

FINAL

**FORMER NATIONAL ZINC SITE
BROWNFIELDS TARGETED ASSESSMENT (BTA)
VOLUME I of V
COMBINED PHASE I-II BTA REPORT WITH APPENDIX A-B
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SECTION 1: INTRODUCTION

The Kansas Department of Health and Environment (KDHE) has a cooperative agreement with the U.S. Environmental Protection Agency (EPA) to perform Brownfields Targeted Assessments (BTAs) at selected sites which are owned or to be purchased by a municipal, county or other quasi-governmental agency. The purpose of the National Zinc BTA is to conduct a Phase I and II property evaluation of the site to facilitate future development of the property and assist the City of Cherryvale, Kansas in determining response options for the candidate property.

On March 25, 1999, the City of Cherryvale submitted an application for KDHE to conduct a BTA on the municipal property known as the "Smelter Grounds". The application was accepted by KDHE in April, 1999. The "Smelter Grounds" property is the location of the former National Zinc facility and is referred to throughout this BTA as the National Zinc site. The BTA investigation included multiple activities. Review of the historical file information was conducted, and field activities included a site reconnaissance, topographic and geophysical surveys, and sampling of environmental media. The BTA has integrated both Phase I and Phase II Association of Testing and Materials (ASTM) activities commonly associated with property assessments. A site-specific Quality Assurance Project Plan (QAPP) was approved by EPA for the National Zinc BTA in May, 1999.

SECTION 2: SITE LOCATION, DESCRIPTION, OPERATIONAL HISTORY

2.0 Site Location

The National Zinc site is located at the northwestern city limits of Cherryvale, Montgomery County, Kansas (see Figure 1) and is located along U.S. Highway 169. Cherryvale is a rural community with some light industry. The population of Cherryvale as of the last census was 2,464 persons (Reference 8). The geographic coordinates of the site are 39° 42' 30.0" North latitude and 96° 25' 00" West longitude (see Appendix H). The site is located in Section 8 in Township 32 South, Range 17 East (Reference 1). Figures 2(a)-2(c) illustrate the site location from aerial photographs.

2.1 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. The maximum 24-hour precipitation event recorded for Montgomery County is 6.38 inches (Reference 3).

2.2 Site Description

The site consists of the former location of the National Zinc smelter facility. The site is bounded by an unnamed creek on the west side of the site, by and by Martin Street on the south, and Montgomery County Roads 5200 (north boundary) and 5400 (east boundary). The former Cherryvale waste water treatment plant is located adjacent to the southeast corner of the site but has been decommissioned. The South Kansas and Oklahoma Railroad transects the site generally from southeast to northwest. A small Williams Pipe Line Company natural gas meter/valve station is located adjacent to the northern side of the railroad right-of-way in the southeastern portion of the site. The area is generally flat with approximately 30 feet of relief across the site. Residential and agricultural properties surround the site.

2.3 Site History

The National Zinc site consists of approximately 350 acres containing the former National Zinc smelter facility on the northern edge of Cherryvale, Kansas. Historical review from Sanborn Fire Insurance maps and historical archive information available during the BTA 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) massive ore roasters and 24 furnaces in operation, consistent with the 1908 configuration.

The Sanborn Maps indicate the facility as operating “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. At least one half of the demand for primary zinc production was for galvanizing purposes. U.S. Steel Corporation may also have had some ownership interest in the Edgar Zinc Company around 1910. The facility operated as the Edgar Zinc Company until sometime after 1928, when it was reorganized as the National Zinc Company (References 6, 28, 29). 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 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. Figure 3 includes a portion of the Sanborn Fire Insurance Map for the former National Zinc smelter facility.

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 the appearance of 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 ground water pollution associated with facility run-off 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 was treated and discharged into the adjacent Drum Creek. Ore and sludge was 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 ground water samples collected in 1982, 1983, and 1984 showed high levels of cadmium and lead.

In an April 5, 1983 letter from KDHE to Mr. Vogel of National Zinc, the clean-up and closure of the surface impoundments were found to be satisfactory. National Zinc was advised by KDHE that erosion of top soil near the low-lying areas must be minimized, barren patches of land observed during a KDHE inspection must be reseeded, and ground water monitoring must continue on a quarterly basis. The letter further explained the need for a restrictive covenant to preserve the integrity of the waste disposal area during the post-closure maintenance period of the disposal areas. A restrictive covenant limiting use or development of the property was prepared in 1983 and still governs the site. A November 17, 1977 KDHE letter advised the Mayor of Cherryvale against entering into any agreements or contracts in which the City would assume the responsibility or liability for the cleanup of the site.

On August 17, 1987, a member of the Cherryvale City Council contacted KDHE. The City Council had an opportunity to obtain the site and were concerned about responsibilities regarding the long term maintenance of the area as well as response actions required if contamination was identified. An inspection of the site was performed and a large exposed area with no vegetation in the southern portion of the site was noted. A December 22, 1987 KDHE letter advised the Mayor of Cherryvale of potential liability should the City chose to purchase the property and stated KDHE's position that continued monitoring and maintenance of the site was warranted.

In addition, KDHE inspected the site in May 1995 following a City of Cherryvale inquiry into possible restrictive covenant termination and redevelopment of the property. Surface water, soil, sediment, and sludge/waste samples were obtained by KDHE personnel. Shallow ground water samples were also collected from existing monitoring wells installed around the lagoon. Laboratory analysis revealed contamination of sludge, soil and sediment samples of selected Resource Conservation and Recovery Act (RCRA) heavy metals above the non-residential Risk-Based Standards for Kansas (RSKs). Lead

was detected at a maximum of 176,750 mg/kg (RSK = 1,000 mg/kg), cadmium at 2,816 mg/kg (RSK = 1,000 mg/kg), and arsenic at a maximum of 240 mg/kg (RSK = 38 mg/kg).

Cadmium was detected in surface and ground water up to 0.111 mg/l, above its maximum contaminant level (MCL) of 0.005 mg/l. In July, 1996, sediment/sludge sampling indicated lead up to 1,786 mg/kg, above its non-residential RSK level of 1,000 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. The PA/SI forms are included in Appendix L. The site is currently also in KDHE's Enforcement/Negotiation program to gather and review information pertaining to potential responsible parties (PRPs) for the National Zinc site. Figures 2(a)-(d)

2.4 Hazardous Substance Characteristics

The primary contaminants of concern at the National Zinc site are lead, cadmium and arsenic. Additional information concerning the chemical and physical properties, uses, and health effects of these metals are included in Appendix A.

SECTION 3: BTA FIELD ACTIVITIES

3.0. Phase I Considerations

The site was visited by KDHE personnel in April, 1999 and June, 1999. Physical evidence of slag and wastes was identified during these site visits. A review of the available records for this site indicated previous evidence of releases of hazardous substances, especially heavy metals, from the site. Since previous evidence of hazardous substance releases was present, Phase II was initiated immediately after completion of the file review. Historic file information collected and reviewed during Phase I is summarized in Appendix E. This BTA therefore incorporates and integrates both the Phase I and Phase II activities for the BTA at the National Zinc site. A Quality Assurance Project Plan (QAPP) for the Phase II activities was approved by EPA in April, 1999 and is included in Appendix J.

A visual inspection of the remaining buildings during the initial BTA site visit did not reveal any other institutional concerns such as asbestos or lead paint/piping since the only remaining buildings are metal shed-type buildings with no insulation or active water piping. Phase II was therefore designed to focus primarily on a targeted assessment of releases of heavy metal constituents and smelter wastes remaining at the site from the former primary smelting operations.

No other CERCLA Information System (CERCLIS) sites were identified within one mile of the site during the Phase I activities. There are several nearby KDHE underground storage tank (UST) sites

that are currently being addressed by KDHE's UST Trust Fund program. The Phase I also identified several Resource Conservation and Recovery Act (RCRA) generators within one mile of the site. These facilities are included in Appendix F. None of the UST or RCRA facilities identified has likely impacted the National Zinc site given the difference in waste streams and constituents from these facilities compared to the smelter wastes and constituents from the National Zinc site. The BTA form in Appendix E includes further Phase I considerations.

3.1 Phase II Field Activities

3.1.0. Site Topographic Survey

A survey of the site was performed by Carlson Surveying of Hays, Kansas in July, 1999. Carlson Surveying is a registered land surveyor with Kansas state registration number LS-715. The surveyors constructed an initial grid of 500' X 500' with lath stakes and surveyed the as-built current elevations at the site. A KDHE field team constructed a 100' X 100' grid with lath stakes off of the surveyed base grid constructed by the surveyor. The KDHE team utilized a Bushnell laser range finder with a typical closure error of 3-6 feet (3-6 % measurement error) for measurement of the 100' X 100' sampling grid. Some grid measurements were also made with a steel 100' surveyor's tape. A copy of the surveyor's maps are included in Appendix K.

3.1.1 Geophysical Survey

A geophysical survey was conducted at the site after surveying with KDHE's Geometrics G-858 cesium magnetometer and a Geonics EM-31 terrain conductivity meter. Because of the large area of the site, both instruments were utilized in continuous data-logging modes. Raw geophysical survey data, and notes are included in Appendix G.

The Geometrics G-858 cesium magnetometer unit was used in a single sensor mode. The instrument was allowed to warm up a minimum of 15 minutes before initiating survey lines. A separate Geometrics G-856 proton precession magnetometer was set up as a discrete base station unit to measure diurnal fluctuations for later data reduction.

The Geonics EM-31 terrain conductivity meter was warmed up and zeroed at the northwest corner of the site in what appeared to be some virgin areas that were undisturbed from previous activities in the area. The EM-31 was zeroed in the in-phase mode, and all initial quadrature precision, sensitivity and accuracy parameters were checked (standard operational checks) prior to initiation of profile lines.

3.1.2 Initial Surficial Soil Sampling

An initial soil sampling event was performed with KDHE's Niton 733 X-ray fluorescence (XRF) unit in May, 1999. The purpose of the initial soil sampling event was to perform XRF sampling consistent with

EPA Method 6200 using both an *in-situ* and homogenized sample preparation technique to compare performance results with laboratory analysis of the same samples by EPA Method 6010. The results were also used to develop an initial semi-quantitative calibration model for use of the Niton 733 XRF unit. Seventeen (17) locations were selected in a biased fashion to include high, low and medium detection areas for lead in surficial soils. Sampling was conducted with an AMS slambar/soil core device from the selected locations. Deeper intervals of some selected cores were also analyzed. Homogenization was conducted by drying soils in a drying oven and sieving in compliance with EPA Method 6200. The samples were then placed in plastic analysis vials for XRF analysis. Composite samples were also obtained from these initial samples for TCLP analysis. The coordinates for the initial sample locations were determined and these results included in the site-wide soil sampling grid.

3.1.3 *In-Situ* XRF Analysis

After review of data from the initial XRF sampling event, it was determined that *in-situ* XRF analysis would produce data of adequate quantitative screening quality. *In-situ* XRF analysis was performed across the site utilizing the 100' X 100' grid to the extent practicable. Some marshy areas and areas around the construction/demolition (C/D) area and the railroad right-of way caused some variations in the soil screening grid, but most of the site was screened on the 100' grid centers. Approximately 659 *in-situ* XRF screening samples were obtained not including the initial XRF screening samples, standards, calibration runs, or field duplicates/quality control (QC) samples. Field analysis was performed by clearing surficial vegetation away from the sampling location with a hand hoe or small mattock. The Niton XRF was then placed directly on the surface of the soil on top of the special soil "sled" used for *in-situ* analysis. The "sled" has a thin protective mylar window which keeps the soil from direct contact with the instrument. The shutter was then opened, and the sample was analyzed for 60 source seconds (Ss) with the XRF. To correlate field readings later in the office and maintain maximum data quality, the XRF readings were recorded in the field on field data sheets and also simultaneously in the XRF data logger unit.

3.1.4 Field XRF Quality Control (QC) Samples

A field duplicate was typically obtained after analysis of every 10-12 unknown field samples. A prepared commercial reference material (NIST) high or medium concentration soil standard was analyzed after every 10-12 unknown field samples. The XRF was calibrated/zeroed every morning of field analysis, and after any period during which the XRF was shut off (lunch breaks, etc.). QC samples and calibration information was included on the XRF field analysis sheets.

3.1.5 Laboratory Confirmation Soil Sampling

Samples were obtained from select XRF screening locations for laboratory analysis by EPA Method 6010 at KDHE's Health and Environment Laboratory (DHEL). Approximately 141 samples were analyzed by DHEL by EPA Method 6010 (not including the initial 17 samples). Of these laboratory

samples, 19 were also analyzed by DHEL for Toxicity Characteristic Leachate Procedure (TCLP) by EPA Method 1311.

3.1.6 Surface Water/Sediment Sampling

Eleven (11) locations were sampled for surface water and collocated sediment samples. Surface water samples were submitted to DHEL for total (unfiltered) metals analysis by EPA Method 6010. Samples were obtained by submerging a cubitainer into standing surface water. Sediment samples were obtained with clean stainless steel spoons in the upper 2-4" of sediment. Sediment samples were submitted to DHEL for total metals analysis by EPA Method 6010.

3.1.7 Ground Water and Subsurface Soil/Waste Profile Samples

Four (4) existing monitoring wells were sampled during the BTA. A fifth monitoring well was not sampled when observed to be dry by the KDHE field team. In addition, nine (9) temporary monitoring wells were also advanced across the site area. Of these, only six (6) yielded water for sampling. Wells were installed by advancing a 5" outside diameter (OD) solid-stem flight auger to refusal and installing a five-foot .010 screen of Schedule 40 plastic (PVC) and completing to the surface with Schedule 40 casing. The screen interval was filter packed with clean 20-40 sand. Wells were sealed with neat cement grout from 1' above the filter pack to surface.

Nine (9) other locations were sampled for subsurface waste thickness determinations by visually logging the upper and lower vertical depth of smelter waste within the waste disposal area. A continuous sampling device (CME) was utilized for some locations but was discontinued after multiple attempts resulted in refusal in slag material. Better penetration was provided by use of a carbide-tip flight auger bit and visual logging of recovered auger cuttings. Well logs and field notes are included in Appendix I. Wells were developed by removing water with either an Enviro-Tech submersible pump or with a disposable polyethylene bailer. Development and purging volumes are also included in Appendix I.

3.1.8 Quality Control (QC) Samples

QC samples typically were field duplicates in the case of laboratory samples. For XRF analysis, QC samples (NIST standards and field duplicates) are discussed in Section 3.1.4 above.

SECTION 4: ANALYTICAL RESULTS

4.0 Geophysical Survey Results

The geophysical surveys were completed in June and November, 1999. The magnetometer survey was conducted June 8-9, 1999 and the Geonics EM-31 terrain conductivity survey was conducted on June 9, 1999 and verified on November 30, 1999. Appendix G includes survey notes and raw data.

A. Magnetometer Survey Results

The separate Geometrics G-856 proton precession magnetometer was utilized as a discrete base station magnetometer to derive a diurnal fluctuation curve for data reduction purposes in interpretation of the magnetometer survey data. The Geometrics G-858 cesium magnetometer was utilized in single sensor mode for total field measurements with an automatic on-board datalogger. The magnetometer data was filtered, processed and corrected for diurnal fluctuation in the office after completion of the survey.

The magnetometer data generally correlated well with the distribution of elevated lead levels observed across the site. The magnetometer survey was likely heavily influenced by a combination of factors including the presence of the railroad track and right of way, iron rebar from the foundations of old production structures present at the site, as well as the relatively high iron content present in the surficial slag waste. The coincidence of these factors may be attributable to the general agreement between the magnetic survey results and the distribution of the XRF field analysis results. One minor anomalous area was identified centered on N 6500, E 5700. This area may represent some variation in the subsurface within or near the edge of the waste disposal area. In general, surficial metallic debris and waste most likely dominates the magnetic field response, since abundant shallow-source metallic or otherwise ferrous material encountered at the site would theoretically dominate any magnetic total field response. An electrical transformer and rural water line are likely responsible for the edge-effect anomalies apparent in the northeast corner of the site area. Figure 4 is a generalized color map of the magnetometer survey, filtered and corrected for diurnal variations. Appendix G includes the magnetometer survey raw data, notes, interpretation and data reduction information.

B. Terrain Conductivity Survey Results

The EM-31 terrain conductivity data was collected simultaneously in both in-phase and quadrature modes in a vertical dipole configuration. The EM-31 data generally was in agreement between the quadrature and in-phase modes. The in-phase mode, measuring differences in induced secondary magnetic fields, is more sensitive to metallic material. The in-phase response appears to be heavily influenced by the metal buildings and surficial debris in the southeast and south-central portions of the site. The quadrature phase measures apparent relative terrain conductivity and is generally less sensitive to smaller metallic body surficial or subsurface anomalies than the in-phase, but is more sensitive to areal variations in apparent terrain conductivity. The quadrature phase survey results generally reflect a similar trend compared to the in-phase results. The quadrature phase data indicates a potential influence from the subsurface disposal area as the area of terrain conductivity over 100 milliSiemens per meter (mS/m) generally correlates with the location of the former waste water lagoon and subsequent waste disposal area.

The maximum centers of both the quadrature terrain conductivity and the relative in-phase response occur in approximately the same location, about N 6000 E 6200. This is within the disposal area, and

subsurface waste profile WP #4 located within this in-phase high anomaly area indicated the maximum thickness of smelter waste. Waste profile WP#3 was also in this area but indicated only 2 feet of waste. This may indicate either a laterally heterogeneity waste thickness or a lateral change in the composition and subsequently the apparent conductivity of the waste.

The EM-31 survey appeared to be generally more sensitive to the thickness or character of the buried smelter waste in the waste disposal area than the overall surficial features of the site. A substantial thickness of smelter waste with a more conductive layer would theoretically increase the apparent observed terrain conductivity as the metallic nature of the smelter waste (iron and other potential higher conductivity metals present) also would cause an associated increase of conductivity relative to undisturbed soils. The high iron content of the smelter waste may also be responsible for the associated high in-phase response. Some disturbance from surficial debris, slag, building foundations and metal buildings is apparent, especially in the southeastern portion of the site in the in-phase mode. The response from the southeastern portion of the site may indicate that some foundations or slag waste may extend to some depth, also and not be necessarily limited to surficial expressions. The EM-31 data is presented in Figures 5 and 6.

4.1 Surface Soil Analytical Results

4.1.0. Initial Surficial Soil Sample Results

The results from the seventeen (17) initial sample locations (23 samples) indicated laboratory lead values ranging from 54.6 to 120,000 mg/kg. The 120,000 mg/kg sample was indicated in the subsurface (5-6") interval of sample S4 which indicated a surficial lead detection of 25,638 mg/kg. Twelve (12) of the 23 samples (52 %) indicated lead levels above 1,000 mg/kg, which is the Risk-Based Standards for Kansas (RSK) value for lead in non-residential soils.

A linear regression was calculated for the Method 6200 XRF *in-situ* analysis data verses the laboratory data, and for the Method 6200 homogenized preparation XRF analysis data versus the laboratory data. The QAPP had determined a threshold regression value (r^2 value) of 0.7-0.9 as being acceptable quantitative screening quality data, and 0.9 or higher for definitive level data. If the r^2 value was calculated to be below 0.7, the XRF data would be of qualitative screening quality data.

The regression for the *in-situ* data determined the r^2 value to be 0.77 (rounded) for the *in-situ* data and 0.99 (rounded) for the homogenized prepared XRF analysis. Since the *in-situ* regression analysis provided acceptable quantitative screening level data, *in-situ* XRF analysis by EPA Method 6200 was utilized site wide. *In-situ* XRF analysis also provided an immense time and cost savings given the large number of XRF screening points (nearly 700), the size of the site (nearly 1/2 square mile) as well as the significant time involved in sample preparation. The initial soil sampling results are summarized in Tables 1-2. The coordinates for the initial soil sampling locations were integrated into the overall XRF and laboratory results grid to create the isoconcentration maps included as Figures 7(a) and (b).

The TCLP composite results indicated that cadmium TCLP exceedences would likely be associated with relatively low total cadmium levels, but lead levels at 1,000 mg/kg would probably not trigger a TCLP failure. Higher lead levels (20,000 mg/kg and higher) indicated both TCLP and cadmium failures, with the cadmium TCLP level increasing with lead TCLP values. Results for the site-wide TCLP analyses are further discussed in Section 4.1.2 below.

4.1.1 Site-Wide Surficial Soil Results

After all laboratory analyses were received, another regression coefficient was calculated to determine if the site-wide (excluding the initial calibration model/regression comparison samples) was also of similar quality. The linear regression calculated after completion of the site-wide XRF screening grid yielded the r^2 value of 0.81, actually better than the initial calibration/regression XRF data. The XRF data site-wide was therefore accepted at 100 % completeness as being of quantitative screening level data. When the XRF data and laboratory data are compared, a correlation is apparent as can be distinguished in Figures 7(a) and (b).

A distinct area of elevated lead concentrations in surficial soils was indicated by both XRF and laboratory in three (3) general areas. The first area generally trends with the existing railroad right-of-way. The second area is located around existing and former locations of production buildings south and immediately southwest of the railroad tracks. The third is downwind (north) of the primary production areas, and may be the combined result of slag disposal as well as wind-blown air releases of particulate process waste from the former smelter facility. This apparent downwind area appears to be limited to approximately N 6500. Much of the northeastern portions of the site did not indicate a significant impact from heavy metals in both field XRF and laboratory confirmation samples. XRF detections ranged from non-detect through much of the northeastern and southwestern portions of the site to a maximum of 35,700 parts per million (ppm or mg/kg) lead at location N 6200 E 6700. Figures 7(a) and (b) indicate contoured XRF and laboratory data. Field XRF data is summarized in Table 3. Table 4 includes the statistical comparison of laboratory vs. XRF data for soil samples, and the laboratory soil sample results are summarized in Table 5. Cadmium was not detected in excess of its 1,000 mg/kg non-residential RSK value.

Arsenic also exceeded its non-residential RSK value of 86 mg/kg, at a maximum concentration of 306 mg/kg in seven (7) of the laboratory samples, or approximately 5 % of the laboratory samples. Four (4) of these seven (57 %) were associated with lead levels over 1,000 mg/kg, and six of the seven arsenic exceedences (86 %) were associated with lead levels greater than 400 mg/kg. In general, the elevated arsenic values are therefore associated with highly elevated lead values.

4.1.2 TCLP Results

Nineteen (19) samples were submitted to DHEL for analysis by EPA Method 1311 for TCLP analysis. TCLP exceedences for cadmium (TCLP threshold 1 mg/l) and lead (TCLP threshold 5 mg/l) were

identified in several samples. Lead indicated a maximum TCLP detection of 288 mg/l, well over its TCLP threshold of 5.0 mg/l, in composite sample C-1.

This TCLP result, however, was in a composite sample from the initial sampling event and may be biased high. The maximum TCLP lead detection value in a grab sample location was 283 mg/l at location N 5500 E 6600. This location also yielded an elevated cadmium TCLP value of 3.5 mg/l. The maximum cadmium TCLP value of 70.2 mg/l was indicated at N 6200 E 6700, which also yielded the third highest lead TCLP value of 118.9 mg/l. This was the location of the maximum in-field XRF detection for lead (35,700 mg/kg). All lead TCLP exceedences were associated with cadmium TCLP exceedences. Eight (8) of the 20 TCLP samples failed TCLP for lead, and these same eight samples and one additional sample (nine total) failed TCLP for cadmium. Therefore, using an empirical relationship, roughly 89 % of all the lead TCLP exceedences were associated with cadmium TCLP exceedences.

The TCLP failure threshold for cadmium appears to be at a minimum total cadmium concentration of 50.93 at N 6000 E 7100 (TCLP value 1.382 mg/l). The minimum total lead concentration associated with a TCLP failure is 2,198.2 mg/kg at N 6400 E 6500 (TCLP value 8.687 mg/l). All lead TCLP exceedences are therefore correlative with total lead values exceeding non-residential RSKs.

Cadmium, however, appears to be more mobile and soluble under the site conditions, as TCLP exceedences were observed in relatively low (<100 mg/kg) soil concentrations. The relatively higher apparent mobility of cadmium is also a likely factor for the elevated cadmium surface water detections observed during the BTA. Table 6 compares TCLP exceedences with total concentrations for lead and cadmium.

The preliminary TCLP results indicate some of the smelter waste and soil material may potentially be Resource Conservation and Recovery Act (RCRA) characteristic hazardous wastes D008 (lead) and D006 (cadmium) if generated as defined by § 261.24 of RCRA. TCLP results are summarized in Tables 6 and 7.

4.2 Ground Water Analytical Results

Heavy metals constituents, primarily cadmium, lead and chromium were identified from DHEL analysis of ground water samples from the site. Cadmium was detected at a maximum of 3.062 mg/l in TW-3, lead at a maximum of 0.136 mg/l and chromium at a maximum of 0.14 also in TW-3. The analytical results by DHEL indicated exceedences of the maximum contaminant levels (MCLs) for lead (.015 mg/l), cadmium (0.005 mg/l) and chromium (0.1 mg/l) in ground water at the site. Silver was also detected at a maximum of 0.113 mg/l, slightly above its lifetime health advisory level (HAL) of 0.1 mg/l in TW-3. Figure 8 indicates the ground water, surface water, and subsurface waste profile sampling

locations. Figure 9 depicts the generalized ground water detections for cadmium identified during the BTA and Figure 10 indicates the shallow potentiometric surface measured during the BTA.

Cadmium exceeded its MCL in all samples obtained within or at the downgradient edge of the smelter waste disposal area, in existing monitoring wells MW-1 (0.1 mg/l), MW-2 shallow (0.931 mg/l), and MW-3 (0.12 mg/l). Well MW-4 indicated cadmium at its MCL at 0.005 mg/l, and MW-2 deep did not indicate cadmium. Temporary wells TW-3 (3.063 mg/l), TW-4 (0.855 mg/l) and TW-5 (0.057 mg/l) all indicated cadmium above its MCL. A trend towards increasing cadmium concentrations beneath the smelter waste disposal area in ground water is apparent from the sample data.

Lead and chromium were detected above MCLs only in TW-3, located in an area interpreted to be near the maximum thickness of smelter waste within the waste disposal unit. The maximum silver detection was also indicated in this sample. The area of elevated lead, chromium, and silver concentrations in ground water appears to be limited to within the disposal unit itself. Ground water sample results are summarized in Table 7. The upgradient temporary well, TW-9, did not indicate any detections of cadmium, chromium, lead or silver. Temporary wells TW-5-8 did not yield sufficient water to develop or sample downgradient of the site. Table 7 includes ground water sample results.

4.3 Subsurface Waste Profile Results

Subsurface waste profiles indicate that smelter waste is typically limited to the disposal unit itself, although near the buildings some areas may have smelter slag mixed with the former structure foundations. Apparent waste thicknesses varied between 0 and seven (7) feet of apparent waste thickness as determined visually. Smelter waste was visually logged to determine apparent smelter waste thickness across the site. Waste thickness sample locations are indicated in Figure 8. Figure 11 depicts the generalized smelter waste thickness observed during the BTA.

Temporary well borings were also logged for waste thickness and were included in the waste thickness map. Selected cuttings from temporary well borings were also bagged and analyzed in-field with the Niton XRF. These results are included with the monitoring well logs in Appendix I. The original monitoring well logs for all existing monitoring wells were also reviewed and an apparent waste thickness derived from the older well logs which were utilized for creation of the waste thickness map. An apparent maximum waste thickness of seven (7) feet was observed in waste profile location (WP)-4.

4.4. Surface Water and Sediment Sample Results

The primary constituent detected in surface water at the site at elevated levels was cadmium (detected in all surface water samples except SW-11). Chromium was detected in SW-1, and lead in SW-1 and SW-10. Arsenic was also detected in SW-1. Barium was detected in all surface water samples but SW-1 indicated the only barium detection greater than 1.0 mg/l. The maximum detection for all surface

water constituents indicated above was at surface water sample location SW-1. Cadmium was indicated at 2.965 mg/l (MCL 0.005 mg/l), lead at 1.789 mg/l (MCL/action level 0.015 mg/l), arsenic at 0.063 mg/l (MCL 0.05 mg/l), and barium at 2 mg/l (MCL 2 mg/l). Surface water results are included in Table 7. Surface water sample locations are indicated on Figure 12.

This location is the nearest surface water sampling location to the primary production areas and downstream of a former waste water lagoon. Sample location SW-4, obtained at the exit point of the unnamed tributary of Drum Creek from the site, indicated cadmium at 0.088 mg/l, above its MCL of 0.005 mg/l. Cadmium was the only constituent elevated above its MCL immediately downstream of the site. Figure 8 indicates surface water and sediment sample locations. Sediment samples did not exceed non-residential RSK values for heavy metal constituents with the exception of SED-11 which indicated 289.82 mg/kg arsenic, above the non-residential RSK value of 86 mg/kg. The surface water sample at this location did not indicate arsenic, which may indicate a laboratory interference problem since the next highest arsenic value was 34.83 in SED-7. All surface water, ground water and sediment samples were also analyzed for cyanide by Pace Laboratories in Lenexa, Kansas by EPA Method 9012A. Since no detections for cyanide were indicated in surface water and ground water near the waste disposal area, further sampling for cyanide was not performed. Sediment sample results are included in Table 8.

As part of the BTA, the available KDHE information for surface water sampling along Drum Creek was reviewed. A station on Drum Creek is included in KDHE's Bureau of Environmental Field Services (BEFS) regular surface quality monitoring network. Review of the BEFS data from the previous ten (10) years did not indicate any significant fluctuations in arsenic and lead results. This station, however, did not sample for cadmium.

4.5 Quality Control Sample Results

Quality control samples for XRF screening were obtained by analyzing field duplicates as well as comparing percent differences of successive analyses of NIST standard reference materials (SRMs). According to EPA Method 6200, a percent difference (PD) of 20 % or less for successive standard analyses is established as the criteria for acceptable instrument fundamental parameter (FP) energy calibration and thus adequate radioactive energy being transmitted into the medium to effectively perform the analysis.

If the PD exceeds 20 % for lead, adjustment to the calibration curve and re-analysis of the SRM are necessary. The 20 % PD value is also used as the threshold value for acceptable calibration verification and checking the instrument accuracy and stability for the analytes of interest. The highest individual PD identified in field XRF analysis was 12.33 %, well below the 20 % maximum PD value. The PD statistical calculations indicate that the instrument accuracy and calibration were acceptable to produce usable XRF data. The PD determination also indicates that the FP energy calibration curve and the internal accuracy of the internal Niton 733 XRF (including internal calculations, detector

sensitivity/calibration and x-ray emission efficiency) were all within acceptable performance limits. Both a high (5,000 mg/kg range) and medium (1,000 mg/kg) range NIST standard were used during field XRF work for SRM analysis.

Approximately 94 (one for every seven field analyses) NIST SRM standard analyses were performed during the XRF field work. Typically, a standard was analyzed at the beginning and end of each day and once every 12 field measurements. EPA Method 6200 recommends one standard analysis at the beginning and end of each work day and one standard every 20 field measurements.

Field duplicates are compared using a relative standard deviation (RSD) calculated according to EPA Method 6200. The RSD allows evaluation of the method precision or reproducibility by successive (duplicate) field analysis. The RSD should not exceed 20 % for lead according to EPA Method 6200. The average RSD calculated for all field duplicate analyses was 7.66 %, well within the acceptable precision threshold value of a 20 % RSD. The RSD also indicates that the XRF data collected at the site is of acceptable precision. Approximately 49 field XRF duplicates were obtained, or approximately one for every 13 XRF field analyses. A minimum of one field duplicate per day was analyzed, consistent with EPA Method 6200 recommendations. QA/QC parameters are summarized in Table 10.

4.6 Data Validation

The data generated during the BTA was validated by an independent data validation team consisting of KDHE personnel Travis Kogl, team leader, Jon Brady, Chemist III from DHEL, and Jean Albrecht, technician. The team was selected of BER persons who had no direct involvement with any field data collection activities for the BTA allowing an impartial and objective approach to the data evaluation and validation process, in addition to a representative from DHEL who did not actually analyze any of the samples but reviewed all of the project data.

Although the QAPP indicated the Field Chemist would perform the data validation review, this alternate approach was decided during the project to include a team of persons not directly involved with data collection for the BTA to conduct the data evaluation and validation. The data validation team determined that data from both field XRF and laboratory was determined to be useable at 100 % completeness and adequate to achieve project goals. The data validation memo is included in Appendix J.

SECTION 5: ANALYTICAL CONCLUSIONS

5.0 Surface Soil Analytical Conclusions

An area of surficial soil contamination exceeding the non-residential RSK value of 1,000 mg/kg for lead was identified at the site through both XRF and laboratory data. Given the more systematic nature and

greater amount of the XRF data compared to laboratory data, the XRF data are more likely representative of the site conditions than the more scattered laboratory confirmation data. The XRF isoconcentration contours are sharper and more refined because the higher volume of data points reduces the smoothing and interpolation performed on a smaller data set. The largest area in excess of 1,000 mg/kg lead is generally in the former production areas at the southeast portion of the site and along the railroad right-of way, which brought ore into the facility and took processed smelted metals out of the facility. The trend near the railroad likely reflects extensive loading/unloading and associated spillage of ore and smelted product along this area. This area is also the location of the ore and smelter furnaces, retorts and ore roasters.

Another linear area of elevated lead levels was identified east-northeast of the railroad right-of-way. This area is interpreted to be resulting from both slag waste disposal east of the tracks as well as being the downwind area from the retorts, furnaces and ore roasters. The relatively even gradation of lead levels decreasing to the north from this area (further downwind) also indicates evidence of air transmission of cinders and ash from the smelter facility. North of this area, however, indicated low levels of lead, and most of the northeastern portion of the site appears to not be significantly impacted by heavy metals.

The former production areas at the National Zinc smelter facility appear to be significant source areas for heavy metals contamination of surficial soils at the site. Limited subsurface soil sampling in the former production areas indicated the highest lead result encountered during the BTA (160,000 mg/kg in S4 at 6 inches) indicating the heavy metal contamination may extend vertically coincidental with the depth of smelter waste and building debris.

Off-site areas of soil contamination in excess of residential (400 mg/kg) or non-residential RKSs (1,000 mg/kg) for lead appear to be present near the southeastern and eastern boundaries of the site. A smaller area may also be present at the western site boundary. Further CERCLA site assessment outside of this BTA (PA/SI or Removal Site Evaluation) is recommended to further evaluate these off-site areas. Since a significant number of on-site XRF and laboratory lead results were below 80-100 mg/kg, the residential RSK value of 400 mg/kg was utilized as an initial lead screening concentration value as it was higher than three times (3X) the observed native undisturbed or background concentration to determine if individual areas were potentially impacted by lead from the former National Zinc facility.

Additional off-site background samples were not deemed necessary since a significant range of difference (2-3 orders of magnitude) existed between undisturbed areas of the site and the maximum concentrations observed at the site, which assisted in interpretation between areas heavily impacted by the former smelter facility and relatively "clean" or areas near ambient concentrations.

5.1 Surface Water Analytical Conclusions

The former National Zinc facility appears to be a source area for heavy metal constituents, especially cadmium, in surface water at the site. Cadmium was detected above its MCL immediately downstream of the site. The downstream drainage from the site enters Drum Creek approximately 3/4 mile from the site. The surface water pathway should be further evaluated to determine the extent of off-site surface water impact from heavy metals leaving the National Zinc site. During most of the BTA, which was conducted during dry conditions, the unnamed tributary was dry as it exited the site to beyond the new U.S. 169 highway.

5.2 Ground Water Analytical Conclusions

Analytical results from temporary and existing monitoring wells indicate an area of elevated levels of primarily cadmium with some localized elevated levels of lead exceeding MCLs in the area of the smelter waste disposal area. Temporary wells installed downgradient of the site for the BTA did not produce sufficient water to satisfactorily develop and sample wells. Cadmium levels in excess of the MCLs appear to extend at least to the western site boundary in the immediate area of MW-1-MW-3.

The existing monitoring wells were installed within the berm at the edge of the waste disposal area, however, and may not be representative of ground water downgradient of the waste disposal unit. During installation of the temporary wells during the BTA, wells installed within the waste disposal area had substantially more available ground water recharge during development and purging than those located outside of the waste disposal area. Some of the ground water encountered may actually be relict waste water remaining from the in-place closure of the former smelter waste water lagoon and sludges from the 1970s.

Ground water appears to be highly localized in occurrence downgradient of the site, and significant off-site ground water impact is not likely given the limited availability of ground water downgradient of the site. The unnamed tributary of Drum Creek which runs across the site and along the perimeter of the former lagoon/smelter waste disposal area may actually be a ground water barrier to the site given the apparent ground water levels observed in the existing monitoring wells and temporary wells installed for the BTA.

Evidence to support this observation is present from the available topographic information, since the bottom of the creek bed exiting the site is approximately 792 feet in elevation, while the lowest observed ground water elevation at the site was 793.64 feet in MW-3. The base flow from the waste disposal area may also be partially accountable for the elevated levels of metals, especially cadmium, in surface water along the western site perimeter.

SECTION 6: GROUND WATER PATHWAY

6.0 Soils

The undisturbed areas of the site (primarily in the northeast half of the site) are typically underlain by the Kenoma series soils. The Kenoma soils 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 (0.2-0.06 in/hr) and shrink-swell potential is high, especially below 12 inches. Permeability generally ranges from 0.2 to 0.6 inches/hour (Reference 3).

6.1 Hydrogeology

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 at the site, bedrock was typically encountered between 14 feet (TW-1) and 3.5 feet (TW-8). The location of TW-8 is in the new U.S. 169 right-of-way which was excavated approximately 6-10 feet for installation of the highway, and the depth to bedrock from surface in TW-8 is not representative of native conditions.

The bedrock units underlying the site are believed to be composed of 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 Formations 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 (Reference 4).

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. A detailed stratigraphic sequence is included as Figure 12. The City of Cherryvale and Montgomery County Rural Water District # 12 supplies water to private residences surrounding the site. The generalized stratigraphic section for Montgomery County is included as Figure 13.

6.2 Ground Water Targets

The entire population of Cherryvale relies on surface water from Big Hill Lake for the its public water supply (PWS). Big Hill Lake is located upstream of surface drainage from the National Zinc site. The Verdigris River upstream of the site near Neodesha supplies Montgomery County Rural Water District #12. Only three (3) domestic wells were identified within one mile of the site, and the nearest well (3/4 mile) is located northeast of the site in an apparent upgradient direction. Well water quality in this portion of Montgomery County is reportedly marginal due to sulfates and excessive hardness (Reference 4). A review of available water well records indicate 17 wells within 4 miles of the site (Reference 7). The breakdown of numbers of ground water targets by distance from the site is:

<u>Distance:</u>	<u>Number of Wells:</u>	<u>Number of Targets:</u>
0-1/2 mile	0	0
1/2-1 mile	3	7.26
1-2 miles	2	4.84
2-3 miles	10	24.20
3-4 miles	2	4.84
Total:	17	41.14

In summary, the total number of potential ground water targets at the National Zinc site is approximately 41 persons (Census). Figure 14 illustrates ground water targets in the site area.

6.3 Ground Water Conclusions

A release of heavy metals, especially cadmium, chromium, lead and silver has been documented in ground water at the site. Lead, chromium, and silver were detected above respective MCLs or other action levels in one ground water sample (TW-3). Cadmium was detected above its MCL in seven (7) of the ground water samples including at the downgradient site perimeter. Cadmium levels in ground water appear to be generally associated with former production areas and especially the former wastewater lagoons which were filled with waste and soil fill and capped.

It is unknown if the ground water results in the waste disposal area/former lagoons represent actual shallow ground water or relict wastewater present in the former lagoon areas, but likely a combination. A ground water sample obtained east of the railroad tracks (TW-9) in an upgradient direction from the production and waste disposal areas did not indicate elevated levels of cadmium, lead, chromium or

silver. Heavy metals releases to ground water observed at the site are therefore attributable to the former National Zinc facility. Elevated cadmium levels were observed downgradient from the former production areas (0.057 mg/l in TW-5) but were most elevated in ground water samples obtained in the waste disposal area/former lagoons (3.062 mg/l in TW-3). Ground water samples were not obtained downgradient of the site since the downgradient temporary wells did not yield sufficient water to develop and sample the wells.

Future monitoring is also recommended in and downgradient of the waste disposal area/former wastewater lagoons. The ground water pathway may not be the most significant exposure pathway at the site given the few private wells near the site and the low availability and quality of local shallow ground water. Evidence is also present to indicate that the creek surrounding the berm of the former waste disposal area may be a shallow ground water barrier and consequently base flow to surface water is probably a greater concern at the site. Approximately 41 potential ground water targets were identified within a 4-mile radius of the site.

SECTION 7: SURFACE WATER PATHWAY

7.0 Hydrologic Setting

An intermittent stream drains the site and enters Drum Creek approximately 3/4 mile from the site. Drum Creek enters the Verdigris River approximately seven (7) linear miles from the site. This unnamed intermittent stream basically drains the entire site, including the former production areas, remaining smelter slag pile/waste areas, and the area of the lagoon cap. Drum Creek enters the Verdigris River downstream of the City of Independence's surface water intake. The unnamed intermittent streams crossing the site which also form the boundaries of the waste disposal area and leave the site at the western edge of the waste disposal area are within the 100-year floodplain of Drum Creek.

7.1 Surface Water Targets

No primary surface water targets have been identified within the 15-mile downstream target distance limit. No surface water intakes were identified along the 15-mile target distance limit. The Black Vermillion and Big Blue Rivers have been designated as critical habitats for the butterfly mussel, the Neosho mucket mussel, the Ouachita kidneyshell mussel, and the rabbitsfoot mussel. Several other threatened or endangered or threatened species occur in Marshall County that may be potential environmental targets at the site. These are as follows:

<u>Species</u>	<u>Status</u>	<u>Occurrence in County</u>
Bald Eagle	E	Occurs occasionally in winter
E. Hognose Snake	T	May occur in suitable habitat
E. Spotted Skunk	T	May occur in suitable habitat
Eskimo Curlew	E	Former spring migrant, last sighting 1902

Least Tern	E	Occurs occasionally in summer
Peregrine Falcon	E	May occur occasionally in winter
Piping Plover	T	May occur occasionally, spring or fall
Snowy Plover	T	May occur occasionally, spring or summer
White-faced Ibis	T	May occur occasionally at wetlands
Whooping Crane	E	Occurs occasionally, spring and fall
American Burying Beetle	E	May occur in suitable grasslands and uplands
Common Map Turtle	T	May occur in streams, lakes and oxbows
Western Fanshell	E	Generally associated with shallow riffles

T=threatened E=endangered

Other potential targets for the site include recreational fisheries of Drum Creek and the Verdigris River upstream of Coffeyville, Kansas and downstream of the confluence of Drum Creek and the Verdigris River.

7.2 Surface Water Conclusions

A release of heavy metals, especially cadmium, has occurred at the National zinc site. Elevated levels of cadmium were observed exiting the site in the downstream direction. No primary surface water targets have been identified, and potential surface water targets include recreational fisheries of Drum Creek and the Verdigris River. All of these surface water bodies are classified for contact recreation as well, and potential surface water targets would include recreational contact along the target distance limit.

SECTION 8: SOIL EXPOSURE AND AIR PATHWAYS

8.0 Physical Conditions/Current Site Conditions

The site is generally vacant, with the exception of the active railroad right-of-way and a natural gas meter/valve station located immediately adjacent to the railroad in the southeast corner of the site. The only remaining intact structures are three (3) metal storage buildings. The buildings are currently used by the City of Cherryvale to store public works equipment such as water pipe, fire hydrants, etc. Several foundations and remnants of smelter structures such as retorts, furnaces, loading ramps, etc. can be found generally in the southeast corner of the site.

Areas of visible smelter waste are scattered across the site, but is generally most prevalent in the former production areas in the southeast portion of the site and along the edge of the berm at the edges of the smelter waste disposal area. A former City of Cherryvale construction/demolition (C/D)debris dump is present north of the remaining sheds adjacent to the railroad right-of way. The C/D area is less than one (1) acre in size. The former City of Cherryvale waste water treatment plant is adjacent to the southeast corner of the site, but has been decommissioned. Some erosion of both the smelter waste/slag piles and the lagoon cap was identified during the BTA.

Several residences are located south of the former National Zinc facility, but only one (1) residence is located along the northern boundary in the northwest corner of the site. A veterinary clinic and truck terminal are located beyond the eastern boundary of County Road 5400 adjacent to the former (old) U.S. Highway 169. The highest average wind speed is 11 miles per hour in April (Reference 4). Prevailing winds are from the south. The nearest residence is within 1/4 mile from the site. The nearest school is approximately 3/4 mile from the site. The site is not fenced and readily accessible. No known day care facilities or schools are present within 200 feet of the site.

8.1 Soil and Air Targets

The total population within four miles of the site is 3,132 persons, based on U.S. Census Bureau information and U.S. Geological Survey topographic maps of the area. The breakdown of population based on radius from the center of the site area is as follows:

<u>Distance:</u>	<u>Number of Targets:</u>
0-1 mile	1,048
1/2-1 mile	1,048
1-2 miles	725
2-3 miles	104
3-4 miles	207
Total:	3,132 persons

Figure 13 illustrates the soil and ground water pathway 4-mile target radius map.

8.2 Soil and Air Conclusions

Surface soil sample results indicated significant levels of lead at the site. All soil samples were taken within two (2) feet of the surface with the exception of screening samples from the advancement of waste profile locations. A significant surficial soil exposure hazard is present from the site due to the observed areas of heavy metal contamination which are not covered or otherwise contained. Air releases have likely occurred within the site boundaries given the observed nature of lead contamination in surficial soils. Although significant off-site air impact does not appear to be present, a potential threat may be present to nearby residents and on-site workers from air releases at the site. Approximately 3,132 potential air and soil exposure targets have been identified for this site.

SECTION 9: CONCLUSIONS

The BTA for the National Zinc Site was conducted to provide an environmental assessment of the subject property to assist in identifying potential development opportunities based on identified environmental conditions. A release of heavy metals, especially lead and cadmium, was observed at the site during the BTA in soils, surface and ground water.

A. Summary

The BTA identified a significant area of lead contamination in *surficial soils* at the site in excess of KDHE 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, former production areas and areas to the north and east directly adjacent to and immediately downwind of former production and loading areas. Cadmium and lead were both identified to exceed TCLP thresholds in selected samples, indicating some of the soil and waste may be RCRA characteristic hazardous wastes (D008 and D006).

Cadmium exceeded KDHE's RSK value for non-residential soils in only one sample, however (N6200 E6700). This was also the location of the maximum XRF and total lead detections with the exception of the initial TCLP composites. A large area, approximately the northeast 1/4 of the site, was identified to not be significantly impacted by heavy metals constituents from the former National Zinc facility.

Surface water was identified to be impacted by several heavy metals constituents, primarily cadmium, across the site. Elevated levels of cadmium were detected in surface water exiting the site. Further downstream sampling for RCRA metals including cadmium should be part of future integrated site assessment at the National Zinc site. All surface water samples exceeded the MCL value for cadmium, including the sample obtained as surface water exists the site downstream. Lead and arsenic were also detected in excess of MCLs in several samples, although not in the immediately downstream sample.

Elevated levels of cadmium in *ground water* were also observed, primarily in areas underlain by the former waste water lagoons which were subsequently used as a waste disposal unit and covered. Cadmium was detected in ground water at the edge of the site; however temporary wells installed downgradient of the site did not yield enough ground water to develop and sample. Ground water availability and yield is highly localized in the site area, and some base flow to surface water may be occurring at the western edge of the site. An area of ground water contamination is centered in the waste disposal unit.

B. Recommendations

The full extent and nature of lead, cadmium and potentially other RCRA metals was not determined during this BTA. Contaminated surficial soil appears to be present over a majority of the site with the exception of an area described as the northeast 1/4 of the site. Soils impacted by heavy metals from the subject property may also be present along adjacent off-property areas. An area at the south and east boundaries of the site as well as a smaller (less than 100 feet square) area at the west-central boundary of the site were identified in excess of the 400 mg/kg residential RSK value for lead in surficial soils. Areas near the southeastern portion of the site are primarily zoned residential. Exposure to contaminated surficial soil through direct contact appears to be one of the primary risk pathways of concern. **Additional investigation** would be required to determine the impact to off-properties (residential areas) from the site.

Surface water has been impacted on and off the property by cadmium and other RCRA metals at elevated levels. Areas potentially impacted by contaminated surface water flowing from the site include residential and agricultural properties. Although there are no human drinking water intakes immediately downstream, potential human exposure to contaminated surface water may occur through direct contact. Additionally, surface water appears to present a higher risk pathway for aquatic life and the environment. **Additional investigation** would be required to determine the impact to downstream surface water and potential receptors.

Ground water has been impacted by various RCRA metals directly beneath the former waste disposal areas at levels well above respective MCLs. It does not appear that the ground water contamination is very mobile and thus, is probably not migrating offsite. Human exposure to contaminated ground water is minimal; although, migration of impacted ground water to surface water via base flow is a probability. Again, **additional investigation** would be required to determine off-property ground water impacts.

Future recommended actions for the subject property and adjacent areas fall into four (4) areas:

I. Additional investigations of the site should be conducted in two parts (assuming capable/cooperative PRPs are not identified to conduct such investigations):

1) a **Removal Site Evaluation (RSE)** should be conducted by KDHE in residential areas and other easily accessible areas adjacent to the boundaries of the site to determine potential soil and surface water impacts based on the data provided in this BTA;

2) an **Integrated CERCLA Expanded Site Inspection (ESI)** should be conducted by KDHE to determine a Hazard Ranking System (HRS) scoring of the site for potential Superfund consideration. Valid data collected during this BTA will be used to minimize duplication of data collection for the RSE and ESI projects.

II. KDHE recommends to continue the PRP search under KDHE's Enforcement/Negotiation Program. KDHE, with the assistance of EPA has sent out CERCLA § 104(e) information request letters to evaluate PRPs under KDHE's Enforcement/Negotiation program. No viable PRPs have yet been identified. The City of Cherryvale is the current property owner for the site, but did not own or operate the site during smelter operations.

III. The existing Restrictive Covenant between the City of Cherryvale and KDHE should remain in effect for a majority of the site. As stated, an area in the northeast 1/4 of the site was identified as not significantly impacted and could be removed from the Restrictive Covenant with a specific request from the City of Cherryvale for future redevelopment.

Areas remaining within the Restrictive Covenant will be further evaluated and **could be redeveloped if appropriate remedial actions were taken by one or more parties.** Redevelopment may be

possible in these areas with potential remedial actions such as covering/capping and stabilizing surficial soils in areas indicated to be exceeding action levels, including the use of deed restrictions to prevent future residential use of the land. It is not recommended the highly contaminated areas of the site be considered for redevelopment until a more extensive investigation and remedial actions are completed. Any amendments or modifications to the current Restrictive Covenant must be requested in writing and approved by KDHE in writing.

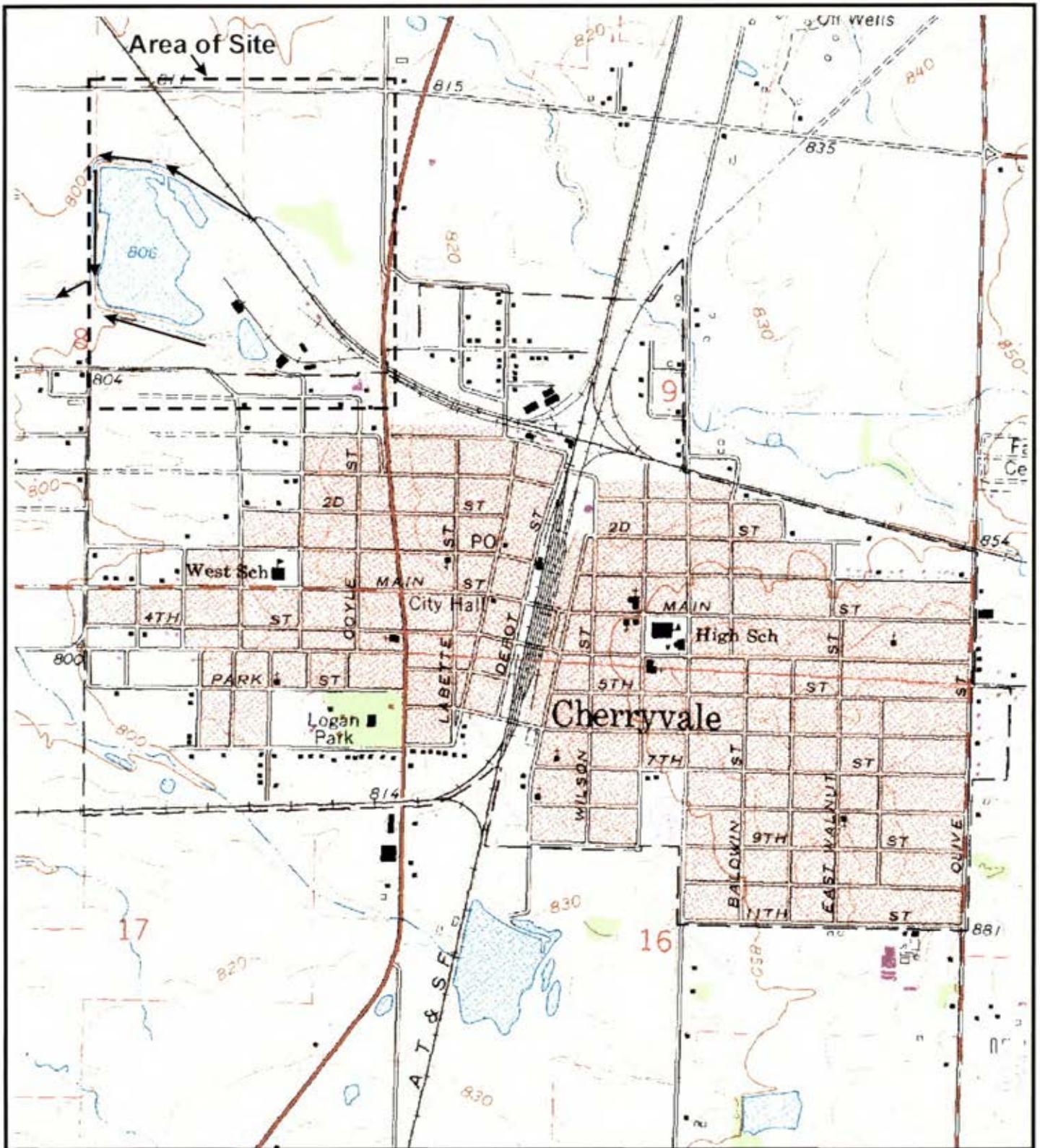
IV. The City of Cherrvale, the current owner of the subject property, **should initiate long-term maintenance** of the waste disposal area including establishing erosional controls and vegetation maintenance of the primary waste disposal area. Additionally, limited access controls including postings should be established.

SECTION 10: REFERENCES

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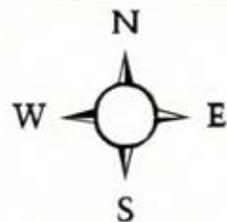
SECTION 11: FIGURES AND TABLES



Explanation:
 Surface Water Flow
 Direction



FIGURE 1
SITE AREA MAP
 National Zinc Site
 Brownfields Targeted Assessment
 Cherryvale, Kansas

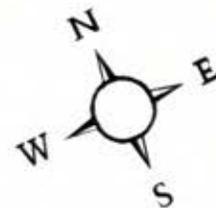


Approximate Scale: 1 inch = 1200 feet

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



FIGURE 2(b)
SITE LOCATION MAP,
DETAIL (1992)
National Zinc Site
Brownfields Targeted Assessment
Cherryvale, Kansas



Source: KDOT Aerial Photo, January, 1992.

Approximate Scale: 1 inch = 209 feet

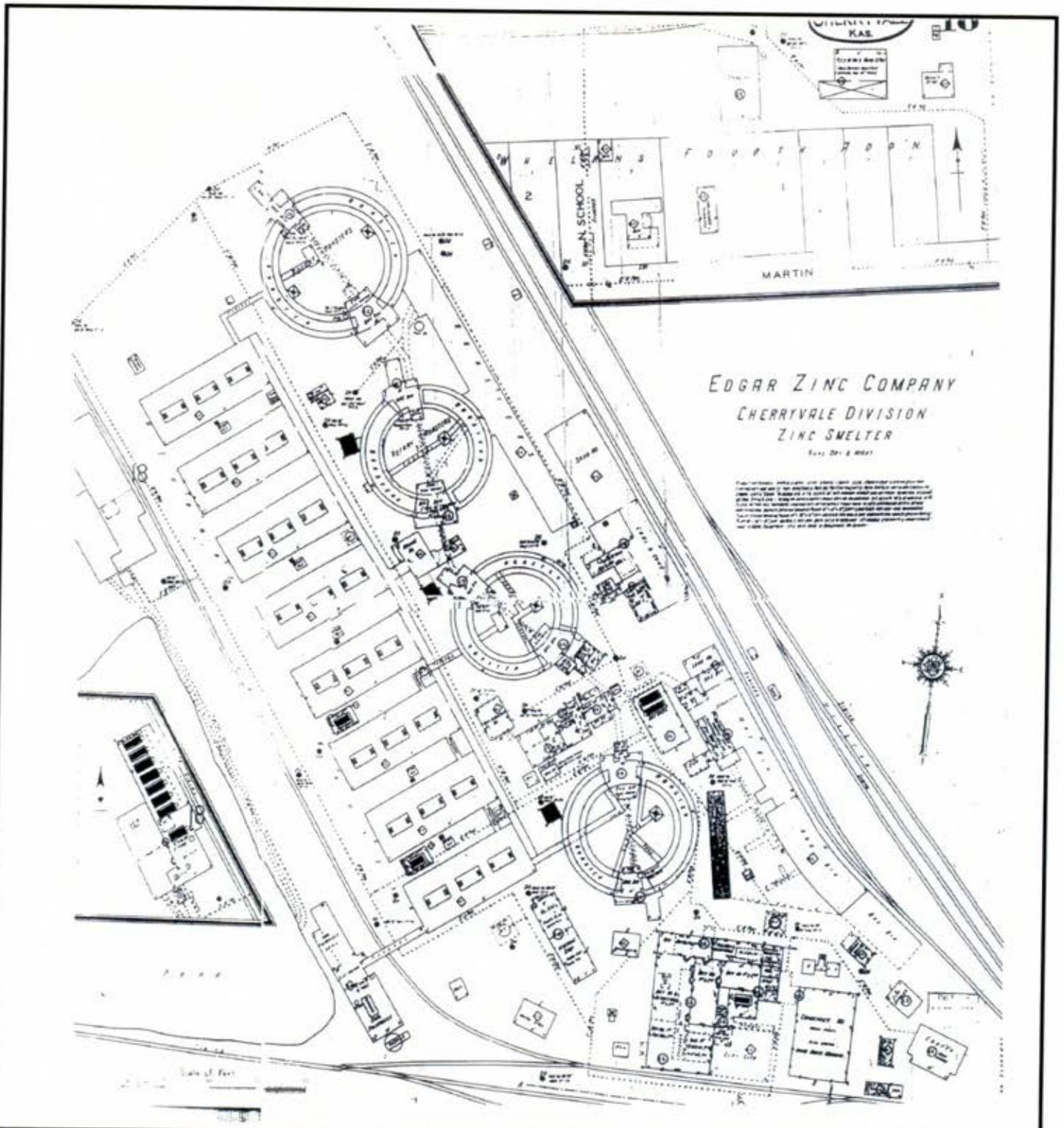
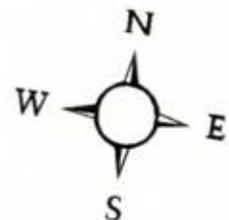


FIGURE 3
NATIONAL ZINC FACILITY
CIRCA 1928
National Zinc Site
Brownfields Targeted Assessment



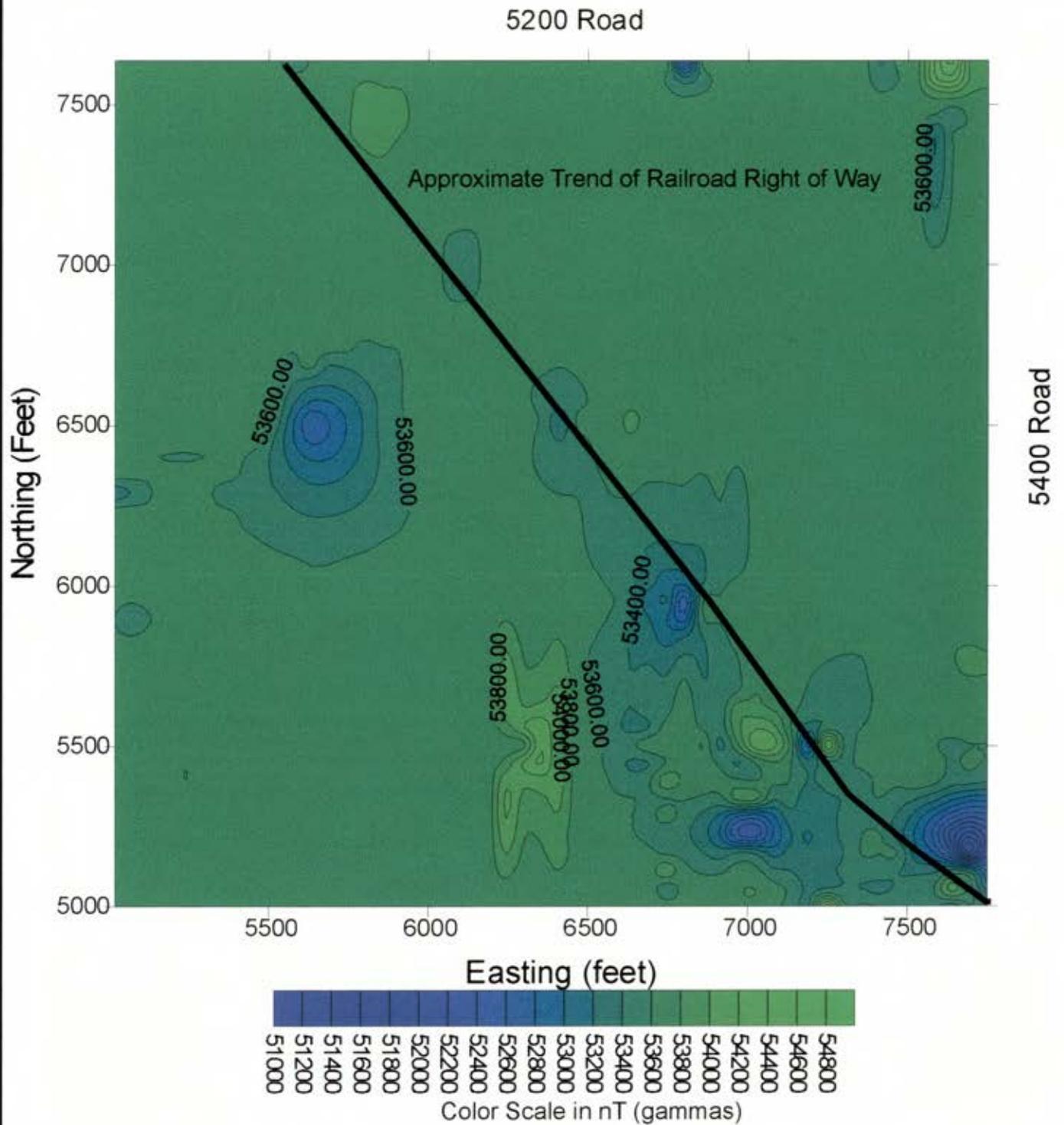
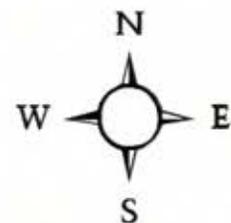


FIGURE 4
GEOMETRICS G-858 CESIUM
MAGNETOMETER SURVEY
 Total Field in nT (gammas) with
 Diurnal Correction Applied and Filtered
 National Zinc Site
 Brownfields Targeted Assessment
 Cherryvale, Kansas



Source:
 Survey conducted by KDHE,
 6/99. Geophysical survey
 conducted, processed and
 interpreted by Randolph
 L. Brown, KDHE/BER Site
 Assessment Unit.

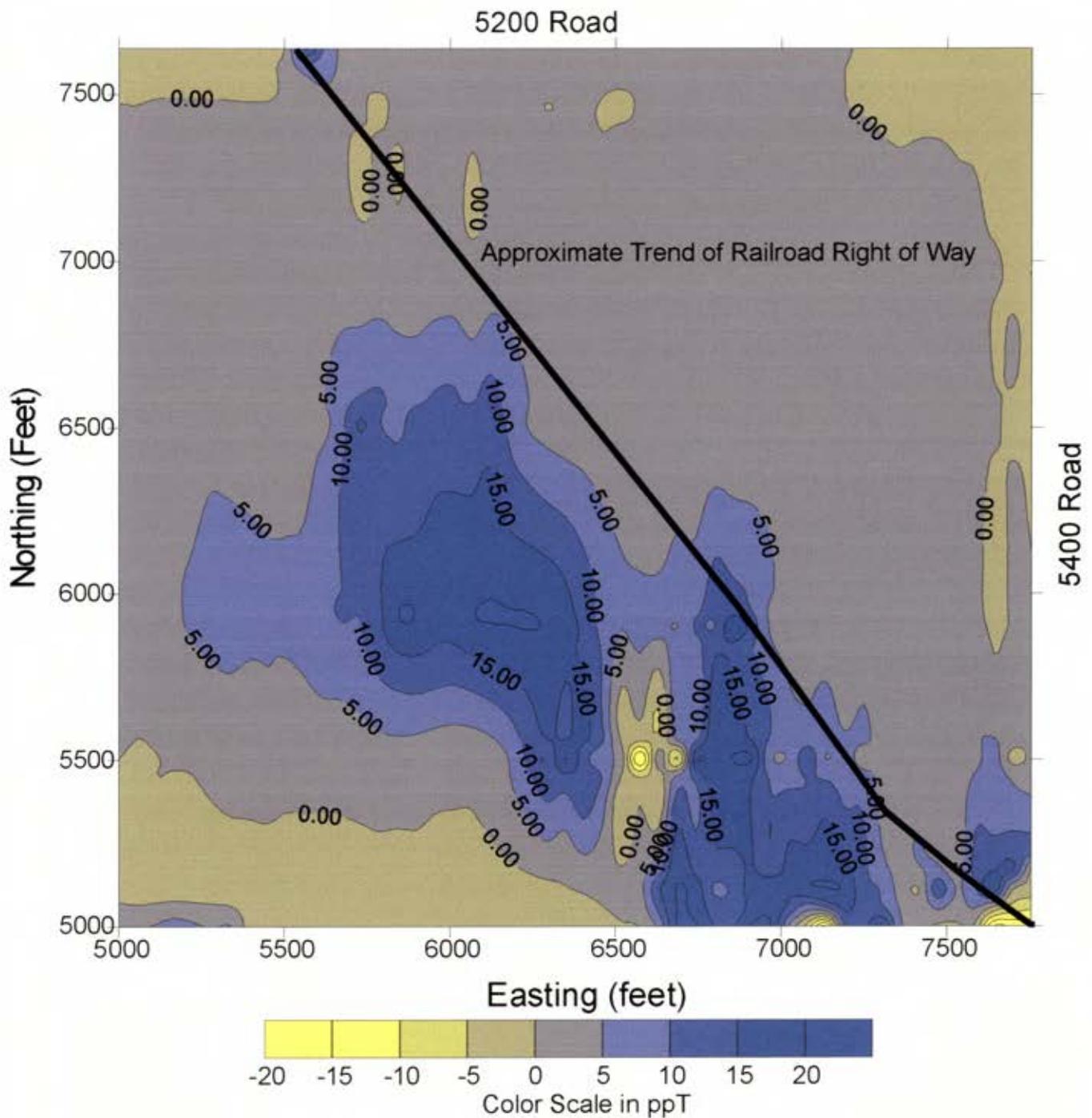
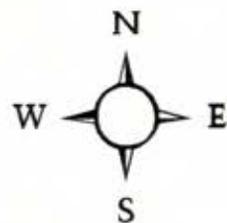


FIGURE 5
GEONICS EM-31 TERRAIN
CONDUCTIVITY SURVEY
 In-Phase Mode in Parts per Thousand
 (ppT) and Filtered
 National Zinc Site
 Brownfields Targeted Assessment
 Cherryvale, Kansas



Source:
 Survey conducted by KDHE,
 6/99 and 11/99. Geophysical
 survey conducted, processed
 and interpreted by Randolph
 L. Brown, KDHE/BER Site
 Assessment Unit.

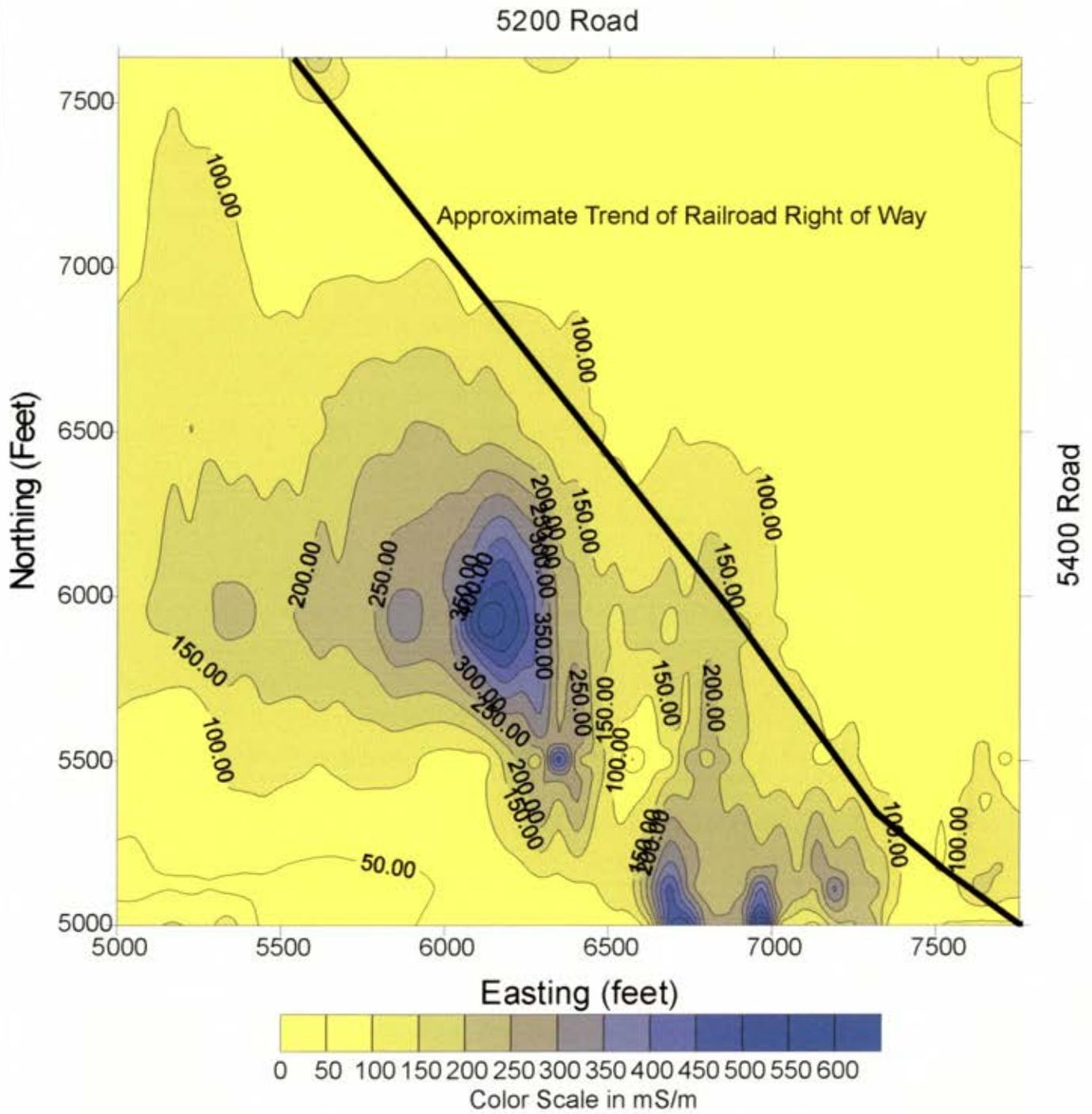
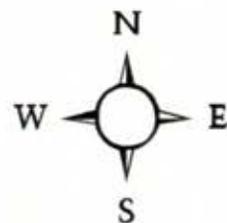


FIGURE 6
GEONICS EM-31 TERRAIN
CONDUCTIVITY SURVEY
 Quadrature Phase Mode in
 milliSiemens/meter (mS/m) and Filtered
 National Zinc Site
 Brownfields Targeted Assessment
 Cherryvale, Kansas



Source:
 Survey conducted by KDHE,
 6/99 and 11/99. Geophysical
 survey conducted, processed
 and interpreted by Randolph
 L. Brown, KDHE/BER Site
 Assessment Unit.



FIGURE 7(a)
IN-SITU SURFICIAL SOIL
DETECTIONS FOR LEAD
WITH SAMPLING GRID
Niton 733 X-Ray Fluorescence
Analysis by EPA Method 6200
National Zinc Site
Brownfields Targeted Assessment
October 1999

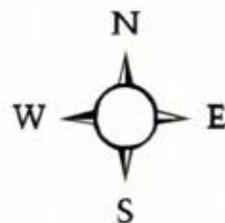


Table 5
Laboratory Total Metal Results for Surficial Soils
National Zinc BTA
Cherryvale, Kansas

Sample Location	Arsenic mg/kg	Barium mg/kg	Cadmium mg/kg	Chromium mg/kg	Lead mg/kg	Selenium mg/kg	Silver mg/kg
N6400 E5028	21.21	216.02	295.21	35.73	904.43	<5.00	1.36
N6600 E5025	28.03	675.97	103.6	18.69	208.66	<5.00	5.87
N6800 E5025Dup	21.42	190.58	11.00	28.7	110.7	<5.00	3.29
N5600 E5100	29.16	123.03	23.81	28.1	300.27	<5.00	5.92
N6900 E5100	5.65	184.01	6.02	28.63	40.21	<5.00	3.24
N5900 E5200	8.34	92.08	78.88	23.98	129.84	<5.00	1.19
N6000 E5200	<5.00	115.43	21.3	25.47	87.69	<5.00	<1.00
N6300 E5200	15.14	215.07	9.07	48.65	60.63	<5.00	<1.00
N5100 E5300	5.14	184.81	1.1	30.93	31.6	<5.00	<1.00
N6200 E5300	7.92	153.29	12.7	41.72	92.61	<5.00	<1.00
N6600 E5400	5.75	196.51	3.27	40.05	46.43	<5.00	<1.00
N5400 E5500	7.24	167.26	27.59	36.36	110.42	<5.00	<1.00
N5500 E5500	32.56	169.65	43.79	42.68	358.77	<5.00	3.53
N5500 E5500Dup	22.11	182.54	52.01	35.73	319.32	<5.00	2.89
N5800 E5500	21.1	365.51	78.24	43.91	429.22	<5.00	7.78
N6500 E5500	8.31	264.02	3.1	41.31	57.01	<5.00	12.63
N7000 E5500	8.48	164.08	2.28	44.3	48.03	<5.00	<1.00
N7637 E5500	10.76	200.43	3.69	31.86	86.7	<5.00	<1.00
N5200 E5600	10.67	177.53	5.17	35.26	87.83	<5.00	<1.00
N5900 E5600	6.61	148.25	31.85	31.61	67.69	<5.00	<1.00
N6000 E5600	7.14	145.36	71.02	40.58	84.48	<5.00	<1.00
N6900 E5600	20.37	278.72	45.6	34.39	211.93	<5.00	5.49
N7400 E5600	9.99	243.31	6.19	36.66	223.37	<5.00	<1.00
N6000 E5700	15.91	158.06	22.39	27.79	161.15	<5.00	1.47
N6900 E5700	238.82	45.76	4.47	40.76	275.84	<5.00	60.17
N7100 E5700	33.79	213.83	6.32	93.71	53.11	<5.00	<1.00
N6400 E5800	10.02	177.14	9.21	32.08	264.16	<5.00	<1.00
N7100 E5800	6.31	246.31	7.44	36.96	97.51	<5.00	20.04
N5700 E5900	6.95	210.59	24.53	36.11	84.84	<5.00	<1.00
N6800 E5900	6.61	115.96	18.41	28.99	457.83	<5.00	<1.00
N6800 E5900Dup	<5.00	114.03	14.53	25.54	230	<5.00	21.54
N7300 E5900	15.1	83.21	18.94	17.24	1,013.30	<5.00	1.79
N6700 E6000	13.05	267.86	76.21	41.78	806.63	<5.00	<1.00
N7200 E6000	18.75	150.46	24.21	21.5	1,073.86	<5.00	52.45
N7500 E6000	<5.00	194.96	1.69	27.63	41.3	<5.00	<1.00
N5315 E6100	15.93	163.94	69.1	58.83	2,195.34	<5.00	1.77
N6300 E6100	12.17	201.31	31.81	50.36	106.07	<5.00	<1.00
N7100 E6100	5.43	153.82	8.96	25.68	191.16	<5.00	<1.00
N5000 E6200	17.06	182.91	6.5	28.27	153.77	<5.00	1.12
N6100 E6200	12.24	300.54	9.88	51	67.33	<5.00	<1.00
N6600 E6170	11.34	183.23	122.4	33.8	1,477.84	<5.00	1.46
N6800 E6200	9.25	176.22	9.96	26.2	527.73	<5.00	<1.00
N7000 E6200	<5.00	92.32	9.11	18.92	205.82	<5.00	<1.00
N5800 E6300	<5.00	141.61	2.77	29.18	26.36	<5.00	<1.00
N6600 E6300	6.11	155.97	11.72	30.43	228.51	<5.00	<1.00
N6700 E6300	72.0	162.08	63.19	26.45	2,925.66	<5.00	21.41
N6500 E6400	13.7	124.77	27.14	24.49	927.08	<5.00	1.59
N6600 E6380	33.93	251.2	77.69	28.3	3,115.81	<5.00	3.01
N6800 E6400	5.49	224.79	6.44	26.05	118.71	<5.00	<1.00
N7300 E6400	<5.00	221.0	0.86	21.32	16.62	<5.00	<1.00
N5500 E6500	19.73	224.66	460.73	34.09	3,290	<5.00	9.38

Table 5
 Laboratory Total Metal Results for Surficial Soils
 National Zinc BTA
 Cherryvale, Kansas

Sample Location	Arsenic mg/kg	Barium mg/kg	Cadmium mg/kg	Chromium mg/kg	Lead mg/kg	Selenium mg/kg	Silver mg/kg
N5500 E6500Dup	19.21	217.82	384.61	30.07	2751	<5.00	8.13
N5800 E6500	5.31	274.71	5.09	29.49	40.03	<5.00	<1.00
N6100 E6500	<5.00	213.39	14.73	27.95	84.61	<5.00	<1.00
N6400 E6500	13.93	186.52	147.29	24.44	2,198.24	<5.00	2.06
N6600 E6505	141.45	138.52	14.55	28.42	679.68	<5.00	7.83
N6800 E6500	<5.00	342.58	1.44	34.55	19.69	<5.00	2.93
N6900 E6500	<5.00	337.11	0.93	25.34	27.24	<5.00	<1.00
N5000 E6600	306.15	130.63	103	37.06	14,794.17	12.09	64.38
N5300 E6600	9.8	216.65	12.41	31.91	162.18	<5.00	<1.00
N6300 E6600	11.98	243.92	115.23	39.92	798.04	<5.00	1.06
N6400 E6600	50.18	95.63	119.19	31.32	2,963.11	<5.00	3.67
N6500 E6600	28.75	232.15	23.83	35.4	1,416.74	<5.00	<1.00
N6600 E6600	14.28	293.62	13.01	44.45	524.96	<5.00	6.9
N5500 E6700	8.56	136.56	20.71	24.1	295.88	<5.00	<1.00
N6200 E6700	77.29	510.26	3,347	41.46	22,354	15.5	20.69
N5100 E6800	6.42	277.16	32.15	40.63	431.73	<5.00	1.41
N5200 E6800	14.35	223.19	112.84	31.83	605	<5.00	1.35
N5300 E6800	11.73	251.11	105.79	31.4	559.6	<5.00	<1.00
N5600 E6800	11.48	735.73	9.99	34.86	2,704	<5.00	<1.00
N5700 E6800	6.4	274.69	2.69	33.52	33.45	<5.00	<1.00
N6100 E6800	36.24	464.75	155.88	36.45	4,399.27	<5.00	1.87
N6200 E6800	20.77	206.71	32.94	35.64	889.52	<5.00	<1.00
N6300 E6800	34.81	136.99	42.5	25.47	3,698.77	<5.00	4.29
N6400 E6800	24.47	190.43	40.76	33.55	1,699.81	<5.00	<1.00
N7400 E6800	7.48	257.84	0.96	32.53	32.94	<5.00	<1.00
N5300 E6900	35.41	171.68	86.12	28.91	7,892.89	14.57	14.84
N5300 E6900Dup	22.35	169.32	85.96	27.99	8,315.03	16.86	11.98
N6200 E6900	45.17	220.82	27.44	28.03	2,589.55	<5.00	2.07
N6400 E6900	11.99	89.05	208.11	14.97	2,226.91	<5.00	4.94
N6500 E6900	20.91	239.63	52.24	27.43	1,061	<5.00	<1.00
N6500 E6900Dup	19.3	170.79	55.18	32.84	1,303.35	<5.00	<1.00
N6600 E6900	20.27	258.24	19.16	36.98	785.23	<5.00	<1.00
N6600 E6900Dup	19.56	280.82	17.49	34.61	480.28	<5.00	<1.00
N7100 E6900	<5.00	341.35	0.7	28.85	13.87	<5.00	<1.00
N7100 E6900Dup	<5.00	292.74	0.88	30.28	15.29	<5.00	<1.00
N7300 E6900	8.62	239.36	1.93	28.18	28.01	<5.00	5.52
N5000 E7000	<5.00	290.69	6.84	25.59	239.22	<5.00	<1.00
N5300 E7000	6.43	156.04	15.93	25.5	412.27	<5.00	<1.00
N5400 E7000	12.87	183.3	14.01	32.03	275.82	<5.00	<1.00
N5900 E7000	17.31	138.93	30.13	34.74	866.71	<5.00	1.52
N6100 E7000	203.74	87.69	17.06	29.68	775.61	<5.00	27.14
N6200 E7000	54.58	258.61	33.12	26.71	5,018.98	6.0	20.55
N6400 E7000	13.7	190.24	38.27	22.5	529.06	<5.00	1.25
N6500 E7000	11.48	182.07	19.82	31.42	248.01	<5.00	1.08
N6800 E7000	7.7	308.28	1.12	36.37	63.87	<5.00	<1.00
N7200 E7000	<5.00	217.84	<0.50	36.11	6.45	<5.00	<1.00
N7637 E7000	31.05	197.69	6.96	35.98	186.71	<5.00	3.5
N5000 E7100	7.26	262.45	34.48	29.8	2,081.91	<5.00	2.21
N5300 E7100	9.67	145.3	9.86	31.44	274.36	<5.00	<1.00
N5800 E7100	55.48	273.48	78.77	34.66	3,860.88	<5.00	1.79
N6000 E7100	70.72	179.19	50.93	25.36	3,878.81	<5.00	6.84
N6100 E7100	45.38	197.73	46.96	39.44	3,231.70	<5.00	2.55

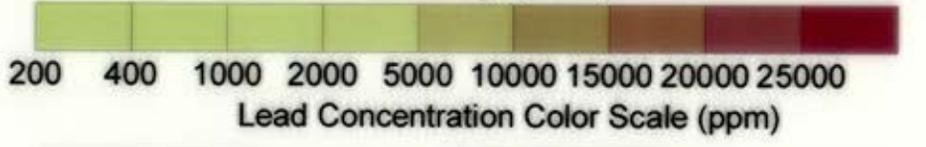
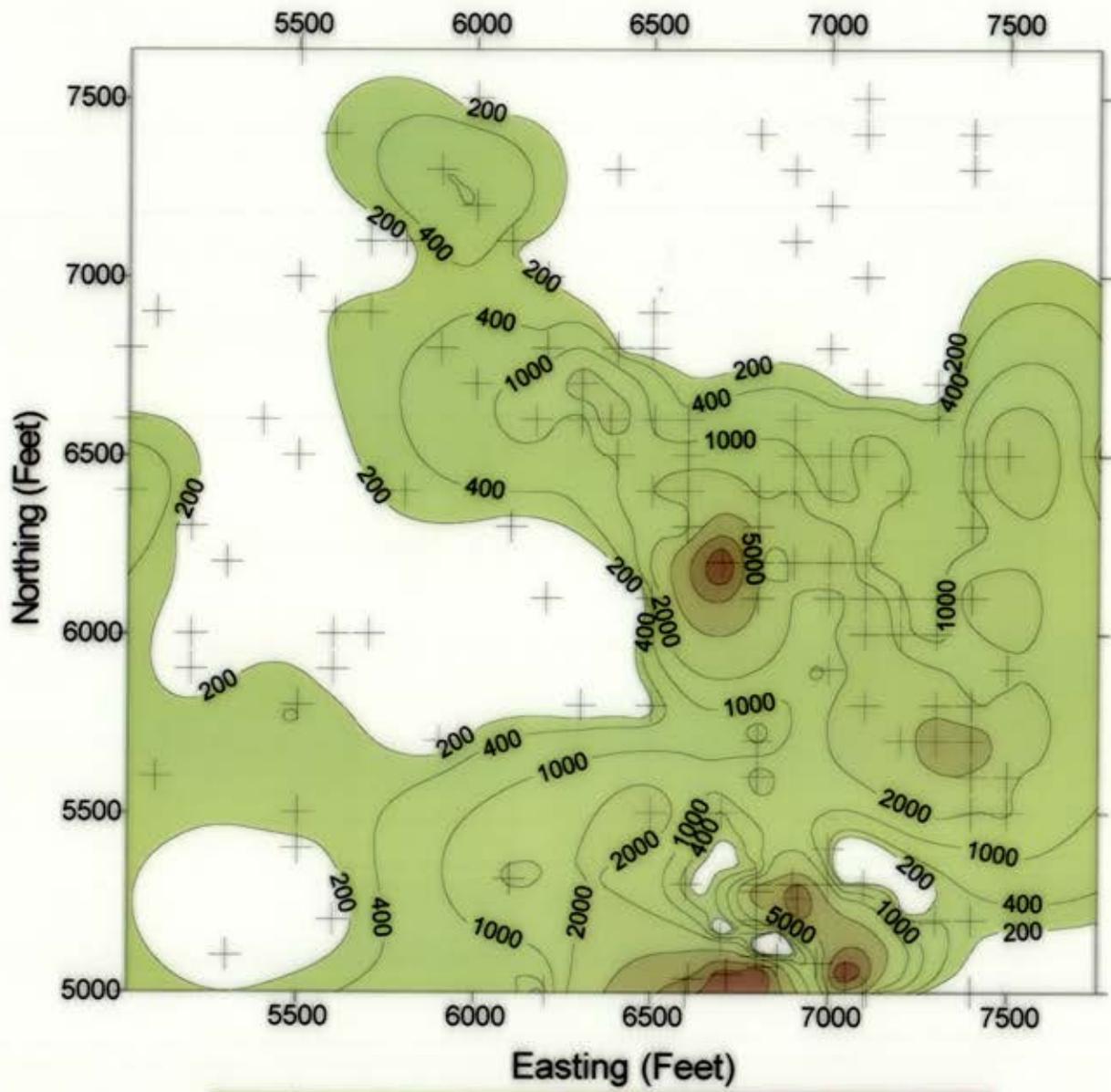




FIGURE 7(b)
SURFICIAL SOIL
DETECTIONS FOR LEAD
WITH SAMPLING GRID
Laboratory Analytical Results
National Zinc Site
Brownfields Targeted Assessment
October 1999



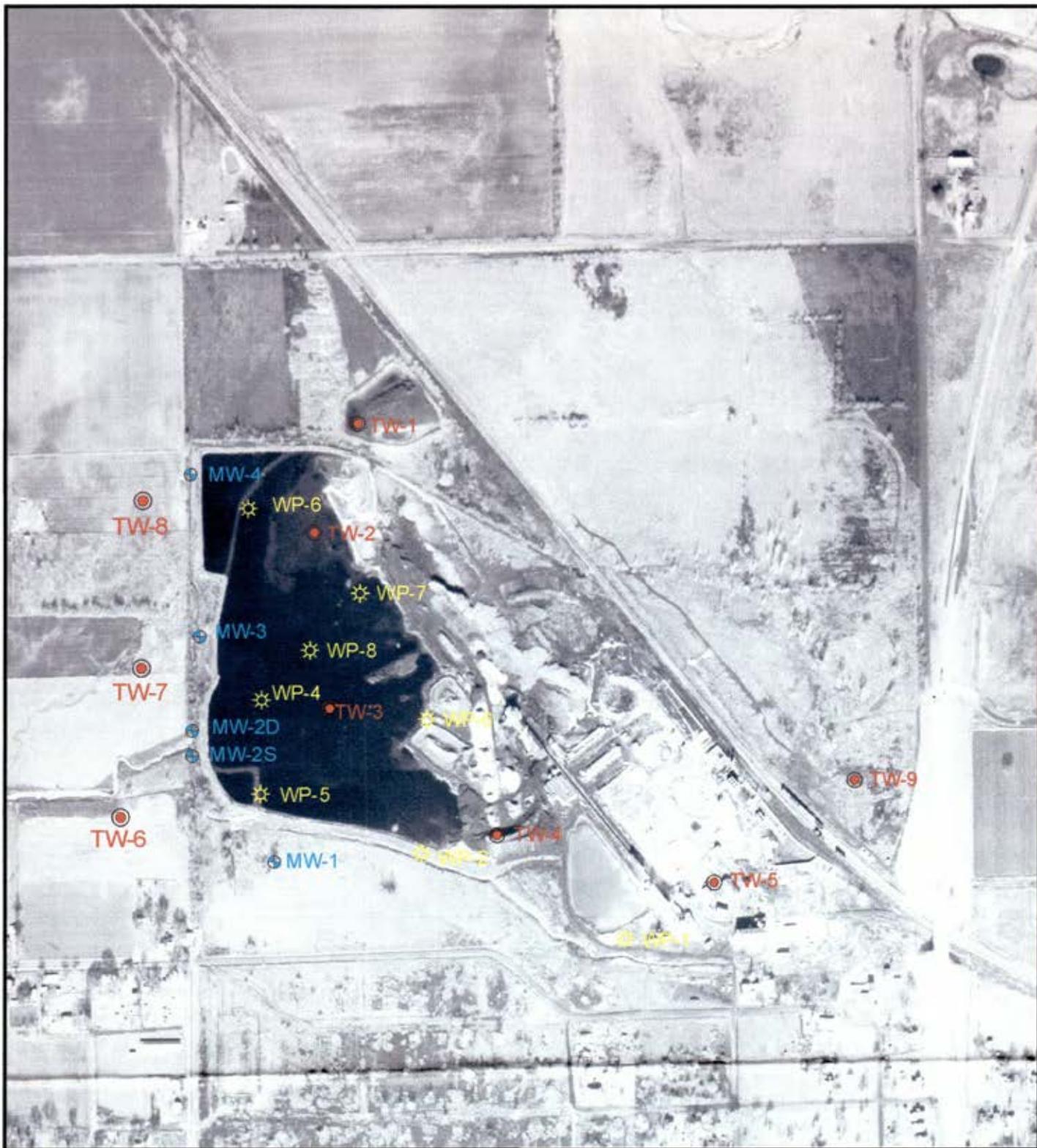


FIGURE 8
GROUNDWATER AND
SUBSURFACE WASTE PROFILE
SAMPLE LOCATION MAP
 National Zinc Site
 Brownfields Targeted Assessment
 Cherryvale, Kansas

Legend:
 ● Temporary Well
 Location



Source: Aerial Photo, 1965.

Approximate Scale: 1 inch = 489 feet

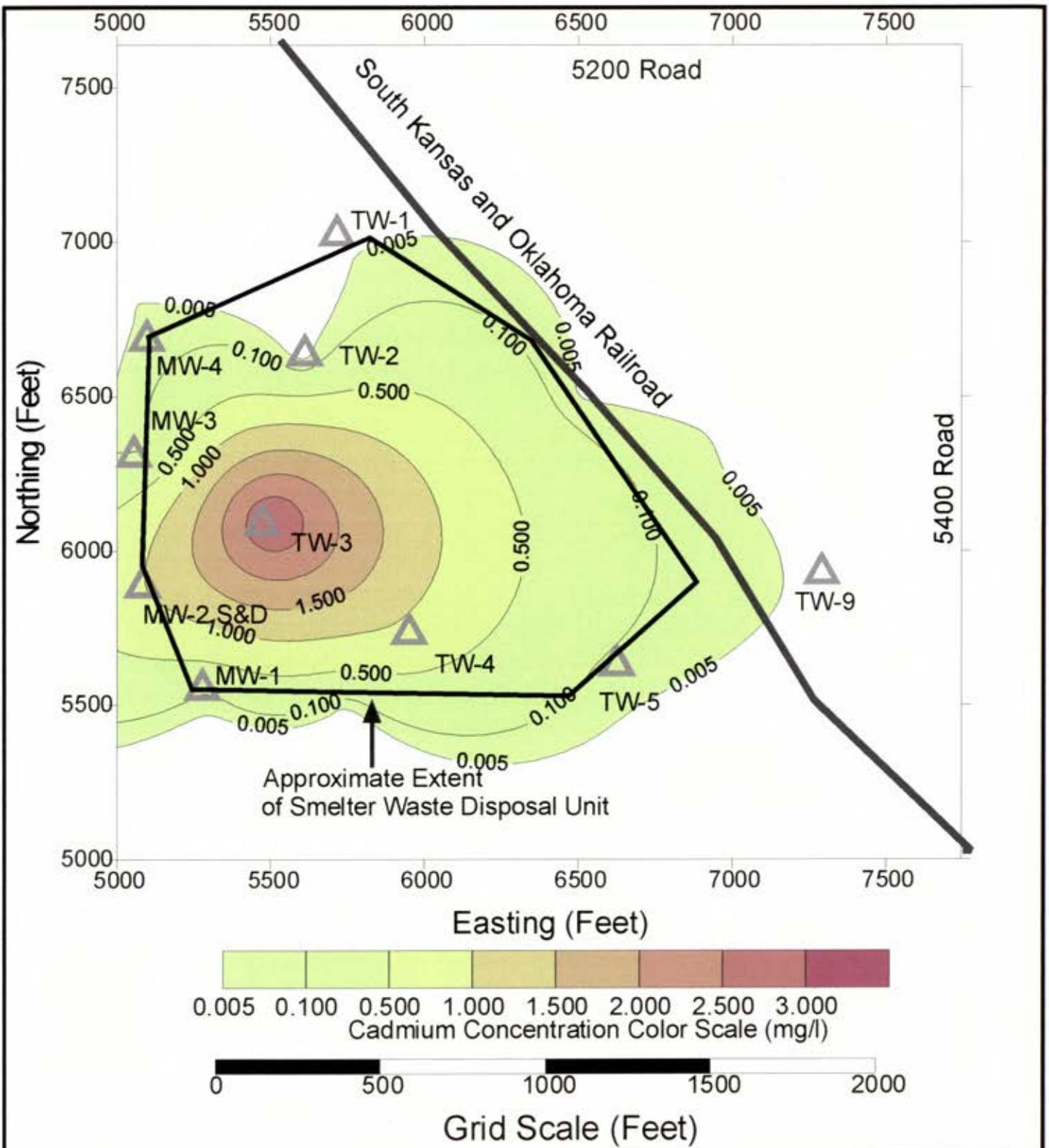
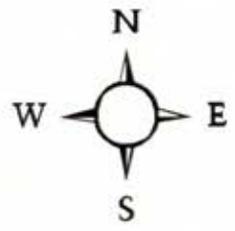


FIGURE 9
 GROUND WATER DETECTIONS
 FOR CADMIUM ISOCONCENTRATION MAP
 National Zinc Site
 Brownfields Targeted Assessment
 Cherryvale, Kansas



Source: KDHE/BER Site Assessment Unit

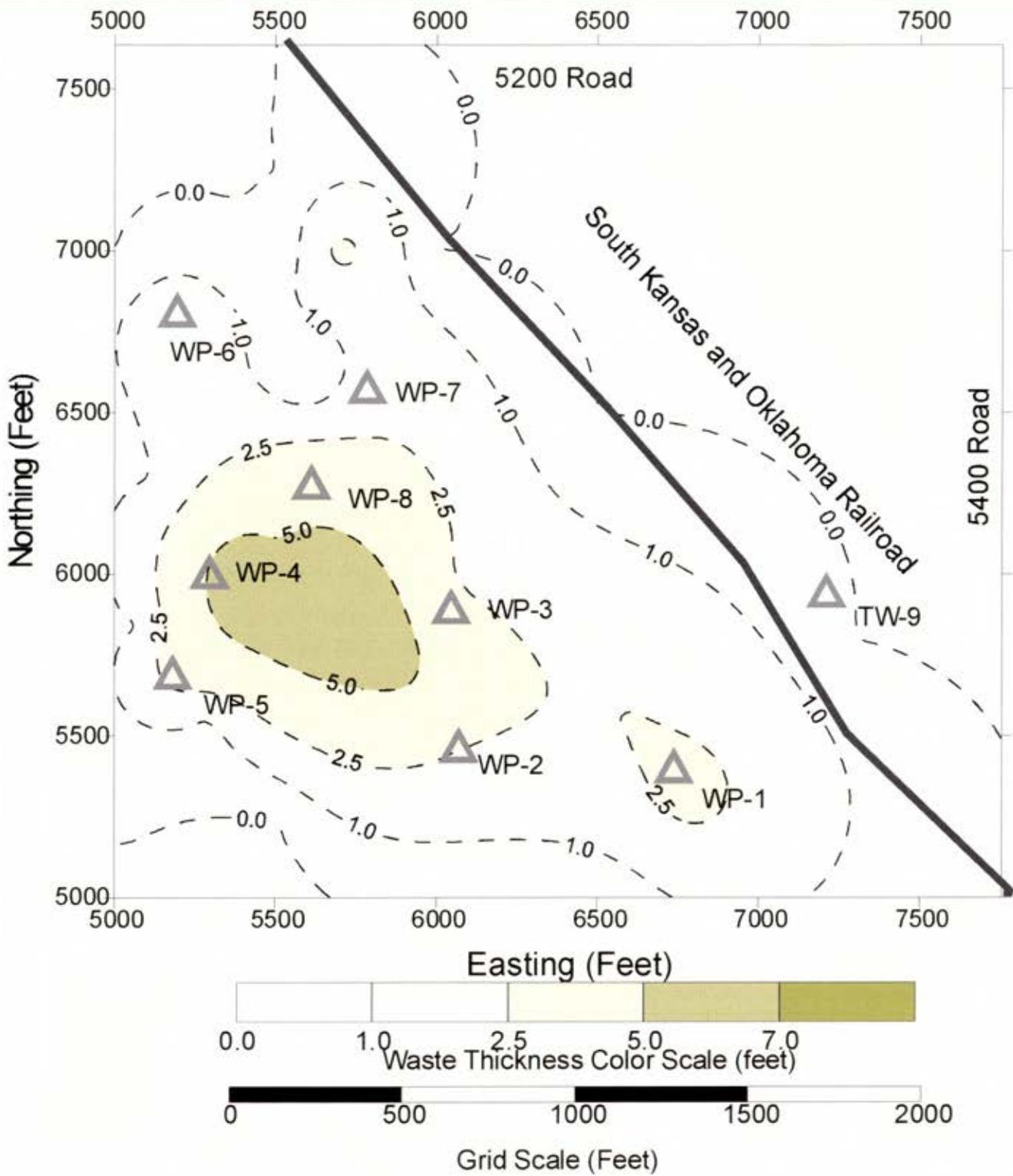


FIGURE 11
 SUBSURFACE WASTE
 THICKNESS PROFILE MAP
 National Zinc Site
 Brownfields Targeted Assessment
 Cherryvale, Kansas



Source: KDHE/BER Site Assessment Unit August, 1999.

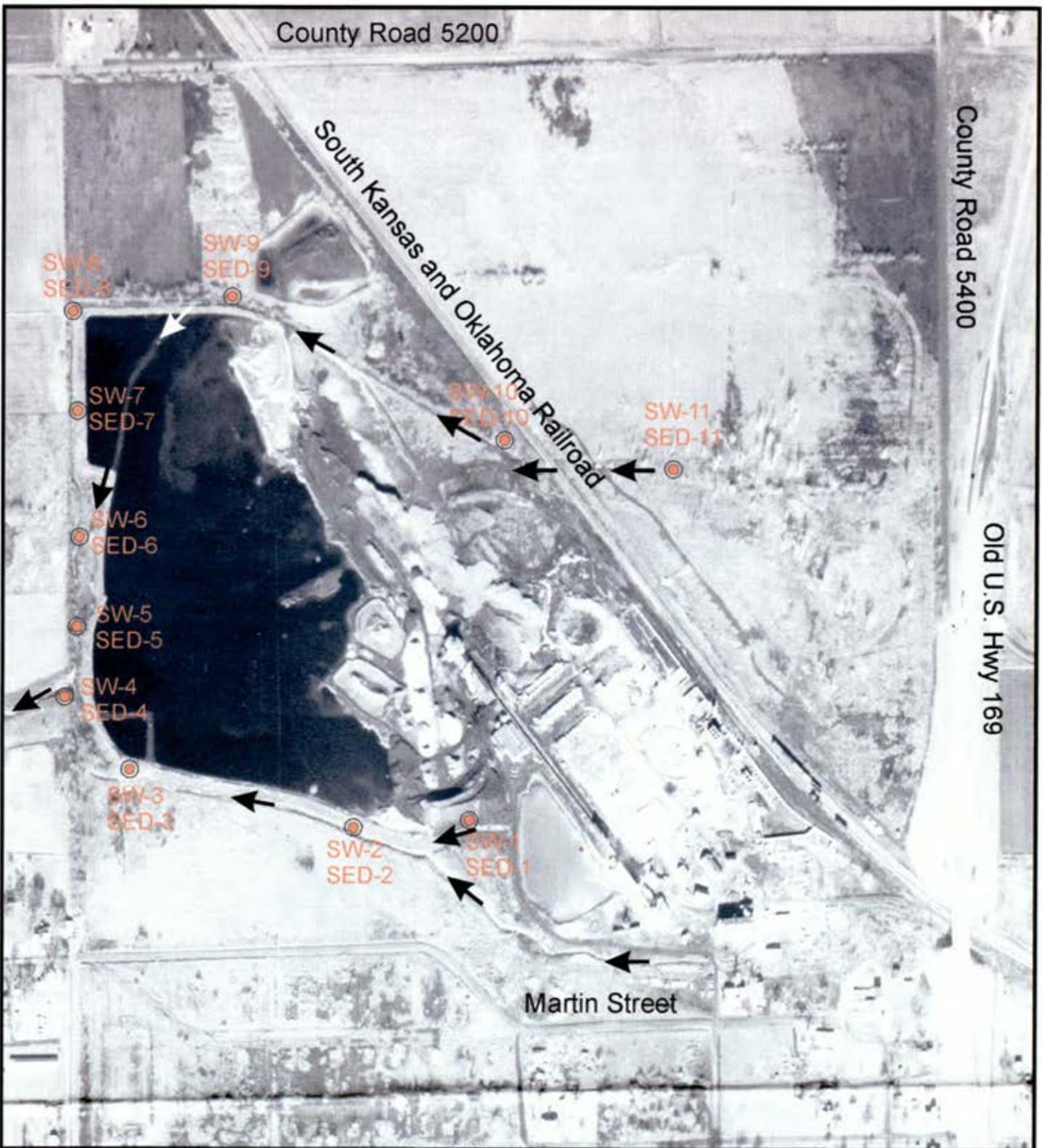


FIGURE 12
SURFACE WATER AND SEDIMENT
SAMPLE LOCATION MAP
 National Zinc Site
 Brownfields Targeted Assessment
 Cherryvale, Kansas

Legend:
 ● Surface Water (SW) and Sediment (SED) Sample Location
 ↑ Surface Water Flow Direction

Approximate Scale: 1 inch = 406 feet

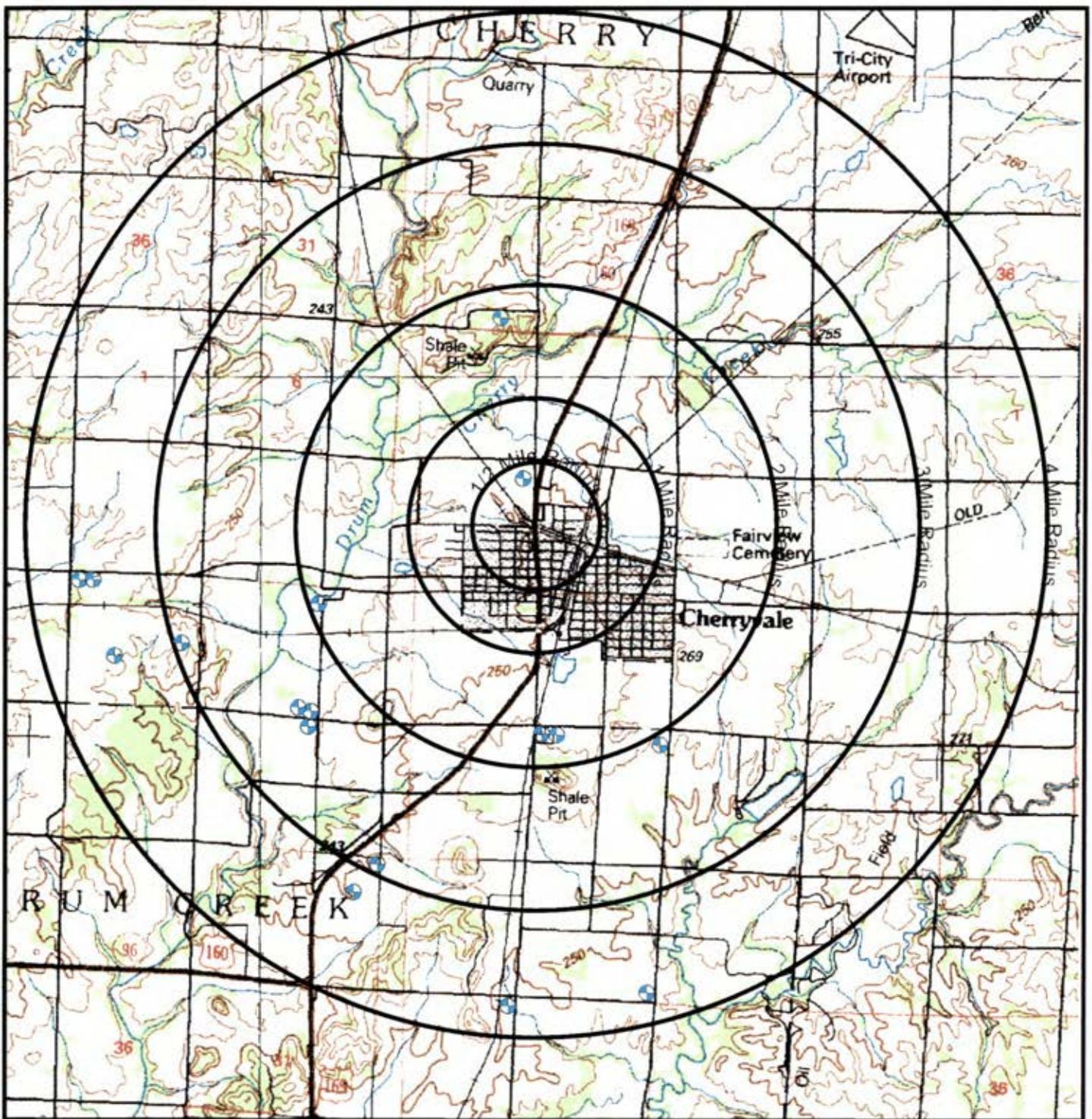
Source: Aerial Photo, 1965.

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 30 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 sandstone. Where sandstone beds are absent, yields very small to small supplies to shallow wells in weathered zone.	
		Lansing		Stanton Limestone	70-130	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.		
		Missourian	Kansas City	Bonner Springs Shale and Lane Shale	85-150	Gray silty to argillaceous shale.		Generally yields little or no water to wells except in the shallow zone of weathering. Yields small supplies to wells locally from black 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.		
				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.	
				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 6 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	
		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 13
GEOLOGIC PROFILE OF
MONTGOMERY COUNTY
 National Zinc Site
 Brownfields Targeted Assessment
 Cherryvale, Kansas

Source: "Geology and Ground-Water Resources of Montgomery County, Southeastern Kansas." *Kansas Geol. Survey Ground-Water Ser. No. 1, 1974.*

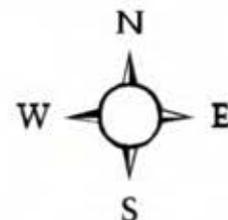


Monitoring Well Location

Population Data:

0-1/2 Mile Radius	1048
1/2-1 Mile Radius	1048
1 - 2 Mile Radius	725
2 - 3 Mile Radius	104
3 - 4 Mile Radius	207

FIGURE 14
MONITORING WELL
LOCATION MAP WITH
POPULATION DATA
 National Zinc Site
 Brownfields Targeted Assessment
 Cherryvale, Kansas



Approximate Scale: 1 inch = 1.12 miles

Source: USGS Topographic Quadrangle Coffeyville, Kans., 1990. United States Census Tiger Data Files, 1990.

Table 1
 X-Ray Fluorescence (XRF) and Laboratory Results
 for Initial Surficial Soil Samples
 National Zinc BTA
 Cherryvale, Kansas

Sample Location	Sample ID	Date Collected	In Situ Results Lead (ppm)	Homogenized XRF Lead (ppm)	DHEL Lead (mg/kg)
N5000 E7000	S1 (0-1")	05/26/99	290	293	268
N5100 E6800	S2 (0-1")	05/26/99	504	391	431
*	S3 (0-1")	05/26/99	875	274	334
N5040 E7050	S4 (0-1")	05/26/99	7,686	27,200	25,638
N5080 E6970	S5 (0-1")	05/26/99	538	375	319
N5070 E6820	S6 (0-1")	05/26/99	5,427	15,900	19,987
N5090 E6860	S7 (0-1")	05/26/99	1,444	833	869
N5164 E6800	S8 (0-1")	05/26/99	5,734	670	807
N5185 E6868	S9 (0-1")	05/26/99	1,168	578	535
N5260 E6915	S10 (0-1")	05/26/99	6,291	16,900	18,311
*	S11 (0-1")	05/26/99	480	1,000	1,011
N5281 E6800	S12 (0-1")	05/26/99	4,704	6,409	8,317
N5188 E6800	S13 (0-1")	05/26/99	882	757	792
N5150 E6700	S14 (0-1")	05/26/99	420	393	383
N5048 E6717	S15 (0-1")	05/26/99	8,454	21,200	19,865
N5036 E6609	S16 (0-1")	05/26/99	4,531	9,990	9,262
*	S17 (0-1")	05/26/99	136	161	148
*	S18 (0-1")	05/26/99	613	1,045	1,216
N5040 E7050	S4 (5-6")	05/26/99	NA	160,000	120,800
N5070 E6820	S6 (5-6")	05/26/99	NA	114,000	98,010
*	S11 (5-6")	05/26/99	NA	13,800	14,341
N5048 E6717	S15 (5-6")	05/26/99	NA	61,200	62,292
*	S17 (5-6")	05/26/99	NA	<70	54.6

Source: KIRK/DBR Site Assessment Unit-DHEL

Comments:

ppm = parts per million
 mg/kg = micrograms per kilogram
 < = less than

DHEL = Department of Health & Environmental Laboratory

Regression Output 1 = In Situ Data vs Laboratory Data

Regression Output 2 = Homogenized XRF Data vs Laboratory Data

XRF analysis by EPA Method 6200

DHEL analysis by EPA Method 6010

* Sample used for XRF statistical data quality determination only, not included in site grid

Regression Output: 1

Constant	1031.9243
Std Err of Y Est	1412.7741
R Squared	0.7745629
No. of Observations	18
Degrees of Freedom	16
X Coefficient(s)	0.2912848
Std Err of Coef.	0.0392864

Regression Output: 2

Constant	-1881.751
Std Err of Y Est	4863.9378
R Squared	0.9859922
No. of Observations	23
Degrees of Freedom	21
X Coefficient(s)	1.2294451
Std Err of Coef.	0.0319777

Table 2
 Laboratory Results for Initial Soil Samples
 National Zinc BTA
 Cherryvale, Kansas

Sample Location	Sample ID	Arsenic mg/kg	Barium mg/kg	Cadmium mg/kg	Chromium mg/kg	Lead mg/kg	Selenium mg/kg	Silver mg/kg
N5000 E7000	S1 (0-1")	<5.00	308	3.46	22.1	268	<5.00	<1.00
N5100 E6800	S2 (0-1")	<5.00	307	11.7	25.5	431	<5.00	<1.00
*	S3 (0-1")	<5.00	416	4.5	27.1	334	<5.00	<1.00
N5040 E7050	S4 (0-1")	48.9	214	181	22	25,638	76.2	8.13
N5080 E6970	S5 (0-1")	<5.00	331	3.87	20.9	319	<5.00	2.07
N5070 E6820	S6 (0-1")	19.8	282	134	19	19,987	49.1	3.98
N5090 E6860	S7 (0-1")	<5.00	338	17.6	31	869	<5.00	<1.00
N5164 E6800	S8 (0-1")	7.17	354	21.4	24.7	807	<5.00	<1.00
N5185 E6868	S9 (0-1")	5.48	275	19.2	23.9	535	<5.00	3.47
N5260 E6915	S10 (0-1")	39.1	195	185	15	18,311	54.2	1.68
*	S11 (0-1")	9.64	208	104	24	1,011	<5.00	2.26
N5281 E6800	S12 (0-1")	18.3	258	323	15	8,317	7.75	<1.00
N5188 E6800	S13 (0-1")	8.01	296	48.8	23.3	792	<5.00	1.68
N5150 E6700	S14 (0-1")	<5.00	337	8.53	19.7	383	<5.00	<1.00
N5048 E6717	S15 (0-1")	40.6	287	134	14	19,865	54.4	3.08
N5048 E6717	S15 Dupilcate	91.3	328	299	42	19,803	100	4.86
N5036 E6609	S16 (0-1")	31.1	243	223	21	9,262	43.9	6.67
*	S17 (0-1")	5.23	283	6.66	29.1	148	<5.00	<1.00
*	S18 (0-1")	14.1	344	40	28	1,216	<5.00	<1.00
N5040 E7050	S4 (5-6")	47.4	188	147	16	120,800	448	8.99
N5070 E6820	S6 (5-6")	137	212	793	93	98,010	594	8.04
*	S11 (5-6")	178	789	259	54	14,341	26.9	6.22
N5048 E6717	S15 (5-6")	8.14	176	257	38	62,292	<5.00	9.97
*	S17 (5-6")	<5.00	231	5.31	29.6	54.6	<5.00	<1.00

Source: KDHE/BER--Dept of Health & Environmental Laboratory

Comments: mg/kg = milligrams per kilogram
 Samples were collected on May 26, 1999.
 < = Not detected at indicated level
 Analysis by EPA Method 6010
 * Sample used for XRF statistical data quality determination only, not included in site grid

Table 3
XRF *In-Situ* and Laboratory Data Summary
National Zinc BTA
Cherryvale, Kansas

Sample Location	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N6400 E5028	812	07/28/99	948 ± 94	904.43
N6400 E5028Dup	813	07/28/99	1,024 ± 98	NA
N6500 E5028	811	07/28/99	183 ± 61	NA
N6600 E5025	799	07/28/99	250±77	208.66
N6600 E5025Dup	800	07/28/99	256±76	NA
N6700 E5025	798	07/28/99	120±50	NA
N6800 E5025	789	07/28/99	130±60	110.7
N6900 E5025	788	07/28/99	186±62	NA
N6928.7 E5027.9	786	07/28/99	101±57	NA
N6928.7 E5027.9Dup	787	07/28/99	ND(78)	NA
N7500 E5024	866	07/29/99	ND(66)	NA
N7640 E5024	865	07/29/99	ND(65)	NA
N6000 E5050	837	07/28/99	ND(91)	NA
N5100 E5100	71	08/11/99	ND(83)	NA
N5200 E5100	72	08/11/99	ND(92)	NA
N5300 E5100	82	08/11/99	ND(129)	NA
N5600 E5100	95	08/12/99	309±84	300.27
N5600 E5100Dup	96	08/12/99	293±82	NA
N5700 E5100	94	08/12/99	112±71	NA
N5800 E5100	93	08/12/99	ND(106)	NA
N5900 E5100	92	08/12/99	ND(88)	NA
N6000 E5100	838	07/29/99	139±54	NA
N6100 E5100	836	07/29/99	ND(77)	NA
N6200 E5100	824	07/28/99	167±59	NA
N6300 E5100	823	07/28/99	ND(112)	NA
N6400 E5100	815	07/28/99	ND(87)	NA
N6500 E5100	810	07/28/99	ND(96)	NA
N6600 E5100	803	07/28/99	141 ± 66	NA
N6700 E5100	797	07/28/99	109±55	NA
N6800 E5100	790	07/28/99	84.6±52	NA
N6900 E5100	785	07/28/99	ND(73)	40.21
N5100 E5200	70	08/11/99	ND(99)	NA
N5200 E5200	73	08/11/99	ND(103)	NA
N5300 E5200	83	08/12/99	105±61	NA
N5600 E5200	97	08/12/99	ND(90)	NA
N5700 E5200	100	08/12/99	173±67	NA
N5800 E5200	101	08/12/99	197±76	NA
N5900 E5200	103	08/12/99	ND(116)	129.84
N6000 E5200	839	07/28/99	260±57	87.69
N6000 E5200Dup	840	07/28/99	245±57	NA
N6100 E5200	835	07/29/99	116±53	NA
N6200 E5200	825	07/28/99	ND(111)	NA
N6300 E5200	822	07/28/99	ND(100)	60.63
N6400 E 5200	816	07/28/99	90.9±56	NA
N6500 E5200	809	07/28/99	181±50	NA
N6600 E5200	804	07/28/99	211±58	NA
N6700 E5200	796	07/28/99	112±53	NA
N6800 E5200	791	07/28/99	ND(82)	NA
N6900 E5200	784	07/28/99	146±51	NA
N5100 E5300	69	08/11/99	139±77	31.6
N5200 E5300	75	08/11/99	ND(92)	NA

Sample #	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N5300 E5300	84	08/11/99	142±73	NA
N5300 E5300Dup	85	08/11/99	109±68	NA
N5500 E5300	98	08/12/99	ND(130)	NA
N5600 E5300	99	08/12/99	ND(94)	NA
N5700 E5300	106	08/12/99	107±65	NA
N5800 E5300	105	08/12/99	119±75	NA
N5900 E5300	104	08/12/99	134±66	NA
N6000 E5300	841	07/29/99	ND(89)	NA
N6100 E5300	834	07/29/99	ND(73)	NA
N6200 E5300	826	07/28/99	124±64	92.61
N6200 E5300Dup	827	07/28/99	136±64	NA
N6300 E5300	821	07/28/99	150±60	NA
N6400 E5300	817	07/28/99	ND(76)	NA
N6500 E5300	808	07/28/99	138±56	NA
N6600 E5300	805	07/28/99	ND(88)	NA
N6700 E5300	795	07/28/99	ND(76)	NA
N6800 E5300	792	07/28/99	ND(85)	NA
N6900 E5300	783	07/28/99	158±52	NA
N5100 E5400	68	08/11/99	ND(109)	NA
N5200 E5400	76	08/11/99	ND(129)	NA
N5300 E5400	86	08/11/99	146±73	NA
N5600 E5400	107	08/12/99	113±75	NA
N5700 E5400	108	08/12/99	ND(76)	NA
N5800 E5400	109	08/12/99	187±63	NA
N5900 E5400	110	08/12/99	ND(74)	NA
N6000 E5400	842	07/29/99	220±60	NA
N6100 E5400	832	07/29/99	132±56	NA
N6200 E5400	828	07/28/99	98.2±56	NA
N6300 E5400	820	07/28/99	287±57	NA
N6400 E5400	818	07/28/99	159±53	NA
N6500 E5400	807	07/28/99	ND(77)	NA
N6600 E5400	806	07/28/99	ND(126)	46.43
N6700 E5400	794	07/28/99	ND(78)	NA
N6800 E5400	793	07/28/99	209±58	NA
N6900 E5400	782	07/28/99	ND(70)	NA
N5100 E5500	67	08/11/99	ND(125)	NA
N5200 E5500	77	08/11/99	ND(94)	NA
N5300 E5500	87	08/11/99	ND(116)	NA
N5400 E5500	37	08/11/99	574±106	110.42
N5400 E5500Dup	38	08/11/99	559±106	NA
N5500 E5500	847	07/29/99	281±74	359/319
N5600 E5500	846	07/29/99	275±65	NA
N5700 E5500	845	07/29/99	137±63	NA
N5800 E5500	844	07/29/99	433±60	429.22
N5900 E5500	843	07/29/99	116±62	NA
N6000 E5500	736	07/28/99	209±59	NA
N6100 E5500	734	07/28/99	ND(72)	NA
N6200 E5500	733	07/28/99	125±59	NA
N6300 E5500	732	07/28/99	167±55	NA
N6400 E5500	731	07/28/99	148±58	NA
N6500 E5500	694	07/27/99	167±69	57.01

Table 3
XRF *In-Situ* and Laboratory Data Summary
National Zinc BTA
Cherryvale, Kansas

Sample Location	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N6500 E5500Dup	693	07/27/99	80.1±48	NA
N6500 E5500Dup	695	07/27/99	115±49	NA
N6600 E5500	692	07/27/99	ND(75)	NA
N6700 E5500	691	07/27/99	ND(74)	NA
N6800 E5500	690	07/27/99	155±53	NA
N6900 E5500	689	07/27/99	ND(58)	NA
N7000 E5500	688	07/27/99	ND(75)	48.03
N7000 E5500	523	07/21/99	119±58	NA
N7000 E5500Dup	525	07/21/99	ND(82)	NA
N7100 E5500	522	07/21/99	ND(82)	NA
N7200 E5500	521	07/21/99	ND(83)	NA
N7300 E5500	520	07/21/99	ND(80)	NA
N7400 E5500	519	07/21/99	ND(101)	NA
N7500 E5500	518	07/21/99	ND(85)	NA
N7637 E5500	867	07/29/99	ND(90)	86.7
N5100 E5600	66	08/11/99	ND(87)	NA
N5200 E5600	78	08/11/99	163±78	87.83
N5200 E5600Dup	79	08/11/99	247±84	NA
N5300 E5600	88	08/11/99	154±74	NA
N5400 E5600	36	08/11/99	183±85	NA
N5500 E5600	848	07/29/99	119±56	NA
N5600 E5600	850	07/29/99	ND(86)	NA
N5700 E5600	851	07/29/99	ND(72)	NA
N5800 E5600	857	07/29/99	84.5±55	NA
N5900 E5600	858	07/29/99	350±73	67.69
N5900 E5600Dup	859	07/29/99	380±71	NA
N6000 E5600	737	07/28/99	275±70	84.48
N6100 E5600	738	07/28/99	215±59	NA
N6200 E5600	739	07/28/99	ND(73)	NA
N6300 E5600	740	07/28/99	76.9±50	NA
N6400 E5600	741	07/28/99	189±56	NA
N6400 E5600Dup	742	07/28/99	107±49	NA
N6500 E5600	696	07/27/99	ND(72)	NA
N6600 E5600	697	07/27/99	101±51	NA
N6700 E5600	702	07/27/99	ND(76)	NA
N6800 E5600	703	07/27/99	97.8±51	NA
N6800 E5600Dup	704	07/27/99	95.7±50	NA
N6900 E5600	705	07/27/99	259±55	211.93
N7000 E5600	510	07/21/99	107±49	NA
N7000 E5600	687	07/27/99	101±52	NA
N7100 E5600	511	07/21/99	143±55	NA
N7200 E5600	512	07/21/99	ND(90)	NA
N7300 E5600	513	07/21/99	ND(82)	NA
N7400 E5600	515	07/21/99	145±56	223.37
N7400 E5600Dup	516	07/21/99	130±54	NA
N7500 E5600	517	07/21/99	109±49	NA
N5100 E5700	64	08/11/99	ND(99)	NA
N5100 E5700Dup	65	08/11/99	ND(96)	NA
N5200 E5700	80	08/11/99	141±71	NA
N5400 E5700	39	08/11/99	ND(87)	NA
N5500 E5700	849	07/29/99	180±56	NA

Sample #	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N5600 E5700	778	07/28/99	188±56	NA
N5700 E5700	777	07/28/99	ND(88)	NA
N5800 E5700	776	07/28/99	244±66	NA
N5900 E5700	860	07/29/99	ND(93)	NA
N6000 E5700	748	07/28/99	107±51	161.15
N6100 E5700	747	07/28/99	123±58	NA
N6200 E5700	746	07/28/99	184±58	NA
N6300 E5700	744	07/28/99	144±50	NA
N6400 E5700	743	07/28/99	223±55	NA
N6500 E5700	710	07/27/99	83.7±51	NA
N6600 E5700	709	07/27/99	168±51	NA
N6700 E5700	708	07/27/99	132±55	NA
N6800 E5700	707	07/27/99	193±54	NA
N6900 E5700	706	07/27/99	373±93	275.84
N7000 E5700	509	07/21/99	284±64	NA
N7100 E5700	508	07/21/99	ND(126)	53.11
N7200 E5700	507	07/21/99	132±65	NA
N7300 E5700	506	07/21/99	121±73	NA
N7400 E5700	505	07/21/99	ND(85)	NA
N7500 E5700	504	07/21/99	166±52	NA
N5100 E5800	62	08/11/99	ND(104)	NA
N5500 E5800	854	07/29/99	146±68	NA
N5500 E5800Dup	855	07/29/99	132±62	NA
N5600 E5800	853	07/29/99	111±61	NA
N5700 E5800	852	07/29/99	232±58	NA
N5800 E5800	775	07/28/99	195±57	NA
N5900 E5800	774	07/28/99	116±54	NA
N6000 E5800	749	07/28/99	171±51	NA
N6100 E5800	750	07/28/99	97.6±55	NA
N6200 E5800	751	07/28/99	94.3±50	NA
N6300 E5800	752	07/28/99	ND(78)	NA
N6400 E5800	753	07/28/99	213±54	264.16
N6400 E5800Dup	754	07/28/99	247±54	NA
N6500 E5800	722	07/27/99	92.4±52	NA
N6600 E5800	721	07/27/99	116±55	NA
N6700 E5800	720	07/27/99	144±56	NA
N6800 E5800	714	07/27/99	236±60	NA
N6900 E5800	715	07/27/99	ND(73)	NA
N7000 E5800	716	07/27/99	ND(72)	NA
N7100 E5800	496	07/20/99	131±59	97.51
N7200 E5800	495	07/20/99	150±57	NA
N7300 E5800	494	07/20/99	119±55	NA
N7400 E5800	493	07/20/99	250±62	NA
N7500 E5800	492	07/20/99	ND(87)	NA
N5100 E5900	61	08/11/99	ND(104)	NA
N5400 E5900	40	08/11/99	ND(106)	NA
N5500 E5900	768	07/28/99	101±50	NA
N5600 E5900	769	07/28/99	143±60	NA
N5700 E5900	770	07/28/99	191±54	84.84
N5700 E5900Dup	771	07/28/99	151±50	NA
N5800 E5900	772	07/28/99	90.6±54	NA

Table 3
XRF *In-Situ* and Laboratory Data Summary
National Zinc BTA
Cherryvale, Kansas

Sample Location	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N5900 E5900	773	07/28/99	ND(70)	NA
N6000 E5900	759	07/28/99	91.5±52	NA
N6100 E5900	758	07/28/99	122±54	NA
N6200 E5900	757	07/28/99	ND(84)	NA
N6300 E5900	756	07/28/99	98.5±49	NA
N6400 E5900	755	07/28/99	99±56	NA
N6500 E5900	723	07/27/99	86.0±55	NA
N6600 E5900	724	07/27/99	ND(88)	NA
N6700 E5900	725	07/27/99	ND(77)	NA
N6800 E5900	718	07/27/99	904±83	457.83
N6800 E5900Dup	719	07/27/99	719±78	230
N6900 E5900	717	07/27/99	121±55	NA
N7000 E5900	483	07/20/99	ND(106)	NA
N7100 E5900	484	07/20/99	ND(71)	NA
N7200 E5900	485	07/20/99	205±56	NA
N7300 E5900	486	07/20/99	789±62	1013.3
N7300 E5900Dup	487	07/20/99	775±61	NA
N7400 E5900	488	07/20/99	ND(84)	NA
N7500 E5900	489	07/20/99	ND(122)	NA
N5100 E6000	60	08/11/99	ND(108)	NA
N5400 E6000	42	08/11/99	ND(112)	NA
N5500 E6000	767	07/28/99	ND(81)	NA
N5600 E6000	766	07/28/99	76.5±50	NA
N5700 E6000	765	07/28/99	ND(75)	NA
N5800 E6000	764	07/28/99	ND(82)	NA
N5900 E6000	763	07/28/99	179±55	NA
N6000 E6000	549	07/21/99	98±35	NA
N6100 E6000	547	07/21/99	92.8±53	NA
N6200 E6000	546	07/21/99	114±70	NA
N6300 E6000	545	07/21/99	ND(90)	NA
N6400 E6000	544	07/21/99	159±62	NA
N6500 E6000	530	07/21/99	149±54	NA
N6600 E6000	529	07/21/99	ND(67)	NA
N6700 E6000	528	07/21/99	693±85	806.63
N6800 E6000	527	07/21/99	157±50	NA
N6900 E6000	526	07/21/99	90.7±53	NA
N7000 E6000	482	07/20/99	137±64	NA
N7100 E6000	481	07/20/99	215±57	NA
N7200 E6000	480	07/20/99	224±44	1073.86
N7300 E6000	479	07/20/99	86.3±54	NA
N7400 E6000	478	07/20/99	ND(98)	NA
N7500 E6000	473	07/20/99	ND(72)	41.3
N7637 E6000	472	07/20/99	ND(70)	NA
N5315 E6100	43	08/11/99	1,501±183	2,195.34
N5315 E6100Dup	44	08/11/99	1,656±156	NA
N5400 E6100	45	08/11/99	ND(111)	NA
N5600 E6100	35	08/11/99	ND(120)	NA
N5700 E6100	34	08/11/99	94.3±36	NA
N5800 E6100	33	08/11/99	143±77	NA
N5900 E6100	32	08/11/99	272±100	NA
N6000 E6100	550	07/21/99	76.1±50	NA

Sample #	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N6100 E6100	551	07/21/99	ND(68)	NA
N6200 E6100	552	07/21/99	ND(110)	NA
N6300 E6100	553	07/21/99	167±72	106.07
N6300 E6100Dup	554	07/21/99	130±69	NA
N6400 E6100	555	07/21/99	182±64	NA
N6500 E6100	531	07/21/99	ND(89)	NA
N6600 E6100	532	07/21/99	128±56	NA
N6700 E6100	533	07/21/99	ND(97)	NA
N6800 E6100	534	07/21/99	ND(95)	NA
N6900 E6100	535	07/21/99	238±64	NA
N7000 E6077	463	07/20/99	1,052±92	NA
N7100 E6100	464	07/20/99	164±62	191.16
N7100 E6100Dup	466	07/20/99	191±60	NA
N7200 E6100	467	07/20/99	ND(87)	NA
N7300 E6100	468	07/20/99	ND(98)	NA
N7400 E6100	469	07/20/99	ND(71)	NA
N7500 E6100	471	07/20/99	ND(78)	NA
N5000 E6200	59	08/11/99	127±75	153.77
N5300 E6200	47	08/11/99	205±84	NA
N5400 E6200	46	08/11/99	519±111	NA
N5500 E6200	30	08/11/99	ND(91)	NA
N5600 E6200	29	08/11/99	ND(89)	NA
N5700 E6200	28	08/11/99	ND(127)	NA
N5800 E6200	27	08/11/99	117±73	NA
N5900 E6200	26	08/11/99	ND(119)	NA
N6000 E6200	563	07/21/99	191±61	NA
N6100 E6200	561	07/21/99	ND(104)	67.33
N6200 E6200	560	07/21/99	ND(90)	NA
N6300 E6200	557	07/21/99	ND(91)	NA
N6400 E6200	556	07/21/99	ND(75)	NA
N6500 E6200	541	07/21/99	175±64	NA
N6600 E6170	540	07/21/99	1,064±96	1,477.84
N6700 E6200	539	07/21/99	ND(86)	NA
N6800 E6200	537	07/21/99	436±83	527.73
N6800 E6200Dup	538	07/21/99	526±85	NA
N6900 E6200	462	07/20/99	656±57	NA
N7000 E6200	461	07/20/99	214±64	205.82
N7100 E6200	460	07/20/99	109±64	NA
N7200 E6200	459	07/20/99	ND(78)	NA
N7300 E6200	458	07/20/99	ND(80)	NA
N7400 E6200	457	07/20/99	ND(111)	NA
N7500 E6200	456	07/20/99	ND(98)	NA
N5000 E6300	58	08/11/99	ND(98)	NA
N5200 E6300	50	08/11/99	ND(106)	NA
N5300 E6300	49	08/11/99	125±67	NA
N5400 E6300	48	08/11/99	118±78	NA
N5500 E6300	21	08/11/99	96.9±49	NA
N5600 E6300	22	08/11/99	ND(111)	NA
N5700 E6300	23	08/11/99	ND(142)	NA
N5800 E6300	24	08/11/99	89.0±51	26.36
N5900 E6300	25	08/11/99	126±64	NA

Table 3
XRF *In-Situ* and Laboratory Data Summary
National Zinc BTA
Cherryvale, Kansas

Sample Location	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N6000 E6300	564	07/21/99	263±71	NA
N6100 E6300	565	07/21/99	ND(97)	NA
N6200 E6300	566	07/21/99	163±64	NA
N6300 E6300	567	07/21/99	ND(69)	NA
N6400 E6300	568	07/21/99	88.8±57	NA
N6500 E6300	542	07/21/99	81.3±52	NA
N6600 E6300	543	07/21/99	206±65	228.51
N6700 E6300	444	07/20/99	1,221±115	2,925.66
N6800 E6300	445	07/20/99	990±86	NA
N6900 E6300	446	07/20/99	190±63	NA
N7000 E6300	447	07/20/99	76.6±49	NA
N7100 E6300	448	07/20/99	114±65	NA
N7200 E6300	449	07/20/99	ND(68)	NA
N7300 E6300	450	07/20/99	ND(84)	NA
N7400 E6300	451	07/20/99	ND(90)	NA
N7500 E6300	452	07/20/99	ND(97)	NA
N5000 E6400	57	08/11/99	ND(94)	NA
N5100 E6400	51	08/11/99	151±79	NA
N5200 E6400	52	08/11/99	166±103	NA
N5300 E6400	54	08/11/99	104±65	NA
N5400 E6400	55	08/11/99	208±86	NA
N5400 E6400Du	56	08/11/99	218±92	NA
N5500 E6400	19	08/11/99	1,192±129	NA
N5600 E6400	18	08/11/99	171±61	NA
N5700 E6400	16	08/11/99	186±85	NA
N5700 E6400Dup	17	08/11/99	131±76	NA
N5800 E6400	15	08/11/99	ND(81)	NA
N5900 E6400	14	08/11/99	89.7±56	NA
N6100 E6400	7	08/11/99	139±53	NA
N6200 E6400	8	08/11/99	ND(72)	NA
N6300 E6400	9	08/11/99	ND(85)	NA
N6400 E6400	569	07/21/99	129±51	NA
N6500 E6400	10	08/11/99	1,415±142	927.08
N6600 E6400	12	08/11/99	113±59	NA
N6600 E6380	443	07/20/99	3,808±205	3,115.81
N6700 E6400	442	07/20/99	162±59	NA
N6800 E6400	439	07/20/99	223±70	118.71
N6800 E6400Dup	440	07/20/99	144±65	NA
N6900 E6400	438	07/20/99	ND(77)	NA
N7000 E6400	436	07/20/99	ND(136)	NA
N7100 E6400	434	07/20/99	ND(110)	NA
N7200 E6400	433	07/20/99	ND(93)	NA
N7300 E6400	432	07/20/99	ND(105)	16.62
N7400 E6400	431	07/20/99	ND(80)	NA
N7500 E6400	430	07/20/99	ND(93)	NA
N5000 E6462	240	07/07/99	ND(79)	NA
N5100 E6500	178	07/07/99	206±53	NA
N5200 E6500	179	07/07/99	99±37	NA
N5300 E6500	225	07/07/99	99±34	NA
N5400 E6500	226	07/07/99	116±38	NA
N5500 E6500	239	07/07/99	1,176±98	3,289/2,751

Sample #	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N5600 E6500	581	07/21/99	123±72	NA
N5700 E6500	582	07/21/99	90.9±59	NA
N5800 E6500	593	07/21/99	93.8±59	40.03
N5900 E6500	594	07/21/99	ND(88)	NA
N6000 E6500	595	07/21/99	ND(95)	NA
N6100 E6500	605	07/21/99	161±67	84.61
N6100 E6500Dup	606	07/21/99	88.3±56	NA
N6200 E6500	573	07/21/99	113±53	NA
N6300 E6500	572	07/21/99	164±61	NA
N6400 E6500	570	07/21/99	1,552±94	2,198.24
N6400 E6500Dup	571	07/21/99	1,589±136	NA
N6500 E6515	285	07/14/99	857±74	NA
N6600 E6500	288	07/14/99	597±100	NA
N6600 E6505	287	07/14/99	462±65	679.68
N6700 E6500	289	07/14/99	155±54	NA
N6800 E6500	314	07/14/99	ND(66)	19.69
N6900 E6500	337	07/14/99	ND(66)	27.24
N7000 E6500	338	07/14/99	ND(62)	NA
N7100 E6500	358	07/15/99	ND(69)	NA
N7200 E6500	380	07/15/99	ND(63)	NA
N7300 E6500	395	07/15/99	ND(67)	NA
N7400 E6500	397	07/15/99	ND(66)	NA
N7500 E6500	422	07/15/99	ND(67)	NA
N7637 E6500	423	07/15/99	ND(61)	NA
N5000 E6600	176	07/07/99	7,264±314	14,794.17
N5100 E6600	177	07/07/99	134±43	NA
N5200 E6600	180	07/07/99	167±52	NA
N5200 E6600Dup	181	07/07/99	211±52	NA
N5300 E6600	224	07/07/99	180±61	162.18
N5400 E6600	227	07/07/99	1,198±77	NA
N5500 E6600	238	07/07/99	119±45	NA
N5600 E6600	580	07/21/99	ND(67)	NA
N5700 E6600	583	07/21/99	ND(114)	NA
N5800 E6600	592	07/21/99	189±73	NA
N5900 E6600	596	07/21/99	ND(110)	NA
N6000 E6600	604	07/21/99	ND(104)	NA
N6100 E6600	607	07/21/99	211±72	NA
N6200 E6600	611	07/21/99	139±83	NA
N6300 E6600	612	07/21/99	896±101	798.04
N6300 E6600Dup	613	07/21/99	808±99	NA
N6400 E6600	11	08/11/99	3,001±227	2,963.11
N6500 E6600	284	07/14/99	980±101	1,416.74
N6600 E6600	286	07/14/99	105±44	524.96
N6700 E6600	290	07/14/99	ND(81)	NA
N6700 E6600Dup	291	07/14/99	87.2±43	NA
N6800 E6600	315	07/14/99	ND(63)	NA
N6900 E6600	336	07/14/99	ND(64)	NA
N7000 E6600	343	07/14/99	ND(68)	NA
N7100 E6600	359	07/15/99	ND(65)	NA
N7200 E6600	379	07/15/99	ND(69)	NA
N7300 E6600	394	07/15/99	ND(63)	NA

Table 3
XRF *In-Situ* and Laboratory Data Summary
National Zinc BTA
Cherryvale, Kansas

Sample Location	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N7400 E6600	398	07/15/99	ND(68)	NA
N7500 E6600	420	07/15/99	ND(70)	NA
N7500 E6600Dup	421	07/15/99	ND(70)	NA
N5000 E6700	175	07/07/99	139±52	NA
N5100 E6700	184	07/07/99	267±61	NA
N5200 E6700	183	07/07/99	237±52	NA
N5300 E6700	219	07/07/99	223±67	NA
N5400 E6700	228	07/07/99	148±39	NA
N5500 E6700	237	07/07/99	318±47	295.88
N5600 E6700	579	07/21/99	115±65	NA
N5700 E6700	584	07/21/99	ND(124)	NA
N5800 E6700	591	07/21/99	268±63	NA
N5900 E6700	597	07/21/99	95.9±59	NA
N6000 E6700	603	07/21/99	ND(112)	NA
N6100 E6700	608	07/21/99	126±71	NA
N6200 E6700	610	07/21/99	35,700±1668	22,354
N6400 E6700	681	07/22/99	1819±154	NA
N6500 E6700	283	07/14/99	ND(71)	NA
N6600 E6700	293	07/14/99	ND(59)	NA
N6700 E6700	313	07/14/99	ND(71)	NA
N6800 E6700	319	07/14/99	ND(63)	NA
N6900 E6700	335	07/14/99	ND(69)	NA
N7000 E6700	344	07/14/99	ND(68)	NA
N7100 E6700	360	07/15/99	ND(67)	NA
N7200 E6700	378	07/15/99	ND(59)	NA
N7300 E6700	393	07/15/99	ND(64)	NA
N7400 E6700	399	07/15/99	ND(61)	NA
N7500 E6700	419	07/15/99	ND(66)	NA
N5000 E6800	174	07/07/99	ND(79)	NA
N5100 E6800	185	07/07/99	298±67	431.73
N5200 E6800	186	07/07/99	752±90	605
N5300 E6800	216	07/07/99	645±70	559.6
N5300 E6800Dup	218	07/07/99	637±66	NA
N5400 E6800	229	07/07/99	135±52	NA
N5500 E6800	236	07/07/99	182±52	NA
N5600 E6800	578	07/21/99	235±58	2,704
N5700 E6800	585	07/21/99	ND(82)	33.45
N5800 E6800	590	07/21/99	105±64	NA
N5900 E6800	598	07/21/99	155±64	NA
N6000 E6800	602	07/21/99	100±64	NA
N6100 E6800	609	07/21/99	2,044±162	4,399.27
N6200 E6800	683	07/22/99	992±111	889.52
N6300 E6800	682	07/22/99	6,121±325	3,698.77
N6400 E6800	679	07/22/99	1,380±109	1,699.81
N6400 E6800Dup	680	07/22/99	1,534±113	NA
N6500 E6800	282	07/14/99	2,139±155	NA
N6600 E6800	294	07/14/99	276±63	NA
N6700 E6800	312	07/14/99	ND(65)	NA
N6800 E6800	320	07/14/99	ND(67)	NA
N6900 E6800	334	07/14/99	ND(61)	NA
N7000 E6800	345	07/14/99	ND(94)	NA

Sample #	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N7100 E6800	361	07/15/99	ND(66)	NA
N7200 E6800	377	07/15/99	ND(62)	NA
N7300 E6800	392	07/17/99	ND(59)	NA
N7400 E6800	400	07/15/99	ND(69)	32.94
N7500 E6800	418	07/15/99	ND(68)	NA
N5000 E6900	173	07/07/99	111±55	NA
N5100 E6900	172	07/07/99	180±61	NA
N5300 E6900	215	07/07/99	7,916±336	7,892/8,315
N5400 E6900	230	07/07/99	176±65	NA
N5500 E6900	235	07/07/99	236±69	NA
N5600 E6900	577	07/21/99	208±75	NA
N5700 E6900	586	07/21/99	ND(116)	NA
N5800 E6900	589	07/21/99	141±67	NA
N6100 E6900	675	07/22/99	1,252±161	NA
N6200 E6900	676	07/22/99	2,769±206	2,589.55
N6300 E6900	677	07/22/99	1,731±137	NA
N6400 E6900	678	07/22/99	561±95	2,226.91
N6500 E6900	281	07/14/99	1,001±96	1,061/1,303
N6600 E6900	295	07/14/99	710±49	785.23
N6600 E6900Dup	296	07/14/99	519±74	480.28
N6700 E6900	311	07/14/99	ND(71)	NA
N6800 E6900	321	07/14/99	ND(61)	NA
N6900 E6900	333	07/14/99	ND(64)	NA
N7000 E6900	346	07/14/99	ND(77)	NA
N7100 E6900	362	07/15/99	ND(62)	13.87/15.29
N7200 E6900	376	07/15/99	ND(66)	NA
N7300 E6900	391	07/15/99	124±50	28.01
N7400 E6900	401	07/15/99	ND(71)	NA
N7500 E6900	417	07/15/99	ND(70)	NA
N5000 E7000	103	05/26/99	290±50	268
N5000 E7000	190	07/07/99	308±62	239.22
N5100 E7000	171	07/07/99	28,200±1,103	NA
N5300 E7000	214	07/07/99	534±65	412.27
N5400 E7000	231	07/07/99	381±72	275.82
N5400 E7000Dup	233	07/07/99	335±67	NA
N5500 E7000	234	07/07/99	220±46	NA
N5600 E7000	576	07/21/99	201±60	NA
N5700 E7000	587	07/21/99	155±67	NA
N5900 E7000	617	07/22/99	929±90	866.71
N6000 E7000	618	07/22/99	1,638±123	NA
N6100 E7000	619	07/22/99	835±95	775.61
N6200 E7000	620	07/22/99	3,760±177	5,018.98
N6300 E7000	621	07/22/99	692±103	NA
N6400 E7000	622	07/22/99	528±82	529.06
N6500 E7000	275	07/14/99	321±62	248.01
N6600 E7000	297	07/14/99	685±81	NA
N6700 E7000	309	07/14/99	ND(70)	NA
N6700 E7000Dup	310	07/14/99	ND(78)	NA
N6800 E7000	322	07/14/99	ND(73)	63.87
N6900 E7000	332	07/14/99	ND(65)	NA
N7000 E7000	348	07/14/99	ND(66)	NA

Table 3
XRF *In-Situ* and Laboratory Data Summary
National Zinc BTA
Cherryvale, Kansas

Sample Location	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N7100 E7000	363	07/15/99	ND(65)	NA
N7200 E7000	375	07/15/99	ND(58)	6.45
N7300 E7000	388	07/15/99	ND(75)	NA
N7360 E7005	389	07/15/99	ND(87)	NA
N7360 E7005Dup	390	07/15/99	ND(75)	NA
N7400 E7000	402	07/15/99	ND(72)	NA
N7500 E7000	416	07/15/99	71.9±44	NA
N7637 E7000	424	07/15/99	130±60	186.71
N5000 E7100	191	07/07/99	1,768±124	2,081.91
N5000 E7110	104	05/26/99	504±62	431
N5100 E7100	204	07/07/99	442±72	NA
N5100 E7100Dup	205	07/07/99	461±72	NA
N5200 E7100	207	07/07/99	254±64	NA
N5300 E7100	213	07/07/99	516±74	274.36
N5800 E7100	632	07/22/99	2,904±171	3,860.88
N5900 E7100	631	07/22/99	161±56	NA
N6000 E7100	630	07/22/99	4,012±176	3,878.81
N6100 E7100	627	07/22/99	1,537±182	3,231.70
N6200 E7100	625	07/22/99	854±82	678.64
N6200 E7100Dup	626	07/22/99	837±91	NA
N6300 E7100	624	07/22/99	457±93	NA
N6400 E7100	623	07/22/99	702±105	NA
N6500 E7100	273	07/14/99	867±84	1,716.60
N6600 E7100	298	07/14/99	ND(71)	NA
N6700 E7100	308	07/14/99	ND(70)	30.09
N6800 E7100	323	07/14/99	ND(73)	NA
N6900 E7100	331	07/14/99	ND(70)	NA
N7000 E7100	349	07/14/99	ND(66)	24.61
N7000 E7100Dup	350	07/14/99	ND(65)	NA
N7100 E7100	364	07/15/99	ND(68)	NA
N7200 E7100	374	07/15/99	ND(60)	NA
N7300 E7100	387	07/15/99	ND(70)	NA
N7400 E7100	403	07/15/99	152±55	114.37
N7400 E7100Dup	404	07/15/99	151±51	NA
N7500 E7100	415	07/15/99	ND(67)	19.21
N5000 E7190	192	07/07/99	2,462±139	NA
N5000 E7190Dup	194	07/07/99	2,576±143	NA
N5100 E7200	203	07/07/99	1,084±109	NA
N5200 E7200	208	07/07/99	351±61	379.03
N5300 E7200	212	07/07/99	101±54	NA
N5700 E7200	633	07/22/99	3,096±166	3,892.40
N5800 E7200	634	07/22/99	652±88	NA
N5900 E7200	635	07/22/99	1,742±153	NA
N6000 E7200	636	07/22/99	3,616±226	1,320.63
N6100 E7200	638	07/22/99	1,905±144	1,091.30
N6200 E7200	639	07/22/99	3,179±179	NA
N6300 E7200	640	07/22/99	1,116±145	NA
N6400 E7200	641	07/22/99	1,995±171	1,043.69
N6400 E7200Dup	642	07/22/99	1,809±175	NA
N6500 E7200	271	07/14/99	620±77	NA
N6600 E7200	299	07/14/99	232±63	NA

Sample #	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N6700 E7200	307	07/14/99	ND(65)	NA
N6800 E7200	324	07/14/99	ND(65)	NA
N6900 E7200	330	07/14/99	ND(61)	NA
N7000 E7200	351	07/14/99	ND(71)	NA
N7100 E7200	365	07/15/99	ND(62)	NA
N7200 E7200	373	07/15/99	ND(67)	NA
N7300 E7200	386	07/15/99	ND(65)	NA
N7400 E7200	405	07/15/99	ND(60)	NA
N7500 E7200	414	07/15/99	ND(71)	NA
N5000 E7300	195	07/07/99	126±58	NA
N5100 E7300	202	07/07/99	151±54	NA
N5200 E7300	209	07/07/99	341±59	478.34
N5300 E7300	211	07/07/99	95.6±61	NA
N5600 E7300	652	07/22/99	3,475±252	NA
N5700 E7300	651	07/22/99	5,721±316	6,771.72
N5800 E7300	650	07/22/99	3,044±193	4,312.29
N5900 E7300	648	07/22/99	748±92	NA
N6000 E7300	647	07/22/99	727±96	705.58
N6100 E7300	646	07/22/99	3,625±216	505.71
N6200 E7300	645	07/22/99	1,219±160	NA
N6300 E7300	644	07/22/99	1,766±111	NA
N6400 E7300	643	07/22/99	781±121	NA
N6500 E7300	272	07/14/99	723±95	NA
N6603 E7300	300	07/14/99	474±66	398.68
N6700 E7300	306	07/14/99	69.0±44	ND(5.0)
N6800 E7300	325	07/14/99	ND(70)	NA
N6900 E7300	327	07/14/99	ND(67)	NA
N7000 E7300	353	07/14/99	ND(69)	NA
N7100 E7300	366	07/15/99	ND(68)	NA
N7200 E7300	371	07/15/99	ND(68)	NA
N7300 E7300	385	07/15/99	ND(67)	NA
N7400 E7300	407	07/15/99	ND(67)	NA
N7500 E7300	413	07/15/99	ND(65)	NA
N5000 E7400	196	07/07/99	126±49	65.15
N5100 E7400	200	07/07/99	186±51	NA
N5200 E7400	201	07/07/99	271±52	274.37
N5300 E7400	210	07/07/99	282±56	NA
N5500 E7400	653	07/22/99	1,297±123	1,744.70
N5600 E7400	654	07/22/99	3,827±181	4,358.10
N5700 E7400	655	07/22/99	5,628±299	7,797/7,357
N5800 E7400	656	07/22/99	1,018±94	1,583.68
N5800 E7400Dup	657	07/22/99	1,106±90	NA
N5900 E7400	659	07/22/99	345±93	NA
N6000 E7400	660	07/22/99	1,681±147	NA
N6100 E7400	661	07/22/99	3,401±201	3,018.89
N6200 E7400	662	07/22/99	1,341±131	NA
N6300 E7400	663	07/22/99	690±98	507.23
N6400 E7400	664	07/22/99	1,562±114	1,260/1,148
N6500 E7400	270	07/14/99	744±71	1,080.51
N6600 E7400	301	07/14/99	ND(67)	NA
N6700 E7400	305	07/14/99	ND(66)	NA

Table 3
XRF *In-Situ* and Laboratory Data Summary
National Zinc BTA
Cherryvale, Kansas

Sample Location	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N6800 E7400	326	07/14/99	ND(75)	NA
N6900 E7400	329	07/14/99	ND(64)	NA
N7000 E7400	354	07/14/99	ND(68)	NA
N7100 E7400	367	07/15/99	ND(71)	NA
N7100 E7400Dup	368	07/15/99	ND(65)	NA
N7200 E7400	370	07/15/99	ND(79)	NA
N7300 E7400	384	07/15/99	ND(70)	27.24
N7400 E7400	408	07/15/99	71.9±46	17.16
N7500 E7400	412	07/15/99	ND(68)	NA
N5000 E7500	197	07/07/99	ND(67)	NA
N5100 E7500	199	07/07/99	205±58	NA
N5200 E7500	115	08/12/99	235±61	NA
N5400 E7500	670	07/22/99	311±78	NA
N5500 E7500	671	07/22/99	3,382±235	2,172.82
N5500 E7500Dup	672	07/22/99	3,280±237	2,143.55
N5600 E7500	673	07/22/99	708±94	1,954.60
N5700 E7500	674	07/22/99	1,998±138	NA
N5800 E7500	668	07/22/99	2,241±134	NA
N5900 E7500	667	07/22/99	2,923±167	1,951.87
N6500 E7500	267	07/14/99	394±65	4,475.16
N6600 E7500	266	07/14/99	ND(72)	NA
N6700 E7500	264	07/14/99	ND(72)	NA
N6800 E7500	263	07/14/99	ND(76)	NA
N6900 E7500	256	07/13/99	ND(67)	NA
N6900 E7500Dup	257	07/13/99	ND(83)	NA
N7000 E7500	255	07/13/99	ND(86)	NA
N7100 E7500	254	07/13/99	ND(88)	NA
N7200 E7500	253	07/13/99	ND(68)	NA
N7300 E7500	252	07/13/99	ND(80)	NA
N7400 E7500	251	07/13/99	ND(88)	NA
N7500 E7500	250	07/13/99	ND(88)	NA
N7637 E7500	425	07/15/99	ND(75)	24.53
N7637 E7500Dup	426	07/15/99	ND(81)	NA
N5889 E7563	666	07/22/99	1,020±91	NA
N5889 E7574	665	07/22/99	1,526±99	NA
N6500 E7600	268	07/14/99	357±59	NA
N7500 E7600	248	07/13/99	ND(74)	NA
N5000 E7640	198	07/07/99	99±50	NA
N6500 E7700	269	07/14/99	293±58	NA
N7500 E7700	249	07/13/99	ND(76)	NA
N6000 E7755	873	07/29/99	379±70	NA
N6500 E7755	871	07/29/99	122±76	58.15
N6500 E7755Dup	872	07/29/99	ND(109)	NA
N7000 E7755	870	07/29/99	ND(109)	NA
N7500 E7755	869	07/29/99	ND(109)	NA
N7637 E7755	247	07/13/99	ND(93)	NA
N7637 E7755	868	07/29/99	ND(98)	NA

Source: KDHE/BER Site Assessment Unit—Department of Health & Environment Laboratory

Comments: ppm = parts per million
mg/kg = milligrams per kilogram
ND() = Not detected with detection limits
in parenthesis
NA = Not analyzed
Laboratory samples collected August 11 & 12, 1999
XRF analysis by EPA Method 6200
DHEL analysis by EPA Method 6010

Table 4
XRF *In-Situ* Data Comparison with Laboratory Data
National Zinc BTA
Cherryvale, Kansas

Sample Location	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N6400 E5028	812	07/28/99	948	904.43
N6600 E5025	799	07/28/99	250	208.66
N6800 E5025	789	07/28/99	130	110.7
N5600 E5100	95	08/12/99	309	300.27
N6900 E5100	785	07/28/99	ND(73)	40.21
N5900 E5200	103	08/12/99	ND(116)	129.84
N6000 E5200	839	07/28/99	260	87.69
N6300 E5200	822	07/28/99	ND(100)	60.63
N5100 E5300	69	08/11/99	139	31.6
N6200 E5300	826	07/28/99	124	92.61
N6600 E5400	806	07/28/99	ND(126)	46.43
N5400 E5500	37	08/11/99	574	110.42
N5500 E5500	847	07/29/99	281	339
N5800 E5500	844	07/29/99	433	429.22
N6500 E5500	694	07/27/99	167	57.01
N7000 E5500	523/525	07/21/99	119/ND(82)	48.03
N7637 E5500	867	07/29/99	ND(90)	86.7
N5200 E5600	78/79	08/11/99	163/247	87.83
N5900 E5600	858/859	07/29/99	350/380	67.69
N6000 E5600	737	07/28/99	275	84.48
N6900 E5600	705	07/27/99	259	211.93
N7400 E5600	515/516	07/21/99	145/130	223.37
N6000 E5700	748	07/28/99	107	161.15
N6900 E5700	706	07/27/99	373	275.84
N7100 E5700	508	07/21/99	ND(126)	53.11
N6400 E5800	753/754	07/28/99	213/247	264.16
N7100 E5800	496	07/20/99	131	97.51
N5700 E5900	770/771	07/28/99	191/151	84.84
N6800 E5900	718	07/27/99	904	457.83
N6800 E5900Dup	719	07/27/99	719	230
N7300 E5900	486/487	07/20/99	789/775	1,013.30
N6700 E6000	528	07/21/99	693	806.63
N7200 E6000	480	07/20/99	224	1,073.86
N7500 E6000	473	07/20/99	ND(72)	41.3
N5315 E6100	43/44	08/11/99	1501/1656	2,195.34
N6300 E6100	553/554	07/21/99	167/130	106.07
N7100 E6100	464/466	07/20/99	164/191	191.16
N5000 E6200	59	08/11/99	127	153.77
N6100 E6200	561	07/21/99	ND(104)	67.33
N6600 E6170	540	07/21/99	1,064	1,477.84
N6800 E6200	537/538	07/21/99	436/526	527.73
N7000 E6200	461	07/20/99	214	205.82
N5800 E6300	24	08/11/99	89	26.36
N6600 E6300	543	07/21/99	206	228.51
N6700 E6300	444	07/20/99	1,221	2,925.66
N6500 E6400	10	08/11/99	1,415	927.08
N6600 E6380	443	07/20/99	3,808	3,115.81
N6800 E6400	439/440	07/20/99	223/144	118.71
N7300 E6400	432	07/20/99	ND(105)	16.62
N5500 E6500	239	07/07/99	1,176	3,020
N5800 E6500	593	07/21/99	93.8	40.03
N6100 E6500	605/606	07/21/99	161/88.3	84.61
N6400 E6500	570/571	07/21/99	1,552/1,589	2,198.24
N6600 E6505	287	07/14/99	462	679.68

Table 4
XRF *In-Situ* Data Comparison with Laboratory Data
National Zinc BTA
Cherryvale, Kansas

Sample Location	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N6800 E6500	314	07/14/99	ND(66)	19.69
N6900 E6500	337	07/14/99	ND(66)	27.24
N5000 E6600	176	07/07/99	7,264	14,794.17
N5300 E6600	224	07/07/99	180	162.18
N6300 E6600	612/613	07/21/99	896/808	798.04
N6400 E6600	11	08/11/99	3,001	2,963.11
N6500 E6600	284	07/14/99	980	1,416.74
N6600 E6600	286	07/14/99	105	524.96
N5500 E6700	237	07/07/99	318	295.88
N6200 E6700	610	07/21/99	35,700	22,354.00
N5100 E6800	185	07/07/99	298	431.73
N5200 E6800	186	07/07/99	752	605
N5300 E6800	216/218	07/07/99	645/637	559.6
N5600 E6800	578	07/21/99	235	2704
N5700 E6800	585	07/21/99	ND(82)	33.45
N6100 E6800	609	07/21/99	2,044	4,399.27
N6200 E6800	683	07/22/99	992	889.52
N6300 E6800	682	07/22/99	6,121	3,698.77
N6400 E6800	679/680	07/22/99	1,380/1,534	1,699.81
N7400 E6800	400	07/15/99	ND(69)	32.94
N5300 E6900	215	07/07/99	7,916	8,103.50
N6200 E6900	676	07/22/99	2,769	2,589.55
N6400 E6900	678	07/22/99	561	2,226.91
N6500 E6900	281	07/14/99	1,001	1,182
N6600 E6900	295	07/14/99	710	785.23
N6600 E6900Dup	296	07/14/99	519	480.28
N7100 E6900	362	07/15/99	ND(62)	14.58
N7300 E6900	391	07/15/99	124	28.01
N5000 E7000	103	05/26/99	290	268
N5000 E7000	190	07/07/99	308	239.22
N5300 E7000	214	07/07/99	534	412.27
N5400 E7000	231/233	07/07/99	381/335	275.82
N5900 E7000	617	07/22/99	929	866.71
N6100 E7000	619	07/22/99	835	775.61
N6200 E7000	620	07/22/99	3,760	5,018.98
N6400 E7000	622	07/22/99	528	529.06
N6500 E7000	275	07/14/99	321	248.01
N6800 E7000	322	07/14/99	ND(73)	63.87
N7200 E7000	375	07/15/99	ND(58)	6.45
N7637 E7000	424	07/15/99	130	186.71
N5000 E7100	104	05/26/99	504	431
N5000 E7100	191	07/07/99	1,768	2,081.91
N5300 E7100	213	07/07/99	516	274.36
N5800 E7100	632	07/22/99	2,904	3,860.88
N6000 E7100	630	07/22/99	4,012	3,878.81
N6100 E7100	627	07/22/99	1,537	3,231.70
N6200 E7100	625/626	07/22/99	854/837	678.64
N6500 E7100	273	07/14/99	867	1,716.60
N6700 E7100	308	07/14/99	ND(70)	30.09
N7000 E7100	349	07/14/99	ND(66)	24.61
N7400 E7100	403	07/15/99	152	114.37
N7500 E7100	415	07/15/99	ND(67)	19.21
N5200 E7200	208	07/07/99	351	379.03
N5700 E7200	633	07/22/99	3,096	3,892.80

Table 4
XRF *In-Situ* Data Comparison with Laboratory Data
National Zinc BTA
Cherryvale, Kansas

Sample Location	Niton Entry #	XRF Date Analyzed	XRF Lead Results ppm	DHEL Lead Results mg/kg
N6000 E7200	636	07/22/99	3,616	1,320.63
N6100 E7200	638	07/22/99	1,905	1,091.30
N6400 E7200	641	07/22/99	1,995	1,043.69
N5200 E7300	209	07/07/99	341	478.34
N5700 E7300	651	07/22/99	5,721	6,771.72
N5800 E7300	650	07/22/99	3,044	4,312.29
N6000 E7300	647	07/22/99	727	705.58
N6100 E7300	646	07/22/99	3,625	505.71
N6603 E7300	300	07/14/99	474	398.68
N6700 E7300	306	07/14/99	69	2.5
N5000 E7400	196	07/07/99	126	65.15
N5200 E7400	201	07/07/99	271	274.37
N5500 E7400	653	07/22/99	1,297	1,744.70
N5600 E7400	654	07/22/99	3,827	4,358.10
N5700 E7400	655	07/22/99	5,628	7,577
N5800 E7400	656	07/22/99	1,018	1,583.68
N6100 E7400	661	07/22/99	3,401	3,018.89
N6300 E7400	663	07/22/99	690	507.23
N6400 E7400	664	07/22/99	1,562	1,204
N6500 E7400	270	07/14/99	744	1,080.51
N7300 E7400	384	07/15/99	ND(70)	27.24
N7400 E7400	408	07/15/99	71.9	17.16
N5500 E7500	671	07/22/99	3,382	2,172.82
N5500 E7500Dup	672	07/22/99	3,280	2,143.55
N5600 E7500	673	07/22/99	708	1,954.60
N5900 E7500	667	07/22/99	2,923	1,951.87
N6500 E7500	267	07/14/99	394	4,475.16
N7637 E7500	425	07/15/99	ND(75)	24.53
N6500 E7755	871	07/29/99	122	58.15

Source: KDHE/BER Site Assessment Unit—Department of Health & Environmental Laboratory

Comments: ppm = parts per million
mg/kg = milligrams per kilogram
ND() = not detected with detection limit in parenthesis
Laboratory samples were collected August 11 & 12, 1999
Values used for the regression analyses were 50% of the ND
and the duplicate values were averaged
____/____ = duplicate results
XRF analysis by EPA Method 6200
DHEL analysis by EPA Method 6010

Regression Output:

Constant	-193.334413925
Std Err of Y Est	1444.58524172
R Squared	0.81171023556
No. of Observations	137
Degrees of Freedom	135
X Coefficient(s)	1.1038526916
Std Err of Coef.	0.0457569514

Table 5
 Laboratory Total Metal Results for Surficial Soils
 National Zinc BTA
 Cherryvale, Kansas

Sample Location	Arsenic mg/kg	Barium mg/kg	Cadmium mg/kg	Chromium mg/kg	Lead mg/kg	Selenium mg/kg	Silver mg/kg
N6200 E7100	9.76	220.89	28.82	28.88	678.64	<5.00	<1.00
N6500 E7100	36.24	192.57	76.01	26.35	1,716.60	<5.00	1.21
N6700 E7100	<5.00	223.48	5.95	26.56	30.09	<5.00	<1.00
N7000 E7100	7.25	268.78	2.57	36.31	24.61	<5.00	<1.00
N7400 E7100	8.47	245.82	12.4	33.37	114.37	<5.00	<1.00
N7500 E7100	5.72	349.03	1.25	35.77	19.21	<5.00	<1.00
N5200 E7200	6.54	193.02	14.7	28.13	379.03	<5.00	<1.00
N5700 E7200	51.01	294.76	122.89	30.32	3,892.40	<5.00	6.51
N6000 E7200	16.31	140.55	22.58	30.01	1,320.63	<5.00	<1.00
N6100 E7200	17.96	156.2	29.96	34.67	1,091.30	<5.00	<1.00
N6400 E7200	9.68	111.95	31.26	30.80	1,043.69	<5.00	<1.00
N5200 E7300	7.25	149.34	18.04	23.35	478.34	<5.00	<1.00
N5700 E7300	265.25	583.07	236.55	46.52	6,771.72	<5.00	28.92
N5800 E7300	118.66	354.05	188.76	36.63	4,312.29	<5.00	13.66
N6000 E7300	19.95	156.53	30.07	50.29	705.58	<5.00	<1.00
N6100 E7300	14.74	148.85	39.24	21.28	505.71	<5.00	<1.00
N6603 E7300	11.76	119.3	12.85	27.38	398.68	<5.00	15.72
N6700 E7300	11.12	196.14	1.12	34.45	<5.00	<5.00	<1.00
N5000 E7400	5.51	206.05	3.56	27.8	65.15	<5.00	<1.00
N5200 E7400	5.11	121.6	17.64	19.84	274.37	<5.00	<1.00
N5500 E7400	54.26	137.55	75.59	33.33	1,744.70	<5.00	4.7
N5600 E7400	58.01	213.78	144.72	32.28	4,358.10	5.77	5.48
N5700 E7400	291	283.56	180.12	43.25	7,797	<5.00	15.09
N5700 E7400Dup	279.24	311.97	151.15	41.2	7,358	<5.00	14.7
N5800 E7400	34.68	186.86	97.52	31.3	1,583.68	<5.00	2.31
N6100 E7400	34.7	201.52	114.07	33.15	3,018.89	<5.00	4.01
N6300 E7400	14.36	148.67	42.47	30.97	507.23	<5.00	<1.00
N6400 E7400	30.04	206.12	43.04	29.78	1,260.46	<5.00	2.28
N6400 E7400Dup	26.64	207.38	39.84	24.89	1,148.71	<5.00	2.23
N6500 E7400	28.72	188.06	25.05	50.6	1,080.51	<5.00	<1.00
N7300 E7400	9.55	360.95	1.49	38.2	27.24	<5.00	<1.00
N7400 E7400	<5.00	269.99	1.19	36.81	17.16	<5.00	11.82
N5500 E7500	33.26	169.82	95.76	29.61	2,172.82	<5.00	1.32
N5500 E7500Dup	34.38	168.76	89.93	33.99	2,143.55	<5.00	1.61
N5600 E7500	17.47	218.11	67.16	26.94	1,954.60	<5.00	1.17
N5900 E7500	27.35	178.5	68.18	28.94	1,951.87	<5.00	2.0
N6500 E7500	18.28	150.46	23.19	29.82	4,475.16	<5.00	5.41
N7637 E7500	7.27	200.02	1.89	38.36	24.53	<5.00	<1.00
N6500 E7755	19.46	111.45	2.72	24.2	58.15	<5.00	<1.00

Source: Compiled by KDHE/BER Site Assessment Unit/Lab data generated by Dept of Health & Environmental Laboratory EPA 6010

Comments: mg/kg = milligrams per kilogram
 < = Less than
 Sample were collected on August 11 & 12, 1999
 Analysis by EPA Method 6010

Table 6
 Comparison of Toxicity Characteristic Leachate Procedure (TCLP) Results
 with XRF Results and Total Metal Results
 National Zinc BTA
 Cherryvale, Kansas

Sample Location	TCLP Lead mg/l	<i>in-Situ</i> XRF Lead ppm	Total Lead mg/kg	TCLP Cadmium mg/l	Total Cadmium mg/kg
N6400 E5028	0.633	948±94	904.43	6.451	295.21
N6400 E6500	8.687	1,552±94	2,198.24	5.992	147.29
N5000 E6600	283	7,264±314	14,794.17	3.546	103
N5300 E6900A	69.29	7,916±336	8,315	2.679	86.12
N5300 E6900B	169	NA	7,892	3.227	85.96
N6000 E7100	15.28	4,012±176	3,878.81	1.382	50.93
N5700 E7200	14.75	3,096±166	3,892.40	2.445	122.89
N5700 E7300	42.33	5,721±316	6,771.72	3.927	236.55
N6200 E6700**	118.927	10,000±609	17,101	70.247	1,488.19
Composite #1	288.796	NA	20,751.81	8.146	286.44
Composite #3	2.155	NA	1,007.38	1.085	55.87
Composite #4	123	NA	83,010.29	6.696	419.91

Source: KDHE/BER Site Assessment Unit--DHEL

Comments: ppm = parts per million
 mg/l = milligrams per liter
 mg/kg = milligrams per kilogram
 NA = not analyzed
 Samples were collected on August 11 & 12, 1999
 **Resampled on 12/20/99 due to laboratory inconsistencies
 Composite #1 a composite of S15 and S15 Duplicate collected on May 25, 1999
 Composite #3 a composite of S7, S11, and S18 collected on May 25, 1999
 Composite #4 a composite of S4(5-6"), S6(5-6"), and S15(5-6") collected on May 25, 1999
 Total lead and cadmium analyzed by EPA Method 6010

Table 7
 Toxicity Characteristic Leachate Procedure (TCLP) Laboratory Results
 National Zinc BTA
 Cherryvale, Kansas

Sample Location	Arsenic mg/l	Barium mg/l	Cadmium mg/l	Chromium mg/l	Lead mg/l	Mercury mg/l	Selenium mg/l	Silver mg/l
N6400 E5028	<0.05	1.83	6.451	<0.01	0.633	<0.0005	<0.05	<0.01
N6900 E5700	<0.05	0.528	0.069	<0.01	0.113	<0.0005	<0.05	<0.01
N6800 E6200	<0.05	1.33	0.107	<0.01	0.306	0.0007	<0.05	<0.01
N6400 E6500	<0.05	1.561	5.992	<0.01	8.687	<0.0005	0.085	<0.01
N5000 E6600	<0.05	1.472	3.546	<0.01	283	<0.0005	0.103	0.014
N6400 E6600	0.121	0.472	0.011	<0.01	0.449	0.0016	0.051	<0.01
N6200 E6700	<0.05	0.428	0.104	<0.01	0.436	0.0028	0.215	<0.01
N6300 E6800	<0.05	0.995	0.576	<0.01	4.598	<0.0005	<0.05	<0.01
N5300 E6900A	<0.05	2.18	2.679	<0.01	69.29	<0.0005	0.99	0.48
N5300 E6900B	<0.05	2.65	3.227	<0.01	169	<0.0005	0.203	0.015
N6500 E6900	<0.05	1.425	0.777	<0.01	0.933	<0.0005	<0.05	<0.01
N5300 E7000	<0.05	1.533	0.212	<0.01	0.366	<0.0005	<0.05	<0.01
N5000 E7100	<0.05	2.312	0.508	<0.01	3.142	<0.0005	<0.05	<0.01
N6000 E7100	0.05	2.3	1.382	<0.01	15.28	<0.0005	0.077	<0.01
N6200 E7100	<0.05	2.274	0.629	<0.01	0.598	<0.0005	0.076	<0.01
N5200 E7200	<0.05	2.105	0.13	<0.01	0.133	<0.0005	<0.05	0.025
N5700 E7200	0.07	2.854	2.445	<0.01	14.75	<0.0005	0.09	<0.01
N6000 E7200	0.055	1.645	0.502	<0.01	3.132	<0.0005	0.078	<0.01
N5700 E7300	0.078	5.773	3.927	<0.01	42.33	<0.0005	0.086	<0.01
N6200 E6700**	<0.05	1.798	70.247	0.012	118.927	<0.0005	<0.05	<0.01
Composite #1	<0.05	1.805	8.146	<0.01	288.796	0.0007	0.176	<0.01
Composite #2	<0.05	2.321	0.086	<0.01	0.387	<0.0005	<0.05	<0.01
Composite #3	<0.05	2.085	1.085	<0.01	2.155	<0.0005	<0.05	<0.01
Composite #4	<0.05	0.672	6.696	0.076	123	0.0005	0.349	<0.01

Source: KDHE/BER Site Assessment Unit-Data generated by Department of Health & Environmental Laboratory ICP/MS

Comment: mg/l = milligrams per liter

< = Less than

Samples were collected on August 11 & 12, 1999

Bold values indicate a TCLP exceedence for cadmium (1.0 mg/l) or lead (5.0 mg/l) as established in § 261.24 of RCRA

Analysis by EPA Method 1311

**Resampled on 12/20/99 due to laboratory inconsistencies

Composite #1 a composite of S15 and S15 Duplicate collected on May 25, 1999

Composite #2 a composite of S3, S5, and S14 collected on May 25, 1999

Composite #3 a composite of S7, S11, and S18 collected on May 25, 1999

Composite #4 a composite of S4(5-6"), S6(5-6"), and S15(5-6") collected on May 25, 1999

Table 8
 Laboratory Results for Surface & Ground Water Samples
 National Zinc BTA
 Cherryvale, Kansas

Sample Location	Date Collected	Arsenic mg/l	Barium mg/l	Cadmium mg/l	Chromium mg/l	Lead mg/l	Selenium mg/l	Silver mg/l
SW1	05/26/99	0.063	2.00	2.965	0.066	1.789	<0.05	<0.01
SW2	05/26/99	<0.05	0.134	0.079	<0.01	<0.05	<0.05	<0.01
SW3	05/26/99	<0.05	0.025	0.364	<0.01	<0.05	<0.05	<0.01
SW4	05/26/99	<0.05	0.087	0.088	<0.01	<0.05	<0.05	<0.01
SW5	05/26/99	<0.05	0.064	0.037	<0.01	<0.05	<0.05	<0.01
SW6	05/26/99	<0.05	0.076	0.034	<0.01	<0.05	<0.05	<0.01
SW7	05/26/99	<0.05	0.069	0.049	<0.01	<0.05	<0.05	<0.01
SW8	05/26/99	<0.05	0.068	0.051	<0.01	<0.05	<0.05	<0.01
SW9	05/26/99	<0.05	0.061	0.053	<0.01	<0.05	<0.05	<0.01
SW10	05/26/99	<0.05	0.062	0.031	<0.01	0.091	<0.05	<0.01
SW11	05/26/99	<0.05	0.047	<0.005	<0.01	<0.05	<0.05	<0.01
SW11 Dup	05/26/99	<0.05	0.041	<0.005	<0.01	<0.05	<0.05	0.014
MW1	05/26/99	<0.05	0.005	0.1	<0.01	<0.05	<0.05	<0.01
MW2 Shallow	05/26/99	<0.05	0.052	0.931	<0.01	<0.05	<0.05	<0.01
MW2 Deep	05/26/99	<0.05	0.058	<0.005	<0.01	<0.05	<0.05	<0.01
MW3	05/26/99	<0.05	0.016	0.12	<0.01	<0.05	<0.05	<0.01
MW4	05/26/99	<0.05	0.013	0.005	<0.01	<0.05	<0.05	<0.01
TW1	08/25/99	<0.05	0.043	<0.005	<0.01	<0.05	<0.05	<0.01
TW2	08/25/99	<0.05	0.026	<0.005	<0.01	<0.05	<0.05	<0.01
TW3	08/25/99	<0.05	0.02	3.062	0.14	0.136	<0.05	0.113
TW4	08/25/99	<0.05	0.035	0.855	<0.01	<0.05	<0.05	0.011
TW5	08/25/99	<0.05	0.008	0.057	<0.01	<0.05	<0.05	0.016
TW9	08/25/99	<0.05	0.078	<0.005	<0.01	<0.05	<0.05	<0.01

Source: KDHE/BER Site Assessment Unit-Data generated by Department of Health & Environmental Laboratory

Comment: mg/l = milligrams per liter
 < = Less than
 MW = Monitoring well
 SW = Surface water sample
 TW = Temporary monitoring well
 Analysis by EPA Method 6010

Table 9
 Laboratory Results for Sediment Samples
 National Zinc BTA
 Cherryvale, Kansas

Sample Location	Date Collected	Arsenic mg/kg	Barium mg/kg	Cadmium mg/kg	Chromium mg/kg	Lead mg/kg	Selenium mg/kg	Silver mg/kg
SED 1	05/26/99	<5.00	45.45	52.55	5.02	178.45	<5.00	<1.0
SED 2	05/26/99	<5.00	39.99	30.83	5.21	72.08	<5.00	<1.0
SED 3	05/26/99	12.64	232.85	86.47	33.92	425.28	<5.00	<1.0
SED 4	05/26/99	12.83	420.13	55.63	29.43	178.17	<5.00	<1.0
SED 5	05/26/99	10.6	293.9	36.06	19.6	245.13	<5.00	1.58
SED 6	05/26/99	10.97	301.36	88.42	31.39	450.03	<5.00	<1.0
SED 7	05/26/99	34.83	133.38	24.26	15.98	166.18	<5.00	3.87
SED 8	05/26/99	20.85	119.37	21.48	13.35	211.64	<5.00	2.08
SED 9	05/26/99	35.62	193.63	24.21	29.99	211.62	<5.00	8.81
SED 10	05/26/99	6.76	158.93	18.21	13.84	419.65	<5.00	<1.0
SED 11	05/26/99	289.82	47.77	27.55	27.65	668.24	<5.00	14.64

Source: KDHE/BER Site Assessment Unit-Data generated by Department of Health & Environmental Laboratory

Comment: mg/kg = milligrams per kilogram
 < = Less than
 SED = Sediment
 Analysis by EPA Method 6010

Table 10
Quality Assurance/Quality Control(QA/QC) Parameters Summary
for Field XRF Data
National Zinc BTA
Cherryvale, Kansas

Date Analyzed	HIGH STD		MED STD		Field Duplicates		
	ppm	% Diff	ppm	% Diff	1st Value	2nd Value	RSD
07/07/99	5625	1.68	1061	-8.69	2462	2576	2.26
	5363	-3.05	1027	-11.62	442	461	2.1
	5596	1.16	1065	-8.35	645	637	0.62
	5612	1.45			381	335	6.42
	5472	-1.08					
	5555	0.42					
07/13/99	5523	-0.16	1175	1.12	<67	<83	
	5472	-1.08	1155	-0.6			
07/14/99	5318	-3.87	1191	2.3	<81	87.2	
	5500	-0.58	1209	4.04	710	519	15.54
	5622	1.63	1184	1.89	<70	<78	
	5782	4.52	1091	-6.11	<66	<65	
	5308	-4.05	1048	-9.81			
	5481	-0.92	1125	-3.18			
07/15/99	5756	4.05	1054	-9.29	<71	<65	
	5526	-0.11	1028	-11.53	<87	<75	
	5379	-2.77	1107	-4.73	152	151	0.33
			1168	0.52	<70	<70	
		1170	0.69				
07/20/99	5548	0.29	1168	0.52	223	144	21.53
	5808	4.99	1144	-1.55	164	191	7.61
	5600	1.23	1124	-3.27	789	775	0.9
	5420	-2.02					
	5568	0.65					
07/21/99	5500	-0.58	1126	-3.1	145	130	5.45
	5408	-2.24	1106	-4.82	119	<82	
	5523	-0.16	1124	-3.27	436	526	9.36
	5507	-0.45	1156	-0.52	167	130	12.46
	5526	-0.11	1087	-6.45	1552	1589	1.18
	5526	-0.11	1056	-9.12	161	88.3	29.16
					896	808	5.16
07/22/99	5468	-1.16	1188	2.24	854	837	1.01
	5395	-2.48	1088	-6.37	1995	1809	4.89
	5468	-1.16	1110	-4.48	1018	1106	4.14
	5408	-2.24			3382	3280	1.53
					1380	1534	5.28
07/27/99	5081	-8.15	1113	-4.22	167	115	18.44
	5500	-0.58	1048	-9.81	97.8	95.7	1.09
	5462	-1.27			904	719	11.4
	5315	-3.92					
07/28/99	5644	2.02	1040	-10.5	189	107	27.7
	5548	0.29	1060	-8.78	213	247	7.39
			1148	-1.2	191	151	11.7
			1139	-1.98	101	<78	
			1108	-4.65	250	256	1.19
			1148	-1.2	948	1024	3.85
			1092	-6.02	124	136	4.62
07/29/99	5241	-5.26	1160	-0.17	260	245	2.97
	5497	-0.63	1123	-3.36	146	132	5.04
	5372	-2.89			350	380	4.11
	5372	-2.89					
	5344	-3.4					
08/11/99	5312	-3.98	1136	-2.24	139	<72	
	5696	2.96	1095	-5.77	186	131	17.35
	5542	0.18	1088	-6.37	574	559	1.32
	5600	1.23	1100	-5.34	1501	1656	4.91
	5404	-2.31			208	218	2.35
					163	247	20.49
					142	109	13.15
08/12/99	5516	-0.29	1100	-5.34	309	293	2.66
	5360	-3.11					

Source: KDHE/BER Site Assessment Unit

Avg RSD 7.66

Comments: Value of High STD = 5532 ppm
Value of Med STD = 1162 ppm
ppm = parts per million
% Diff = Percent difference between actual value of standard and the determined value calculated according to EPA Method 6200 guidance
RSD = Relative standard deviation between successive field duplicates calculated according to EPA Method 6200 guidance

**NATIONAL ZINC SITE
CHERRYVALE, KANSAS**

APPENDIX A

Hazardous Substance Characteristics

CADMIUM AND COMPOUNDS⁽¹⁾

Hazard Summary

- The acute (short-term) effects of cadmium in humans through inhalation exposure consist mainly of **effects on the lung, such as pulmonary irritation**.
- The **kidney** is the major target organ in humans following chronic inhalation and oral exposure. Cadmium is a cumulative toxicant in some organs such as the kidney; the cessation of exposure does not lead to a decrease in effect.
- The U.S. Environmental Protection Agency (EPA) has not established a Reference Concentration (RfC) for cadmium.
- The Reference Dose (RfD) for cadmium in drinking water is 0.0005 mg/kg/d and the RfD for cadmium in food is 0.001 mg/kg/d.^a EPA estimates that consumption of these levels or less, over a lifetime, would not likely result in the occurrence of chronic noncancer effects.^b
- Cadmium has been shown to be a developmental toxicant in animals, resulting in **fetal malformations and other effects**, but no conclusive evidence exists in humans. These effects could be seen from acute, as well as chronic exposures.
- Human and animal studies have seen an increase in **lung cancer** from long-term inhalation exposure to cadmium. EPA has classified cadmium as a Group B1, **probable human carcinogen of medium carcinogenic hazard**, with a 1/ED₁₀ value of 58 per (mg/kg)/d^c and an inhalation unit risk estimate of $1.8 \times 10^{-3} (\mu\text{g}/\text{m}^3)^{-1}$.

^a Milligrams per kilogram per day is one way to measure the amount of the contaminant that is consumed in food.

^b The RfD is not a direct estimator of risk but rather a reference point to gauge the potential effects. Exceedance of the RfD does not imply that an adverse health effect would necessarily occur. As the amount and frequency of exposures exceeding the RfD increase, the probability of adverse health effects also increases.

^c The 1/ED₁₀ value is a measure of the carcinogenic potency of a chemical. The value reported here has been proposed in the hazard ranking of hazardous air pollutants in EPA's proposed rulemaking (Section 112(g) of the Clean Air Act, April 1994).

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (IRIS), which contains information on oral chronic toxicity and the RfD, and the carcinogenic effects of cadmium including the unit cancer risk for inhalation exposure, and the Agency for Toxic Substances and Disease Registry's (ATSDR's) *Toxicological Profile for Cadmium*. Other secondary sources include the Hazardous Substances Data Bank (HSDB), a database of summaries of peer-reviewed literature, and the Registry of Toxic Effects of Chemical Substances (RTECS), a database of toxic effects that are not peer reviewed.

Environmental/Occupational Exposure

- The largest airborne sources of cadmium in the environment are the burning of fossil fuels such as coal or oil and the incineration of municipal waste materials. Cadmium may also escape into the air from zinc, lead, or copper smelters. (1)
- Exposure to cadmium may also occur through food. Application of phosphate fertilizers or sewage sludge may increase the cadmium levels in soil, which, in turn, can cause increased cadmium levels in food. (1)
- Smoking is another important source of cadmium. Smokers have about twice as much cadmium in their bodies as do nonsmokers. (1)
- Cadmium has been listed as a pollutant of concern to EPA's Great Waters Program due to its persistence in the environment, potential to bioaccumulate, and toxicity to humans and the environment. (2)

Assessing Personal Exposure

- The amount of cadmium present in blood or urine can be measured by atomic absorption spectrophotometry and used as an indication of cadmium exposure. (1)
- A more precise method, called neutron activation analysis, can be used to measure cadmium concentrations in the liver or kidney. This method gives a very useful indication of the amount of cadmium in the body; however it is usually too costly and inconvenient for routine use. (1)

Health Hazard Information

Acute Effects:

- Acute (short-term) inhalation exposure to high levels of cadmium in humans may result in effects on the lung, such as bronchial and pulmonary irritation. A single acute exposure to high levels of cadmium can result in long-lasting impairment of lung function. (1,3,4)
- Cadmium is considered to have high acute toxicity, based on short-term animal tests such as the LC₅₀ test in rats. (5)
- EPA's Office of Air Quality Planning and Standards, for a hazard ranking under Section 112(g) of the Clean Air Act Amendments, considers cadmium oxide to be a "high concern" pollutant based on severe acute toxicity. (6)

Chronic Effects (Noncancer):

- Chronic (long-term) inhalation and oral exposure to cadmium in humans affects the kidney, with proteinuria, a decrease in glomerular filtration rate, and an increased frequency of kidney stone formation noted. (1,3,4)
- Other effects noted from chronic exposure to cadmium in air in humans are effects on the lung, including bronchiolitis and emphysema. (1,3,4)
- Chronic inhalation or oral exposure to cadmium in animals results in effects on the kidney, liver, lung, bone, immune system, blood, and nervous system. (1,3)
- The RfD for cadmium in drinking water is 0.0005 mg/kg/d and the RfD for dietary exposure to cadmium is 0.001 mg/kg/d; both are based on significant proteinuria in humans. (7)
- EPA has not ranked the confidence level of the study on which the RfD was based since the choice of no-observed-adverse-effect level (NOAEL) does not reflect the information from any single study; rather, it reflects the data obtained from many studies on the toxicity of cadmium in both humans and animals. These data also permit calculation of pharmacokinetic parameters of cadmium absorption, distribution, metabolism, and elimination. EPA has ranked high confidence in the database due to these data; and, consequently, high confidence in both RfDs. (7)
- EPA has not established an RfC for cadmium. (7)

Reproductive/Developmental Effects:

- Human developmental studies on cadmium are limited, although there is some evidence to suggest that maternal cadmium exposure may result in decreased birthweights. (1)

- Animal studies provide evidence that cadmium has developmental effects, such as low fetal weight, skeletal malformations, interference with fetal metabolism, and impaired neurological development, via inhalation and oral exposure. (1,3,4)
- Oral exposure may cause reproductive effects in humans, but only at high levels of exposure. Limited evidence exists for an association between inhalation exposure and reproductive effects. (1)
- Some developmental effects, such as impaired neurobehavioral development, and reproductive effects, such as decreased reproduction and testicular damage, have been noted in oral animal studies. (1)
- Reproductive or developmental effects could occur as the result of acute as well as chronic exposures. (1)

Cancer Risk:

- Several occupational studies have reported an excess risk of lung cancer from exposure to inhaled cadmium. However, the evidence is limited rather than conclusive due to confounding factors. (1,3,7)
- Animal studies have reported cancer resulting from inhalation exposure to several forms of cadmium, while animal ingestion studies have not seen cancer from exposure to cadmium compounds. (1,3,7)
- EPA considers cadmium to be a probable human carcinogen (cancer-causing agent) and has classified it as a Group B1 carcinogen. (7)
- EPA uses mathematical models, based on animal studies, to estimate the probability of a person developing cancer from breathing air containing a specified concentration of a chemical. EPA calculated an inhalation unit risk estimate of $1.8 \times 10^{-3}(\mu\text{g}/\text{m}^3)^{-1}$. EPA estimates that, if an individual were to breathe air containing cadmium at $0.0006 \mu\text{g}/\text{m}^3$ * over his or her entire lifetime, that person would theoretically have no more than a one-in-a-million increased chance of developing cancer as a direct result of breathing air containing this chemical. Similarly, EPA estimates that breathing air containing $0.006 \mu\text{g}/\text{m}^3$ would result in not greater than a one-in-a-hundred thousand increased chance of developing cancer, and air containing $0.06 \mu\text{g}/\text{m}^3$ would result in not greater than a one-in-ten thousand increased chance of developing cancer. (7)
- EPA's Office of Air Quality Planning and Standards, for a hazard ranking under Section 112(g) of the Clean Air Act Amendments, has ranked cadmium in the nonthreshold category. The $1/\text{ED}_{10}$ value is 58 per (mg/kg)/d and this would place it in the medium category under Superfund's ranking for carcinogenic hazard. (6)

Physical Properties

- Cadmium is a soft silver-white metal that is usually found in combination with other elements. (1)
- Cadmium compounds range in solubility in water from quite soluble to practically insoluble. (1)
- The chemical symbol for cadmium is Cd and the atomic weight is 112.41 g/mol. (1)

Uses

- Most cadmium used in the United States today is obtained as a byproduct from the smelting of zinc, lead, or copper ores. (1)
- Cadmium is used to manufacture pigments and batteries and in the metal-plating and plastics industries. (1)

*Micrograms per cubic meter is the unit of measurement for chemicals in air.

Conversion Factors:

To convert from ppm to mg/m^3 : $\text{mg}/\text{m}^3 = (\text{ppm}) \times (\text{molecular weight of the compound})/(24.45)$. For

cadmium: 1 ppm = 4.6 mg/m³.

Health Data from Inhalation Exposure

Concentration (mg/m ³)	Health numbers ^a	Regulatory, advisory numbers ^b	Reference
1,000.0			
-- -- -- -- 100.0	<ul style="list-style-type: none"> • LC₅₀ (rats) (500 mg/m³) 		5
-- -- -- -- 10.0		<ul style="list-style-type: none"> • NIOSH IDLH (cadmium dusts or fumes) (40 mg/m³) 	1,2
-- -- -- -- 1.0			
-- -- -- -- 0.1		<ul style="list-style-type: none"> • OSHA PEL (cadmium dust) (0.2 mg/m³) • OSHA PEL (cadmium fumes) (0.1 mg/m³) 	1,3 1,3
-- -- -- -- 0.01		<ul style="list-style-type: none"> • ACGIH TLV (cadmium dust and cadmium oxide) (0.05 mg/m³) 	1,3
--			

0.001			
0.0001			
0.00001			
0.000001			
0.0000001	<ul style="list-style-type: none"> EPA Cancer Risk Level (1 in-a-million excess lifetime risk) = 6×10^{-7} mg/m³ 		7

ACGIH TLV--American Conference of Governmental and Industrial Hygienists' threshold limit value expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effects.

LC₅₀ (Lethal Concentration₅₀)--A calculated concentration of a chemical in air to which exposure for a specific length of time is expected to cause death in 50% of a defined experimental animal population.

NIOSH IDLH--National Institute of Occupational Safety and Health's immediately dangerous to life and health; NIOSH concentration representing the maximum level of a pollutant from which an individual could escape within 30 minutes without escape-impairing symptoms or irreversible health effects.

OSHA PEL--Occupational Safety and Health Administration's permissible exposure limit expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effect averaged over a normal 8-h workday or a 40-h workweek.

^a Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.

^b Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are nonregulatory values provided by the Government or other groups as advice.

References

1. Agency for Toxic Substances and Disease Registry (ATSDR). *Toxicological Profile for Cadmium*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. 1992.
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3. E.J. Calabrese and E.M. Kenyon. *Air Toxics and Risk Assessment*. Lewis Publishers, Chelsea, MI. 1991.
4. U.S. Department of Health and Human Services. Hazardous Substances Data Bank (HSDB, online database). National Toxicology Information Program, National Library of Medicine, Bethesda, MD. 1993.
5. U.S. Department of Health and Human Services. Registry of Toxic Effects of Chemical Substances (RTECS, online database). National Toxicology Information Program, National Library of Medicine, Bethesda, MD. 1993.
6. U.S. Environmental Protection Agency. *Technical Background Document to Support Rulemaking Pursuant to the Clean Air Act--Section 112(g). Ranking of Pollutants with Respect to Hazard to Human Health*. EPA-450/3-92-010. Emissions Standards Division, Office of Air Quality Planning and Standards, Research Triangle Park, NC. 1994.
7. U.S. Environmental Protection Agency. *Integrated Risk Information System (IRIS) on Cadmium*. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH. 1993.

1. * This fact sheet discusses cadmium and cadmium compounds. Most of the information is on cadmium, except in those cases where there are differences in toxicity between cadmium and cadmium compounds. In these cases, information on the cadmium compound is presented.

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[Contact UATW Webmaster](#)
May 18, 1998

ARSENIC AND COMPOUNDS⁽¹⁾

107-02-8

Hazard Summary

- Acute (short-term) inhalation exposure to inorganic arsenic has resulted in gastrointestinal effects (nausea, diarrhea, abdominal pain), **hemolysis, and central and peripheral nervous system disorders. Arsine is extremely toxic to humans, with a half-hour exposure to 25 to 50 ppm reported to be lethal.**
- Chronic (long-term) inhalation exposure to inorganic arsenic in humans is associated with **irritation of the skin and mucous membranes** (dermatitis, conjunctivitis, pharyngitis, and rhinitis), while chronic oral exposure has resulted in **gastrointestinal effects, anemia, peripheral neuropathy, skin lesions, and liver or kidney damage.**
- The U.S. Environmental Protection Agency (EPA) has not established a Reference Concentration (RfC) for inorganic arsenic. The RfC for arsine is 0.00005 mg/m³.^a EPA estimates that inhalation of this concentration or less over a lifetime would not likely result in the occurrence of chronic noncancer effects.^b
- The Reference Dose (RfD) for inorganic arsenic is 0.0003 mg/kg/d.^c EPA estimates that consumption of this dose or less over a lifetime would not likely result in the occurrence of chronic noncancer effects. EPA has not established an RfD for arsine.
- Human data suggest a relationship between inhalation exposure to inorganic arsenic in humans and an increased risk of reproductive effects, such as spontaneous abortions. However, these data are not sufficient to suggest a cause and effect relationship, due to the chance that other chemicals and risk factors were involved. Oral animal studies have reported inorganic arsenic to be fetotoxic and to cause birth defects.
- Inorganic arsenic exposure in humans, by the inhalation route, has been shown to be strongly associated with lung cancer, while ingestion of inorganic arsenic in humans has been linked to a form of skin cancer and also to bladder, liver, and lung cancer. EPA has classified inorganic arsenic as a Group A, human carcinogen of high carcinogenic hazard, with a 1/ED10 value of 140 per (mg/kg)/dd and an inhalation unit risk estimate of 4.3 x 10⁻³ (µg/m³)-1. EPA has not classified arsine for carcinogenicity.

^a Milligrams per cubic meter is the unit of measurement for chemicals in air.

^b The RfC is not a direct estimator of risk but rather a reference point to gauge the potential effects. Exceedance of the RfC does not imply that an adverse health effect would necessarily occur. As the amount and frequency of exposures exceeding the RfC increase, the probability of adverse health effects also increases.

^c Milligrams per kilogram per day is one way to measure the amount of the contaminant that is consumed in food.

^d The 1/ED10 value is a measure of the carcinogenic potency of a chemical. The value reported here has

been proposed in the hazard ranking of hazardous air pollutants in EPA's proposed rulemaking (Section 112(g) of the Clean Air Act,

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (IRIS), which contains information on inhalation chronic toxicity and the RfC for arsine, oral chronic toxicity and the RfD for inorganic arsenic, and the carcinogenic effects of inorganic arsenic including the unit cancer risk for inhalation exposure, and the Agency for Toxic Substances and Disease Registry's (ATSDR's) *Toxicological Profile for Arsenic*. Other secondary sources include the Hazardous Substances Data Bank (HSDB), a database of summaries of peer-reviewed literature, and the Registry of Toxic Effects of Chemical Substances (RTECS), a database of toxic effects that are not peer reviewed.

Environmental/Occupational Exposure

- Inorganic arsenic is found throughout the environment; it is released into the air by volcanoes, the weathering of arsenic-containing minerals and ores, and by commercial or industrial processes. (1,2)
- For most people, food is the largest source of inorganic arsenic exposure (about 25 to 50 µg/d), with lower amounts coming from drinking water and air. (1)
- Elevated levels of inorganic arsenic may be present in soil, either from natural mineral deposits or contamination from human activities, which may lead to dermal or ingestion exposure. (1)
- Workers in metal smelters and nearby residents may be exposed to elevated inorganic arsenic levels from arsenic released into the air. (1)
- Most accidents in industry have involved the conversion of inorganic arsenic to arsine gas. (3)
- Other sources of inorganic arsenic exposure include burning plywood treated with an arsenic wood preservative or dermal contact with wood treated with arsenic. (2)

Assessing Personal Exposure

- Measurement of inorganic arsenic in the urine is the best way to determine recent exposure (within the last 1 to 2 days), while measuring inorganic arsenic in hair or fingernails may be used to detect chronic exposures. (1)

Health Hazard Information

Acute Effects:

- Acute (short-term) inorganic arsenic exposure, via inhalation, in humans, may result in gastrointestinal effects (nausea, diarrhea, abdominal pain), hemolysis, and central and peripheral nervous system disorders. (3)
- Acute oral exposure to inorganic arsenic, at doses of approximately 600 µg/kg/d or higher in humans, has resulted in death. Oral exposure to lower levels of inorganic arsenic has resulted in effects on the gastrointestinal tract (nausea, vomiting), central nervous system (CNS) (headaches, weakness, delirium), cardiovascular system (hypotension, shock), liver, kidney, and blood (anemia, leukopenia). (1,2)
- Acute inhalation exposure to arsine by humans has resulted in death; it has been reported that a half-hour exposure to 25 to 50 ppm can be lethal. (4)
- The major effects from acute arsine exposure in humans include hemolytic anemia, hemoglobinuria, and jaundice; these effects can lead to kidney failure. (4)
- Acute animal tests, such as the LD₅₀ test in rats and mice, have shown inorganic arsenic to have moderate to high acute toxicity, while arsine has extreme acute toxicity. (5)
- EPA's Office of Air Quality Planning and Standards, for a hazard ranking under Section 112(g) of the Clean Air Act Amendments, considers arsine to be a "high-concern" pollutant based on severe acute toxicity. (6)

Chronic Effects (Noncancer):

- Chronic, inhalation exposure to inorganic arsenic in humans is associated with irritation of the

- skin and mucous membranes (dermatitis, conjunctivitis, pharyngitis, and rhinitis). (1,2)
- Chronic, oral exposure to inorganic arsenic in humans has resulted in gastrointestinal effects, anemia, peripheral neuropathy, skin lesions, hyperpigmentation, gangrene of the extremities, vascular lesions, and liver or kidney damage. (1,2)
- No chronic inhalation exposure studies have been performed in animals for any inorganic arsenic compound or for arsine. (1)
- Some studies have suggested that inorganic arsenic is an essential nutrient in goats, chicks, mini pigs, and rats. However, no comparable data are available for humans. (4,7,8)
- EPA has not established an RfC for inorganic arsenic. (7)
- The RfC for arsine is 0.00005 mg/m^3 based on increased hemolysis, abnormal red blood cell morphology, and increased spleen weight in rats, mice, and hamsters. (4)
- EPA has high confidence in the studies on which the RfC for arsine was based because the sample sizes were adequate, statistical significance was reported, concentration dose-response relationships were documented, three species were investigated, and both a no-observed-adverse-effect level (NOAEL) and a lowest-observed-adverse-effect level (LOAEL) were identified; medium confidence in the database because there are three inhalation animal studies and a developmental/reproductive study, but no data on human exposure; and, consequently, medium confidence in the RfC. (4)
- The RfD for inorganic arsenic is 0.0003 mg/kg/d based on hyperpigmentation, keratosis, and possible vascular complications in humans. (7)
- EPA has medium confidence in the study on which the RfD for inorganic arsenic was based because an extremely large number of people were included in the assessment (>40,000) but the doses were not well-characterized and other contaminants were present; medium confidence in the database because the supporting human toxicity database is extensive but somewhat flawed; and, consequently, medium confidence in the RfD. (7)
- EPA has not established an RfD for arsine. (4)

Reproductive/Developmental Effects:

- Several studies suggest that women who work in, or live near, metal smelters may have higher than normal spontaneous abortion rates, and their children may exhibit lower than normal birthweights. However, these studies are limited because they were designed to evaluate the effects of smelter pollutants in general, and are not specific for inorganic arsenic. (1)
- Human studies have indicated higher than expected spontaneous abortion rates in women in the microelectronics industry who were exposed to arsine. However, these studies have several limitations, including small sample size and exposure to other chemicals in addition to arsine. (4)
- Inorganic arsenic can cross the placenta in humans, exposing the fetus to the chemical. (2)
- Oral animal studies have reported inorganic arsenic at very high doses to be fetotoxic and to cause birth defects. (1)

Cancer Risk:

- Human, inhalation studies have reported inorganic arsenic exposure to be strongly associated with lung cancer. (1,2,7)
- Ingestion of inorganic arsenic in humans has been associated with an increased risk of nonmelanoma skin cancer and also to an increased risk of bladder, liver, and lung cancer. (1,7)
- Animal studies have not associated inorganic arsenic exposure via the oral route with cancer, and no cancer inhalation studies have been performed for inorganic arsenic or for arsine. (1)
- EPA has classified inorganic arsenic as a Group A, human carcinogen. (7)
- EPA has not classified arsine for carcinogenicity. (4)
- EPA used a mathematical model, using data from an occupational study of arsenic-exposed copper smelter workers, to estimate the probability of a person developing cancer from breathing air containing a specified concentration of arsenic. EPA calculated an inhalation unit risk estimate of $4.3 \times 10^{-3}(\mu\text{g/m}^3)^{-1}$. EPA estimates that, if an individual were to breathe air containing inorganic arsenic at $0.0002 \mu\text{g/m}^3$, over his or her entire lifetime, that person would theoretically have no more than a one-in-a-million increased chance of developing cancer as a direct result of breathing

air containing this chemical. Similarly, EPA estimates that breathing air containing $0.002 \mu\text{g}/\text{m}^3$ would result in not greater than a one-in-a-hundred thousand increased chance of developing cancer, and air containing $0.02 \mu\text{g}/\text{m}^3$ would result in not greater than a one-in-ten thousand increased chance of developing cancer. (7)

- EPA's Office of Air Quality Planning and Standards, for a hazard ranking under Section 112(g) of the Clean Air Act Amendments, has ranked inorganic arsenic in the nonthreshold category. The $1/\text{ED}_{10}$ value is 140 per $(\text{mg}/\text{kg})/\text{d}$ and this would place it in the high category under Superfund's ranking for carcinogenic hazard. (6)

Physical Properties

- Inorganic arsenic is a naturally occurring element in the earth's crust. (1)
- Pure inorganic arsenic is a gray-colored metal, but inorganic arsenic is usually found combined with other elements such as oxygen, chlorine, and sulfur. (1)
- The chemical symbol for inorganic arsenic is As, and it has an atomic weight of $74.92 \text{ g}/\text{mol}$. (3)
- The chemical formula for arsine is AsH₃, and it has a molecular weight of $77.93 \text{ g}/\text{mol}$. (8)

Uses

- The major use for inorganic arsenic is in wood preservation; arsine is used in the microelectronics industry and in semiconductor manufacture. (2)
- Until the 1940s, inorganic arsenic solutions were widely used in the treatment of various diseases, such as syphilis and psoriasis. Inorganic arsenic is still used as an antiparasitic agent in veterinary medicine and in homeopathic and folk remedies in the United States and other countries. (2)

Conversion Factors:

To convert from ppm to mg/m^3 : $\text{mg}/\text{m}^3 = (\text{ppm}) \times (\text{molecular weight of the compound})/(24.45)$. For inorganic arsenic: $1 \text{ ppm} = 3.06 \text{ mg}/\text{m}^3$.

For arsine: $1 \text{ ppm} = 3.19 \text{ mg}/\text{m}^3$.

To convert from $\mu\text{g}/\text{m}^3$ to mg/m^3 : $\text{mg}/\text{m}^3 = (\mu\text{g}/\text{m}^3) \times (1 \text{ mg}/1,000 \mu\text{g})$.

Health Data from Inhalation Exposure

Concentration (mg/m^3)	Health numbers ^a	Regulatory, advisory numbers ^b	Reference
1.0			
--		• ACGIH TLV ($0.2 \text{ mg}/\text{m}^3$)	9
--			
--			
0.1			
--		• OSHA PEL ($0.01 \text{ mg}/\text{m}^3$)	9
--			
--			

0.01			
0.001		<ul style="list-style-type: none"> • NIOSH REL (15-min ceiling) (0.002 mg/m³) 	9
0.0001			
0.00001			
0.000001			
0.0000001	<ul style="list-style-type: none"> • EPA Cancer Risk Level (1×10^{-6} excess lifetime risk) = 2×10^{-7} mg/m³ 		7

ACGIH TLV--American Conference of Governmental and Industrial Hygienists' threshold limit value expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effects.

NIOSH REL--National Institute of Occupational Safety and Health's recommended exposure limit; NIOSH-recommended exposure limit for an 8- or 10-h time-weighted-average exposure and/or ceiling.

OSHA PEL--Occupational Safety and Health Administration's permissible exposure limit expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effect averaged over a normal 8-h workday or a 40-h workweek.

^a Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.

^b Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are nonregulatory values provided by the Government or other groups as advice.

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1. Agency for Toxic Substances and Disease Registry (ATSDR). *Toxicological Profile for Arsenic* (Draft). U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. 1989.
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3. U.S. Environmental Protection Agency. *Health Assessment Document for Inorganic Arsenic*. EPA/540/1-86/020. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Washington, DC. 1984.
4. U.S. Environmental Protection Agency. *Integrated Risk Information System (IRIS) on Arsenic*. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH. 1993.
5. U.S. Department of Health and Human Services. Registry of Toxic Effects of Chemical Substances (RTECS, online database). National Toxicology Information Program, National Library of Medicine, Bethesda, MD. 1993.
6. U.S. Environmental Protection Agency. *Technical Background Document to Support Rulemaking Pursuant to the Clean Air Act--Section 112(g). Ranking of Pollutants with Respect to Hazard to Human Health*. EPA-450/3-92-010. Emissions Standards Division, Office of Air Quality Planning and Standards, Research Triangle Park, NC. 1994.
7. U.S. Environmental Protection Agency. *Integrated Risk Information System (IRIS) on Arsenic*. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH. 1993.
8. M. Windolz. *The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals*. 10th ed. Merck and Co., Rahway, NJ. 1983.
9. E.J. Calabrese and E.M. Kenyon. *Air Toxics and Risk Assessment*. Lewis Publishers, Chelsea, MI. 1991.

1. * This fact sheet addresses the toxicity of the inorganic arsenic compounds as well as the toxicity of the gaseous arsenic trihydride: arsine.

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[Contact UATW Webmaster](#)
May 18, 1998



CHROMIUM AND COMPOUNDS

Hazard Summary

Chromium (VI) compounds are much more toxic than chromium (III) compounds.

Chromium (III) is an **essential element in humans**, with a daily intake of 50 to 200 $\mu\text{g}/\text{d}$ recommended for an adult. The body can detoxify some amount of chromium VI to chromium III.

The respiratory tract is the major target organ for both chromium (VI) and chromium (III) toxicity, for acute (short-term) and chronic (long-term) inhalation exposures. The effects seem to be similar, although chromium (III) is less toxic. Dyspnea, coughing, and wheezing were reported from a case of acute exposure to chromium (VI), while perforations and ulcerations of the septum, bronchitis, decreased pulmonary function, pneumonia, and other respiratory effects have been noted from chronic exposure.

The Reference Dose (RfD) for chromium (VI) is 0.005 $\text{mg}/\text{kg}/\text{d}$ ^a and the RfD for chromium (III) is 1 $\text{mg}/\text{kg}/\text{d}$. The U.S. Environmental Protection Agency (EPA) estimates that consumption of these doses or less over a lifetime would not likely result in the occurrence of chronic noncancer effects.^b

The Reference Concentrations (RfC) for chromium (III) and chromium (VI) are under review by EPA.

Limited human studies suggest that chromium (VI) exposure may be associated with complications during pregnancy and childbirth, while animal studies have not reported reproductive effects from inhalation exposure to chromium (VI). Oral animal studies have reported developmental and reproductive effects in mice from chromium (VI) exposure.

Human studies have clearly established that inhaled chromium is a human carcinogen, resulting in an increased risk of lung cancer. Animal studies have shown chromium VI to cause lung tumors via inhalation exposure. EPA has classified chromium (VI) as a Group A, human carcinogen of high carcinogenic hazard, with a 1/ED10 value of 390 per $(\text{mg}/\text{kg})/\text{dc}$ and an inhalation unit risk estimate of $1.2 \times 10^{-2} (\mu\text{g}/\text{m}^3)^{-1}$. EPA has classified chromium (III) as a Group D, not classifiable as to carcinogenicity in humans.

^a Milligrams per kilogram per day is one way to measure the amount of the contaminant that is consumed in food.

^b The RfD is not a direct estimator of risk but rather a reference point to gauge the potential effects. Exceedance of the RfD does not imply that an adverse health effect would necessarily occur. As the amount and frequency of exposures exceeding the RfD increase, the probability of adverse health effects also increases.

^c The 1/ED10 value is a measure of the carcinogenic potency of a chemical. The value reported here has been proposed in the hazard ranking of hazardous air pollutants in EPA's proposed rulemaking (Section 112(g) of the Clean Air Act, April 1994).

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (IRIS), which contains information on oral chronic toxicity and the RfD, and the carcinogenic effects of chromium including the unit cancer risk for inhalation exposure, EPA's *Health Assessment Document for Chromium*, and the Agency for Toxic Substances and Disease Registry's (ATSDR's) *Toxicological Profile for Chromium*. Other secondary sources include the Hazardous Substances Data Bank (HSDB), a database of summaries of peer-reviewed literature, and the Registry of Toxic Effects of Chemical Substances (RTECS), a database of toxic effects that are not peer reviewed.

Environmental/Occupational Exposure

Chromium occurs in the environment in two major valence states, trivalent chromium (Cr III) and hexavalent chromium (Cr VI). (1)

The general population is exposed to chromium (generally chromium [III]) by eating food, drinking water, and inhaling air that contains the chemical. The average daily intake from air, water, and food is estimated to be approximately 0.01 to 0.03 μg , 2.0 ppb, and 60 μg , respectively. (1)

Dermal exposure to chromium may occur during the use of consumer products that contain chromium, such as wood treated with copper dichromate or leather tanned with chromic sulfate. (1)

Occupational exposure to chromium occurs from chromate production, stainless-steel production, chrome plating, and working in tanning industries; occupational exposure can be two orders of magnitude higher than exposure to the general population. (1)

People who live in the vicinity of chromium waste disposal sites or chromium manufacturing and processing plants have a greater probability of elevated chromium exposure than the general population. These exposures are generally to mixed chromium (VI) and chromium (III). (1)

Chromium (III) is essential to normal glucose, protein, and fat metabolism and is thus an essential dietary element. The body has several systems for reducing chromium (VI) to chromium (III). This chromium (VI) detoxification leads to increased levels of chromium (III). (1)

Assessing Personal Exposure

Laboratory tests can detect chromium in the blood, urine, and hair of exposed individuals. (1-3)

Laboratory tests find it difficult to separate chromium VI from chromium III; in many cases analysis is done for total chromium. (1)

Health Hazard Information

Acute Effects:

Chromium (VI) is much more toxic than chromium (III), for both acute (short-term) and chronic (long-term) exposures. (1-3)

Chromium (III) is an essential element in humans, with a daily intake of 50 to 200 $\mu\text{g}/\text{d}$ recommended for adults. (1)

The respiratory tract is the major target organ for chromium (VI) following inhalation exposure in humans. Dyspnea, coughing, and wheezing were reported in cases where an individual inhaled very high concentrations of chromium trioxide. (1)

Other effects noted from acute inhalation exposure to very high concentrations of chromium (VI) include gastrointestinal and neurological effects, while dermal exposure causes skin burns. (1-3)

Acute animal tests, such as the LC_{50} and LD_{50} tests in rats, have shown chromium (VI) to have extreme

toxicity from inhalation and oral exposure, while chromium (III) has been shown to have moderate toxicity from oral exposure. (1,4)

Chronic Effects (Noncancer)

Chronic inhalation exposure to chromium (VI) in humans results in effects on the respiratory tract, with perforations and ulcerations of the septum, bronchitis, decreased pulmonary function, pneumonia, asthma, and nasal itching and soreness reported. (1-3)

Chronic exposure to high levels of chromium (VI) by inhalation or oral exposure may produce effects on the liver, kidney, gastrointestinal and immune systems, and possibly the blood. (1-3)

Rat studies have shown that, following inhalation exposure, the lung and kidney have the highest tissue levels of chromium. (1,2)

Dermal exposure to chromium (VI) may cause contact dermatitis, sensitivity, and ulceration of the skin. (1-3)

The RfD for chromium (VI) is 0.005 mg/kg/d based on no effects noted in rats exposed to chromium in the drinking water. (5)

EPA has low confidence in the study on which the RfD for chromium (VI) was based because a small number of animals were tested, a small number of parameters were measured, and no toxic effects were noted at the highest dose tested; low confidence in the database because the supporting studies are of equally low quality and teratogenic and reproductive endpoints are not well studied; and, consequently, low confidence in the RfD. (5)

The RfD for chromium (III) is 1 mg/kg/d based on no effects observed in rats exposed to chromium (III) in the diet. (5)

EPA has low confidence in the study on which the RfD for chromium (III) was based due to the lack of explicit detail on study protocol and results; low confidence in the database due to the lack of high-dose supporting data; and low confidence in the RfD due to the above, as well as the lack of an observed-effect-level. (5)

The RfCs for chromium (VI) and chromium (III) are under review by EPA. (5)

Reproductive/Developmental Effects:

Limited information on the reproductive effects of chromium (VI) in humans by inhalation exposure suggest that exposure to chromium (VI) may result in complications during pregnancy and childbirth. (1)

Animal studies have not reported reproductive effects from inhalation exposure to chromium (VI). Oral studies have reported severe developmental effects in mice such as gross abnormalities and reproductive effects including decreased litter size, reduced sperm count, and degeneration of the outer cellular layer of the seminiferous tubules. (1)

Cancer Risk:

Epidemiological studies of workers have clearly established that inhaled chromium is a human carcinogen, resulting in an increased risk of lung cancer. These studies were not able to differentiate between exposure to chromium (III) and chromium (VI) compounds. (1,3,5)

Animal studies have shown chromium (VI) to cause lung tumors via inhalation exposure. (1)

EPA has classified chromium (VI) as a Group A, human carcinogen, and chromium (III) as a Group D,

not classifiable as to carcinogenicity in humans. (2,5)

EPA used a mathematical model, based on data from an occupational study of chromate production workers, to estimate the probability of a person developing cancer from breathing air containing a specified concentration of chromium. EPA calculated an inhalation unit risk estimate of $1.2 \times 10^{-2} (\mu\text{g}/\text{m}^3)^{-1}$. EPA estimates that, if an individual were to breathe air containing chromium at $0.00008 \mu\text{g}/\text{m}^3$ over his or her entire lifetime, that person would theoretically have no more than a one-in-a-million increased chance of developing cancer as a direct result of breathing air containing this chemical. Similarly, EPA estimates that breathing air containing $0.0008 \mu\text{g}/\text{m}^3$ would result in not greater than a one-in-a-hundred thousand increased chance of developing cancer, and air containing $0.008 \mu\text{g}/\text{m}^3$ would result in not greater than a one-in-ten-thousand increased chance of developing cancer. (5)

EPA's Office of Air Quality Planning and Standards, for a hazard ranking under Section 112(g) of the Clean Air Act Amendments, has ranked chromium (VI) in the nonthreshold category. The $1/\text{ED}_{10}$ value is 390 per (mg/kg)/d and this would place it in the high category under Superfund's ranking for carcinogenic hazard. (3)

Physical Properties

Chromium is a naturally occurring element found in rocks, animals, plants, soil, and in volcanic dust and gases. (1)

The metal, chromium (Cr), is a steel-gray solid with a high melting point and an atomic weight of 51.996 g/mol. (1)

Chromium forms a large number of compounds, in both the chromium (III) and the chromium (VI) forms. The chromium (III) compounds are sparingly soluble in water, while the chromium (VI) compounds are readily soluble in water. (1)

Uses

The metal chromium is used mainly for making steel and other alloys. (1)

Chromium compounds, in either the chromium (III) or chromium (VI) forms, are used for chrome plating, the manufacture of dyes and pigments, leather and wood preservation, and treatment of cooling tower water. Smaller amounts are used in drilling muds, textiles, and toner for copying machines. (1)

Conversion Factors:

To convert from ppm to mg/m^3 : $\text{mg}/\text{m}^3 = (\text{ppm}) \times (\text{molecular weight of the compound})/(24.45)$. For chromium: $1 \text{ ppm} = 2.12 \text{ mg}/\text{m}^3$.

To convert from $\mu\text{g}/\text{m}^3$ to mg/m^3 : $\text{mg}/\text{m}^3 = (\mu\text{g}/\text{m}^3) \times (1 \text{ mg}/1,000 \mu\text{g})$.

Health Data from Inhalation Exposure

Concentration (mg/m^3)	Health numbers ^a	Regulatory, advisory numbers ^b	Reference
100.0			

--	LC ₅₀ (rats) (chromium trioxide) (87 mg/m ³)	1
--		1
--	LC ₅₀ (rats) (Cr VI) (45 mg/m ³)	
10.0		
--	OSHA PEL (Cr metal and insoluble compounds) (1 mg/m ³)	6
--		
1.0		
--	OSHA PEL (Cr II and Cr III compounds) and ACGIH TLV (Cr metal and Cr II & Cr III) (0.5 mg/m ³)	
--		
--	NIOSH REL (ceiling) (chromic acid) (0.2 mg/m ³)	
0.1		
--	ACGIH TLV (water soluble Cr VI compounds) and NIOSH REL (chromic acid) (0.05 mg/m ³)	6
--		6
--	NIOSH REL (other Cr VI compounds) (0.025 mg/m ³)	
0.01		
--	NIOSH REL (carc. Cr VI compounds) (0.001 mg/m ³)	6
--		
--		
0.001		
--		
--		
--		
0.0001		

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0.00001

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0.000001

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0.0000001

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EPA Cancer Risk Level
(1-in-a-million excess lifetime
risk) = 8×10^{-8} mg/m³

5

--

--

--

0.00000001

ACGIH TLV--American Conference of Governmental and Industrial Hygienists' threshold limit value expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effects.

LC₅₀ (Lethal Concentration₅₀)--A calculated concentration of a chemical in air to which exposure for a specific length of time is expected to cause death in 50% of a defined experimental animal population.

NIOSH REL--National Institute of Occupational Safety and Health's recommended exposure limit; NIOSH-recommended exposure limit for an 8- or 10-h time-weighted-average exposure and/or ceiling.

OSHA PEL--Occupational Safety and Health Administration's permissible exposure limit expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effect averaged over a normal 8-h workday or a 40-h workweek.

^a Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.

^b Regulatory numbers are values that have been incorporated in Government regulations, while advisory

numbers are nonregulatory values provided by the Government or other groups as advice.

References

1. Agency for Toxic Substances and Disease Registry (ATSDR). *Toxicological Profile for Chromium*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. 1993.
2. U.S. Environmental Protection Agency. *Health Assessment Document for Chromium*. EPA/600/8-83/014A. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Research Triangle Institute, NC. 1983.
3. World Health Organization. Chromium. *Environmental Health Criteria 61*. Geneva, Switzerland. 1988.
4. U.S. Department of Health and Human Services. Registry of Toxic Effects of Chemical Substances (RTECS, online database). National Toxicology Information Program, National Library of Medicine, Bethesda, MD. 1993.
5. U.S. Environmental Protection Agency. *Integrated Risk Information System (IRIS) on Chromium*. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH. 1993.
6. E.J. Calabrese and E.M. Kenyon. *Air Toxics and Risk Assessment*. Lewis Publishers, Chelsea, MI. 1991.

1. *Micrograms per cubic meter is the unit of measurement for chemicals in air.

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<http://www.epa.gov/ttn/uatw/hlthef/chromium.html>

[Contact UATW Webmaster](#)
May 18, 1998

LEAD AND COMPOUNDS

Hazard Summary

- Lead is a **very toxic** element, causing a variety of effects at low dose levels.
- **Brain damage, kidney damage, and gastrointestinal distress** are seen from acute (short-term) exposure to high levels of lead in humans.
- Chronic (long-term) exposure to lead in humans results in effects on the **blood, central nervous system (CNS), blood pressure, kidneys, and Vitamin D metabolism**. **Children** are particularly sensitive to the chronic effects of lead, with slowed cognitive development, **reduced growth** and other effects reported.
- The U.S. Environmental Protection Agency (EPA) has not established a Reference Dose (RfD) or a Reference Concentration (RfC) for lead.
- **Reproductive effects, such as decreased sperm count in men and spontaneous abortions in women**, have been associated with lead exposure.
- The developing fetus is at particular risk from maternal lead exposure, with **low birth weight and slowed postnatal neurobehavioral development noted**.
- Human studies are inconclusive regarding lead exposure and cancer, while animal studies have seen an increase in **kidney cancer** from lead exposure by the oral route. EPA has classified lead as a Group B2, **probable human carcinogen**.

^a Human exposure to lead occurs through a combination of inhalation and oral exposure, with inhalation generally contributing a greater proportion of the dose for occupationally exposed groups, and the oral route generally contributing a greater proportion of the dose for the general population. The effects of lead are the same regardless of the route of exposure (inhalation or oral) and are correlated with internal exposure, as blood lead levels. For this reason, this fact sheet will not discuss the exposure in terms of route but will present it in terms of blood lead levels.

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (IRIS), which contains information on the carcinogenic effects of lead, the Agency for Toxic Substances and Disease Registry's (ATSDR's) *Toxicological Profile for Lead*, and EPA's *Supplement to the Criteria Document on Lead*. Other secondary sources include the Hazardous Substances Data Bank (HSDB), a database of summaries of peer-reviewed literature, and the Registry of Toxic Effects of Chemical Substances (RTECS), a database of toxic effects that are not peer reviewed.

Environmental/Occupational Exposure

- The largest source of lead in the atmosphere has been from leaded gasoline combustion, but with the phasedown of lead in gasoline, air lead levels have decreased considerably. Other airborne sources include combustion of solid waste, coal, and oils, emissions from iron and steel production and lead smelters, and tobacco smoke. (1,2)
- Exposure to lead can also occur from food and soil. Children are at particular risk to lead exposure since they commonly put hands, toys, and other items in their mouths, which may come in contact with lead-containing dust and dirt. (1,2)

- Lead-based paints were commonly used for many years and flaking paint, paint chips, and weathered paint powder may be a major source of lead exposure, particularly for children. (1,2)
- Lead in drinking water is due primarily to the presence of lead in certain pipes, solder, and fixtures. (1,2)
- Exposure to lead may also occur in the workplace, such as lead smelting and refining industries, steel and iron factories, gasoline stations, and battery manufacturing plants. (1,2)
- Lead has been listed as a pollutant of concern to EPA's Great Waters Program due to its persistence in the environment, potential to bioaccumulate, and toxicity to humans and the environment. (3)

Assessing Personal Exposure

- The amount of lead in the blood can be measured to determine if exposure to lead has occurred. (1,2)
- Exposure to lead can also be evaluated by measuring erythrocyte protoporphyrin (EP), a component of red blood cells known to increase when the amount of lead in the blood is high. This method was commonly used to screen children for potential lead poisoning. (1,2)
- Methods to measure lead in teeth or bones by X-ray fluorescence techniques are currently being developed. (1)

Health Hazard Information

Acute Effects:

- Death from lead poisoning may occur in children who have blood lead levels greater than 125 $\mu\text{g/dL}$ (1) and brain and kidney damage have been reported at blood lead levels of approximately 100 $\mu\text{g/dL}$ in adults and 80 $\mu\text{g/dL}$ in children. (1,2)
- Gastrointestinal symptoms, such as colic, have also been noted in acute exposures at blood lead levels of approximately 60 $\mu\text{g/dL}$ in adults and children. (1,2)
- Short-term (acute) animal tests, such as the LC_{50} test in rats, have shown lead to have moderate to high acute toxicity. (4)

Chronic Effects (Noncancer):

- Chronic (long-term) exposure to lead in humans can affect the blood. Anemia has been reported in adults at blood lead levels of 50 to 80 $\mu\text{g/dL}$, and in children at blood lead levels of 40 to 70 $\mu\text{g/dL}$. (1,2,5)
- Lead also affects the nervous system. Neurological symptoms have been reported in workers with blood lead levels of 40 to 60 $\mu\text{g/dL}$, and slowed nerve conduction in peripheral nerves in adults occurs at blood lead levels of 30 to 40 $\mu\text{g/dL}$. (1,2,5)
- Children are particularly sensitive to the neurotoxic effects of lead. There is evidence that blood lead levels of 10 to 30 $\mu\text{g/dL}$, or lower, may affect the hearing threshold and growth in children. (1,2,5)
- Other effects from chronic lead exposure in humans include effects on blood pressure and kidney function, and interference with vitamin D metabolism. (1,2,6)
- Animal studies have reported effects similar to those found in humans, with effects on the blood, kidneys, and nervous, immune, and cardiovascular systems noted. (1,2,6)
- EPA has not established an RfC or an RfD for lead. (7)
- EPA's Office of Air Quality Planning and Standards, for a hazard ranking under Section 112(g) of the Clean Air Act Amendments, considers lead to be a "high concern" pollutant based on severe chronic toxicity. (8)

Reproductive/Developmental Effects:

- Studies on male lead workers have reported severe depression of sperm count and decreased function of the prostate and/or seminal vesicles at blood lead levels of 40 to 50 $\mu\text{g/dL}$. These

- effects may be seen from acute as well as chronic exposures. (1,5,6)
- Occupational exposure to high levels of lead has long been associated with a high likelihood of spontaneous abortion in pregnant women. However, the lowest blood lead levels at which this occurs has not been established. These effects may be seen from acute as well as chronic exposures. (1,6)
 - Prenatal exposure to lead produces toxic effects on the human fetus, including increased risk of preterm delivery, low birthweight, and impaired mental development. These effects have been noted at maternal blood lead levels of 10 to 15 $\mu\text{g}/\text{dL}$, and possibly lower. Decreased IQ scores have been noted in children at blood lead levels of approximately 10 to 50 $\mu\text{g}/\text{dL}$. (1,2,5,9)
 - Human studies are inconclusive regarding the association between lead exposure and birth defects, while animal studies have shown a relationship between high lead exposure and birth defects. (1,6)

Cancer Risk:

- Human studies are inconclusive regarding lead and an increased cancer risk. Four major human studies of workers exposed to lead have been carried out; two studies did not find an association between lead exposure and cancer, one study found an increased incidence of respiratory tract and kidney cancers, and the fourth study found excesses for lung and stomach cancers. However, all of these studies are limited in usefulness because the route(s) of exposure and levels of lead to which the workers were exposed were not reported. In addition, exposure to other chemicals probably occurred. (1,2,5)
- Animal studies have reported kidney cancer in rats and mice exposed to lead via the oral route. (1,2,5,6)
- EPA considers lead to be a probable human carcinogen (cancer-causing agent) and has classified it as a Group B2 carcinogen. (7)

Physical Properties

- Lead is a naturally occurring, bluish-gray metal that is found in small quantities in the earth's crust. (1,2)
- Lead is present in a variety of compounds such as lead acetate, lead chloride, lead chromate, lead nitrate, and lead oxide. (1,2)
- Pure lead is insoluble in water; however, the lead compounds vary in solubility from insoluble to water soluble. (1,2)
- The chemical symbol for lead is Pb and the atomic weight is 207.2 g/mol. (1)
- The vapor pressure for lead is 1.0 mm Hg at 980 C. (1)

Uses

- The primary use of lead is in the manufacture of batteries. (1)
- Lead is also used in the production of metal products, such as sheet lead, solder, and pipes, and in gasoline additives, ammunition, cable covering, and other products. (1)

Conversion Factors:

To convert from ppm to mg/m^3 : $\text{mg}/\text{m}^3 = (\text{ppm}) \times (\text{molecular weight of the compound})/(24.45)$. For lead: $1 \text{ ppm} = 8.5 \text{ mg}/\text{m}^3$.

Health Data from Inhalation Exposure

Concentration (mg/m^3)	Health numbers ^a	Regulatory, advisory numbers ^b	Reference
10,000.0			

-- -- -- -- 1,000.0	<ul style="list-style-type: none">• LC₅₀ (tetramethyl lead) (8,870 mg/m³)		4
-- -- -- -- 150.0	<ul style="list-style-type: none">• LC₅₀ (tetraethyl lead) (850 mg/m³)		4
-- -- -- -- 100.0			
-- -- -- -- 75.0			
-- -- -- -- 50.0			
-- -- -- -- 40.0			

30.0			
20.0			
10.0			
1.0			
0.1		<ul style="list-style-type: none"> • ACGIH TLV (0.15 mg/m³) • NIOSH REL (0.10 mg/m³) 	5
0.01		<ul style="list-style-type: none"> • OSHA PEL (0.05 mg/m³) 	5

0.001		<ul style="list-style-type: none"> NAAQS (0.0015 mg/m³) 	5
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ACGIH TLV--American Conference of Governmental and Industrial Hygienists' threshold limit value expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effects.

LC₅₀ (Lethal Concentration₅₀)--A calculated concentration of a chemical in air to which exposure for a specific length of time is expected to cause death in 50% of a defined experimental animal population.

NIOSH REL--National Institute of Occupational Safety and Health's recommended exposure limit; NIOSH-recommended exposure limit for an 8- or 10-h time-weighted-average exposure and/or ceiling.

NAAQS--National Ambient Air Quality Standard.

OSHA PEL--Occupational Safety and Health Administration's permissible exposure limit expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effect averaged over a normal 8-h workday or a 40-h workweek.

^a Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.

^b Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are nonregulatory values provided by the Government or other groups as advice.

Major Health Effects Noted from Lead Exposure

Blood lead levels (µg/dL)	Health numbers ^a	Regulatory, advisory numbers ^b	Reference
150.0			
-- -- -- -- 100.0	<ul style="list-style-type: none"> Death (children) (125 µg/dL) Brain and kidney damage (adults) (100 µg/dL) 		1 1
-- -- --	<ul style="list-style-type: none"> Brain and kidney damage (children) (80 µg/dL) 		1

75.0			
--			
--			
--			
--			
50.0			
--	<ul style="list-style-type: none"> Increased blood pressure (40 $\mu\text{g}/\text{dL}$) 		1
--			
--			
--			
40.0			
--	<ul style="list-style-type: none"> Slowed nerve conduction velocity (30 $\mu\text{g}/\text{dL}$) 		1
--			
--			
--			
30.0			
--	<ul style="list-style-type: none"> Decreased IQ and growth in young children (20 $\mu\text{g}/\text{dL}$) 		1
--			
--			
20.0			
--	<ul style="list-style-type: none"> Preterm birth, reduced birthweight (10 to 15 $\mu\text{g}/\text{dL}$) 		1
--			
--			
10.0			

^a Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.

^b Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are nonregulatory values provided by the Government or other groups as advice.

References

1. Agency for Toxic Substances and Disease Registry (ATSDR). *Toxicological Profile for Lead* (Draft). U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. 1993.
2. Agency for Toxic Substances and Disease Registry (ATSDR). *Case Studies in Environmental Medicine, Lead Toxicity*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. 1992.
3. U.S. Environmental Protection Agency. *Deposition of Air Pollutants to the Great Waters. First Report to Congress*. EPA-453/R-93-055. Office of Air Quality Planning and Standards, Research Triangle Park, NC. 1994.
4. U.S. Department of Health and Human Services. Registry of Toxic Effects of Chemical Substances (RTECS, online database). National Toxicology Information Program, National Library of Medicine, Bethesda, MD. 1993.
5. E.J. Calabrese and E.M. Kenyon. *Air Toxics and Risk Assessment*. Lewis Publishers, Chelsea, MI. 1991.
6. U.S. Department of Health and Human Services. Hazardous Substances Data Bank (HSDB, online database). National Toxicology Information Program, National Library of Medicine, Bethesda, MD. 1993.
7. U.S. Environmental Protection Agency. *Integrated Risk Information System (IRIS) on Lead*. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH. 1993.
8. U.S. Environmental Protection Agency. *Technical Background Document to Support Rulemaking Pursuant to the Clean Air Act--Section 112(g). Ranking of Pollutants with Respect to Hazard to Human Health*. EPA-450/3-92-010. Emissions Standards Division, Office of Air Quality Planning and Standards, Research Triangle Park, NC. 1994.
9. U.S. Environmental Protection Agency. Supplement to Criteria Document on Lead. 1990.

1. *The level of lead in the blood is measured in micrograms per deciliter ($\mu\text{g}/\text{dL}$).

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<http://www.epa.gov/ttn/uatw/hlthef/lead.html>

[Contact UATW Webmaster](#)
May 26, 1998

**NATIONAL ZINC SITE
CHERRYVALE, KANSAS**

APPENDIX B

Photographic Documentation

Photo #1 - National Zinc Brownfields Targeted Assessment Site



Date: 7/13/99

View: South

Photographer: Randolph L. Brown

Comments: KDHE field crew members John Cregan and Laura Rand measuring soil sampling grid points with laser range finder and stadia rods.

Photo #2 - National Zinc Brownfields Targeted Assessment Site



Date: 7/13/99

View: South

Photographer: Randolph L. Brown

Comments: KDHE field crew members marking soil sampling grid points with wooden lath stakes.

Photo #3 - National Zinc Brownfields Targeted Assessment Site



Date: 7/21/99

View: South

Photographer: Randolph L. Brown

Comments: In-Situ analysis of location N 5700 E 6800 with Niton 733 X-Ray Fluorescence (XRF) analyzer by KDHE personnel Randy Brown.

Photo #4 - National Zinc Brownfields Targeted Assessment Site



Date: 8/11/99

View: Southeast

Photographer: Randolph L. Brown

Comments: KDHE personnel Jeff Neel obtaining surficial soil sample for laboratory analysis at location N 7400 E 6800.

Photo #5 - National Zinc Brownfields Targeted Assessment Site



Date: 8/11/99

View: South

Photographer: Randolph L. Brown

Comments: KDHE field personnel Laura Rand obtaining surficial soil sample for laboratory analysis at location N 7400 E 7100.

Photo #6 - National Zinc Brownfields Targeted Assessment Site



Date: 7/13/99

View: East

Photographer: Randolph L. Brown

Comments: Unnamed tributary leaving site. Photo taken from new U.S. 169 Highway. This creek was dry during nearly all of the BTA fieldwork.

Photo #7 - National Zinc Brownfields Targeted Assessment Site



Date: 7/13/99

View: West

Photographer: Randolph L. Brown

Comments: Same creek as in Photo #6 as it passes beneath U.S. 169. Small pool of water in background was the only standing water identified in the entire creek valley.

Photo #8 - National Zinc Brownfields Targeted Assessment Site



Date: 5/26/99

View: Southeast

Photographer: Randolph L. Brown

Comments: Remaining structures at National Zinc site are visible at center of the photo (metal buildings). A former ore house structure is visible at the left edge of the photo.

Photo #9 - National Zinc Brownfields Targeted Assessment Site



Date: 8/19/99

View: West

Photographer: Randolph L. Brown

Comments: Former National Zinc facility hopper structure. Discoloration and staining from operations is visible on surface of concrete. Surficial soil samples in this area yielded elevated lead levels.

Photo #10 - National Zinc Brownfields Targeted Assessment Site



Date: 8/19/99

View: South

Photographer: Randolph L. Brown

Comments: KDHE field crew advancing WP-1. Former National Zinc hopper (center) and furnace (left of hopper) foundations are visible in photo. Elevated lead levels were generally detected in surficial soils around these former production areas by XRF analysis.

Photo #11 - National Zinc Brownfields Targeted Assessment Site



Date: 8/19/99

View: West

Photographer: Randolph L. Brown

Comments: KDHE crew advancing TW-9. Former ore bin/coke house foundations are visible in background of photo.

Photo #12 - National Zinc Brownfields Targeted Assessment Site



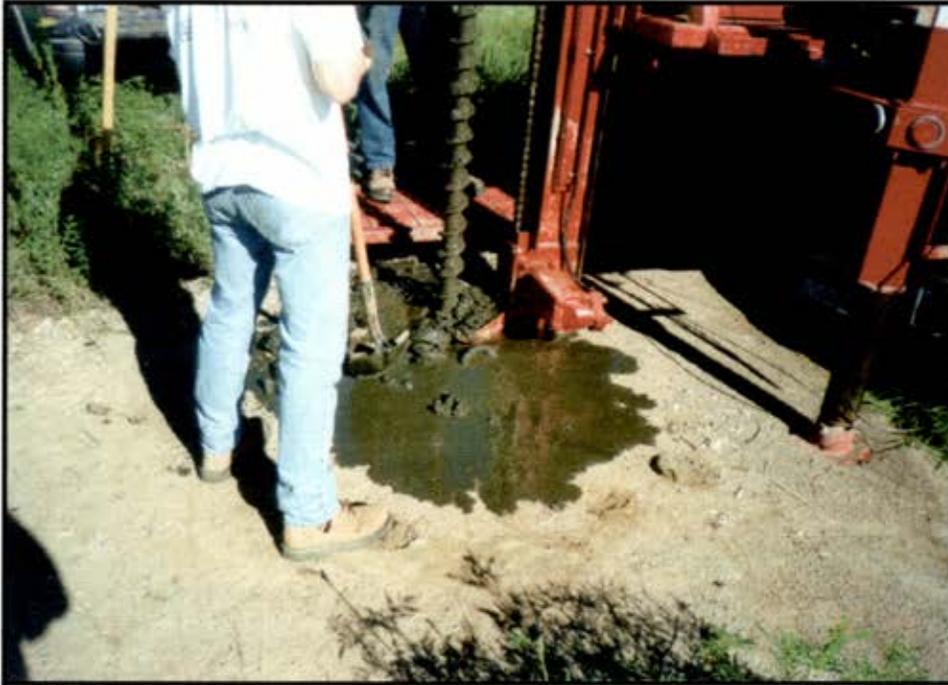
Date: 8/19/99

View: West

Photographer: Randolph L. Brown

Comments: KDHE field crew advancing WP-7 in barren area of waste disposal area/former waste water lagoon cap.

Photo #13 - National Zinc Brownfields Targeted Assessment Site



Date: 8/19/99

View: West

Photographer: Randolph L. Brown

Comments: KDHE field crew advancing WP-9. A green leachate was temporarily produced from this location and nearby TW-3.

Photo #14 - National Zinc Brownfields Targeted Assessment Site



Date: 8/16/99

View: Southeast

Photographer: Randolph L. Brown

Comments: KDHE field crew advancing TW-1. Barren areas and surficial smelter slag is visible to left of drill rig.

Photo #15(a) - National Zinc Brownfields Targeted Assessment Site



Photo #15(b) - National Zinc Brownfields Targeted Assessment Site



Date: 8/17/99

View: Southeast

Photographer: Randolph L. Brown

Comments: KDHE field crew advancing TW-5. Former National Zinc metal building is visible in center of photo behind truck in 15(a), ore bins/coke hous foundations visible behind rig in 15(b).

Photo #16 - National Zinc Brownfields Targeted Assessment Site



Date: 8/17/99

View: North

Photographer: Randolph L. Brown

Comments: KDHE field crew advancing TW-4 in waste area cap.

Photo #17 - National Zinc Brownfields Targeted Assessment Site



Date: 5/26/99

View: South

Photographer: Randolph L. Brown

Comments: Foundation from dry house/retort/pug mill area at former National Zinc facility. Discoloration and staining from smelting operations is visible on concrete. Soil samples in this area yielded elevated XRF lead levels.

Photo #18 - National Zinc Brownfields Targeted Assessment Site



Date: 8/17/99

View: West

Photographer: Randolph L. Brown

Comments: KDHE field crew advancing TW-7 along new U.S. Highway 169 right-of-way (visible in background). This is one of three (3) off-site monitoring well locations.

Photo #19 - National Zinc Brownfields Targeted Assessment Site



Date: 5/26/99

View: South

Photographer: Randolph L. Brown

Comments: Barren areas on waste disposal area/former waste water lagoon cap. Cattails are visible in foreground near gravel drainage ditch installed to drain standing water from the cap.

Photo #20 - National Zinc Brownfields Targeted Assessment Site



Date: 5/26/99

View: North

Photographer: Randolph L. Brown

Comments: Additional barren areas on waste disposal area cap.

Photo #21 - National Zinc Brownfields Targeted Assessment Site



Date: 5/26/99

View: South

Photographer: Randolph L. Brown

Comments: Existing monitoring well MW-3 at western edge of the site.

Photo #22 - National Zinc Brownfields Targeted Assessment Site



Date: 5/26/99

View: West

Photographer: Randolph L. Brown

Comments: Unnamed tributary of Drum Creek below berm of waste disposal area as the creek leaves the site. Surface water samples SW-4 and SW-5 were obtained in this area.

Photo #23 - National Zinc Brownfields Targeted Assessment Site



Date: 5/26/99

View: Southeast

Photographer: Randolph L. Brown

Comments: Slag piles and erosional feature which is the upstream reach of the unnamed tributary of Drum Creek which drains the site. TW-1 is located approximately 100 feet from this location.

Photo #24 - National Zinc Brownfields Targeted Assessment Site



Date: 5/26/99

View: West

Photographer: Randolph L. Brown

Comments: Erosional ditch at base of waste disposal area cap meeting unnamed tributary of Drum Creek which drains the site.

Photo #24 - National Zinc Brownfields Targeted Assessment Site



Date: 5/26/99

View: East

Photographer: Randolph L. Brown

Comments: Drain pipe apparently draining cap area entering unnamed tributary of Drum Creek. Surface water sample SW-5 was obtained at this point.

Photo #26 - National Zinc Brownfields Targeted Assessment Site



Date: 5/26/99

View: West

Photographer: Randolph L. Brown

Comments: Former furnace house foundation Remnants of brick walls are visible in photo.