Assessment of Environmental Lead Found in Soil and Indoor Dust in Communities of the City of Sunland Park, New Mexico

Final Report[1]

A. Overview

Sunland Park is an incorporated municipality in southwestern New Mexico just proximate to the international border with Mexico to the south, and bordering El Paso County Texas to the east. Sunland Park has a population within its incorporated limits of approximately 13,309 residents (based on U.S. 2000 Census) and includes the communities of Sunland Park, Meadow Vista, Riverside, Desert View, Anapra and parts of Santa Teresa. The Rio Grande bisects the City into two parts, north and south. The northern sector is an industrial and commercial area, with the Sunland Park Casino and Racetrack occupying the central area; while the area of the City south of the Rio Grande is primarily residential, open desert and undeveloped properties and lots. The community of Anapra, with 96 homes and a population estimated between 328 (U.S. Census) and 432 (based on 4.5 persons per household), is recognized as one of the poorest areas in the State of New Mexico and has been officially designated as a *colonia* community by both the State and the Federal Government, an indication of substandard services and living conditions.

Sunland Park and its communities are located within a 2-4 mile radius north-northwest of the point of confluence of the borders of the State of New Mexico, State of Texas, and the State of Chihuahua, Mexico, which is also near the location of the American Smelting and Refining Company's (ASARCO) smelting facility located in El Paso, Texas. This facility was operating since 1887 until it ceased lead smelting operations in the year 1985 and suspended copper smelting in 1999 in response to the worldwide decline in copper prices.[2] The facility is allegedly the source of the elevated lead, cadmium and arsenic levels found in air and soil throughout much of the Paso del Norte Valley. There are also other potential sources of environmental lead contamination in the region, including: lead paint in older homes, water sources, emissions from automobiles before lead was removed from fuels beginning in the late 1970s, and other nearby mining and smelting operations. However, according to Pingitore *et al* (2005), local geological formations do not appear to be the source of lead contamination: "There are no significant natural sources [of lead] beyond the typical crustal (rock) background in the region; thus they represent anthropogenic input."[3] Also, the problems of inversions and reduced wind velocities in the Paso del Norte Region in fall and winter contribute greatly to the trapping and build up of airborne contaminants, including lead.

Regardless of the source, lead is deposited in soils and is picked up into airborne dust and redeposited, especially during high wind events under predominately dry desert climatic conditions. Fine dust particles (<250 microns) of lead can be ingested through the respiratory system and are easily transported into homes and buildings where they may build up over time and be ingested through contact and respiration. Also, when soils are disturbed locally through excavation and construction or during the play of children, lead dust may be ingested by mouth or the respiratory system. Exposure to

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1 Presented to the Office of Border Health, New Mexico Department of Health on June 30, 2005 by Paul Dulin, Environmental Specialist and Contractor/Principal Investigator, in fulfillment of Contract No. 05.665.0009.0031.

2 ASARCO is currently in the process of requesting renewal of its 10-year operating permit before the Texas Commission on Environmental Quality.

3 According to Hawley (1978) *in* Pingitore *et al* (2005), local rock formations are predominately Paleozoic and Mesozoic sediments (mostly carbonates) and unconsolidated Tertiary and Quaternary sediments lacking lead and other toxic metals.

elevated concentrations of lead, which accumulates in the body and is stored in the bones, can cause brain damage, kidney damage, developmental learning and behavioral problems and a host of other serious health effects, particularly in young children and the unborn. The U.S. Environmental Protection Agency (EPA) and Centers for Disease Control and Prevention (CDC) have established 10 micrograms per 100 milliliters of lead as the threshold for endangering human health, especially in children and infants. A human health risk threshold, also referred to as the screening level by EPA, of 500 milligrams per kilogram (mg/kg) or 500 parts per million (ppm) has also been established for lead in soils (400 mg/kg for areas frequented by children). For indoor dust, the Federal Toxic Substance Control Act establishes a residential lead screening level of 40 micrograms per square foot ($\mu g/ft^2$).

Numerous studies have been carried out over the last 30 years to study the distribution and concentrations of environmental lead and other metals in soils, dust, air, and in the bloodstream of residents in selected areas in the Paso del Norte region. As most of these have focused on El Paso, the New Mexico Health Department's Office of Border Health determined the need to carry out its own series of assessments specifically within the city limits of Sunland Park to assess the level of human health risks posed by environmental metals, including lead. These studies, begun in March of 2005, include three components: (i) biomonitoring of metals (including lead and arsenic) in drinking water and urine of adult volunteers;[4] (ii) assessment of depositional lead concentrations in soils and indoor dust in and around residences; and (iii) screening of blood lead levels in children.

The current report addresses the results of second component, which was carried out between March and June of 2005. Under this environmental lead assessment, a total of 112 sites, including yards and gardens of private residences, industrial and commercial properties, public venues (parks, schools), and open areas (undeveloped areas and open desert) were sampled for lead levels in soils. Additionally, wipe samples were taken of indoor dust in a total of 58 residences among various communities in Sunland Park and were analyzed for lead contamination (soil samples were also collected for each of these residences).

The samples were then sent to a certified private independent laboratory (Hall Environmental Analysis Laboratory) in Albuquerque for analysis. Also, 10% of the soil samples were split, with a total of 12 samples sent to a different certified private independent laboratory (Assaigai Analytical Laboratories, Inc.) for quality control.

B. Previous Environmental Lead Assessments in the El Paso/Sunland Park Region

Environmental lead has been an issue analyzed in the Paso del Norte Region beginning in earnest the early 1970s with blood lead screening. Since then, there have been a number of studies carried out in differing scales and locations, but focusing primarily on the City of El Paso and areas adjacent to and west and southwest of the ASARCO smelter facility. Just a few of these studies have included Sunland Park.

1. Soils and Indoor Dust

A review of the literature produced various assessments of lead contamination of soils, indoor dust and air in the Paso del Norte region. The great majority of these assessments focus on communities in El Paso, with a limited number including Sunland Park and Doña Ana County New Mexico. A brief and non-exhaustive overview of the results of a selection of these reports is provided in order to put the current study in context. Readers are encouraged to access the documents and websites included in the list of *References Consulted* at the end of this report.

[4] This biomonitoring effort is not specific to the Sunland Park area and includes areas throughout the State, including Village of Columbus, also in Doña Ana County.

Numerous studies have been carried out to measure the levels of lead and other metals in soils, indoor dust and air in the region beginning in the 1950s and continuing up until today. Elevated levels of lead in soils and household dust (1000-3600 mg/kg) were detected in close proximity to the ASARCO smelter in the early 1970s by the El Paso City County Health Unit (Rosenblum, Shoults and Candelaria 1975). In 1972, the New Mexico Environmental Improvement Agency (Summers 1972 *in* Pingitore *et al* 2005) analyzed soil samples taken from Anthony, Meadow Vista and Anapra communities in southwestern New Mexico finding lead concentrations varying from below detection levels up to 220 mg/kg.

A series of studies were carried out by graduate students and professors of the University of Texas El Paso (UTEP) beginning in the early 1990s. Brenda Barnes, a graduate student (1993), carried out her thesis research on metals concentrations in surface soils around smelter operations in the El Paso area, finding the highest levels of lead, arsenic and other metals in the area around the ASARCO Smelter. Three other thesis research studies (Ndame 1993; Devanahalli 1994; and Srinivas 1994) showed elevated levels of lead especially on the UTEP campus (up to 1500 mg/kg), while levels in downtown El Paso and in parks and other public areas varied from 17 mg/kg to 560 mg/kg.

Recently this year, a series of studies were published by UTEP researchers (Pingitore *et al* 2005) under Monograph No. 12, *Toxic Metals in the Air and Soil of the Paso del Norte Region*. Analysis of soils around two smelters, a copper refining plant and several outlying control areas in El Paso showed that Downtown El Paso and the west side of the Franklin Mountains, the areas closest to the ASARCO facility, had the highest concentrations of lead, with most samples in the range of 1000-5200 mg/kg. Studies of airborne particulates showed the highest levels of metals contaminants (including lead) are occurring during the fall and winter (coinciding with reduced wind velocities and inversions), with smelter operations contributing a significant, but not necessarily dominant quantity of metals to the Paso del Norte airshed. Also, there have been significant reductions in toxic particulates in the airshed over the last 25 years, with lead being reduced on the order of 850 nanograms per cubic meter in 1977 to 23 nanograms per cubic meter in 2001—most likely related to the phase-out of leaded gasoline and the cessation of lead smelting in 1985 at the ASARCO facility.

The Encuentros Project, initiated in 2001, is a five-year research project currently in its final year being carried out by a multidisciplinary team of scientists from the UTEP, Texas Tech University Health Sciences Center at El Paso, the Center for Border Health Research, and a Binational Consortium of community-based organizations and Binational Task Force of representatives from health and environmental agencies and governments from El Paso Texas and Ciudad Juarez, Chihuahua in Mexico. The project, supported by a grant from the National Institute of Environmental Health Sciences (NIEHS), National Institutes of Health, has been applying a community-based public health research approach for evaluating exposure to environmental lead among children in the border communities of El Paso and Ciudad Juarez. Project objectives are: (i) estimation of the geographic distribution of environmental lead contamination; (ii) estimation of the environmental lead concentrations in and around selected households; (iii) estimation of the prevalence of elevated blood lead levels (EBL) in children; (iv) differentiation of chronic and acute lead exposure in children with EBL; and (v) involvement of the community in the research process and in the definition of intervention strategies to reduce children's exposure to lead. The project has published the results of analyses of consolidated soil samples for 500 city blocks in El Paso. Concentrations of lead exceeding 150 mg/kg were found in the western downtown area with the lowest levels found in peripheral areas away from the urban center (Pingitore *et al* 2005). Intermediate levels of lead contamination (100-150 mg/kg) were found on the west side of the Franklin Mountains, through downtown and eastward to the central part of the city. The geographic distribution of elevated levels of lead in soil coincides with results from the aforementioned metals particulate matter study.

Results from the studies carried out by UTEP graduate students were brought to the attention of U.S.EPA Region 6 and data from these studies and data taken by the Texas Air Control Board (1989) was reviewed March 2001. U.S. EPA Region 6 then initiated a series of lead and indoor dust assessments in the Paso del Norte region, which are further described below.

In July of 2001, EPA, through the U.S. Army Corps of Engineers, Tulsa District, contracted the firm of Ecology and Environment, Inc. to carry out a surface and subsurface soils sampling program in El Paso and southern Doña Ana County, including arsenic and lead, to confirm the results of previous studies, including those by UTEP graduate students (U.S. Army Corps of Engineers 2001). The study focused on locations of high public use, including the UTEP campus, schools, parks, Mount Cristo Rey, and libraries. A total of 112 locations were sampled at a depth of 0 to 1 inch (2.5 cm). At 12 schools in the El Paso Independent School District, a consolidated sample was taken between depths of 1 to 2 feet. In Sunland Park, lead values for surface samples (0-1 inch) varied. Soil samples were collected and tested for lead and arsenic concentrations for: 21 public schools and 20 public parks in El Paso, Texas; 3 schools and 8 parks in Sunland Park, New Mexico; and 10 locations on the UTEP campus. Elevated lead and/or arsenic concentrations, above the established human health threshold, were identified at 5 public schools and 4 parks in El Paso, and at 10 locations on the UTEP campus. EPA contracted additional sampling in August 2001 to better assess these sites. Results from sampling on several sites on the UTEP campus and in areas closer to downtown El Paso showed high concentrations (some exceeding 1000 mg/kg). Results from sampling on several sites on the UTEP campus and in areas closer to downtown El Paso showed much higher concentrations (some exceeding 1000 mg/kg). No elevated levels for arsenic or lead were identified at the schools or parks in Sunland Park. For the Sunland Park City Offices, Mender Park, Levee Park, Riverside Park, Sunland Park Elementary, Desert View Elementary, and Riverside Elementary, results were all under 50 mg/kg for lead. However, samples for the Mount Cristo Rey area, which lies within the city limits of Sunland Park, ranged from 591to 875 mg/kg.

As resampling confirmed elevated levels of lead and arsenic in the El Paso area, on the UTEP campus, and at Mount Cristo Rey, EPA Region 6 carried out another more comprehensive assessment in El Paso, and Sunland Park. During February and March of 2002, EPA contracted Weston Solutions, Inc. through the U.S. Army Corps of Engineers, Tulsa District to execute soil sampling and analysis program (primarily arsenic and lead) for residences, day cares, schools, parks, municipal properties and undeveloped and/or industrial areas in the City of El Paso and El Paso County, Texas and Sunland Park and Doña Ana County, New Mexico (Weston Solutions 2002). Sampling was done on a 750-foot grid network at 341 locations, including commercial and residential locations, within a 3-mile radius of the point of confluence of the Texas, New Mexico and Mexico borders. A total of 1,686 soil samples collected at varying depths (0-6 inches, 6-12 inches, 12-18 inches and 18-24 inches), with laboratory analysis for lead and arsenic performed on 1,293 of these samples. Values for lead exceeded 500 mg/kg in 28 residential locations in the El Paso area and were found at greater than 1000 mg/kg in 12 industrial locations. No exceedances for lead or arsenic were found for residences in Sunland Park; however the number of residential samples was limited.[5]

Weston also carried out indoor dust sampling (surface wipe and carpet vacuum samples), assessment of lead-based paints and plumbing systems, but only for 30 residential properties in El Paso. For 66 sieved dust samples obtained through vacuuming, 53% has elevated lead concentrations exceeding 40 micrograms per square foot. None of the swab samples indicated concentrations above 40 micrograms per square foot. However, elevated lead was found in the paint of 27 of the 30 homes tested.

[5] *Note*: as maps were redacted from the report, it was not possible at this writing to calculate the exact number of residential properties sampled in the Sunland park area; but it is understood to be less than 20 locations for all of Sunland Park.

Additional sampling was done in El Paso to further define contaminated areas from 2002 until June 2004. EPA Region 6 has sampled soils on over 3,600 residential properties, mostly in the Greater El Paso area. Soil removal and remediation of contaminated residential soils activities was initiated by EPA in El Paso in November of 2002 and continued up until September of 2004. A total of 505 residential properties have been remediated to date at a cost of $8 million. EPA has estimated that 300-600 properties will need to be remediated.[6] Recently in January of 2005, EPA authorized the use of $2 million from the ASARCO Trust Fund to continue remediation of contaminated residential and public-use sites in the West Mesa area El Paso, where the highest concentrations of lead contamination have been found. Also in January, public meetings were being held in response to the process of EPA's and the Texas Council on Environmental Quality's considering re-issuance of ASARCO's air emissions permit which, if approved, could result in the renewal of smelting operations at the facility, which has been inactive in the smelting of lead since 1985 and the all smelting operations (primarily copper) since 1999.

2. Blood lead screening

Landrigan *et al* (1975) reported elevated blood lead levels (BLL) above 40 micrograms per 100 milliliters or deciliter (μg/dl), then the accepted screening level, in 42% of the children tested of 1 to 19 years of age living within 1.6 kilometers of the ASARCO facility. Diaz-Barriga (1997) reported that 52% of those children tested in the Anapra community of Mexico near the ASARCO smelter (just across the border from El Paso, Texas and Sunland Park, New Mexico) showed elevated BLL in excess of 40 μg/dl.

The Texas Department Health, in coordination with the El Paso City-County Health and Environmental District has offered free blood lead screening of children throughout El Paso. Records for BLL from 1997 to 2003 indicate that for the total of 25,755 screenings conducted for children under the age of 6 years, 1,122 tested positive for elevated BLL above the 10 μg/dl threshold determined by U.S. EPA to adversely affect their health. At the same time, the data show that the percent (rate) of those with elevated BLL above this threshold has gradually been going down each year, potentially implying that lead in the environment and incidence of exposure is in decline.[7] Under the Texas Health Department's *Texas Childhood Lead Poisoning Prevention Program* cases for elevated BLL screened in El Paso between 1997 and 2000 were plotted on city maps. There is an obvious clustering of positive cases just in neighborhoods west and southwest of the smelter facility, these coinciding with neighborhoods that exhibit elevated lead in residential soils. However, some of these clusters also coincide with housing that dates to before 1960 and lead paint could also be an agent of lead contamination in these homes.

The NM Department of Health offers free BLL screening under Medicaid for those interested in receiving the tests. To date, four cases have screened above the 10 μg/dl threshold in Sunland Park.[8] The NM Department of Health, Office of Border Health carried out a one-day free BLL screening campaign in Sunland Park in late June, but the number tested was quite low (about 18 cases) and the results were not available at the time of preparation of this report.

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[6] Jon Rinehart, El Paso and Doña Ana Counties Metals Survey Project, U.S. Environmental Protection Agency/Region 6, personal communication, 7 July 2005.

[7] The reduction in incidence over the years could also be related to the fact that those being screened in later years were not necessarily from areas where elevated levels of lead in soils have been found.

[8] Dana Bahar, NM Department of Health, personal communication, 7 July 2005. *Note*: the total number of children tested for BLL is unknown, so the statistical significance and residential locations of these children are unknown.

3. Speciation studies for determining the source of lead in the Paso del Norte Region

Speciation studies carried out for lead and arsenic in soils of the El Paso have produced inconclusive and conflicting results and conclusions. Speciation studies are used to determine the source-origin of substances. EPA Region 6 contracted a speciation study of lead, arsenic and other metals found in soils in the El Paso area (Drexler, June 5, 2003). In this case, lead and arsenic found in soil samples at selected sites in the El Paso area was analyzed using electronic microprobe techniques. The study concluded that the lead and arsenic found in soils in the El Paso "…are the result of both smelter-stack emissions and fugitive dust from plant raw materials" and that "There is nothing in the geological record that could account for the elevated metal [lead, arsenic, copper, cadmium and zinc] concentration found in residential soils."

ASARCO contracted a speciation study at the same time (Walker & Associates, Inc., July 2, 2003). This speciation study, using optical and electronic microscopy and X-ray diffraction, came up with conclusions that disputed findings in the Drexler report, further indicating that: "To date, no evidence of significant smelter fallout has been found in the soils examined." Rather, this study postulates that the source of lead and arsenic are probably slag materials that were crushed for use as construction and fill materials, and railroad beds. The authors also state that lead-based paints, naturally-occurring lead in local geologic formations, and fallout from other nearby mining, brick fabrication, and smelting operations in the area could also account for elevated levels in El Paso soils.

C. Strategic and Analytical Methods used in the Current Assessment of Lead in Soils and Indoor Dust in Sunland Park

The assessment team consisted of three persons: (i) an Environmental Specialist as the Principal Investigator and responsible for all aspects of the study and its deliverables; (ii) a Geographic Information Systems Specialist/Cartographer; and (iii) a Community Liaison.[9] Field sample collection procedures and laboratory analytical protocols are consistent with generally-accepted standards and EPA guidelines. The following sections are used to describe each of the principal groups of activities related to the assessment. The activities were carried out essentially in the same sequence as presented.

1. Technical literature review and consultation

Several discussions were held with the Office of Border Health's Project Manager for the assessment to obtain guidance in carrying out the study and ascertain information on other ongoing initiatives (especially the biomonitoring and blood screening activities). Several reports were obtained at this time and reviewed. EPA's website was consulted to obtain information on the Agency's Region 6 *El Paso/Doña Ana County Metals Program*, especially in terms of the results for previous and ongoing assessments of environmental lead which are cited in the previous section. The website search was followed up with several telephone conversations with managers of the El Paso/Doña Ana County Metals Survey Team in EPA's Region 6 office in Dallas to ensure compatibility of the sampling and laboratory protocols to be used in the current Sunland Park assessment.

Other websites were also visited and queried for pertinent information, including the Centers for Disease Control and Prevention (CDC) and the Agency for Toxic Substances and Disease Registry (ATSDR). Information was also consulted on the website of the Get the Lead Out Coalition, a non-government group advocating the protection of health of border residents and opposition to the reopening of the ASARCO smelter. ASARCO also maintains a section of its webpage dedicated to the El Paso/Doña Ana County Metals Program, including access to reports and data produced under the program.

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[9] The Environmental Specialist and the Community Liaison are fully fluent in Spanish, as was required for communication with 90% of the residents contacted during sampling.

Other entities contacted included: the Community Development Director, Fire Marshall and Chief of Police of the City of Sunland Park to obtain census data and to discuss the objectives and plan for the assessment; staff and the webpage of the New Mexico Environment Department's Air Quality Section to ascertain data from meteorological and air quality monitoring stations in the project area; and the State Climatologist of New Mexico, headquartered at New Mexico State University, to obtain wind data. A list of references consulted during the study is presented at the end of the current report.

2. Public meetings to announce the project

Two public meetings were held in order to garner support from the community for carrying out the assessment, especially the soil and interior dust sampling activities. The first meeting was held at the La Casita Community Center in Anapra on March 12 and was shared with an information outreach presentation organized by the Office of Border Health and the Southern Area Health Education Center (SoAHEC) to inform residents about the risks of environmental lead. A short presentation was made regarding the upcoming environmental lead assessment, as well as the biomonitoring study and their objectives, and was used to request assistance of community members to carry out sampling in their respective neighborhoods and homes. On May 3, a short presentation was made during the public comment period of the Sunland Park City Council meeting.

3. Determination of the sampling sites

The assessment involved two sampling campaigns. The first campaign, carried out on May 20, 2005, included the collection of 23 soil samples spaced over a wide geographic area within the community of Anapra and west to the road leading to the sanitary landfill. The campaign included 13 samples in residential areas and the remainder in open areas, including desert locations. The first campaign was used to ascertain areas of higher or lower concentrations of lead. Samples were sent to the laboratory for analysis and once results were available, the values were plotted using their Global Positioning Satellite System (GPS) locations on the study base map.

Spatial distribution of lead concentrations resulting from the first sampling campaign were then interpreted and preliminary locations for sampling sites for the second campaign were marked on the project base map (field map). For this procedure, intended sampling locations were marked on the field map using random spaced points with uniform spacing, while interpreting basic geographic parameters (local topography, hydrography, and wind direction) and settlement patterns (location and density of houses and public use areas). Also, greater density and number of sampling points were assigned to the Anapra community where relatively higher concentrations were determined during the first campaign.

The team walked or drove to each predetermined sampling point. For each public area (parks, municipal properties, schools) and open areas (non-residential and open desert sites) locations, samples were taken essentially at the same point previously indicated on the field map. For locations in residential areas, sampling locations became *self-selecting* based on the presence of owners or occupiers in their homes. In all cases, final residential sampling sites were established in close proximity (within 100-200 feet) of the points originally indicated on the field map. *Maps indicating the locations for soil and indoor dust samples are depicted in the maps following this page.*

4. Collection and laboratory analysis of soil/dust samples

Soil samples were taken at a total of 112 locations (two locations were re-sampled for quality control where elevated lead values were determined).[10] Indoor dust was sampled in a total of 58 residences. A bilingual one-page circular was prepared describing the human health risks of environmental lead,

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[10] *Note*: three samples were taken within residential areas just across the border in El Paso County Texas, as these homes were adjacent to the general study area.

overall objectives of the study, a basic description of the sampling and analysis procedures, and provided contact information of the Principal Investigator. A copy of the circular was presented to each owner/occupier of the residences in the study area and used as a basis for soliciting their collaboration and permission for taking soil and/or indoor dust samples.

As previously noted the first sampling campaign was carried out on May 20, 2005 and included collection of 23 soil samples. The second campaign was carried out according to the following schedule:

Sampling Schedule for Sampling Campaign #1 and #2	
Date	**Matrix/Analyte**
Sampling Campaign #1	
May 20, 2005	23 soil samples
Sampling Campaign #2	
June 11, 2005	27 soil samples 21 indoor dust samples (*includes one re-sample for confirmation*)
June 12, 2005	31 soil samples 26 indoor dust samples
June 16, 2005	5 soil samples (*involved sites only on El Paso Electric property*)
June 18, 2005	27 soil samples 11 indoor dust samples
July 7, 2005	2 soil samples (*two re-samples of one site for confirmation*)

Soil sample locations established during the second campaign cover an area bordered by Gibson-Veck Road and Doniphan Road to the north, the Southern Pacific Railroad to the south, Sunland Park City limits and Brickland Road to the east, and Doña Ana Community College as the westernmost sampling location. An effort was made to collect samples from relatively undisturbed locations and away from structures (walls, homes). In the case of yards of residences, owners/occupiers were asked if soils in their yards were fill material (*relleno*) brought in within the last 10 years, or original soils; with several locations rejected as not meeting this parameter. Similarly, for open-area locations (desert, vacant lots, undeveloped land), sample sites of more natural, undisturbed appearance were selected.

For soils, at each location a five-point consolidated (composite) grab sample was collected within an approximately 12 x 12 foot square in the front or backyards of homes (or in parks, vacant lots or other open areas). For each sample, five uniform sub-samples were collected in a uniform manner from each of the corners of the 12 x 12-foot (3.9 x 3.9 meters) square and at the center point, from the surface down to about 2.5 cm (a sample size of 2.5cm x 2.5cm x 2.5cm, or roughly one square inch). The center point was located using GPS. Each five-point soil sample was collected with a separate plastic spoon and placed in a zippered plastic bag, and labeled with the sample number, date and time of collection. Each sample was then field logged with the same information, and as applicable for residential locations, the name of the owner/occupier, street address and physical location (back, front or side yard). For open area samples, the relative geographic location was noted on field sheets (e.g., east of water tower, sand hill west of Mount Cristo Rey, etc.). Each sample was then thoroughly tumble-mixed in its zippered bag for matrix uniformity.

For each indoor dust sample, pre-treated digestible "ghost" wipes were used to swab (three strokes down, three strokes left to right, and three strokes up) a uniform area within a cardboard template measuring 100 cm^2. Locations for collecting dust within each residence varied depending on the availability of dust, especially in terms of areas where the owner/occupier does not or had not recently cleaned the surface. Generally, these locations included window sills, on top of televisions or cabinets, under furniture, the top of refrigerators and/or corners of floors behind doors. The dust sample contained on the swab was then immediately enclosed in a sealed container (digestion tube), and then placed in a zippered plastic bag and labeled with the sample number, date and time of collection. Samples were then field logged into with the same information, plus the name of the owner/occupier, street address and physical location (surface that was swabbed).

Samples from the first campaign were sent to the laboratory (Hall Environmental Analysis Laboratory in Albuquerque) on May 21, with results received on June 6, 2005. Samples from all four collection days during the second campaign were consolidated for shipment to the laboratory on June 20, 2005. All samples were unsieved. Ten percent of the soil samples were split, with 12 split samples sent to a second laboratory (Assaigai Analytical Laboratories, Inc. in Albuquerque) on June 20, 2005. Both laboratories applied EPA 6010 procedures for metals analysis (and EPA 3050 for soil digestion). Values for lead in soils is reported in milligrams per kilogram (mg/kg), which is also known as parts per million (ppm). Values for indoor lead in dust are reported in micrograms per 100 square centimeters (µg/100cm^2). Laboratory analysis of dust samples involved a proprietary digestion procedure wherein the special-material swab dissolves leaving only the dust residue for testing. Results of laboratory analysis for all soil and indoor dust samples are presented in the Annex.

5. Data and spatial analysis

Once results were received from the laboratories, data was assimilated in a georeferenced format in a GIS. Analytical software was used in the GIS to ascertain trends and anomalies. The resulting spatial distributions of lead concentrations were then analyzed in relation to geographic factors, including but no limited to topography and terrain, wind direction, distance from the ASARCO smelting facility or other potential sources, and the location and dates of development of subdivisions. While the study is focused especially on determining the level of risk associated with lead levels in soil above the 500 mg/kg threshold for soil and 40 µg/100cm^2 for indoor dust (established by EPA as thresholds of human health risk), all values were calculated and entered into the database, plotted and analyzed. A series of maps were produced to depict the locations of the soil and indoor dust sampling locations, as well as the results of the analyses.

6. Preparation of final report and information disclosure to the public

An interim report was presented to the Office of Border Health once sampling was completed and included maps of sampling locations and preliminary results of laboratory analyses. The present final report includes details on all aspects of the study and the results of each of the five groups of activities described above. In order to meet the Office of Border Health's policy for full and open communication with the public and those parties potentially affected by high levels of environmental lead, a letter was hand-delivered to each of the residents that permitted sampling of their soils and indoor dust indicating the values ascertained by laboratory analysis, together with an explanation of what the values entail in terms of human health risk.[11] At the time of a simplified PowerPoint presentation was prepared to present salient results of the assessment in a public meeting to the residents of Sunland Park, and as appropriate and/or requested by the Office of Border Health, to representatives of the City of Sunland Park, the NM Department of Health, NM Environment Department, Doña Ana County Commission, and

[11] The letters were hand-delivered in order to protect the right of those residents that may want to keep the information private. The names and addresses relating to those residences where sampling took place are considered confidential and will not be disclosed to the public by the NM Department of Health or its contractor.

others as may be appropriate. At the time of publication of this final report, two final public meetings were scheduled for August 2005 at the Sunland Park Public Library and to the Sunland Park City Council to present the final results of the assessment and interpret the level of risk of exposure to lead to the community and its residents.

D. Results of the Analysis

This section presents the results of the laboratory analysis of lead values for all soil and indoor dust samples collected and analyzed under the assessment, with full results presented in tabular form in the Annex. These data are depicted on maps showing the locations of each sample, lead values for each sample location, and a map showing trends in the spatial distribution of lead in soils of communities of Sunland Park.

1. Lead in soil samples

A total of 112 locations were sampled, including: 63 residential properties (yards and lots), 40 open space sites (desert, undeveloped land), 5 public sites (2 schools, a church, a park and the Sunland Park municipal grounds), and 4 industrial locations (all on grounds of the El Paso Electricity Plant). Lead was found for *all* soil samples collected during the assessment, thus indicating that lead is pervasive throughout the environment in Sunland Park, albeit at varying concentrations (see corresponding maps in the following pages).

Out of the total of 63 residential properties sampled, only two residential properties, both found in Anapra, were determined to have lead levels above the 500 mg/kg threshold. Both of these locations (samples S-008 and S-040) showed lead levels at 1300 mg/kg, or 260% above the threshold.[12] These sites were resampled in a slightly different place within the same yards (within approximately 30-40 feet of each of the original locations). In both cases, elevated lead was again recorded: 840 mg/kg for the first site (sample S-028), and 460 mg/kg (sample S-114 taken at the surface) and 1200 mg/kg (sample S-115 taken at the same grab points but at a depth of 6-7 inches). These locations will need to be further analyzed and a determination made with the owners if they would require removal of the contaminated soil and its replacement with certified clean fill in order to reduce health risks. Only three other residential locations, all found in Anapra, showed moderate levels of lead, ranging from 160 to 190 mg/kg. No other soils in residential properties were determined to have lead levels above 150 mg/kg, although a uniform cluster of values between 88 and 95 mg/kg were found in the only residential area north of the Rio Grande on Gibson-Veck Road.

For public space locations, relatively low lead values were determined. Both of the schools sampled, Desert View Elementary and Sunland park Elementary, had very low levels (7.7 and 11 mg/kg respectively). The only park sampled, Red Mender Park in the Anapra, showed only 8.2 mg/kg, while the only church, Victoria en Jesus Cristo, also located in Anapra, had a lead value of 94 mg/kg. The Sunland Park municipal grounds directly in front of the Sunland Park Library showed a level of only 11 mg/kg.

Lead levels in soils of open spaces varied, with the highest concentrations detected at sampling locations on Mount Cristo Rey.[13] Of the 10 samples analyzed from Mount Cristo Rey, values ranged from 310 mg/kg up to 1500 mg/kg, with 5 samples registering above 500 mg/kg. Three (3) of these, located nearest to the point of confluence of the borders of the States of New Mexico, Texas and Chihuahua,

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[12] *Note*: in one of these cases, the owner stated that soil fill materials were transported to his yard some 12 years previously. The origin of this fill material was not known and could have been come from Mount Cristo Rey or slag from the smelter. For the other case, the owners stated that their yard was used as a workshop for the repair and painting of automobiles.

[13] *Note*: Mount Cristo Rey could also be classified as an industrial property due to the mining of minerals and rocks by the Jobe Cement Products Company (now Cemex).

Mexico (and near the site of the ASARCO facility), registered above 900 mg/kg. West of Mount Cristo Rey, lead values at open space locations generally dropped almost immediately to below 50 mg/kg and continued dropping gradually toward the west with distance from Mount Cristo Rey. However, to the north of Mount Cristo Rey at open space sites near Anapra and across the river, several lead values in open space soils showed higher levels in the 100-180 mg/kg range. Another phenomenon noted is that lead values were higher on east facing slopes of Mount Cristo Rey than of those facing north or west. This could indicate that these facie may have received higher levels of deposition from atmospheric sources coming in from the east.

Finally, for the 4 locations sampled on the grounds of El Paso Electric's generating facility, values ranged from 13 to 180 mg/kg, with the two highest concentrations found at relatively undisturbed floodplain sites.

2. Lead in indoor dust

A total of 58 residences were sampled for indoor dust collected with moistened wipes. Each dust sample was correlated with a soil sample taken from the yards of each residence sampled. In the maps on the following pages, values from each sample site are shown along with their location. Based on the results of the laboratory analysis, none of the samples showed elevated lead levels above the threshold of 40 µg/100cm^2. Only 5 of the samples (D-216, D-217, D-218, D-221 and D-230) were found to have lead moderate levels equal to and above 20 mg/kg. Four of the homes with these moderate levels (ranging from 21 to a maximum of 27 µg/100cm^2) are clustered in Anapra, three in the northern sector of the community and one case south of McNutt Road.[14] Also one isolated home in a subdivision west of Mount Cristo Rey presented a value of 20 µg/100cm^2. Of the total 58 cases, values for 37 homes (64% of the total sample) were below the detection level of the laboratory.

3. Trends in the spatial distribution of lead in soils

As part of the assessment, an analysis was carried out to determine variations and trends in the spatial distribution of lead in soils for all samples collected. Radiuses were plotted from the point of the confluence of the borders of Texas, New Mexico and Chihuahua, Mexico (near the site of the ASARCO facility) and coincided with natural breaks in settlement density and groupings of soil samples (see the maps on the following pages). Ring boundaries are set from the center point of the radius at 0-1.8 miles, 1.8-2.8 miles, 2.8-3.8 miles, and 3.8-4.5 miles. Then the mean and median of lead values for all sample soil sample locations within each concentric ring were determined. As can be seen in the accompanying maps on the following pages, lead levels in soils decline with distance from the center point of the radius. The highest mean concentration for lead (644 mg/kg) is found in the ring closest to the radius center point and includes all values related to sampling locations on Mount Cristo Rey, leading up to the area just behind residences found on the south side of McNutt Road in Anapra. The median for this ring is 460 mg/kg. The second ring includes all the values for the Anapra community, the commercial district of Sunland Park and a number of sampling locations in communities west of Mount Cristo Rey. The mean for this ring is 116 mg/kg, influenced by the higher levels in Anapra, while the median is 39.5 mg/kg, implying that a much greater number of sample sites within the ring had lower lead values. The mean for the third ring falls to 34 mg/kg and the median to 27 mg/kg, which demonstrates that lead values are becoming much more uniform for all sampling locations and at a lower lead level. Finally, the fourth and last ring, which is farthest from the radius center point (3.8-4.5 miles) shows that the mean and the median are converging at 21.9 and 20 respectively, an indication that lead values are near uniform for all the samples in that ring.

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[14] *Note*: the case with the highest concentration of lead in dust coincided with one of the residential properties showing the highest levels of soil lead.

Several conclusions can be drawn from this analysis. First, the most elevated concentrations of lead are found in areas closest to the point of the confluence of the Texas, New Mexico and Chihuahua borders, which also coincides with the site of the ASARCO facility. These also coincide with Mount Cristo Rey which appears to have acted as a receptor of lead-laden dust that may have been transported by southeast winds that predominate for approximately 30% of the average year. Second, it is clear from the analysis that lead concentrations in soil decline with distance from the center of the radius. Statistically, the mean and median of each concentric ring come closer together especially in the last two rings of greatest distance (2.8-3.8 miles, and 3.8-4.5 miles respectively), which implies that lead concentrations are becoming more uniform at lower levels. This also indicates that spatial distribution of lead becomes more uniform with distance from the center of the radius.

In the case of Anapra, values ranged from a low of 8.2 mg/kg at Red Mender Park, up to 1300 mg/kg in the backyards of two residences. As spatial analysis of such a broad range in a small area is difficult at best to analyze, a color coded system is used to characterize lead levels. This serves more to see where clusters can be perceived, rather than statistically significant trends. A cluster of higher concentrations of lead can be observed among properties sampled south of McNutt Road, at the northern base of Mount Cristo Rey.

E. Phenomena Affecting the Spatial Distribution of Lead in the Environment and Limitations to the Assessment

The conclusions presented in this report are based on the interpretation of the spatial distribution of lead concentrations as determined through the sampling of soils and indoor dust in a limited number of locations throughout Sunland Park, and should be perceived based on these limitations . Also, there are several phenomena which affect the distribution of environmental lead which should also be considered in interpreting the results of this assessment. Some of these are identified in order to put the conclusions presented in this report into context.

Limited number of samples. Any analysis of lead levels in soils and indoor dust is only as good as the data collected during such an assessment. The current study could be improved with additional sampling, which would permit a more rigorous analysis of spatial distribution of lead in the environment and, potentially, shed more light on the source of the lead. With a greater the number of samples, the validity of the analysis and resulting conclusions can be strengthened. But it is also pointed out here that in the case of the Anapra community, the current assessment included sampling of soils in approximately 33% of all residences and indoor dust in about 30% of all residences, thus giving a high level of confidence in the results where the highest concentrations were found among all residential areas in Sunland Park.

Movement of soil fill materials. A number of residents indicated that they had hauled in soil from other undisclosed locations in order to level their yards and/or improve drainage. Depending on the source of the fill materials (some residents mentioned that Jobe Concrete Company employees were informally contracted to haul in fill materials and level their yards and may have brought in fill materials from Mount Cristo Rey or even slag piles near the smelter) soils with higher concentrations of lead could have been brought in and influenced the lead readings. Others have carried out landscaping, including soil movement with heavy equipment, which can invert and mix the soils, bring lead up from deeper soils or, vice versa, bury elevated lead-laden soils with cleaner fill.

Movement of lead in soil and dust particles by wind or stormwater. As the region is characterized by desert landscapes and a very dry climate, and seasonal wind storms are common, soil and dust is picked up and redistributed and redeposited locally and regionally. A residence may not have elevated lead concentrations in soils of their yard, but could have elevated lead in dust found in their homes, as has been determined by the current study. Generally, soils on Mount Cristo Rey have been shown to have much higher levels of lead than surrounding areas (with the exception of two residences in Anapra, where extremely high lead levels were found). Thus, Mount Cristo Rey could be a continuous source for lead picked up and redeposited in soils and dust in surrounding communities. Similarly, local topography determines drainage and stormwater runoff. Lead can be transported with soil particles especially during heavy rains when runoff can be sudden and voluminous (i.e., intermittent arroyo flows typical of the desert region during the monsoon in late summer). Soils will be redeposited downstream and could accumulate in sites far from the source of the lead (including residential areas depending on local drainage patterns). Thus, a low-lying area could have higher lead levels than surrounding areas because of sediment deposition.

Availability of dust in households. The availability of indoor dust is directly dependent on the frequency that homeowners leave their windows open during wind events, how tightly sealed are the homes, and the frequency and efficacy of cleaning within the household. Consequently, homes left open to the air will collect more dust and thus be subject to higher levels of dust and lead deposition, if lead is carried in the air. However, in homes where cleaning is carried out meticulously and regularly, less dust collects that could cause health problems and will be insufficient in volume to be picked up by sampling. But this same cleaning efficiency also offers greater protection to residents should fugitive lead-laden dust enter their homes.

Lead paint, leaded gasoline and human-induced concentrations. In older homes (pre-1960s), lead was a base substance in paints used for both indoors and outdoors. Exfoliating exterior paint can fall into residential yards and/or excess or waste paint could be disposed of into yards and be recombined with soil, thus resulting in elevated levels. A number of people used leaded gasoline as a solvent, cleaning car parts or to remove residue from tools and equipment (one of the residences exhibiting the highest levels of soil lead stated that the yard was used as an automobile repair and paint workshop). Also, leaded gasoline leaks from automobiles or storage tanks can result in elevated concentrations of lead at locally specific sites. If soil samples are taken at the locations, high levels could be recorded. Finally, lead may be available in foods, water sources and food containers (lead-based glazes on ceramics) that could expose individuals to human health risks. However, such sources would not be determined through testing of soils and indoor dust. Rather, the articles would have to be tested for lead content.

F. Final Conclusions and Considerations for Follow-on Studies

The results of the current assessment indicate that lead is indeed pervasive throughout Sunland Park; although it represents a human health risk primarily to residents of two individual properties in the Anapra community. Generally, Mount Cristo Rey has the highest concentrations of lead (ranging from a low of 310 mg/kg to a high of 1500 mg/kg at locations sampled). Concentrations of lead decline rapidly to the west of Cristo Rey, which appears to have acted as a natural barrier, and somewhat more gradually from Anapra and to the northwest, where the fetch of wind from the southeast and possible deposition of lead is less impeded.

Based strictly on the extrapolation of the results of the current assessment of lead in soils, there could be an additional four residential properties in the Anapra community with elevated lead concentrations above the human health risk threshold established by U.S. EPA.[15] Therefore, it is advisable yards of those remaining residential properties (approximately 60) be sampled for elevated lead and, should elevated levels be detected above the established threshold, the owners of these properties should confer with the proper authorities to take any necessary actions to reduce inherent human health risks.

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[15] As sampling for lead in soils of 33% of residences in Anapra detected 2 cases of elevated lead, it may be assumed that sampling of the remaining properties could result in the detection of an additional 4 cases.

Elevated lead in indoor dust appears to be much less of a problem—at least as has been determined under the current assessment. However, there are many factors that affect dust availability, including cleaning frequency, location of homes in relation to winds, and if homes are more open and exposed to fugitive dust. It may be worthwhile to consider placement of an air quality monitoring unit in the Anapra community to measure atmospheric lead and determine if there is a risk to the community.

The conclusions made in this report concerning the possible source for environmental lead are based on the limited number of samples analyzed and the evaluation of the influence of natural factors that affect the spatial distribution of lead in soils in Sunland Park. Locations and lead values of all other studies carried out in the region—including the EPA-financed studies implemented between 2001 and 2004, the Encuentros Project and other studies carried out by professors and graduate students at UTEP, and the Texas Air Quality Board, among others—should be plotted into a single GIS and analyzed with different analytical software programs to ascertain spatial trends in concentrations and distribution, and compare these with natural and anthropogenic phenomena to better ascertain the probable origin of environmental lead, including: terrain, winds, inversions, geology and stormwater deposition; as well as other potential sources including lead-based paints, atmospheric lead from auto emissions, and other industrial processes (mining, brick-making, foundries, etc.).

Human health is basic reason for carrying out the current environmental lead assessment. Elevated lead in the environment can pose risks to residents of Sunland Park depending on exposure pathways into the body. Blood lead screening is the best way to determine if residents, and especially children and infants, have been exposed to environmental lead. A comprehensive blood lead screening program should be carried out for Sunland Park residents and especially for those of Anapra. If elevated blood lead levels are detected, individual assessments should be carried out at the residences of those affected to determine the cause and source of lead contamination, potentially including lead levels in soils and dust, paints, foods and food containers.

There is still a great deal of controversy, both public and scientific, as to the origin of the elevated lead levels found in soils in the Paso del Norte region. While the U.S. EPA has stated that smelter-stack emission and fugitive dust from the ASARCO facility as the most likely source, the Company insists that elevated lead concentrations were produced by other sources, including lead-based paints. Speciation studies are either inconclusive and/or offer conflicting evidence. The current study does support, at least based on the analyses carried out herein, that lead does come from a source that correlates with the location of the smelter facility, or at the least, a location southeast of Sunland Park. As the liabilities involved are quite important to all affected parties, it would be worthwhile to carry out a more comprehensive speciation study by an independent group of scientists to ascertain the exact source-origin of lead in the region.

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List of Materials in the Annex[16]

- Laboratory Results for Analysis of Lead in Soil Samples
- Laboratory Results for Analysis of Lead in Wipe Samples of Indoor Dust
- Comparison of Results of Selected Samples from the Principal Laboratory and Quality Control Laboratory
- Form Letter used to present individual residents with the results of testing for lead in soil and/or indoor dust in their home
- Flyer used to announce the public meeting for presentation of results of the Sunland Park Environmental Lead Assessment

[16] *Note*: Annexes are not included with this report. For more information, please contact the Office of Border Health, 1170 N. Solano, Las Cruces NM 88001; TEL: 575-528-5154.

List of Materials in the Confidential Appendix[17]

- Field Data Log for Soil Samples
- Field Data Log for Dust-Wipe Samples
- Global Positioning Satellite System Locations for Soil and Indoor Dust Samples
- Certificates of Analysis for Laboratory Results from Hall Environmental Analysis Laboratory (Principal Lab) & Assaigai Analytical Laboratories, Inc. (Control Lab)

[17] *Note*: Appendixes are considered confidential as particular information on sampling sites could disclose the exact location and/or names of residents who permitted sampling, thereby abusing their rights to privacy and personal use of the data.