DRAFT FINAL

RCRA FACILITY INVESTIGATION REPORT FOR INACTIVE LANDFILL YPG-27 U.S. ARMY GARRISON YUMA PROVING GROUND

Submitted To:

U.S. ARMY GARRISON YUMA PROVING GROUND

Prepared By:

PARSONS

November 2011

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

APPENDICES

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

ADEQ	Arizona Department of Environmental Quality
AGFD	Arizona Game and Fish Department
AMSL	Above Mean Sea Level
bgs	Below Ground Surface
BTV	Background Threshold Values
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
COC	Chemical of Concern
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
CSM	Conceptual Site Model
DoD	Department of Defense
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
°F	Degrees Fahrenheit
ft	Feet
GPL	Groundwater Protection Level
GPR	Ground Penetrating Radar
GPS	Global Positioning System
HI	Hazard Index
HQ	Hazard Quotient
HRA	Human Risk Assessment
HSWA	Hazardous and Solid Waste Amendment
km	Kilometers
LOAEL	Lowest Observable Adverse Effects Level
Ma	Million Years
mg/kg	Milligram per Kilogram
mph	Miles Per Hour
MSWLF	Municipal Solid Waste Landfill
NA	Not Applicable
ND	Non Detect
NFA	No Further Action
NOAEL	No Observable Adverse Effects Level
NRCS	National Resource Conservation Service
nrSRL	Non-Residential Soil Remediation Level
OB/OD	Open Burn/Open Detonation
PAH	Polycyclic Aromatic Hydrocarbon
QAPP	Quality Assurance Project Plan
QSM	Quality Systems Manual
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
rSRL	Residential Soil Remediation Level

ACRONYMS AND ABBREVIATIONS (CONTINUED)

SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
TCLP	Toxicity Characteristic Leaching Procedure
TRV	Toxicity Reference Value
UCL	Upper Confidence Level
U.S.	United States
USAGYPG	U.S. Army Garrison Yuma Proving Ground
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UXO	Unexploded Ordnance
VOC	Volatile Organic Compound
yd^3	Cubic Yard(s)

Registered Professional Engineer (Civil)
CERTIFICATE NO
[illegible]
EDWARD G.
STAES
Date Signed 11/17/11
ARIZONA U.S.A.
Expires 3/31/2012

EXECUTIVE SUMMARY

This report presents the results of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) activities conducted for the inactive landfill YPG-27 at U.S. Army Garrison Yuma Proving Ground (USAGYPG), Yuma Arizona. This report also includes a human health and ecological risk assessment, which evaluates the potential for human health and ecological impacts from assumed exposures to chemicals of potential concern (COPCs) within the site.

The RFI activities at YPG-27 consisted of removal of surface debris followed by a geophysical survey, excavation of test pits, and drilling of soil borings to characterize the landfill and define its boundaries. Subsequent soil samples were also collected and analyzed from the test pits and soil borings.

The surface debris removal action at YPG-27 consisted of the removal and recycling of discarded concrete and surface scrap metal. Following the removal action, a geophysical survey was conducted at the site. Geophysical survey results show magnetic anomalies in an area near the center of the site, which are believed to coincide with buried metallic debris. Based on the results of the geophysical survey, sixteen biased test pits and two soil borings were excavated to define the vertical and horizontal extent of the buried waste. The two soil borings were also used to validate a previous Sting® resistivity model (Jason, 2007). One background test pit and associated soil samples were also collected for use in calculating background threshold values (BTVs) for metals.

A total of 26 soil samples were collected from the test pits and analyzed to define the extent of detectable contamination. At test pits where waste was encountered, subsurface soil samples were collected from within and below the waste. Of the sixteen test pits excavated, only four test pits contained solid waste (027EP004, 027EP 007, 027EP008, and 027EP015), which included wood, glass, rusted metal, cinder block, wire, pipe, bottles, and rusted metal debris. In addition to the samples collected from test pits, two subsurface soil samples were collected from the two soil borings drilled at the site (027SB001 and 027SB002).

A total of 27 surface and subsurface soil samples were collected from test pits and soil borings at YPG-27 and analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), explosives and metals. The vertical and horizontal extent of impacts to soil was determined by comparing soil concentrations of COPCs to remediation goals (State of Arizona residential soil remediation levels [rSRLs] and non-residential [nrSRLs] and the groundwater protection levels [GPLs]). In addition, metals detections were evaluated using BTVs to determine if the detection is a result of site activities.

Analytical results from soil sampling at YPG-27 show that, although multiple organic compounds were detected in site soils, no compounds had concentrations above their corresponding rSRLs or GPLs. Arsenic was the only inorganic compound detected above an rSRL, and exceeded the remediation goal in only one of the 28 samples collected at the site. This elevated detection is believed to be the result of the clay soil conditions from which the sample was collected, which has naturally higher levels of arsenic, lead, iron and other inorganic constituents

Surface and subsurface investigation activities conducted during the RFI delineated the extent of buried waste at the YPG-27, and determined that waste at the site consists of municipal mixed with industrial waste. The presence of charred wood and low levels of hydrocarbons and polyaromatic hydrocarbons (PAHs) suggests some of the waste may have been burnt. No evidence of hazardous waste or munitions debris was identified in the excavation pits at the site, and no further sampling is required.

A human health and ecological risk assessment was performed for YPG-27 to assess potential risks and hazards from exposure to contaminants in soils and to recommend either no further action (NFA) (if the risks and hazards are acceptable) or of the development of cleanup goals and remedial alternatives under a corrective measures study (CMS) task if unacceptable risks or hazards were identified. The results of the human risk assessment (HRA) indicate that there are no chemicals of concern (COCs) identified as potential hazards for human or ecological receptors. Therefore, a CMS is not required.

SECTION 1.0
INTRODUCTION

This report was prepared by Parsons, Inc. (Parsons) for the U.S. Army Garrison Yuma Proving Ground (USAGYPG) located near Yuma, Arizona. The purpose of this document is to present activities, procedures, and results of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) for YPG-27, an inactive landfill located approximately 3 miles south-southeast of the Main Administrative Area, south of Laguna Dam Road. This RFI was performed pursuant to contract number W91ZLK-05-D-0016, Task Order 0002.

The objectives of the RFI were to: 1) collect data to adequately identify and characterize the nature and extent of buried waste and contamination; 2) conduct a risk assessment (human and ecological) to determine if constituents have been released to the environment which pose a risk to human health or the environment; and 3) evaluate if chemical constituents are present at levels that pose a threat to groundwater.

1.1 REGULATORY FRAMEWORK

Six inactive landfills were identified during the RCRA Facility Assessment (RFA) at USAGYPG as potentially containing hazardous waste; therefore, regulatory procedures regarding the landfills have followed the RCRA process as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984. Under Subtitle C of RCRA, the State of Arizona has the authority to implement the RCRA program and many of the HSWA requirements. The Arizona Department of Environmental Quality (ADEQ) monitors RCRA compliance and enforces its provisions at USAGYPG. For example, the USAGYPG is currently operating the open burn/open detonation (OB/OD) areas under a RCRA Part B permit issued in June of 2007. Primarily, RCRA regulations traditionally apply to active waste management facilities; however, HSWA added provisions to RCRA that enable inactive solid waste sites to be investigated and, if needed, remediated through a “corrective action” program. Based on these provisions, the inactive landfill sites at USAGYPG have been included within the USAGYPG Part B Permit and currently fall under the administration of RCRA and ADEQ.

The regulatory framework under which RFIs are completed is the RCRA corrective action process. The authority for RCRA corrective action is derived from RCRA Section 3004(u) and is comprised of four phases:

- RFA - Identifies releases and potential releases of hazardous wastes or constituents from the site.
- RFI - Verifies release(s) from the site and characterizes the nature and extent of contaminant migration.
- Corrective Measures Study (CMS) - Determines appropriate corrective measures for the site.
- Corrective Measures Implementation (CMI) – Provides the design, construction, operation and maintenance, and monitoring of the corrective measures.

An RFA was previously conducted at the six inactive landfill sites (Tetra Tech EM Inc., 1998). This RFA report was completed to satisfy the requirements of the RCRA permit issued by the state of Arizona. Based on the recommendation of the RFA, an RFI has been completed for each of the six inactive landfills.

The six abandoned landfills were identified in the RFA as solid waste management units base records and interviews indicating a potential history of solid waste disposal, which could include the presence of regulated waste such as munitions and solvents. Facility engineering drawings, results of the RFA, and personnel interviews indicate that three of the landfills (YPG-27, YPG-29, and YPG-141) had previously been used by USAGYPG as municipal landfills. However, based on the results of this RFI, regulated wastes were not disposed of at YPG-27. Therefore, the landfill is subject to the rules and statues of the ADEQ Solid Waste Unit under ARS § 49-701 (3)(b) and (29) and the United States Environmental Protection Agency (USEPA) (40 CFR 258.1(c)).

1.2 DESCRIPTION AND HISTORY OF USAGYPG

The USAGYPG installation is located in a remote area of southwestern Arizona, bordered on the west by the Colorado River (Figure 1.1). It lies 37 kilometers (km) (23 miles) northeast of the city of Yuma along U.S. Highway 95, between Interstate Highways 8 and 10, and is approximately 200 km (125 miles) west of Phoenix, Arizona and 288 km (180 miles) east of San Diego, California. The nearest major population center to USAGYPG is the city of Yuma, which has a population of approximately 91,000 inhabitants (U.S. Census Bureau, 2009). The USAGYPG is one of the Department of Defense's (DoD's) largest installations, and encompasses an area of approximately 830,000 acres in size, or roughly 1300 square miles. Comparatively, it is slightly larger than the state of Rhode Island.

The USAGYPG is a general purpose facility with over 50 years of experience testing weapon systems of all types and sizes. Equipment and munitions tested at the installation consist of medium and long-range artillery; aircraft target acquisition equipment and armament, armored and wheeled vehicles, a variety of munitions, and personnel and supply parachute systems. Testing programs are conducted for all U.S. military services, friendly foreign nations, and private industry. The USAGYPG is the Army's center for desert natural environment testing; the management center of cold weather testing at the Cold Regions Test Center (Alaska); and tropic testing at the Tropic Test Center (various locations). It is one of 22 major test ranges that comprise the DoD Major Range Test Facility Base.

Military use of USAGYPG began in 1942 for training desert troops (USAEHA, 1988). The mission changed in January 1943 when the site began to be used as a testing ground for bridges, river crossing equipment, boats, vehicles, and well drilling equipment under the designation Yuma Test Branch, Corps of Engineers. On October 1, 1947, it was designated the Engineering Research and Development Laboratories, Yuma Test Branch, Sixth Army. This installation was deactivated in January 1950 because of a military austerity program; however, on April 1, 1951, it was reactivated as the Yuma Test Station for desert environmental testing of equipment ranging from tanks to water purification units. On August 1, 1962, the station was assigned to the U.S. Army Materiel Command, and on July 1, 1963, it was renamed Yuma Proving Ground (USAEHA, 1988).

Today, USAGYPG has a working population of approximately 3000 people, including test and support soldiers, civil service employees, and supporting civilian contractors. It hosts about 23,000 visitors per year, including test customers, training units, U.S. government and foreign dignitaries, local organizations, and school groups (USAGYPG, 2009).

1.3 REPORT ORGANIZATION

This report contains the results of the RFI activities, including results of a nature and extent evaluation and human health and ecological risk assessment. The report is divided into seven sections and five appendices, and contains the necessary elements as required by the RFI program.

Section 1 **Introduction –** Presents the project overview including the regulatory framework and a description and history of USAGYPG.

Section 2 **Environmental Setting –** Provides a description of the environmental settings of the USAGYPG installation and the YPG-27 inactive landfill site. This section also includes an overview of the site location, description, and history of waste disposed of at the site.

Section 3 **Previous Investigations –** Describes previous investigations and activities conducted at YPG-27.

Section 4 **Nature and Extent Investigation –** Identifies the RFI approach and strategies along with investigation results and recommendations.

Section 5 **Human Health and Ecological Risk Assessment –** Provides an evaluation of the risks associated with potential waste buried at YPG-27.

Section 6 **Summary and Recommendations –** Summarizes human health and ecological risk screening results along with a corrective action evaluation and recommendations.

Section 7 **References –** Provides information resources cited in the report.

Appendix A Field Logs

Appendix B Site Photographs

Appendix C Analytical Data and Quality Control Tables

Appendix D Calculation of Background Threshold Values

SECTION 2.0

ENVIRONMENTAL SETTING

2.1 U.S. ARMY GARRISON YUMA PROVING GROUND FACILITY

2.1.1 Topography

The USAGYPG installation is located within the Sonoran Desert Southern Basin and Range Physiographic Province. The distinctive topography within this province consists of elongate low rugged uplifted mountains trending north-northwest with intervening sediment-filled valleys. The majority of the basins are structural depressions filled with alluvial sediments from the river systems that dissect the area and locally derived sediments from the surrounding mountains (Entech Engineers, Inc., 1988; Argonne, 2004).

Four major landforms are present: 1) alluvial fan (47% of the total area); 2) mountain highlands (27% of total area); 3) active washes (14% of the total area); and 4) alluvial plain (8% of the total area). The remaining 4% of the total USAGYPG land area consists of badlands, pediment, alluvial terrace, old terrace, and dunes (DRI, 2009).

The relief of the mountain ranges is relatively low but the topography is rugged, with slopes locally exceeding 40%. The maximum elevation of 2,822 feet (ft) above mean sea level (AMSL) occurs in the Chocolate Mountains and the lowest elevation, 195 ft AMSL, is just south of the Main Administrative Area. Surface drainage in the northern and western portion of USAGYPG flows west into the Colorado River while the remainder flows south into the Gila River. Most of the surface flow occurs on lowland washes that generally have slopes on the order of 1% to 3% and are dry except during occasional periods of intense rainfall (Entech Engineers, Inc., 1987).

2.1.2 Climate

Because the USAGYPG is in the Sonoran Desert, its climate is typical of a low elevation, hot, arid desert. The average monthly air temperature ranges from a low of 47.6 degrees Fahrenheit (°F) in January to a high of 106.8°F in July (NWS, 2011). The average annual precipitation in Yuma and other areas along the lower Colorado River is approximately 3.5 inches per year (NWS, 2011). Rainfall occurs predominantly in the form of summertime thunderstorms, which are sometimes very intense and produce local flash flooding. Evaporation in the arid climate is very high. The Yuma Citrus Station, located eight miles southwest of the city of Yuma, has an average annual pan evaporation rate of 99.2 inches per year, approximately 30 times the average annual precipitation (2.6 inches per year) (WRCC, 2011).

The wind speed averages from 3 miles per hour (mph) during September through February to nearly 6 mph from March through August. The prevailing direction is from the north-northwest from late autumn until early spring. As temperatures warm, winds shift to a more southerly direction. Winds associated with the summer monsoons shift toward the southeast (Woodcock, 1992).

2.1.3 Soils

Eight distinct soil types based on textural description, in accordance with the National Resource Conservation Service (NRCS), occur over the entire USAGYPG facility. These soil types, along with their corresponding percentages (DRI, 2009) are described in Table 2.1.

2.1.4 Hydrology

2.1.4.1 Surface Water

No perennial lakes or streams are present within USAGYPG, however, two major rivers flow through the adjacent desert. The Colorado River traverses a north-south direction, west of USAGYPG. The mostly dry Gila River drainage traverses an east-west direction, south of USAGYPG. Surface drainage on the northern and western part of USAGYPG flows into the Colorado River, with the central and eastern parts of USAGYPG flowing into the Gila River.

Both rivers have breached their banks during wet years and caused property damage. However, upstream dams and reservoirs, such as Mittry Lake, Martinez Lake, Squaw Lake, Imperial Dam, Ferguson Lake, and Senator Wash Reservoir (all located along the Colorado River west of USAGYPG) and Painted Rock Dam (on the Gila River) have decreased the severity of recent flood events.

Surface water within USAGYPG is limited to brief periods during and after intense rainfall events which produce flash flooding and ponding in low areas (Argonne, 2004). Infrequent rainfall produces localized flash-flooding and temporary surface water, especially during thunderstorms in August and September. Rainfall averages 3.5 inches per year, and the evaporation pan rate is 99.2 inches per year (WRCC, 2011). The combination of low precipitation and high evaporation prevents surface water from infiltrating deeply into the soil. Thus, most of the year, desert washes are dry. The dry washes vary in size, from less than 3 ft in width and depth, to more than a half mile in width and 30 ft in depth. Each wash contains numerous smaller channels that can change course during major flood events.

The USAGYPG has few natural, year-round sources of water. Some natural water sources have been modified to provide year-round water to wildlife. The four types of natural and artificial water sites are described below (Palmer, 1986):

- Tinajas are naturally occurring, bowl-shaped cavities scoured out of bedrock. Tinajas are usually found at the base of waterfalls where the bedrock formation that created the waterfall changes from harder to softer rock. Rocks trapped in the cavity increase scouring. Tinajas are usually located in the mountain canyons.
- Enhanced tinajas are tinajas that have been artificially improved to increase and prolong water storage capacity. Most enhanced tinajas retain water throughout the year.
- Water catchments are storage tanks, sized from 1500 to 34,500 gallons, constructed by Arizona Game and Fish Department (AGFD). These tanks are located in the Cibola and Kofa Regions.
- Other artificial water sources have developed over the years as a result of leaking landscape irrigation pipes, excess water released by stand pipes, or by pumping water into impoundments (Morrill, 1990). These include Lake Alex, which is a well-pumped impoundment near Pole Line Road and north of Red Bluff Mountain in the eastern Kofa Region, and Ivan’s Well, which is a well-pumped impoundment near Growl Road and Kofa Mohawk Road in the Kofa Region.

2.1.4.2 Groundwater

The principal water-producing aquifer within USAGYPG is the unconsolidated alluvial aquifer. This aquifer varies in thickness from tens of feet at the margins of the basins to hundreds of feet in the center of the basins. Based on the results of a hydrogeologic study of this aquifer conducted in the early 1980s (Entech Engineers, Inc., 1988), the top of the groundwater aquifer ranges in elevation from approximately 155 to 200 ft AMSL. The depth to groundwater ranged from 30 ft below ground surface (bgs) in Well X (located in the main Cantonment area near the Colorado River) to greater than 600 ft bgs in Well M (located near the Castle Dome Heliport). Water levels in these wells did not substantially change over a one-year period in 1987 (Entech Engineers, Inc., 1988). The potentiometric surface data suggest that the direction of groundwater flow is southwest toward the Colorado and Gila Rivers. The groundwater gradient is about 4 to 5 ft/mile upgradient of the major pumping wells, and less than about 4 ft/mile near the rivers. Near the rivers, the groundwater elevation becomes shallower, and it may be within 10 ft of the surface in floodplain deposits (Click and Cooley, 1967). Local precipitation and runoff are very minor sources of groundwater recharge.

Groundwater was also observed in the underlying bedrock (Entech Engineers, Inc., 1988). However, in the bedrock the water quality is more mineralized and groundwater flow is much slower than the overlying unconsolidated aquifer due to fracture flow and lack of permeability. According to the U.S. Geological Survey (USGS), the estimated recoverable groundwater in the aquifer of the basin is 50 million acre-ft. The estimated annual inflow and outflow to the aquifer is 65 thousand acre-ft (Freethey and Anderson, 1986).

2.1.5 Geology

The USAGYPG is located within the Sonoran Desert Southern Basin and Range Physiographic Province. The distinctive topography within this province is uplifted mountains with intervening sediment-filled valleys associated with the tectonic extension which started approximately 19 Million years (Ma) ago. The majority of the basins are structural depressions filled with alluvial sediments from the river systems that dissect the area and locally derived sediments from the surrounding mountains (Anderson et al, 1992).

The basement rocks in the vicinity of the USAGYPG and surrounding areas are Pre-Tertiary metamorphic and igneous rocks consisting of schist, gneiss, granite, and weakly metamorphosed sedimentary rocks, all intruded by dikes of diorite porphyry and overlain by a thick series of lavas cut by dikes of rhyolite porphyry. Later Tertiary non-marine red-bed sedimentary rocks and volcanics overlie the basement sequence. The Laguna Mountains and Chocolate Mountains are made up of 33 Ma Tertiary volcanics. The late Tertiary, Miocene-Pliocene Bouse Formation overlies a 5.47 Ma tuff. The Bouse Formation is a massive siltstone unit with a basal limestone and is lacustrine/estuarine in origin.

Pliocene paleo-Colorado River sediments and Quaternary locally-derived alluvium dominate the basin fill. The abandoned landfill YPG-27 and the Main Administration Area are located on deposits of a former channel of the Colorado River. The deposits are an interfingering of locally-derived sediments and Colorado River sediments and gravels. The Colorado River gravels contain well rounded quartzite, chert, and petrified wood. The locally-derived sediments are generally more angular and volcanic in origin. The Colorado River gravels have been incised by more recent smaller drainages and overlapping pediment Quaternary deposits.

The Palomas and Tank Mountains contain mostly extrusive igneous rocks with lesser amounts of metamorphic rocks. Intrusive igneous rocks are also found in the southern part of the Palomas Mountains. The Muggins Mountains are made up of metamorphic and extrusive igneous rocks with some sedimentary rocks. The Middle Mountains are composed of mostly extrusive igneous rocks with metamorphic and sedimentary rocks. The Trigo and Chocolate Mountains are largely extrusive igneous rocks with some metamorphic rocks. The basins or lowlands between mountain ranges are composed of alluvium which is typically comprised of sand, silt, and clay layers of Quaternary origin. The depth of the sediments is not known; however, wells 1,300 ft in depth have not reached the basin’s bedrock floor (Entech Engineers, Inc., 1987). Sand dunes are visible features along the base of some mountains in the USAGYPG vicinity.

Also, there is evidence in the Materiel Test Area that sand dunes existed in the geologic past. Cross-bedded sands, indicating the presence of buried sand dunes, were found by the U.S. Bureau of Reclamation in soil borings at the petroleum, oil, and lubricants bladder test spill site (USBR, 1993).

2.2 YPG-27 - INACTIVE LANDFILL

2.2.1 Location and Site Description

The YPG-27 site is located approximately 3 miles south-southeast of the Main Administrative Area, south of Laguna Dam Road and encompasses an area of approximately 5.03 acres in size (Figures 2.1 and 2.2). Disposal activities at the site may have occurred as early as 1950 to as late as 1964 (Tetra Tech, 1998). Prior to the surface debris removal action in November 2009, a large area (approximately 600 ft by 60 ft) was covered with scattered concrete pieces. In addition, minor amounts of asphalt and soil piles were present along the eastern portion of the site. The surface was also littered with broken glass, burnt wood, cans, and pieces of metal. Localized depressions (trending from north to south) are present in the northeastern portion of the site, which are indicative of soil collapse. These depressions are coincident with magnetic anomalies that were identified during a geophysical (magnetometer) survey conducted at the site (Jason, 2007). Based on these observations along with the results of the RFI, metallic wastes were likely buried in cut and fill trenches at the site. From the geophysical data, it appeared that these lineaments continued in a southerly direction under the large area of surface concrete debris (now removed), indicating that the concrete debris was disposed of over older waste burial trenches.

2.2.2 Topography

The YPG-27 site is generally flat with a slight rise in elevation along the west side and a natural drainage area juxtaposing the east side of the site. The elevation of the site is approximately 235 ft AMSL.

2.2.3 Geology

The shallow subsurface lithology at YPG-27 was obtained from 17 test pits excavated throughout the site and two soil borings drilled to 30 ft bgs (Section 4.1.3). The generalized lithology at YPG-27 consists of a sequence of unconsolidated gravelly sands with interbedded sandy clay and sand units overlying a shallow volcanic bedrock. These unconsolidated deposits are light reddish-brown in color and poorly sorted. The sand is fine to medium-grained. The gravel ranges from pea- to cobble-size, and from angular to subrounded.

The uppermost unit, in which the test pits were excavated, consists of a weakly interbedded sand and gravel, with some silt. This unit is reddish-brown in color with pea-sized gravel of rounded to subrounded clasts. Beneath this unit lies a medium-hard plastic sandy clay approximately 6 ft thick. A fine to medium, light beige to white, well-graded sand underlies the sandy-clay with sand with gravel underlying the sand. While the dominant sediments are sand and gravels, isolated clay horizons have been observed in both test pits and drill core.

The alluvium at YPG-27 is likely the result of two distinct sources: the nearby paleo-Colorado River alluvial deposits; and, secondarily, locally-derived alluvium from the Laguna Mountains to the south and the small hill (elevation 438 ft AMSL) directly behind the landfill. A dry wash from the Laguna Mountains passes to the east of YPG-27 and then turns west towards the Colorado River.

Bedrock was exposed at 8 ft bgs at the base of one of the northwestern test pits (027EP003) and the initial background test pit, located to the southwest of the site, encountered bedrock near the surface. This indicates that bedrock is near surface at the western side of the site. Bedrock consisted of a loosely consolidated medium grained white to light tan sandstone.

2.2.4 Hydrology

2.2.4.1 Surface Water

The YPG-27 site borders a dry wash on the eastern side, and the nearest surface water is Imperial Dam located approximately 3 miles down gradient. During periods of intense rainfall, the drainage area may experience surface water flow for short periods of time.

2.2.4.2 Groundwater

No groundwater was observed in the test pits or borings. However, based on the regional potentiometric surface, groundwater would be anticipated to occur at approximately 115 ft bgs and flow southwest at 1-4 ft per mile (Jason, 2007).

2.2.5 Vegetation and Wildlife

Vegetation at YPG-27 is sparse, and much of the site has been disturbed due to the landfill disposal activities (Figure 2.3). The undisturbed areas are scattered with small bushes and trees that include bursage, creosote, and paloverde. Wildlife at USAGYPG and YPG-27 includes numerous mammals including herbivores, omnivores, predators, and reptiles. There are also over 100 species of birds at the installation. Vegetation and wildlife at the site are presented in more detail in the ecological risk assessment (Section 5.2).

2.2.6 Land Use

At the present time, YPG-27 is no longer operational as a landfill. The future use of the YPG-27 site is expected to continue as undeveloped/vacant land. The site is located on the active Kofa Military Training Range and access to the site is controlled by range control. No physical controls such as fences are present.

SECTION 3.0
PREVIOUS INVESTIGATIONS

This section describes previous investigations and activities conducted at the YPG-27 abandoned landfill. These activities were performed to determine the contents of the landfill and define the shape and size of the landfill area. Investigations conducted at the site include an RFA performed in 1998, a release assessment conducted in 2001, and a geophysical survey performed in 2006.

3.1 1998 RCRA FACILITY ASSESSMENT

The YPG-27 inactive landfill was not visited during the 1998 Facility Assessment; however, the Facility Assessment Report (Tetra Tech, 1998) documented that the site was used for the burial of household and potentially construction debris. Potential industrial wastes may have included solvents, paints thinners, empty pesticide containers, and petroleum sludge from Building 2060 holding tank (Solid Waste Management Unit [SWMU] 17). Detected constituents from the Building 2060 holding tank included various metals, methylene chloride, C10-C22 and C22-34 petroleum hydrocarbons, and PAHs (Argonne, 2004). At the time of the Facility Assessment, there was no indication that sampling at YPG-27 had ever been performed.

3.2 2001 RELEASE ASSESSMENT

During the 2001 Release Assessment, a field team visited YGP-27 and observed construction debris at the surface of the landfill. According to the Release Assessment Report (Argonne, 2001), it was presumed that the landfill was unlined, and the report recommended that information be obtained on the landfill contents, and that geophysics, soil sampling, and if warranted, groundwater monitoring be performed at the site.

3.3 2006 GEOPHYSICAL SURVEY

In 2006 a geophysical evaluation was performed at YPG-27 to assess the apparent lateral limits of buried landfill debris within accessible areas of the site (Jason, 2007). The study included the use of a Geonics EM31 terrain conductivity meter and a

Geomtrics 858 cesium magnetometer in conjunction with a Trimble Pro XRS global positioning system (GPS) for spatial control. In addition, ground penetrating radar (GPR) traverses and a Sting® resistivity survey were conducted along an east-west transect to provide additional information regarding the presence of landfill debris. Results of the geophysical survey indicated the presence of several areas that may contain buried metal or relatively conductive materials. The GPR was essentially ineffective at characterizing the subsurface conditions due to local soil conditions and irregular ground surface, and the results of the Sting® survey showed the presence of a conductive layer and an underlying resistive layer, which was interpreted as indicating that waste may be present as deep as 50 ft bgs.

SECTION 4.0

NATURE AND EXTENT INVESTIGATION

A nature and extent investigation was conducted at YPG-27 as part of the RFI. A description of the investigation activities and the results of these activities are presented in the following sections. This section also presents an evaluation of whether sufficient sampling was conducted to adequately characterize the nature and extent of chemicals detected in site media, and provides data to support a human health and ecological risk screening evaluation.

4.1 INVESTIGATION ACTIVITIES

The investigation activities at YPG-27 consisted of removing surface debris, performing a post-surface removal geophysical survey, excavating 17 exploratory test pits, and drilling two vertical soil borings. Magnetometer geophysical surveys were conducted to outline the areas of subsurface metallic debris disposal. Exploratory test pits were excavated to determine the vertical and horizontal extent of buried debris, and soil borings were drilled to confirm the horizontal extent. Soil samples were collected from the test pits and soil borings to determine if chemical constituents have been released from the waste, and if so, do the constituents pose a threat to human health or the environment. Table 4.1 presents the investigation activities conducted during the RFI and the characterization objectives of each activity.

4.1.1 Surface Debris Removal

A surface debris removal was conducted at YPG-27 in November 2009 to remove debris and recycle concrete and surface scrap metal at the site. The origin of the concrete is unknown; however, based on visual inspection it appeared to be composed of numerous demolished slab-on-grade foundations. The concrete debris consisted of cobble-size pieces to 2 ft by 2 ft slabs with a thickness of between four and six inches. A portion of the concrete contained steel reinforced rebar. The disposal of this concrete appeared to have occurred after the closure of the landfill since it was on top of the burial trenches.

Three waste characterization samples were collected from the concrete prior to removal and were analyzed for toxicity characteristic leaching procedure (TCLP) metals, TCLP semivolatile organic compounds (SVOCs), and TCLP pesticide and herbicides. All TCLP compounds had concentrations less than regulatory limits. Since the slabs of concrete were intermixed with rocks and soil material, concrete was segregated using a 6-inch grizzly separator. The separator allowed the concrete to be removed from material smaller than 6-inch diameter. Only concrete pieces greater than 6 inches in diameter were removed for recycling and reuse. The material that passed through the separator was kept on site. Approximately 1300 cubic yards (yd^3) of concrete was removed from the site and taken to CEMEX cement plant, a local concrete crushing company, for reuse. Surface metal debris was also removed from the site and consolidated with metal debris removed from other landfills. This metal debris was taken to the U.S. Marine Corps Yuma facility for inspection and recycling. Approximately ¼ yd^3 of scrap metal was removed from the site. Photographs of the concrete and other debris removal are shown in Appendix F.

4.1.2 Geophysical Survey

A magnetometer G-858 geophysical survey was conducted on the site following the concrete and surface metal debris removal. The G-858 was also used for the previous magnetic geophysical survey (Jason, 2007). Magnetometer results show an area near the center of the site with a series of linear magnetic anomalies (Figure 4.1). These anomalies are believed to coincide with buried metallic debris. Based on the strength of the magnetic gradient found between the two sensors, it is estimated that the top of the waste is within five feet of the ground surface. The red and blue contoured areas signify the locations with high and low magnetic values (dipole geophysical anomalies) and may represent areas with buried ferro-magnetic debris. These anomalous areas were visually surveyed and no surface waste was present, indicating the anomalies were likely buried metallic debris.

4.1.3 Test Pit Excavations and Soil Borings

Sixteen test pit excavations and two soil borings were used to define the vertical and horizontal extent of potential buried waste. The two soil borings drilled at the site were also used to validate the results of the Sting® resistivity model results. Associated surface and subsurface soil sampling activities were conducted to define the nature and extent of potential chemical contamination. Additionally, one background test pit was excavated and one associated surface and one subsurface soil sample were collected for use in background threshold value (BTV) calculations for metals at the inactive landfills (Appendix D).

Test pit locations were selected following the general strategy outlined in the RFI Work Plan (Parsons, 2010). Based on the results of geophysical survey (Section 4.1.2), the area of YPG-27 was divided into fourteen 200 ft by 200 ft grids, and one or two biased test pits were excavated within each grid cell (Figure 4.1). Five test pits (027EP004, 027EP007, 027EP008, 027EP012 and 027EP015) were excavated at the locations of linear dipole magnetic anomalies found during the geophysical surveys. An additional 11 test pits were excavated in the area of dipole magnetic anomalies (thought to represent ferro-magnetic debris).to determine the horizontal extent of the buried waste. The depth, width, length, and number of soil samples collected from each of the test pits are presented on Table 4.2.

Test pits were excavated using a wheeled backhoe with an extension arm allowing a 15-ft maximum depth of excavation. Debris and soil excavated during the test pit operations were visually inspected by unexploded ordnance (UXO)-qualified technicians for the presence of munition debris. Test pits were oriented perpendicular to the linear geophysical trends in order to cross-cut the suspected burial trenches. Once the soil was inspected by the UXO technicians, the on-site geologist prepared a geologic log of the test pit showing depth of waste, soil type and soil sample locations. Test pit excavation logs are presented in Appendix A. Representative photographs of the test pit operations are presented in Appendix B. Of the 16 test pits excavated, four test pits contained solid waste (027EP004, 027EP 007, 027EP008, and 027EP015), which included wood, glass, cinder block, wire, pipe, bottles, and rusted metal debris (Table 4.2).

Two soil borings were drilled near the locations of two of the test pits where debris was identified (027SB001 near 027EP007 and 027SB002 near 027EP008) to define the vertical extent of contamination and determine if waste extended beyond the vertical boundary of the landfill as shown in the test pit logs (Appendix A). The soil borings were completed adjacent to test pit locations where the greatest depth of waste was identified. Each soil boring was completed to a depth of 30 feet past the bottom of the adjacent test pit excavation. Soil borings were used to investigate the depth of waste and to confirm that additional deeper cells of waste were not present at the site, as had been interpreted previously from Sting® resistivity data (Jason, 2007; Section 3.3).

4.1.4 Soil Sampling Activities

A total of 26 soil samples (including one field duplicate) were collected from within the 16 test pits 027EP001 through 027EP016. Surface (i.e., 0.2-0.7 ft bgs) soil samples were collected from each of the 16 test pit locations. At test pits where waste was encountered, subsurface soil samples were also collected from within and below the waste. In addition to the samples collected from test pits, two subsurface soil samples were collected from the two soil borings drilled at the site (027SB001 and 027SB002). Split spoon samples were collected from the borings to retain as much of the in-place texture as possible. Soil samples appeared to contain the original layered texture and are believed to be residual. Sample depths for each test pit and soil boring are detailed in Table 4.2.

At one test pit location, 027EP008, waste was still visible when the excavation reached 14 ft bgs. At this location, excavation ceased at 15 ft bgs, and samples were collected from the surface, within the waste, and in the soils at the bottom of the excavation. A soil boring was later drilled near this location (027SB002) and a subsurface soil sample was collected at 34.5 ft bgs. The soil boring log at this location shows waste that extends to approximately 15 ft bgs, similar to the depth of waste identified in the nearby test pit. A geologic cross-section showing the relationship between the test pits and the soil boring is presented in Figure 4.2. The cross-section A-A' roughly corresponds to the Sting® resistivity transect (Figure 4.1), showing that waste does not extend below 15 ft bgs.

Two soil samples were collected at the background test pit (027BG001), one from the ground surface (0.2-0.7 ft bgs), and one from the base of the excavation (9-9.5 ft bgs). These samples were analyzed for metals. Data from the background test pit at YPG-27 were combined with background data from other inactive landfill RFI sites at USAYPG to calculate BTVs (Appendix D).

Surface and subsurface soil samples from the test pit locations and soil borings were analyzed for volatile organic compounds (VOCs), SVOCs, explosives, and metals. Default analytes specific to these test panels are provided in the Quality Assurance Project Plan (QAPP, Appendix A of the RFI Work Plan [Parsons, 2010]) and were based on the list of chemicals contained within the DoD Quality Systems Manual (QSM) version 4.1. Complete analytical results for the soil samples are provided in Appendix C (Table C.1). Test pit and soil boring logs are provided in Appendix A, and photographs of the investigation are presented in Appendix B. Test pit locations, including the background excavation, are depicted on Figure 4.1.

4.1.5 Planned Versus Completed RFI Activities

Test pit excavations, soil borings, and sampling activities proposed in the RFI Work Plan (Parsons, 2010) were conducted as planned with the exception of the following minor deviations: 1) the location of the background test pit was moved from the southeast side of the landfill to south of the land fill due to the presence of bedrock at the original location; and 2) based on the geophysical survey, waste was expected to be encountered at 027EP012. However, when the excavation was performed no waste was encountered. Three additional exploratory test pits were then excavated adjacent to the 027EP012 location (027EP012A, 027EP012B, and 027EP012C) to confirm the lack of waste at 027EP012. Only minor surface debris was identified during the excavation of these pits. Samples at this test pit location consisted of one surface soil and one subsurface soil sample collected at the bottom of the original test pit (027EP012).

4.2 INVESTIGATION RESULTS

4.2.1 Data Quality

The analytical data generated from the soil samples collected from the test pits and soil borings have been reviewed, verified and validated with regard to its quality and usability. No major quality control issues were discovered during the quality control assessment and therefore the data are considered complete and usable for decision making purposes. A more detailed analytical quality control summary report is included in Appendix C. Appendix C also contains table of all analytical results (Table C.1).

One data quality issue discussed in Appendix C involves the detections of acetone and methyl ethyl ketone in the majority of samples. This issue was identified, investigated, and these detections were determined to be false positives due to an unknown abiotic soil reaction that occurs with the addition of sodium bisulfate, gamma radiation or heat. Although these detections were determined to be likely false positives, the data was conservatively used in the risk assessment.

4.2.2 Soil Screening Values

4.2.2.1 Background Threshold Values

The objectives of collecting soil samples at YPG-27 were to determine if soils were impacted by waste disposal activities, evaluate the vertical and horizontal extent of impacted areas, and provide data to support human health and ecological risk screening assessments (Section 5.0).

To evaluate metals results and determine if site activities have impacted soils, background test pits were excavated at each landfill and a surface and subsurface soil sample were collected and analyzed for 27 metals. These data were combined into a background soil database. Organic compounds were not analyzed in the background soils and detections of organic constituents are considered site related. The background inorganic data was processed using the statistical approach presented in Appendix A of the RFI Work Plan (Parsons 2010, Appendix A). Statistical calculations of the data were used to derive a BTV for each detected metal. The BTVs represent the ninety-five percent upper confidence level for the background value. The BTV calculation methods, background dataset, and the BTVs for inorganic compounds at the six abandoned landfills are presented in Appendix D.

The BTVs are used to establish background inorganic concentrations to identify soils that may have been impacted by waste disposal activities. If a soil concentration exceeds the BTV at the YPG-27 site, it is assumed that the concentration may be a result of waste disposal activities. Other information and professional judgment such as; changes in soil type or unrealistic concentration trends may support that the soil is not a result of waste disposal activities. Soil sample results at YPG-27 with inorganic concentrations that exceed the BTV and all detections of organic compounds were identified as site related.

4.2.2.2 Remediation Goals

The vertical and horizontal extent of impacts to soil was determined by comparing soil concentrations to remediation goals. Remediation goals include the state of Arizona residential and non-residential soil remediation levels (rSRLs and nrSRLs) and the groundwater protection levels (GPLs). The rSRLs and nrSRLs are published in Appendix A of the Arizona Administrative Code R18-7-205. GPLs are based on state of Arizona guidance document *A Screening Method to Determine Soil Concentrations Protective of Groundwater Quality* (ADEQ, 1996). Vertical and horizontal extent of soil impacted by site activities is defined by soil samples that have concentrations that exceed remediation goals.

4.2.3 Evaluation of Soil Analytical Results

The purpose of this section is to present and evaluate inorganic and organic constituents detected during the investigation. The evaluation includes comparing soil metal concentrations to BTV and remediation goals and comparing inorganic constituents to remediation goals. The specific evaluation includes the following:

1. Identifying chemicals of potential concern (COPCs) detected in site soils with concentrations above BTVs for metals.

2. Determining which (if any) chemicals identified during Step 1 and any detected organic chemicals exceeded corresponding ADEQ rSRLs, nrSRLs, or GPLs.

3. Using professional judgment (consisting of an evaluation of the magnitude, frequency, and spatial distributions of chemical concentrations) to determine if adequate soil sampling was conducted for the chemicals identified in Step 2.

A total of 28 surface and subsurface soil samples (including 1 field duplicate) were collected from test pits and soil borings at YPG-27 and analyzed for VOCs, SVOCs, metals, and explosives (Section 4.1). Locations and analyte concentrations detected above the rSLRs, nrSRLs, or GPLs are presented on Figure 4.3.

Detections in surface and subsurface soil samples consisted of select VOCs, SVOCs, explosives, and metals (Tables 4.3 and 4.4). Surface and subsurface soil samples were collected from soil borings and test pit excavations from biased locations with the greatest potential for contamination based on geophysical and visual survey results reported in Jason, 2007 [Appendix B] and Parsons, 2010. The BTV and rSRL comparison steps are presented below.

Step 1 – Background Threshold Value Comparison

The first step in evaluating impacts to soil at YPG-27 was to compare the analytical soil sample results to the BTVs. The BTV calculation method was identified in the RFI Work Plan and included background samples from YPG-27, -28, -29, -141 and -178 (Appendix D). Table 4.3 presents the inorganic soil sample results for samples collected during the field investigation. Soil concentrations were compared to the BTVs and results shown in bold font indicate values that exceed the BTV. Eleven of the 28 soil samples have inorganic concentrations greater than their respective BTV. These ten samples were collected from the following locations:

- 027EP004
- 027EP007
- 027EP008
- 027EP009
- 027EP015
- 027SB002

Of the 11 samples with inorganic concentrations greater than BTVs, four were collected from within debris zones. Of the remaining seven samples with concentrations greater than BTVs, five were collected from samples underlying the same debris zones (027EP004, 027EP007, 027EP008, 027EP015, and 027SB002; Table 4.3).

Three of the samples collected within the debris zones had multiple inorganics (up to 10) that exceeded the respective BTV. Only two other samples (027EP004, 8-8.5 ft and 027EP015, 8.5-9 ft) had multiple inorganics with concentrations that exceed BTVs. Both of these samples were taken below debris zones. Sample location 027EP015 (8.5-9 ft bgs), had detections of the same inorganic constituents above the BTVs as the overlying debris zone sample collected at 4-4.5 ft bgs; however, at lower concentrations.

Eight inorganic compounds were detected at concentrations that exceed the BTVs at a depth of 8-8.5 ft bgs at sample location 027EP004. The sampling log for this test pit indicates the sample was collected from a clay layer below a debris zone. During the background sampling, clay soils were not encountered and therefore not represented in the BTV calculation (Appendix D). Furthermore, the sample collected within the debris zone at this location only had one inorganic compound (silver) with a concentration that exceeded the BTV. The elevated inorganics detected in the 8-8.5 foot sample are believed to be related to the composition of the clay soil type and do not represent a contamination release.

Step 2 – rSRL and GPL Comparison

The extent of contamination was evaluated by comparing organic (Table 4.4) and inorganic (Table 4.3) analytical results to the ADEQ rSRL and GPL remediation goals. Detected organic compounds and inorganic results with concentrations above BTVs were included in this evaluation (i.e., potentially site-related inorganics). The evaluation showed that although multiple organic compounds were detected in site soils, none had concentrations above their corresponding rSRL or GPL. Three samples had inorganic compound concentrations that exceeded the minimum GPL. These three samples are discussed below.

Arsenic was the only inorganic detected at a concentration that exceeded its corresponding rSRL. This anomalous arsenic detection was from a sample collected below the waste in a clay layer at 027EP004. As discussed above, the elevated level of arsenic is likely due to the clay soil type and not a result of site contamination. Therefore, no further sampling to characterize the extent of arsenic is required.

Lead was detected at concentrations that exceeded the GPL in two samples within debris zones (027EP008 and 027EP015). However, lead concentrations did not exceed the GPL in the deeper interval samples at both locations and were not detected above the GPL at any other location at the site; therefore, the horizontal and vertical extent of lead impacted soil at these locations have been characterized, and no further sampling to characterize the extent of lead contamination is required.

No other inorganic or organic constituents exceeded their corresponding rSRL or GPL. Therefore, the horizontal and vertical extent of potential impacts from disposal activities at YPG-27 has been delineated and additional soil sampling and analyses are not required.

Step 3 - Professional Judgment

Arsenic was the only inorganic compound detected above an rSRL. Arsenic exceeded the rSRL in one of the 28 samples collected at the site. This elevated detection is believed to be the result of the clay soil conditions from which the sample was collected, which has naturally higher levels of arsenic, lead, iron and other inorganic constituents. The relationship of arsenic concentrations and clay mineralogy has been the subject of numerous studies (Petty et. al., 2001; Goldberg, 2000; and Welch et. al., 1998). Early work by Welch and others documented high arsenic concentrations in Arizona groundwater related to the clay mineralogy within the Cenozoic lake beds (Welch et. al., 1988). Welch (1988) associated the attraction of arsenic to the clay minerals due to adsorption onto the large surface areas present on the clay particles. Goldberg (2000) demonstrated that the composition of the clay minerals influences the adsorption capacity of arsenic onto the mineral surface. A study of 260 Mississippi background soils showed a direct correlation between the concentration of arsenic and the percentage of clay (Petty et al., 2001). Based on the established relationship between clay content and the elevated arsenic result detected at YPG-27, arsenic in this isolate soil sample is considered representative of background conditions and not assessed as a COPC in the risk assessment (Section 5).

4.3 CONTAMINATION ASSESSMENT

The abandoned landfill YPG-27 is situated adjacent to a dry stream bed which receives storm run-off during major precipitation events. During the geophysical survey conducted in 2006 (Jason, 2007), a cesium gradiometer magnetometer was used to determine the extent of the metallic buried waste. The magnetometer was found to be effective in identifying suspect burial areas. Electromagnetic methods were also tested and corroborated the magnetic survey results. Sting® resistivity surveys were also conducted to evaluate the depth of burial at the site. The Sting® resistivity results were not definitive but suggested that depth of burial could be as deep as 50 ft bgs (Section 3.3).

In November 2009, a surface removal of 1,200 yd^3 of concrete and surface scrap metal was completed. Once the surface was cleared, a post-removal geophysical survey was conducted to obtain additional information about the potential locations of subsurface debris. A series of north-south and northwest-southeast linear anomalous zones were identified, believed to be representative of buried debris in trenches (Section 4.1.2). Investigation of the area consisted of excavating 17 test pits with one of these excavations used to represent background conditions. Debris was encountered within four of these pits and correlated with the location of geophysical anomalous zones. Debris identified within the test pits included wood, glass, cinder block, wire, pipe, bottles, and rusted metal debris. Each test pit excavation was supervised by UXO technicians who visually inspected the material for evidence of munition debris. No evidence of munition debris was identified.

A total of 28 soil samples were collected from the test pit excavations and soil borings. These samples were collected from above the waste (surface), within the waste itself, and soils underlying the waste. Arsenic from one sample was the only inorganic compound that exceeded an rSRL. This anomalous arsenic detection correlated with the only sample collected from clay rich soil and is not believed to be representative of a contamination release. Numerous detections of organic compounds were detected sporadically across the site; however, these detections were near the method detection limit (i.e. trace levels) and were in most cases one to two orders of magnitude lower than any remediation goals (i.e., the rSRLs and GPLs).

Two soil borings were completed along the Sting® resistivity transect to determine the validity of the technique in predicting the depth of the landfill. These borings were completed adjacent to two test pits excavated where waste was encountered to depths of eight and 14 ft bgs, respectively. Each soil boring was completed to a depth of 30 feet past the bottom of the adjacent test pit excavation. Debris was not found in either boring past the bottom of the adjacent test pit. Split spoon samples were collected from the borings to retain as much of the in-place texture as possible. Soil samples appeared to contain the original layered texture and are believed to be native. The lack of any additional waste and the presence of the original soil layering indicate that the landfill burial was probably a cut and fill operation. A dozer was probably used to cut a long linear trench and debris was buried in the trench and either burned or soil was pushed over the trench. This type of disposal operation was common for small landfill sites operating during the 1950-1960 time-frame.

4.4 NATURE AND EXTENT RECOMMENDATIONS

Surface and subsurface investigation activities conducted during the RFI indicate the debris identified within the landfill consists of municipal mixed with industrial waste. The presence of charred wood and low levels of hydrocarbons and PAHs suggests some of the waste may have been burned. No evidence of hazardous waste or munitions debris was identified in the excavation pits at the site. Soil sampling results show lead concentrations below the residential soil screening level, but slightly exceeding the minimum GPL in two test pit samples. These samples were collected from within the waste layer, and the elevated lead is most-likely related to metal debris. Solid metal debris is highly stable in the environment and does not migrate to any significant degree. This is confirmed by the deeper interval soil samples collected from within these two test pit locations, and shows there is no evidence of vertical migration. Based on the above findings, the nature and extent of burial operations and associated contamination at YPG-27 has been delineated and no further sampling is required.

SECTION 5.0

HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

The objectives of the human health risk assessment (HRA) and ecological risk assessment (ERA) were to:

- Assess potential risks and hazards from exposure to site soils.
- Support development of either a no further action (NFA) decision (if no unacceptable risks or hazards are identified) or cleanup goals and remedial alternatives under the CMS task (if unacceptable risks and/or hazards are identified).

This Section presents the methods and results of the HRA and ERA performed as one of the steps of the RFI for YPG-27.

5.1 SCREENING LEVEL HUMAN HEALTH RISK ASSESSMENT

This screening level HRA evaluates the potential for human health impacts from assumed exposures to COPCs within YPG-27, an inactive landfill at USAGYPG in Yuma, Arizona. The results of this HRA provide a basis for decisions regarding further action, if necessary, with respect to the COPCs at the site.

Following USEPA (1989) guidance, the HRA process consists of six major components:

- Development of the Conceptual Site Model (CSM)
- Selection of COPCs
- Estimation of chemical exposure
- Toxicity assessment
- Risk characterization
- Uncertainty analysis

Each step of the HRA process is discussed in detail below. This HRA was conducted using methods consistent with USEPA (1989, 1990, 2002, 2010) guidance.

5.1.1 Development of the Conceptual Site Model

Developing a CSM is a critical step in properly evaluating potential exposures at a site. The CSM is a comprehensive representation of the site that documents the potential for exposure (under current and future land use) to chemicals at a site based on the source of contamination, the release mechanism, migration routes, exposure pathways, and receptors either at the site or that may reasonably be anticipated to be at the site (USEPA, 2002).

As discussed in Section 2.2.1, YPG-27 is located approximately 3 miles south-southeast of the Main Administrative Area, south of Laguna Dam Road (Figure 2.1) and encompasses an area of approximately 5.03 acres in size (Figure 2.2). The site has been listed in the base master plan as "to be removed from consideration for new construction projects," meaning that there are no plans for development of the site in the future. Although residents and industrial workers are not present at the site, and will not be present at the site in the future, they were selected for evaluation to evaluate whether the site qualifies for an NFA determination or closure under an industrial use scenario. Therefore, two hypothetical human receptors were evaluated: 1) residents and 2) industrial workers.

5.1.2 Selection of Chemicals of Potential Concern

The COPCs are those chemicals detected in environmental media at the site for which human contact may result in adverse health effects. The selection of COPCs consisted of a three step process, as follows:

- Data review;
- Exclusion of essential nutrients;
- Identification of metals elevated above background; and
- Screening against risk-based screening levels.

Each of these steps is presented below.

The data collected at the site is presented in detail in Section 4. Briefly, 28 soil samples (including 1 field duplicate) were collected and analyzed for metals, VOCs, SVOCs, and explosives per the methods specified in the QAPP (Appendix A of the RFI Work Plan [Parsons, 2010]). Soil samples were collected from surface soils (0.2-0.7 ft bgs) at all sampling locations, with subsurface samples collected at depths up to 35 ft bgs (Table 4.2).

The validated data collected at 0-10 ft bgs was evaluated in the selection of COPCs. Data validation classified the data through the use of several qualifiers (Appendix C). Data without qualifiers and data with J qualifiers were considered appropriate for risk assessment purposes (USEPA, 1989, 1992). U and UJ qualified data were considered to be non-detect (ND) but usable for risk assessment purposes. NJ qualified data were treated as detections, although they were determined to be potentially false positives (Appendix C). The R qualified data were excluded from this risk assessment (USEPA, 1989, 1992).

Essential human nutrients that are toxic only at very high doses (i.e., much higher than those associated with exposure at a site) were excluded as COPCs. These include calcium, iron, magnesium, potassium, and sodium (USEPA 1989).

Next, metals were compared to the BTVs (see Appendix D). Metals detected at concentrations below the BTVs were assumed to be present at background concentrations and were not evaluated further, while metals detected at concentrations greater than the BTVs were evaluated in the next step. The following metals were detected at concentrations greater than the BTVs at 0-10 ft bgs (Table 5.1):

- Aluminum
- Arsenic
- Beryllium
- Cadmium
- Chromium, total
- Copper
- Lead
- Manganese
- Molybdenum
- Nickel
- Silver
- Zinc

Last, the maximum detected concentrations of inorganics exceeding the BTVs and all detected organic compounds were compared to the ADEQ (2007) rSRLs. Those chemicals detected at concentrations exceeding the rSRLs were identified as COPCs for evaluation in the HRA.

Only arsenic was detected at concentrations exceeding the rSRLs (Table 5.1). The maximum detected concentration of arsenic (12.2 milligrams per kilogram [mg/kg]) was collected from 027EP004 at 8-8.5 ft bgs (Table 4.3). This anomalous arsenic detection was from a sample collected below the waste in a clay layer at 027EP004. As discussed in Section 4.2.2, the elevated level of arsenic is likely due to the clay soil type and not a result of site contamination (Figure 4.2). Aside from the sample collected at 8-8.5 ft bgs from 027EP004, the maximum detected arsenic concentration at YPG-27 was 4.01 mg/kg (Table 4.3), including the samples collected within the waste material. The elevated arsenic in 027EP004 at 8-8.5 ft bgs is not indicative of leaching from the waste material, as the arsenic concentration in the corresponding sample at 5-5.5 ft bgs was only 3.36 mg/kg (Table 4.3). Further, the moisture content of the soil samples collected above the clay layer at the site (i.e., 0.06 to 3.5%; Table C.1 of Appendix C), indicate that there is insufficient water for either leaching or infiltration to occur. However, arsenic adsorbs to clays, which often makes clays higher in arsenic concentrations (Section 4.2.2). Thus, the arsenic in this sample is believed to be representative of the clay layer from which the sample was collected and is not indicative of contamination. Therefore, arsenic was not identified as a COPC.

Since no COPCs were selected for evaluation at this site, no further evaluation is required, as detailed in the approved work plan (Parsons 2010). Therefore, risks to human health from potential exposures to COPCs at YPG-27 are not anticipated and further action is not needed at the site on the basis of human health risk.

5.2 ECOLOGICAL RISK ASSESSMENT

This ERA evaluates the potential for ecological impacts from potential exposure to chemicals of potential ecological concern (COPECs) in soils at YPG-27. The results of this ERA provide a basis for consideration in making decisions regarding further action with respect to the COPECs in soils at the site. This section presents a summary of the ERA for YPG-27. The ERA is presented in detail in Appendix E.

Following USEPA (1997, 1998) guidance, the ERA process consists of four major components:

- Problem formulation
- Analysis
- Risk characterization
- Uncertainty analysis

This section presents a summary of the ERA for YPG-27. The ERA is presented in detail in Appendix E. Each step of the ERA process is summarized below

5.2.1 Problem Formulation

5.2.1.1 Habitat Characterization

The USAGYPG is located in the Sonoran Desert, a low elevation, hot, arid desert. It is characterized by high daytime temperatures with large daily temperature variations, low relative humidity, and very low average precipitation. No perennial lakes or streams occur within USAGYPG; however, two major rivers flow through the adjacent desert; (i.e., the Colorado and Gila Rivers) See Section 2.1 for additional information regarding the climate and surface water hydrology of USAGYPG.

Approximately 62 species of mammals, 141 species of birds, 33 species of reptiles, and three species of amphibians have been observed at USAGYPG. No fish have been recorded at USAGYPG. Numerous plant species have been recorded at USAGYPG, including eight Arizona special status species (Table E.1).

5.2.1.2 Site Description and Land Use

As discussed in Section 2.2.1 and 5.1.1, YPG-27 is a 4.59 acre area located approximately 3 miles south-southeast of the Main Administrative Area, south of Laguna Dam Road (Figures 2.2 and 2.3). The site was used as a landfill from approximately 1950 to 1964 (Tetra Tech EM, Inc, 1998). Currently, the site is vacant with no structures. Further, the site has been listed in the base master plan as “to be removed from consideration for new construction projects,” meaning that there are no plans for development of the site in the future. Therefore, the site will remain open land for the indefinite future.

Much of the site has been disturbed by past landfill disposal activities and has little to no vegetation (Figure 2.3). In the undisturbed parts of the site, there are scattered small bushes and trees, including bursage, creosote, and paloverde (Section 2.2.5).

5.2.1.3 Selection of Representative Ecological Receptors

Ecological receptors (i.e., representative species) include non-domesticated plants and wildlife that may reasonably be expected to inhabit or regularly forage at the site, given current and anticipated future site conditions. As recognized by ERA guidance documents, it is impractical to evaluate all possible ecological receptors for a given site. Instead, a few species representative of the habitat functions and trophic structure present are selected for evaluation in the ERA. The representative species selected for evaluation are listed below in Table 5.2.

5.2.1.4 Selection of Chemicals of Potential Ecological Concern

Five COPECs were selected for evaluation in this ERA:

- Cadmium
- Copper
- Lead
- Manganese
- Zinc

The COPEC selection process is described in detail in Appendix E.

5.2.1.5 Exposure Pathways

Exposures to COPECs were quantitatively evaluated for the following pathways at YPG-27:

- Incidental ingestion of soils
- Ingestion of site-associated biota

These pathways are described in detail in Appendix E. Note that there is no surface water at YPG-27 and groundwater occurs at approximately 115 ft bgs. Therefore, the surface water, sediment, and groundwater exposure pathways were determined to be incomplete and were not evaluated.

5.2.2 Analysis

Toxicity reference values (TRVs) are used to evaluate the potential hazards from the exposure estimated for each COPEC. TRVs protective of reproductive and developmental effects were used in this ERA. The sources from which the TRVs were obtained are provided in Appendix E.

To estimate exposures, exposure point concentrations (EPCs) were calculated for the COPECs in soils as the lesser of the upper confidence level (UCL) and the maximum detected concentration. For plants and invertebrates, the soil EPC was used to evaluate exposures. For birds, mammals, and reptiles, dietary exposures were estimated using bioaccumulation models, estimated ingestion rates, and dietary composition. The models and parameters used to estimate dietary exposures are described in detail in Appendix E.

5.2.3 Risk Characterization

Risk characterization involves two components; hazard estimates and risk description. For vertebrates, hazard estimates are based on the comparison of average daily dose to the chemical- and receptor-specific TRVs and are expressed as a hazard quotient (HQ). For invertebrates and plants, the HQ is calculated by dividing the soil EPC by the benchmark concentration. The HQs greater than one indicate that adverse effects may occur. A no observable adverse effects level (NOAEL)-based HQ of 1 is the threshold at or below which the contaminant is unlikely to cause adverse ecological effects; NOAEL-based HQs greater than 1 indicate that exposures exceed a no-effect dose and do not necessarily indicate that adverse effects will occur. Lowest observable adverse effects level (LOAEL)-based HQs better indicate the potential for adverse effects to receptors because they are based on effect-based toxicological data. Thus, LOAEL-based HQs greater than one indicate that adverse effects will probably occur, but whether or not significant effects would actually occur cannot be judged with certainty.

5.2.3.1 Plant and Invertebrate Receptor Hazard Estimates

The EPC for manganese exceeded the benchmark concentration for plants and the EPC for zinc exceeded the screening levels for both plants and invertebrates (Table E.12 of Appendix E). However, based on an evaluation of exposures at the site compared to background conditions, there is no incremental increase in the HQ over background from exposures to manganese at the site (Appendix E). For zinc, the contribution from background exposures is relatively small and, therefore, the HQs (2 and 3 for plants and invertebrates, respectively) are mostly site-related. This indicates that that there is a low potential for adverse effects to plants and invertebrates from estimated exposures to zinc at the site (Table E.12 of Appendix E).

5.2.3.2 Vertebrate Receptor Hazard Estimates

For the vertebrate receptors, the LOAEL-based HQs for all receptors and the NOAEL-based HQs for kit foxes, little pocket mice, American kestrels, Gambel's quails, verdins, and Sonoran desert tortoises were all less than one, indicating that exposures to soil at YPG-27 are not likely to pose a threat to these vertebrate wildlife receptors. The only NOAEL-based HQ that exceeded one was the NOAEL-based HQ for assumed desert shrew exposures to cadmium. As discussed in Section 5.2.3 above, NOAEL-based HQs greater than one indicate a need for further evaluation and do not necessarily indicate that adverse effects will occur.

All hazard indices (HI; i.e., the summation of the HQs for all COPECs were less than one, with the exception of the NOAEL-based HIs for the desert shrew and the verdin, which were 4 and 2, respectively (Table E.13). However, adverse effects due to site-related exposures are unlikely for desert shrews and verdins based on a comparison of site HQs with HQs calculated for background conditions (see Tables E.13 and E.14). In addition, corresponding LOAEL-based HIs for both receptors were less than the threshold of one, which indicate that adverse effects are not likely.

Based on the results of the ERA, concentrations of COPECs in site soils do not pose a threat to ecological receptors and further action is not needed at the site on the basis of ecological risk.

5.2.4 Uncertainty Analysis

All risk assessments involve the use of assumptions, professional judgment, and imperfect data to varying degrees, which results in uncertainty in the final hazard estimates. A complete discussion of the uncertainties associated with this ERA is presented in detail in Appendix E.

5.3 SOIL-TO-GROUNDWATER EVALUATION

Lead was detected at a concentration that exceeded the GPL in one sample within a debris zone (027EP008). However, lead concentrations did not exceed the GPL in the deeper interval sample and was not detected above the GPL at any other location at the site; therefore, the horizontal and vertical extent of lead impacted soil at this location has been characterized, and no further sampling to characterize the extent of lead contamination is required.

5.4 CONCLUSIONS OF THE RISK ASSESSMENT

One of the final steps of an RFI includes an evaluation of the human health and ecological risks associated with potential exposure to hazardous constituents which may be present at a site. The objectives of this risk assessment were to assess potential risks and hazards from exposure to contaminants in soils and to recommend either NFA (if the risks and hazards are acceptable) or of the development of cleanup goals and remedial alternatives under a CMS task if unacceptable risks or hazards were identified. The results of this risk assessment indicate that there are no chemicals of concern (COCs) identified as potential hazards for human or ecological receptors. Therefore, a CMS is not required.

SECTION 6.0

SUMMARY AND RECOMMENDATIONS

An RFI has been completed at YPG-27 to 1) collect data to adequately identify and characterize the nature and extent of buried waste and contamination, including to determine whether regulated waste is present in the abandoned landfill; 2) conduct a risk assessment (human and ecological) to determine if constituents have been released to the environment which pose a risk to human health or the environment; and 3) evaluate if chemical constituents are present at levels that pose a threat to groundwater.

The landfill was reported to have received municipal and industrial waste between 1950 and 1964 (Tetra Tech, 1998). Surface debris removed from the site consisted of concrete and rusted metal debris such as strapping, cans, and wire. Geophysical surveys were completed and outlined areas where subsurface metal debris burial occurred. Test pit excavations and soil borings were conducted to determine the nature of the waste and to collect soil samples. Debris encountered during test pit excavations was visually inspected by UXO technicians for the presence of military munitions. No munitions or munition debris were identified and debris was consistent with municipal and industrial waste. Waste consisted of wood, glass, cinder block, wire, pipe, bottles, and rusted metal debris.

A total of 28 soil samples (including one field duplicate) were collected from the surface and subsurface soils. With the exception of one arsenic result collected from a clay type soil in one of the test pits (027EP004), results of soil and debris sampling performed at the site did not detect inorganic or organic compounds above the rRSLs or GPLs. The spurious arsenic result was determined to be an artifact of the clay soil type from which the soil sample was collected and is not representative of a release from landfill waste (Sections 4.2.3 and 5.1.2). Based on the nature and extent evaluation presented in Section 4.0, the waste and associated soil contamination associated with the landfills has been adequately characterized and further characterization activities are not warranted.

Analytical results obtained from the site were used to complete an HRA and ERA. The risk assessment concluded that the site does not pose unacceptable risks to potential human or ecological receptors (Section 5.0).

Hazardous (regulated) waste was not identified at the site during RFI activities. Therefore, the landfill is subject to the rules and statutes of the ADEQ Solid Waste Unit under ARS § 49-701 (3)(b) and (29) and USEPA 40 CFR 258.2. Under this rule, YPG-27 meets the criteria for a closed municipal solid waste landfill (MSWLF) unit. These regulations define a MSWLF as

> …a discrete area of land or excavation that receives household waste, and that is not a land application unit, surface impoundment, injection well, or waste pile. A MSWLF unit also may receive other types of RCRA subtitle D wastes, such as commercial solid waste, nonhazardous sludge, conditionally exempt small quantity generator waste and industrial solid waste. Such a landfill may be publicly or privately owned.

The YPG-27 landfill ceased receiving waste before January 1, 1986; therefore, the landfill is a non-regulated solid waste landfill (ARS § 49-701 (3)(b) and (29)). However, it is recommended that a post closure plan be developed to: 1) address surface runoff control to prevent uncovering of the debris; 2) conduct annual inspections for identifying subsidence and the uncovering of any debris; and 3) survey the area and incorporated into the USAGYPG Master Plan, given that waste is left in-place.

SECTION 7.0

REFERENCES

ADEQ (Arizona Department of Environmental Quality). 1996. *A Screening Method to Determine Soil Concentrations Protective of Groundwater Quality.* Prepared by the Leachability Working Group of the Cleanup Standards/Policy Task Force. September.

ADEQ (Arizona Department of Environmental Quality). 2007. Arizona Administrative Code Title 18, Chapter 7: Remedial Action. March.

Anderson, T. W. et al., 1992. *Geohydrology and Water Resources of Alluvial Basins in South Central Arisona and Parts of Adjacent States,* U.S. Geological Survey Professional Paper 1406

Argonne (Argonne National Laboratory). 2001. *Final Release Assessment for Solid Waste Management Units at Yuma Proving Ground, AZ.* Environmental Sciences Divisions. June.

Argonne. 2004. *Final Remedial Investigation Report for Selected Sites at Yuma Proving Ground, Arizona*. Prepared for the Environmental Sciences Division, Yuma Proving Ground. March.

Click, D.E., M.E. Cooley. 1967. *Synopsis of Groundwater Conditions in the Southwestern Part of the Yuma Proving Ground*, Arizona, U.S. Geological Survey, Tuscon, Arizona. April.

DRI (Desert Research Institute). 2009. *Landforms and Surface Cover of U.S. Army Yuma Proving Ground*. September.

Entech Engineers. Inc. 1987. *Yuma Proving Ground Hydrologic and Pollution Investigation Study, Cibola and KOFA Ranges*. Los Angeles: U.S. Army Corps of Engineers, Los Angeles District.

Entech Engineers, Inc. 1988. *Geohydrologic Study of the Yuma Proving Ground with Particular Reference to the Open Burning/Open Detonation Facility at Yuma County, Arizona*, prepared for U.S. Army Corps of Engineers, Los Angeles District.

Freethey, G.W., T.W. Anderson. 1986. *Predevelopment hydrologic conditions in the alluvial basins of Arizona and adjacent parts of California and New Mexico*: U.S. Geological Survey Hydrologic Investigations Atlas HA-664, 3 pl.

Goldberg, S. 2000. *Competitive Adsorption of Inorganic Arsenic Species on Oxides and Clay Minerals.* Presented at the Chemical Speciation and Reactivity in Water Chemistry and Water Technology: A Symposium in Honor of James J. Morgan. August 20-24.

Jason (Jason Associates Corporation). 2007. *Final Geophysical Evaluation Inactive Landfills Solid Waste Management Units* (SWMUs):37 (CCYPG-027), 36

(CCYPG-028), 41 (CCYPG-029), 39 (CCYPG-141), 40 (CCYPG-143) and CCYPG-178. U.S. Army, Yuma Proving Ground. February.

Morrill V. 1990. *U.S. Army Yuma Proving Ground Horse and Burro Waters* Unpublished Survey, Laguna Army Airfield and Directorate of Environmental Sciences. Yuma: U.S. Army Yuma Proving Ground.

NWS (National Weather Service). 2011. New 1981-2010 Climate Normals. http://www.wrh.noaa.gov/psr/pns/2011/July/newNormals.php. July.

NCRS (Natural Resources Conservation Service). 2011 http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Palmer, B. 1986. *Special Status Species Summary Report, Yuma Proving Ground.* Phoenix: Arizona Game and Fish Department, Special Services Division.

Parsons. 2010. *Final RCRA Facility Investigation Work Plan for Inactive Landfills and Muggins Mountain OB/OD Sites for U.S. Army Garrison Yuma Proving Ground*. May.

Petty, J.D., May, T.W., Schmitt, C.J., Brumbaugh, W.G. 2001. *Arsenic concentrations in U.S. freshwater fish, 1976-1986: National Contaminant Biomonitoring Program, U.S. Geological Survey Workshop on Arsenic in the Environment.* February 20-21, Denver, CO (extended abstract at *http://wwwbrr.cr.usgs.gov/Arsenic/*).

Tetra Tech EM Inc. 1998. *Final RCRA Facility Report*. U.S. Army Yuma Proving Ground, AZ. August.

USAEHA (U.S. Army Environmental Hygiene Agency). 1988. *Evaluation of Solid Waste Management Units, Yuma Proving Ground, Yuma, Arizona*, Interim Final Report, Groundwater Contamination Survey No. 38-26-0882-89, Aberdeen Proving Ground, MD. August 21–31.

USAGYPG (U.S. Army Yuma Proving Ground). 2009. The History of USAGYPG and Base Population Available at http://www.yuma.army.mil.

USBR (U.S. Bureau of Reclamation). 1993. *Preliminary Site Assessment for the Petroleum, Oil, and Lubricant Test Site at the U.S. Army Yuma Proving Ground*. September.

USEPA (U.S. Environmental Protection Agency). 1989. Risk Assessment Guidance for Superfund (RAGS). Human Health Evaluation Manual Part A. Interim Final. OSWER 9285.701A. EPA/540/1-89/002.

USEPA. 1990. National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (Final Rule). 40 CFR Part 300: 55 Federal Register 8666.

USEPA. 1992. Guidance for data usability in risk assessment (Part A) Final. Publication Number 9285.7-09A.

USEPA. 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments EPA540-R-97-006.

USEPA. 1998. Guidelines for Ecological Risk Assessment EPA/630/R-95/002F.

USEPA. 2002. Supplemental guidance for developing soil screening levels for Superfund sites. OSWER 9355.4-24.

USEPA. 2010. ProUCL Version 4.1 User guide. statistical software for environmental applications for data sets with and without nondetect observations. EPA/600/R-07/041.

USEPA. 2011. Ecological Soil Screening Levels. Available online at: http://www.epa.gov/ecotox/ecossl/

U.S. Census Bureau. 2009. Incorporated Places and Minor Civil Divisions at http://www.census.gov/popest/cities/SUB-EST2009-4.html

Welch, A.H., Lico M.S., J.L. Hughes. 1988. Arsenic in ground water of the western United States. *Ground Water 26*, no. 3: 333-347.

Welch, A.H. and Lico M.S. 1998. Factors controlling As and U in shallow ground water, southern Carson Desert, Nevada. *Applied Geochemistry* 13, no. 4: 521-539.

WRCC (Western Regional Climate Center). 2011. Western Evaporation Stations. http://www.wrcc.dri.edu/htmlfiles/westevap.final.html.

Wilson, E.D. 1933. *Geology and Mineral Deposits of Southern Yuma County Arizona* University of Arizona Bulletin. Vol IV, No 2. February.

Woodcock, A.B. 1992. *A Climatology* (1954 – 1992) Prepared by the U.S. Army Test and Evaluation Command, Atmospheric Sciences Division. Yuma Proving Ground, Arizona.

TABLES

TABLE 2.1

SOIL TYPES AT USAGYPG

US ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Soil Type	Composition	Percent of USAGYPG	Landforms	pH
Rositas	sand	0.0019	dunes and sand sheets	8.0
Superstition-Rositas	sand	0.0843	sandy eolian deposits	7.8 to 8.4
Carrizo	extremely gravelly loamy coarse sand	0.1434	flood plains, alluvial fans, fan piedmonts and bolson floors	7.8 to 8.0
Riverbend	extremely cobbly sandy loam	0.0054	stratified fan alluvium	7.8 to 8.2
Cristobal-Gunsight	silty, clayey gravel with sand to extremely gravelly loamy fine sand to very gravelly silt	0.2897	fan alluvium	8.2
Gunsight-Chuckawalla	extremely gravelly sandy loam to extremely gravelly loamy fine sand to very gravelly silt	0.1764	fan terraces or stream terraces	8.3
Carsitas-Chuckawalla	extremely gravelly sand to extremely gravelly loamy fine sand to very gravelly silt loam	0.0262	alluvial fans, moderately steep valley fills and dissected remnants of alluvial fans	Unspecified, generally characterized as mildly to moderately alkaline
Lithic Torriorthents	extremely gravelly sandy loam	0.2728	steeper hillsides and mountain slopes	8.2 to 8.4

Source: DRI (2009)

TABLE 4.1
CHARACTERIZATION OBJECTIVES
RCRA FACILITY INVESTIGATION REPORT - YPG-27

YUMA PROVING GROUND, YUMA, ARIZONA

Field Activity	Characterization Objective of Field Activity				
	Determine Disposal Site Boundaries	**Evaluate Potential Surface Soil Contamination Source Areas**	**Evaluate Potential Subsurface Soil Contamination Source Areas**	**Determine if Contamination is Migrating from Source Areas**	**Determine Concentrations of Background Metals**
Surface Debris Removal	Surface debris removed to prevent possible geophysical survey interference	Surface debris removal assisted in determining possible areas of surface soil contamination			
EM Geophysical Survey	10.7 Acres		10.7 Acres		
Test Pits	<u>EP001 – EP016</u> 26 Total Samples including 1 field duplicate	<u>EP001 – EP016</u> 17 Surface Soil Samples	<u>EP001 – EP016</u> 9 Subsurface Soil Samples	Surface and subsurface soil samples collected from outside landfill boundary and below suspected waste	
Vertical Soil Borings	<u>SB001 and SB002</u> 2 Subsurface Samples Vertical soil borings used to determine depth of waste			<u>SB001 and SB002</u> 2 Subsurface Samples Vertical soil borings used to determine possible leaching of contaminants	
Background Test Pit					<u>BG001</u> 1 Surface and 1 Subsurface Soil Sample

TABLE 4.2
SOIL SAMPLING SUMMARY
RCRA FACILITY INVESTIGATION REPORT - YPG-27
U.S. ARMY GARRISON YUMA PROVING GROUND, YUMA ARIZONA

Sample Location	Total Depth (ft)	Total Width (ft)	Total Length (ft)	Sample Depth (ft bgs)			Notes
				First	Second	Third	
EP001	9	2-3	14	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP002	9	2-3	12	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP003	8	2-3	13	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed. Bedrock encountered at 8 ft bgs.
EP004	8.5	6	18	0.2-0.7	5-5.5	8-8.5	Waste present from 2 to 6 ft bgs. Waste included glass (broken and bottles), aluminum cans, metal debris (rusting), burned wood, copper wire, metal cans, radio and vehicle parts, ceramics, window glass, a melted glass headlight.
EP005	9	4	15	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP006	8	3	12	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP007	10	10	16-18	0.2-0.7	4.5-5	9.5-10	Waste present from 2 to 9 ft bgs centered vertically in excavation. Waste included asphalt, wood, glass, rusted metal, mixed with silty sand and melted glass.
EP008	15	10	28	0.2-0.7	6-6.5	14.5-15	Waste present from 2 to 14 ft bgs. Waste included wood, cinder block, wire, pipe, bottles, and metal debris (heavily rusted).
EP009	9	3-4	13	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP010	9	6	17	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.

TABLE 4.2 (CONTINUED)
SOIL SAMPLING SUMMARY
RCRA FACILITY INVESTIGATION REPORT - YPG-27
U.S. ARMY GARRISON YUMA PROVING GROUND, YUMA ARIZONA

Sample Location	Total Depth (ft)	Total Width (ft)	Total Length (ft)	Sample Depth (ft bgs)			Notes
				First	Second	Third	
EP011	9	4	13	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP012	7	3-4	26	0.2-0.7	6.5-7	NA	Four trenches dug, no waste, staining, or evidence of contamination encountered except minor surface debris. Samples collected at surface and bottom of one trench.
EP013	8	3-4	12	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP014	8	4	13	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP015	9	10	15	0.2-0.7	4-4.5	8.5-9	Waste present throughout west half of excavation. Waste (damp) included burned wood, metal, glass (broken and bottles), rust and charcoal staining, bricks, concrete, wire, melted glass, radio parts, lab glass, firebrick.
EP016	10	2-3	15	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
SB001	31	NA	NA	29.5-30.5	NA	NA	See test pit 027EP007 for details from 0-10 ft bgs. From 10-15.5 ft bgs no recovery sandy soils. No stain, debris, or other evidence of contamination observed below 9 ft bgs
SB002	35	NA	NA	34-35	NA	NA	See test pit 027EP008 for details from 0-15 ft bgs. No stain, debris, or other evidence of contamination observed below 14 ft bgs
Background (BG001)	11	3.5	16	0.2-0.7	10.5-11	NA	No stain, debris, or other evidence of contamination observed.

Definitions: NA = not applicable, ft = feet, bgs = below ground surface.

TABLE 4.3

INORGANIC ANALYTICAL RESULTS - DETECTIONS

US ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Location ID	Sample Depth	Sample Type	Sample Date	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium (Total)	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
			rSRL	76,000	31	10	15,000	23	39	NA	17,000	1,400	3,100	NA	400	NA	3300
			GPL	NA	35	290	12,000	150	29	NA	590	NA	NA	NA	290	NA	NA
			Background Threshold Values	12,000	--	6.6	290	0.92	0.65	37,000	14	7.9	15	15,000	14	6,100	920
027EP001	0.2-0.7	N	14-Jul-10	5,060	--	3.02	166 J	0.27 J	0.089 J	21,500 J	6.67 J	2.57 J	8.46	8,550 J	6.03 J	2,490 J	203 J
027EP002	0.2-0.7	N	14-Jul-10	4,130	--	2.52	125 J	0.2 J	0.07 J	13,500 J	6.83 J	2.58 J	4.51	8,670 J	4.89 J	2,720 J	162 J
027EP003	0.2-0.7	N	14-Jul-10	1,940	--	1.15 J	113 J	0.12 J	0.04 J	7,260 J	4.83 J	1.76 J	2.24	6,440 J	2.97 J	1,130 J	138 J
027EP004	0.2-0.7	N	15-Jul-10	6,730	--	3.1	157 J	0.35 J	0.098 J	21,500 J	7.44 J	3 J	7.38	9,630 J	8.12 J	3,290 J	202 J
027EP004	5-5.5	N	15-Jul-10	4,720	--	3.36	192 J	0.25 J	0.13 J	23,900 J	6.69 J	2.41 J	7.69	10,500 J	7.58 J	2,290 J	288 J
027EP004	8-8.5	N	15-Jul-10	**16,300**	--	**12.2**	127 J	**1 J**	0.089 J	22,200 J	11.8 J	5.11 J	15	**17,200 J**	11.2 J	**6,530 J**	138 J
027EP005	0.2-0.7	N	15-Jul-10	4,350	--	2.74	114 J	0.22 J	0.1 J	17,600 J	7.01 J	2.61 J	8.29	9,090 J	8.08 J	2,600 J	179 J
027EP006	0.2-0.7	N	20-Jul-10	2,760	--	1.37 J	64.3 J	0.17 J	0.093 J	10,900	5.77	2.1 J	3.04	7,430	3.86	1,610	127
027EP007	0.2-0.7	N	21-Jul-10	3,520	--	1.92	96.1	--	0.067 J	14,300	5.4	2.16	4.66	6,250	6.31	2,350	157
027EP007	4.5-5	N	21-Jul-10	3,950	**0.49 J**	3.06	83.7	--	**2.97**	10,400	7.31	2.49	**22.1**	8,410	**147**	1,770	170
027EP007	9.5-10	N	21-Jul-10	3,110	--	2.1	86	--	0.2 J	11,800	5.26	2.15	6.73 J	5,580	12.1 J	1,830	211 J
027EP007	9.5-10	FD	21-Jul-10	3,320	--	2	65.2	--	0.21	12,100	5.62	2.28	6.15	5,860	**17.9**	1,960	136
027EP008	0.2-0.7	N	21-Jul-10	3,370	--	2.19	89.8	--	0.045 J	13,300	4.67	1.94	4.48	5,160	4.5	1,900	120
027EP008	6-6.5	N	21-Jul-10	6,000	**5.75**	4.01	164	--	**0.94 J**	23,600	**17**	4.84	**152**	**23,200**	**310**	2,700	329
027EP008	14.5-15	N	21-Jul-10	2,460	--	2.56	67.1	--	0.018 J	6,810	5.11	1.86	4.66	5,900	4.64	1,410	98.5
027EP009	0.2-0.7	N	21-Jul-10	2,530	--	1.78	69.6	--	0.02 J	11,200	4.89	1.93	3.02	5,830	3.86	1,900	123
027EP010	0.2-0.7	N	19-Jul-10	3,430	--	2.45	85.6	0.17 J	0.1 J	12,800	6.58	2.38 J	4.09	8,130	4.28	1,820	138
027EP011	0.2-0.7	N	19-Jul-10	3,310	--	1.9	83.6	0.16 J	0.11 J	11,500	6.95	2.27 J	3.83	8,760	5.67	1,890	143
027EP012	0.2-0.7	N	20-Jul-10	3,930	--	2.53	184	0.21	0.11 J	13,900	7.95	2.52 J	4.27	8,450	5.81	1,850	144
027EP012	6.5-7	N	20-Jul-10	3,360	--	2.22	67.7	0.16 J	--	10,700	5.49	1.87 J	3.55	6,830	3.67	1,710	102
027EP013	0.2-0.7	N	20-Jul-10	3,500	--	2.55	95	0.17 J	--	12,700	6.89	2.21 J	3.53	8,090	3.91	1,960	133
027EP014	0.2-0.7	N	19-Jul-10	2,660	--	1.21 J	73.3	0.14 J	0.11 J	9,180	7.17	2.4 J	2.68	9,410	4.53	1,590	136
027EP015	0.2-0.7	N	19-Jul-10	3,610	--	2.14	94.1	0.17 J	0.11 J	11,800	6.8	2.31 J	4.73	7,910	6.93	1,910	153
027EP015	4-4.5	N	19-Jul-10	3,960	**1.92 J**	3.41	160	--	**0.66**	9,870	**17.7**	2.63 J	**70**	12,400	**294**	1,920	**1350**
027EP015	8.5-9	N	19-Jul-10	2,790	**1.11 J**	2.72	167	0.13 J	0.36	8,270	8.99	2.79 J	**21.9**	8,160	**72.4**	1,600	328
027EP016	0.2-0.7	N	15-Jul-10	2,310	--	1.9	99.8 J	0.11 J	0.049 J	9,390 J	4.69 J	1.67 J	2.6	6,700 J	3.12 J	1,330 J	96.3 J
027SB001	29.5-30.5	N	15-Feb-11	1,560	--	1.03 J	31.6 J	0.09 J	--	5,400	2.52	1.32	11.3	3,950	2.92	783 J	80.3 J
027SB002	34-35	N	14-Feb-11	1,770	--	1.13 J	91.8	0.086 J	0.054 J	8,440	3.83	1.41	**29.2**	4,450	3.08	863	66.8

TABLE 4.3 (CONTINUED)

INORGANIC ANALYTICAL RESULTS - DETECTIONS

US ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Location ID	Sample Depth	Sample Type	Sample Date	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
			rSRL	23	390	1,600	NA	390	390	NA	5.2	78	23,000
			GPL	12	NA	590	NA	290	NA	NA	12	NA	NA
			Background Threshold Values	0.016	0.49	14	2,500	--	0.062	8400	0.57	26	44
027EP001	0.2-0.7	N	14-Jul-10	--	--	5.33 J	1,170 J	--	--	306 J	--	17.7 J	22.3
027EP002	0.2-0.7	N	14-Jul-10	--	--	4.88 J	1,360 J	--	--	--	--	18.1 J	20.4
027EP003	0.2-0.7	N	14-Jul-10	--	--	2.74 J	542 J	--	--	39.3 J	--	16.8 J	12.8
027EP004	0.2-0.7	N	15-Jul-10	--	--	6.88 J	1,560 J	--	0.037 J	220 J	--	16.8 J	29.4
027EP004	5-5.5	N	15-Jul-10	--	0.1 J	5.6 J	1,030 J	--	**0.11 J**	664 J	--	16.8 J	24.1
027EP004	8-8.5	N	15-Jul-10	--	0.29 J	**15.2 J**	**2,710 J**	--	--	2220 J	--	24.3 J	**50.5**
027EP005	0.2-0.7	N	15-Jul-10	0.0089 J	--	5.68 J	1,280 J	--	--	--	--	17.8 J	26.9
027EP006	0.2-0.7	N	20-Jul-10	0.0049 J	--	3.45 J	808 J	--	--	--	--	18.5	15.9 J
027EP007	0.2-0.7	N	21-Jul-10	--	0.15 J	4.36	1,170	--	--	--	--	13	23.2
027EP007	4.5-5	N	21-Jul-10	--	0.47 J	9.88	1,020	**0.48 J**	**31.3**	413 J	--	12.7	**827**
027EP007	9.5-10	N	21-Jul-10	--	0.17 J	4.43	921 J	--	**0.61 J**	223 J	--	12.8	32.6
027EP007	9.5-10	FD	21-Jul-10	0.0094 J	0.19 J	4.45	962	--	**0.51**	220 J	0.31 J	12.7	32.8
027EP008	0.2-0.7	N	21-Jul-10	0.0043 J	0.12 J	4.14	944	--	--	--	--	11.3	17.1
027EP008	6-6.5	N	21-Jul-10	--	**1.58 J**	12	1,700	--	**9.75**	1080 J	**0.8 J**	14.9	**432**
027EP008	14.5-15	N	21-Jul-10	0.008 J	0.15 J	3.8	586	**0.29 J**	--	186 J	--	11.9	14.5
027EP009	0.2-0.7	N	21-Jul-10	--	0.18 J	3.44	825	**0.35 J**	--	33.7 J	0.43 J	13.9	15.4
027EP010	0.2-0.7	N	19-Jul-10	0.0067 J	--	4.55 J	805	--	--	--	--	18.3	18 J
027EP011	0.2-0.7	N	19-Jul-10	0.0052 J	--	3.99 J	973	--	--	--	--	20.3	20 J
027EP012	0.2-0.7	N	20-Jul-10	--	--	4.77 J	985	--	--	--	--	24.3	21.5 J
027EP012	6.5-7	N	20-Jul-10	0.007 J	--	3.53 J	933	--	--	133	--	15.8	14.3 J
027EP013	0.2-0.7	N	20-Jul-10	--	--	3.98 J	969	--	--	313	--	19.4	17.2 J
027EP014	0.2-0.7	N	19-Jul-10	0.011 J	--	3.65 J	809	--	--	--	--	25.4	18.7 J
027EP015	0.2-0.7	N	19-Jul-10	0.008 J	--	4.27 J	946	--	--	--	--	18	25.2 J
027EP015	4-4.5	N	19-Jul-10	0.011 J	**1.32 J**	10.9 J	1,070	--	**1.78**	389	**2.66**	16	**700 J**
027EP015	8.5-9	N	19-Jul-10	--	0.37 J	7.97 J	618	--	**0.24 J**	243	--	17	**201 J**
027EP016	0.2-0.7	N	15-Jul-10	--	--	2.92 J	736 J	--	--	38.1 J	--	14.7 J	13.2
027SB001	29.5-30.5	N	15-Feb-11	0.013	0.07 J	2.42	376 J	--	--	168	--	7.73	13.5
027SB002	34-35	N	14-Feb-11	0.0086 J	0.12 J	2.96	459 J	--	--	309	--	8.91	21.7

Notes: results are reported in units of milligrams per kilogram (mg/kg). Sample depths are in feet below ground surface (ft bgs). rSRL = ADEQ residential soil remediation level. GPL = ADEQ minimum groundwater protection level. 'NA' means not available. Bolded values are above the background threshold value. Highlighted rows are samples collected within the debris zone. '--' means non-detect. 'J' flag means estimated value.

TABLE 4.4

ORGANIC ANALYTICAL RESULTS - DETECTIONS

US ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Location ID	Sample Depth	Sample Type	Sample Date	1,1-Dichloroethene	1,2-Dichloropropane	1,3,5-Trinitrobenzene	2-Hexanone	3-Nitrotoluene	Anthracene	Benzene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene
			rSRL	120	3.4	1,800	NA	730	22,000	0.65	6.9	0.69	6.9	2,300
			GPL	0.81	NA	NA	NA	NA	NA	0.71	NA	NA	NA	NA
027EP001	0.2-0.7	N	14-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP002	0.2-0.7	N	14-Jul-10	--	--	0.014 J	--	--	--	0.00319 J	--	--	--	--
027EP003	0.2-0.7	N	14-Jul-10	--	--	--	--	--	--	0.000699 J	--	--	--	--
027EP004	0.2-0.7	N	15-Jul-10	0.00125 J	--	--	--	--	--	0.0014 J	0.0239 J	--	0.0203 J	--
027EP004	5-5.5	N	15-Jul-10	--	--	--	--	--	--	0.000998 J	--	--	--	--
027EP004	8-8.5	N	15-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP005	0.2-0.7	N	15-Jul-10	--	--	--	--	--	--	0.00119 J	--	--	--	--
027EP006	0.2-0.7	N	20-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP007	0.2-0.7	N	21-Jul-10	--	0.00401 J	--	--	--	--	--	--	--	--	--
027EP007	4.5-5	N	21-Jul-10	--	--	--	--	--	--	0.0111	0.0588 J	0.0317 J	0.0992 J	0.0596 J
027EP007	9.5-10	N	21-Jul-10	--	--	--	--	--	0.371 J	0.0014 J	1.21 J	0.374 J	1.04 J	0.278 J
027EP007	9.5-10	FD	21-Jul-10	--	--	--	--	0.12 J	0.375	0.0014 J	1.21	0.449	1.11	0.294 J
027EP008	0.2-0.7	N	21-Jul-10	--	--	--	0.00514 J	--	--	--	--	--	--	--
027EP008	6-6.5	N	21-Jul-10	--	--	--	--	--	--	0.0184	--	--	--	--
027EP008	14.5-15	N	21-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP010	0.2-0.7	N	19-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP012	0.2-0.7	N	20-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP012	6.5-7	N	20-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP013	0.2-0.7	N	20-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP014	0.2-0.7	N	19-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP015	0.2-0.7	N	19-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP015	4-4.5	N	19-Jul-10	--	--	--	--	--	--	0.00937	--	--	--	--
027EP015	8.5-9	N	19-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP016	0.2-0.7	N	15-Jul-10	--	--	--	--	--	--	--	--	--	--	--

TABLE 4.4 (CONTINUED)

ORGANIC ANALYTICAL RESULTS - DETECTIONS

US ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Location ID	Sample Depth	Sample Type	Sample Date	Benzo(k)fluoranthene	bis(2-Ethylhexyl) Phthalate	Carbazole	Carbon Disulfide	Chlorobenzene	Chloromethane	Chrysene	Dibenzofuran	Ethylbenzene	Fluoranthene	Indeno(1,2,3-c,d)pyrene
			rSRL	69	390	270	360	150	48	680	140	400	2,300	6.9
			GPL	NA	NA	NA	NA	22	NA	NA	NA	120	NA	NA
027EP001	0.2-0.7	N	14-Jul-10	--	0.0152 J	--	--	--	--	--	--	--	--	--
027EP002	0.2-0.7	N	14-Jul-10	--	0.0306 J	--	--	--	--	--	--	--	--	--
027EP003	0.2-0.7	N	14-Jul-10	--	0.0139 J	--	--	--	--	--	--	--	--	--
027EP004	0.2-0.7	N	15-Jul-10	--	0.013 J	--	--	--	--	0.0277 J	--	--	0.042 J	0.131 J
027EP004	5-5.5	N	15-Jul-10	--	0.0132 J	--	--	--	--	--	--	0.000354 J	--	--
027EP004	8-8.5	N	15-Jul-10	--	0.0281 J	--	--	--	--	--	--	--	--	--
027EP005	0.2-0.7	N	15-Jul-10	--	0.0283 J	--	--	--	--	--	--	--	--	--
027EP006	0.2-0.7	N	20-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP007	0.2-0.7	N	21-Jul-10	--	--	--	--	--	--	0.0145 J	--	--	0.0172 J	
027EP007	4.5-5	N	21-Jul-10	0.0371 J	--	--	0.00545 J	--	--	0.166 J	--	--	0.0953 J	0.16 J
027EP007	9.5-10	N	21-Jul-10	0.41 J	--	0.186 J	--	--	--	1.93 J	0.0256 J	--	3.03 J	0.406 J
027EP007	9.5-10	FD	21-Jul-10	0.402	--	0.215 J	--	--	--	1.9	0.0346 J	--	3.07	0.433
027EP008	0.2-0.7	N	21-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP008	6-6.5	N	21-Jul-10	--	--	--	--	--	0.00867	--	--	--	--	--
027EP008	14.5-15	N	21-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP010	0.2-0.7	N	19-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP012	0.2-0.7	N	20-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP012	6.5-7	N	20-Jul-10	--	--	--	--	0.00177 J	--	--	--	--	--	--
027EP013	0.2-0.7	N	20-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP014	0.2-0.7	N	19-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP015	0.2-0.7	N	19-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP015	4-4.5	N	19-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP015	8.5-9	N	19-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP016	0.2-0.7	N	15-Jul-10	--	--	--	--	--	--	--	--	--	--	--

TABLE 4.4 (CONTINUED)

ORGANIC ANALYTICAL RESULTS - DETECTIONS

US ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Location ID	Sample Depth	Sample Type	Sample Date	Methyl Isobutyl Ketone (4-Methyl-2-Pentanone)	Methylene Chloride	Nitroglycerin	o-Xylene (1,2-Dimethylbenzene)	p-Cymene (p-Isopropyltoluene)	Phenanthrene	Pyrene	Tetrachloroethylene (PCE)	Tetryl	Toluene	Xylenes (Total)
			rSRL	5,300	93	9.3	270	NA	22,000	2,300	5.1	610	650	270
			GPL	NA	NA	NA	2,200	NA	NA	NA	1.3	NA	400	2,200
027EP001	0.2-0.7	N	14-Jul-10	--	--	--	--	--	0.0159 J	--	--	--	0.00384 J	--
027EP002	0.2-0.7	N	14-Jul-10	0.00298 J	0.0429	--	--	0.00131 J	--	--	--	--	0.00534	--
027EP003	0.2-0.7	N	14-Jul-10	--	0.00843 J	--	--	--	--	--	--	--	--	--
027EP004	0.2-0.7	N	15-Jul-10	--	0.0691	--	--	--	0.0304 J	0.0504 J	--	--	0.00247 J	--
027EP004	5-5.5	N	15-Jul-10	--	0.0061 J	--	0.00107 J	--	--	--	--	--	0.00077 J	0.00102 J
027EP004	8-8.5	N	15-Jul-10	--	--	--	--	--	--	--	--	--	0.00128 J	--
027EP005	0.2-0.7	N	15-Jul-10	--	0.0161 J	--	--	--	--	--	--	--	0.00172 J	--
027EP006	0.2-0.7	N	20-Jul-10	--	0.00336 J	--	--	--	--	--	--	--	--	--
027EP007	0.2-0.7	N	21-Jul-10	--	0.00438 J	--	--	--	--	--	0.00243 J	--	--	--
027EP007	4.5-5	N	21-Jul-10	--	--	--	--	--	0.0365 J	0.0741 J	0.00202 J	--	--	--
027EP007	9.5-10	N	21-Jul-10	--	0.00523 J	--	--	--	1.73 J	2.18 J	--	--	--	--
027EP007	9.5-10	FD	21-Jul-10	--	--	--	--	--	1.91	2.25	--	0.068 J	--	--
027EP008	0.2-0.7	N	21-Jul-10	--	0.00321 J	--	--	--	--	--	--	--	--	--
027EP008	6-6.5	N	21-Jul-10	--	--	0.063 J	--	--	--	--	--	--	--	--
027EP008	14.5-15	N	21-Jul-10	0.00402 J	0.00173 J	--	--	--	--	--	--	--	--	--
027EP010	0.2-0.7	N	19-Jul-10	--	0.0209 J	--	--	--	--	--	--	--	--	--
027EP012	0.2-0.7	N	20-Jul-10	--	0.00609 J	--	--	--	--	--	--	--	--	--
027EP012	6.5-7	N	20-Jul-10	--	--	--	--	--	--	--	--	--	--	--
027EP013	0.2-0.7	N	20-Jul-10	--	0.00137 J	--	--	--	--	--	--	--	--	--
027EP014	0.2-0.7	N	19-Jul-10	--	0.00708 J	--	--	--	--	--	--	--	--	--
027EP015	0.2-0.7	N	19-Jul-10	--	0.0183	--	--	--	--	--	--	--	--	--
027EP015	4-4.5	N	19-Jul-10	--	0.0028 J	--	--	--	--	--	--	--	--	--
027EP015	8.5-9	N	19-Jul-10	--	0.00457 J	--	--	--	--	--	--	--	--	--
027EP016	0.2-0.7	N	15-Jul-10	0.00218 J		--	--	--	--	--	--	--	--	--

Notes: results are reported in units of milligrams per kilogram (mg/kg). Sample depths are in feet below ground surface (ft bgs). rSRL = ADEQ residential soil remediation level. GPL = ADEQ minimum groundwater protection level. 'NA' means not available. Highlighted rows are samples collected within the debris zone. '--' means non-detect. 'J' flag means estimated value. Samples from 027EP009, 027EP011, 027SB001, and 027SB002 are not shown since there were no organic detections in these samples.

TABLE 5.1

COMPARISON OF MAXIMUM DETECTED CONCENTRATIONS TO BACKGROUND AND SRLs

U.S. ARMY GARRISON YUMA PROVING GROUND, YUMA ARIZONA

Group	Chemical	Max Detect[1] (mg/kg)	BTV (mg/kg)	rSRL[2] (mg/kg)	Exceeds	
					BTV	rSRL
Metals	Aluminum	16,300	12,000	76,000	Yes	No
	Antimony	5.75	-	31	-	No
	Arsenic	12.2	6.6	10	Yes	Yes
	Barium	192	290	15,000	No	No
	Beryllium	1	0.92	150	Yes	No
	Cadmium	2.97	0.65	39	Yes	No
	Chromium, total	17.7	14	120000	Yes	No
	Cobalt	5.11	7.9	1400	No	No
	Copper	152	15	3,100	Yes	No
	Lead	310	14	400	Yes	No
	Manganese	1350	920	3,300	Yes	No
	Mercury	0.0089	0.016	23	No	No
	Molybdenum	1.58	0.49	390	Yes	No
	Nickel	15.2	14	1,600	Yes	No
	Selenium	0.48	-	390	-	No
	Silver	31.3	0.062	390	Yes	No
	Thallium	2.66	-	5.2	-	No
	Vanadium	25.4	26	78	No	No
	Zinc	827	44	23,000	Yes	No
Organics	1,1-Dichloroethene	0.00125	NA	120	NA	No
	1,2-Dichloropropane	0.00401	NA	3.4	NA	No
	1,3,5-Trinitrobenzene	0.014	NA	1,800	NA	No
	2-Hexanone	0.00514	NA	5,300	NA	No
	3-Nitrotoluene	0.12	NA	730	NA	No
	Acetone	0.144	NA	14,000	NA	No
	Anthracene	0.375	NA	22,000	NA	No
	Benzene	0.0184	NA	0.65	NA	No
	Benzo(a)anthracene	1.21	NA	6.9	NA	No
	Benzo(a)pyrene	0.449	NA	0.69	NA	No
	Benzo(b)fluoranthene	1.11	NA	6.9	NA	No
	Benzo(g,h,i)perylene[3]	0.294	NA	2,300	NA	No
	Benzo(k)fluoranthene	0.41	NA	69	NA	No
	Bis(2-ethylhexyl) phthalate	0.0306	NA	390	NA	No
	Carbazole	0.215	NA	270	NA	No
	Carbon disulfide	0.00545	NA	360	NA	No
	Chlorobenzene	0.00177	NA	150	NA	No
	Chloromethane	0.00867	NA	48	NA	No
	Chrysene	1.93	NA	680	NA	No
	Dibenzofuran	0.0346	NA	140	NA	No
	Ethylbenzene	0.000354	NA	400	NA	No
	Fluoranthene	3.07	NA	2,300	NA	No
	Indeno(1,2,3-c,d)pyrene	0.433	NA	6.9	NA	No
	Methyl ethyl ketone (2-butanone)	0.00298	NA	23,000	NA	No
	Methyl isobutyl ketone (4-methyl-2-pentanone)	0.00298	NA	5,300	NA	No
	Methylene chloride	0.0691	NA	93	NA	No
	Nitroglycerin	0.063	NA	390	NA	No
	o-Xylene (1,2-dimethylbenzene)	0.00107	NA	270	NA	No
	p-Cymene (p-isopropyltoluene)[4]	0.00131	NA	92	NA	No
	Phenanthrene[5]	1.91	NA	22,000	NA	No
	Pyrene	2.25	NA	2,300	NA	No
	Tetrachloroethylene	0.00243	NA	5.1	NA	No
	Tetryl	0.068	NA	610	NA	No
	Toluene	0.00534	NA	650	NA	No
	Xylenes, total	0.00102	NA	270	NA	No

Notes:
1 - For 0-10 ft bgs.
2 - Lesser of the 10^{-5} risk and noncarcinogen based residential SRLs
3 - No SRL. Pyrene used as a surrogate.
4 - No SRL. Isopropylbenzene used as a surrogate.
5 - No SRL. Anthracene used as a surrogate.

Definitions: BTV - Background threshold value (see Appendix D); NA - not applicable; rSRL - 2007 Arizona residential soil remediation level

TABLE 5.2
REPRESENTATIVE SPECIES

YUMA PROVING GROUND, YUMA, ARIZONA

Class	Species - Common Name (Scientific Name)
Plants	Terrestrial Plants
Invertebrates	Terrestrial (soil dwelling) invertebrates
Mammals	Desert shrew (*Notiosorex crawfordi*) Little pocket mouse (*Perognathus longimembris*) Kit fox (*Vulpes macrotis*)
Birds	Gambel's quail (*Callipepla gambelii*) Verdin (*Auriparus flaviceps*) American kestrel (*Falco sparverius*)
Reptiles	Sonoran desert tortoise (*Gopherus morafkai*)

FIGURES

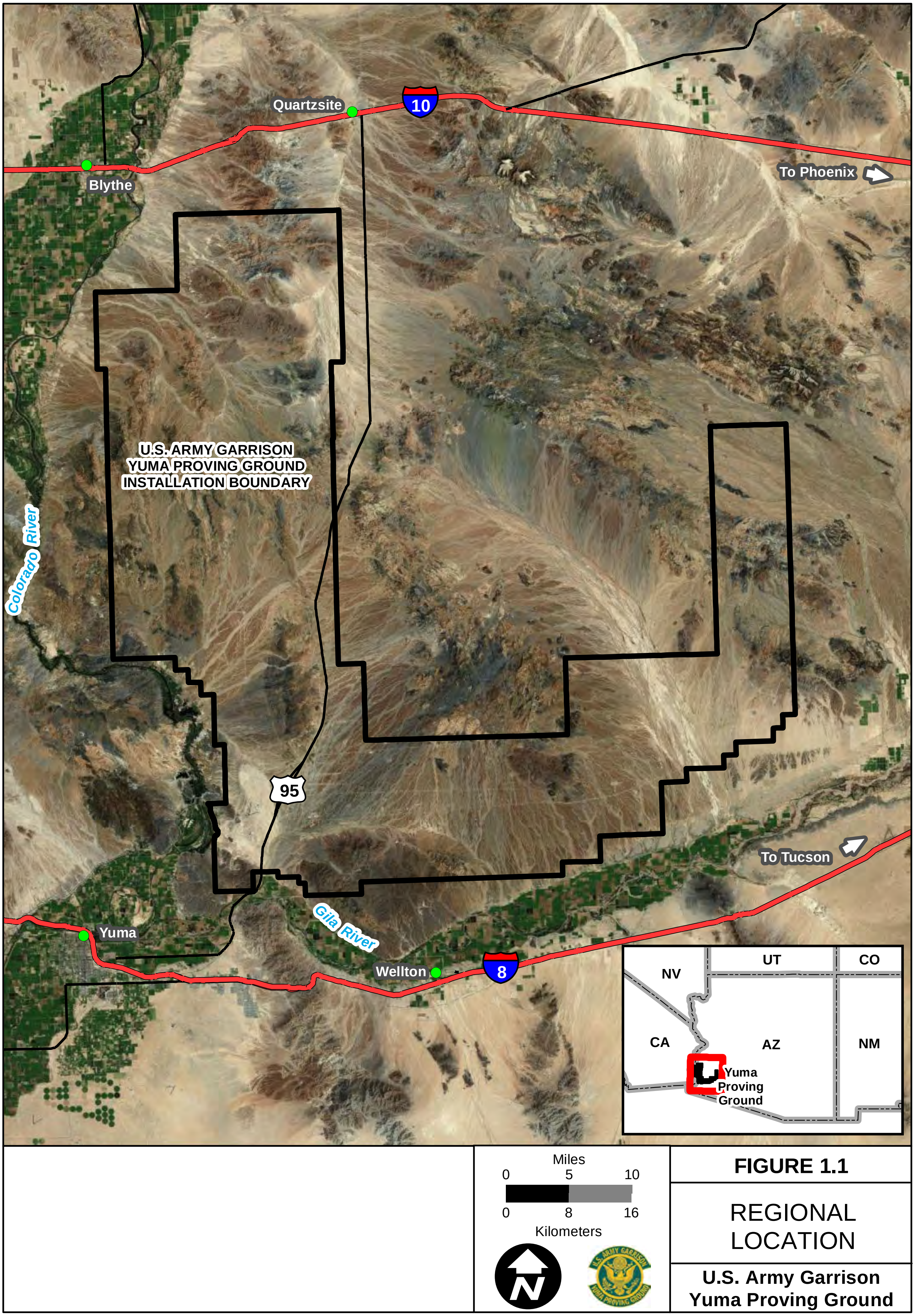


FIGURE 1.1

REGIONAL LOCATION

U.S. Army Garrison Yuma Proving Ground

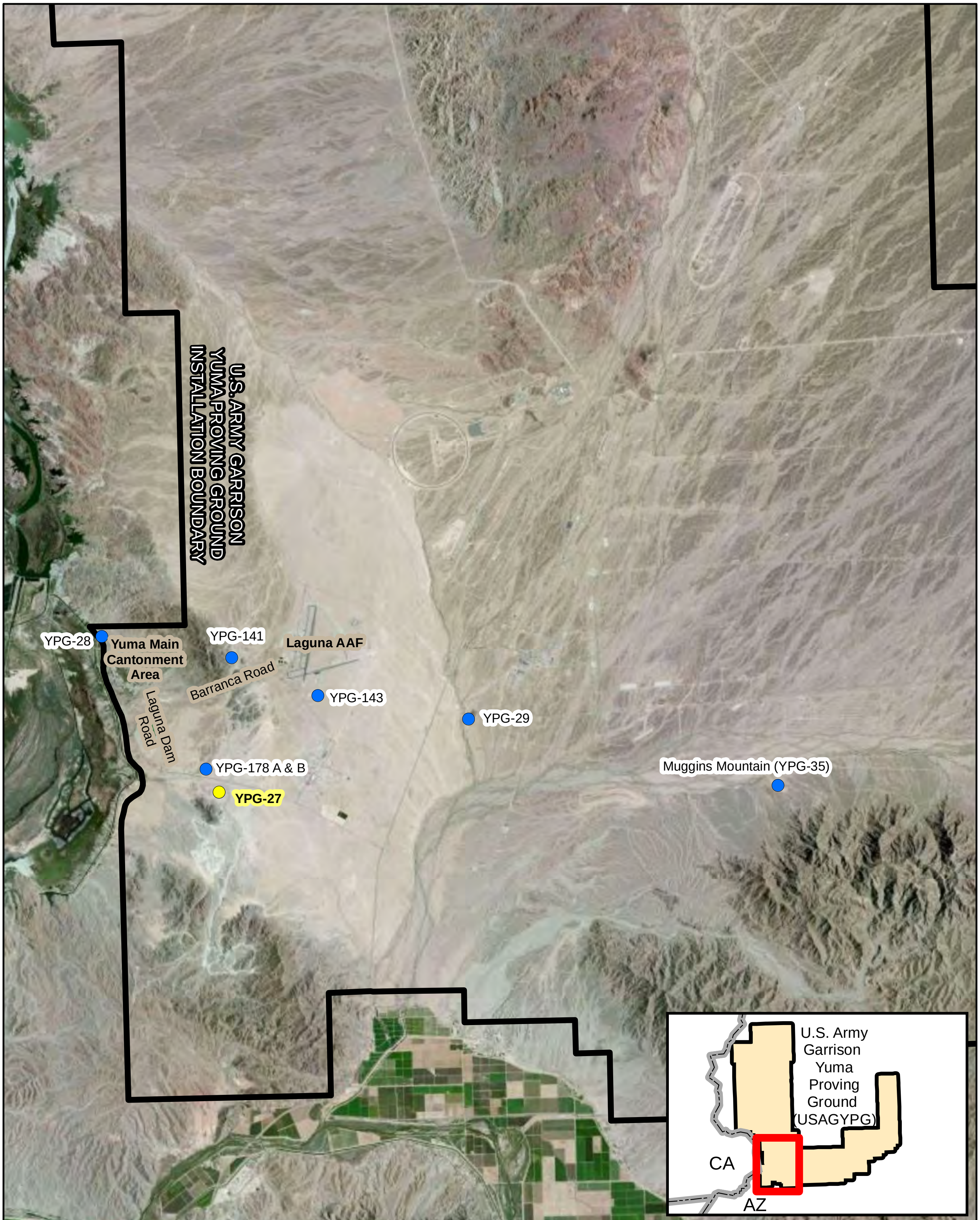
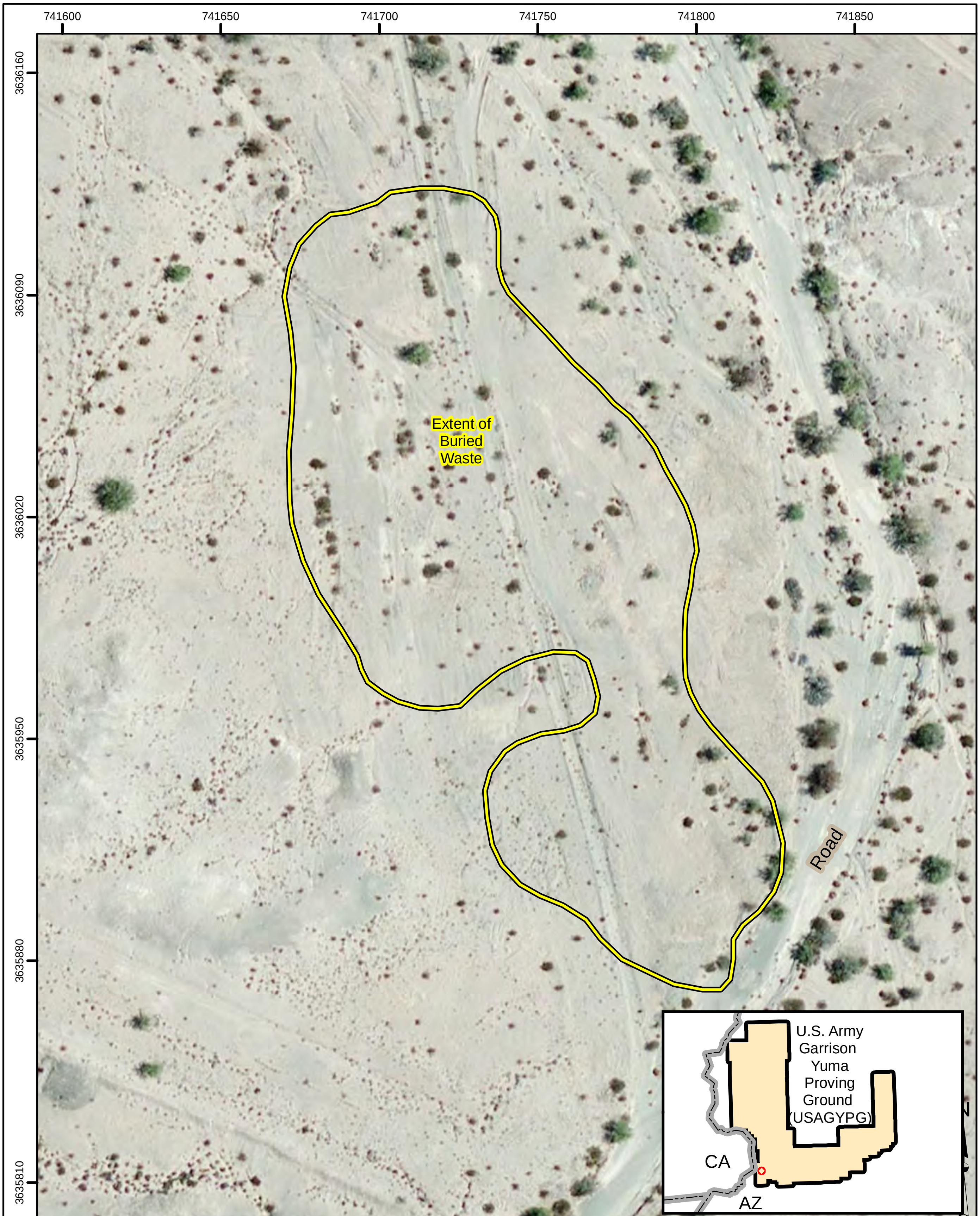


FIGURE 2.1

SITE LOCATIONS

U.S. Army Garrison Yuma Proving Ground

X:\GISCADD\projects\yuma\mapfiles\YPG_27\RFI_Draft\RFI_27_site_locations.mxd 10/13/2011



LEGEND

Extent of Buried Waste

Coordinate System: WGS 1984 UTM Zone 11N

Feet
0 70 140

0 20 40
Meters

FIGURE 2.2

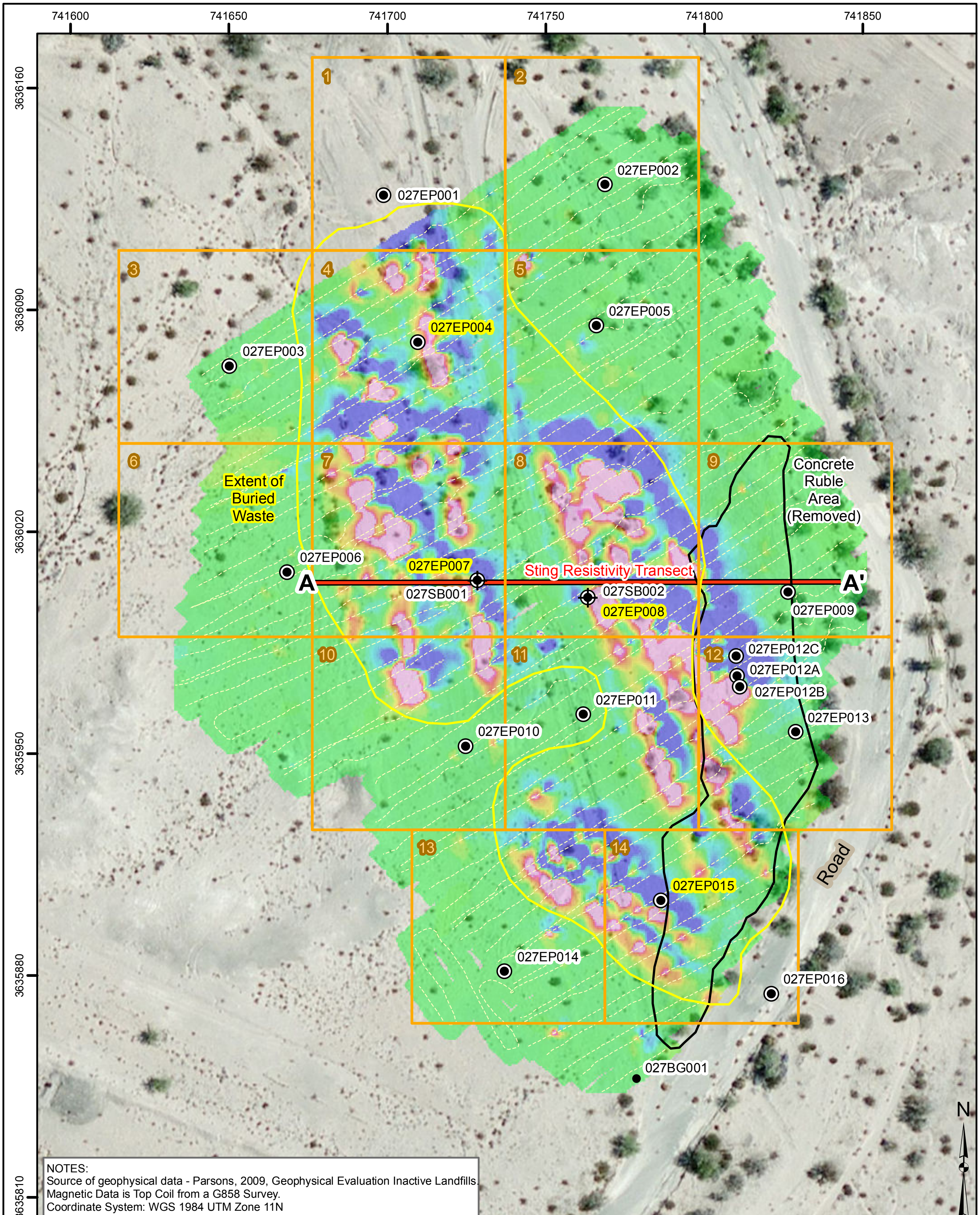
YPG-27
SITE MAP

U.S. Army Garrison
Yuma Proving Ground

PARSONS

FIGURE 2.3

Inactive Landfill YPG-27



LEGEND

Top Sensor Magnetic Reading (nT/M)

-91.0 -46.2 -1.3 34.6 70.5 106.4 151.3 196.2 241.0

- Background Sample
- Soil Boring
- Test Pit
- Concrete Ruble Area (Removed)
- Extent of Buried Waste
- Path Lines of Geophysical Survey
- Sting Resistivity Transect and Cross Section
- 2 Sampling Grid with Grid ID
- 027EP015 Test Pits with Waste

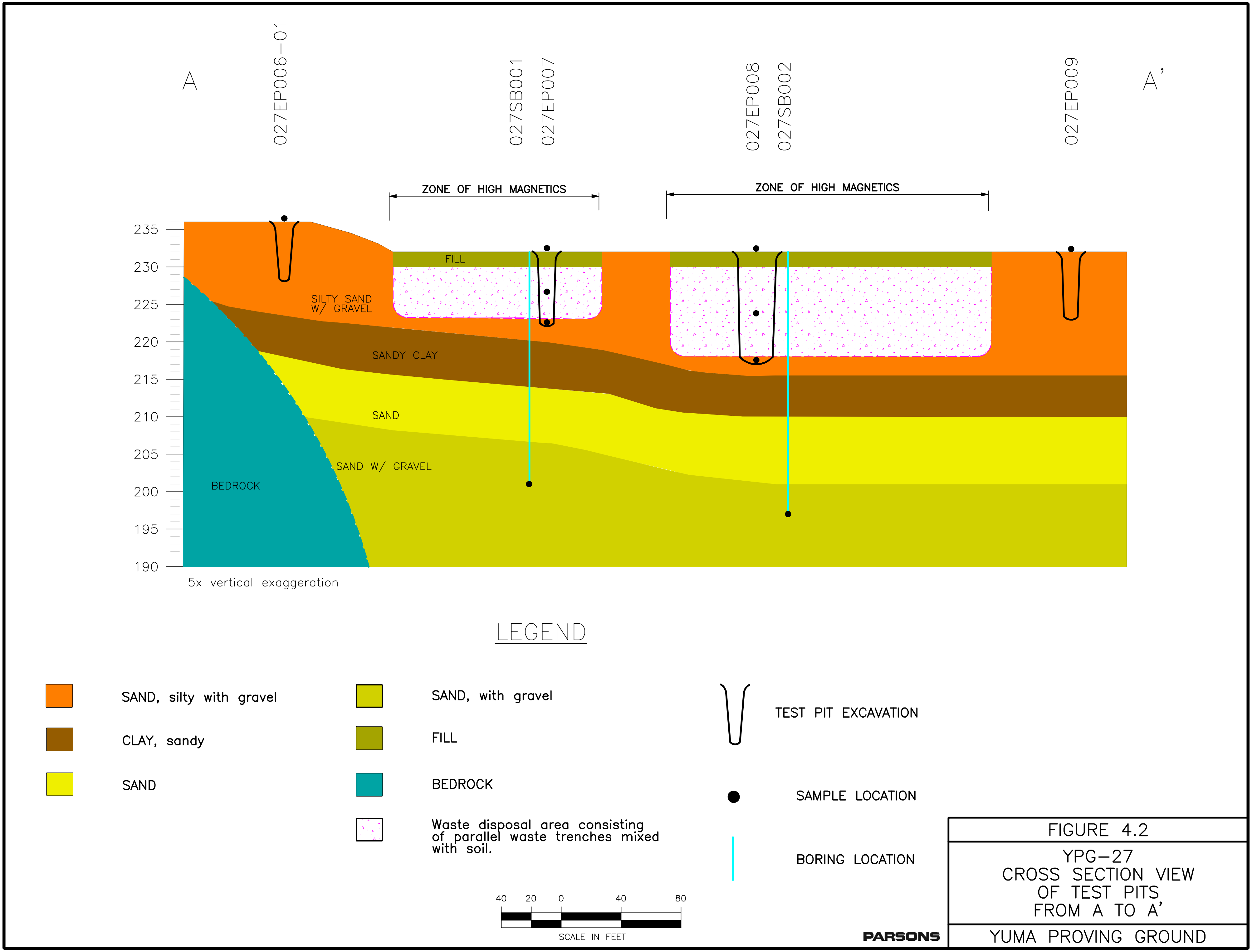
Feet
0 70 140

0 20 40
Meters

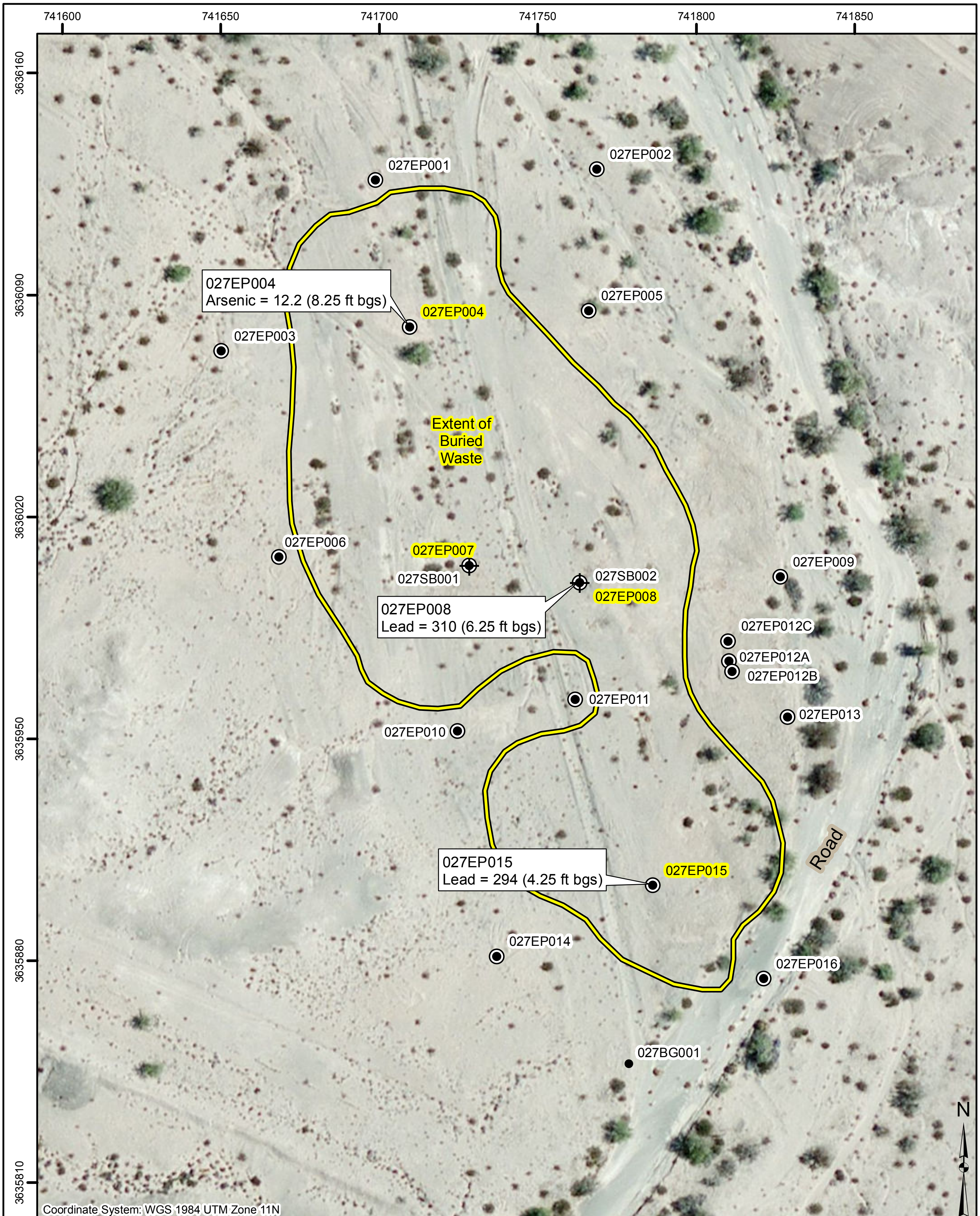
FIGURE 4.1

YPG-27
GEOPHYSICAL
SURVEY RESULTS

U.S. Army Garrison
Yuma Proving Ground



A
A'
027EP006-01
027SB001
027EP007
027EP008
027SB002
027EP009
ZONE OF HIGH MAGNETICS
ZONE OF HIGH MAGNETICS
235
230
225
220
215
210
205
200
195
190
FILL
SILTY SAND W/ GRAVEL
SANDY CLAY
SAND
SAND W/ GRAVEL
BEDROCK
5x vertical exaggeration
LEGEND
SAND, silty with gravel
CLAY, sandy
SAND
SAND, with gravel
FILL
BEDROCK
Waste disposal area consisting of parallel waste trenches mixed with soil.
TEST PIT EXCAVATION
SAMPLE LOCATION
BORING LOCATION
40 20 0 40 80
SCALE IN FEET
PARSONS
FIGURE 4.2
YPG-27
CROSS SECTION VIEW
OF TEST PITS
FROM A TO A'
YUMA PROVING GROUND
$FILE$
$DATE$



LEGEND

- Background Sample
- Soil Boring
- Test Pit
- Extent of Buried Waste
- 027EP015 Test Pits with Waste

NOTE: Results less than Background Threshold Values (BTVs) and remediation goals not shown.

Feet
0 70 140

0 20 40
Meters

FIGURE 4.3

YPG-27
SOIL SAMPLING
RESULTS

U.S. Army Garrison
Yuma Proving Ground

X:\GISCADD\projects\yuma\mapfiles\YPG_27\RFI_Draft\RFI_27_soil_sampling.mxd 11/14/2011