during high water flow conditions. There were no exceedences for any metals under any flow conditions at all locations below 75 feet from the confluence with Unnamed Creek

OBSERVATIONS AND CONCLUSIONS

1. During low flow conditions, the segment of Drum Creek starting approximately 300 feet downstream from the mouth of Unnamed Creek and extending to the low water crossing is in the form of a long narrow pond. The ponding effect was created by the raised stream bottom elevations at the low water crossing and, possibly, at the bridge crossings located throughout this segment of the creek. During low water flow

conditions the only visible and accessible sediments in this segment of Drum Creek (between Unnamed Creek and the low water crossing) are those located within 300 feet downstream from the mouth of Unnamed Creek. Any other sediments are inundated even during low flow conditions.

2. The water quality has not been jeopardized in Drum Creek during all flow level conditions.

3. The metal concentrations in Drum Creek do not appear to be increasing with the flow rate with the exception of Lead and Chromium during high water flow.

4. Chromium exceeded detection levels in several samples during high water flow conditions. None the less, the levels of Chromium in Drum Creek under all of the flow conditions (low, normal and high) were below its MCL.

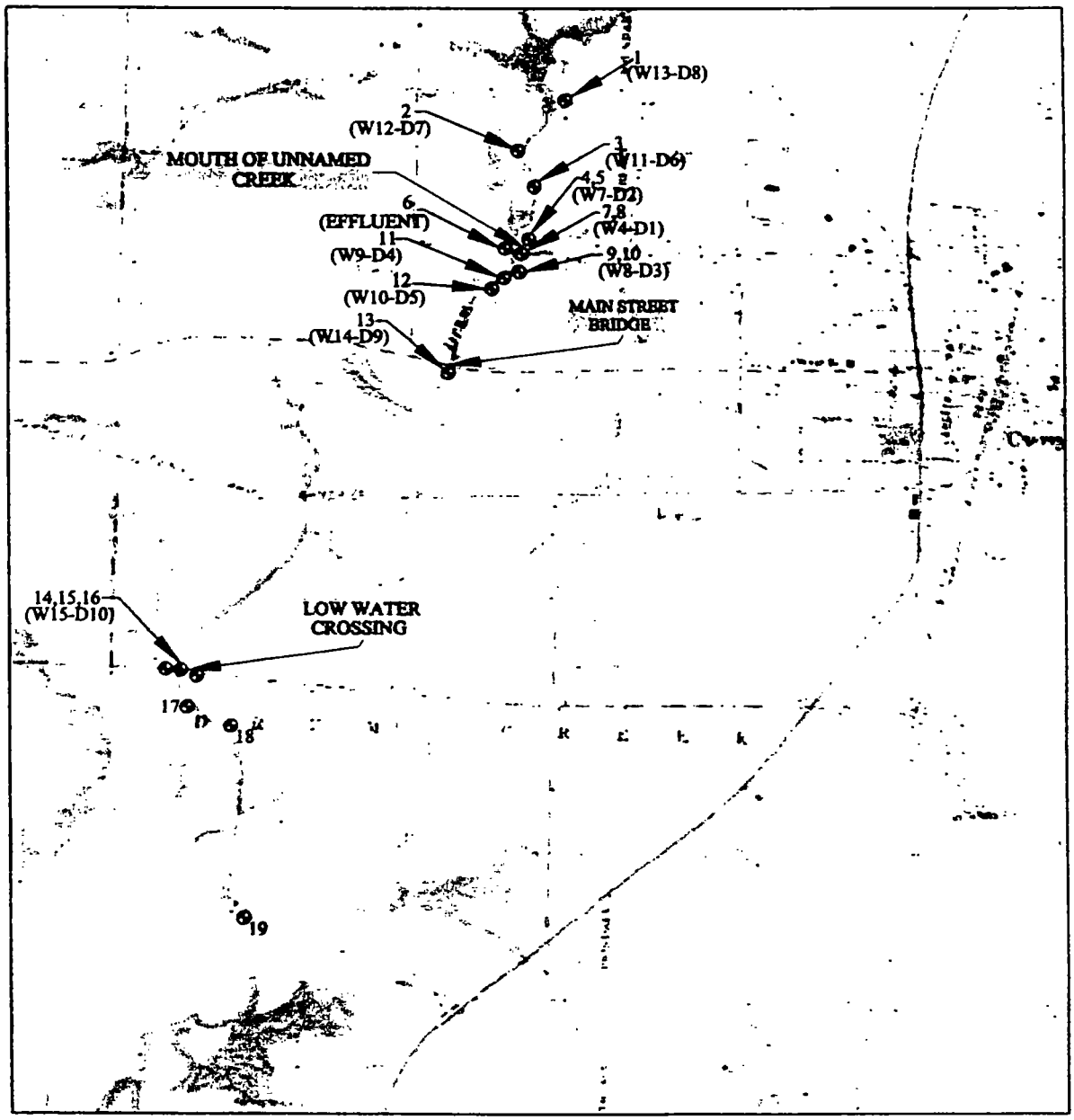
5. The trace amount of Lead detected in Sample 6 is from the new City treatment plant. The trace amounts detected in Samples 8 and 10 are within 75 feet of the confluence.

6. Except for the first 300 feet below the confluence of Unnamed and Drum Creeks, the sediment contamination levels appear to be very similar to background levels.

7. The sediments in Drum Creek do not present a risk to the drinking water quality, unless the sediments are disturbed.

8. The ponding in Drum Creek between the mouth of Unnamed Creek and the low water crossing, approximately 6,000 feet downstream, provides a natural control system that limits the distribution of the contaminated sediments downstream below the low water crossing.

9. All aquatic criteria exceedences were minor and occurred within 75 feet of the confluence of Drum Creek and Unnamed Creek.



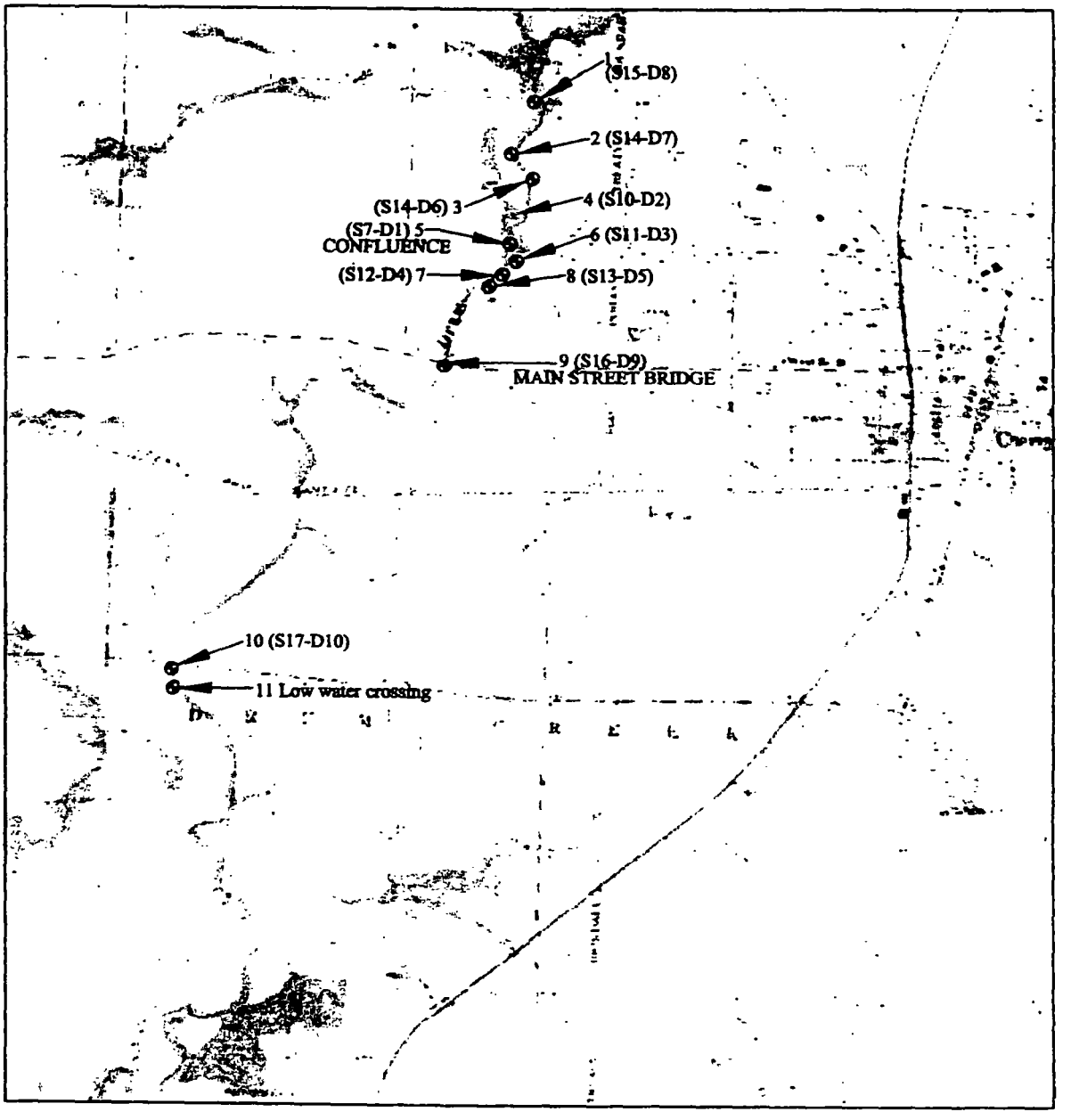
• SAMPLE POINTS

NORTH

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING – ENVIRONMENTAL – CONSTRUCTION

WATER QUALITY SAMPLING LOCATIONS FOR DRUM CREEK		
SCALE: NOT TO SCALE	DATE: 03/31/04	FIGURE NO. FIGURE 1
APPROVED BY: AME	DRAWN BY: TME	PROJECT NO. 1804-002-1002



⊙ SAMPLE POINTS

NORTH

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING — ENVIRONMENTAL — CONSTRUCTION

SEDIMENT SAMPLING LOCATIONS FOR DRUM CREEK		
SCALE: NOT TO SCALE	DATE: 03/31/04	FIGURE NO. FIGURE 2
APPROVED BY: AME	DRAWN BY: TME	PROJECT NO. 1804-002-1002

Table 1
Water Quality Alalytical Data
Drum Creek

Sampling point	Date	Mercury	Arsenic	Cadmium	Chromium	Lead	Zinc	Sampling locations
1	6/24/03	BDL	BDL	BDL	BDL	BDL	BDL	W13-D8
2	6/24/03	BDL	BDL	BDL	BDL	BDL	BDL	W12-D7
3	6/24/03	BDL	BDL	BDL	BDL	BDL	BDL	W11-D6
4	6/24/03	BDL	BDL	BDL	BDL	BDL	BDL	W7-D2
5	1/30/04	BDL	BDL	BDL	0.027	BDL	BDL	Upstream same location as #4
6	1/30/04	BDL	BDL	BDL	0.024	0.00938	0.034	Effluent
7	6/24/03	BDL	BDL	BDL	BDL	BDL	0.0322	W4-D1
8	1/30/04	BDL	BDL	0.0112	0.0961	0.0358	1.07	(Confluence) same location as #7
9	6/24/03	BDL	BDL	BDL	BDL	BDL	0.132	W8-D3
10	1/30/04	BDL	BDL	BDL	0.069	0.0251	0.0152	75FT Downstream same as #9
11	6/24/03	BDL	BDL	BDL	BDL	BDL	0.132	W9-D4
12	6/24/03	BDL	BDL	BDL	BDL	BDL	0.0544	W10-D5
13	6/24/03	BDL	BDL	BDL	BDL	BDL	BDL	W14-D9
14	6/24/03	BDL	BDL	BDL	BDL	BDL	0.0204	W15-D10
15	1/30/04	BDL	BDL	BDL	0.028	BDL	0.0205	Low water crossing same location as #14
16	3/1/04	BDL	BDL	BDL	BDL	BDL	BDL	Low water crossing same location as #'s 14 and 15
17	1/30/04	BDL	BDL	BDL	0.028	BDL	0.036	300FT Below low water crossing
18	3/1/04	BDL	BDL	BDL	BDL	BDL	BDL	300FT Below low water crossing same as #17
19	3/1/04	BDL	BDL	BDL	BDL	BDL	BDL	2 miles downstream

* Blue indicates low water levels and is reported in the Analytical Report
* Red indicates high water levels
* Black indicates normal water levels
Note: Parameters are in mg/L

MCL's

0.002	0	0.005	0.1	0	5

Table 2
Sediment Analytical Data
Drum Creek

Sampling point	Date	Mercury	Arsenic	Cadmium	Chromium	Lead	Zinc	Sampling location
1	6/24/03	0.038	2.3	1.8	8.68	8.87	49.9	S15-D8
2	6/24/03	0.052	1.81	1.7	8.2	16	81.2	S14-D7
3	6/24/03	0.18	3.17	2.55	9.7	24.5	94.6	S14-D6
4	6/24/03	0.086	7.16	4.63	13.9	20.6	78.8	S10-D2
5	6/24/03	0.13	30.7	430	14	473	10,300	(Confluence) S7-D1
6	6/24/03	0.099	11.4	90.4	11.7	144	3,680	S11-D3
7	6/24/03	0.12	13.9	73	13.5	223	5,950	S12-D4
8	6/24/03	0.1	8.84	71.1	18.6	109	1,520	300' downstream from #5 S13-D5
9	6/24/03	0.046	1.66	1.77	8.86	10.1	49.6	Main Street bridge S16-D9
10	6/24/03	0.051	18.5	14.3	11.6	48.2	517	Low water crossing S17-D10
11	1/30/04	BDL	6.76	2.99	14.6	9.73	24.9	300' below low water crossing

Note: Parameters are in mg/L

TABLE 3

Aquatic Life Support Criteria Calculations Based on K.A.R. 28-16-28

			Cadmium			Chromium		
Sample ID	**WER**	**Hardness**	(µg/L)	Acute Criterion	Chronic Criterion	(µg/L)	Acute Criterion	Chronic Criterion
W7-D2	1	240		12.1	4.90		3693	177
W7-D2 (H)	1	**240**		12.1	4.90	27	3693	177
Effluent	1	***220***		11.0	4.57	24	3439	164
W4-D1	1	240		12.1	4.90		3693	177
W4-D1 (H)	1	**240**	11.2	12.1	4.90	96.1	3693	177
W8-D3	1	240		12.1	4.90		3693	177
W8-D3 (H)	1	**240**		12.1	4.90	69	3693	177
W9-D4	1	230		11.6	4.73		3567	170
W10-D5	1	240		12.1	4.90		3693	177
W14-D9	1	250		12.7	5.06		3819	183
W15-D10	1	220		11.0	4.57		3439	164
W15-D10 (H)	1	**220**		11.0	4.57	28	3439	164
LWC-300	1							

			Lead			Zinc		
Sample ID	**WER**	**Hardness**	(µg/L)	Acute Criterion	Chronic Criterion	(µg/L)	Acute Criterion	Chronic Criterion
W7-D2	1	240		249	9.7		252	252
W7-D2 (H)	1	**240**		249	9.7		252	252
Effluent	1	***220***	9.38	223	8.7	34	234	234
W4-D1	1	240		249	9.7	32.2	252	252
W4-D1 (H)	1	**240**	35.8	249	9.7	1070	252	252
W8-D3	1	240		249	9.7	132	252	252
W8-D3 (H)	1	**240**	25.1	249	9.7	15.2	252	252
W9-D4	1	230		236	9.2	132	243	243
W10-D5	1	240		249	9.7	54.4	252	252
W14-D9	1	250		262	10.2		260	260
W15-D10	1	220		223	8.7	20.4	234	234
W15-D10 (H)	1	**220**		223	8.7	20.5	234	234
LWC-300								

APPENDIX A

#1

Original background location (5200 Street Bridge) looking south.

#2

Looking upstream from old sample point just above City discharge.

#3

Sample point upstream of Unnamed Creek is also old sample point just above City discharge

#4

Effluent from City lagoons.

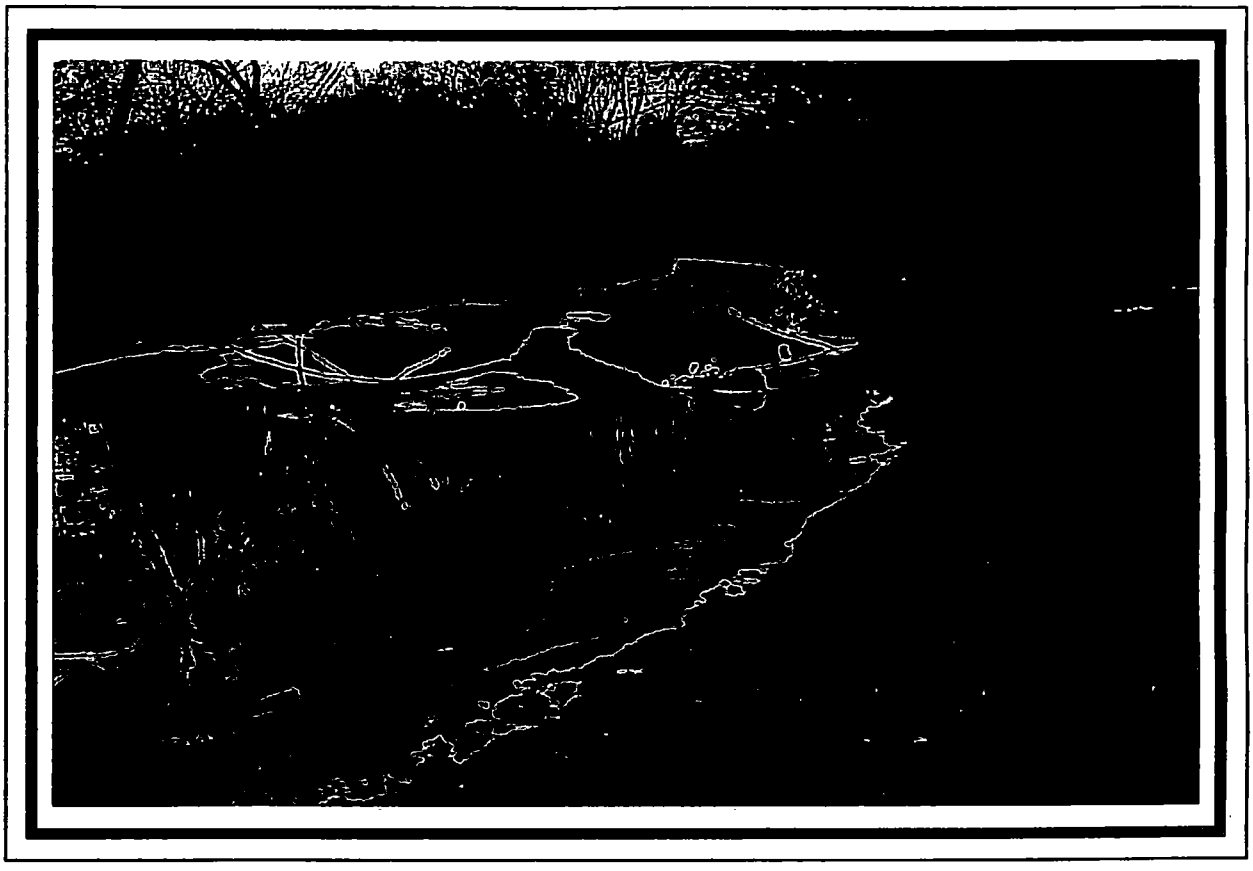
#5

Mouth of Unnamed Creek.

#6

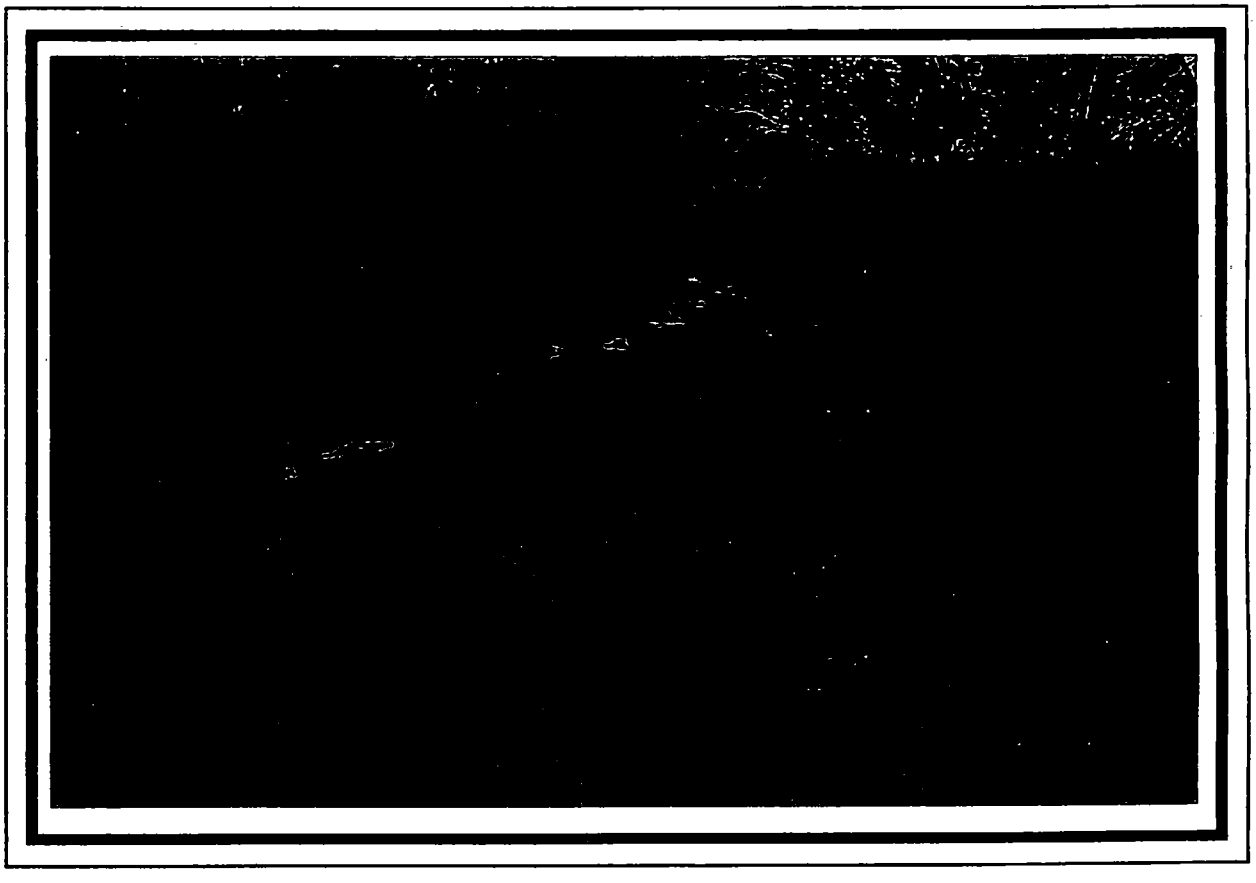
Sediment pile ~300′ downstream of Unnamed Creek.

#7



View looking downstream from previous picture (#6).

#8



Looking north from Main Street Bridge toward picture #7 leave-off point.

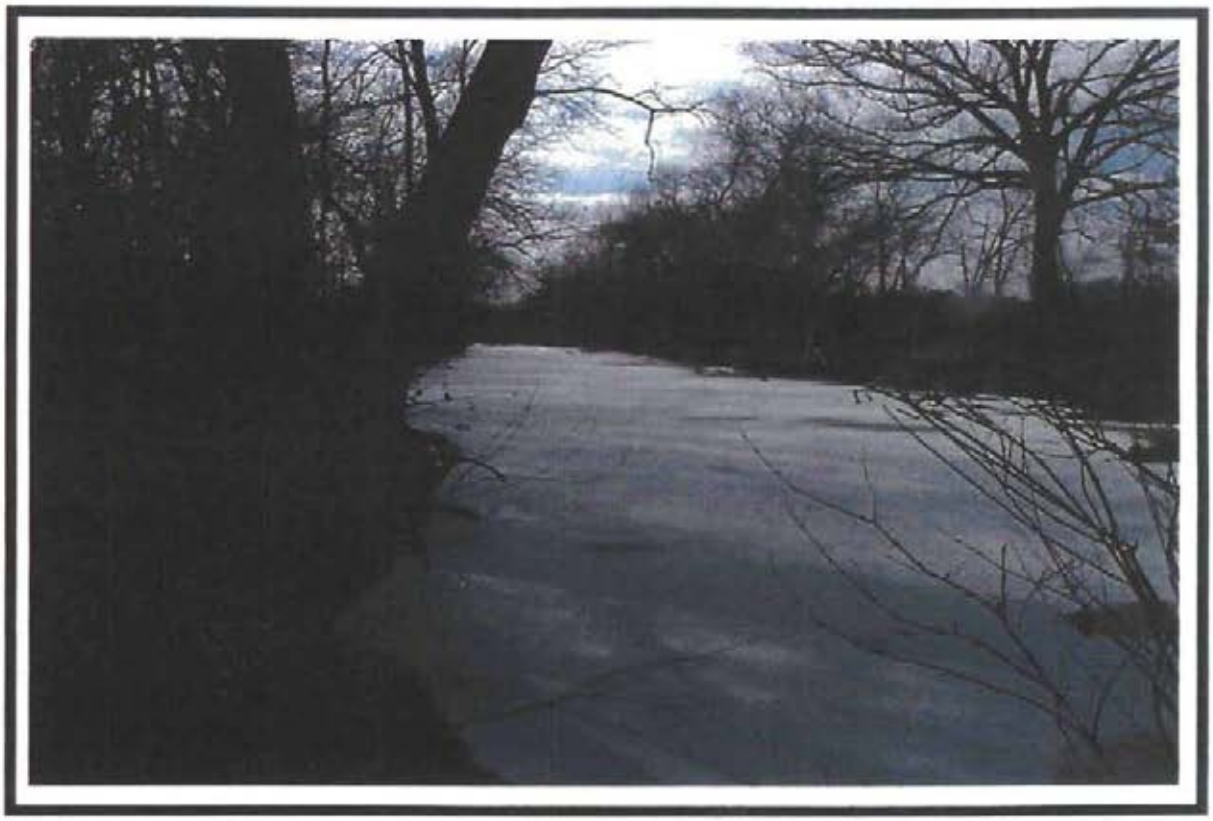
#9

Looking south from Main Street Bridge original sample point labeled 1000′ downstream from Unnamed Creek.

#10

One half mile north of low water crossing looking north

#11



Same location as picture #10 looking south toward low water crossing.

#12

Typical side-slope bank of Drum Creek.

#13

Low water crossing looking north.

#14

Low water crossing looking south toward sample point.

#15

Approximately 100 yards south of low water crossing looking downstream.

#16

Looking north at low water crossing from sample point.

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Tulsa OK 74145
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(800)324-5757

Irfan Taner
A & M Engineering
10010 E. 16th St.
Tulsa, OK 74128-4813
TEL: (918)665-6574
FAX ( ) 665-6576

February 10, 2004
Order No.: T04010372

RE: Cherryvale

Dear Irfan Taner:

Sherry Laboratories received 7 samples on 1/30/2004 for the analyses presented in the following report.

In accordance with your instructions, Sherry Laboratories/Oklahoma conducted the analysis shown on the following pages on samples submitted by your company. The results related only to the items tested. Unless otherwise noted, all analysis was conducted using EPA approved methodologies. Test reports meet all the NELAC requirements. All relevant sampling information is on the attached chain-of-custody form. The initials SUB as the analyst designate any testing sub-contracted by SLO.

Certifications/Accreditation: OK - 7604
AR - ADEQ
KS - E-10232
LA - 4002

A scope of Certified/Accredited parameters is available upon request. If you have any questions regarding these tests results, please feel free to call.

Sincerely.

Approved By:

Brian Duzan. Director
Environmental Services

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Tulsa OK 74145
(918)828-9977

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Fax: (918)828-7756
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CLIENT: A & M Engineering
Lab Order: T04010372 **Date Received:** 1/30/2004
Project: Cherryvale **Date Reported:** *10-Feb-04*

Lab ID: T04010372-01 Collection Date: 1/30/2004 11:00:00 A Sample ID: Effluent

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL		**E245.2**			**KR**
Mercury	< 0.000100	0.000100	mg/L	2/2/2004	
METALS IN WATER BY ICP, TOTAL		**E200.7**			**KR**
Arsenic	< 0.00500	0.00500	mg/L	2/3/2004 3:27:10 P	
Cadmium	< 0.00100	0.00100	mg/L	2/3/2004 3:27:10 P	
Chromium	0.0240	0.0100	mg/L	2/3/2004 3:27:10 P	
Lead	0.00938	0.00500	mg/L	2/3/2004 3:27:10 P	
Silver	< 0.00200	0.00200	mg/L	2/3/2004 3:27:10 P	
Zinc	0.0340	0.0100	mg/L	2/3/2004 3:27:10 P	
TOTAL SUSPENDED SOLIDS		**E160.2**			**PB**
Suspended Solids (Residue, Non-Filterable)	34.0	10.0	mg/L	2/4/2004 9:55:00 A	

Lab ID: T04010372-02 Collection Date: 1/30/2004 1:30:00 PM Sample ID: Low Water Crossing

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL		**E245.2**			**KR**
Mercury	< 0.000100	0.000100	mg/L	2/2/2004	
METALS IN WATER BY ICP, TOTAL		**E200.7**			**KR**
Arsenic	< 0.00500	0.00500	mg/L	2/3/2004 3:32:05 P	
Cadmium	< 0.00100	0.00100	mg/L	2/3/2004 3:32:05 P	
Chromium	0.0280	0.0100	mg/L	2/3/2004 3:32:05 P	
Lead	< 0.00500	0.00500	mg/L	2/3/2004 3:32:05 P	
Silver	< 0.00200	0.00200	mg/L	2/3/2004 3:32:05 P	
Zinc	0.0205	0.0100	mg/L	2/3/2004 3:32:05 P	
TOTAL SUSPENDED SOLIDS		**E160.2**			**PB**
Suspended Solids (Residue, Non-Filterable)	8.00	5.00	mg/L	2/4/2004 9:55:00 A	

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CLIENT: A & M Engineering
Lab Order: T04010372 **Date Received:** 1/30/2004
Project: Cherryvale **Date Reported:** *10-Feb-04*

Lab ID: T04010372-03 Collection Date: 1/30/2004 1:50:00 PM Sample ID: Downstream

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL		**E245.2**			**KR**
Mercury	< 0.000100	0.000100	mg/L	2/2/2004	
METALS IN WATER BY ICP, TOTAL		**E200.7**			**KR**
Arsenic	< 0.00500	0.00500	mg/L	2/3/2004 3:37:00 P	
Cadmium	< 0.00100	0.00100	mg/L	2/3/2004 3:37:00 P	
Chromium	0.0280	0.0100	mg/L	2/3/2004 3:37:00 P	
Lead	< 0.00500	0.00500	mg/L	2/3/2004 3:37:00 P	
Silver	< 0.00200	0.00200	mg/L	2/3/2004 3:37:00 P	
Zinc	0.0360	0.0100	mg/L	2/3/2004 3:37:00 P	
TOTAL SUSPENDED SOLIDS		**E160.2**			**PB**
Suspended Solids (Residue, Non-Filterable)	39.0	5.00	mg/L	2/4/2004 9:55:00 A	

Lab ID: T04010372-04 Collection Date: 1/30/2004 11:45:00 A Sample ID: Upstream

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL		**E245.2**			**KR**
Mercury	< 0.000100	0.000100	mg/L	2/2/2004	
METALS IN WATER BY ICP, TOTAL		**E200.7**			**KR**
Arsenic	< 0.00500	0.00500	mg/L	2/3/2004 3:41:49 P	
Cadmium	< 0.00100	0.00100	mg/L	2/3/2004 3:41:49 P	
Chromium	0.0270	0.0100	mg/L	2/3/2004 3:41:49 P	
Lead	< 0.00500	0.00500	mg/L	2/3/2004 3:41:49 P	
Silver	< 0.00200	0.00200	mg/L	2/3/2004 3:41:49 P	
Zinc	< 0.0100	0.0100	mg/L	2/3/2004 3:41:49 P	
TOTAL SUSPENDED SOLIDS		**E160.2**			**PB**
Suspended Solids (Residue, Non-Filterable)	7.00	5.00	mg/L	2/4/2004 9:55:00 A	

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CLIENT: A & M Engineering
Lab Order: T04010372 **Date Received:** 1/30/2004
Project: Cherryvale **Date Reported:** *10-Feb-04*

Lab ID: T04010372-05 Collection Date: 1/30/2004 12:15:00 P Sample ID: Unnamed Creek

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL		**E245.2**			**KR**
Mercury	< 0.000100	0.000100	mg/L	2/2/2004	
METALS IN WATER BY ICP, TOTAL		**E200.7**			**KR**
Arsenic	< 0.00500	0.00500	mg/L	2/5/2004 11:45:03	
Cadmium	0.0112	0.00100	mg/L	2/5/2004 11:45:03	
Chromium	0.0961	0.0100	mg/L	2/5/2004 11:45:03	
Lead	0.0358	0.00500	mg/L	2/5/2004 11:45:03	
Silver	< 0.00200	0.00200	mg/L	2/5/2004 11:45:03	
Zinc	1.07	0.0100	mg/L	2/5/2004 11:45:03	

Lab ID: T04010372-06 Collection Date: 1/30/2004 12:05:00 P Sample ID: 75 Foot

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL		**E245.2**			**KR**
Mercury	< 0.000100	0.000100	mg/L	2/2/2004	
METALS IN WATER BY ICP, TOTAL		**E200.7**			**KR**
Arsenic	< 0.00500	0.00500	mg/L	2/5/2004 12:19:42	
Cadmium	< 0.00100	0.00100	mg/L	2/5/2004 12:19:42	
Chromium	0.0690	0.0100	mg/L	2/5/2004 12:19:42	
Lead	0.0251	0.00500	mg/L	2/5/2004 12:19:42	
Silver	< 0.00200	0.00200	mg/L	2/5/2004 12:19:42	
Zinc	0.0152	0.0100	mg/L	2/5/2004 12:19:42	
TOTAL SUSPENDED SOLIDS		**E160.2**			**PB**
Suspended Solids (Residue, Non-Filterable)	13.0	5.00	mg/L	2/4/2004 9:55:00 A	

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CLIENT: A & M Engineering
Lab Order: T04010372
Project: Cherryvale

Date Received: 1/30/2004
Date Reported: *10-Feb-04*

Lab ID: T04010372-07 Collection Date: 1/30/2004 1:50:00 PM Sample ID: Downstream Solid

Matrix: SOLID

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		**SW7471**				**KR**
Mercury	< 0.025		0.025	mg/Kg	2/3/2004	
METALS IN SOIL OR SLUDGE BY ICP		**SW6010A**				**KR**
Arsenic	6.76		0.500	mg/Kg	2/9/2004	
Cadmium	2.99		0.250	mg/Kg	2/9/2004	
Chromium	14.6		0.250	mg/Kg	2/9/2004	
Lead	9.73		0.125	mg/Kg	2/9/2004	
Silver	< 0.0500		0.0500	mg/Kg	2/9/2004	
Zinc	24.9		0.250	mg/Kg	2/9/2004	
PH IN SOIL		**SW9045C**				**PB**
pH	7.09		0.10	pH Units	2/2/2004 2:16:00 P	

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Sherry Laboratories

Date: *10-Feb-04*

CLIENT: A & M Engineering
Work Order: T04010372
Project: Cherryvale

QC SUMMARY REPORT

TestCode	Analyte	BatchID	QCType	Result	PQL	Units	%Rec	%RPD
HG_S	Mercury	R17390	MBLK	< 0.025	0.025	mg/Kg		
	Mercury	R17390	LCS	0.2482	0.025	mg/Kg	99.3	
	Mercury	R17390	MS	0.2389	0.025	mg/Kg	95.6	
	Mercury	R17390	MSD	0.2618	0.025	mg/Kg	105	9.15
HG_WW	Mercury	R17380	MBLK	< 0.00010	0.0001	mg/L		
	Mercury	R17380	LCS	0.001057	0.0001	mg/L	106	
	Mercury	R17380	MS	0.00099	0.0001	mg/L	99	
	Mercury	R17380	MSD	0.000993	0.0001	mg/L	99.3	0.303
MET_S_ICP	Arsenic	R17461	MBLK	< 0.50	0.5	mg/Kg		
	Cadmium	R17461	MBLK	< 0.25	0.25	mg/Kg		
	Chromium	R17461	MBLK	< 0.25	0.25	mg/Kg		
	Lead	R17461	MBLK	< 0.12	0.125	mg/Kg		
	Silver	R17461	MBLK	< 0.050	0.05	mg/Kg		
	Zinc	R17461	MBLK	< 0.25	0.25	mg/Kg		
	Arsenic	R17461	LCS	1.939	0.5	mg/Kg	97	
	Arsenic	R17461	LCS	1.976	0.5	mg/Kg	98.8	1.89
	Cadmium	R17461	LCS	1.982	0.25	mg/Kg	99.1	
	Cadmium	R17461	LCS	2.019	0.25	mg/Kg	101	1.85
	Chromium	R17461	LCS	2.01	0.25	mg/Kg	100	2.16
	Chromium	R17461	LCS	1.967	0.25	mg/Kg	98.4	
	Lead	R17461	LCS	1.977	0.125	mg/Kg	98.8	
	Lead	R17461	LCS	2.017	0.125	mg/Kg	101	2
	Silver	R17461	LCS	0.199	0.05	mg/Kg	99.5	2.03
	Silver	R17461	LCS	0.195	0.05	mg/Kg	97.5	
	Zinc	R17461	LCS	2.006	0.25	mg/Kg	100	1.41
	Zinc	R17461	LCS	1.978	0.25	mg/Kg	98.9	
	Arsenic	R17461	MS	2.074	0.5	mg/Kg	104	
	Cadmium	R17461	MS	2.16	0.25	mg/Kg	108	
	Chromium	R17461	MS	2.116	0.25	mg/Kg	106	
	Lead	R17461	MS	2.15	0.125	mg/Kg	108	
	Silver	R17461	MS	0.208	0.05	mg/Kg	104	
	Zinc	R17461	MS	2.172	0.25	mg/Kg	109	
	Arsenic	R17461	MSD	2.08	0.5	mg/Kg	104	0.289
	Cadmium	R17461	MSD	2.181	0.25	mg/Kg	109	0.968
	Chromium	R17461	MSD	2.124	0.25	mg/Kg	106	0.377
	Lead	R17461	MSD	2.172	0.125	mg/Kg	109	1.02
	Silver	R17461	MSD	0.21	0.05	mg/Kg	105	0.957
	Zinc	R17461	MSD	2.191	0.25	mg/Kg	110	0.871
MET_WW_ICP	Arsenic	1759	mblk	< 0.0050	0.005	mg/L		
	Arsenic	1763	mblk	< 0.0050	0.005	mg/L		
	Cadmium	1759	mblk	< 0.0010	0.001	mg/L		
	Cadmium	1763	mblk	< 0.0010	0.001	mg/L		
	Chromium	1759	mblk	< 0.010	0.01	mg/L		
	Chromium	1763	mblk	< 0.010	0.01	mg/L		
	Lead	1759	mblk	< 0.0050	0.005	mg/L		
	Lead	1763	mblk	< 0.0050	0.005	mg/L		
	Silver	1759	mblk	< 0.0020	0.002	mg/L		
	Silver	1763	mblk	< 0.0020	0.002	mg/L		
	Zinc	1759	mblk	< 0.010	0.01	mg/L		

CLIENT: A & M Engineering
Work Order: T04010372
Project: Cherryvale

QC SUMMARY REPORT

TestCode	Analyte	BatchID	QCType	Result	PQL	Units	%Rec	%RPD
	Zinc	1763	mblk	< 0.010	0.01	mg/L		
	Arsenic	1759	lcs	1.965	0.005	mg/L	98.3	
	Arsenic	1763	lcs	2.009	0.005	mg/L	100	
	Cadmium	1759	lcs	1.974	0.001	mg/L	98.7	
	Cadmium	1763	lcs	2.008	0.001	mg/L	100	
	Chromium	1759	lcs	1.992	0.01	mg/L	99.6	
	Chromium	1763	lcs	2.088	0.01	mg/L	104	
	Lead	1759	lcs	2.043	0.005	mg/L	102	
	Lead	1763	lcs	2.108	0.005	mg/L	105	
	Silver	1759	lcs	0.1999	0.002	mg/L	99.9	
	Silver	1763	lcs	0.2058	0.002	mg/L	103	
	Zinc	1759	lcs	1.978	0.01	mg/L	98.9	
	Zinc	1763	lcs	2.028	0.01	mg/L	101	
	Arsenic	1759	ms	2.004	0.005	mg/L	100	
	Arsenic	1763	ms	2.165	0.005	mg/L	108	
	Cadmium	1759	ms	1.991	0.001	mg/L	99.5	
	Cadmium	1763	ms	2.122	0.001	mg/L	106	
	Chromium	1759	ms	1.995	0.01	mg/L	98.8	
	Chromium	1763	ms	2.129	0.01	mg/L	102	
	Lead	1759	ms	1.984	0.005	mg/L	97.7	
	Lead	1763	ms	2.077	0.005	mg/L	102	
	Silver	1759	ms	0.202	0.002	mg/L	99.3	
	Silver	1763	ms	0.2107	0.002	mg/L	105	
	Zinc	1759	ms	2.046	0.01	mg/L	101	
	Zinc	1763	ms	3.138	0.01	mg/L	103	
	Arsenic	1759	msd	1.99	0.005	mg/L	99.5	0.702
	Arsenic	1763	msd	2.159	0.005	mg/L	108	0.303
	Cadmium	1759	msd	1.982	0.001	mg/L	99.1	0.416
	Cadmium	1763	msd	2.111	0.001	mg/L	105	0.508
	Chromium	1759	msd	1.983	0.01	mg/L	98.2	0.6
	Chromium	1763	msd	2.138	0.01	mg/L	102	0.427
	Lead	1759	msd	1.961	0.005	mg/L	96.6	1.13
	Lead	1763	msd	2.08	0.005	mg/L	102	0.119
	Silver	1759	msd	0.2004	0.002	mg/L	98.5	0.775
	Silver	1763	msd	0.2086	0.002	mg/L	104	1
	Zinc	1759	msd	2.033	0.01	mg/L	100	0.623
	Zinc	1763	msd	3.125	0.01	mg/L	103	0.42
PH_S	pH	R17376	DUP	7.09	0.1	pH Units	0	0
TSS	Suspended Solids (Residue, Non-Filt	R17429	MBLK	< 5.0	5	mg/L		
	Suspended Solids (Residue, Non-Filt	R17429	LCS	85	5	mg/L	96.3	
	Suspended Solids (Residue, Non-Filt	R17429	DUP	17	5	mg/L	0	6.06
	Suspended Solids (Residue, Non-Filt	R17429	DUP	164	10	mg/L	0	1.21

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Page 1 of 1

Chain of Custody Record

Laboratory Number: 104010372

Client Name: Ontm

Contact Name: Irfan Tanner

Phone/Fax:

Project Name: 1804-002 Chemvale.

Project #: Jon Kuhn

Sampler's Signature:

Collection Date	Collection Time	Grab	Comp	Sample Identification / Description	Preservative	Number / Type of Container	Matrix Code	TSS	Mercury	Cadmium	Zinc	Arsenic	Chromium	Lead	Silver	Test Requested	Comments / Remarks
1-30/04	11:00	1		effluent		2	Liq	X	X	X	X	X	X	X	X		pH on sediment
1-30/04	13:30			low water crossing		2	Liq	X	X	X	X	X	X	X	X		
1-30/04	13:50			Downstream		3	Soil Liq	X	X	X	X	X	X	X	X		1 sediment.
1-30/04	11:45			upstream		2	Liq	X	X	X	X	X	X	X	X		
1-30/04	12:15			Unnamed Creek		2	Liq	X	X	X	X	X	X	X	X		Unnamed creek was not running for TSS. Client was notified.
1-30/04	12:05			75 foot		2	Liq	X	X	X	X	X	X	X	X		

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All samples submitted to Sherry Laboratories for analysis are accepted on a custodial basis only. Ownership of the material remains with the client submitting the samples. Sherry Laboratories reserves the right to return unused sample portions.

P.O. Number

Relinquished by: (Signature)	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Received by: (Signature)	Date	Time
Relinquished by: (Signature)	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Received by Laboratory: (Signature)	Date	Time
				Jon Kuhn	[illegible]	1/30/04	1700

Matrix Codes
DW = Drinking Water, MW = Monitoring Well
WW = Waste Water, SL = Sludge
SO = Soil, O = Oil, OT = Other

Container Types
G = Glass
P = Plastic

Shipping Conditions
☐ Iced
Temp. ____
☐ Ambient

Which Regulations Apply
☐ RCRA ☐ Drinking Water
☐ POTW ☐ Other ____
☐ NPDES

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CLIENT: A & M Engineering
Lab Order: T04010347 **Date Received:** 1/29/2004
Project: Cherryvale **Date Reported:** *10-Feb-04*

Lab ID: T04010347-01 Collection Date: 1/28/2004 5:30:00 PM Sample ID: Drum Creek

Matrix: AQUEOUS

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL		**E245.2**				**KR**
Mercury	< 0.000100		0.000100	mg/L	2/2/2004	
METALS IN WATER BY ICP, TOTAL		**E200.7**				**KR**
Arsenic	< 0.00500		0.00500	mg/L	2/2/2004 8:57:28 P	
Cadmium	< 0.00100		0.00100	mg/L	2/2/2004 8:57:28 P	
Chromium	0.139		0.0100	mg/L	2/2/2004 8:57:28 P	
Lead	< 0.00500		0.00500	mg/L	2/2/2004 8:57:28 P	
Silver	< 0.00200		0.00200	mg/L	2/2/2004 8:57:28 P	
Zinc	< 0.0100		0.0100	mg/L	2/2/2004 8:57:28 P	
TOTAL SUSPENDED SOLIDS		**E160.2**				**PB**
Suspended Solids (Residue, Non-Filterable)	8.00		5.00	mg/L	2/2/2004 3:45:00 P	

Lab ID: T04010347-02 Collection Date: 1/28/2004 5:30:00 PM Sample ID: Drum Creek

Matrix: SOIL

Analyses	Result		Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN SOIL OR SLUDGE		**SW7471**				**KR**
Mercury	< 0.025		0.025	mg/Kg	2/3/2004	
METALS IN SOIL OR SLUDGE BY ICP		**SW6010A**				**KR**
Arsenic	26.9		0.500	mg/Kg	2/2/2004	
Cadmium	15.7		0.250	mg/Kg	2/2/2004	
Chromium	19.3		0.250	mg/Kg	2/2/2004	
Lead	40.6		0.125	mg/Kg	2/2/2004	
Zinc	960		2.50	mg/Kg	2/2/2004	
PH IN SOIL		**SW9045C**				**PB**
pH	6.61		0.10	pH Units	1/30/2004 10:58:0	

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Sherry Laboratories

Date: *10-Feb-04*

CLIENT: A & M Engineering
Work Order: T04010347
Project: Cherryvale

QC SUMMARY REPORT

TestCode	Analyte	BatchID	QCType	Result	PQL	Units	%Rec	%RPD
HG_S	Mercury	R17390	MBLK	< 0.025	0.025	mg/Kg		
	Mercury	R17390	LCS	0.2482	0.025	mg/Kg	99.3	
	Mercury	R17390	MS	0.2389	0.025	mg/Kg	95.6	
	Mercury	R17390	MSD	0.2618	0.025	mg/Kg	105	9.15
HG_WW	Mercury	R17380	MBLK	< 0.00010	0.0001	mg/L		
	Mercury	R17380	LCS	0.001057	0.0001	mg/L	106	
	Mercury	R17380	MS	0.00099	0.0001	mg/L	99	
	Mercury	R17380	MSD	0.000993	0.0001	mg/L	99.3	0.303
MET_S_ICP	Arsenic	1756	MBLK	< 0.50	0.5	mg/Kg		
	Cadmium	1756	MBLK	< 0.25	0.25	mg/Kg		
	Chromium	1756	MBLK	< 0.25	0.25	mg/Kg		
	Lead	1756	MBLK	< 0.12	0.125	mg/Kg		
	Zinc	1756	MBLK	< 0.25	0.25	mg/Kg		
	Arsenic	1756	LCS	1.893	0.5	mg/Kg	94.6	
	Arsenic	1756	LCS	1.934	0.5	mg/Kg	96.7	2.14
	Cadmium	1756	LCS	1.951	0.25	mg/Kg	97.6	
	Cadmium	1756	LCS	1.986	0.25	mg/Kg	99.3	1.78
	Chromium	1756	LCS	2.132	0.25	mg/Kg	107	0.895
	Chromium	1756	LCS	2.113	0.25	mg/Kg	106	
	Lead	1756	LCS	1.916	0.125	mg/Kg	95.8	
	Lead	1756	LCS	1.962	0.125	mg/Kg	98.1	2.37
	Zinc	1756	LCS	1.959	0.25	mg/Kg	98	1.34
	Zinc	1756	LCS	1.933	0.25	mg/Kg	96.6	
	Arsenic	1756	MS	48.55	0.5	mg/Kg	97.1	
	Cadmium	1756	MS	52.14	0.25	mg/Kg	104	
	Chromium	1756	MS	60.91	0.25	mg/Kg	99.4	
	Lead	1756	MS	52.09	0.125	mg/Kg	104	
	Zinc	1756	MS	423.5	2.5	mg/Kg	82.6	
	Arsenic	1756	MSD	47.94	0.5	mg/Kg	95.9	1.26
	Cadmium	1756	MSD	51.42	0.25	mg/Kg	103	1.39
	Chromium	1756	MSD	58.48	0.25	mg/Kg	94.5	4.08
	Lead	1756	MSD	51.42	0.125	mg/Kg	103	1.29
	Zinc	1756	MSD	418.9	2.5	mg/Kg	73.3	1.1
MET_WW_ICP	Arsenic	1757	mblk	< 0.0050	0.005	mg/L		
	Cadmium	1757	mblk	< 0.0010	0.001	mg/L		
	Chromium	1757	mblk	< 0.010	0.01	mg/L		
	Lead	1757	mblk	< 0.0050	0.005	mg/L		
	Silver	1757	mblk	< 0.0020	0.002	mg/L		
	Zinc	1757	mblk	< 0.010	0.01	mg/L		
	Arsenic	1757	lcs	1.933	0.005	mg/L	96.6	
	Cadmium	1757	lcs	1.977	0.001	mg/L	98.8	
	Chromium	1757	lcs	2.289	0.01	mg/L	114	
	Lead	1757	lcs	1.971	0.005	mg/L	98.6	
	Silver	1757	lcs	0.1902	0.002	mg/L	95.1	
	Zinc	1757	lcs	1.971	0.01	mg/L	98.6	
	Arsenic	1757	ms	1.921	0.005	mg/L	96	
	Cadmium	1757	ms	1.942	0.001	mg/L	97.1	
	Chromium	1757	ms	2.273	0.01	mg/L	92.3	
	Lead	1757	ms	1.864	0.005	mg/L	93.2	

CLIENT: A & M Engineering
Work Order: T04010347
Project: Cherryvale

QC SUMMARY REPORT

.estCode	Analyte	BatchID	QCType	Result	PQL	Units	%Rec	%RPD
	Silver	1757	ms	0.1904	0.002	mg/L	95.2	
	Zinc	1757	ms	2.09	0.01	mg/L	101	
	Arsenic	1757	msd	1.952	0.005	mg/L	97.6	1.64
	Cadmium	1757	msd	1.963	0.001	mg/L	98.2	1.08
	Chromium	1757	msd	2.305	0.01	mg/L	93.8	1.39
	Lead	1757	msd	1.883	0.005	mg/L	94.2	1.01
	Silver	1757	msd	0.1937	0.002	mg/L	96.8	1.71
	Zinc	1757	msd	2.11	0.01	mg/L	102	0.934
PH_S	pH	R17349	DUP	6.6	0.1	pH Units	0	0.151
TSS	Suspended Solids (Residue, Non-Filt	R17387	MBLK	< 5.0	5	mg/L		
	Suspended Solids (Residue, Non-Filt	R17387	LCS	94	5	mg/L	106	
	Suspended Solids (Residue, Non-Filt	R17387	DUP	54	5	mg/L	0	3.64
	Suspended Solids (Residue, Non-Filt	R17387	DUP	78	10	mg/L	0	7.41

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Altay Ertugrul
A & M Engineering
10010 E. 16th St.
Tulsa, OK 74128-4813
TEL: (918) 665-6574
FAX ( ) 665-6576

March 05, 2004
Order No.: T04030012

RE: Cherryvale

Dear Altay Ertugrul:

Sherry Laboratories received 3 samples on 3/1/2004 for the analyses presented in the following report.

In accordance with your instructions, Sherry Laboratories/Oklahoma conducted the analysis shown on the following pages on samples submitted by your company. The results related only to the items tested. Unless otherwise noted, all analysis was conducted using EPA approved methodologies. Test reports meet all the NELAC requirements. All relevant sampling information is on the attached chain-of-custody form. The initials SUB as the analyst designate any testing sub-contracted by SLO.

Certifications/Accreditation: OK - 7604
AR - ADEQ
KS - E-10232
LA - 4002

A scope of Certified/Accredited parameters is available upon request. If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Approved By: _____
Brian Duzan, Director
Environmental Services

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CLIENT: A & M Engineering
Lab Order: T04030012 **Date Received:** 3/1/2004
Project: Cherryvale **Date Reported:** *05-Mar-04*

Lab ID: T04030012-01 Collection Date: 3/1/2004 12:00:00 PM Sample ID: Low Water Crossing

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	3/3/2004	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	3/4/2004 12:51:53	
Cadmium	< 0.00100	0.00100	mg/L	3/4/2004 12:51:53	
Chromium	< 0.0100	0.0100	mg/L	3/4/2004 12:51:53	
Lead	< 0.00500	0.00500	mg/L	3/4/2004 12:51:53	
Silver	< 0.00200	0.00200	mg/L	3/4/2004 12:51:53	
Zinc	< 0.0100	0.0100	mg/L	3/4/2004 12:51:53	

Lab ID: T04030012-02 Collection Date: 3/1/2004 12:10:00 PM Sample ID: Below Low Water Crossing

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	3/3/2004	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	3/4/2004 1:21:34 P	
Cadmium	< 0.00100	0.00100	mg/L	3/4/2004 1:21:34 P	
Chromium	< 0.0100	0.0100	mg/L	3/4/2004 1:21:34 P	
Lead	< 0.00500	0.00500	mg/L	3/4/2004 1:21:34 P	
Silver	< 0.00200	0.00200	mg/L	3/4/2004 1:21:34 P	
Zinc	< 0.0100	0.0100	mg/L	3/4/2004 1:21:34 P	

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CLIENT: A & M Engineering
Lab Order: T04030012 **Date Received:** 3/1/2004
Project: Cherryvale **Date Reported:** *05-Mar-04*

Lab ID: T04030012-03 Collection Date: 3/1/2004 2:10:00 PM Sample ID: Downstream

Matrix: AQUEOUS

Analyses	Result	Detection Limit	Units	Date Analyzed	Analyst
MERCURY IN WATER, TOTAL	**E245.2**				**KR**
Mercury	< 0.000100	0.000100	mg/L	3/3/2004	
METALS IN WATER BY ICP, TOTAL	**E200.7**				**KR**
Arsenic	< 0.00500	0.00500	mg/L	3/4/2004 1:26:32	P
Cadmium	< 0.00100	0.00100	mg/L	3/4/2004 1:26:32	P
Chromium	< 0.0100	0.0100	mg/L	3/4/2004 1:26:32	P
Lead	< 0.00500	0.00500	mg/L	3/4/2004 1:26:32	P
Silver	< 0.00200	0.00200	mg/L	3/4/2004 1:26:32	P
Zinc	< 0.0100	0.0100	mg/L	3/4/2004 1:26:32	P

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Sherry Laboratories

Date: *05-Mar-04*

CLIENT: A & M Engineering
Work Order: T04030012
Project: Cherryvale

QC SUMMARY REPORT

TestCode	Analyte	BatchID	QCType	Result	PQL	Units	%Rec	%RPD
HG_WW	Mercury	R17711	MBLK	< 0.00010	0.0001	mg/L		
	Mercury	R17711	LCS	0.001029	0.0001	mg/L	103	
	Mercury	R17711	MS	0.001024	0.0001	mg/L	102	
	Mercury	R17711	MSD	0.001028	0.0001	mg/L	103	0.39
met_ww_icpt	Arsenic	1799	mblk	< 0.0050	0.005	mg/L		
	Cadmium	1799	mblk	< 0.0010	0.001	mg/L		
	Chromium	1799	mblk	< 0.010	0.01	mg/L		
	Lead	1799	mblk	< 0.0050	0.005	mg/L		
	Silver	1799	mblk	< 0.0020	0.002	mg/L		
	Zinc	1799	mblk	< 0.010	0.01	mg/L		
	Arsenic	1799	lcs	1.935	0.005	mg/L	96.8	
	Cadmium	1799	lcs	2.066	0.001	mg/L	103	
	Chromium	1799	lcs	1.963	0.01	mg/L	98.2	
	Lead	1799	lcs	1.944	0.005	mg/L	97.2	
	Silver	1799	lcs	0.1978	0.002	mg/L	98.9	
	Zinc	1799	lcs	1.926	0.01	mg/L	96.3	
	Arsenic	1799	ms	2.022	0.005	mg/L	101	
	Cadmium	1799	ms	2.061	0.001	mg/L	103	
	Chromium	1799	ms	1.962	0.01	mg/L	98.1	
	Lead	1799	ms	1.872	0.005	mg/L	93.6	
	Silver	1799	ms	0.1958	0.002	mg/L	97.9	
	Zinc	1799	ms	1.941	0.01	mg/L	97	
	Arsenic	1799	msd	2.015	0.005	mg/L	101	0.304
	Cadmium	1799	msd	2.06	0.001	mg/L	103	0.0674
	Chromium	1799	msd	1.964	0.01	mg/L	98.2	0.121
	Lead	1799	msd	1.874	0.005	mg/L	93.7	0.0889
	Silver	1799	msd	0.195	0.002	mg/L	97.5	0.417
	Zinc	1799	msd	1.933	0.01	mg/L	96.6	0.42

TO-1030012

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

TULSA, OKLAHOMA

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

10010 E. 16th Street - TULSA, OKLAHOMA 74128-4813
TEL: (918)665-6575 FAX: (918)665-6576 E-Mail: aandm@aandmengineering.com

SAMPLING FIRM	CLIENT CONTACT	PHONE NUMBER
A & M ENGINEERING	Altay E.	(918) 665-6575

PROJECT NUMBER	PROJECT NAME
1804-002	Cherryvale

SAMPLERS: (Signature) Jon Kuhn

ANALYTICAL TESTS REQUIRED

STA. NO	DATE	TIME	COMP	GRAB	STATION LOCATION	MATRIX	NO. OF CONTAINERS	RUSH ? YES	RUSH ? NO	Cadmium	Arsenic	Lead	Zinc	Chromium	Mercury	Silver						REMARKS
	3-1-04	12:00		✓	Low Water Crossing	L.q	1		X	X	X	X	X	X	X	X						
	3-1-04	12:10		✓	Below Low Water Crossing	L.q	1		X	X	X	X	X	X	X	X						
	3-1-04	14:10		✓	Downstream	L.q	1		X	X	X	X	X	X	X	X						

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
				Jon Kuhn	3/1/04	16:12	[illegible]
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	REMARKS:			

APPENDIX B

Table 1b. Formulae for calculation of hardness-dependent aquatic life support criteria for chromium III and total cadmium, total copper, total lead, total nickel, total silver and total zinc and pHdependent aquatic life support criteria for pentachlorophenol. A WER value of 1.0 is applied in the hardness-dependent equations for total metals unless a site-specific WER has been determined and adopted by the department in accordance with K.A.R. 28-16-28e(a) and K.A.R. 28-16-28f(f). Hardness values in metal formulae are entered in units of mg/L as CaCO3. Pentachlorophenol formulae apply only over the pH range 6.5-8.5.

"Water-effect ratio (WER)" means the numerical toxicity (median lethal concentration or no-observed-effect level) of a chemical pollutant diluted in water from a given stream, lake, or wetland divided by the numerical toxicity of the same pollutant diluted in laboratory water.

28-16-28b. Definitions.

(o) "Condition of acute toxicity" means any concentration of a toxic substance that exceeds the applicable acute criterion for aquatic life support presented in K.A.R. 28 -16-28e or, for substances not listed in K.A.R. 28 -16-28e or for mixtures of toxic substances, any concentration that exceeds 0.3 times the median lethal concentration. The concentration at which acute toxicity exists shall be determined through laboratory toxicity tests conducted in accordance with the United States environmental protection agency's "methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms," fourth edition, as published in August 1993, which is hereby adopted by reference.

(p) "Condition of chronic toxicity" means any concentration of a toxic substance that exceeds the applicable chronic criterion for aquatic life support presented in K.A.R. 28-16-28e or, for substances not listed in K.A.R. 28 -16-28e or for mixtures of toxic substances, any concentration that exceeds the no -observed-effect level. The concentration at which chronic toxicity exists shall be determined throug h laboratory toxicity tests conducted in accordance with the United States environmental protection agency's "short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms," third edition, as published in July 1994, which is hereby adopted by reference.

CADMIUM (ug/L):
acute criterion = WER[EXP[(1.1280*(LN(hardness)))-3.6867]]
chronic criterion = WER[EXP[(0.7852*(LN(hardness)))-2.715]]

CHROMIUM III (ug/L):
acute criterion = WER[EXP[(0.819*(LN(hardness)))+3.7256]]
chronic criterion = WER[EXP[(0.819*(LN(hardness)))+0.6848]]

LEAD (ug/L):
acute criterion = WER[EXP[(1.273*(LN(hardness)))-1.460]]
chronic criterion = WER[EXP[(1.273*(LN(hardness)))-4.705]]

ZINC (ug/L):
acute criterion = WER[EXP[(0.8473*(LN(hardness)))+0.884]]
chronic criterion = WER[EXP[(0.8473*(LN(hardness)))+0.884]]

TABLE 3

Aquatic Life Support Criteria Calculations Based on K.A.R. 28-16-28

			Cadmium			Chromium		
Sample ID	WER	Hardness	(µg/L)	Acute Criterion	Chronic Criterion	(µg/L)	Acute Criterion	Chronic Criterion
W7-D2	1	240		=1*EXP(1.128*(LN(C4))-3.6867)	=1*EXP(0.7852*(LN(C4))-2.715)		=1*EXP(0.819*(LN(C4))+3.7256)	=1*EXP(0.819*(LN(C4))+0.6848)
W7-D2 (H)	1	240		=1*EXP(1.128*(LN(C5))-3.6867)	=1*EXP(0.7852*(LN(C5))-2.715)	27	=1*EXP(0.819*(LN(C5))+3.7256)	=1*EXP(0.819*(LN(C5))+0.6848)
Effluent	1	220		=1*EXP(1.128*(LN(C6))-3.6867)	=1*EXP(0.7852*(LN(C6))-2.715)	24	=1*EXP(0.819*(LN(C6))+3.7256)	=1*EXP(0.819*(LN(C6))+0.6848)
W4-D1	1	240		=1*EXP(1.128*(LN(C7))-3.6867)	=1*EXP(0.7852*(LN(C7))-2.715)		=1*EXP(0.819*(LN(C7))+3.7256)	=1*EXP(0.819*(LN(C7))+0.6848)
W4-D1 (H)	1	240	11.2	=1*EXP(1.128*(LN(C8))-3.6867)	=1*EXP(0.7852*(LN(C8))-2.715)	96.1	=1*EXP(0.819*(LN(C8))+3.7256)	=1*EXP(0.819*(LN(C8))+0.6848)
W8-D3	1	240		=1*EXP(1.128*(LN(C9))-3.6867)	=1*EXP(0.7852*(LN(C9))-2.715)		=1*EXP(0.819*(LN(C9))+3.7256)	=1*EXP(0.819*(LN(C9))+0.6848)
W8-D3 (H)	1	240		=1*EXP(1.128*(LN(C10))-3.6867)	=1*EXP(0.7852*(LN(C10))-2.715)	69	=1*EXP(0.819*(LN(C10))+3.7256)	=1*EXP(0.819*(LN(C10))+0.6848)
W9-D4	1	230		=1*EXP(1.128*(LN(C11))-3.6867)	=1*EXP(0.7852*(LN(C11))-2.715)		=1*EXP(0.819*(LN(C11))+3.7256)	=1*EXP(0.819*(LN(C11))+0.6848)
W10-D5	1	240		=1*EXP(1.128*(LN(C12))-3.6867)	=1*EXP(0.7852*(LN(C12))-2.715)		=1*EXP(0.819*(LN(C12))+3.7256)	=1*EXP(0.819*(LN(C12))+0.6848)
W14-D9	1	250		=1*EXP(1.128*(LN(C13))-3.6867)	=1*EXP(0.7852*(LN(C13))-2.715)		=1*EXP(0.819*(LN(C13))+3.7256)	=1*EXP(0.819*(LN(C13))+0.6848)
W15-D10	1	220		=1*EXP(1.128*(LN(C14))-3.6867)	=1*EXP(0.7852*(LN(C14))-2.715)		=1*EXP(0.819*(LN(C14))+3.7256)	=1*EXP(0.819*(LN(C14))+0.6848)
W15-D10 (H)	1	220		=1*EXP(1.128*(LN(C15))-3.6867)	=1*EXP(0.7852*(LN(C15))-2.715)	28	=1*EXP(0.819*(LN(C15))+3.7256)	=1*EXP(0.819*(LN(C15))+0.6848)
LWC-300	1							

			Lead			Zinc		
Sample ID	WER	Hardness	(µg/L)	Acute Criterion	Chronic Criterion	(µg/L)	Acute Criterion	Chronic Criterion
W7-D2	1	240		=1*EXP(1.273*(LN(C22))-1.46)	=1*EXP(1.273*(LN(C22))-4.705)		=1*EXP(0.8473*(LN(C22))+0.884)	=1*EXP(0.8473*(LN(C22))+0.884)
W7-D2 (H)	1	240		=1*EXP(1.273*(LN(C23))-1.46)	=1*EXP(1.273*(LN(C23))-4.705)		=1*EXP(0.8473*(LN(C23))+0.884)	=1*EXP(0.8473*(LN(C23))+0.884)
Effluent	1	220	9.38	=1*EXP(1.273*(LN(C24))-1.46)	=1*EXP(1.273*(LN(C24))-4.705)	34	=1*EXP(0.8473*(LN(C24))+0.884)	=1*EXP(0.8473*(LN(C24))+0.884)
W4-D1	1	240		=1*EXP(1.273*(LN(C25))-1.46)	=1*EXP(1.273*(LN(C25))-4.705)	32.2	=1*EXP(0.8473*(LN(C25))+0.884)	=1*EXP(0.8473*(LN(C25))+0.884)
W4-D1 (H)	1	240	35.8	=1*EXP(1.273*(LN(C26))-1.46)	=1*EXP(1.273*(LN(C26))-4.705)	1070	=1*EXP(0.8473*(LN(C26))+0.884)	=1*EXP(0.8473*(LN(C26))+0.884)
W8-D3	1	240		=1*EXP(1.273*(LN(C27))-1.46)	=1*EXP(1.273*(LN(C27))-4.705)	132	=1*EXP(0.8473*(LN(C27))+0.884)	=1*EXP(0.8473*(LN(C27))+0.884)
W8-D3 (H)	1	240	25.1	=1*EXP(1.273*(LN(C28))-1.46)	=1*EXP(1.273*(LN(C28))-4.705)	15.2	=1*EXP(0.8473*(LN(C28))+0.884)	=1*EXP(0.8473*(LN(C28))+0.884)
W9-D4	1	230		=1*EXP(1.273*(LN(C29))-1.46)	=1*EXP(1.273*(LN(C29))-4.705)	132	=1*EXP(0.8473*(LN(C29))+0.884)	=1*EXP(0.8473*(LN(C29))+0.884)
W10-D5	1	240		=1*EXP(1.273*(LN(C30))-1.46)	=1*EXP(1.273*(LN(C30))-4.705)	54.4	=1*EXP(0.8473*(LN(C30))+0.884)	=1*EXP(0.8473*(LN(C30))+0.884)
W14-D9	1	250		=1*EXP(1.273*(LN(C31))-1.46)	=1*EXP(1.273*(LN(C31))-4.705)		=1*EXP(0.8473*(LN(C31))+0.884)	=1*EXP(0.8473*(LN(C31))+0.884)
W15-D10	1	220		=1*EXP(1.273*(LN(C32))-1.46)	=1*EXP(1.273*(LN(C32))-4.705)	20.4	=1*EXP(0.8473*(LN(C32))+0.884)	=1*EXP(0.8473*(LN(C32))+0.884)
W15-D10 (H)	1	220		=1*EXP(1.273*(LN(C33))-1.46)	=1*EXP(1.273*(LN(C33))-4.705)	20.5	=1*EXP(0.8473*(LN(C33))+0.884)	=1*EXP(0.8473*(LN(C33))+0.884)
LWC-300								

Table 2
Sediment Analytical Data
Drum Creek

Sampling point	Date	Mercury	Arsenic	Cadmium	Chromium	Lead	Zinc	Sampling location
1	6/24/03	0.038	2.3	1.8	8.68	8.87	49.9	S15-D8
2	6/24/03	0.052	1.81	1.7	8.2	16	81.2	S14-D7
3	6/24/03	0.18	3.17	2.55	9.7	24.5	94.6	S14-D6
4	6/24/03	0.086	7.16	4.63	13.9	20.6	78.8	S10-D2
5	6/24/03	0.13	30.7	430	14	473	10,300	(Confluence) S7-D1
6	6/24/03	0.099	11.4	90.4	11.7	144	3,680	S11-D3
7	6/24/03	0.12	13.9	73	13.5	223	5,950	S12-D4
8	6/24/03	0.1	8.84	71.1	18.6	109	1,520	300' downstream from #5 S13-D5
9	6/24/03	0.046	1.66	1.77	8.86	10.1	49.6	Main Street bridge S16-D9
10	6/24/03	0.051	18.5	14.3	11.6	48.2	517	Low water crossing S17-D10
11	1/30/04	BDL	6.76	2.99	14.6	9.73	24.9	300' below low water crossing

Note: Parameters are in mg/L

APPENDIX E

HEALTH INFORMATION

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

CONTENTS

1.1 What is cadmium?
1.2 What happens to cadmium when it enters the environment?
1.3 How might I be exposed to cadmium?
1.4 How can cadmium enter and leave my body?
1.5 How can cadmium affect my health?
1.6 How does it affect children?
1.7 How can families reduce the risk of exposure to cadmium?
1.8 Is there a medical test to determine whether I have been exposed to cadmium?
1.9 What recommendations has the federal government made to protect human health?
1.10 Where can I get more information?
References

RELATED RESOURCES

ToxFAQ™ 102k
ToxFAQ™ en Español 29k
Public Health Statement 145k
Toxicological Profile 9.3MB

A-Z INDEX

A B C D E
F G H I J K
L M N O P
Q R S T U
V W X Y Z

ATSDR RESOURCES

ToxFAQs™
ToxFAQs™ en Español
Public Health Statements
Toxicological Profiles
Minimum Risk Levels

July 1999

Public Health Statement for Cadmium

CAS# 1306-19-0

This Public Health Statement is the summary chapter from the Toxicological Profile for cadmium. It is one in a series of Public Health Statements about hazardous substances and their health effects. A shorter version, the ToxFAQs™, is also available. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present. For more information, call the ATSDR Information Center at 1-888-422-8737.

This public health statement tells you about cadmium and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for a long-term federal cleanup. Cadmium has been found in at least 776 of the 1,467 current or former NPL sites. However, its unknown how many NPL sites have been evaluated for this substance. As more sites are evaluated, the sites with cadmium may increase. This is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You can be exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance or by skin contact.

If you are exposed to cadmium, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), the chemical or physical form of cadmium present, and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

MMGs
MHMIs
Interaction Profiles
Priority List of Hazardous Substances
Division of Toxicology

1.1 What is cadmium?

Cadmium is an element that occurs naturally in the earth's crust. Pure cadmium is a soft, silver-white metal. Cadmium is not usually present in the environment as a pure metal, but as a mineral combined with other elements such as oxygen (cadmium oxide), chlorine (cadmium chloride), or sulfur (cadmium sulfate, cadmium sulfide). Cadmium is most often present in nature as complex oxides, sulfides, and carbonates in zinc, lead, and copper ores. It is rarely present in large quantities as the chlorides and sulfates. These different forms of cadmium compounds are solids that dissolve in water to varying degrees. The chlorides and sulfates are the forms that most easily dissolve in water. Cadmium may change forms, but the cadmium metal itself does not disappear from the environment. Knowing the particular form of cadmium, however, is very important when determining the risk of potential adverse health effects.

Cadmium compounds are often found in or attached to small particles present in air. Most people can not tell by smell or taste that cadmium is present in air or water, because it does not have any recognizable taste or odor. Soils and rocks contain varying amounts of cadmium, generally in small amounts but sometimes in larger amounts (for example in some fossil fuels or fertilizers).

Most cadmium used in the United States is extracted as a by-product during the production of other metals such as zinc, lead, or copper. Cadmium has many uses in industry and consumer products, mainly in batteries, pigments, metal coatings, plastics, and some metal alloys.

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1.2 What happens to cadmium when it enters the environment?

It is estimated that about 25,000 to 30,000 tons of cadmium are released to the environment each year, about half from the weathering of rocks into river water and then to the oceans. Forest fires and volcanoes also release some cadmium to the air. Release of cadmium from human activities is estimated at from 4,000 to 13,000 tons per year, with major contributions from mining activities, and burning of fossil fuels. Cadmium can enter the air from the burning of fossil fuels (e.g., coal fired electrical plants) and from the burning of household waste. Because of regulations, only small amounts currently enter water from the disposal of waste water from households or industries. Fertilizers often contain some cadmium that will enter the soil when fertilizers are applied to crops. Cadmium can also enter the soil or water from spills or leaks at hazardous waste sites if large amounts of dissolved cadmium are present at the site. The form of cadmium at these sites is important since many forms do not easily dissolve in water.

Cadmium that is in or attached to small particles can enter the air and travel a long way before coming down to earth as dust, or in rain or snow. The cadmium metal itself does not break down in the environment, but it can change into different forms. Most forms of cadmium stay for a long time in the same place where they first entered the environment. Some forms of the cadmium that goes into the water will bind to soil, but some will remain in the water. Some forms of cadmium in soil can enter water or be taken up by plants. Fish, plants, and animals can take some forms of cadmium into their bodies from air, water, or food. Cadmium can change forms in the body, but it also stays in the body for a very long time (years).

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1.3 How might I be exposed to cadmium?

Food and cigarette smoke are the biggest sources of cadmium exposure for people in the general population. Average cadmium levels in U.S. foods range from 2 to 40 parts of cadmium per billion parts of food (2–40 ppb). Lowest levels are in fruits and beverages, and highest levels are in leafy vegetables and potatoes. Air levels of cadmium in U.S. cities are low, ranging from less than 1 to 40 nanograms per cubic meter (ng/m^3) (a nanogram is one billionth of a gram). Air levels greater than 40 ng/m^3 may occur in urban areas with high levels of air pollution from the burning of fossil fuels. The level of cadmium in most drinking water supplies is less than 1 ppb, well below the drinking water standard of 50 ppb. Levels in drinking water, however, may vary greatly depending on local conditions. The average level of cadmium in unpolluted soil is about 250 ppb. At hazardous waste sites, cadmium levels have been measured in soil at about 4 parts cadmium per million parts (4 ppm; a part per million is 1,000 times more than a ppb) and in water at 6 ppm. In the United States, the average person eats food with about 30 micrograms (μg) of cadmium in it each day, but only about 1–3 μg per day of that cadmium from food is absorbed and enters the body. Cadmium exposure from smoking cigarettes may be a more serious health concern than cadmium in food. Smokers may double their daily intake of cadmium compared with nonsmokers. Each cigarette may contain from 1 to 2 μg of cadmium, and 40–60% of the cadmium in the inhaled smoke can pass through the lungs into the body. This means that smokers may take in an additional 1–3 μg of cadmium into their body per day from each pack of cigarettes smoked. Smoke from other people's cigarettes probably does not cause nonsmokers to take in much cadmium.

Aside from tobacco smokers, people who live near hazardous waste sites or factories that release cadmium into the air have the potential for exposure to cadmium in air. However, numerous state and federal regulations control the amount of cadmium that can be released to the air from waste sites and incinerators so that properly regulated sites are not hazardous. The general population

and people living near hazardous waste sites may be exposed to cadmium in contaminated food, dust, or water from unregulated releases or accidental releases. Numerous regulations and use of pollution controls are enforced to prevent such releases.

Workers can be exposed to cadmium in air from the smelting and refining of metals, or from the air in plants that make cadmium products such as batteries, coatings, or plastics. Workers can also be exposed when soldering or welding metal that contains cadmium. Approximately 512,000 workers in the United States are in environments each year where a cadmium exposure may occur. Regulations that set permissible levels of exposure, however, are enforced to protect workers and to make sure that levels of cadmium in the air are considerably below levels thought to result in harmful effects.

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1.4 How can cadmium enter and leave my body?

Cadmium can enter your body from the food you eat, the water you drink, from particles it may be attached to in the air you breathe, or from breathing in cigarette smoke that contains cadmium. Higher amounts of cadmium can enter your body from the cadmium in air or smoke that you inhale (25 to 60% of the cadmium present) than from cadmium in foods you eat (about 5–10% enters the body). The cadmium not taken into your body through the lungs is breathed out. The cadmium not taken into your body from food or water leaves your body in feces. If you do not eat foods that contain enough iron or other nutrients, you are likely to take up more cadmium from your food than usual. Virtually no cadmium enters your body through your skin.

Most of the cadmium that enters your body goes to your kidney and liver and can remain there for many years. A small portion of the cadmium that enters your body leaves slowly in urine and feces. Your body can change most cadmium to a form that is not harmful, but too much cadmium can overload the ability of your liver and kidney to change the cadmium to a harmless form, and the harmful form may damage your health.

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1.5 How can cadmium affect my health?

The potential for cadmium to harm your health depends upon the form of cadmium present, the amount taken into your body, and whether the cadmium is eaten or breathed. There are no known good effects from taking in cadmium. Breathing air with very high levels of cadmium can severely damage the lungs and may cause death. Breathing air with lower levels of cadmium over long periods of time (for years) results in a build-up of cadmium in the kidney, and if sufficiently high, may result in kidney disease. Other effects that may occur after breathing cadmium for a long time are lung damage and fragile bones.

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

We do not have many good studies on the health effects of cadmium in people. Exposures to cadmium throughout most of the world are currently regulated so there are relatively few people receiving high levels, and the effects from long-term low-level exposure to cadmium are hard to determine with the many other factors that can come into play. A number of studies on workers exposed to cadmium in the air have not resulted in convincing evidence that cadmium can cause lung cancer in humans. In animals studies, mice or hamsters that breathed in cadmium did not get lung cancer, but rats that breathed in cadmium did develop lung cancer. There is no good information on people to suggest that breathing cadmium can affect your ability to have children. Female rats and mice, however, that breathed high levels of cadmium had fewer litters, and their babies may have had more birth defects than usual. Breathing cadmium has also been shown to cause liver damage and changes in the immune system in rats and mice. There is no reliable information on people to indicate that breathing cadmium harms peoples' liver, heart, nervous system, or immune system.

Eating food or drinking water with very high cadmium levels severely irritates the stomach, leading to vomiting and diarrhea, and sometimes death. Eating lower levels of cadmium over a long period of time can lead to a build-up of cadmium in the kidneys. If the levels reach a high enough level, the cadmium in the kidney will cause kidney damage, and also causes bones to become fragile and break easily. We do not have good direct information from people who have been exposed to cadmium to know if eating cadmium at levels, below which other toxic effects are not seen, might effect your ability to have children. Animals eating or drinking cadmium sometimes get high blood pressure, iron-poor blood, liver disease, and nerve or brain damage. We have no good information on people to indicate that the levels that people would need to eat or drink cadmium to result in these diseases, or if they would occur at all. Studies of humans or animals that eat or drink cadmium have not found increases in cancer, although additional

research is needed to be more certain that eating or drinking cadmium definitely does or does not cause cancer. Skin contact with cadmium is not known to affect the health of people or animals because virtually no cadmium can enter the body through the skin under normal circumstances (i.e., without exposure to very high concentrations for long times or exposure to skin that was not damaged).

As a conservative approach, and based on the limited human data and the studies in rats, the United States Department of Health and Human Services (DHHS) has determined that cadmium and cadmium compounds may reasonably be anticipated to be carcinogens. The International Agency for Research on Cancer (IARC) has determined that cadmium is carcinogenic to humans. The EPA has determined that cadmium is a probable human carcinogen by inhalation.

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1.6 How can cadmium affect children?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans. Potential effects on children resulting from exposures of the parents are also considered.

The health effects seen in children from exposure to toxic levels of cadmium are expected to be similar to the effects seen in adults (kidney, lung, and intestinal damage depending on the route of exposure). These effects are most easily seen in short-term high-level exposures. Harmful effects on child development or behavior have not generally been seen in populations exposed to cadmium, but more research is needed. It is also difficult to determine the cause of harmful effects on child behavior or development from exposures to low levels over long periods of time, which are the most likely exposures for children as well adults in the general population.

We do not know whether cadmium can cause birth defects in people. Studies in animals exposed to high enough levels of cadmium during pregnancy have resulted in harmful effects in the young. The nervous system appears to be the most sensitive target. Young animals exposed to cadmium before birth have shown effects on behavior and learning. There is also some information from animal studies that high enough exposures to cadmium before birth can reduce body weights and affect the skeleton in the developing young. Similar effects, however, have not been observed in humans. Humans may respond differently or the exposure levels in humans may be considerably below the levels that produced these adverse effects in animals. More research on human health effects is needed to answer these questions.

Most cadmium taken into the stomach and intestines passes through without being absorbed. At high enough levels, however, damage to the stomach and intestines can occur. A few studies in animals indicate that younger animals absorb more cadmium than adults. Animal studies also indicate that the young are more susceptible than adults to a loss of bone and decreased bone strength from exposure to cadmium. Animal studies also indicate that more cadmium is absorbed into the body from the diet if the diet is low in calcium, protein, or iron, or if the diet is high in fat (because fat slows down the passage of food in the gut and allows more time for absorption). Children who do not get enough iron, calcium, or protein may also absorb more cadmium.

Women with low levels of calcium or iron, due to multiple pregnancies and/or dietary deficiencies, may also absorb more cadmium when exposed to cadmium in food or water. Cadmium does not readily go from a pregnant woman's body into the developing child, but some can cross the placenta. Cadmium levels in human milk can also be from 5 to 10% of the levels found in the mother's blood.

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1.7 How can families reduce the risk of exposure to cadmium?

If your doctor finds that you have been exposed to significant amounts of cadmium, ask your doctor if children may also be exposed. When necessary, your doctor may need to ask your state public health department to investigate.

You can reduce the risk of your family being exposed to cadmium by identifying potential sources of cadmium exposure (in or around your home, at work, or where your children play), and by taking measures to prevent your family members from being exposed. A balanced diet that includes enough calcium, iron, protein, and zinc will also help reduce the amount of cadmium that may be absorbed into the body from food or drink.

Take an inventory of items in and around your home that might contain cadmium. Examples include fungicides (cadmium chloride), batteries (nickel-cadmium batteries also called Ni-Cad batteries), and hobbies that use materials that contain cadmium (electroplating or welding of metals, some fabric dyes, ceramic and glass glazes). Generally, the label of ingredients for a product will list cadmium or a cadmium compound as an active ingredient, or you can contact the manufacturer and ask whether the item contains cadmium. If you think that a fertilizer might contain cadmium, ask the supplier or the manufacturer. The cadmium in these items would have to get into your body before it could do any harm. This could happen if, for example, a fungicide containing cadmium was accidentally or intentionally swallowed, or if Ni-Cad batteries were being burned in a waste incinerator and

a family member was breathing in the smoke, or if you were welding metal alloys that contain cadmium or using a cadmium glaze on a piece of pottery and were breathing in fumes that contained cadmium. You can prevent these exposures by making sure that you and your family members do not accidentally swallow substances that contain cadmium or breathe in air contaminated with cadmium. All cadmium-containing fungicides or dyes should be properly stored, safely out of the reach of children. If you or your family members have a hobby where metals or materials that contain cadmium are being heated or welded, you should seek advice on proper ventilation of your workspace and the proper use of a safety respirator.

Nickel-cadmium batteries are not harmful when properly used, but can release cadmium fumes if burned in an incinerator or waste fire. Breathing in these fumes may be harmful to your health. Small children also may mistake Ni-Cad batteries for toys and may accidentally swallow them. If the battery case is damaged, then some cadmium could escape and come in contact with the stomach or intestines. Keep Ni-Cad batteries out of the reach of small children, and teach your older children that the contents in Ni-Cad batteries can be harmful to their health if swallowed or burned. Teach your family how to properly dispose of the batteries. Information on where to dispose of Ni-Cad batteries is available from your city or county waste disposal office or the office for a waste disposal service.

If you are using fungicides or fertilizers that contain cadmium on your lawn or garden, read the instructions to learn the safe way to use these materials. One possible route of exposure from fungicides or fertilizers would be from breathing in small particles of cadmium-containing dusts. Protective safety gear including dust masks are available at hardware and building supply stores.

If you have a water well and are concerned that your water may contain cadmium, you can have your water tested. Water filters that remove cadmium, as well as lead and other metals, from drinking water are also available at your local stores. You should ask for advice from your public health officials or from knowledgeable suppliers of water filters on the proper filter or filters to use for your water system.

It is sometimes possible to carry cadmium-containing dust from work on your clothing, skin, hair, tools, or other objects removed from the workplace. This is particularly true when working in buildings where there is smelting or refining of cadmium-containing metal ores, soldering or welding of metals that contain cadmium, or where cadmium batteries, coatings, or plastics are made. You may contaminate your car, home, or other locations outside work where children might be exposed to cadmium.

Your occupational health and safety officer at work can and should tell you whether chemicals you work with are dangerous and likely to be carried home on your clothes, body, or tools and whether you should be showering and changing clothes before you leave work, storing your street clothes in a separate area of the workplace, or laundering your work clothes at home separately from other clothes. If cadmium is being used in your workplace, there should be a material safety data sheet (MSDS) available at your place of work, as required by the Occupational Safety and Health Administration (OSHA). The MSDS information will include the chemical name(s) of any hazardous cadmium ingredients, fire and explosion data, potential health effects, how you get the chemical(s) in your body, how to properly handle the materials, and what to do in an emergency.

Your employer is legally responsible for providing a safe workplace and should freely answer your questions about hazardous chemicals. Your OSHA-approved state occupational safety and health program or OSHA can answer any further questions, and help your employer identify and correct problems with hazardous substances. Your OSHA-approved state occupational health program or OSHA will also listen to formal complaints you would like to make about workplace health hazards and will inspect your workplace, if necessary. Employees have a right to seek safety and health on the job without fear of punishment.

Potential sources of exposure to cadmium away from home include exposures at hazardous waste sites or from air near waste incinerators. Young children should not play near or in hazardous wastes sites, and regulations that prevent this activity are generally enforced. Proper enforcement of regulations also prevents releases of cadmium to the air from waste incinerators or to water from hazardous waste sites. If you or your family live near a hazardous waste site and you have reason to believe that regulations are not being enforced and that you or your children are being exposed to cadmium, contact your local health official and report your concern.

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1.8 Is there a medical test to determine whether I have been exposed to cadmium?

You can be tested for exposure to cadmium in several ways. The amount of cadmium in your blood, urine, hair, or nails can be measured by some medical laboratories. The amount of cadmium in your blood shows your recent exposure to cadmium. The amount of cadmium in your urine shows both your recent and your past exposure. Cadmium levels in hair or nails are not as useful as an indication of when or how much cadmium you may have taken in, partly because cadmium from outside of your body may attach to the hair or nails. Tests are also available to measure the amount

of cadmium inside your liver and kidneys. The results of these tests can help a doctor evaluate the risk of liver or kidney disease. However, these tests are too costly and inconvenient for routine use. Your urine can be tested to see if your kidneys are damaged. If you do have kidney damage, the urine tests do not prove that cadmium caused the damage.

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1.9 What recommendations has the federal government made to protect human health?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals, then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for cadmium include the following:

The government has taken steps to protect humans from excessive cadmium exposure. The EPA allows only up to 5 parts of cadmium per billion parts of water (5 ppb) in drinking water. The EPA also limits how much cadmium can be put into lakes, rivers, dumps, and cropland, and does not allow cadmium in pesticides. The FDA limits the amount of cadmium in food colors to 15 parts per million (ppm).

OSHA now limits the amount of cadmium in workplace air to 5 micrograms per cubic meter ($\mu g/m^3$).

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1.10 Where can I get more information?

If you have any more questions or concerns, please contact your community or state health or environmental quality

department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333

Information line and technical assistance:

Phone: 888-422-8737
FAX: (404)498-0093

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

To order toxicological profiles, contact:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: 800-553-6847 or 703-605-6000

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References

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for cadmium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

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This page was updated on Tuesday, September 16, 2003

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September 2003

Public Health Statement for Zinc

CAS# 7440-66-6

This Public Health Statement is the summary chapter from the Toxicological Profile for zinc. It is one in a series of Public Health Statements about hazardous substances and their health effects. A shorter version, the ToxFAQs™, is also available. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present. For more information, call the ATSDR Information Center at 1-888-422-8737.

This public health statement tells you about zinc and the effects of exposure. Zinc is an essential element needed by your body and is commonly found in nutritional supplements. However, taking too much zinc into the body can affect your health.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup activities. Zinc has been found in at least 953 of the 1,636 current or former NPL sites. However, the total number of NPL sites evaluated for zinc is not known. As more sites are evaluated, the sites at which zinc is found may increase. This information is important because exposure to zinc may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact.

If you are exposed to zinc, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

MMGs
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1.1 What is zinc?

Zinc is one of the most common elements in the earth's crust. Zinc is found in the air, soil, and water and is present in all foods. In its pure elemental (or metallic) form, zinc is a bluish-white, shiny metal. Powdered zinc is explosive and may burst into flames if stored in damp places. Metallic zinc has many uses in industry. A common use is to coat iron or other metals to prevent rust and corrosion. Metallic zinc is also mixed with other metals to form alloys such as brass and bronze. A zinc and copper alloy is used to make pennies in the United States. Metallic zinc is also used to make dry cell batteries.

Zinc can also combine with other elements, such as chlorine, oxygen, and sulfur, to form zinc compounds. Zinc compounds that may be found at hazardous waste sites are zinc chloride, zinc oxide, zinc sulfate, and zinc sulfide. Most zinc ore found naturally in the environment is in the form of zinc sulfide. Zinc compounds are widely used in industry. Zinc sulfide and zinc oxide are used to make white paints, ceramics, and other products. Zinc oxide is also used in producing rubber. Zinc compounds, such as zinc acetate, zinc chloride, and zinc sulfate, are used in preserving wood and in manufacturing and dyeing fabrics. Zinc chloride is also the major ingredient in smoke from smoke bombs. Zinc compounds are used by the drug industry as ingredients in some common products, such as vitamin supplements, sun blocks, diaper rash ointments, deodorants, athlete's foot preparations, acne and poison ivy preparations, and antidandruff shampoos. Information can be found on the chemical and physical properties of zinc in Chapter 4 and on its occurrence and fate in the environment in Chapter 6.

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1.2 What happens to zinc when it enters the environment?

Zinc enters the air, water, and soil as a result of both natural processes and human activities. Most zinc enters the environment as the result of mining, purifying of zinc, lead, and cadmium ores, steel production, coal burning, and burning of wastes. These activities can increase zinc levels in the atmosphere. Waste streams from zinc and other metal manufacturing and zinc chemical industries, domestic waste water, and run-off from soil containing zinc can discharge zinc into waterways. The level of zinc in soil increases mainly from disposal of zinc wastes from metal manufacturing industries and coal ash from electric utilities. In air, zinc is present mostly as fine dust particles. This dust eventually settles over land and water. Rain and snow aid in removing zinc from air. Most of the zinc in lakes or rivers settles on the bottom. However, a small amount may remain either dissolved in water or as fine suspended particles. The level of dissolved zinc in water may increase as the acidity of water increases. Fish can collect zinc in their bodies from water containing zinc. Most of the zinc in soil is bound to the soil and does not dissolve in water. However, depending on the type of

soil, some zinc may reach groundwater, and contamination of groundwater has occurred from hazardous waste sites. Zinc may be taken up by animals eating soil or drinking water containing zinc. For more information about what happens to zinc in the environment, see Chapter 6.

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1.3 How might I be exposed to zinc?

Zinc is an essential element needed by your body in small amounts. We are exposed to zinc compounds in food. The average daily zinc intake through the diet in this country ranges from 5.2 to 16.2 milligrams (milligram = 0.001 gram). Food may contain levels of zinc ranging from approximately 2 parts of zinc per million (2 ppm) parts of foods (e.g., leafy vegetables) to 29 ppm (meats, fish, poultry). Zinc is also present in most drinking water. Drinking water or other beverages may contain high levels of zinc if they are stored in metal containers or flow through pipes that have been coated with zinc to resist rust. If you take more than the recommended daily amount of supplements containing zinc, you may have higher levels of zinc exposure.

In general, levels of zinc in air are relatively low and fairly constant. Average levels of zinc in the air throughout the United States are less than 1 microgram of zinc per cubic meter ($\mu g/m^3$;) of air, but range from 0.1 to 1.7 $\mu g/m^3$; in areas near cities. Air near industrial areas may have higher levels of zinc. The average zinc concentration for a 1-year period was 5 $\mu g/m^3$; in one area near an industrial source.

In addition to background exposure that all of us experience, about 150,000 people also have a source of occupational exposure to zinc that might elevate their total exposure significantly above the average background exposure. Jobs where people are exposed to zinc include zinc mining, smelting, and welding; manufacture of brass, bronze, or other zinc-containing alloys; manufacture of galvanized metals; and manufacture of machine parts, rubber, paint, linoleum, oilcloths, batteries, some kinds of glass and ceramics, and dyes. People at construction jobs, automobile mechanics, and painters are also exposed to zinc. For more information on exposure to zinc, see Chapter 6.

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1.4 How can zinc enter and leave my body?

Zinc can enter the body through the digestive tract when you eat food or drink water containing it. Zinc can also enter through your lungs if you inhale zinc dust or fumes from zinc-smelting or zinc-welding operations on your job. The amount of zinc that passes directly through the skin is relatively small. The most likely route of exposure near NPL waste sites is through drinking water containing a high amount of zinc. Zinc is stored throughout the body. Zinc increases in blood and bone most rapidly after

exposure. Zinc may stay in the bone for many days after exposure. Normally, zinc leaves the body in urine and feces. More information on how zinc enters and leaves your body can be found in Chapter 3.

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1.5 How can zinc affect my health?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

Inhaling large amounts of zinc (as zinc dust or fumes from smelting or welding) can cause a specific short-term disease called metal fume fever. However, very little is known about the long-term effects of breathing zinc dust or fumes.

Taking too much zinc into the body through food, water, or dietary supplements can also affect health. The levels of zinc that produce adverse health effects are much higher than the Recommended Dietary Allowances (RDAs) for zinc of 11 mg/day for men and 8 mg/day for women. If large doses of zinc (10-15 times higher than the RDA) are taken by mouth even for a short time, stomach cramps, nausea, and vomiting may occur. Ingesting high levels of zinc for several months may cause anemia, damage the pancreas, and decrease levels of high-density lipoprotein (HDL) cholesterol.

Eating food containing very large amounts of zinc (1,000 times higher than the RDA) for several months caused many health effects in rats, mice, and ferrets, including anemia and injury to the pancreas and kidney. Rats that ate very large amounts of zinc became infertile. Rats that ate very large amounts of zinc after becoming pregnant had smaller babies. Putting low levels of certain zinc compounds, such as zinc acetate and zinc chloride, on the skin of rabbits, guinea pigs, and mice caused skin irritation. Skin irritation from exposure to these chemicals would probably occur in humans. EPA has determined that because of lack of information, zinc is not classifiable as to its human carcinogenicity.

Consuming too little zinc is at least as important a health problem

as consuming too much zinc. Without enough zinc in the diet, people may experience loss of appetite, decreased sense of taste and smell, decreased immune function, slow wound healing, and skin sores. Too little zinc in the diet may also cause poorly developed sex organs and retarded growth in young men. If a pregnant woman does not get enough zinc, her babies may have birth defects.

More information on the health effects linked with exposure to higher-than-normal levels of zinc is presented in Chapter 3.

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1.6 How can zinc affect children?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans.

Zinc is essential for proper growth and development of young children. Mothers who did not eat enough zinc during pregnancy had a higher frequency of birth defects and gave birth to smaller children (lower birth weight) than mothers whose zinc levels were sufficient. Very young children who did not receive enough zinc in the diet were smaller, both in length and in body weight, than children who ate enough zinc. Some foods, such as soy-based formulas, contain high levels of phytate, which can result in a decreased absorption of zinc in the diet. Too much of these foods may result in effects similar to those that occur when children receive too little zinc in the diet.

Little is known about whether children who eat too much zinc will react differently from adults who have ingested large amounts of zinc. A child who accidentally drank a large amount of a caustic zinc solution was found to have damage to his mouth and stomach, and later to his pancreas, but similar effects have been seen in adults who accidentally drank the same solution.

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1.7 How can families reduce the risk of exposure to zinc?

If your doctor finds that you have been exposed to significant amounts of zinc, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate.

Children living near waste sites containing zinc are likely to be exposed to higher environmental levels of zinc through breathing, drinking contaminated drinking water, touching soil, and eating contaminated soil. Children sometimes eat dirt, which should be discouraged. Parents should supervise to see that children wash their hands frequently and before eating. Parents should consult their family physicians about whether (and how) hand-to-mouth behaviors in their children might be discouraged. A more complete

discussion can be found in Section 3.11 of the profile.

Children and adults require a certain amount of zinc in the diet in order to remain healthy. However, overuse of some medicines or vitamin supplements containing zinc might be harmful; these medicines should always be used appropriately. If you are accidentally exposed to large amounts of zinc, consult a physician immediately.

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1.8 Is there a medical test to determine whether I have been exposed to zinc

A medical test exists that can determine whether your body fluids contain high levels of zinc. Samples of blood or feces can be collected in a doctor's office and sent to a laboratory that can measure zinc levels. It is easier for most laboratories to measure zinc in blood than in feces. The presence of high levels of zinc in the feces can mean recent high zinc exposure. High levels of zinc in the blood can mean high zinc consumption and/or high exposure. High zinc levels in blood or feces reflect the level of exposure to zinc. Measuring zinc levels in urine and saliva also may provide information about zinc exposure. Tests to measure zinc in hair may provide information on long-term zinc exposure; however, no useful correlation has been found between hair zinc levels and zinc exposure and these tests are not routinely used. More information on tests to measure zinc in the body can be found in Chapter 7.

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1.9 What recommendations has the federal government made to protect human health?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that

provides it. Some regulations and recommendations for zinc include the following:

The federal government has set standards and guidelines to protect individuals from the potential health effects of excessive zinc. EPA has stated that drinking water should contain no more than 5 mg of zinc per liter of water (5 mg/L or 5 ppm) because of taste. Furthermore, any release of more than 1,000 pounds (or in some cases 5,000 pounds) of zinc or its compounds into the environment (i.e., water, soil, or air) must be reported to EPA.

The National Academy of Sciences (NAS) estimates an RDA for zinc of 11 mg/day (men). Eleven mg/day is the same as 0.16 mg per kilogram (kg) of body weight per day for an average adult male (70 kg). An RDA of 8 mg/day, or 0.13 mg per kg of body weight for an average adult female (60 kg), was established for women because they usually weigh less than men. Lower zinc intake was recommended for infants (2-3 mg/day) and children (5-9 mg/day) because of their lower average body weights. The RDA provides a level of adequate nutritional status for most of the population. Extra dietary levels of zinc are recommended for women during pregnancy and lactation. An RDA of 11-12 mg/day was set for pregnant women. Women who nurse their babies need 12-13 mg/day.

To protect workers, OSHA has set an average legal limit of 1 mg/m^3; for zinc chloride fumes and 5 mg/m^3; for zinc oxide (dusts and fumes) in workplace air during an 8 hour workday, 40 hour work week. This regulation means that the workroom air should contain no more than an average of 1 mg/m^3; of zinc chloride over an 8 hour working shift of a 40 hour work week. NIOSH similarly recommends that the level of zinc oxide in workplace air should not exceed an average of 1 mg/m^3; over a 10 hour period of a 40 hour work week. For more information on recommendations and standards for zinc exposure, see Chapter 8.

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1.10 Where can I get more information?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333

Information line and technical assistance:

Phone: 888-422-8737
FAX: (404)498-0093

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

To order toxicological profiles, contact:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: 800-553-6847 or 703-605-6000

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2003. Toxicological profile for zinc. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

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August 1997

Public Health Statement for Lead

CAS# 12709-98-7

This Public Health Statement is the summary chapter from the Toxicological Profile for lead. It is one in a series of Public Health Statements about hazardous substances and their health effects. A shorter version, the ToxFAQs™, is also available. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present. For more information, call the ATSDR Information Center at 1-888-422-8737.

This public health statement tells you about lead and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup activities. Lead has been found in at least 1,026 of the 1,467 current or former NPL sites. However, the total number of NPL sites evaluated for this substance is not known. As more sites are evaluated, the sites at which lead is found may increase. This information is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always result in exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance or by skin contact.

If you are exposed to lead, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health

MMGs
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Division of Toxicology

1.1 What is lead?

Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. It has no characteristic taste or smell. Metallic lead does not dissolve in water and does not burn. Lead can combine with other chemicals to form what are usually known as lead compounds or lead salts. Some lead salts dissolve in water better than others. Some natural and manufactured substances contain lead but do not look like lead in its metallic form. Some of these substances can burn—for example, organic lead compounds in some gasolines.

Lead has many different uses. Its most important use is in the production of some types of batteries. It is also used in the production of ammunition, in some kinds of metal products (such as sheet lead, solder, some brass and bronze products, and pipes), and in ceramic glazes. Some chemicals containing lead, such as tetraethyl lead and tetramethyl lead, were once used as gasoline additives to increase octane rating. However, their use was phased out in the 1980s, and lead was banned for use in gasoline for transportation beginning January 1, 1996. Other chemicals containing lead are used in paint. The amount of lead added to paints and ceramic products, caulking, gasoline, and solder has also been reduced in recent years to minimize lead's harmful effects on people and animals. Lead used in ammunition, which is the largest non-battery end-use, has remained fairly constant in recent years. Lead is used in a large variety of medical equipment (radiation shields for protection against X-rays, electronic ceramic parts of ultrasound machines, intravenous pumps, fetal monitors, and surgical equipment). Lead is also used in scientific equipment (circuit boards for computers and other electronic circuitry) and military equipment (jet turbine engine blades, military tracking systems).

Most lead used by industry comes from mined ores ("primary") or from recycled scrap metal or batteries ("secondary"). Human activities (such as the former use of "leaded" gasoline) have spread lead and substances that contain lead to all parts of the environment. For example, lead is in air, drinking water, rivers, lakes, oceans, dust, and soil. Lead is also in plants and animals that people may eat.

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1.2 What happens to lead when it enters the environment?

Lead occurs naturally in the environment. However, most of the lead found throughout the environment comes from human activities. Before the use of leaded gasoline was banned, most of the lead released into the U.S. environment came from car exhaust. In 1979, cars released 94.6 million kilograms (kg; 1 kg equals 2.2 pounds) of lead into the air in the United States. In 1989, when the use of lead was limited but not banned, cars

released only 2.2 million kg to the air. Since EPA banned the use of leaded gasoline for highway transportation in 1996, the amount of lead released into the air has decreased further. Other sources of lead released to the air include burning fuel, such as coal or oil, industrial processes, and burning solid waste. Once lead goes into the atmosphere, it may travel thousands of miles if the lead particles are small or if the lead compounds easily evaporate. Lead is removed from the air by rain and by particles falling to the ground or into surface water.

The release of lead to air is now less than the release of lead to land. Most of the lead in inner city soils comes from old houses painted with paint containing lead and previous automotive exhaust emitted when gasoline contained lead. Landfills may contain waste from lead ore mining, ammunition manufacturing, or other industrial activities such as battery production.

Sources of lead in dust and soil include lead that falls to the ground from the air, and weathering and chipping of lead-based paint from buildings and other structures. Lead in dust may also come from windblown soil. Disposal of lead in municipal and hazardous waste dump sites may also add lead to soil. Mining wastes that have been used for sandlots, driveways, and roadbeds can be also sources of lead.

Higher levels of lead in soil can be measured near roadways. This accumulation came from car exhaust in the past. Once lead falls onto soil, it usually sticks to soil particles. Small amounts of lead may enter rivers, lakes, and streams when soil particles are moved by rainwater. Lead may remain stuck to soil particles in water for many years. Movement of lead from soil particles into underground water or drinking water is unlikely unless the water is acidic or "soft." Movement of lead from soil will also depend on the type of lead salt or compound and on the physical and chemical characteristics of the soil.

Sources of lead in surface water or sediment include deposits of lead-containing dust from the atmosphere, waste water from industries that handle lead (primarily iron and steel industries and lead producers), urban runoff, and mining piles.

Some of the chemicals that contain lead are broken down by sunlight, air, and water to other forms of lead. Lead compounds in water may combine with different chemicals depending on the acidity and temperature of the water. Lead itself cannot be broken down.

The levels of lead may build up in plants and animals from areas where air, water, or soil are contaminated with lead. If animals eat contaminated plants or animals, most of the lead that they eat will pass through their bodies.

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1.3 How might I be exposed to lead?

People living near hazardous waste sites may be exposed to lead and chemicals that contain lead by breathing air, drinking water, eating foods, or swallowing or touching dust or dirt that contains lead. For people who do not live near hazardous waste sites, exposure to lead may occur in several ways: (1) by eating foods or drinking water that contain lead, (2) by spending time in areas where leaded paints have been used and are deteriorating, (3) by working in jobs where lead is used, (4) by using health-care products or folk remedies that contain lead, and (5) by having hobbies in which lead may be used such as sculpturing (lead solder) and staining glass.

Foods such as fruits, vegetables, meats, grains, seafood, soft drinks, and wine may have lead in them. Cigarette smoke also contains small amounts of lead. Lead gets into food from water during cooking and into foods and beverages from dust that contains lead falling onto crops, from plants absorbing lead that is in the soil, and from dust that contains lead falling onto food during processing. Lead may also enter foods if they are put into improperly glazed pottery or ceramic dishes and from leaded-crystal glassware. Illegal whiskey made using stills that contain lead-soldered parts (such as truck radiators) may also contain lead. The amount of lead found in canned foods decreased 87% from 1980 to 1988, which indicates that the chance of exposure to lead in canned food from lead-soldered containers has been greatly reduced. Lead may also be released from soldered joints in kettles used to boil water for beverages.

In general, very little lead is found in lakes, rivers, or groundwater used to supply the public with drinking water. More than 99% of all publicly supplied drinking water contains less than 0.005 parts of lead per million parts of water (ppm). However, the amount of lead taken into your body through drinking water can be higher in communities with acidic water supplies. Acidic water makes it easier for the lead found in pipes, leaded solder, and brass faucets to enter water. Public water treatment systems are now required to use control measures to make water less acidic. Sources of lead in drinking water include lead that can come out of lead pipes, faucets, and leaded solder used in plumbing. Plumbing that contains lead may be found in public drinking water systems, and in houses, apartment buildings, and public buildings that are more than twenty years old.

Breathing in or swallowing airborne dust and dirt that have lead in them is another way you can be exposed. In 1984, burning leaded gasoline was the single largest source of lead emissions. Very little lead in the air comes from gasoline now because EPA has banned its use in gasoline. Other sources of lead in the air include releases

to the air from industries involved in iron and steel production, lead-acid-battery manufacturing, and non-ferrous (brass and bronze) foundries. Lead released into air may also come from burning of solid lead-containing waste, windblown dust, volcanoes, exhaust from workroom air, burning or weathering of lead-painted surfaces, fumes from leaded gasoline, and cigarette smoke.

Skin contact with dust and dirt containing lead occurs every day. Some cosmetics and hair dyes contain lead compounds. However, not much lead can get into your body through your skin. Leaded gasoline contains a lead compound that may be quickly absorbed.

In the home, you or your children may be exposed to lead if you take some types of home remedy medicines that contain lead compounds. Lead compounds are in some non-Western cosmetics, such as surma and kohl. Some types of hair colorants and dyes contain lead acetate. Read the labels on hair coloring products, use them with caution, and keep them away from children.

People who are exposed at work are usually exposed by breathing in air that contains lead particles. Exposure to lead occurs in many jobs. People who work in lead smelting and refining industries, brass/bronze foundries, rubber products and plastics industries, soldering, steel welding and cutting operations, battery manufacturing plants, and lead compound manufacturing industries may be exposed to lead. Construction workers and people who work at municipal waste incinerators, pottery and ceramics industries, radiator repair shops, and other industries that use lead solder may also be exposed. Between 0.5 and 1.5 million workers are exposed to lead in the workplace. In California alone, more than 200,000 workers are exposed to lead. Families of workers may be exposed to higher levels of lead when workers bring home lead dust on their work clothes.

You may also be exposed to lead in the home if you work with stained glass as a hobby, make lead fishing weights or ammunition, or if you are involved in home renovation that involves the removal of old lead-based paint.

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1.4 How can lead enter and leave my body?

Some of the lead that enters your body comes from breathing in dust or chemicals that contain lead. Once this lead gets into your lungs, it goes quickly to other parts of the body in your blood.

You may swallow lead by eating food and drinking liquids that contain it, and also by swallowing large particles (diameter greater than 5 micrometers; 1 micrometer is one millionth of a meter). Most of the lead that enters your body comes through swallowing,

even though very little of the amount you swallow actually enters your blood and other parts of your body. In addition to the lead that may be present in food and drink, accidental ingestion of lead may occur due to skin contamination while eating, drinking, smoking, or applying cosmetics (including lip balm). The amount that gets into your body from your stomach partially depends on when you ate your last meal. It also depends on how old you are and how well the lead particles you ate dissolved in your stomach juices. Experiments using adult volunteers showed that, for adults who had just eaten, the amount of lead that got into the blood from the stomach was only about 6% of the total amount taken in. In adults who had not eaten for a day, about 60–80% of the lead from the stomach got into their blood. In general, if adults and children swallow the same amount of lead, a bigger proportion of the amount swallowed will enter the blood in children than in adults.

Dust and soil that contain lead may get on your skin, but only a small portion of the lead will pass through your skin and enter your blood if it is not washed off. More lead can pass through skin that has been damaged (for example by scrapes, scratches, and wounds). The only kinds of lead compounds that easily penetrate the skin are the additives in leaded gasoline, which is no longer sold to the general public. Therefore, the general public is not likely to encounter lead that can enter through the skin.

Shortly after lead gets into your body, it travels in the blood to the "soft tissues" (such as the liver, kidneys, lungs, brain, spleen, muscles, and heart). After several weeks, most of the lead moves into your bones and teeth. In adults, about 94% of the total amount of lead in the body is contained in the bones and teeth. About 73% of the lead in children's bodies is stored in their bones. Some of the lead can stay in your bones for decades; however, some lead can leave your bones and reenter your blood and organs under certain circumstances, for example, during pregnancy and periods of breast feeding, after a bone is broken, and during advancing age.

Your body does not change lead into any other form. Once it is taken in and distributed to your organs, the lead that is not stored in your bones leaves your body in your urine or your feces. About 99% of the amount of lead taken into the body of an adult will leave in the waste within a couple of weeks, but only about 32% of the lead taken into the body of a child will leave in the waste. Under conditions of continued exposure, not all the lead that enters the body will be eliminated, and this may result in accumulation of lead in body tissues, notably bone.

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1.5 How can lead affect my health?

The effects of lead are the same whether it enters the body through breathing or swallowing. The main target for lead toxicity is the

nervous system, both in adults and in children. Long-term exposure of adults to lead at work has resulted in decreased performance in some tests that measure functions of the nervous system. Lead exposure may also cause weakness in fingers, wrists, or ankles. Some studies in humans have suggested that lead exposure may increase blood pressure, but the evidence is inconclusive. Lead exposure may also cause anemia, a low number of blood cells. The connection between the occurrence of some of these effects (e.g., increased blood pressure, altered function of the nervous system) and low levels of exposure to lead is not certain. At high levels of exposure, lead can severely damage the brain and kidneys in adults or children. In pregnant women, high levels of exposure to lead may cause miscarriage. High-level exposure in men can damage the organs responsible for sperm production.

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

We have no proof that lead causes cancer in humans. Kidney tumors have developed in rats and mice given large doses of lead. The animal studies have been criticized because of the very high doses used, among other things. The results of high-dose studies should not be used to predict whether lead may cause cancer in humans. The Department of Health and Human Services (DHHS) has determined that lead acetate and lead phosphate may reasonably be expected to be capable of causing cancer, based on sufficient evidence from animal studies, but there is inadequate evidence from human studies.

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1.6 How can lead affect children?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans. Potential effects on children resulting from exposures of the parents are also considered.

Studies carried out by the Center for Disease Control and Prevention (CDC) show that the levels of lead in the blood of U.S.

children have been getting lower and lower. This is because lead is banned from gasoline, residential paint, and solder that is used for food cans and water pipes. Still, about 900,000 U.S. children between the ages of 1 and 5 years are believed to have blood lead levels equal or greater than 10 µg/dL, the CDC level of concern.

Children are more vulnerable to lead poisoning than adults. Children are exposed to lead all through their lives. They can be exposed to lead in the womb if their mothers have lead in their bodies. Babies can swallow lead when they breast feed, or eat other foods and drink water that contains lead. Babies and children can swallow and breathe lead in dirt, dust, or sand while they play on the floor or ground. These activities make it easier for children to be exposed to lead than adults. The dirt or dust on their hands, toys, and other items may have lead particles in it. In some cases children swallow nonfood items such as paint chips; these may contain very large amounts of lead, particularly in and around older houses that were painted with lead-based paint. The paint in these houses often chips off and mixes with dust and dirt. Some old paint is 5–40% lead. Also, compared to adults, a bigger proportion of the amount of lead swallowed will enter the blood in children.

Children are more sensitive to the effects of lead than adults. Lead affects children in different ways depending how much lead a child swallows. A child who swallows large amounts of lead will develop blood anemia, kidney damage, colic (severe "stomachache"), muscle weakness, and brain damage which can kill the child. A large amount of lead might get into a child's body if the child ate small pieces of old paint that contained large amounts of lead. If a child swallows smaller amounts of lead, much less severe effects on blood and brain function may occur. In this case, recovery is likely once the child is removed from the source of lead exposure and the amount of lead in the child's body is lowered by giving the child certain drugs that help eliminate lead from the body. At still lower levels of exposure, lead can affect a child's mental and physical growth. Fetuses exposed to lead in the womb, because their mothers had a lot of lead in their bodies, may be born prematurely and have lower weights at birth. Exposure in the womb, in infancy, or in early childhood may also slow mental development and lower intelligence later in childhood. There is evidence that some effects may persist beyond childhood.

Health workers can find out whether a child may have been exposed to harmful levels of lead by taking a blood sample. They can also find out how much lead is in a child's bones by taking a special type of X-ray of the finger, knee, or elbow.

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1.7 How can families reduce the risk of exposure to lead?

If your doctor finds that you have been exposed to significant amounts of lead, ask your doctor if children may also be exposed. When necessary your doctor may need to ask your state public health department to investigate.

The most important way families can lower exposures to lead is to know about the sources of lead in their homes and avoid exposure to these sources. Some homes or day-care facilities may have more lead in them than others. Families who live in or visit these places may be exposed to higher amounts of lead. These include homes built before 1978 that may have been painted with paint that contains lead (lead-based paint). If you are buying a home that was built before 1978, you may want to known if it contains lead based paint. Federal government regulations require a person selling a home to tell the real estate agent or person buying the home of any known lead-based hazards on the property. Adding lead to paint is no longer allowed. If your house was built before 1978, it may have been painted with lead-based paint. This lead may still be on walls, floors, ceilings, and window sills, or on the outside walls of the house. The paint may have been scraped off by a previous owner, and the paint chips and dust may still be in the yard soil. In some states, homeowners can have the paint in their homes tested for lead by their local health departments. Families can lower the possibility of children swallowing paint chips by not allowing their children to chew or mouth these painted surfaces and be sure they wash their hands often, especially before eating. Families can also have a professional lead paint removal expert remove and dispose of peeling or flaking paint or painted surfaces, and repaint the surface. Using heat guns or dry scrapping of old lead containing paint during home reconstruction and remodeling can be a substantial source of lead exposure to children. Surfaces should be tested before such activities, and professional home repair personnel should be consulted to make sure that safe procedures are used and removed materials and dust are contained in order to keep exposures to children to a minimum. These repairs should not be made by homeowners themselves, unless they consult with a professional to get the information they need to prevent the possibility of lead poisoning during or after the repairs.

Older homes that have plumbing with lead or lead solder may have higher amounts of lead in drinking water. You cannot see, taste, or smell lead in water, and boiling your water will not get rid of lead. Running your water for 15 to 30 seconds before drinking or cooking with it will get rid of lead that may leach out from the pipes, especially if you have not used your water for a while, for example, overnight. You can contact your local health department or water supplier to find out about testing your water for lead.

You can bring lead home in the dust on your hands or clothes if lead is used in the place where you work. Lead dust is likely to be

found in places where lead is mined or smelted, where car batteries are made or recycled, where electric cable sheathing is made, where fine crystal glass is made, or where certain types of ceramic pottery are made. Pets can also bring lead into the home in dust or dirt on their fur or feet if they spend time in places that have high levels of lead in the soil.

Lead may be taken up in edible plants from the soil by the roots; therefore, home gardening may also contribute to exposure if the produce is grown in soils that have high lead concentrations. Certain hobbies and home or car repair activities like radiator repair can add lead to the home as well. These include soldering glass or metal, making bullets or slugs, or glazing pottery. Some non-Western "folk remedies" contain lead. Examples of these include greta and azarcon used to treat diarrhea.

Some types of paints and pigments that are used as facial make-up or hair coloring contain lead. Cosmetics that contain lead include surma and kohl, which are popular in certain Asian countries. Read the labels on hair coloring products, and keep hair dyes that contain lead acetate away from children. Do not allow children to touch hair that has been colored with lead-containing dyes or any surfaces that have come into contact with these dyes because lead compounds can rub off onto their hands and be transferred to their mouths.

Swallowing of lead in house dust or soil is a very important exposure pathway for children. This problem can be reduced in many ways. Regular hand and face washing to remove lead dusts and soil, especially before meals, can lower the possibility that lead on the skin is accidentally swallowed while eating. Families can lower exposures to lead by regularly cleaning the home of dust and tracked in soil. Door mats can help lower the amount of soil that is tracked into the home; removing your shoes before will also help. Planting grass and shrubs over bare soil areas in the yard can lower contact that children and pets may have with soil and the tracking of soil into the home.

Families whose members are exposed to lead dusts at work can keep these dusts out of reach of children by showering and changing clothes before leaving work, and bagging their work clothes before they are brought into the home for cleaning. Proper ventilation and cleaning—during and after hobby activities, home or auto repair activities, and hair coloring with products that contain lead—will decrease the possibility of exposure.

It is important that children have proper nutrition and eat a balanced diet of foods that supply adequate amounts of vitamins and minerals, especially calcium and iron. Good nutrition lowers the amount of swallowed lead that passes to the bloodstream and also may lower some of the toxic effects of lead.

You can find out whether your child may have been exposed to lead by having your doctor take a blood sample.

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1.8 Is there a medical test to determine whether I have been exposed to lead?

The amount of total lead in the blood can be measured to determine if exposure to lead has occurred. This test can tell if you have been recently exposed to lead. Lead can be measured lead in teeth or bones by X-ray techniques, but these methods are not widely available. These tests tell about long-term exposures to lead. Exposure to lead can be evaluated by measuring erythrocyte protoporphyrin (EP) in blood samples. EP is a part of red blood cells known to increase when the amount of lead in the blood is high. However, the EP level is not sensitive enough to identify children with elevated blood lead levels below about 25 micrograms per deciliter (µg/dL). For this reason, the primary screening method is measurement of blood lead.

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1.9 What recommendations has the federal government made to protect human health?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for lead include the following:

CDC recommends that states develop a plan to find children who may be exposed to lead and have their blood tested for lead. They make basic recommendations for states to follow. These include

testing children at ages 1 and 2. Children who are 3 to 6 years old should be tested if they have never been tested for lead before and they receive services from public assistance programs for the poor such as Medicaid or the Supplemental Food Program for Women, Infants and Children (WIC); if they live in a building or frequently visit a house built before 1950; if they visit a home (house or apartment) built before 1978 that has been recently remodeled; or if they have a brother, sister, or playmate who has had lead poisoning.

CDC considers children to have an elevated level of lead if the amount of lead in the blood is at least 10 μg/dL. Medical evaluation and environmental investigation and remediation should be done for all children with blood lead levels equal or greater than 20 μg/dL. Medical treatment may be necessary in children if the lead concentration in blood is higher than 45 μg/dL.

EPA requires that the concentration of lead in air that the public breathes be no higher than 1.5 micrograms per cubic meter ($\mu g/m^3$) averaged over 3 months. EPA regulations no longer allow lead in gasoline. The Clean Air Act Amendments (CAAA) of 1990 banned the sale of leaded gasoline as of December 31, 1995.

EPA regulations also limit lead in drinking water to 0.015 milligrams per liter (mg/L). The 1988 Lead Contamination Control Act requires the Consumer Product Safety Commission (CPSC), EPA, and the states to recall or repair water coolers containing lead. This law also requires new coolers to be lead-free. In addition, drinking water in schools must be tested for lead, and the sources of lead in this water must be removed.

To help protect small children, CPSC requires that the concentration of lead in most paints available through normal consumer channels be not more than 0.06%. The Federal Hazardous Substance Act (FHSA) bans children's products containing hazardous amounts of lead.

The Department of Housing and Urban Development (HUD) develops recommendations and regulations to prevent exposure to lead. HUD requires that federally funded housing and renovations, public housing, and Indian housing be tested for lead-based paint hazards and that such hazards be fixed by covering the paint or removing it. When determining whether lead-based paint applied to interior or exterior painted surfaces of dwellings should be removed, the standard used by EPA and HUD is that paint with a lead concentration equal to or greater than 1.0 milligram per square centimeter (mg/cm^2) of surface area should be removed or otherwise treated. HUD is carrying out demonstration projects to determine the best ways of covering or removing lead-based paint in housing.

EPA has developed standards for lead paint hazards, lead in dust, and lead in soil. To educate parents, homeowners, and tenants about lead hazards, lead poisoning prevention in the home, and the lead abatement process, EPA has published several general information pamphlets. Copies of these pamphlets can be obtained from the National Lead Information Center or from various Internet sites, including http://www.epa.gov/opptintr/lead.

OSHA regulations limit the concentration of lead in workroom air to 50 $\mu g/m^3$ for an 8-hour workday. If a worker has a blood lead level of 50 $\mu g/dL$, then OSHA requires that worker be removed from the workroom where lead exposure is occurring.

FDA includes lead on its list of poisonous and deleterious substances. FDA considers foods packaged in cans containing lead solders to be adulterated. Tin-coated lead foil has been used as a covering applied over the cork and neck areas of wine bottles for decorative purposes and to prevent insect infestations. Because it can be reasonably expected that lead could become a component of the wine, the use of these capsules is also a violation of the Federal Food, Drug, and Cosmetic Act. FDA has reviewed several direct human food ingredients and has determined them to be "generally recognized as safe" when used in accordance with current good manufacturing practices. Some of these ingredients contain allowable lead concentrations that range from 0.1 to 10 parts per million (ppm).

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1.10 Where can I get more information?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333

Information line and technical assistance:

Phone: 888-422-8737
FAX: (404)498-0093

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

To order toxicological profiles, contact:

National Technical Information Service

5285 Port Royal Road
Springfield, VA 22161
Phone: 800-553-6847 or 703-605-6000

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References

Agency for Toxic Substances and Disease Registry (ATSDR). 1997. Toxicological profile for lead. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

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ATSDR Information Center / ATSDRIC@cdc.gov / 1-888-422-8737

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ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

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September 2000

Public Health Statement for Arsenic

CAS# 7440-38-2

This Public Health Statement is the summary chapter from the Toxicological Profile for arsenic. It is one in a series of Public Health Statements about hazardous substances and their health effects. A shorter version, the ToxFAQs™, is also available. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present. For more information, call the ATSDR Information Center at 1-888-422-8737.

This public health statement tells you about arsenic and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup activities. Arsenic has been found in at least 1,014 of the 1,598 current or former NPL sites. However, the total number of NPL sites evaluated for this substance is not known. As more sites are evaluated, the sites at which arsenic is found may increase. This information is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact.

If you are exposed to arsenic, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you are exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 What is arsenic?

MMGs
MHMIs
Interaction Profiles
Priority List of Hazardous Substances
Division of Toxicology

Arsenic is an element that is widely distributed in the earth's crust. Elemental arsenic is ordinarily a steel grey metal-like material that sometimes occurs naturally. However, arsenic is usually found in the environment combined with other elements such as oxygen, chlorine, and sulfur. Arsenic combined with these elements is called inorganic arsenic. Arsenic combined with carbon and hydrogen is referred to as organic arsenic. Understanding the difference between inorganic and organic arsenic is important because the organic forms are usually less harmful than the inorganic forms.

Most inorganic and organic arsenic compounds are white or colorless powders that do not evaporate. They have no smell, and most have no special taste. Thus, you usually cannot tell if arsenic is present in your food, water, or air.

Inorganic arsenic occurs naturally in soil and in many kinds of rock, especially in minerals and ores that contain copper or lead. When these ores are heated in smelters, most of the arsenic goes up the stack and enters the air as a fine dust. Smelters may collect this dust and take out the arsenic as arsenic trioxide. However, arsenic is no longer produced in the United States; all the arsenic we use is imported.

Presently about 90% of all arsenic produced is used as a preservative for wood to make it resistant to rotting and decay. The preservative is chromated copper arsenate (CCA) and the treated wood is referred to as "pressure-treated." In the past, arsenic was primarily used as a pesticide, primarily on cotton fields and in orchards. Inorganic arsenic compounds can no longer be used in agriculture. However, organic arsenicals, namely cacodylic acid, disodium methylarsenate (DSMA), and monosodium methylarsenate (MSMA) are still used as pesticides, principally on cotton. Small quantities of arsenic metal are added to other metals forming metal mixtures or alloys with improved properties. The greatest use of arsenic in alloys is in lead-acid batteries used in automobiles. Another important use of arsenic compounds is in semiconductors and light-emitting diodes.

To learn more about the properties and uses of arsenic, see Chapters 3 and 4 of the toxicological profile.

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1.2 What happens to arsenic when it enters the environment?

Arsenic occurs naturally in soil and minerals and therefore it may enter the air, water, and land from wind-blown dust and may get into water from runoff and leaching. Volcanic eruptions are another source of arsenic. Arsenic is associated with ores mined for metals, such as copper and lead, and may enter the environment during the mining and smelting of these ores. Small amounts of arsenic also may be released into the atmosphere from

coal-fired power plants and incinerators because coal and waste products often contain some arsenic.

Arsenic cannot be destroyed in the environment. It can only change its form, or become attached or separated, from particles. It may change its form by reacting with oxygen or other molecules present in air, water, or soil, or by the action of bacteria that live in soil or sediment. Arsenic released from power plants and other combustion processes is usually attached to very small particles. Arsenic contained in wind-borne soil is generally found in larger particles. These particles settle to the ground or are washed out of the air by rain. Arsenic that is attached to very small particles may stay in the air for many days and travel long distances. Many common arsenic compounds can dissolve in water. Thus, arsenic can get into lakes, rivers, or underground water by dissolving in rain or snow or through the discharge of industrial wastes. Some of the arsenic will stick to particles in the water or sediment on the bottom of the lakes or river, and some will be carried along by the water. Ultimately most arsenic ends up in the soil or sediment. Although some fish and shellfish take in arsenic which may build up in tissues, most of this arsenic is in a form (often called "fish arsenic") that is less harmful.

For more information on how arsenic behaves in the environment, see Chapter 5 of the toxicological profile.

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1.3 How might I be exposed to arsenic?

Arsenic is found naturally in the environment. You may be exposed to arsenic by eating food, drinking water, or breathing air. Children may also be exposed to arsenic by eating dirt. You may also be exposed by skin contact with soil or water that contains arsenic. Analytical methods used by scientists to determine the levels of arsenic in the environment generally do not determine the specific form of arsenic present. Therefore, we do not always know the form of arsenic a person may be exposed to. Similarly, we often do not know what forms of arsenic are present at hazardous waste sites. Some forms of arsenic may be so tightly attached to particles or embedded in minerals that they are not taken up by plants and animals.

The concentration of arsenic in soil varies widely, generally ranging from about 1 to 40 parts of arsenic to a million parts of soil (ppm) with an average level of 5 ppm. However soils in the vicinity of arsenic-rich geological deposits, some mining and smelting sites, or agricultural areas where arsenic pesticides had been applied in the past may contain much higher levels of arsenic. The concentration of arsenic in natural surface and groundwater is generally about 1 part in a billion parts of water (1 ppb) but may exceed 1,000 ppb in mining areas or where arsenic levels in soil are high. Groundwater is far more likely to contain

high levels of arsenic than surface water. Surveys of U.S. drinking water indicate that about 80% of water supplies have less than 2 ppb of arsenic, but 2% of supplies exceed 20 ppb of arsenic. Levels of arsenic in food range from about 20 to 140 ppb. However, levels of inorganic arsenic, the form of most concern, are far lower. Levels of arsenic in the air generally range from less than 1 to about 2,000 nanograms (1 nanogram equals a billionth of a gram) of arsenic per cubic meter of air (less than 1–2,000 ng/m^3), depending on location, weather conditions, and the level of industrial activity in the area. However urban areas generally have mean arsenic levels in air ranging from 20 to 30 ng/m^3, most of which is attached to small particles.

You normally take in small amounts of arsenic in the air you breathe, the water you drink, and the food you eat. Of these, food is usually the largest source of arsenic. Fish and seafood contain the greatest amounts of arsenic, but this is mostly the organic form of arsenic that is less harmful. Children are likely to eat small amounts of dust or dirt each day, so this is another way they may be exposed to arsenic. The total amount of arsenic you take in from these sources is generally about 50 µg each day. The level of inorganic arsenic (the form of most concern) you take in from these sources is generally about 3.5 µg/day.

In addition to the normal levels of arsenic in air, water, soil, and food, you could be exposed to higher levels in several ways, such as the following:

- Some areas of the United States contain unusually high natural levels of arsenic in rock, and this can lead to unusually high levels of arsenic in soil or water. If you live in an area like this, you could take in elevated amounts of arsenic in drinking water. Children may be taking in arsenic because of hand to mouth contact or eating dirt.
- Some hazardous waste sites contain large quantities of arsenic. If the material is not properly disposed of, it can get into surrounding water, air, or soil. If you live near such a site, you could be exposed to elevated levels of arsenic from these media.
- If you work in an occupation that involves arsenic production or use (for example, copper or lead smelting, wood treating, pesticide application), you could be exposed to elevated levels of arsenic during your work.
- If you saw or sand arsenic-treated wood, you could inhale some of the sawdust into your nose or throat. Similarly, if you burn arsenic-treated wood, you could inhale arsenic in the smoke.
- If you live in a formerly agricultural area where arsenic was used on crops, the soil could contain high levels of arsenic.
- In the past, several kinds of products used in the home (rat poison, ant poison, weed killer, some types of medicines)

had arsenic in them. However, most of these uses of arsenic have ended, so you are not likely to be exposed from home products any longer.

You can find more information on how you may be exposed to arsenic in Chapter 5 of the toxicological profile.

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1.4 How can arsenic enter and leave my body?

If you swallow arsenic in water, soil, or food, most of the arsenic may quickly enter into your body. The amount that enters your body will depend on how much you swallow and the kind of arsenic that you swallow. This is the most likely way for you to be exposed near a waste site. If you breathe air that contains arsenic dusts, many of the dust particles settle onto the lining of the lungs. Most of the arsenic in these particles is then taken up from the lungs into the body. You might be exposed in this way near waste sites where arsenic-contaminated soils are allowed to blow into the air. If you get arsenic-contaminated soil or water on your skin, only a small amount will go through your skin into your body, so this is usually not of concern.

If you are exposed to arsenic, your liver changes some of this to a less harmful organic form. Both inorganic and organic forms leave your body in your urine. Most of the arsenic will be gone within several days, although some will remain in your body for several months or even longer.

You can find more information on how arsenic enters and leaves your body in Chapter 2 of the toxicological profile.

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1.5 How can arsenic affect my health?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

Inorganic arsenic has been recognized as a human poison since ancient times, and large oral doses (above 60,000 ppb in food or water) can produce death. If you swallow lower levels of inorganic

arsenic (ranging from about 300 to 30,000 ppb in food or water), you may experience irritation of your stomach and intestines, with symptoms such as stomach ache, nausea, vomiting, and diarrhea. Other effects you might experience from swallowing inorganic arsenic include decreased production of red and white blood cells which may cause fatigue, abnormal heart rhythm, blood-vessel damage resulting in bruising, and impaired nerve function causing a "pins and needles" sensation in your hands and feet.

Perhaps the single most characteristic effect of long-term oral exposure to inorganic arsenic is a pattern of skin changes. These include a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso. A small number of the corns may ultimately develop into skin cancer. Swallowing arsenic has also been reported to increase the risk of cancer in the liver, bladder, kidneys, prostate, and lungs. The Department of Health and Human Services (DHHS) has determined that inorganic arsenic is a known carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans. Both the EPA and the National Toxicology Program (NTP) have classified inorganic arsenic as a known human carcinogen.

If you breathe high levels of inorganic arsenic, you are likely to experience a sore throat and irritated lungs. You may also develop some of the skin effects mentioned above. The exposure level that produces these effects is uncertain, but it is probably above 100 micrograms of arsenic per cubic meter (g/m^3) for a brief exposure. Longer exposure at lower concentrations can lead to skin effects, and also to circulatory and peripheral nervous disorders. There are some data suggesting that inhalation of inorganic arsenic may also interfere with normal fetal development, although this is not certain. An important concern is the ability of inhaled inorganic arsenic to increase the risk of lung cancer. This has been seen mostly in workers exposed to arsenic at smelters, mines, and chemical factories, but also in residents living near smelters and arsenical chemical factories. People who live near waste sites with arsenic may have an increased risk of lung cancer as well.

If you have direct skin contact with inorganic arsenic compounds, your skin may become irritated, with some redness and swelling. However, it does not appear that skin contact is likely to lead to any serious internal effects.

Despite all the adverse health effects associated with inorganic arsenic exposure, there is some evidence that the small amounts of arsenic in the normal diet (10–50 ppb) may be beneficial to your health. For example, animals fed a diet with unusually low concentrations of arsenic did not gain weight normally. They also became pregnant less frequently than animals fed a diet containing a normal amount of arsenic. Further, the offspring from these

animals tended to be smaller than normal, and some died at an early age. However, no cases of arsenic deficiency in humans have ever been reported.

Almost no information is available on the effects of organic arsenic compounds in humans. Studies in animals show that most simple organic arsenic compounds (such as methyl and dimethyl compounds) are less toxic than the inorganic forms and that some complex organic arsenic compounds are virtually non-toxic. However, high doses can produce some of the same effects. Thus, if you are exposed to high doses of an organic arsenic compound, you might develop nerve injury, stomach irritation, or other effects, but this is not known for certain.

You can find more information on the health effects of inorganic and organic arsenic in Chapter 2 of the toxicological profile.

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1.6 How can arsenic affect children?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans.

Children are exposed to arsenic in many of the same ways that adults are. Since arsenic is found in the soil, water, food, and air, children may take in arsenic in the air they breathe, the water they drink, and the food they eat. Since children tend to eat or drink less of a variety of foods and beverages than do adults, ingestion of contaminated food or juice or infant formula made with arsenic-contaminated water may represent a significant source of exposure. In addition, since children often play in the dirt and put their hands in their mouths and sometimes intentionally eat dirt, ingestion of contaminated soil may be a more important source of arsenic exposure for children than for adults. In areas of the United States where natural levels of arsenic in the soil and water are high, or in areas in and around contaminated waste sites, exposure of children to arsenic through ingestion of soil and water may be significant. In addition, contact with adults who are wearing clothes contaminated with arsenic (e.g., with dust from copper- or lead-smelting factories, from wood-treating or pesticide application, or from arsenic-treated wood) could be a source of exposure. Because of the tendency of children to taste things that they find, accidental poisoning from ingestion of pesticides is also a possibility. Thus, although most of the exposure pathways for children are the same as those for adults, children may be at a higher risk of exposure because of their lack of consistent hygiene practices and their curiosity about unknown powders and liquids.

Children who are exposed to arsenic may have many of the same effects as adults, including irritation of the stomach and intestines, blood vessel damage, skin changes, and reduced nerve function.

Thus, all health effects observed in adults are of potential concern in children. We do not know if absorption of arsenic from the gut in children differs from adults. There is some information suggesting that children may be less efficient at converting inorganic arsenic to the less harmful organic forms. For this reason, children may be more susceptible to health effects from inorganic arsenic than adults.

At present, there is no convincing evidence that inhaled or ingested arsenic can injure pregnant women or their fetuses, although studies in animals show that large doses of arsenic that cause illness in pregnant females can also cause low birth weight, fetal malformations, and even fetal death. Arsenic can cross the placenta and has been found in fetal tissues. Arsenic is found at low levels in breast milk.

You can find more information about how arsenic can affect children in Sections 2.7 and 5.6 of the toxicological profile.

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1.7 How can families reduce the risk of exposure to arsenic?
If your doctor finds that you have been exposed to significant amounts of arsenic, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate.

If you use arsenic-treated wood in home projects, personal protection from exposure to arsenic-containing sawdust may be helpful in limiting exposure of family members. These measures may include dust masks, gloves, and protective clothing. If you live in an area with a high level of arsenic in the water or soil, substituting cleaner sources of water and limiting contact with soil (for example, through use of a dense groundcover or thick lawn) would reduce family exposure to arsenic. By paying careful attention to dust and dirt control in the home (air filters, frequent cleaning), you can reduce family exposure to contaminated dirt. Some children eat a lot of dirt. You should prevent your children from eating dirt. You should discourage your children from putting objects in their mouths. Make sure they wash their hands frequently and before eating. Discourage your children from putting their hands in their mouths or other hand-to-mouth activity. Since arsenic may be found in the home as a pesticide, household chemicals containing arsenic should be stored out of reach of young children to prevent accidental poisonings. Always store household chemicals in their original labeled containers; never store household chemicals in containers children would find attractive to eat or drink from, such as old soda bottles. Keep your Poison Control Center's number by the phone.

It is sometimes possible to carry arsenic from work on your clothing, skin, hair, tools, or other objects removed from the

workplace. This is particularly likely if you work in the fertilizer, pesticide, glass, or copper/lead smelting industries. You may contaminate your car, home, or other locations outside work where children might be exposed to arsenic. You should know about this possibility if you work with arsenic.

Your occupational health and safety officer at work can and should tell you whether chemicals you work with are dangerous and likely to be carried home on your clothes, body, or tools and whether you should be showering and changing clothes before you leave work, storing your street clothes in a separate area of the workplace, or laundering your work clothes at home separately from other clothes. Material safety data sheets (MSDS) for many chemicals used should be found at your place of work, as required by the Occupational Safety and Health Administration (OSHA) in the U.S. Department of Labor. MSDS information should include chemical names and hazardous ingredients, and important properties, such as fire and explosion data, potential health effects, how you get the chemical(s) in your body, how to properly handle the materials, and what to do in the case of emergencies. Your employer is legally responsible for providing a safe workplace and should freely answer your questions about hazardous chemicals. Your state OSHA-approved occupational safety and health program or U.S. OSHA can answer any further questions and help your employer identify and correct problems with hazardous substances. Your state OSHA-approved occupational safety and health program or U.S. OSHA will listen to your formal complaints about workplace health hazards and inspect your workplace when necessary. Employees have a right to seek safety and health on the job without fear of punishment.

You can find more information about how arsenic can affect children in Sections 2.7 and 5.6 of the toxicological profile.

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1.8 Is there a medical test to determine whether I have been exposed to arsenic?

Several sensitive and specific tests can measure arsenic in your blood, urine, hair, or fingernails, and these tests are often helpful in determining if you have been exposed to above-average levels of arsenic. These tests are not usually performed in a doctor's office. They require sending the sample to a testing laboratory.

Measurement of arsenic in your urine is the most reliable means of detecting arsenic exposures that you experienced within the last several days. Most tests measure the total amount of arsenic present in your urine. Sometimes this can be misleading, because the nonharmful forms of arsenic in fish and shellfish can give a high reading even if you have not been exposed to a toxic form of arsenic. For this reason, laboratories sometimes use a more complicated test to separate "fish arsenic" from other forms.

Because most arsenic leaves your body within a few days, analysis of your urine cannot detect if you were exposed to arsenic in the past. Tests of your hair or fingernails can tell if you were exposed to high levels over the past 6–12 months, but these tests are not very useful in detecting low-level exposures. If high levels of arsenic are detected, this shows that you have been exposed, but unless more is known about when you were exposed and for how long, it is usually not possible to predict whether you will have any harmful health effects.

You can find more information on how arsenic can be measured in your hair, urine, nails, and other tissues in Chapters 2 and 6 of the toxicological profile.

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1.9 What recommendations has the federal government made to protect human health?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for arsenic include the following:

The federal government has taken several steps to protect humans from arsenic. First, EPA has set limits on the amount of arsenic that industrial sources can release into the environment. Second, EPA has restricted or canceled many of the uses of arsenic in pesticides and is considering further restrictions. Third, EPA has set a limit of 50 ppb for arsenic in drinking water. EPA has recently proposed lowering this value to 5 ppb. Finally, OSHA has established a permissible exposure limit (PEL), 8-hour time-

weighted average, of 10 :g/m³ for airborne arsenic in various workplaces that use inorganic arsenic.

You can find more information on regulations and guidelines that apply to arsenic in Chapter 7 of the toxicological profile.

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1.10 Where can I get more information?
If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333

Information line and technical assistance:

Phone: 888-422-8737
FAX: (404)498-0093

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

To order toxicological profiles, contact:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: 800-553-6847 or 703-605-6000

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References

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological profile for arsenic (*update*). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

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APPENDIX F
SAMPLING PLAN

SAMPLING PLAN

The following sampling plan applies to the areas where additional sampling is needed to verify the extent of contamination outside the isoconcentration lines, and samples taken once contaminated soils and sediments have been removed. This plan is consistent with the KDHE approved amended sampling plan dated September 16, 2002 and later amended in a letter dated April 29, 2003. At all times, the sampling procedures will be consistent with KDHE and U.S. EPA sampling and sample handling protocol.

EPA REPOSITORY AREA

A composite sample will be taken from each of the sampling locations marked on Figure 5. A SIMKO 2400 SK Model-purpose Shallow Depth Exploration Drill capable of direct push sampling or auger sampling will be used for collecting samples at these new locations. In locations where the thickness of the material exceeds 5 feet, a composite sample will be collected from each five foot material depth or portion there of. If the thickness of the material exceeds five feet, an additional composite sample will be taken for that five-foot section, or part thereof. The same applies for a third five-foot section, if needed. A sample core probe 5 feet in length will be used for obtaining the samples.

SAMPLING PROTOCOL

Sampling of soil within the EPA's disposal site is as follows:

- The sampling staff will don the appropriate level of personal protective equipment including hard hat, safety glasses, rubber boots, and nitrite or vinyl gloves. They will thoroughly clean the soil sampler (particularly the sampling tube) and stainless steel or plastic washtubs with alconox, distilled water and rinse with distilled water.
- At each sample location the soil sampler will penetrate the first 5 foot segment of soil or part thereof and put into a stainless steel mixing tub (the top 8 inches of

soil will be disregarded as clean soil cover). The sample will be mixed to form a composite sample. The composite sample will be split two ways, one split will be sent to the laboratory while the other sample will be retained for archive. The sample splits will be placed in separate labeled glass jars and placed in collars for shipment to the laboratory and one set of split samples will be maintained in the samples custody.

- A soil-sampling log will be maintained by the sampling team for future reference. A copy of the log is located at the end of this section.
- Sampling team members will then clean the soil sampler(s), tubs and tools with alcohol and distilled water. Sampling team members will don clean nitrite gloves prior to continuing with sampling.
- The above sampling sequence will be followed for each of the remaining points to be sampled.
- At the conclusion of sampling, conduct final decontamination of sampling equipment and reusable personal protective equipment.

SOILS ON-SITE

Additional samples will be taken as outlined on Figures 3 and 3-2. The samples taken will be of the top six inches of soil. Equipment utilized for these sampling events may include, Tube-type soil sample(s) filled with a 6-inch sampling tube, sharpshooter type shovel, and stainless steel or plastic hardware for compositing.

- Sampling staff will don the appropriate level of personal protective equipment with a minimum of boots, safety glasses, and nitrite or vinyl gloves. They will thoroughly clean all sample equipment before and after each sample taken. The team will core with the sampler to the depth of 6inches, remove the soil and place into the stainless steel bowl, it will be mixed and then sampled. The sample will be split two ways, one split will be sent to the lab while the other will be archived. The sample splits will be placed in separate labeled glass jars and placed in coolers for shipment to the laboratory and one set of split samples will be maintained in the samplers custody.

- Sampling team members will then clean the soil sampler(s) and miscellaneous equipment with alconox and distilled water. Sampling team members will don clean gloves and proceed to the next sampling point
- The above sampling sequence will be followed for each of the remaining points to be sampled.
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SEDIMENT

This plan will initiate after all visible sediments have been removed form Unnamed Creek. The areas to be sampled on Unnamed Creek will be the same areas previously sampled as outlined on Figure1. The same areas will be sampled to verify the success of sediment removal. The equipment involved and sampling protocol for after sediment removal is the same protocol and equipment use as sampling the On-site soils.

PRESERVATION PROCEDURES

Since the only constituent of concern associated with these three are metals and all soil, no preservatives are required. The samples will be placed in the appropriately sized glass jars in coolers while in transit to the laboratory. One set of split samples will be retained by the sampling team for additional analyses should it be deemed necessary or desirable at a later date.

LABELING & CHAIN OF CUSTODY

A label with the following information will be affixed to each sample jar:

- Name of sampling firm
- Initials of sampler
- Client/source
- Site name
- Sample identification
- Identified as grab (discrete) or composite

- Date of sample collection
- Time of sample collection
- Preservatives (if used)
- Analysis requested to be performed by laboratory

The chain of custody form located in the back of this Appendix will be completed and submitted with the samples and procedures outlined in EPA SW-846 followed throughout delivery of samples to the analytical laboratory.

DECONTAMINATION PROCEDURES

Decontamination procedures will consist of the following.

- Sampling team members will don clean nitrite or vinyl gloves prior to initiating sampling and after
- The soil sampling tools will be cleaned with a brush and a solution of alconox prior to the beginning sampling and after each sample has been obtained. Particular attention will be paid to any portion of the sampling tools with cracks, crevices or an irregular surface which might trap contaminated material. The sampling tool will then be rinsed with distilled water and, if necessary, dried with a clean paper towel.
- After sampling is complete, re-usable protective equipment will be washed with an alconox soap solution and scrub brush followed by thorough rinsing with distilled water.

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- After sampling is complete, re-usable protective equipment will be washed with an alconox soap solution and scrub brush followed by thorough rinsing with distilled water.