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RCRA FACILITY INVESTIGATION REPORT FOR INACTIVE LANDFILL YPG-028 U.S. ARMY GARRISON YUMA PROVING GROUND

Submitted To:

U.S. ARMY GARRISON YUMA PROVING GROUND

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ACRONYMS AND ABBREVIATIONS

%	Percent
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
CFR	Code of Federal Regulations
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
EPA	Environmental Protection Agency
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
°F	Degrees Fahrenheit
ft	Feet
ft^2	Feet Squared
GPL	Groundwater Protection Level
GPS	Global Positioning System
HQ	Hazard Quotient
HRA	Human Risk Assessment
HSWA	Hazardous and Solid Waste Amendment
km	Kilometers
LOAEL	Lowest Observable Adverse Effects Level
LUC	Land Use Controls
Ma	Million Years
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
mph	Miles Per Hour
NFA	No Further Action
ND	Non-Detect
NOAEL	No Observable Adverse Effects Level
NRCS	National Resource Conservation Service
nrSRL	Non-Residential Soil Remediation Level
OB/OD	Open Burn/Open Detonation
QAPP	Quality Assurance Project Plan
QSM	Quality Systems Manual
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
TRV	Toxicity Reference Values
UCL	Upper Confidence Level
U.S.	United States
USAGYPG	U.S. Army Garrison Yuma Proving Ground
USATHAMA	U.S. Toxic and Hazardous Materials Agency
USAEHA	U.S. Army Environmental Hygiene Agency
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile Organic Compound
yd^3	Cubic Yard(s)

EXECUTIVE SUMMARY

This report presents the results of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) activities conducted for YPG-028 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-028 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 2009 removal action at YPG-028 consisted of the removal of debris and the recycling of metal scrap at the site. Scrap metal consisted of a piece of a vehicle fender, a metal drill bit, and other smaller pieces of rusted metallic debris. No indication of munitions and explosives of concern (MEC) or munitions debris (MD) was found at the site.

Following the removal action, a geophysical survey was conducted at the site. Results showed that one large anomaly was identified near the area where the fender was previously located. Other smaller anomalies were identified along the road. Visual inspection results show these anomalies are associated with roadside debris and not buried waste. All other areas of the site did not appear to contain buried metal debris.

Investigation and sampling activities at YPG-028 included the excavation of five test pits (028EP001 through 028EP005) and the collection of soil samples from the test pits to define the vertical and horizontal extent of potential buried waste. In addition to the five test pits, one background test pit was also excavated and soils samples associated soil samples were collected. Analytical results of these samples were used in calculating background threshold values (BTVs) for metals. Debris was encountered within one (028EP002) of the test pits at YPG-028. This test pit correlated with the location of the magnetic anomalies identified during the geophysical survey. Debris encountered in the test pit included broken glass, decomposed aluminum, and pieces of concrete. A total of seven soils samples (and one field duplicate) were collected from within the five test pits.

The test pit containing waste was sampled above the waste, within the waste itself, and within soils underlying the waste. Inorganic compounds were detected in surface and subsurface soils exceeding BTVs from this test pit. Metals contamination is believed to be associated with buried metallic debris from within the landfill, since the sample with elevated concentrations was collected from within the debris zone. These metals are believed to be stable and have not migrated to any significant degree, based on concentrations less than remediation goals in underlying samples. One anomaly was the detection of cadmium above BTVs in a surface sample from a test pit containing no identified debris; however, none of these levels exceeded the Arizona Department of Environmental Quality (ADEQ) residential soil remediation level (rSRL), non-residential soil remediation level (nrSRL), or groundwater protection level (GPL) remediation goals.

A human health and ecological risk assessment was performed for YPG-028 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. 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 (i.e., vertebrate) receptors. Therefore, a CMS is not required. It is recommended that an interim removal action be performed to remove the solid waste and the site be closed under the RFI. No further soil sampling is needed as the soil samples collected during the test pit activities are representative of the solid waste materials.

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-028, an inactive landfill located approximately 1/2 mile north of the Main Administrative Area, southeast of Imperial Dam Road and within 200 yards of the new Kofa sewage lagoon. 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 could 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, 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. This classification was based on records and interviews indicating a potential history of solid waste disposal, which could include the presence of regulated waste such as munitions and solvents. Based on this classification, YPG-028 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, 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 **Facility and Site Environmental Setting** – Provides a description of the environmental settings of the USAGYPG installation and the YPG-028 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-028.

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-028.

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.

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Appendix B Site Photographs

Appendix C Analytical Data and Quality Control Tables

Appendix D Calculation of Background Threshold Values

Appendix E Ecological Risk Assessment

Appendix F Removal Action Photographs

SECTION 2.0

FACILITY AND SITE 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, 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, 1987).

2.1.2 Climate

Because the USAGYPG is in the Sonoran Desert, its climate is typical of 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. 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 very low, 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, 2012).

The wind speed in the Yuma area averages from 7.1 miles per hour (mph) during September through February to 8.6 mph from March through August with a yearly mean of 7.8 mph (NWS, 2011). The prevailing direction is from the north from late autumn until early spring (Oct. - Feb.), westerly to northwesterly in the spring (Mar. – May). Winds associated with the summer monsoons shift and come out of the south and south-southeast (WRCC, 2012).

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 generally 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. 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, 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, 1988). The potentiometric surface data suggest that the direction of groundwater flow is southwest toward the Colorado and Gila Rivers. The groundwater gradient is approximately 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, 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.

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, 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-028 - INACTIVE LANDFILL

2.2.1 Location and Site Description

The YPG-028 site is located approximately ½ mile north of the Main Administrative Area, southeast of Imperial Dam and within 200 yards of the Gila Main Canal (Figure 2.1). The YPG-028 site is approximately 2,500 square feet (ft^2) or 0.06 acres in size (Figure 2.2). Disposal activities at this landfill reportedly occurred in the late 1940s.

Prior to a surface removal action in November, 2009, scattered pieces of broken glass and rusted metal were present at the site, along with a relatively large, shallow excavation and related soil piles near the northwest corner of the site. A small collapse feature containing visible, partially buried glass and metallic waste was present at the site, which coincided with a metallic geophysical anomaly identified during the previous magnetometer geophysical survey performed at the site (Jason, 2007).

2.2.2 Topography

The YPG-028 site is located near low-lying bedrock outcrops among a series of small hills and associated drainages. The elevation of the site is approximately 240 ft AMSL.

2.2.3 Geology

The shallow subsurface lithology at YPG-028 was discerned from five test pits excavated to depths ranging from 4.5 ft bgs to 15 ft bgs. Based on these excavations, the shallow subsurface consists of unconsolidated alluvial materials comprised of silt, sand, and gravel. Silt and sand form a light reddish-brown matrix with medium to coarse grained sand dominant. Gravels are dispersed in the silt-sand matrix, but are present as weakly defined beds in some locations. Gravel clasts range from pea to cobble size and are subrounded to subangular. Bedrock was not encountered at site YPG-028 during the RFI.

2.2.4 Hydrology

2.2.4.1 Surface Water

The nearest surface water to YPG-028 is the Gila Main Gravity Canal (used for transporting irrigation water), which lies approximately 700 ft west of the site. The Colorado River is also located approximately 1 mile west of the site. 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. Based on the regional potentiometric surface, groundwater would be anticipated to occur at approximately 49 ft bgs and the groundwater gradient is to the southwest at 1-4 ft per mile (Jason, 2007).

2.2.5 Vegetation and Wildlife

Vegetation at YPG-028 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-028 includes numerous mammals including herbivores, omnivores, predators, and reptiles. There are also over one hundred species of birds at the installation. Vegetation and wildlife at the site are presented in more detail in the ecological risk assessment (Section 5.1).

2.2.6 Land Use

At the present time, YPG-028 is no longer operational. The future use of the YPG-028 site is expected to continue as undeveloped/vacant land. The USAGYPG has established Land

Use Controls (LUC) for all solid waste management units on the installation. These LUCs are part of the Installation Master Plan. Use of these sites, including YPG-028 is prohibited.

SECTION 3.0
PREVIOUS INVESTIGATIONS

The following sections describe previous investigations and activities conducted at the YPG-028 abandoned landfill. These activities were performed to determine the contents of the landfill and define the shape and size of the landfill area.

3.1 1998 RCRA FACILITY ASSESSMENT

The YPG-028 inactive landfill was not visited during the 1998 Facility Assessment; however, the Facility Assessment Report (Tetra Tech, 1998) documented that according to records reviewed during the 1978 Impact Assessment, the landfill was used from 1948 to 1949 to dispose of administrative and domestic solid wastes. A landfill in this location was not mentioned in either the 1980 U.S. Toxic and Hazardous Materials Agency (USATHAMA) II-A report (USATHAMA, 1980) or the 1988 U.S. Army Environmental Hygiene Agency (USAEHA) report (USAEHA, 1988). At the time of the 1998 RCRA Facility Assessment there had been no indication that sampling had ever been conducted at the site (Tetra Tech, 1998).

3.2 2001 RELEASE ASSESSMENT

During the 2001 Release Assessment, a team visited the YGP-028 site and observed miscellaneous debris scattered on the surface and also in mounds at the inactive landfill. According to the Release Assessment Report (Argonne, 2001), it was presumed that the landfill was unlined. The report recommended that information be obtained on the landfill contents, and geophysics, soil sampling, and if warranted, groundwater monitoring be performed at the site.

3.3 2006 GEOPHYSICAL SURVEY

In 2006, a geophysical survey was performed at YPG-028 to assess the apparent lateral limits of buried landfill debris within accessible areas of the site (Jason, 2007). At the time of the geophysical evaluation, scattered pieces of broken glass and pieces of metal were observed on the surface, and a relatively shallow excavation and a soil stockpile were also present near the northwest corner of the site. A small collapse feature containing visible, partially buried glass

and metallic waste was present at the site, which coincided with a metallic geophysical anomaly identified during the geophysical survey.

The geophysical survey consisted of the use of a Geonics EM31 terrain conductivity meter and a Geometrics 858 cesium magnetometer in conjunction with a Trimble Pro XRS global positioning system (GPS) for spatial control. Results of the geophysical survey indicated that only a small area of suspected buried debris existed at the site.

SECTION 4.0
NATURE AND EXTENT OF CONTAMINATION INVESTIGATION

A nature and extent investigation was conducted at YPG-028 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-028 consisted of removing surface debris, performing a geophysical survey, and excavating five exploratory test pits. Surface debris, including scrap metal, was removed from the site prior to the geophysical survey so that suspected buried waste could be more accurately defined during the geophysical survey. A magnetometer geophysical survey was then conducted to outline the areas of suspected subsurface debris. Following the geophysical survey, test pits were excavated in these areas to confirm the vertical and lateral extent of buried debris. Associated soil samples were collected within test pits when waste was encountered to characterize potential subsurface contamination. These investigation activities are described in detail in the following sections and presented in Table 4.1 with their characterization objectives.

4.1.1 Surface Debris Removal

A surface debris removal was conducted at YPG-028 in November 2009 to remove debris and recycle surface scrap metal at the site. During the removal action, the locations of three previously identified magnetometer anomalies were reacquired using GPS and a Schonstedt magnetometer. The source of these anomalies consisted of a piece of a vehicle fender, a metal drill bit, and other smaller pieces of rusted metallic debris which were identified and removed. Photographs of the metal debris removed from the site are presented in Appendix F. A total of 5 cubic yards (yd^3) of metal debris from YPG-028 was collected and consolidated with metal debris from other landfills and taken to the U.S. Marine Corps Yuma facility for

inspection and recycling. No indication of munitions and explosives of concern (MEC) or munitions debris (MD) was found at the site.

4.1.2 Geophysical Survey

A magnetometer G-858 geophysical survey was conducted on the site following the surface metal debris removal. The G-858 was also used for the previous magnetic geophysical survey (Jason, 2007). Magnetometer results show that one large anomaly was identified near the area where the fender was previously located. Other smaller anomalies were identified along the road, which appear to be associated with roadside debris and not buried waste. All other areas of the site did not appear to contain buried metal debris. Results of this survey confirmed the previous geophysical survey results.

4.1.3 Test Pit Excavations

Investigation activities at YPG-028 included the excavation of five test pits (028EP001 through 028EP005) to define the vertical and horizontal extent of potential buried waste. One background test pit (028BG001) was also excavated for use in calculating background threshold values for metals at the inactive landfills (Appendix D). All test pit excavations were conducted as proposed in the RFI Work Plan (Parsons, 2010).

Test pit locations were selected following the general strategy outlined in the RFI Work Plan (Parsons, 2010). Based on results of the previous geophysical survey (Section 3.1), the area of YPG-028 was divided into four 200 ft by 200 ft grids, and one or two biased test pits were excavated within each grid cell (Figure 4.1). Test Pit 028EP002 was excavated within grid 2 at the location of the previously removed fender and remaining magnetic anomaly. Test pit 028EP004 was excavated within grid 3 to investigate the magnetic low-level anomalies on the road. Test pits 028EP001, 028EP003, and 028EP005 were excavated from grids 1, 2, and 4 in areas without magnetic anomalies to confirm the results of the geophysical survey and ensure that the nature and extent of buried waste has been characterized. A geologic cross-section of four test pits (A-A'; Figure 4.1) is presented in Figure 4.2. Test pit logs are provided in Appendix A, and photographs of test pit and sampling activities are included as Appendix B.

4.1.4 Soil Sampling Activities

A total of seven soils samples (and one field duplicate) were collected from within the five test pits 028EP001 through 028EP005. Surface (i.e. 0.2-0.7 ft bgs) soil samples were collected from each of the five test pit locations. At test pits where waste was encountered, subsurface soil samples were also collected from within and below the waste. Sampling activities were conducted as proposed in the RFI Work Plan (Parsons, 2010), and sample depths for each test pit are detailed in Table 4.2.

Two soil samples were collected at the background test pit (028BG001), 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-028 were combined with background data from other inactive landfill RFI sites at USAGYPG to calculate background threshold values (BTVs) for metals (Appendix D).

Surface and subsurface soil samples from the test pit locations were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (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 System Manual (QSM) version 4.1. Complete analytical results for the soil samples are provided in Appendix C (Table C.1). Test pit 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 and sampling activities proposed in the RFI Work Plan (Parsons, 2010) were conducted as planned.

4.2 INVESTIGATION RESULTS

4.2.1 Data Quality

The analytical data from soil samples collected from the test pits have been reviewed, verified, and validated with regard to quality and usability. No major quality control issues were discovered during the quality control assessment; 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 a 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 all of samples. This issue was identified and 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 were 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-028 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 metals data were 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 metals are presented in Appendix D.

The BTVs were used to establish background metals concentrations for the purposes of identifying soils that may have been impacted by waste disposal activities. If a YPG-028 soil sample concentration exceeded the BTV, it was assumed that the concentration may be a result of waste disposal activities. A final step in the evaluation of metals concentrations in soils was the application of professional judgment (e.g., changes in soil type and an evaluation of

concentration gradients) to evaluate whether soil sample results with metals concentrations that exceed the BTV are a result of waste disposal activities.

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 screening levels (rSRLs and nrSRLs) and the minimum groundwater protection levels (GPLs). The rSRLs and nrSRLs are published in Appendix A of the Arizona Administrative Code R18-7-205. The 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 metals and organic constituents detected during the RFI. The evaluation includes comparing soil metal concentrations to BTVs and remediation goals, and comparing organic 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) analytes 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 seven surface and subsurface soil samples (and one field duplicate) were collected from test pits and soil borings at YPG-028 and analyzed for VOCs, SVOCs, metals, and explosives (Section 4.1).

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 (Appendix B of Jason, 2007; Parsons, 2010). The BTV and remediation goal comparison steps are presented below.

Step 1 – Background Threshold Value Comparison

The first step in evaluating impacts to soil at YPG-028 was to compare the analytical inorganic soil sample results to the BTVs. The BTV calculation method was presented in the RFI Work Plan (Parsons, 2010), which included background samples from YPG-027, -028, -029, -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. Three of the seven soil samples have inorganic concentrations greater than their respective BTV. These three samples were collected from test pits 028EP001 and 028EP002.

Of the three samples with inorganic concentrations greater than BTVs, one was collected from within debris zone at 028EP002. Samples collected from the interval underlying this debris zone did not contain inorganic concentrations exceeding BTVs.

Based on the results of the BTV comparison cadmium, copper, lead, mercury, nickel, potassium, silver, and zinc were carried forward to the subsequent steps in this analysis. All other metals were eliminated from further consideration.

Step 2 – rSRL, nrSRL and GPL Comparison

The extent of contamination was evaluated by comparing organic (Table 4.4) and inorganic (Table 4.3) analytical results to the remediation goals (i.e., ADEQ rSRL, nrSRL and minimum 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 organic compounds were detected in site soils, no organic compounds had concentrations above their corresponding rSRL, nrSRL or GPL. In addition, no metal concentrations were found to exceed their corresponding rSRLs, nrSRL, or GPL.

Step 3 - Professional Judgment

Based on the results of this evaluation, the horizontal and vertical extent of chemical impacts to soil from waste disposal activities at YPG-028 has been adequately delineated and additional soil sampling and analyses are not required.

4.3 CONTAMINATION ASSESSMENT

During the geophysical survey conducted in 2006 (Jason, 2007), a cesium gradiometer magnetometer was used to determine the extent of the metallic buried waste at the abandoned landfill YPG-028. The magnetometer was found to be effective in identifying suspect burial areas. One depression was noted to coincide with metallic anomalies identified during the geophysical survey.

In November 2009, a surface removal of metal debris was completed. Removed surface debris consisted of a piece of a vehicle fender, a metal drill bit, and other smaller pieces of rusted metallic debris which were identified and removed.

Investigation of the area consisted of excavating five test pits and one additional background test pit. Debris was encountered within one of the five test pits and correlated with the location of the magnetic anomalies identified during the geophysical survey. Debris at this test pit included broken glass, decomposed aluminum, and pieces of concrete.

A total of seven soil samples and one field duplicate were collected from the test pit excavations at YPG-028. The test pit containing waste was sampled above the waste, within the waste itself, and soils underlying the waste. Inorganic compounds were detected in surface and subsurface soils exceeding BTVs from this test pit. Metals contamination is believed to be associated with buried metallic debris from within the landfill because the sample with elevated concentrations was collected from within the debris zone. These metals are believed to be stable and have not migrated to any significant degree, based on concentrations less than remediation goals in underlying samples. One anomaly was the detection of cadmium above BTVs in a surface sample from a test pit with no found debris; however, none of these levels exceeded the ADEQ rSRL, nrSRL, or GPL remediation goals.

4.4 NATURE AND EXTENT RECOMMENDATIONS

Surface and subsurface investigation activities conducted during the RFI indicate the debris at YPG-028 consists of municipal and industrial waste. No visual evidence of hazardous waste was identified in the excavation pits at the site such as drums or munitions. Soil sampling results show several metal concentrations exceeding BTVs, but no results exceeding rSRLs, nrSRLs, and GPLs. Metal concentrations above BTVs were collected from within the debris zone, excluding the detection of cadmium found in one surface sample. Elevated concentrations are most likely related to buried metal debris. Based on the results of the field investigation, the nature and extent of burial operations and associated contamination at YPG-028 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-028.

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-028, 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 U.S. Environmental Protection Agency (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).

The YPG-028 site is located on the southwestern base boundary, approximately ½ mile north of the Main Administrative Area and 1.2 miles southeast of Imperial Dam (Figure 2.1). Although a geophysical survey was performed at YPG-028 that covered approximately 1.61 acres, the extent of buried waste at the site is only approximately 0.06 acres (Figure 4.1).

Prior to a surface removal action in November, 2009, scattered pieces of broken glass and rusted metal were present at the site, along with a relatively large, shallow excavation and related soil piles near the northwest corner of the site (see Section 2.2.1). At present, the site consists of vacant unused land. Much of the site consists of disturbed soils without any vegetation (Figure 2.2). However, there are a few small undisturbed areas with small bushes and trees that include bursage, creosote, and paloverde.

At the present time, YPG-028 is no longer operational. The future use of the YPG-028 site is expected to continue as undeveloped/vacant land.

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, a total of 8 soil samples, including one field duplicate, were collected from 5 test pits at depths ranging between 0-4.5 ft bgs (Table 4.2). All samples were analyzed for metals via USEPA Method 6010B and 7471A, VOCs via USEPA Method 8260B, SVOCs via USEPA Method 8270C, and explosives via USEPA Method 8330.

The validated data collected at 0-4.5 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). R qualified data were excluded from this risk assessment (USEPA, 1989, 1992). Normally, data from 0-10 ft bgs would be used in the selection of COPCs; however, no soil samples were collected at depths greater than 4.5 ft bgs at YPG-028. Therefore, soil data from 0-4.5 ft bgs was used in the selection of COPCs.

Essential human nutrients are toxic only at very high doses (i.e., much higher than those associated with exposure at a site) and 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 0-4.5 ft bgs (Table 5.1):

- Cadmium
- Copper
- Lead
- Mercury
- Zinc

Lastly, the maximum detected concentrations were compared to the ADEQ (2007) rSRLs and nrSRLs. None of the chemicals detected in soils at YPG-028 exceeded either the rSRLs or nrSRLs. Therefore, no COPCs were identified.

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-028 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-028. 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-028. 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 site YPG-028. 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

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

The YPG-028 site is located on the southwestern base boundary, approximately ½ mile north of the Main Administrative Area and 1.2 miles southeast of Imperial Dam (Figure 2.1).

Although a geophysical survey was performed at YPG-028 that covered approximately 1.61 acres, the extent of buried waste at the site is only approximately 0.06 acres (Figure 4.1).

Prior to a surface removal action in November, 2009, scattered pieces of broken glass and rusted metal were present at the site, along with a relatively large, shallow excavation and related soil piles near the northwest corner of the site (see Section 2.2.1). At present, the site consists of vacant unused land. Much of the site consists of disturbed soils without any vegetation (Figure 2.2). However, there are a few small undisturbed areas with small bushes and trees that include bursage, creosote, and paloverde.

For the foreseeable future, YPG-028 will remain vacant unused land. 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.

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 generally 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 in Table 5.2.

5.2.1.4 Selection of Chemicals of Potential Ecological Concern

Using the process presented in Appendix E, the following COPECs were selected for YPG-028 (Table E2):

- Antimony
- Bis(2-ethylhexyl) phthalate
- Cadmium
- Copper
- Lead
- Zinc

All COPECs were evaluated in this ERA.

5.2.1.5 Exposure Pathways

Exposures to COPECs were quantitatively evaluated for the following pathways at YPG-028:

- 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-028 and groundwater occurs at approximately 49 ft bgs at the site (Section 2.2.4). 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. Only 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

For both plants and invertebrates, the HQs for assumed exposures to antimony, cadmium, and lead were all less than one. However, the HQs for assumed plant and invertebrate exposures to copper were both approximately 2; and the HQs for assumed plant and invertebrate exposures to zinc were approximately 2 and 3, respectively (Table E.12). This indicates that assumed exposure to copper and zinc in soils may result in adverse effects to plants and invertebrates.

5.2.3.2 Vertebrate Receptor Hazard Estimates

For the vertebrate receptors, only the NOAEL-based HQs for assumed desert shrew exposures to cadmium and copper were greater than one (Table E.13). Since the LOAEL-based HQs and HIs did not exceed 1, assumed exposures to the COPECs at this site are unlikely to result in adverse effects to vertebrate receptors.

Based on the results of the ERA, the concentrations of the COPECs in site soils do not pose a threat to vertebrate 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

Potential impacts to groundwater were evaluated by comparing detected concentrations of analytes identified during the soil sampling as part of the RFI to the minimum GLPs listed in the ADEQ guidance (1996). The minimum GPLs for organics and inorganics (ADEQ, 1996) were established using conservative assumptions, which include: 1) no attenuation with depth to

groundwater (i.e. 100% of soil concentrations reach groundwater); and 2) 100% leachability of the analyte. These assumptions represent a 'worse-case' scenario, and the minimum GPLs should be used as a first-level screening of contaminants (ADEQ, 1996). At YPG-028, no detected concentrations of analytes exceeded its associated minimum GPL; therefore, potential future impacts to groundwater are not expected at this site.

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 (i.e., vertebrate) receptors. Therefore, a CMS is not required.

SECTION 6.0
SUMMARY AND RECOMMENDATIONS

An RFI has been completed at YPG-028: 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.

Disposal activities at this landfill reportedly occurred in the late 1940s. Surface debris removed from the site consisted of scattered pieces of broken glass and rusted metal. Geophysical surveys were completed to outline areas where subsurface metal debris burial is present. Test pit excavations 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 in the subsurface excavations, and debris was consistent with municipal and industrial waste. Waste was identified in only one test pit and included broken glass, decomposed aluminum, and pieces of concrete.

A total of 7 soil samples and one field duplicate were collected from the surface and subsurface soils. Results of soil and debris sampling performed at the site did not detect inorganic or organic compounds above the ADEQ rRSLs or GPLs. 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 a HRA and ERA. The risk assessment concluded that the site does not pose unacceptable risks to potential human or ecological receptors (Section 5.0).

Test pit excavations indicate that a small amount of buried solid waste is present at one locality at the site. It is recommended that an interim removal action be performed to remove the solid waste and the site be closed under the RFI. No further soil sampling is needed as the soil samples collected during the test pit activities are representative of the solid waste materials.

SECTION 7.0

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TABLES

TABLE 2.1
SOIL TYPES AT USAGYPG
RCRA FACILITY INVESTIGATION REPORT
YPG-028
U.S. 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-028

U.S. ARMY GARRISON YUMA PROVING GROUND, 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			
Geophysical Survey	0.06 Acres		0.06 Acres		
Test Pits	028EP001 – 028EP005 7 Samples 1 Field Duplicate	028EP001 – 028EP005 5 Surface Soil Samples	028EP001 – 028EP005 2 Subsurface Soil Samples 1 Field Duplicate	Surface and subsurface soil samples collected from outside landfill boundary and below suspected waste	
Background Test Pit					BG001 1 Surface and 1 Subsurface Soil Sample

TABLE 4.2
SOIL SAMPLING SUMMARY
RCRA FACILITY INVESTIGATION REPORT
YPG-028
U.S. ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Sample Location	Total Depth (ft)	Total Width (ft)	Total Length (ft)	Sample Depth 1 (ft bgs)	Sample Depth 2 (ft bgs)	Sample Depth 3 (ft bgs)	Notes
028EP001	14.6	2.67	14	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
028EP002	4.5	2.67	12	0-0.5	2.5-3	4-4.5	Waste present from 2.5 to 3 ft bgs; waste consisted of decomposed aluminum, broken glass, and concrete pieces.
028EP003	15	2.67	13	0-0.5	NA	NA	No stain, debris, or other evidence of contamination observed.
028EP004	7.5	2.67	14	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
028EP005	7.5	2.67	13	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
Background (BG001)	9	2.67	15.5	0.2-0.7	9.0-9.5	NA	No stain, debris, or other evidence of contamination observed.

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

TABLE 4.3

INORGANIC ANALYTICAL RESULTS - DETECTIONS
RCRA FACILITY INVESTIGATION REPORT
YPG-028
U.S. 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
			rSRL	76,000	31	10	15,000	23	39	NA	120,000	1,400	3,100	NA	400	NA
			nrSRL	920,000	410	10	170,000	1,900	510	NA	1,000,000	13,000	41,000	NA	800	NA
			GPL	NA	35	290	12,000	150	29	NA	590	NA	NA	NA	290	NA
			Background Threshold Values	12,000	--	6.6	290	0.92	0.65	37,000	14	7.9	15	15,000	14	6,100
028EP001	0.2-0.7	N	13-Jul-10	7,110	--	3.73	93.7 J	0.36 J	**1.84**	24,000	9.21 J	3.83 J	10.1	11,400 J	7.82 J	4,080 J
028EP002	0.2-0.7	N	13-Jul-10	9,500	--	4.99	123 J	0.46 J	**2.71**	30,400	10.5 J	4.25 J	**16.2**	12,900 J	12.4 J	5,560 J
028EP002	2.5-3	N	13-Jul-10	10,700	--	5.86	153 J	0.41 J	0.34 J	28,300	11.8 J	4.16 J	**135**	13,800 J	**17.1 J**	4,710 J
028EP002	2.5-3	FD	13-Jul-10	10,900	--	6.12	125 J	0.44 J	**0.69**	28,100	11.8 J	4.5 J	**136**	14,800 J	**18.8 J**	5,060 J
028EP002	4-4.5	N	13-Jul-10	4,300	--	4.71	60.6 J	0.26 J	0.055 J	8,220 J	10.6 J	3.17 J	8.07	9,720 J	6.08 J	2,600 J
028EP003	0.2-0.7	N	13-Jul-10	6,050	--	3.81	65.2 J	0.33 J	0.11 J	13,500	12.3 J	3.83 J	9.28	12,100 J	8.49 J	4,460 J
028EP004	0.2-0.7	N	14-Jul-10	5,730	--	5.57	59.5 J	0.31 J	0.097 J	16,100	10.5 J	3.77 J	9.39	11,400 J	8.89 J	3,920 J
028EP005	0.2-0.7	N	14-Jul-10	3,660	0.38 J	3.39	33.6 J	0.22 J	0.074 J	7,070 J	6.9 J	2.86 J	6.66	9,140 J	6.67 J	2,690 J

TABLE 4.3 (Continued)

INORGANIC ANALYTICAL RESULTS - DETECTIONS
RCRA FACILITY INVESTIGATION REPORT
YPG-028
U.S. ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Location ID	Sample Depth	Sample Type	Sample Date	Manganese	Mercury	Molybdenum	Nickel	Potassium	Silver	Sodium	Vanadium	Zinc
			rSRL	3300	23	390	1,600	NA	390	NA	78	23,000
			nrSRL	32,000	310	5,100	20,000	NA	5,100	NA	1,000	310,000
			GPL	NA	12	NA	590	NA	NA	NA	NA	NA
			Background Threshold Values	920	0.016	0.49	14	2,500	0.062	8400	26	44
028EP001	0.2-0.7	N	13-Jul-10	215 J	--	0.15 J	8.36 J	1,950 J	--	2,230 J	17.4 J	29
028EP002	0.2-0.7	N	13-Jul-10	260 J	--	0.2 J	**16 J**	**2,760 J**	**0.88**	160 J	19.1 J	44
028EP002	2.5-3	N	13-Jul-10	248 J	**0.019**	0.27 J	10 J	2,180 J	--	455 J	19.3 J	**246**
028EP002	2.5-3	FD	13-Jul-10	271 J	0.0051 J	0.27 J	11.4 J	2,320 J	--	449 J	20.1 J	**345**
028EP002	4-4.5	N	13-Jul-10	133 J	--	0.14 J	7.25 J	1,140 J	--	81.7 J	14.1 J	26
028EP003	0.2-0.7	N	13-Jul-10	287 J	--	0.077 J	9.13 J	1,770 J	--	78.8 J	19.5 J	33.1
028EP004	0.2-0.7	N	14-Jul-10	290 J	--	0.17 J	8.04 J	1,780 J	--	209 J	18.6 J	30.6
028EP005	0.2-0.7	N	14-Jul-10	177 J	--	--	5.89 J	1,380 J	--	39.2 J	12.4 J	26.4

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 availible. 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
RCRA FACILITY INVESTIGATION REPORT
YPG-028
U.S. ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Location ID	Sample Depth	Sample Type	Sample Date	1,3,5-Trinitrobenzene	2,4,6-Trinitrotoluene	2,4-Dinitrotoluene	Acetone	Benzene	bis(2-Ethylhexyl) Phthalate	Chlorobenzene	Methyl Ethyl Ketone (2-Butanone)	Methyl Isobutyl Ketone (4-Methyl-2-Pentanone)	Methylene Chloride	Pentachlorophenol	Toluene
			rSRL	1,800	31	120	14,000	0.65	390	150	23,000	5,300	93	32	650
			nrSRL	18,000	310	1,200	54,000	1.4	1,200	530	34,000	17,000	210	90	650
			GPL	NA	NA	NA	NA	0.71	NA	22	NA	NA	NA	NA	400
1	0.2-0.7	N	13-Jul-10	0.058 J	J	--	0.08 NJ	--	--	--	NJ	--	--	--	J
2	0.2-0.7	N	13-Jul-10	--	--	--	NJ	J	--	--	NJ	--	J	J	J
2	2.5-3	N	13-Jul-10	--	--	--	NJ	--	J	--	NJ	--	--	--	J
2	2.5-3	FD	13-Jul-10	--	--	--	0.07 NJ	--	J	--	NJ	--	--	--	J
2	4-4.5	N	13-Jul-10	--	--	--	NJ	--	--	--	NJ	--	--	--	--
3	0.2-0.7	N	13-Jul-10	--	--	--	NJ	J	J	--	NJ	--	--	--	J
4	0.2-0.7	N	14-Jul-10	--	--	--	NJ		0.02 J	--	NJ	--	J	--	J
5	0.2-0.7	N	14-Jul-10	--	--	J	NJ	J	--	J	NJ	0.003	0.004 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 availible. Highlighted rows are samples collected within the debris zone. '--' means non-detect. 'J' flag means estimated value. 'NJ' flag means detections are suspected to be false positivies.

TABLE 5.1
CHEMICALS OF POTENTIAL CONCERN
RCRA FACILITY INVESTIGATION REPORT
YPG-028
U.S. ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Group	Chemical	Max Detect[1] (mg/kg)	BTV (mg/kg)	rSRL[2] (mg/kg)	nrSRL (mg/kg)	MaxD Exceeds BTV	MaxD Exceeds rSRL	MaxD Exceeds nrSRL	COPC
Metals	Aluminum	10,900	12,000	76,000	920,000	No	No	No	No
	Antimony	0.38	NA	31	410	NA	No	No	No
	Arsenic	6.12	6.6	10	10	No	No	No	No
	Barium	153	290	15,000	170,000	No	No	No	No
	Beryllium	0.46	0.92	150	1,900	No	No	No	No
	Cadmium	2.71	0.65	39	510	Yes	No	No	No
	Chromium, Total[3]	12.3	14	120,000	1,000,000[4]	No	No	No	No
	Cobalt	4.5	7.9	1,400	13,000	No	No	No	No
	Copper	136	15	3,100	41,000	Yes	No	No	No
	Lead	18.8	14	400	800	Yes	No	No	No
	Manganese	290	920	3,300	32,000	No	No	No	No
	Mercury	0.019	0.016	23	310	Yes	No	No	No
	Molybdenum	0.27	0.49	390	5,100	No	No	No	No
	Nickel	16	14	1,600	20,000	Yes	No	No	No
	Silver	0.88	0.062	390	5,100	Yes	No	No	No
	Vanadium	20.1	26	78	1,000	No	No	No	No
	Zinc	345	44	23,000	310,000	Yes	No	No	No
SVOCs	bis(2-Ethylhexyl) Phthalate	0.0339	NA	390	1,200	NA	No	No	No
	Pentachlorophenol	0.0281	NA	32	90	NA	No	No	No
VOCs	Acetone	0.0958	NA	14,000	54,000	NA	No	No	No
	Benzene	0.00117	NA	0.65	1.4	NA	No	No	No
	Chlorobenzene	0.000506	NA	150	530	NA	No	No	No
	Methyl Ethyl Ketone (2-Butanone)	0.0167	NA	23,000	34,000[5]	NA	No	No	No
	Methyl Isobutyl Ketone	0.00316	NA	5,300	17,000[5]	NA	No	No	No
	Methylene Chloride	0.00825	NA	93	210	NA	No	No	No
	Toluene	0.00291	NA	650[5]	650[5]	NA	No	No	No
Explosives	1,3,5-Trinitrobenzene	0.058	NA	1,800	18,000	NA	No	No	No
	2,4,6-Trinitrotoluene	0.023	NA	31	310	NA	No	No	No
	2,4-Dinitrotoluene	0.0091	NA	120	1,200	NA	No	No	No

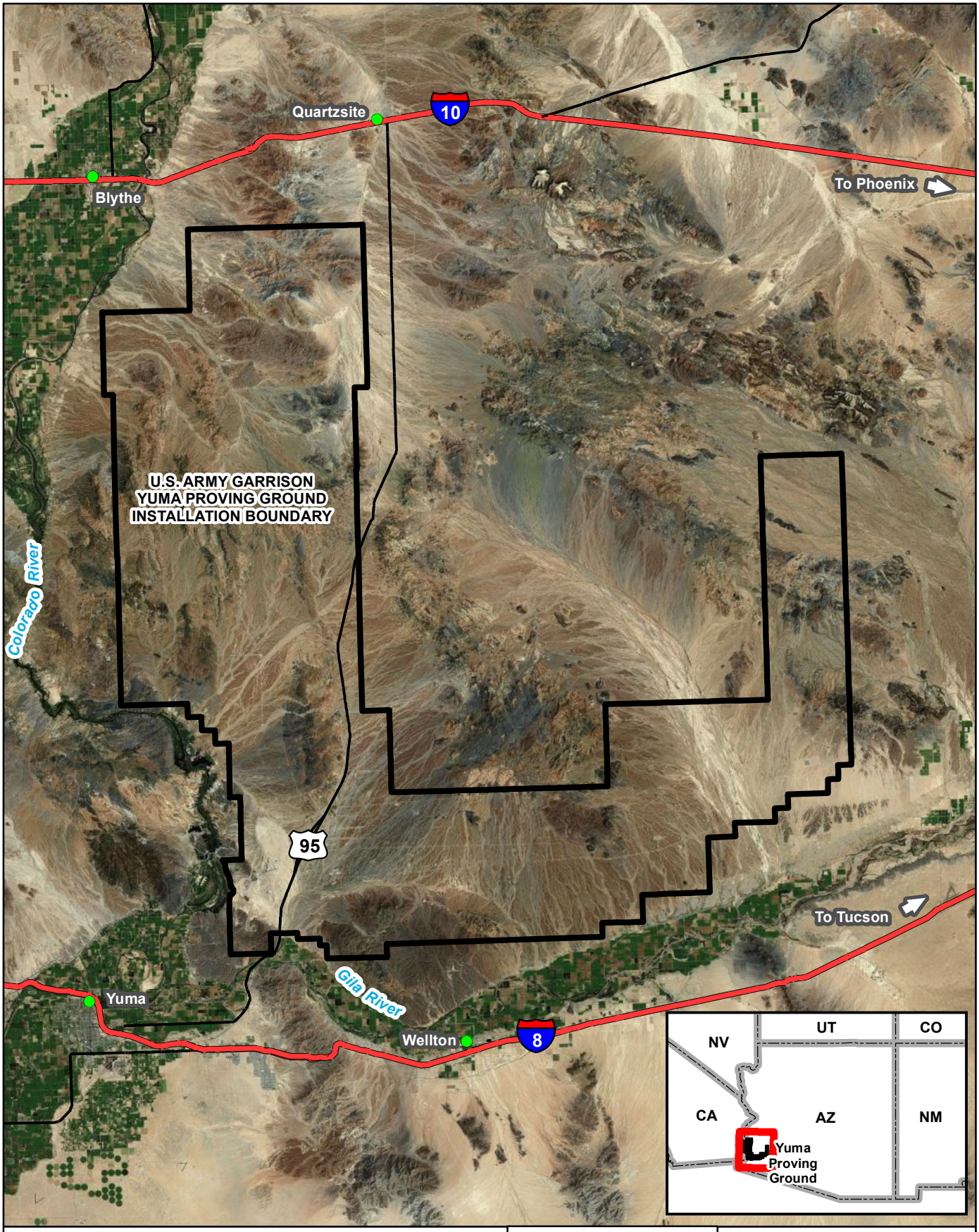
Notes:
1 For 0-4.5 ft bgs
2 Lesser of the 10^{-5} carcinogenic risk and noncarinogen rSRLs
3 As Chromium III
4 Indicated SRL is based on 100% saturation ceiling limit for non-volatile chemicals.
5 Indicated SRL is based on the chemical-specific saturation level in soil for volatile organic chemicals only.

Definitions: BTV = background threshold value. COPC = chemical of potential concern. Max Detect = maximum detection value. NA = not applicable.
nrSRL = non-residential soil remediation level. SVOC = semi-volatile organic compound. Shaded = exceeded screening levels.
VOC = volatile organic compound

TABLE 5.2
REPRESENTATIVE SPECIES
RCRA FACILITY INVESTIGATION REPORT
YPG-028
U.S. ARMY GARRISON YUMA PROVING GROUND, 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



Miles
0 5 10
0 8 16
Kilometers

FIGURE 1.1

REGIONAL LOCATION

U.S. Army Garrison Yuma Proving Ground

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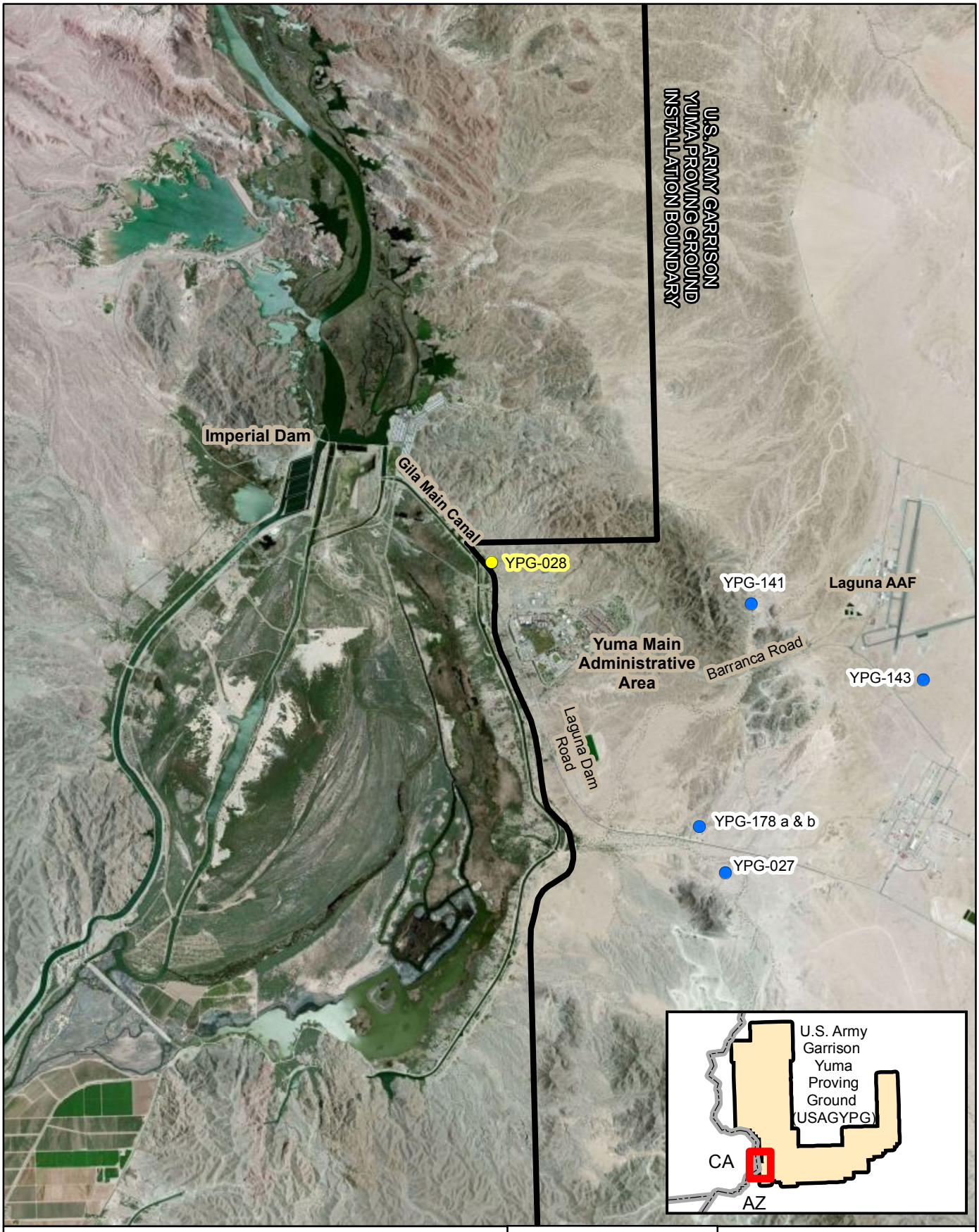


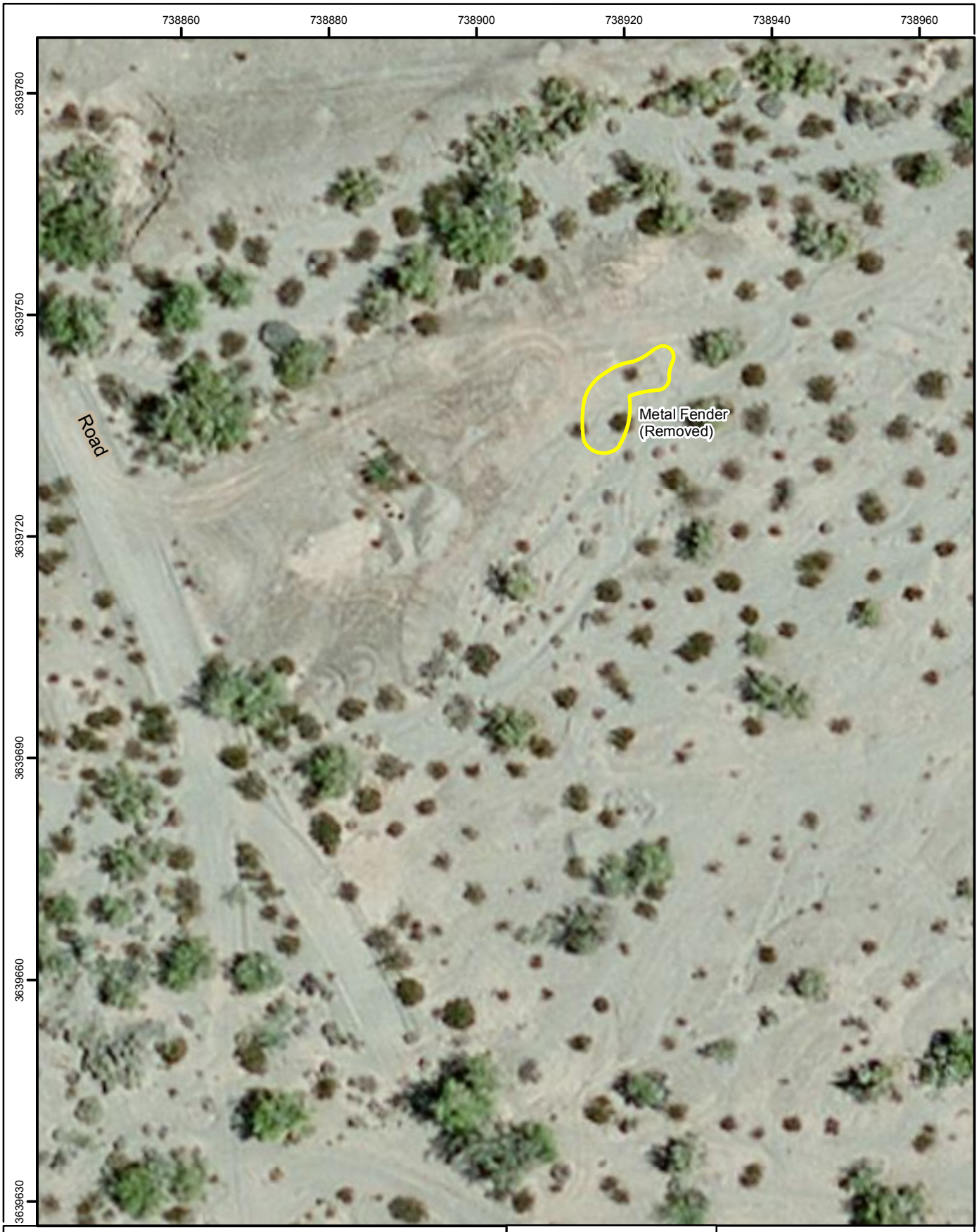
Miles
0 0.5 1
0 1 2
Kilometers

FIGURE 2.1

SITE LOCATION

U.S. Army Garrison Yuma Proving Ground

X:\GISCADD\projects\yuma\mapfiles\YPG_28\RFI\RFI_28_site_location.mxd 7/9/2012



LEGEND

Extent of Buried Waste

North and East Coordinates in WGS 1984, UTM, Zone 11, Meters.

Feet
0 30 60
0 10 20
Meters

FIGURE 2.2

YPG-028
SITE MAP

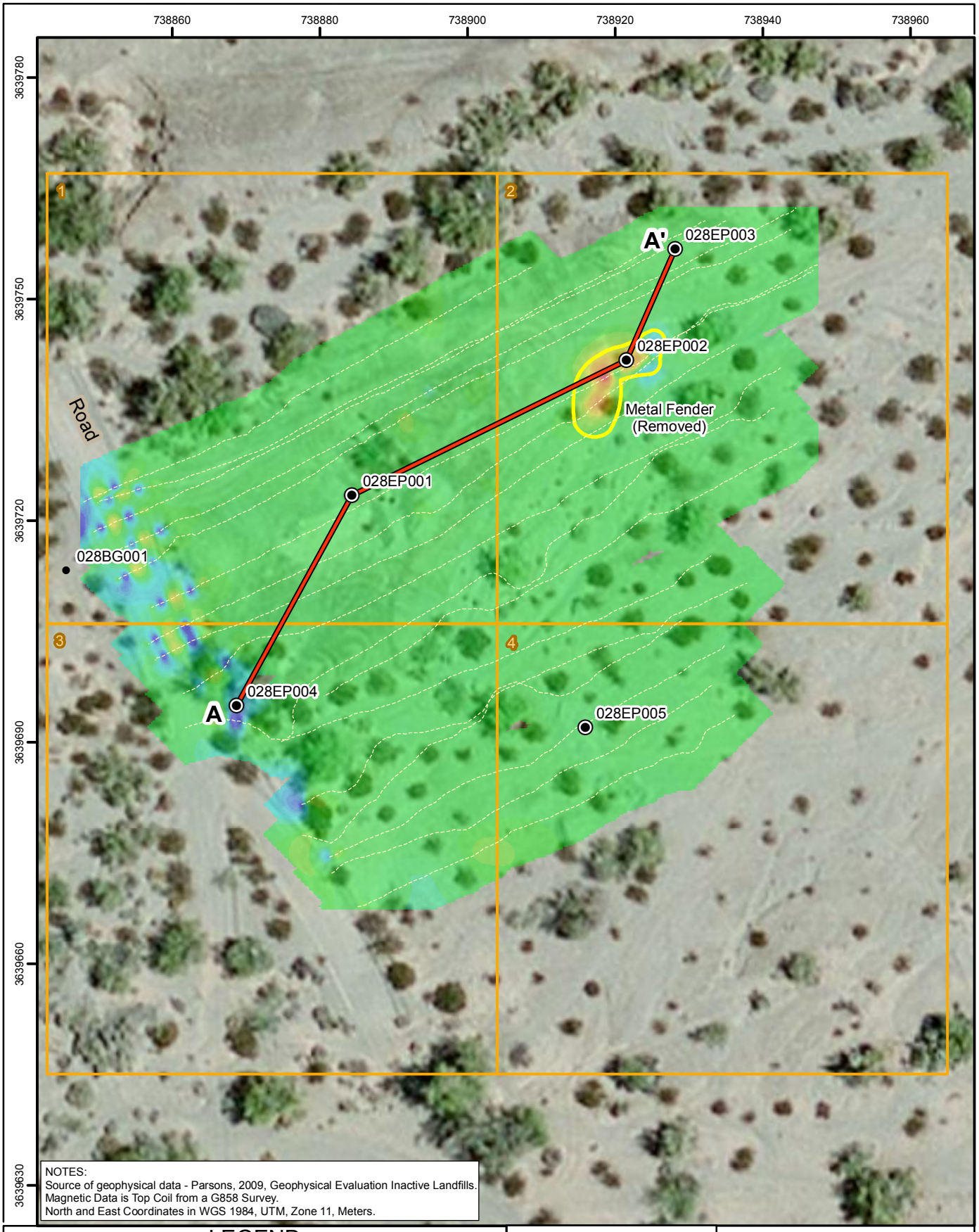
U.S. Army Garrison
Yuma Proving Ground

X:\GISCADD\projects\yuma\mapfiles\YPG_28\RFI\RFI_28_extent_buried_waste.mxd 7/9/2012

PARSONS

FIGURE 2.3

Inactive Landfill YPG-028



NOTES:
Source of geophysical data - Parsons, 2009, Geophysical Evaluation Inactive Landfills.
Magnetic Data is Top Coil from a G858 Survey.
North and East Coordinates in WGS 1984, UTM, Zone 11, Meters.

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
- Test Pit
- Extent of Buried Waste
- Path Lines of Geophysical Survey
- Cross Section Line
- Sampling Grid with Grid ID

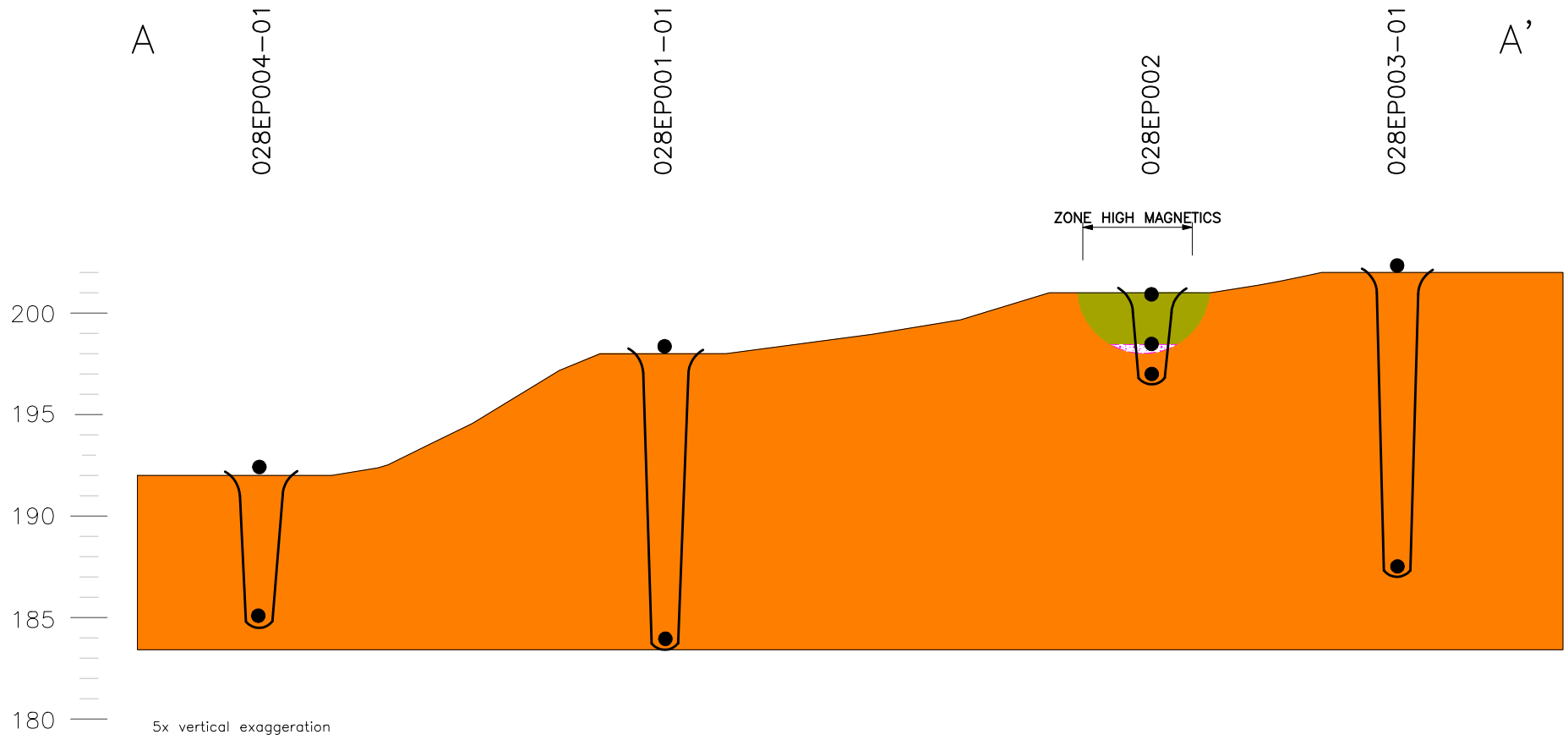
Feet
0 30 60
0 10 20
Meters

FIGURE 4.1

YPG-028
2009
MAGNETIC DATA

U.S. Army Garrison
Yuma Proving Ground

X:\GISCADD\projects\yuma\mapfiles\YPG_28\RFI\RFI_28_magnetic.mxd 7/9/2012



LEGEND

- SAND, silty with gravel
- FILL
- WASTE
- TEST PIT EXCAVATION
- SAMPLE LOCATION

20 10 0 20 40
SCALE IN FEET

PARSONS

FIGURE 4.2

YPG-028
CROSS SECTION VIEW
TEST PITS
FROM A TO A'

YUMA PROVING GROUND

$FILE$
$DATE$