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RCRA FACILITY INVESTIGATION REPORT FOR INACTIVE LANDFILL YPG-178 U.S. ARMY GARRISON YUMA PROVING GROUND

Submitted To:

U.S. ARMY GARRISON YUMA PROVING GROUND

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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 Value
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
GPS	Global Positioning System
HI	Hazard Index
HQ	Hazard Quotient
HRA	Human Risk Assessment
HSWA	Hazardous and Solid Waste Amendment
IDW	Investigation Derived Waste
km	Kilometers
LOAEL	Lowest Observable Adverse Effects Level
Ma	Million Years
mg/kg	Milligram per Kilogram
mph	Miles Per Hour
ND	Non-Detect
NFA	No Further Action
NOAEL	No Observable Adverse Effects Level
NRCS	National Resource Conservation Service
nrSRL	Non-Residential Soil Remediation Level
PAH	Polycyclic Aromatic Hydrocarbon
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
SVOC	Semivolatile Organic Compound
TCLP	Toxicity Characteristic Leaching Procedure
TRV	Toxicity Reference Value

ACRONYMS AND ABBREVIATIONS (CONTINUED)

UCL	Upper Confidence Level
U.S.	United States
USAEHA	United States Army Environmental Hygiene Agency
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

EXECUTIVE SUMMARY

This report presents the results of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) activities conducted for YPG-178 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-178 consisted of: 1) removal of the surface debris and ash piles; 2) surface soil sampling; and 3) test pit excavation and sampling, used to characterize the ash/debris areas and define their boundaries.

The 2009 removal action at YPG-178 consisting of the removal of several large piles of ash and debris, which included glass, burnt wood, cans, and scrap metal. Representative samples of the ash and debris were collected and analyzed using Toxicity Characteristic Leaching Procedure (TCLP) methods. All constituents were below TCLP regulatory limits. Approximately 190 cubic yards of soil and ash were removed from the site and disposed at the Yuma Proving Ground landfill. Ash from YPG-178b could not be completely removed and further investigation of the extent of the ash was required and performed as part of the RFI. The RFI included; post removal confirmation surface soil samples were collected and test pits were excavated to intrusively investigate the extent of the areas suspected to contain ash/debris. Associated soil samples were collected at test pit locations where waste was encountered. Two background test pits were also excavated and associated soil samples collected for use in calculating background threshold values (BTVs) for metals.

Of the ten test pits excavated, six were found to contain ash and debris (178EP002, 178EP003, 178EP004, 178EP005, 178EP009, and 178EP010), which included mostly ash with wood, glass, wire, bottles, burnt paper and rusted metal debris. At test pits where waste was encountered, subsurface soil samples were collected from within and below the waste. In addition to the samples collected from test pits, nine post-removal confirmation surface soil samples were collected in areas where ash piles had

been removed. A total of 31 soil samples were collected from the test pits and removal areas and analyzed to define the extent of detectable contamination.

Soil samples collected at YPG-178 were analyzed for volatile organic compounds (VOCs), semi-volatile 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 minimum groundwater protection levels [GPLs]). In addition, metal detections were evaluated using BTVs to determine if the detections are the result of site related activities.

Analytical results from soil sampling at YPG-178 show that, although a few organic compounds were detected, no compound had a concentration above its corresponding rSRL or GPL. Ten metals (arsenic, cadmium, chromium, copper, iron, lead, mercury, molybdenum, silver, and zinc) were found to exceed their corresponding BTVs at eight sample locations (178EP001-5, 178EP009-10, and 178SS019). The metal contamination is believed to be associated with buried metallic debris from within the landfill, and to be stable and not significantly migrating. This conclusion is based on soil sampling results that show elevated concentrations of metals found in samples collected from within the debris zone, but not in samples collected from the overlying and underlying zones. Although several inorganic constituents exceed their corresponding BTVs, no concentrations exceed the associated rSRL or GPL at the site.

Surface and subsurface investigation activities conducted during the RFI indicate that debris at YPG-178 consists of ash and other debris. The presence of charred wood and low levels of polycyclic aromatic hydrocarbons (PAHs) suggests a portion of the waste may have been burned. No evidence of liquid waste or munitions debris was identified in the excavated pits. Based on the results of the field investigation, the nature and extent of burial operations and associated contamination at YPG-178 has been delineated and no further sampling is required.

A human health and ecological risk assessment was performed for YPG-178 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 receptors. Additionally, since no detected constituents exceed the minimum GPLs, future impacts to groundwater are not expected at the site.

A Corrective Measures Study is recommended to evaluate the impacts to the site due to the remaining ash/debris present at Areas 1 and 2 (YPG-178a) and Area 6 (YPG-178b) (Figures 4.5 and 4.6). However, based on waste characterization and test pit sampling of the ash and debris, the remaining waste was determined to be non-hazardous. Additionally, the HRA and Ecological Risk Assessment (ERA) results indicate no unacceptable risks to human or ecological receptors were identified. Future impacts to groundwater from site related chemical constituents are not expected, since sampling results did not exceed the GPLs. Therefore, no further action to mitigate risks to human health or the environment is 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-178, an inactive landfill located approximately 2 miles south-southeast of the Main Administrative Area, north 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 surface and buried waste and associated soil 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:

- RCRA Facility Assessment (RFA) - Identifies releases and potential releases of hazardous wastes or constituents from the site.
- RCRA Facility Investigation (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 hazardous waste such as munitions and solvents. Based on this classification, YPG-178 is subject to the rules and statues of the ADEQ RCRA Part B Permit issued to USAGYPG.

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 a 50-year history of 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 3,000 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 screening 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-178 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 **Site Description** – Describes previous investigations and activities conducted at YPG-178.

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

Section 5 **Human Health and Ecological Screening Assessment** – Provides an evaluation of the risks associated with potential waste buried at YPG-178.

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

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Appendix D Calculation of Background Threshold Values

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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. Rainfall averages 3.5 inches per year, and the evaporation pan rate is 99.2 inches per year (WRCC, 2012). 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-178 - INACTIVE LANDFILL

2.2.1 Location and Site Description

The YPG-178 site is located approximately 2 miles south-southeast of the Main Administrative Area, north of Laguna Dam Road (Figure 2.1), and consists of multiple surface and shallow subsurface disposal sites located approximately 200 ft apart. These areas are located on a low-lying series of small rocky hills and have been designated YPG-178a and YPG-178b. The YPG-178a site is approximately 1.68 acres in size, and YPG-178b is approximately 0.76 acres (Figure 2.2). Disposal activities at the landfill reportedly occurred during the 1960s and 1970s (Jason, 2007).

Prior to the surface debris removal action in November 2009 (Section 4.1.2), the landfill was scattered with glass, burnt wood, cans, and scrap metal. Disturbed soil was also observed at the sites. In addition, localized burn areas were observed at YPG-178a, and a partially buried

drum was observed at YPG-178b (Jason, 2007). In 2009, the drum was removed and found to be empty. No other drums were found associated with the empty drum.

2.2.2 Topography

The YPG-178 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-178 was obtained from ten test pits excavated throughout the site. 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 layer approximately 6 ft thick. A fine to medium, light beige to white, well-graded sand layer underlies the sandy-clay. Bedrock was not encountered at site YPG-178 during the RFI.

2.2.4 Hydrology

2.2.4.1 Surface Water

The nearest surface water to YPG-178 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 the groundwater gradient is to the southwest at 1-4 ft per mile (Jason, 2007).

2.2.5 Vegetation and Wildlife

Vegetation at YPG-178 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-178 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-178 is no longer operational. The future use of the YPG-178 site is expected to continue as undeveloped/vacant land and remain part of USAGYPG.

SECTION 3.0
PREVIOUS INVESTIGATIONS

The following sections describe previous investigations and activities conducted at YPG-178. YPG-178 has been defined as a landfill, but the site actually consists of surface ash piles and layers of covered ash on the top and sides of the small hillsides. Ash piles located on the hillsides have been covered by bulldozing rock and gravel over the top of the ash.

Past activities were performed to determine the constituents of the ash and define the shape and size of the surface ash piles and the ash layers buried in the low-lying hills. YPG-178 disposal area was not mentioned or investigated in the 1998 RCRA Facility Assessment; however, investigations conducted at the site include a release assessment in 2001, and a geophysical survey performed in 2006.

3.1 2001 RELEASE ASSESSMENT

During the 2001 Release Assessment, a field team visited YPG-178 and observed miscellaneous debris lying at the surface. Debris was also found in small mounds scattered throughout the site. Based on visual inspection, the surface ash piles were presumed to be unlined (Argonne, 2001). The Release Assessment Report recommended that information be obtained on the waste piles contents; and that geophysics, soil sampling, test pitting, and, if warranted, groundwater monitoring be performed at the site.

3.2 2006 GEOPHYSICAL SURVEY

In 2006, a geophysical survey was performed at YPG-178 to assess the apparent lateral limits of debris within accessible areas of the site (Jason, 2007). At that time, the area was divided into two potential sub-areas which were designated as YPG-178a and YPG-178b. Glass, burnt wood, cans, scrap metal, and disturbed soils were observed in both areas. In addition, localized burn areas were observed at YPG-178a, and a partially buried drum was observed at YPG-178b.

The geophysical survey consisted of the use of Geonics an EM31 terrain conductivity meter and Geometrics 858 cesium magnetometer in conjunction with a Trimble Pro XRS global positioning system (GPS) for spatial control. Results of the geophysical survey showed the

lateral limits of buried debris are reasonably well defined, with a few small areas extending beyond the survey boundaries.

3.3 2009 ASH REMOVAL

In October 2009, four soil samples were collected from burnt debris intermixed with ash and analyzed for: metals, semivolatile organic compounds (SVOCs), and explosives. Additional samples were collected from the same locations and analyzed using Toxicity Characteristic Leaching Procedure (TCLP) methods for pesticides and volatile organic compounds (VOCs). All constituents were below TCLP regulatory limits. Based on the analytical results from both the total and TCLP analyses and following the ADEQ Investigation Derived Waste (IDW) Policy (ADEQ, 2005), the waste was determined to be non-hazardous. Approximately 190 cubic yards of soil and ash were removed from the site and disposed at the Yuma Proving Ground landfill. Ash from YPG-178b could not be completely removed and further investigation of the extent of the ash was required and performed as part of the RFI.

SECTION 4.0
NATURE AND EXTENT OF CONTAMINATION INVESTIGATION

A nature and extent of contamination investigation was conducted at YPG-178 as part of the RFI. A description of the investigation activities and 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 RFI at YPG-178a and b consisted of the following activities:

- Collecting pre-removal and TCLP soil samples from four locations at YPG-178;
- Removing surface debris/ash at YPG-178;
- Collecting surface soil samples from areas where surface ash/debris was removed to determine if chemical constituents have been released from the waste;
- Excavating exploratory test pits in areas suspected of containing buried waste; and
- Collecting soil samples from the excavated test pits to determine if chemical constituents have been released into the surface and/or subsurface soil.

The following sections describe these activities in detail, and Table 4.1 presents the activities conducted and characterizes the objectives of each activity.

4.1.1 Pre-removal Sampling

In October and November 2009, four soil samples were collected from areas of YPG-178 known to contain burnt debris intermixed with ash. These samples were analyzed for metals, SVOCs, pesticides/herbicides VOCs, explosives, and reactive cyanide and sulfides. Analytical results for these samples are included at Table C.5 in Appendix C. One sample, which exceeded the 20x TCLP limits for metals, was extracted and analyzed using TCLP for metals. TCLP results of this waste sample show all constituents at levels below regulatory limits (TCLP, residential soil remediation levels [rSRLs], and minimum GLPs). Based on analytical results from both the total and TCLP analysis, the waste was determined to be non-hazardous (Appendix C).

4.1.2 2009 Removal Action

A removal action was conducted at YPG-178 in November 2009. Based on results of the previous geophysical survey (Jason, 2007), ash, debris (including discarded bottles, and small pieces of metal scrap) and associated soil were excavated and removed from YPG-178 and disposed at the USAGYPG landfill. The extent of ash/debris was excavated and removed from two areas located at YPG-178a (Areas 3 and 4; Figure 4.1) and two areas located at YPG-178b (Areas 5 and 7; Figure 4.2) until no visible evidence of waste remained. Ash/debris and associated soil were also partially removed from two locations at YPG-178a (Areas 1 and 2; Figure 4.1). Extent of ash/debris at these areas was larger than originally estimated; however, since the waste was determined to be non-hazardous, further removal of the material was unwarranted. A larger area at YPG-178b (Area 6; Figure 4.2) was minimally excavated during the removal action since the ash/debris went into the hillside and was covered by several feet of rock, sand and silt. The 2009 ash and debris removal areas are shown on Figures 4.1 and 4.2. Photographs of YPG-178a before and after the removal action are presented in Figures 4.3 and 4.4. Further investigation of the extent of ash/debris at the site conducted during RFI, including test pit excavations, is described in the following sections. Photographs of the removal action are presented in Appendix F.

4.1.3 Surface Soil Sampling and Test Pit Excavations

A total of nine surface soil samples and one field duplicate, (178SS007 through 178SS014 and 178SS019), were collected from Areas 3, 4, 5, and 7 where ash, debris and associated soil was removed (Figures 4.1 and 4.2). This sampling was performed to determine if chemical constituents were released at the site. Surface soil samples were analyzed for 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).

Ten test pits (178EP001 through 178EP010) were excavated to define the vertical and horizontal extent of buried waste at Areas 1, 2, and 6, where waste was not completely removed in 2009 (Figures 4.1 and 4.2). Associated surface and subsurface soil and ash sampling was conducted to define the nature and extent of any detectable contamination.

The test pits were excavated using a wheeled backhoe with an extension arm allowing a 15-ft maximum depth of excavation. Ash/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 to cross-cut the suspected areas where ash may be covered by rock and soil. Once the debris/soil was inspected by the UXO technicians, the on-site geologist prepared a geologic log of the test pit showing depth and thickness of waste, soil type and soil sample locations. Test pit excavation logs are presented in Appendix A and photographs of the test pit operations are presented in Appendix B.

Of the ten test pits excavated, six test pits contained solid waste (178EP002, 178EP003, 178EP004, 178EP005, 178EP009, and 178EP010), which included ash, wood, glass, wire, bottles, burnt paper and rusted metal debris (Table 4.2). Ash/debris was found in these test pits between 1 and 6 ft bgs. A total of 22 surface and subsurface soil samples (and one field duplicate) were collected from within the ten test pits. These samples included ten surface (i.e., 0.2-0.7 ft bgs) soil samples (one from each of the test pit locations), and thirteen subsurface soil samples from test pits where waste was encountered. Subsurface soil samples were collected from within and below the waste.

Surface soil samples collected from the test pits were analyzed for SVOCs, explosives and metals; and subsurface soil samples were analyzed for 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 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.

Two soil samples were collected from each of two background test pits located at YPG-178 (178BG001 at YPG-178a; 178BG002 at YPG-178b); one sample from the ground surface (0.2-0.7 ft bgs), and one sample from the base of the excavation (7.5-8 ft bgs at 178BG001 and 8-8.5 ft bgs at 178BG002). These samples were analyzed for metals. Data from the background test pit at YPG-178 were combined with background data from other inactive landfill RFI sites at USAGYPG to calculate Background Threshold Values (BTVs) (Appendix D).

4.1.3.1 YPG-178a

Six surface soil samples (178SS007 - 178SS009 from Area 3 and 178SS010 - 178SS012 from Area 4) were collected from YPG-178a during the RFI (Figure 4.1). As stated previously, ash/debris and associated soil was removed from these areas until there was no visible evidence of remaining waste during the November 2009 removal action. Soil sampling in these areas was performed to determine if chemical constituents have been released into surrounding soil.

Following surface soil sampling activities, test pits (178EP009 and 178EP010) were excavated at Areas 1 and 2 to define the vertical and horizontal extent of buried ash/debris remaining at the site. Associated surface and subsurface soil sampling was conducted at the test pits to define the nature and extent of potential chemical contamination. Additionally, one background test pit (178BG001) was excavated and one associated surface and one subsurface soil sample were collected for use in BTV calculations for metals at the inactive landfills (Appendix D).

4.1.3.2 YPG-178b

Two surface soil samples (178SS013 and 178SS014) were collected from Area 5 and one surface soil sample (178SS019) was collected from Area 7 at YPG-178b during the RFI (Figure 4.2). As stated previously, ash/debris was excavated from these areas until there was no visible evidence of remaining waste during the 2009 removal action. Because the surface soil sample collected from 178SS019 was not originally analyzed for explosives, a second soil sample was collected from the same location in January, 2011 and analyzed for explosives. Soil sampling at YPG-178b was performed to determine if chemical constituents from the ash/debris were released into the surrounding soil.

Following the surface soil sampling, eight test pits (178EP001 through 178EP008) were excavated in Area 6. The purpose of these test pits was to delineate the horizontal and vertical extent of the buried ash/debris at the site. Associated surface and subsurface soil sampling was also conducted at the test pits to define the nature and extent of potential chemical contamination. Additionally, one background test pit (178BG002) was excavated and a surface and one subsurface soil sample were collected. Analyses for these two samples were combined with other samples collected at the other inactive landfills for use in BTV metals calculations (Appendix D).

4.1.4 Planned Versus Complete RFI Activities

Test pit excavations and soil sampling activities proposed in the RFI Work Plan (Parsons, 2010) were conducted as planned, with the exception of the following minor deviations: 1) Test pits were excavated at Areas 1 and 2 at YPG-178a in locations where surface soil sampling was proposed in the work plan (Parsons, 2010) because these areas were found to contain ash/debris extending into a larger area than originally estimated. 2) An additional four test pits (making a total of eight) were excavated in Area 5 at YPG-178b because ash/debris was also found to extent into a larger area than originally estimated. Two of these test pits replaced surface soil samples proposed in the work plan (Parsons, 2010).

As proposed in the work plan (Parson, 2010), all surface soil samples were analyzed for SVOCs, explosives and metals and subsurface soil samples collected from the test pit excavations were analyzed for VOCs, SVOCs, explosives, and metals. The surface soil sample collected from 178SS019 was not originally analyzed for explosives. Therefore, a second soil sample was collected from the location in January, 2011 and analyzed for explosives. As proposed in the work plan (Parsons, 2010), soil samples collected from the background test pits were analyzed for metals only.

4.2 INVESTIGATION RESULTS

4.2.1 Data Quality

The analytical data generated from the surface soil sampling and subsurface test pit sampling 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).

4.2.2 Soil Screening Values

4.2.2.1 Background Threshold Values

The objectives of collecting soil samples at YPG-178 were to determine if soils were impacted by the disposal of ash/debris at the site, 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-178 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-178 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 rSRLs and non-residential soil remediation levels (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 BTVs 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 31 surface and subsurface soil samples (and 2 field duplicates) were collected from YPG-178. Surface soils samples were analyzed for SVOCs, metals, and explosives, and subsurface soil samples were analyzed for VOCs, SVOCs, metals, and explosives (Section 4.1). Detections in surface and subsurface soil samples consisted of select SVOCs, metals, and one explosive (Tables 4.3 and 4.4). Surface and subsurface soil samples were collected at areas where ash/debris was removed during the 2009 removal action and from test pit excavations containing ash/debris. No analyte concentrations were detected above the rSLRs, nrSRLs, or GPLs. 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-178 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. Nine of the 33 soil samples have inorganic concentrations greater than their respective BTV. These nine samples were collected from the following eight locations:

- 178EP001
- 178EP002
- 178EP003
- 178EP004
- 178EP005
- 178EP009
- 178EP010
- 178SS019

The following inorganic compounds had concentrations exceeding BTVs:

- Arsenic
- Cadmium
- Chromium
- Copper
- Iron
- Lead
- Mercury
- Molybdenum
- Silver
- Zinc

Of the nine samples with inorganic concentrations greater than BTVs, six were collected from within debris zones. Of the remaining three samples with concentrations greater than BTVs, one was collected from a sample underlying the same debris zone (178EP004; Table 4.3).

All six of the samples collected within the debris zones had multiple inorganics (up to seven) that exceeded their respective BTV. No other samples had multiple inorganics with concentrations that exceed BTVs. Sample location 178EP004 (5-5.5 ft bgs), had detections of the same inorganic constituent (silver) above the BTV as the overlying debris zone sample collected at 2-2.5 ft bgs; however, at lower concentrations.

Two inorganic compounds (arsenic and silver) were detected at estimated concentrations (8.42J milligrams per kilogram [mg/kg] and 0.069J mg/kg) that exceed the BTVs at surface sample locations 178EP001 and 178SS019.

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, nrSRL 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 and inorganic compounds were detected in site soils, no samples had concentrations above their corresponding rSRL, nrSRL or GPL.

Because no inorganic or organic constituents exceeded their corresponding rSRL, nrSRL or GPL, the horizontal and vertical extent of potential impacts from disposal activities at YPG-178 has been delineated and additional soil sampling and analyses are not required.

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-178 has been adequately delineated and additional soil sampling and analyses are not required.

4.3 CONTAMINATION ASSESSMENT

The YPG-178 site consists of multiple surface and rock covered disposal sites located approximately 200 ft apart. These areas are located within a series of alluvial small hills and associated drainages.

During a removal action conducted in November 2009, ash, debris and associated soil were excavated and removed from four locations at YPG-178 (Areas 3, 4, 5, and 7) until there was no visible evidence of remaining waste. At that time, ash/debris was also partially removed from two areas at YPG-178a (Areas 1 and 2). Excavation activities were also conducted at a larger area at YPG-178b (Area 6); however, no waste was removed. Because the extent of ash/debris in Areas 1, 2 and 6 extended into the hillside and was covered by rock, sand and silt complete removal of ash/debris could not be accomplished.

During the RFI, nine surface soil samples were collected from Areas 3, 4, 5 and 7, to determine if chemical constituents from the ash/debris have been released into the surrounding soil. Ten test pits were also excavated in Areas 1, 2, and 6 to further delineate the extent of ash/debris underlying the rock covered hillside. Two additional test pits were excavated to represent background conditions. Results of the test pit excavations show that ash/debris was encountered within six of these pits. Based on results of the test pit excavations, the approximate extent of remaining waste at Areas 1, 2, and 6 was estimated. The footprint of remaining waste underlying the gravel hills is presented on Figures 4.5 and 4.6.

A total of 22 soil samples were collected from the test pit excavations, with samples taken from above the waste (surface), within the waste, and from soils underlying the waste. An additional four soil samples were collected from background test pits.

Analytical results from the 31 soil samples collected (surface, test pit, and background samples) at YPG-178 show that although numerous detections of inorganic compounds slightly exceed the BTVs, no soil samples contain concentrations of organic or inorganic compounds exceeding the corresponding ADEQ rSRLs, nrSRLs, or GPLs.

4.4 NATURE AND EXTENT RECOMMENDATIONS

Surface and subsurface investigation activities conducted during the RFI indicate ash/debris identified within YPG-178 consists of burnt municipal and industrial waste. No evidence of liquid waste or munitions debris disposal was identified in the excavated and

removed ash/debris or the excavation/test pits at the site. The nature and extent of ash material has been delineated at YPG-178, and detected constituents did not exceed ADEQs nrSRL, rSRL or GPL remediation goals 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-178.

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-178 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-178 site is located approximately 2 miles south-southeast of the Main Administrative Area, north of Laguna Dam Road (Figure 2.1), and consists of multiple surface and shallow subsurface disposal sites located approximately 200 ft apart. These areas are located on a series of small hills and have been designated YPG-178a and YPG-178b. The YPG-178a site is approximately 1.68 acres in size, and YPG-178b is approximately 0.76 acres (Figure 2.2). Disposal activities reportedly occurred during the 1960s and 1970s (Jason, 2007).

There were several large piles of ash and debris (including glass, burnt wood, cans, and scrap metal) at YPG-178a and b (Jason, 2007). These piles and associated soils were excavated and disposed at the USAGYPG landfill. The ash/debris piles were excavated and removed from Areas 3 and 4 at YPG-178a (Figure 4.1) and Areas 5 and 7 at YPG-178b (Figure 4.2) until there was no visible evidence waste. Ash/debris and associated soil was also partially removed from Areas 1 and 2 at YPG-178a (Figure 4.1) and Area 6 at YPG-178b (Figure 4.2). The extent of ash/debris at these areas was larger than originally estimated and further removal was postponed until additional investigation to delineate the extent could be performed. The footprints of the approximate ash and debris removed from YPG-178 in 2009 are illustrated in Figures 4.5 and 4.6, as are the extents of buried ash/debris material.

5.1.2 Selection of Chemicals of Potential Concern

Chemicals of potential concern (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, 14 samples were collected at YPG-178a, including two field duplicates and 18 samples were collected at YPG-178b, excluding the two samples that were collected from Area 7. All samples collected at YPG-178a and b were analyzed for metals, VOCs, SVOCs, and explosives using 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 8 ft bgs (Table 4.2).

The validated data collected at 0-8 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).

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 0-8 ft bgs (Table 5.1):

- Arsenic
- Cadmium
- Chromium, total
- Copper
- Lead
- Mercury

- Molybdenum
- Silver
- Zinc

Lastly, the maximum detected concentrations were compared to the ADEQ (2007) rSRLs and nrSRLs. As an initial step, the maximum detected concentrations from both YPG-178a and b were compared to the rSRLs and nrSRLs. Since no chemicals were detected at concentrations greater than the rSRLs and/or nrSRLs, separate evaluations of YPG-178a and b were not required. Additionally, since no chemicals were detected at concentrations exceeding the rSRLs and/or nrSRLs, 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-178 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-178a and b. 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-178a and b. 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-178. 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-178 site is located approximately 2 miles south-southeast of the Main Administrative Area, north of Laguna Dam Road (Figure 2.1) and consists of multiple surface and shallow subsurface disposal sites located approximately 200 ft apart. These areas are located on low-lying bedrock outcrops among a series of small hills and have been designated YPG-178a and YPG-178b. The YPG-178a site is approximately 1.6 acres in size, and YPG-178b is approximately 0.8 acres (Figure 2.2). Disposal activities reportedly occurred during the 1960s and 1970s (Jason, 2007).

Prior to the surface debris removal action in November 2009 (Section 4.1.2), the area was scattered with glass, burnt wood, cans, and scrap metal. Disturbed soil was also observed at the sites. In addition, localized burn areas were observed at YPG-178a, and a partially buried drum was observed at YPG-178b (Jason, 2007).

For the forseeable future, YPG-178 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.

Much of the site has been disturbed by past disposal activities and has little to no vegetation. Vegetation across YPG-178 consists of low-lying shrubs and brush including desert ironwood, palo verde, catclaw acacia, saguaro cactus, ocotillo, Anderson thornbush, Smoketree,

and creosote bush. Brittlebush, saltbush, and Bebbia are some common shrubs in the Yuma Proving Ground.

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 each site (Tables E2 and E3):

- YPG-178a
    - Antimony
    - Copper
    - Lead
    - Mercury
    - Zinc
- YPG-178b
    - Antimony
    - Lead
    - Mercury
    - 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-178a and b:

- 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-178 and groundwater occurs at approximately 115 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. 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 EPCs for antimony, copper, and mercury did not exceed the screening level at both YPG-178a and b. However, the EPCs for lead exceeded the screening level for plants at both YPG-178a and b and the EPC for zinc exceeded the screening levels for both plants and invertebrates at YPG-178b (see Appendix E). This indicates that site related exposures to lead may result in adverse effects for plants at both YPG-178a and b while site related exposures to zinc may result in adverse effects for plants and invertebrates at YPG-178b.

5.2.3.2 Vertebrate Receptor Hazard Estimates

At YPG-178a, and 178b the LOAEL-based HQs and Hazard Indexes (HIs) (i.e., the sum of all HQs for an individual receptor) did not exceed the threshold value of one for any receptor (see Appendix E). This indicates that adverse effects to vertebrate receptors from soil exposures at YPG-178a and 178b are unlikely.

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-178, no detected concentrations of analytes exceeded its associated minimum GLP; 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., vertebrates) receptors. Therefore, a CMS is not required.

SECTION 6.0
SUMMARY AND RECOMMENDATIONS

6.1 INVESTIGATION AND HRA SUMMARY

An RFI has been completed at YPG-178 to: 1) collect data to adequately identify and characterize the nature and extent of ash and potential chemical 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.

Disposal activities at YPG-178 reportedly occurred during the 1960s and 1970s (Jason, 2007). Prior to the surface debris removal action in November 2009, the site was scattered with glass, burnt wood, cans, and scrap metal. Surface ash piles were also observed at the sites and were plotted on maps by Jason. A partially buried drum was observed at YPG-178b (Jason, 2007); however, during the 2009 removal action the drum was removed and was found to be empty.

Ash, debris and associated soil were excavated and removed from four locations at YPG-178a and b (Areas 3, 4, 5, and 7) during the November 2009 removal action. The procedure for removing the ash/debris was to excavate until there was no visible evidence of remaining ash/debris material. Waste material (ash/debris) was also partially removed from two areas at YPG-178a (Areas 1 and 2). Excavation activities were also conducted at a larger area at YPG-178b (Area 6); however, no waste was removed from this area. Ash/debris removal in Areas 1, 2 and 6 was not completed because the extent of material was larger than originally estimated, extending into the hillside and covered by several feet of rock, sand and silt. Further removal was postponed until additional delineation of the disposal boundaries could be conducted.

A total of 33 soils samples were collected from surface locations, test pits, and background samples at YPG-178a and b. Analytical results show that although numerous detections of inorganic compounds slightly exceed the BTVs, no soil samples contain concentrations of organic or inorganic compounds exceeding the corresponding ADEQ rSRL, nrSRL, or GPL.

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

6.2 RECOMMENDATIONS

A Corrective Measures Study is recommended to evaluate the impacts to the site due to the remaining ash/debris present at Areas 1 and 2 (YPG-178a) and Area 6 (YPG-178b) (Figures 4.5 and 4.6). However, based on waste characterization and test pit sampling of the ash and debris, the remaining waste was determined to be non-hazardous. Additionally, the HRA and ERA results indicate no unacceptable risks to human or ecological receptors were identified. Future impacts to groundwater from site related chemical constituents are not expected, since sampling results did not exceed the GPLs. Therefore, no further action to mitigate risks to human health or the environment is required.

SECTION 7.0

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TABLES

TABLE 2.1

SOIL TYPES AT USAGYPG
RCRA FACILITY INVESTIGATION REPORT

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-178
U.S. ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Field Activity	Characterization Objective of Field Activity			
	Determine Disposal Site Boundaries	**Evaluate Potential Subsurface Soil Contamination Source Areas**	**Determine if Contamination is Migrating from Source Areas**	**Determine Concentrations of Background Metals**
Surface Debris Removal	Ash/debris and associated soil removed from 178a and 178b			
Test Pits	178EP001 – 178EP010 23 Total Samples including 1 field duplicate	178EP001 – 178EP010 12 Subsurface Soil Samples	178EP001 – 178EP010 Soil samples collected at test pits from surface, within debris, and below debris	
Surface Soil Samples			178SS007 - 178SS014 and 178SS019 10 Surface Samples including 1 field duplicate	
Background Test Pits				178BG001 and 178BG002 2 Surface and 2 Subsurface Soil Samples

TABLE 4.2
TEST PIT EXCAVATION AND SOIL SAMPLING SUMMARY - YPG-178
RCRA FACILITY INVESTIGATION REPORT
U.S. ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Sample Location	Total Depth (ft)	Total Width (ft)	Total Length (ft)	Sample Depth (ft bgs)			Notes
				First	Second	Third	
Test Pits Excavated and Soil Samples Collected from YPG-178a							
178EP009	9	2-3	38	0.2-0.7	3-3.5	7.5-8	Waste present from surface to 4.5 ft bgs; waste located in the sand and was slightly damp. Waste included copper wire, lots of broken glass, jars, and rusted metal Burn zone consisted burned paper and ash. Waste found in a distinctive zone from the surface to 3-4 ft bgs.
178EP010	7	3	64	0.2-0.7	3-3.5	5-5.5	Waste in sand is thining in thickness to < 1 ft in SE direction. The NW end fo tench is approximatley 4-5 ft higher in elevation than the SE end. Waste continued to the NW into the hillside. Excavation could not extend further as the sides kept caving. Waste included glass bottles, broken glass, metal pipe, ash, plaster, rusted metal wire, and a battery casing.
178SS007	NA	NA	NA	0.2-0.7	NA	NA	Surface Soil Sample taken from Area 3 of YPG-178a.
178SS008	NA	NA	NA	0.2-0.7	NA	NA	Surface Soil Sample taken from Area 3 of YPG-178a.
178SS009	NA	NA	NA	0.2-0.7	NA	NA	Surface Soil Sample taken from Area 3 of YPG-178a.
178SS010	NA	NA	NA	0.2-0.7	NA	NA	Surface Soil Sample taken from Area 4 of YPG-178a.
178SS011	NA	NA	NA	0.2-0.7	NA	NA	Surface Soil Sample taken from Area 4 of YPG-178a.
178SS012	NA	NA	NA	0.2-0.7	NA	NA	Surface Soil Sample taken from Area 4 of YPG-178a.
Test Pits Excavated and Soil Samples Collected from YPG-178b							
178EP001	9	4	16	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed. Waste was expected but not encountered.
178EP002	6	3	30	0.2-0.7	2-2.5	6-6.5	Waste present from 2 to 6 ft bgs; waste included glass bottles and jars, rusted metal, and carbon rods from batteries. Burn zone consisted of burned wood ash.
178EP003	6	3	65	0.2-0.7	2-2.5	6-6.5	Waste present from 1 to 4 ft bgs; waste included glass bottles and jars, rusted metal, ash, carbon tubes from batteries. Burn zone consisted of burned wood. Waste ends approximately 16 ft north of south edge of pit and tapers at edges.

TABLE 4.2
TEST PIT EXCAVATION AND SOIL SAMPLING SUMMARY - YPG-178
RCRA FACILITY INVESTIGATION REPORT
U.S. ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Sample Location	Total Depth (ft)	Total Width (ft)	Total Length (ft)	Sample Depth (ft bgs)			Notes
				First	Second	Third	
178EP004	6.5	3.5	87?	0.2-0.7	2-2.5	5-5.5	Test pits EP004 & EP005 are two halves of one large test pit, as defining the limits of the waste included both locations. Waste present from 1 to 4 ft bgs; waste included metal wire, broken glass, 1.5" iron pipe, glass bottles and jars, pieces and flakes of rusted metal, copper wire, newspaper, a metal spoon, and blue and green christmas bulbs. The burn zone consisted of burned wood and ash.
178EP005	6.5	3.5	58?	0.2-0.7	3-3.5	6-6.5	Test pits EP004 & EP005 are two halves of one large test pit, as defining the limits of waste included both proposed locations. Waste present from 1 to 4 ft bgs; waste included metal wire, broken glass, 1.5" iron pipe, glass bottles and jars, pieces and flakes of rusted metal, copper wire, newspaper, a metal spoon, and blue and green Christmas bulbs. The burn zone consisted of burned wood and ash.
178EP006	6	2-3	16	0.2-0.7	NA	NA	No staining, debris, or other evidence of contamination observed.
178EP007	7.5	2-3	16	0.2-0.7	NA	NA	No staining, debris, or other evidence of contamination observed.
178EP008	7	3	16	0.2-0.7	NA	NA	No staining, debris, or other evidence of contamination observed.
178SS013	NA	NA	NA	0.2-0.7	NA	NA	Surface Soil Sample taken from Area 5 of YPG-178b.
178SS014	NA	NA	NA	0.2-0.7	NA	NA	Surface Soil Sample taken from Area 5 of YPG-178b.
178SS019	NA	NA	NA	0.2-0.7	NA	NA	Surface Soil Sample taken from Area 7 of YPG-178b.
Background Soil Samples							
178BG001	8	3	18	0.2-0.7	7.5-8	NA	No staining, debris, or other evidence of contamination observed.
178BG002	8.5	3	16	0.2-0.7	8-8.5	NA	No staining, debris, or other evidence of contamination observed.

TABLE 4.3

INORGANIC ANALYTICAL RESULTS - DETECTIONS, YPG-178
RCRA FACILITY INVESTIGATION REPORT

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
			rSRL	76,000	31	10	15,000	23	39	NA	17,000	1,400	3,100	NA	400
			nrSRL	920,000	410	10	170,000	1900	510	NA	1,000,000	13,000	41,000	NA	800
			GPL	NA	35	290	12,000	150	29	NA	590	NA	NA	NA	290
			Background Threshold Values	12,000	--	6.6	290	0.92	0.65	37,000	14	7.9	15	15,000	14
YPG-178a															
178EP009	0.2-0.7	N	20-Dec-10	3,580		2.46	52.9			4,870	6.13	3.12	4.34	7,220	5.13
178EP009	3-3.5	N	20-Dec-10	4,080	1.87 J	4.67	285		**0.95**	10,300	**14.4**	3.61	**51.7**	**21,400**	**163**
178EP009	7.5-8	N	20-Dec-10	2,100		1.92	236		0.033 J	8,110	4.49	1.36	2.18	6,520	3.42
178EP010	0.2-0.7	N	20-Dec-10	1,880	0.2 J	2.24	48.9			5,560	3.18	1.34	2.3	4,450	3.51
178EP010	3-3.5	N	20-Dec-10	3,400		5.75	126		0.34	13,200	10.2	2.78	**52.9**	**16,800**	**271**
178EP010	5-5.5	N	20-Dec-10	1,660		1.09 J	70.4			1,300	3.95	1.77	1.81	5,620	3.26
178EP010	5-5.5	FD	20-Dec-10	1,710		1.2 J	78.3			1,350	3.91	1.68	1.73	5,540	3.23
178SS007	0.2-0.7	N	13-Dec-10	1,360		1.29 J	56.7 J		0.065 J	15,300	2.93	1.05	1.39	3,520	2.9
178SS007	0.2-0.7	FD	13-Dec-10	1,510		1.43 J	64.1		0.1 J	20,100	3.16	1.18	1.48	3,560	3.11
178SS008	0.2-0.7	N	13-Dec-10	1,530		1.42 J	211		0.022 J	9,550	3.21	1.12	1.47	3,900	2.72
178SS009	0.2-0.7	N	13-Dec-10	2,170		1.27 J	33		0.028 J	10,900	4.22	1.76	2.45	5,120	3.46
178SS010	0.2-0.7	N	13-Dec-10	2,040		1.33 J	219		0.019 J	7,280	2.75	1.59	2.2	3,970	3.18
178SS011	0.2-0.7	N	13-Dec-10	1,100		0.92 J	176		0.046 J	11,100	2.37	0.99	1.51	3,560	2.36
178SS012	0.2-0.7	N	13-Dec-10	1,560		1.81	69.7			3,620	2.58	1.43	1.82	3,660	2.76
YPG-178b															
178EP001	0.2-0.7	N	14-Dec-10	4,690	0.16 J	**8.42 J**	114		0.055 J	15,400	6.18	1.82	3.06 J	5,870	3.33
178EP002	0.2-0.7	N	15-Dec-10	5,470		4.44	218	0.13 J	0.17 J	23,600	6.92	2.41	4.95 J	6,910	5.43
178EP002	2-2.5	N	15-Dec-10	4,040		2.97	147		0.34	13,300	8.89	2.31	**23.8 J**	**20,000**	**107**
178EP002	6-6.5	N	15-Dec-10	2,840		0.73 J	186		0.029 J	3,820	3.85	1.75	2.63 J	4,360	3.07
178EP003	0.2-0.7	N	15-Dec-10	2,760		2.53	66.7		0.057 J	9,830	5.75	1.79	3.36 J	5,500	5.61
178EP003	2-2.5	N	15-Dec-10	4,110	4.34	5.85	130		0.63	9,050	10.2	2.71	**38.1 J**	10,200	**203**
178EP003	6-6.5	N	15-Dec-10	1,310		1.18 J	89.5		0.15 J	21,500	2.76	1.18	2.33 J	3,390	4.5

TABLE 4.3

INORGANIC ANALYTICAL RESULTS - DETECTIONS, YPG-178
RCRA FACILITY INVESTIGATION REPORT

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
			rSRL	76,000	31	10	15,000	23	39	NA	17,000	1,400	3,100	NA	400
			nrSRL	920,000	410	10	170,000	1900	510	NA	1,000,000	13,000	41,000	NA	800
			GPL	NA	35	290	12,000	150	29	NA	590	NA	NA	NA	290
	Background Threshold Values			12,000	--	6.6	290	0.92	0.65	37,000	14	7.9	15	15,000	14
178EP004	0.2-0.7	N	15-Dec-10	3,310		3.82	56.6		0.039 J	7,960	4.84	1.71	2.86 J	5,450	3.59
178EP004	2-2.5	N	15-Dec-10	2,820		3.55	74		0.49	7,530	5.51	2.1	8.02 J	8,990	**177**
178EP004	5-5.5	N	15-Dec-10	1,400		1.57 J	37.2			1,490	3.06	1.53	1.86 J	4,530	3.42
178EP005	0.2-0.7	N	15-Dec-10	4,070		4.69	101		0.014 J	11,500	6.88	2.19	3.39 J	5,980	3.75
178EP005	3-3.5	N	15-Dec-10	4,180	1.69 J	5.13	149		0.37	14,000	9.86	2.51	**42.7 J**	10,100	**144**
178EP005	6-6.5	N	15-Dec-10	2,070		1.62 J	154		0.05 J	11,700	3.44	1.2	2 J	4,560	3.02
178EP006	0.2-0.7	N	16-Dec-10	4,970		3.3	82.8	0.043 J	0.041 J	10,100	6.47	2.64	5.59 J	7,550	5.73
178EP007	0.2-0.7	N	16-Dec-10	1,440		4.18	55.1			10,100	6.32	1.39	1.71 J	5,560	2.73
178EP008	0.2-0.7	N	16-Dec-10	1,240		2.37	39			3,570	5.83	1.4	1.49 J	5,690	3.21
178SS013	0.2-0.7	N	14-Dec-10	2,520		1.53 J	82.2	0.11 J	0.046 J	6,760	3.92	1.76	3.6	4,210	4.1
178SS014	0.2-0.7	N	14-Dec-10	3,330		5.2	102		0.046 J	17,800	5.05	1.76	3.02	4,840	2.97
178SS019	0.2-0.7	N	14-Dec-10	2,510		3.29	132		0.017 J	2,800	5.38	1.39	1.73	5,050	3.82

TABLE 4.3

INORGANIC ANALYTICAL RESULTS - DETECTIONS, YPG-178
RCRA FACILITY INVESTIGATION REPORT

U.S. ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Location ID	Sample Depth	Sample Type	Sample Date	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Vanadium	Zinc
			rSRL	NA	3,300	23	390	1,600	NA	390	390	NA	78	23,000
			nrSRL	NA	32,000	310	5,100	20,000	NA	5,100	5,100	NA	1,000	310,000
			GPL	NA	NA	12	NA	590	NA	290	NA	NA	NA	NA
			Background Threshold Values	6,100	920	0.016	0.49	14	2,500	--	0.062	8400	26	44
YPG-178a														
178EP009	0.2-0.7	N	20-Dec-10	2,060	156	0.0087 J	0.16 J	5.72	1,070			175	18.2	19.5
178EP009	3-3.5	N	20-Dec-10	1,490	246	**0.068**	**1.6**	11.9	1,010		**0.28 J**	1,670	19.5	**164**
178EP009	7.5-8	N	20-Dec-10	894	104	0.0056 J	0.056 J	2.7	476			1,120	20.2	13.7
178EP010	0.2-0.7	N	20-Dec-10	935	90.4	0.0063 J	0.13 J	2.4	485			70.2	13.4	10.6
178EP010	3-3.5	N	20-Dec-10	1,730	695	0.0068 J	**1.25**	8.01	1,070		**0.71**	1,180	15.6	**279**
178EP010	5-5.5	N	20-Dec-10	717 J	78.3	0.0044 J		2.58	345			909	16	12
178EP010	5-5.5	FD	20-Dec-10	677	71.6	0.0083 J	0.048 J	2.54	353			783	15.8	12
178SS007	0.2-0.7	N	13-Dec-10	652 J	60.4 J		0.075 J	1.67	300 J			371 J	11.1	7.93
178SS007	0.2-0.7	FD	13-Dec-10	663	66.5		0.089 J	1.87	327 J	0.2 J		481 J	11.9	7.83
178SS008	0.2-0.7	N	13-Dec-10	535	61.9		0.058 J	1.99	291 J	0.21 J		226 J	10.4	8.76
178SS009	0.2-0.7	N	13-Dec-10	998	121		0.11 J	3.1	421 J			572 J	16.4	12.9
178SS010	0.2-0.7	N	13-Dec-10	1,070	98		0.067 J	2.78	462 J			371 J	8.88	23.5
178SS011	0.2-0.7	N	13-Dec-10	525	64.2		0.068 J	1.92	247 J			226 J	8.44	8.39
178SS012	0.2-0.7	N	13-Dec-10	693	68.4		0.084 J	2.46	316 J			686 J	8.94	8.85
YPG-178b														
178EP001	0.2-0.7	N	14-Dec-10	1,620	138		0.22 J	3.33	1,110 J			218	18.4	14.3
178EP002	0.2-0.7	N	15-Dec-10	2,220	182		0.14 J	4.76	1,150		0.055 J	6,240	18.9	21
178EP002	2-2.5	N	15-Dec-10	1,690	253	**0.019**	**0.54 J**	5.87	948		**4.1**	2,080	15.4	**148**
178EP002	6-6.5	N	15-Dec-10	880	94.9		0.091 J	3.25	570		0.052 J	1,840	11.2	11.3
178EP003	0.2-0.7	N	15-Dec-10	1,630	114		0.11 J	3.38	775		0.035 J	70.7	15.3	17.9
178EP003	2-2.5	N	15-Dec-10	1,950	394	**0.093**	**0.56 J**	5.25	927		**1.04**	3,650	16.6	**566**
178EP003	6-6.5	N	15-Dec-10	635	64.6		0.14 J	1.94	298			1,000	7.43	12.4

TABLE 4.3

INORGANIC ANALYTICAL RESULTS - DETECTIONS, YPG-178
RCRA FACILITY INVESTIGATION REPORT

U.S. ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Location ID	Sample Depth	Sample Type	Sample Date	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Vanadium	Zinc
			rSRL	NA	3,300	23	390	1,600	NA	390	390	NA	78	23,000
			nrSRL	NA	32,000	310	5,100	20,000	NA	5,100	5,100	NA	1,000	310,000
			GPL	NA	NA	12	NA	590	NA	290	NA	NA	NA	NA
			Background Threshold Values	6,100	920	0.016	0.49	14	2,500	--	0.062	8400	26	44
178EP004	0.2-0.7	N	15-Dec-10	1,360	119		0.15 J	3.05	737		0.058 J	415	15.2	13.8
178EP004	2-2.5	N	15-Dec-10	1,180	182		0.27 J	4.86	548		**0.2 J**	183	14.7	**298**
178EP004	5-5.5	N	15-Dec-10	695	88.7		0.099 J	2.54	309		**0.068 J**	453	12.4	10.6
178EP005	0.2-0.7	N	15-Dec-10	1,790	104		0.12 J	3.92	726			658	19.6	15.3
178EP005	3-3.5	N	15-Dec-10	1,700	767	0.01 J	**0.6 J**	5.58	1,040		**0.64**	3,250	18.1	**1,060**
178EP005	6-6.5	N	15-Dec-10	835	95.4		0.13 J	2.48	421			1,640	11.5	12.1
178EP006	0.2-0.7	N	16-Dec-10	2,390	175	0.016	0.18 J	4.93	1,070		0.051 J	68.7	18.3	22.8
178EP007	0.2-0.7	N	16-Dec-10	841	81.4		0.081 J	2.25	414			30.5 J	20.6	12.4
178EP008	0.2-0.7	N	16-Dec-10	727	87.7		0.082 J	2.11	358			22.5 J	19.7	12.9
178SS013	0.2-0.7	N	14-Dec-10	1,220	137		0.12 J	3.35	545 J			689 J	12	11.5
178SS014	0.2-0.7	N	14-Dec-10	1,460	126		0.34 J	3.3	740 J			1,370 J	16.1	12.5
178SS019	0.2-0.7	N	14-Dec-10	907	58		0.13 J	2.3	417 J		**0.069 J**	1,510 J	15.3	13.1

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 (BTV). Highlighted rows are samples collected within the debris zone. '--'means non-detect. 'J' flag means estimated value.

TABLE 4.4

ORGANIC ANALYTICAL RESULTS - DETECTIONS, YPG-178
RCRA FACILITY INVESTIGATION REPORT

U.S. ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Location ID	Sample Depth	Sample Type	Sample Date	Benzo(g,h,i)perylene	Dibenz(a,h)anthracene	Indeno(1,2,3-c,d)pyrene	Octahydro-1,3,5,7-Tetranitro-1,3,5,7-Tetrazocine (HMX)
			rSRL	2,300	0.69	6.9	3,100
			nrSRL	190	2.1	21	31,000
			GPL	NA	0.00	NA	0
YPG-178b							
178EP003	2-2.5	N	15-Dec-10	--	--	--	0.013 J
178EP004	2-2.5	N	15-Dec-10	0.222 J	0.0146 J	0.201 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. '--' means non-detect. 'J' flag means estimated value. Test Pits 178EP001, 178EP002, and 178EP005-178EP008 from YPG-178b and Test Pits 178EP009-178EP010 from YPG-178a are not shown since there were no organic detections in these samples.

TABLE 5.1
CHEMICALS OF POTENTIAL CONCERN
YPG-178
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)	Exceeds			COPC
						BTV	rSRL	nrSRL	
Metals	Aluminum	5,470	12,000	76,000	920,000	No	No	No	No
	Antimony	4.34	-	31	410	NA	No	No	No
	Arsenic	8.42	6.6	10	10	Yes	No	No	No
	Barium	285	290	15,000	170,000	No	No	No	No
	Beryllium	0.13	0.92	150	1,900	No	No	No	No
	Cadmium	0.95	0.65	39	510	Yes	No	No	No
	Chromium, Total	14.4	14	120,000	1,000,000	Yes	No	No	No
	Cobalt	3.61	7.9	1,400	13,000	No	No	No	No
	Copper	52.9	15	3,100	41,000	Yes	No	No	No
	Lead	271	14	400	800	Yes	No	No	No
	Manganese	767	920	3,300	32,000	No	No	No	No
	Mercury	0.093	0.016	23	310	Yes	No	No	No
	Molybdenum	1.6	0.49	390	5,100	Yes	No	No	No
	Nickel	11.9	14	1,600	20,000	No	No	No	No
	Selenium	0.21	-	390	5,100	NA	No	No	No
	Silver	4.1	0.062	390	5,100	Yes	No	No	No
	Vanadium	20.6	26	78	1,000	No	No	No	No
	Zinc	1,060	44	23,000	310,000	Yes	No	No	No
Organics	Benzo(g,h,i)perylene[3]	0.222	NA	56	190	NA	No	No	No
	Dibenz(a,h)anthracene	0.0146	NA	0.69	2.1	NA	No	No	No
	Indeno(1,2,3-c,d)pyrene	0.201	NA	6.9	21	NA	No	No	No
	Octahydro-1,3,5,7-Tetranitro-1,3,5,7-Tetrazocine	0.013	NA	3,100	31,000	NA	No	No	No

Notes:

1 For 0-8 ft bgs

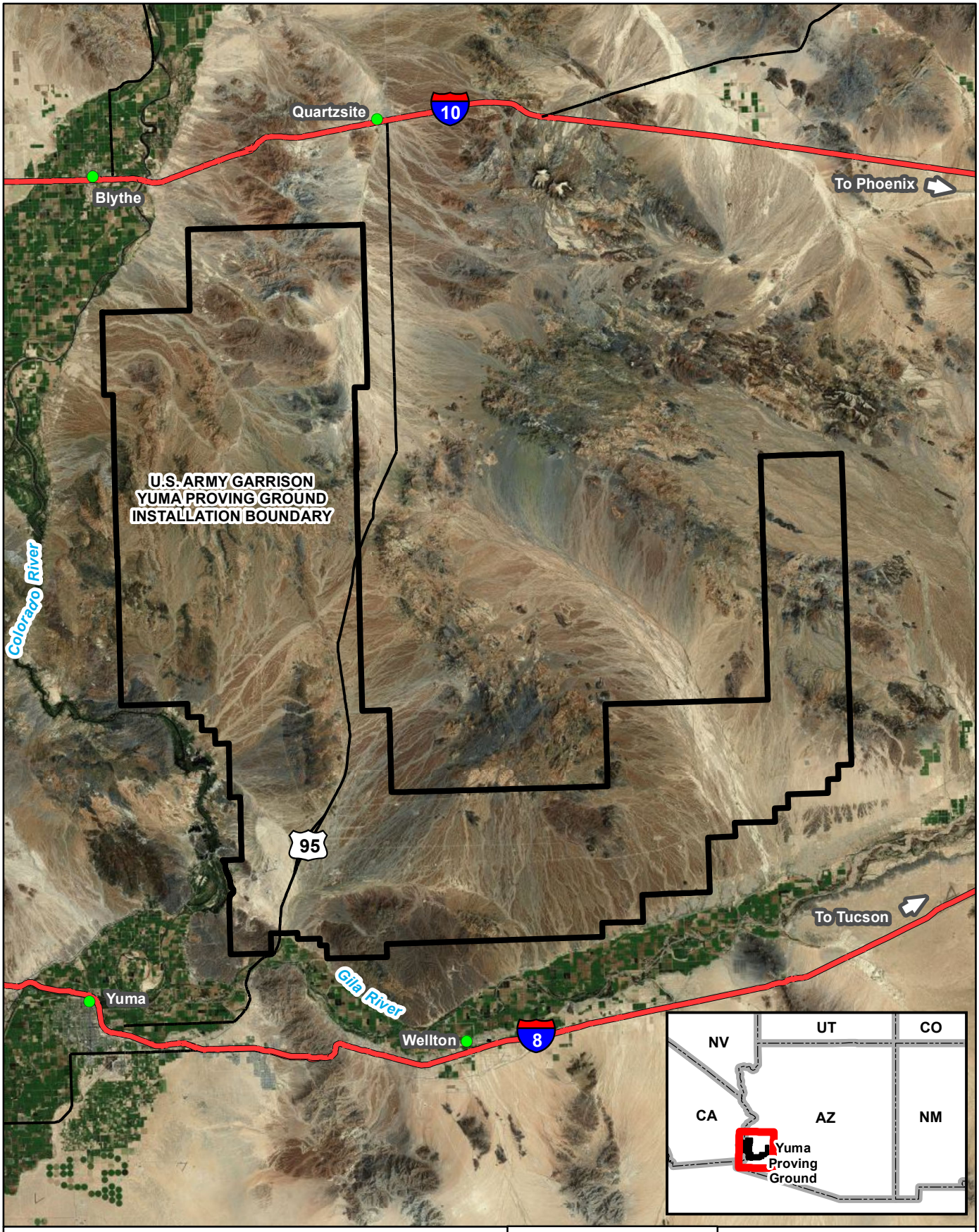
2 Lesser of the 10^{-5} carcinogenic risk and noncarinogen rSRLs

3 No SRL. Naphthalene used as a surrogate.

Definitions:

Max Detect - Maximum detected value
BTV - Background threshold value
rSRL - Residential soil remediation level
nrSRL - Non-residential soil remediation level
COPC - Chemical of potential concern
NA - Not applicable

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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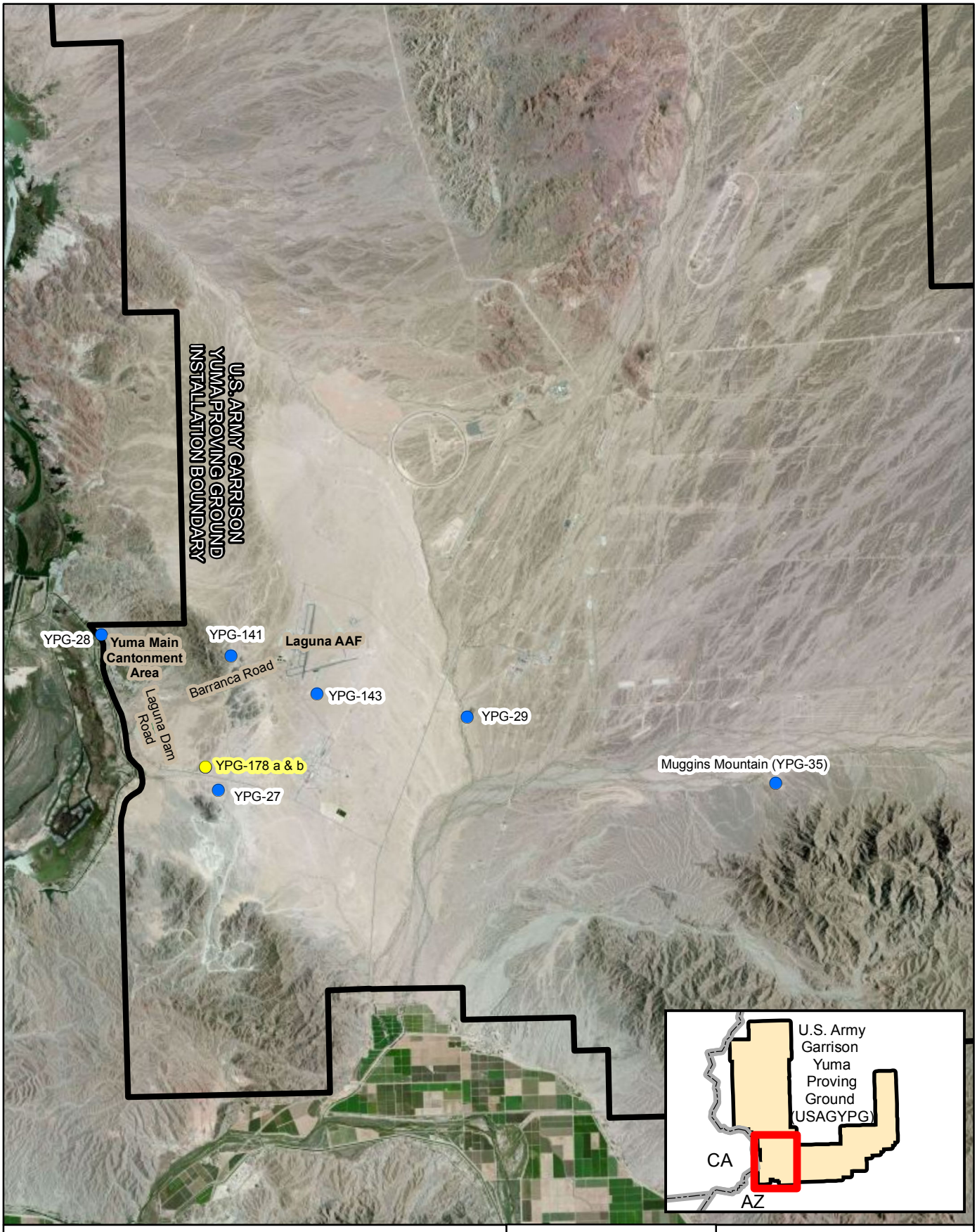

FIGURE 2.1

SITE LOCATION

U.S. Army Garrison Yuma Proving Ground

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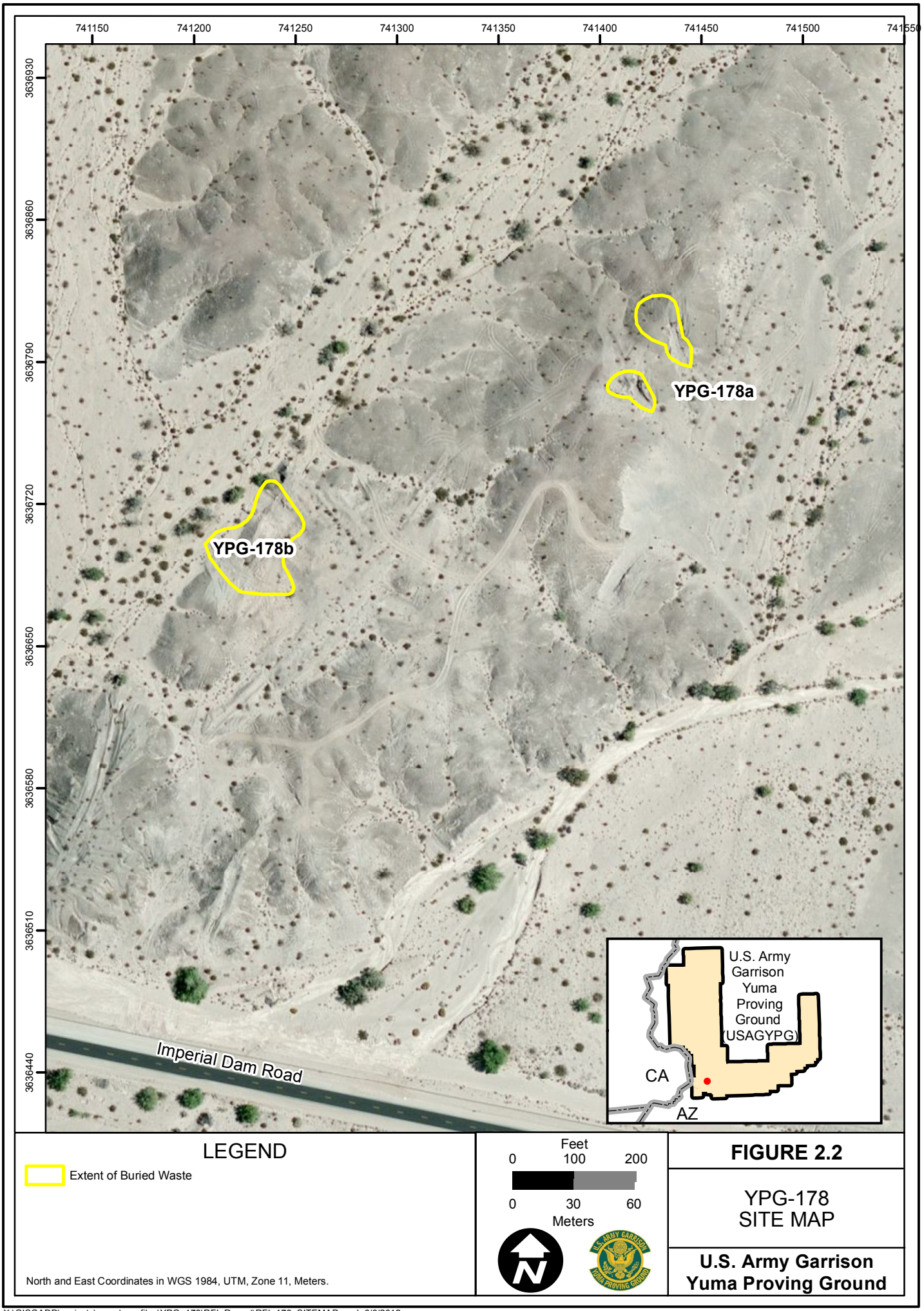

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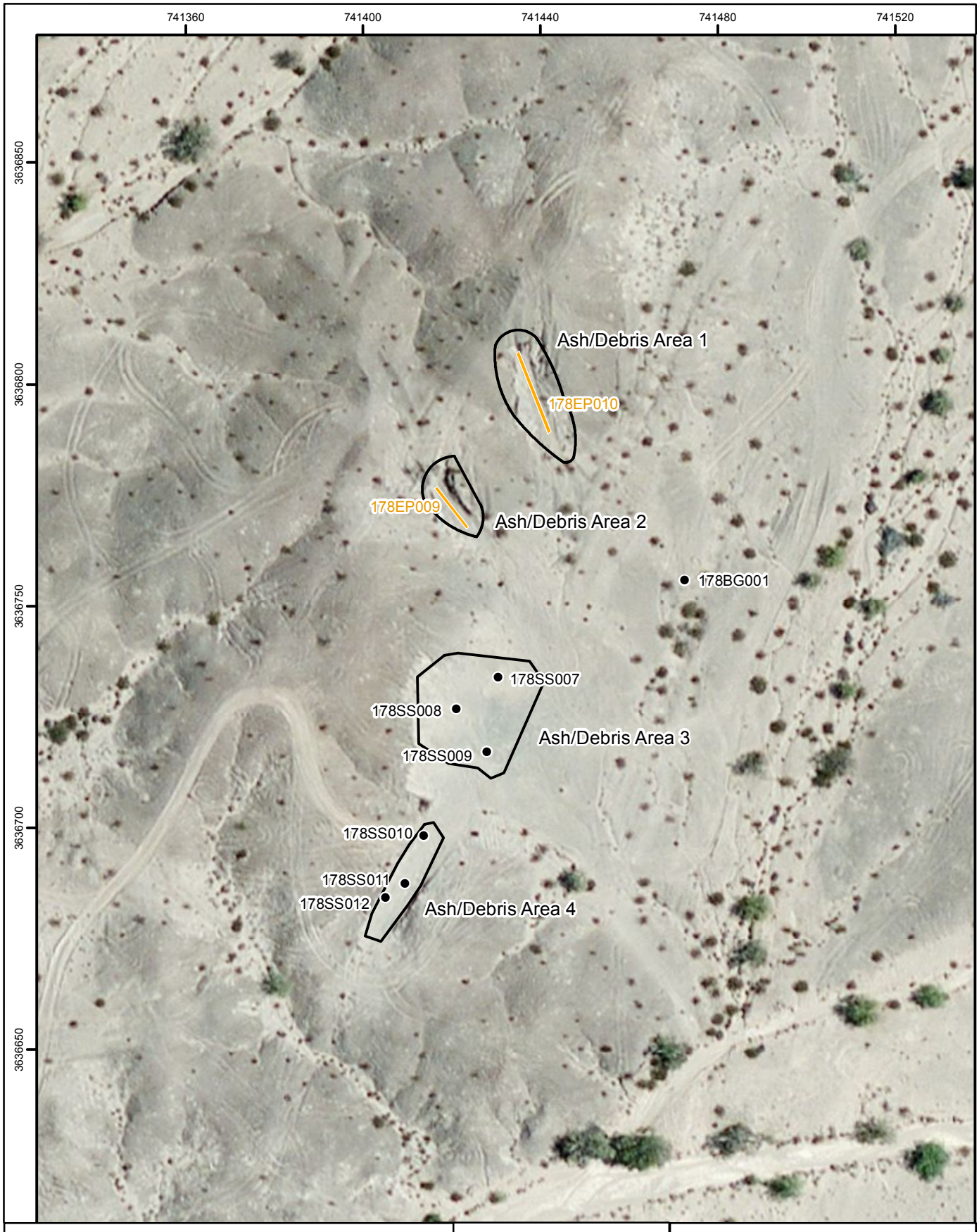
PARSONS

FIGURE 2.3

Inactive Landfill YPG-178



LEGEND

- Surface Soil Sample Location
- Test Pit Containing Waste
- Debris/Ash Removed During November 2009 Removal Action

Feet
0 50 100
0 15 30
Meters

N

U.S. ARMY GARRISON YUMA PROVING GROUND

FIGURE 4.1

YPG-178a
SOIL REMOVAL AREAS
AND SAMPLES

U.S. Army Garrison
Yuma Proving Ground

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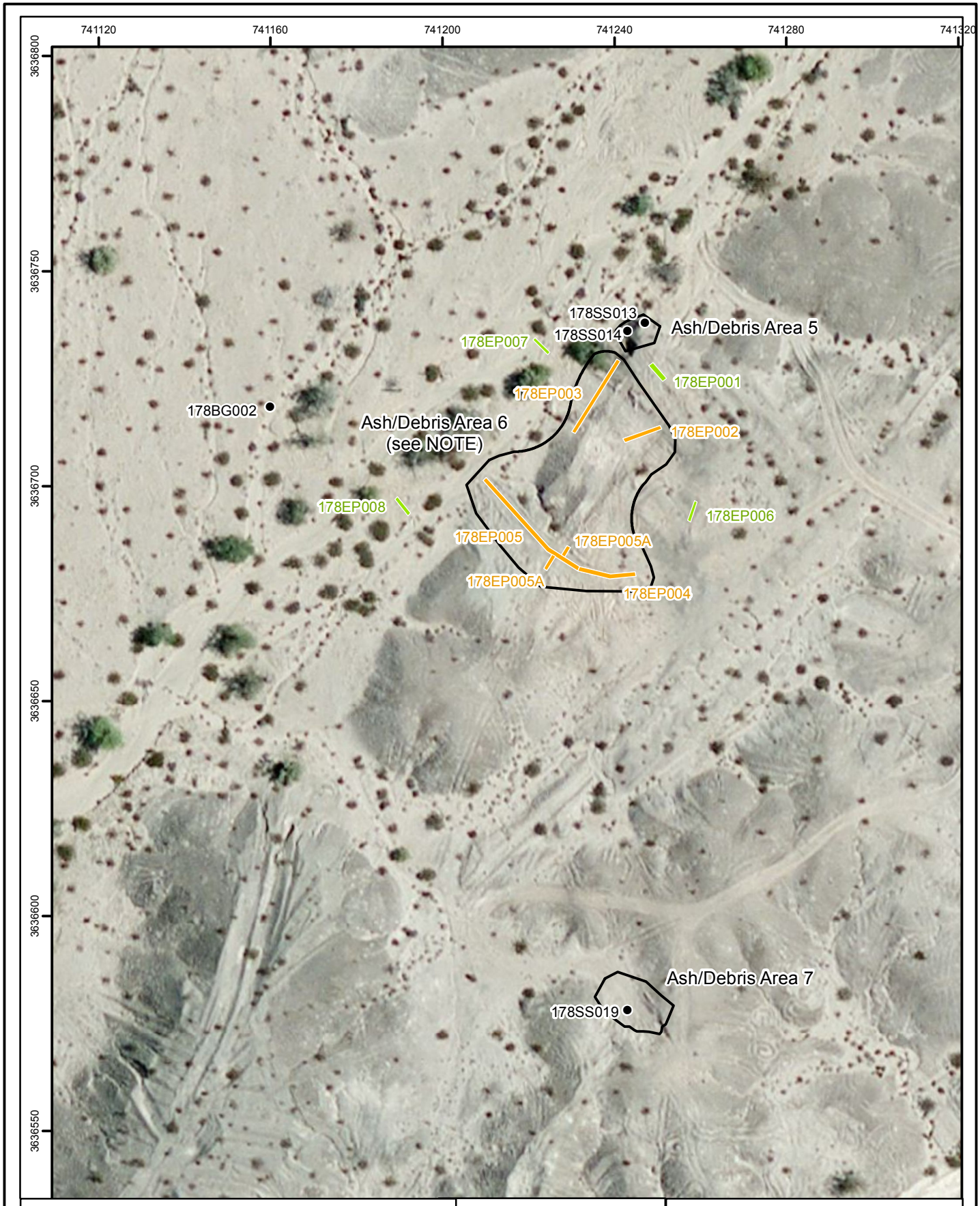


LEGEND

- Surface Soil Sample Location
- Test Pit Containing Waste
- Test Pit Not Containing Waste
- Debris/Ash Removed During November 2009 Removal Action

NOTE: Ash/Debris Area 6 was excavated during the 2009 removal action; however, no ash/debris was removed.

Feet
0 50 100
0 15 30
Meters

FIGURE 4.2

YPG-178b
SOIL REMOVAL AREAS
AND SAMPLES

U.S. Army Garrison
Yuma Proving Ground

X:\GISCADD\projects\yuma\mapfiles\YPG_178\RFI_Report\RFI_178b_sitemap.mxd 6/6/2012

PARSONS

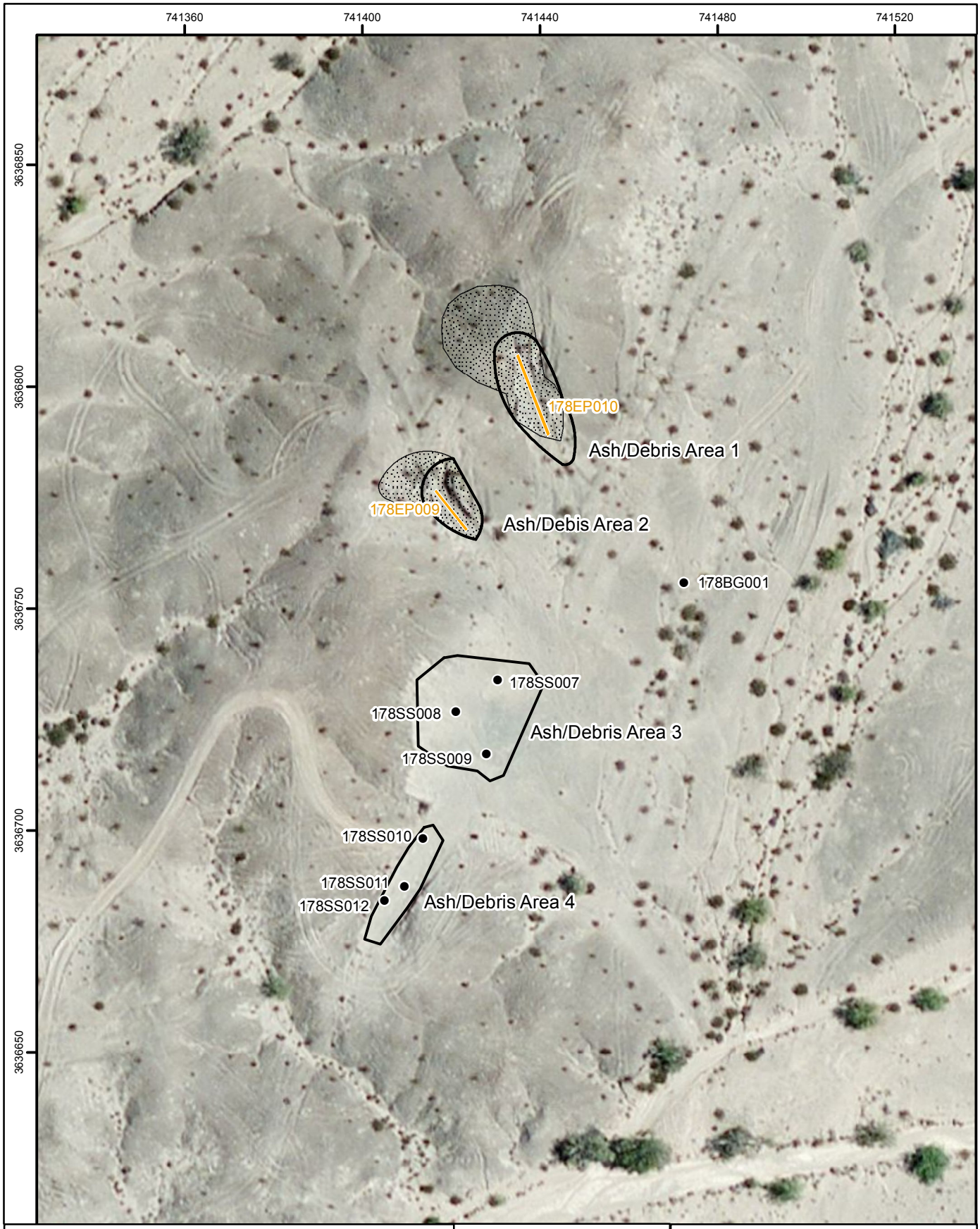
FIGURE 4.3

YPG-178a Prior to 2009 Removal Action

PARSONS

FIGURE 4.4

YPG-178a Following 2009 Removal Action



LEGEND

- Surface Soil Sample Location
- Test Pit Containing Waste
- Debris/Ash Removed During November 2009 Removal Action
- Approximate Extent of Buried Debris/Ash

Feet
0 50 100
0 15 30
Meters

N

U.S. ARMY GARRISON YUMA PROVING GROUND

FIGURE 4.5

YPG-178a
SOIL REMOVAL AREAS
AND EXTENT OF
BURIED DEBRIS/ASH

U.S. Army Garrison
Yuma Proving Ground

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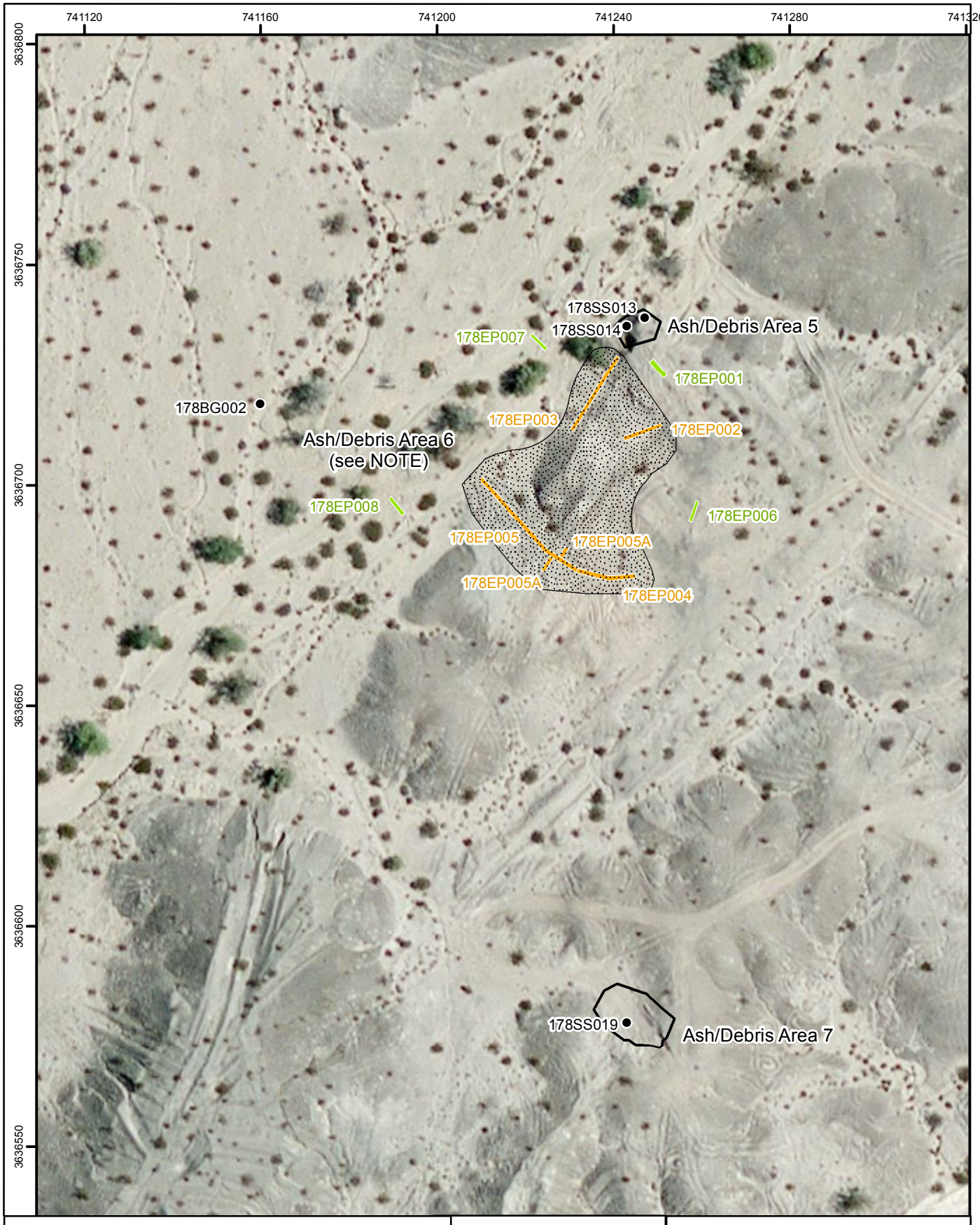

LEGEND

- Surface Soil Sample Location
- Test Pit Containing Waste
- Test Pit Not Containing Waste
- Debris/Ash Removed During November 2009 Removal Action
- Approximate Extent of Buried Debris/Ash

NOTE: Ash/Debris Area 6 was excavated during the 2009 removal action; however, no ash/debris was removed.

Feet
0 50 100
0 15 30
Meters

FIGURE 4.6

YPG-178b
SOIL REMOVAL AREAS
AND EXTENT OF
BURIED DEBRIS/ASH

U.S. Army Garrison
Yuma Proving Ground

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