TABLE 2-3. ADULT LEAD EXPOSURE CALCULATIONS AT COMMERCIAL/INDUSTRIAL FACILITIES, IBWC WORKERS (INVESTIGATION AREA 5)

The average concentration of 45 samples obtained from Smeltertown during the Phase I RI indicated a lead concentration of 790 mg/kg and an Upper Confidence Limit estimate of 1884 mg/kg (Table 2-4 and Figure 2-3). TARA reviewed the findings resulting from the re-evaluation of the IEBK model and concurred that: ***"IBWC workers may not be exposed to lead at levels of concern"***. Therefore, based on TCEQ TARA concurrence, no further investigation or corrective action will be proposed to address the potential exposure due to the incidental ingestion of lead contaminated soil and the inhalation of airborne dust by IBWC workers.

2.3 RIO GRANDE FLOODPLAIN, IN THE VICINITY OF MONITORING WELLS EP-111, EP-127, EP-128, AND EP-132

2.3.1 Background Information

An additional phase of subsurface investigation was recommended in the Rio Grande floodplain area in the vicinity of monitoring wells EP-111, EP-128, EP-127, and EP-132 following the Phase III. Historically, these wells have shown some significant levels of arsenic in groundwater. The primary objectives of this investigation were:

- To further understand the groundwater conditions in the vicinity of monitoring wells EP-111, EP-127, EP-128 and EP-132 (Investigation Area 5).
- To better understand the preferential pathways for the migration of impacted groundwater and to determine whether or not other unknown source metals existed in the area.
- To evaluate the relationship between identified source area materials and groundwater impacts in the historic Smeltertown and the Rio Grande floodplain area (vicinity of monitoring wells EP-111, EP-127, and EP-128).

TABLE 2-4. SUMMARY OF SOIL SAMPLING RESULTS FOR SMELTER TOWN AREA (INVESTIGATION AREA 5), PHASE I REMEDIAL INVESTIGATION (OCTOBER OF 1998)

FIGURE 2-3. INVESTIGATION AREA 5 (FLOOD PLAIN OF THE RIO GRANDE, VICINITY OF EP-111, EP-127, EP-128, AND EP-132), SOIL SAMPLING LOCATIONS

2.3.2 Borings and Monitoring Well Installation

Nine borings ranging in depth from 4 ft to 22 ft deep were installed during the course of this investigation. Five of these borings were converted to monitoring wells (EP-133 through EP-137). All borings/monitoring wells were drilled using a truck-mounted hollow-stem auger drill. Soil samples were collected at one-foot intervals, from the ground surface to a maximum depth of five feet and then every five feet from the five foot depth to the bottom of the boring. The monitoring wells were located on the floodplain of the Rio Grande and in historical Smeltertown (Figure 2-3). Well depths for each monitoring well were determined during the soil boring and sampling activities. Soil samples were collected using a split-spoon sampler.

Monitoring wells were constructed using 4-inch diameter, flush-threaded, Schedule 40 PVC pipe for the riser and screen. The well screen was 0.020-inch machine-slotted PVC with a threaded bottom cap. Above the screened interval, a solid riser was installed with an expanding well plug to seal the well casing. The annulus between the PVC and the outer well bore was filled with 12-20 sieve size sand to a depth of approximately 2 feet above the upper screen interval. Above this interval, bentonite chips were installed and hydrated to a depth of approximately 5 to 10 feet below ground level. The remaining annulus space was filled with concrete to the surface. Wells were completed with an 8-inch diameter, above-ground steel casing with locking cover to a height of 2 to 4 feet above the ground surface.

Upon well completion, all monitoring wells were developed by extracting three to ten well volumes of water. Development water was monitored for pH, specific conductivity, temperature and turbidity until parameter measurements stabilized, indicating representative water was being extracted from the aquifer. Development volumes were based on parameter stabilization and a visual observation of reduced turbidity.

A State of Texas Well Report was completed by the well driller (Raba-Kistner Consultants) and submitted to the Texas Department of Licensing and Regulations to document the well construction activities. Figure 2-4 shows the sampling locations and Appendix D contains the boring logs and monitoring well completion details.

2.3.3 Soil Sample Results

A total of 55 soil samples were collected, including samples used for Quality Assurance/Quality Control (QA/QC). All samples were submitted to Asarco Technical Services Center in Salt Lake City for total metals (arsenic, cadmium, chromium, copper, iron, lead, selenium and zinc) analysis in accordance with EPA method 3050.

Analytical test results for the soil samples showed maximum arsenic, lead and cadmium concentrations of 210 mg/kg, 2,140 mg/kg, and 80 mg/kg, respectively and average concentrations of 38 mg/kg, 286 mg/kg, and 22 mg/kg, respectively for the same metals. Selenium was detected in only five samples at concentrations ranging from bldl (10 mg/kg) to 120 mg/kg. Chromium was detected in all the samples, at concentrations ranging from bldl (10 mg/kg) to 55 mg/kg. Copper was detected in slightly more than half of the samples, at concentrations ranging from bldl (10 mg/kg) to 1,780 mg/kg. Iron was detected in all samples at concentrations ranging from 3,680 mg/kg to 21,400 mg/kg. Zinc was detected in all samples at concentrations ranging from 13 mg/k to 1,180 mg/kg.

Table 2-5 contains a summary of soil sample results. A copy of the analytical data is presented in Appendix B.

2.4 RESIDENTIAL SOIL SAMPLING

2.4.1 Background Information

This section of the report summarizes the work undertaken by Walker and Associates, Inc. for Asarco to determine the source and speciation of lead and arsenic occurring in residential soils in the vicinity of the Asarco El Paso Smelter. The specific objectives of this study were to:

FIGURE 2-4. INVESTIGATION AREA 5 (SMELTERTOWN AREA), PHASE I SOIL SAMPLING LOCATIONS

TABLE 2-5. SUMMARY OF SOIL SAMPLING RESULTS, FLOOD PLAIN OF THE RIO GRANDE, VICINITY OF EP-111, EP-127, EP-128, AND EP-132 (INVESTIGATION AREA 5)

- Examine the chemical data for off-site residential soils to determine if any specific patterns of metal distribution occur.
- Determine whether smelter stack emissions have had an impact on metal contents in the soil.
- Compare the chemistry and species distribution observed in the soil to that observed in samples of other material present at the smelter to determine if these materials are likely to have had an impact on metal content in the residential soils.
- Examine the possible impact that the product of third party crushing operations, which produce slag fines, may have had on metal contents in residential soil.
- Examine the soil samples with low magnification microscopy, X-ray diffraction and scanning electron microscopy to determine the major soil particle composition patterns.

2.4.2 Soil Sample Results

Approximately 339 soil samples were obtained from about 71 sampling locations. At each location, shallow borings (0-18 inches) were advanced using a hand auger. Soil samples for analytical testing were obtained from depths ranging from 0 to 2 inches; 2 to 6 inches; and 6 to 18 inches. All samples were submitted to Asarco's Technical Services Center in Salt Lake City, Utah for total metal analysis by Energy Dispersive X-Ray Flourescence (EDXRF).

Analytical reports of the samples collected displayed arsenic and lead concentrations ranging from bldl (10 mg/kg) to 199 mg/kg and from bldl (10 mg/kg) to 1674 mg/kg, respectively. Exhibit 2 shows all residential sampling locations and a summary of the soil data is presented in Table 2-6.

TABLE 2-6. SUMMARY OF RESIDENTIAL SOIL SAMPLING RESULTS

2.4.3 Speciation Results

The soils were analyzed using a combination of independent analytical methods, each of which provides information on the source of the metals found in the soil. The methods included:

- Total metal content and metals ratios (via X-Y scatter plots) observed in the soils compared to the same ratios in the suspect source material (e.g., air particles);
- Optical microscopy, which can identify soil minerals, particle morphology, and easily identifiable particles such as slag particles, paint, concrete, metal bearing ores and other source material,
- X-ray diffraction (XRD) with heavy mineral separation and thin section analysis, which quantitates soil mineral composition and heavy metal-bearing phases common to ores, slag particles, and other source; and
- Scanning electron microscopy, which allows identification of lead and arsenic bearing phases on the microscopic level and can usually identify small air particles indicative of air emissions.

These methods should all converge on a common accurate description of the source of arsenic and lead in the samples.

Speciation results suggest that lead paint, slag particles, possibly ore concentrate, perlite, and slag-derived fertilizer are the primary human-caused sources of metals in residential soils. No evidence of stack emission particles was observed in any of the residential soils. A report documenting the results of the speciation analysis will be submitted to TCEQ for review.

3.0 HYDROGEOLOGY AND GROUNDWATER RESOURCES

To evaluate the potential of the affected groundwater to impact surface water and groundwater resources, the hydrogeologic characteristics of the main aquifer in the El Paso-Ciudad Juarez area were evaluated. These aquifers include the Mesilla Basin Groundwater aquifer system; the Hueco-Tularosa Bolson; and the Rio Grande aquifer (Figure 3-1).

3.1 MESILLA BASIN GROUNDWATER AQUIFER SYSTEM

The Mesilla Basin aquifer system that includes the Rio Grande Floodplain Alluvium, Mesilla Bolson, and the Jornada del Muerto extends from southern New Mexico to northern Mexico (Conejo Medanos aquifer). The San Agustin Mountains, Organ Mountains, Bishop Cap, and the Franklin Mountains bound this aquifer system to the east. To the west it is delimited by the east and west Potrillo Mountains, Aden Hills, and Sleeping Lady Hills. On the North, the aquifer is bounded by the Robledo Mountains and Dona Ana Mountains. On the southeast, the aquifer is limited by the Sierra de Cristo Rey and the Sierra de Juarez . (Figure 3-1).

The Rio Grande enters the basin through Selden canyon between the Robledo Mountains and Dona Ana Mountains. From Selden canyon the river traverses the Mesilla basin diagonally for approximately 60 miles until it exists into the Hueco Bolson through the El Paso narrows between the Franklin Mountains and the Sierra de Cristo Rey.

Productive aquifers in the Mesilla basin groundwater system occur in both Pleistocene to Holocene-Rio Grande alluvium deposits and the Upper Tertiary and Quaternary unconsolidated sediments of the Santa Fe Group.

FIGURE 3-1. TRANSBOUNDARY AQUIFERS IN THE STUDY AREA

3.1.1 Hydrogeologic Characteristics

The Santa Fe group hydrogeological characteristics vary from place to place due to heterogeneity of its lacustrine, playan, and fluvial and alluvial deposits. The Santa Fe group consists of three hydro-stratigraphic units, which are referred to as the upper, middle and deep units. The upper unit is only saturated in the northern part of the bolson and consists of gravels with lenticular deposits of clay. This unit may be the most permeable based on larger grain sizes and less cementation. The middle unit is less permeable than the upper unit due to a greater degree of cementation. This unit also consists of gravel and lenticular deposits of clay. The lower unit consists of uniform fine sand and averages approximately 600 ft in thickness. In general, the basin fill deposits of the Santa Fe group are deep under the Mesilla Valley and generally thin toward the basin edges. The maximum thickness of the Santa Fe deposits is estimated at 2,500 feet.

Rio Grande Valley Floodplain Alluvium (New Mexico)

The Rio Grande Valley Floodplain consists of alternating and interfingering layers of clay and fluvial facies. These deposits extend laterally for hundreds of feet beyond the valley slopes with a basal gravel layer about 30 to 40 feet thick. Alluvial fill consists of reworked Bolson fill material, eroded bedrock, and extrabasinal sediments transported by the Rio Grande from its headwaters in New Mexico and Colorado. The water generally ranges from 500 TDS to over 1,000 TDS. Transmissivity values range from 10,000 to 30,000 ft^2/day and hydraulic conductivity from 100 to 350 ft/day.

Mesilla Bolson

The major source of the fresh groundwater within the Mesilla Bolson is from the Quaternary to Tertiary age Santa Fe Group. The Santa Fe Group has thick sequences of clay and silt facies that interfinger with fluvial facies, which create confined/leaky aquifer conditions in the basin fill. The largest amount of fresh water can be found in the fluvial facies. This facies varies in depth from 280 ft in the northern part of the bolson to over 2000 ft near the center of the bolson. Hydraulic conductivities range from 2-68 ft/day, 1-

100 ft/day and 1-34 ft/day for the upper, middle and deeper hydrostratigraphic units respectively. Estimates of transmissivity range from 2,600 ft^2/day for the upper intermediate unit to 4,700 ft^2/day for the deep zones.

Jornada del Muerto Bolson

La Jornada del Muerto Bolson is located east of the Rio Grande Valley. It is bordered by the Caballo Mountains and Point of Rocks to the west, the Dona Ana Mountains, San Diego Mountains, and the Tortuga Mountains to the southwest, and the Organ Mountains and the San Andres Mountains to the east. The Jornada del Muerto Bolson is composed of a fluvial facies, a clay facies, and an alluvial-fan facies. It does not have a noticeable boundary with the Mesilla Bolson. The two bolsons are separated by a subsurface Tertiary volcanic rock high bounded by normal faults that extended from Dona Ana Mountains to Tortuga mountain to Fillmore Pass. Estimated transmissivity values in the southern section of the aquifer vary from 5,000 ft^2/day to 15,000 ft^2/day.

3.2 HUECO-TULAROSA AQUIFER SYSTEM

The Hueco-Tularosa Basin is bounded by the San Andres, Organ, and Franklin Mountains on the east and by the Sacramento and Hueco Mountains on the west. The Tularosa Basin is bounded on the north by Chupadera Mesa. A surface divide near the New Mexico/Texas state line separates the Tularosa Basin (a closed basin) and the Hueco Basin (a through-flowing basin) topographically. The two basins are connected by interbasin ground-water flow; therefore, they are considered a single aquifer. Structurally, the Hueco Bolson is created by the down-dropped block between the Franklin Mountains and the Hueco Mountains that subsequently filled with lacustrine and fluvial deposits. In Texas, the Hueco Bolson extends south from the New Mexico/Texas State line to the Sierra de Juarez to the west and to the Sierra del Presidio and Sierra de Guadalupe to the south (Figure 3-1).

3.2.1 Hydrogeologic Characteristics

Basin fill sediments are usually weakly consolidated, heterogeneous material that overly Precambrian through tertiary rocks. Non-indurated units in the Tularosa Bolson include gravels, sands, muds and dune deposits, mostly gypsum sand. Weakly and moderately consolidated basin fill deposits include fanglomerates, conglomerates, soft sandstones, caliche, shale, and gypsum. Coarse materials are deposited on the flanks of the mountains and form alluvial fans. Lacustrine deposits predominate in the center of the Tularosa Bolson and may correlate to the Fort Hancock deposits in the Hueco and Mesilla Bolsons.

Fort Hancock deposits south of the New Mexico State line include lacustrine muds interbedded with layers of bentonitic claystone and siltstone and some discontinuous lenses. Overlying the Fort Hancock formation is the Camp Rice Formation, a Pleistocene unit that consists of stream-channel and floodplain deposits. Deposits in the Camp Rice Formation include predominantly gravels and sands, interbedded with muds, volcanic ash, and caliche.

Hueco Bolson

The Hueco Bolson provides over two-thirds of the municipal water used in the El Paso region with the balance coming from the Rio Grande. The Bolson underlies 70 percent of El Paso County and extends several miles into Mexico where it is also an important source of drinking water. The deepest part of the basin underlies the El Paso International Airport and consists of nearly 10,000 feet of sediments before bedrock is encountered. Transmissivity values in wells in the northern part of El Paso County vary typically from 4,000 to 28,000 ft^2/day. In the central and southern part of the City of El Paso transmissivity values range from 4,000 to 15,000 ft^2/day.

3.3 RIO GRANDE AQUIFER SYSTEM

Southeast of El Paso Narrows, the Rio Grande flows across a broad alluvial floodplain that has incised the surface of the Hueco Bolson. A complex mosaic of braided and meandering river deposits underlies the Rio Grande alluvial floodplain in the El

Paso/Juarez valley. Formed during alternating periods of scour and fill in the late Quaternary period, the river deposits consist of irregularly distributed gravels sands, clay and silt lenses and beds. Alluvial fill consists of reworked Bolson fill material, eroded bedrock, and extrabasinal sediments transported by the Rio Grande from its headwaters in New Mexico and Colorado. Saturated alluvium thicknesses average 188 and 148 ft respectively in the American and Mexican portions of the floodplain. Estimated hydraulic conductivity ranges from 20 to 250 ft/day.

3.4 LOCAL HYDROGEOLOGY

Information gathered during the remedial investigations and consultation of professional publications has been used to assess the geology and hydrogeology of the Asarco Plant and the El Paso Narrows area. El Paso Narrows is the area located between the Franklin Mountains and the Sierra de Cristo Rey (Figure 3-1). The Rio Grande traverses the Mesilla basin and enters into the Hueco Bolson through the El Paso Narrows.

Drilling logs were utilized to generate geological cross-sections across the Plant, as illustrated in Appendix E (Seven geological cross-sections, Figures 2-26 through 2-33 were developed during Phase I RI and five geological cross-sections, Exhibits 2 and 3 were generated during the Phase III RI). Each geological cross-section illustrates the subsurface geology. The geologic units at the facility in order of youngest to oldest (generally shallow to deep) are described below.

- Rio Grande Alluvial Aquifer (Smeltertown Area): Consists of reworked colluvial and terrace deposits. In the upper 20 feet, the unit is predominately sand, silts and clays. This unit is 86 feet thick in El Paso Canyon (Slichter, 1905).
- Arroyo Colluvial (Plant Area and East of I-10): The colluvial fill in these arroyos on the Plant Site generally consists of well-graded silty sands, gravels, cobbles and boulders. Some portions of the unit contain cement of "caliche" calcium carbonate (Lovejoy, 1976). Locally, this unit is estimated to be 300-400 feet thick

in the canyon (Rose, 1953). In the vicinity of the plant, the thickness of this unit is estimated to be between 150 feet and 200 feet.

- Bedrock (Campus Andesite and Areas beneath the Arroyo Colluvial and Rio Grande Alluvial Aquifer): The bedrock unit consists of Tertiary andesites (laccolith), Cretaceous sandstones, shales, limestones and siltstones. The primary porosity of these units is expected to be very low. However, fractures and solution features in limestone units may enhance the hydraulic conductivity in zones of heavy faulting or in solution zones.

- The shallow aquifer located underneath the El Paso Plant is composed primarily of interbedded and mixed sand, gravels, boulders and bedrock. The water is considered separate from the Hueco and Mesilla Bolsons. The aquifer is considered saline, with a total dissolved solid (TDS) concentration ranging from 3,000 mg/l to 10,000 mg/l. Local groundwater elevations fluctuate in conjunction with the amount of water in the Rio Grande. Such fluctuations are a result of seasonal releases of water from Elephant Butte Dam, near Truth or Consequences, New Mexico, which is approximately 100 miles north of El Paso. In the spring, water is released for irrigation purposes, and in the fall the amount of water released is restricted to conserve the water over the winter months.

3.5 GROUNDWATER RESOURCES

3.5.1 Mesilla Bolson

In the southern section of the Mesilla Bolson, near Canutillo, Texas, drinking water is obtained from the deep aquifer at depths greater than 1,000 ft bgs. This aquifer is separated from the shallow Rio Grande Floodplain aquifer by alternating and interfingering layers of clay and fluvial facies. At the El Paso Narrows, the groundwater resource is limited to the shallow Rio Grande Alluvial aquifer. A bedrock high (campus andesite), below this shallow aquifer, prevents much of the groundwater from leaving the Mesilla Bolson into the Hueco Bolson.

3.5.2 Hueco Bolson

The primary source of drinking water for the region is extracted from the poorly sorted, irregularly stratified fluvial deposits of the Camp Rice Formation, which outcrop over most of east El Paso and range from 400 to 1300 feet thick. Depths to groundwater beneath the City of El Paso are usually between 250 ft and 400 ft. Present depths to groundwater beneath Cd. Juarez vary from about 100 ft to 250 ft, except near the Rio Grande where depths are often less than 70 ft. The Hueco Bolson aquifer is separated from the shallow Rio Grande aquifer by alternating and interfingering layers of clay and fluvial facies. Although the two aquifers are considered hydrogeologically connected in the El Paso downtown area, the connection is controlled by aquitards, which prevent shallow groundwater from vertically migrating into the deeper aquifer.

3.5.3 Rio Grande

As indicated above, the Hueco Bolson provides over two-thirds of the municipal water used in the El Paso region with the balance coming from the Rio Grande via the American Canal. The American Canal is managed by the IBWC and is used by the United States to remove water from the Rio Grande for drinking and irrigation purposes.

3.6 POTENTIAL DRINKING WATER IMPACT

The potential for any affected groundwater in the vicinity of the Asarco Smelter to impact the drinking water resources is very unlikely.

The closest boundary of the Mesilla Bolson is located far north and upgradient of the affected groundwater zone. Additionally, drinking water from this aquifer is obtained from depths greater than 1,100 ft.

The boundary of the Hueco Bolson aquifer along the Rio Grande is approximately three miles from the affected groundwater zone. Drinking water from this aquifer is obtained from depths greater than 250 ft. The Hueco Bolson aquifer is separated from the shallow

Rio Grande Alluvium aquifer by alternating and interfingering layers of clay that prevent any vertical hydraulic connectivity between these two aquifers.

This conclusion is further supported by groundwater data gathered from the Leaking Petroleum Storage Tank (LPST) site 98827, owned by the City of El Paso Sun Metro Fleet Maintenance facility. This LPST site is located adjacent to the Rio Grande between the Asarco facility and the City of El Paso downtown area (Figures 3-1 and 3-2 (**73498U38.dwg**)). In 1990, a release of approximately 1,000,000 gallons of diesel from the Sun Metro facility was reported to TNRCC. Approximately 100 borings and monitoring wells were installed to characterize and delineate the extent of the diesel release. In 1991, a remediation system was installed to recover diesel from the groundwater. To date, approximately, 500,000 gallons of diesel have been recovered. Currently, diesel recovery rates vary from 30 gallons to 80 gallons per day. Monitoring data indicate that the diesel plume is confined to the shallow aquifer and not moving. Water wells located in downtown El Paso have not shown any evidence of hydrocarbon impact.

With respect to the American Canal, gauging data indicate that the intersection of groundwater with the bottom of the American Canal occurs (May through October) in the area of monitoring wells EP-20 and EP-6 located approximately half a mile from the affected groundwater zone.

FIGURE 3-2. LOCATION MAP, SUN METRO FLEET MAINTENANCE FACILITY, LPST ID 98827

4.0 GROUNDWATER AND SURFACE WATER INVESTIGATION RESULTS

4.1 OVERVIEW

To comply with the groundwater investigation requirements of the TNRCC Agreed Order, a total of 70 monitoring wells have been installed during four phases of RI activities. The following is a summary of monitoring wells installed:

- Phase I RI - 24 monitoring wells were originally installed (on-Plant and off-Plant) to characterize groundwater conditions.

- Phase II RI - 27 additional monitoring wells were installed with the addition of new IAs to further characterize groundwater conditions associated with the facility.

- Phase III RI - 14 additional monitoring wells were installed with the addition of new IAs for further groundwater characterization purposes.

- Phase IV - 5 additional monitoring wells were installed to further delineate the groundwater conditions within the Smeltertown/Rio Grande floodplain area (IA-5).

Additionally, the groundwater characterization has been supported by approximately 35 pre-existing monitoring wells associated with other environmental projects. The present site-monitoring network has a total of 91 wells. Well completion details are summarized in Table 4-1.

TABLE 4-1. SUMMARY OF MONITORING WELL CONSTRUCTION DETAILS

As part of RI activities, the surface water quality of the Rio Grande and the American Canal has been assessed. The water quality of these two surface water bodies has been characterized by observations at three stations located along the American Canal (SEP-1, SEP-3 and SEP-7) and seven stations located along the Rio Grande (SEP-2, SEP-4, SEP-9, SEP-10, SEP-11, SEP-12 and SEP-13).

Figure 4-1 shows the location of monitoring wells and surface water stations associated with the Remedial Investigation.

A total of twenty-three groundwater/surface water monitoring and sampling events have been performed during the four phases of RI activities. Samples obtained during the Phase I RI were evaluated for total dissolved metals (TD); however, beginning in August of 1999, pursuant to comments provided by the TNRCC and in accordance with the TNRCC Consistency Document, groundwater and surface water samples were analyzed for Total Metals (TMs). After extensive review of the groundwater analytical data, it was concluded that laboratory results for TMs may be significantly influenced by turbidity. As a result, in July of 2001, TD was again included in the sample analyses. Upon completion of the Phase III RI in November of 2001, review of historical analytical data suggested that the presence of metals in groundwater and surface water was well documented. Therefore, a new sampling and monitoring program was proposed (see section 4.2.31 of the Phase III RI and letter dated December 17, 2002)). This proposed program was implemented during the 4th quarter of 2002, 1st and 2nd quarters of 2003. In May 19, 2003, TCEQ responded to the review of the Phase III RI report. In its comments, TCEQ indicated that the proposed sampling and monitoring program was not appropriate at this time. Instead, TCEQ approved a semi-annual groundwater sampling program for all existing monitoring wells (Appendix F).

FIGURE 4-1. SURFACE WATER AND GROUNDWATER SAMPLING LOCATIONS

4.2 PHASE IV RI GROUNDWATER INVESTIGATION

Five groundwater monitoring wells (EP-133 through EP-137) were installed in November of 2002 as part of the Phase IV RI (Figure 4-1). The primary purpose of the Phase IV RI groundwater investigation was:

- To further understand groundwater conditions in the vicinity of monitoring wells EP-111, EP-127, and EP-128 (Investigation Area 5).
- To better understand the preferential pathways for migration of impacted groundwater and to determine whether or not other unknown source metal (arsenic) materials exist in the area.
- To evaluate the relationship between identified source area materials and groundwater impacts in the historic Smeltertown and the Rio Grande floodplain area (vicinity of monitoring wells EP-111, EP-127, and EP-128).
- To evaluate the regional/local hydrogeology and groundwater resources.

4.2.1 PHASE IV MONITORING WELL INSTALLATION

All wells were drilled using a hollow stem auger rig. Each borehole was drilled to total depth using 6-inch outside diameter (OD) augers and then overdrilled to total depth using 10-inch OD augers. Total depths for these wells ranged from 14 to 25 feet bgs.

Wells EP-133, EP-134, EP-136, and EP-137 were installed on land owned by the International Boundary and Water Commission (IBWC). All wells were completed within the Rio Grande alluvium material. The monitoring wells were completed with 4-inch inside diameter (ID) Schedule 40 polyvinyl chloride (PVC) casing with flush joints and threaded couplings within 10-inch diameter boreholes. All wells were completed with 0.020-inch slot well screens. Lithologic logs and construction details for the Phase IV RI monitoring wells are in Appendix D and well construction details are summarized in Table 4-1.

Following completion, each monitoring well was developed by pumping to ensure adequate hydraulic continuity with the aquifer. Groundwater sampling was conducted following well completion and development. All construction, development, and sampling of monitoring wells were consistent with the RI Work Plan.

4.2.2 PHASE IV GROUNDWATER INVESTIGATION RESULTS

Water Table

During drilling activities, the water table depth at the newly installed monitoring wells was encountered at depths ranging from 7.74 ft to 12.15 ft bgs.

Chemical Analysis

Upon completion of monitoring wells, groundwater samples for field and laboratory analysis were obtained from each of the newly installed wells.

Water quality measurements indicate that groundwater was near neutral with pH ranging from 6.49 at well EP-134 to 7.03 at EP-133. Specific conductance (SC) and total dissolved solids (TDS) were moderate, with SC and TDS concentrations ranging from 4,990 μmhos/cm SC (EP-137) and 3,370 mg/l TDS (EP-137) to 9,220 μmhos/cm SC (EP-135) and 7,212 mg/l TDS (EP-135), respectively. Measurements for turbidity ranged from 40 nephelometric turbidity units (ntu) at EP-136 to 126 ntu at EP-134.

The major-ion chemistry of shallow groundwater is generally sodium/potassium and bicarbonate dominated. Sodium concentrations ranged from 833 mg/l at EP-137 to 1,383 mg/l at EP-135. Potassium concentrations ranged from 18 mg/l at EP-135 to 99 mg/l at EP-136. Calcium ranged from 160 mg/l at wells EP-137 to 637 mg/l at EP-135. Magnesium ranged from 60 mg/l at EP-133 to 201 mg/l at EP-135. Sulfate concentrations ranged from 1,456 mg/l at EP-137 to 3,066 mg/l at EP-135. Chloride concentrations ranged from 557 mg/l at EP-1331, to 1,407 mg/l at EP-135.

Dissolved and total arsenic concentrations ranged from bldl (0.005 mg/l) to 2.7 mg/l and 3.0 mg/l, respectively, at EP-135. Dissolved and total cadmium ranged from bldl (0.005 mg/l) to 0.016 mg/l and 0.054 mg/l, respectively at EP-137. Dissolved lead was bldl for all samples. The maximum total lead detected was 0.025 mg/l at both EP-134 and EP-137. Dissolved selenium concentrations ranged from 0.012 mg/l at EP-136 to 0.49 mg/l at EP-137, and total selenium ranged from 0.017 mg/l at EP-136 to 0.46 mg/l at EP-137. The chromium, copper, mercury, and silver total concentrations were below laboratory detection limits Laboratory reports of groundwater samples obtained from the Phase IV monitoring wells are summarized in Table 4-2.

Hydrogeological Characteristics

The hydrogeological conditions in the Smeltertown area/Rio Grande floodplain suggest that the primary source of metals in the underlying groundwater is Category I materials identified throughout the facility. Specifically, from the sediments and process water historically stored in three unlined ponds. This media impacted the underlying groundwater system through percolation and leaching. This impacted groundwater then likely migrated downgradient to Smeltertown/Rio Grande flood plain area via the preferential pathways of the arroyos.

Other source of metals to groundwater included:

- The Medford Sump.
- The Sludge Storage Area.
- The Ephemeral Pond.
- The Pond Sediment Storage Area.
- The Acid Plant 1 and 2.
- Soils Downslope of the Acid Plants and the Medford Sump.
- Soils Downslope of the Lead Plant.

TABLE 4-2. SUMMARY OF GROUNDWATER SAMPLING RESULTS, PHASE IV RI MONITORING WELLS

Exhibit 1 displays the locations of the above mentioned metal source areas. Section 5 presents a detailed discussion of the relationships between on-site source areas and groundwater impacts.

Results of the evaluation of the local and regional hydrogeology and groundwater resources indicate:

- The main aquifers in the area include The Mesilla Basin Groundwater aquifer system; the Hueco-Tularosa Bolson; and the Rio Grande aquifer.
- Geologic units at the facility in order of youngest to oldest include:
  - ✓ Rio Grande Alluvial Aquifer (Smeltertown Area): Consists of reworked colluvial and terrace deposits. This unit is approximately 86 feet thick in El Paso Canyon (Slichter, 1905).
  - ✓ Arroyo Colluvial (Plant Area and East of I-10): It consists of well-graded silty sands, gravels, cobbles and boulders. Locally, this unit is estimated to be 300-400 feet thick in the canyon (Rose, 1953). In the vicinity of the plant, the thickness of this unit is estimated to be between 150 feet and 200 feet.
  - ✓ Bedrock (Campus Andesite and Areas beneath the Arroyo Colluvial and Rio Grande Alluvial Aquifer): The bedrock unit consists of Tertiary andesites (laccolith), Cretaceous sandstones, shales, limestones and siltstones.
- In Texas drinking water from the Mesilla Bolson is obtained from the deep aquifer at depths greater than 1,000 ft bgs.
- The primary source of drinking water in the Hueco Bolson is from the poorly sorted, irregularly stratified fluvial deposits of the Camp Rice Formation, which outcrop over most of east El Paso and range from 400 to 1300 feet thick. Depths to groundwater beneath the City of El Paso are usually between 250 ft and 400 ft.
- A complex mosaic of braided and meandering river deposits underlies the Rio Grande alluvial floodplain in the El Paso/Juarez valley. The Hueco Bolson aquifer

is separated from the shallow Rio Grande aquifer by alternating and interfingering layers of clay and fluvial facies.

- The potential for any affected groundwater in the vicinity of the Asarco Smelter to impact the drinking water resources is very unlikely.

Section 3 provides a detailed discussion of the local and regional hydrogeology and groundwater resources.

4.3 HYDRAULIC GRADIENTS AND GROUNDWATER FLOW CONDITIONS

Groundwater levels on the site typically fluctuate seasonally with high water table conditions in July and August and low water table conditions occurring from November through February. During low flow conditions, the water table depth at monitoring wells located in the Smeltertown area (and adjacent to the Rio Grande) and at the plant site fluctuate between 1.5 ft and 3.0 ft and 1.0 ft and 17 ft, respectively. During high flow conditions, the water table depths at these two locations fluctuate between 0.5 ft and 2.0 ft at Smeltertown area and 1.0 ft to 5.0 ft at the plant site area. Groundwater table elevation maps for the four quarters of 2002 are in Figures 4-2 through 4-5.

The general groundwater flow direction across the site is to the west-southwest, towards the Rio Grande. Flow directions vary locally, particularly on the western half of the Plant where flow lines converge near the arroyos. Flow directions also vary in the Rio Grande alluvium in response to seasonal changes in stream elevations. The hydraulic gradient within the shallow groundwater system beneath the Plant generally ranges from 0.01 to 0.03 feet/foot. Hydraulic gradients in the Rio Grande alluvium are lower, ranging from 0.01 to 0.004 feet/foot with the lowest gradients in the alluvial deposits at the northern end of the site.

FIGURE 4-2. GROUNDWATER ELEVATION MAP, FEBRUARY OF 2002

FIGURE 4-3. GROUNDWATER ELEVATION MAP, MAY OF 2002

FIGURE 4-4. GROUNDWATER ELEVATION MAP, AUGUST OF 2002