



White Sands Missile Range

| **Revised** RCRA Facility
Investigation Report for the
Stallion Range Center Former
Firefighter Training Area
(SWMU 162)

| Original: August 2010

Revised: June 2011

~~August 2010~~



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**Revised RCRA Facility
Investigation Report for the
Stallion Range Center Former
Firefighter Training Area
(SWMU 162)**

White Sand Missile Range
New Mexico

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Executive Summary

This **Revised** Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report was written on behalf of White Sands Missile Range (WSMR) pursuant to requirements of WSMR's Hazardous Waste Permit Number NM2750211235 (Permit) dated December 2009. This RFI Report describes activities conducted to characterize soil and groundwater conditions at the Stallion Range Center (SRC) Former Firefighter Training Area (FFTA), listed as Solid Waste Management Unit (SWMU) 162 in the Permit, and also known as Compliance Cleanup Waste Site (CCWS)-04. The former FFTA is located on the southern side of the SRC and was the location of firefighter training activities before the late 1980s; however, the exact dates of use of the area are unknown.

A chronology of the RFI activities at the SRC FFTA is as follows:

- September 2009 – *RCRA Facility Investigation Work Plan for the WSMR Stallion Range Center Former Firefighter Training Area CCWS-04, SWMU 162*, dated September 9, 2009, was submitted to the New Mexico Environment Department (NMED) (ARCADIS, 2009).
- December 19, 2009 – WSMR provided NMED notice that the RFI field work would begin at risk, prior to receiving approval of the September 2009 RFI Work Plan.
- January 20-21, 2010 – The initial field RFI activities were conducted and included collecting soil samples from eight (8) investigation borings (SB-001 through SB-006) and three (3) background borings (BG-001 through BG-003). The investigation samples were tested for total petroleum hydrocarbons (TPH) gasoline range organics (GRO), TPH diesel range organics (DRO), volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and RCRA 8 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver), and the background samples were analyzed for the for RCRA 8 metals.
- January 25, 2010 – NMED issued a *Notice of Disapproval RCRA Facility Investigation Work Plan for the Stallion Range Center Former Fire Fighter Training Area CCWS-04, SWMU 162*. This NOD required submittal of a revised Work Plan by May 21, 2010.
- April 8, 2010 – Additional soil sampling was conducted to delineate soil impacts noted during the initial field investigation conducted in January 2010. Soil samples were collected from two additional soil borings (SB-007 and SB-008).

- May 13, 2010 – WSMR submitted a request to the NMED for a 90-day extension of the May 21, 2010 submittal date to August 21, 2010 and indicated that the submittal would be a RFI Report rather than a revised Work Plan since field work had been completed.
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- March 2011 – In response to the NMED's request for additional investigation, trenching was performed in the area of soil impacts and possible subsurface debris noted during the RFI activities in January and April 2010. Trenching revealed that the extent of contamination and debris was limited and provided delineation of these impacts. Therefore, WSMR opted to remove affected soils and debris that was encountered during the trenching activities. Confirmation soil sampling and waste characterization was conducted as part of the removal action.

The purpose of this report is to provide a comprehensive summary of the RFI activities conducted to-date and to address the NMED's comments from the January 25, 2010 Notice of Disapproval (NOD) letter. The RFI activities included the following specific tasks.

- Collection of soil samples to characterize subsurface conditions and complete lateral and vertical delineation of potentially affected soils to the NMED residential soil screening levels (SSLs).
- Collection of background soil samples to establish site-specific background values for metals.

- Evaluation to determine whether subsurface soil impacts could potentially affect the underlying groundwater.
- Screening of potential risks to various receptors following the NMED SSL Guidance and the NMED TPH Guidance documents.
- Removal of affected soils

~~., summarize the RFI activities conducted in January and April 2010, discuss the results of the RFI, summarize the additional investigation activities (i.e., trenching) and soil removal activities conducted in March 2011, and discuss the results of the soil removal action.~~

~~This RFI was conducted according to the RCRA Facility Investigation Work Plan for the WSMR Stallion Range Center Former Firefighter Training Area CCWS-04, SWMU-162, submitted to the New Mexico Environment Department (NMED) in September 2009. WSMR elected to proceed with implementation of the Work Plan prior to receiving the NMED's comments on the Work Plan. The NMED provided comments to the work plan in a Notice of Disapproval letter dated January 25, 2010. Information provided in this report addresses the NMED's January 25, 2010 comments.~~

~~The former FFTA is located on the southern side of the SRC and was the location of firefighter training activities before the late 1980s; however the exact dates of use of the area are unknown.~~

~~The primary objectives of the initial RFI activities conducted in January and April 2010, as stated in the September 2009 RFI Work Plan, were: 1) to determine whether the training activities resulted in a release to the surrounding soils or groundwater; 2) to characterize the nature and extent of affected soils and/or groundwater; and 3) to evaluate potential risks to human and ecological receptors exposed to the affected media. The work conducted included the following specific tasks.~~

- ~~Collection of soil samples to characterize subsurface conditions and complete lateral and vertical delineation of potentially affected soils to the New Mexico Environment Department (NMED) residential soil screening levels (SSLs).~~
- ~~Collection of background soil samples to establish site-specific background values for metals.~~

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- ~~Screening of potential risks to various receptors following the NMED SSL Guidance and the NMED TPH Guidance documents Screening of potential risks to human health and ecological receptors.~~

~~According to the FY 2008 Compliance-Related Cleanup Installation Action Plan (USAEC, 2008) the site was cleaned up in the late 1980s. An area of soil approximately 50 ft by 100 ft by 4 ft deep was excavated, aerated in the sun, and used as clean fill for the Stallion Range Landfill. No record of a written report documenting this cleanup has been discovered, and no records are available indicating that previous investigations have occurred at this site.~~

~~Five groundwater monitoring wells are located nearby, in the vicinity of the SRC sewage lagoons and desalinization pond. Data from these wells indicate that the average depth to water in these wells is approximately 191 feet below ground surface (ft bgs) (WTS, 2007). The wells are sampled annually as part of the Groundwater and Effluent Sampling Wastewater Discharge Program associated with the SRC.~~

~~As part of this RFI, During the initial phase of the RFI, soil samples were collected from three background locations (BG-001 through BG-003) located outside the FFTA and eight boring locations (SB-001 through SB-008) within the former FFTA on January 20 and 21, 2010. Soil samples were collected from four depth intervals from each background and investigation borings. Investigation samples were: 0 to 1 ft bgs, 4 to 5 ft bgs, 8 to 10 ft bgs, and 13 to 15 ft bgs. Soil samples collected from the borings within the former FFTA and were analyzed for total petroleum hydrocarbons (TPH) gasoline range organics (GRO), TPH diesel range organics (DRO), volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and RCRA 8 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver), and soil samples from the background borings were analyzed for RCRA 8 metals.~~

- ~~Total petroleum hydrocarbons (TPH) gasoline range organics (GRO) by USEPA Method 8015 Modified;~~
- ~~TPH diesel range organics (DRO) by USEPA Method 8015 Modified;~~
- ~~Volatile organic compounds (VOCs) by USEPA Method 8260B;~~

- ~~• Polycyclic aromatic hydrocarbons (PAHs) by USEPA Method 8270C; and~~
- ~~• RCRA 8 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver) by USEPA Methods 6020 and 7471A.~~

Soil samples were collected from two additional borings (SB-009 and SB-010) within the former FFTA on April 8, 2010 to provide additional delineation of TPH DRO detected during the initial ~~samples investigation collected~~ in January. ~~The lateral extent of the TPH DRO detections was successfully delineated by these two additional borings.~~

The only constituents that exceeded the NMED residential SSLs in soil samples from the January and April 2010 sampling events were arsenic and TPH DRO. Arsenic exceeded the residential SSL in only one sample, SB-006 0.5-1 ft. The lateral and vertical extent of this exceedance was delineated. Arsenic was detected in all soil samples, including background samples, and all of the detections exceeded the NMED DAF20 SSL. However, with the exception of the soil sample from SB-006 0.5 – 1ft, all of the arsenic concentrations were below the site specific background value calculated for arsenic (95% Upper Tolerance Interval of 3.0 ug/Kg). TPH DRO concentrations exceeded the NMED residential SSL in the 0.5-1, 4-5 and 8-9 ft samples from SB-006. The horizontal and vertical extents of these exceedances were delineated. TPH DRO were detected in only three other samples (SB-004 0.5-1 ft, SB-008 0.5-1 ft, and SB-010 0.5-1ft) at concentrations below the residential SSL. -

No VOCs or PAHs were detected above residential SSLs or DAF20 criteria. None of the metals, with the exception of arsenic, were detected above their respective residential SSLs or DAF20 criteria.

~~Soil samples from the background borings located outside the former FFTA were analyzed for RCRA 8 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver) by USEPA Methods 6020 and 7471A.~~

~~The analytical results are summarized, as follows:~~

- ~~• TPH GRO was not detected at reportable concentrations in any of the soil samples.~~

- ~~TPH DRO was detected in three samples at concentrations exceeding the Residential SSL: SB-006 (0.5-1), SB-006 (4-5) and SB-006 (8-9). The lateral and vertical extents of the TPH DRO concentrations were fully delineated.~~
- ~~VOCs were not detected at reportable concentrations in any of the soil samples collected and analyzed for VOCs.~~
- ~~The following PAH constituents were detected in one or more samples:~~
 - ~~— 2-Methylnaphthalene: SB-006 (0.5-1)~~
 - ~~— Anthracene: SB-006 (0.5-1); SB-006 (4-5); SB-008 (0.5-1)~~
 - ~~— Benzo(g,h,i)perylene: SB-006 (4-5); SB-008 (0.5-1)~~
 - ~~— Chrysene: SB-001 (4-5)~~
 - ~~— Fluoranthene: SB-006 (0.5-1)~~
 - ~~— Phenanthrene: SB-006 (0.5-1)~~
 - ~~— Pyrene: SB-006 (0.5-1); SB-006 (4-5)~~

~~None of the reported concentrations were above either their respective Residential SSLs or DAF 20 SSLs.~~

- ~~The reported concentrations of RCRA 8 metals ranged in value, as follows:~~
 - ~~— Arsenic: 1.09 to 11.4 mg/kg~~
 - ~~— Barium: 50.5 to 338 mg/kg~~
 - ~~— Cadmium: 0.0966 to 0.491 mg/kg~~
 - ~~— Chromium: 4.57 to 13.3 mg/kg~~
 - ~~— Lead: 3.64 to 371 mg/kg~~
 - ~~— Mercury: not detected with maximum detection limit of 0.0536 mg/kg~~
 - ~~— Selenium: 0.825 to 2.53 mg/kg~~
 - ~~— Silver: not detected to 0.132 mg/kg~~

~~None of the reported concentrations for barium, cadmium, chromium, lead, selenium or silver exceeded either the Residential SSL or the DAF20 SSL. All of the reported concentrations of arsenic exceeded the DAF20 SSL and the reported concentration of arsenic in one sample, SB-006 (0.5-1), exceeded the Residential SSL.~~

~~A statistical evaluation was performed to compare the reported concentrations of RCRA 8 metals-arsenic from within the former FFTA to the reported concentrations or~~

~~arsenic in the background samples. An upper tolerance limit (UTL) was calculated for the background data set, excluding mercury and silver due to the large number of non-detected results for those two compounds. An and an upper confidence limit (UCL) was calculated for the RFI data set as a whole, for the shallow (0.5 to 1 ft bgs) interval RFI data and for the three deeper intervals (combined). No UCLs were calculated for mercury or silver due to the large number of non-detected results. The UCLs for the RFI data sets shallow and deeper soils within the SRC FFTA area were compared to the background UTLs to evaluate whether the reported concentrations within the former FFTA are similar to the background or naturally occurring concentrations. Arsenic and lead concentrations in the shallow soil data set (0.5 to 1 ft bgs) were determined to be statistically elevated compared to the background concentrations.~~

The data were reviewed to evaluate the potential for cross-media contamination from soil to groundwater. This evaluation consisted of comparing the data to published DAF 20 values, while considering other site-specific conditions including depth of contamination, depth to groundwater, and surface water infiltration conditions. With the exception of arsenic, no constituents were detected in the soils at concentrations exceeding the DAF 20 values. While arsenic concentrations in all of the soil samples exceeded the DAF 20 values, ~~only the soils in the shallowest interval (0.5 to 1 ft bgs) also exceeded the UTL~~ Only two samples (the 0.5 – 1 ft samples from Borings SB-002 and SB-006) exceeded the site-specific background value (95% Upper Tolerance Limit [UTL]) of 3.0 mg/kg calculated for arsenic. All of the other soil samples, including deeper samples from Borings SB-002 and SB-006 were below the site-specific background value of 3.0 ug/kg, ~~indicating that arsenic concentrations in deeper soils were consistent with background arsenic concentrations.~~ Based on the very shallow exceedances of DAF 20 ~~and UTL~~ relative to the very deep occurrence of groundwater at approximately 190 feet, there is little or no risk that the arsenic in the shallow soils represents a threat to the groundwater. This is further supported by the fact that surface water infiltration depths in the area ~~do not exceed about 15 feet because of the~~ are negligible due to very high evapotranspiration rates. The evapotranspiration extinction depth (maximum depth at which evapotranspiration occurs) near Holloman Air Force Base was estimated to be around 15 ft bgs (Burns and Hart, 1988). -Finally, arsenic is not a constituent associated with the former FFTA activities and is documented as a naturally occurring metal in throughout this region (Welch et al, 1988). -

~~A human health risk assessment (HHRA) was conducted to evaluate exposure to constituents of potential concern (COPCs) in surface soil (0 to 2 ft bgs), combined surface and subsurface soil (0 to 10 ft bgs), and total soil (0 to 20 ft bgs) for site-~~

~~workers under current and future land-use conditions, and construction workers and residents (adult and child) under hypothetical future land-use conditions. The HHRA indicated that constituent concentrations in surface soil and in combined surface and subsurface soil at the former FFTA are unlikely to result in adverse health impacts to current or future site workers, construction workers or residents via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal)~~

~~Although no buildings are currently present at the site, the vapor intrusion pathway was evaluated for possible future site usage. The evaluation demonstrated that the constituent concentrations in soil at the former FFTA are unlikely to result in adverse health impacts via inhalation of indoor air for future site workers and future residents (adults and children).~~

~~A screening level ecological risk assessment (SLERA) and baseline ecological risk assessment (BERA) were completed for the former FFTA to evaluate whether ecological receptors may be adversely affected by exposure to site-related constituents detected in surface soil and subsurface soil, and to conduct food chain modeling for the constituents of potential ecological concern (COPECs) identified as bioaccumulative. The results of the SLERA and BERA for direct contact exposure and for food chain modeling indicate that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in soil. Therefore, no further ecological evaluation of the former FFTA is warranted.~~

The original RFI Report included a Human Health Risk Assessment (HHRA) and an Ecological Risk Assessment (ERA) to address potential risks associated with the constituents detected in soils at the SRC FFTA. However, ~~Based upon the January 22, 2011 comments from received from the NMED regarding the original RFI Report submitted in August 2010, additional investigation, which included removal of affected soils, additional investigation in the form of exploratory trenching was performed in March 2011 near sample location SB-006, where DRO and arsenic were reported above the SSLs and where potential debris was identified by the ground penetrating radar GPR used for utility clearance. Because the affected area appeared to be very limited in extent, In March 2011, limited excavation was performed to removed the affected soils. A small area of affected soils occurred within an area that was approximately 8 feet wide by 16 feet long was removed. Excavation depths ranged from 2 to 10 ft bgs.~~

A small amount of debris including ash, cardboard, plastic, wood, pieces of railroad ties and a small section of pipe was encountered and was removed along with stained soil

that had a slight hydrocarbon odor. The total volume of soil and debris removed from the area was approximately 60 cubic yards. The waste material was disposed of off-site at a non-hazardous waste landfill.

Confirmation soil samples were collected from the floor of the excavation and from all four side walls of the excavation. The confirmation samples were analyzed for the constituents of concern, including DRO, arsenic, lead, and SVOCs. Results of the confirmation samples indicated that affected soils were successfully removed to below the residential SSLs. The excavation was backfilled with clean soil and graded to match the surrounding area. ~~Since~~ Because the affected soils were removed, a HHRA and ERA were no longer warranted and discussions regarding the risk assessments have been removed from this Revised RFI Report.-

The RFI for the former FFTA was successfully completed and meets the requirements specified in the Permit. ~~Corrective action has been completed and potentially impacted soil has been removed from the site.~~ No further investigation is recommended.-
Corrective action has been completed and the site meets the requirements for Corrective Action Complete.

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~~D—Data Validation Reports and Laboratory Analytical Reports~~

~~E—Risk Assessment Reports~~

~~F—Statistical Evaluations~~

List of Acronyms

AMSL	Above Mean Sea Level
BERA	Baseline Ecological Risk Assessment
CCWS	Compliance Cleanup Waste Site
COPC	Constituent of Potential Concern
COPEC	Constituent of Potential Ecological Concern
DAF	Dilution Attenuation Factor
DQO	Data Quality Objective
DoD ELAP	Department of Defense Environmental Laboratory Accreditation Program
DRO	Diesel Range Organics
ELCR	Excess Lifetime Cancer Risk
°F	Degrees Fahrenheit
FFTA	Former Firefighter Training Area
ft	Feet
ft bgs	feet below ground surface
FY	Fiscal Year
GPR	Ground Penetrating Radar
GRO	Gasoline Range Organics
HHRA	Human Health Risk Assessment
HI	Hazard Index
HWC	Hazardous Waste Center
IDW	Investigation Derived Waste
mg/kg	milligrams/kilogram
NELAC	National Environmental Laboratory Accreditation Conference
NMED	New Mexico Environment Department
PAH	Polycyclic Aromatic Hydrocarbons
PID	Photoionization detector
QA	Quality Assurance
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RSL	Regional Screening Level
SLERA	Screening Level Ecological Risk Assessment
SRC	Stallion Range Center
SSL	Soil Screening Level
SVOC	Semi-volatile Organic Compounds
SWMU	Solid Waste Management Unit
TPH	Total Petroleum Hydrocarbons



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New Mexico

UCL	Upper Confidence Limit
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit
VOC	Volatile Organic Compounds
WMC	Waste Management Center
WSMR	White Sands Missile Range

1. Introduction

This Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report was written on behalf of White Sands Missile Range (WSMR) pursuant to requirements of WSMR's Hazardous Waste Permit Number NM2750211235 (Permit) dated December 2009. This RFI Report describes activities conducted to characterize soil and groundwater conditions at the Stallion Range Center (SRC) Former Firefighter Training Area (FFTA), listed as Solid Waste Management Unit (SWMU) 162 in the Permit, and also known as Compliance Cleanup Waste Site (CCWS)-04. The former FFTA is located on the southern side of the SRC and was the location of firefighter training activities before the late 1980s; however, the exact dates of use of the area are unknown. The location of the FFTC within the SRC is shown on Figure 1.

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- Evaluation to determine whether subsurface soil impacts could potentially affect the underlying groundwater.
- Screening of potential risks to human health and ecological receptors.

~~The original RFI Report included a Human Health Risk Assessment (HHRA) and an Ecological Risk Assessment (ERA) to address potential risks associated with the constituents detected in soils at the SRC FFTA. However, based upon the January 22, 2011 comments from the NMED (Bearzi, 2011), additional investigation in the form of expository trenching was performed in March 2011 near sample location SB-006, where DRO and arsenic were reported above the SSLs and where potential debris was identified by the GPR used for utility clearance. Because the affected area appeared to be very limited in extent, excavation was performed to removed the affected soils. A small area of affected soils and debris approximately 8 feet wide by 16 feet long was removed. Excavation depths ranged from 2 to 10 ft bgs. Results of confirmation samples collected from the excavation indicated that remaining soils met the residential SSLs. Therefore, risk assessment was no longer warranted for the site and discussions of the risk assessment have been removed from this Revised RFI Report.~~

~~These RFI~~ activities are described in more detail in the following sections.

2. Background Information

2.1 Site Operational History

The Site is located at the SRC in Socorro County, New Mexico, along the northwestern border of WSMR, approximately 118 miles north of the Main Post and 17 miles southeast of San Antonio, New Mexico. The SRC operates as a technical support center for the monitoring and evaluation of long range missile tests.

The FFTA is located south of the SRC and was in use prior to the late 1980s. Based on interviews with WSMR personnel conducted in February 2009, the FFTA consisted of an area approximately 200 feet (ft) by 50 ft adjacent to a dirt road where firefighter training occurred. Firefighter training activities included setting small controlled fires so that the firefighters could practice putting them out. Typically, a flammable liquid **was** used to start the fires and depending on the facility, may **have** included diesel and/or gasoline. No structures were present at the FFTA and no further details regarding the training activities were available. WSMR personnel familiar with the area did not know when activities first began at the FFTA. However, personnel stated that no activity has occurred at the FFTA since the late 1980s.

The ~~location and~~ approximate boundaries **and site features** of the FFTA are shown in Figure 2. The location was **determined based on interviews with WSMR personnel and** confirmed through visual inspection of the area based on differences in the vegetation within the FFTA compared to the surrounding areas.

2.2 Regulatory History

According to the ~~Fiscal Year (FY)~~ 2008 Compliance-Related Cleanup Installation Action Plan (USAEC, 2008) the site was cleaned up in the late 1980s. An area of soil approximately 50 ft by 100 ft by 4 ft deep was excavated, aerated in the sun, and used as clean fill for the Stallion Range Center Landfill. No record of a written report documenting this cleanup has been discovered, and no records are available indicating that previous investigations have occurred at this site. Five monitoring wells are present nearby, in the vicinity of the SRC sewage lagoons and desalinization pond (Figure 3). These wells are sampled regularly as part of the Groundwater and Effluent Sampling Wastewater Discharge Program associated with the SRC. Data from these wells was included in the RFI Work Plan for the SRC FFTA (ARCADIS, 2009).

2.3 Surface Conditions (Topography)

WSMR lies within the Mexican Highland Section of the Basin and Range Province. This province is characterized by a series of tilted fault blocks forming longitudinal, asymmetric ridges, or mountains, and broad intervening basins.

The SRC lies in the Jornada Del Muerto Basin, approximately 4,900 ft above mean sea level (amsl). The Jornada Del Muerto Basin, east of the Rio Grande Valley, covers approximately 3,344 square miles and at its widest is nearly 12 miles across. It is bordered by Point of Rocks and the Caballo Mountains to the west, the Dona Ana, San Diego, and Tortugas Mountains to the southwest, and the Organ and San Andreas Mountains to the east. This eastern boundary is a single, steeply-dipping normal fault; the western boundary of the Jornada Del Muerto Basin is a semi-buried volcanic horst, known as the Jornada Horst (Woodward and Myers, 1997).

Very little surface water exists at WSMR due to low annual precipitation, high evapotranspiration rates, and high infiltration characteristics of the soils. During the summer season, when thunderstorm activity is most common, playas within the basin may contain standing water. Recharge into the Jornada Del Muerto Basin comes from precipitation and infiltration of mountain runoff and through major arroyos. Arroyos which drain the surrounding mountains usually contain water only following heavy precipitation events.

The nearest arroyo is located to the north of the FFTA, as seen ~~in the aerial photograph inset~~ in Figure 2.

2.4 Geology

The Jornada Del Muerto Basin shares a subsurface Tertiary volcanic boundary with the Mesilla Basin. There is no evidence that the Rio Grande has ever flowed across the Jornada Del Muerto Basin.

The dominant basin landforms comprise an extensive remnant of the ancestral Rio Grande fluvial plain (Plio-Pleistocene La Mesa geomorphic surface), and broad alluvial-fan-piedmont surfaces flanking the San Andres Range and Doña Ana Mountains (Gile et al. 1981, 1995; Gile 2002; Seager et al. 1987). The isolated Goat Mountain and Tortugas Mountain “hills” to the south of the Doña Anas (eastern Las Cruces metro-area) are the sole surface expression of the discontinuous bedrock high that separates the Mesilla and Jornada Del Muerto structural basins. The FFTA is located in the Rio

Grande rift tectonic province, which is characterized by north-south trending series deep structural basins between tilted-fault-block ranges and volcanic highlands. This major continental rift zone extends through central New Mexico from southern Colorado to Trans-Pecos Texas and northern Chihuahua (Chapin and Seager 1975; Hawley 1978; Chapin and Cather 1994).

2.5 Hydrogeology

The primary aquifer systems of the Rio Grande rift region are comprised of: 1) thin Upper Quaternary fluvial deposits of the inner Rio Grande Valley (valley-fill aquifer system); and 2) the thick sedimentary fill of intermontane basins (basin-fill aquifer system). The Upper Cenozoic Santa Fe Group forms the bulk of the latter unit. The hydrogeologic framework is formed by: 1) the lithofacies and stratigraphic subdivisions of these two aquifer systems; and 2) associated rift – basin and range structures. This framework has a profound influence on groundwater and surface-water flow and quality in the entire region. Valley- and basin-fill aquifer systems are locally linked with respect to both surface and subsurface flow (Bryan 1938; King et al. 1971; Wilson et al. 1984; Nickerson and Myers 1993; Hawley and Kernodle 2000; Hawley et al. 2001).

The SRC obtains its potable water supply from two supply wells, SRC-02 and SRC-03 (Figure 3) located ~~approximately 0.5 mile to the~~ **approximately 0.5 mile to the northwest** and ~~approximately 0.8 north~~ **approximately 0.8 north west, respectively**, of the SRC FFTA. The wells draw brackish water from Quaternary/Tertiary alluvial and upper bolson-fill deposits within the Jornada del Muerto Basin. The brackish water is processed through a desalinization plant prior to distribution. The majority of the groundwater recharge to this bolson aquifer occurs through the coarse, unconsolidated Tertiary/Quaternary alluvial fan deposits and arroyos along the eastern flank of the Organ, San Agustin and San Andres Mountains.

There are five monitoring wells (SRM-01 through SRM-05) completed in the regional aquifer in the vicinity of the SRC ~~and located approximately 400 to 1200 ft northeast of the SRC FFTA in the vicinity of the sewage lagoons and desalinization pond (Figure 3).~~ The depths of these wells average ~~29975~~ **2997.5** feet below ground surface (ft bgs) ~~and they are located in the vicinity of the sewage lagoons and desalinization pond (Figure 3).~~ ~~The and the~~ average depth to water in these wells is approximately 191 ft bgs (WTS, 2007). The wells are sampled annually as part of the Groundwater and Effluent Sampling Wastewater Discharge Program associated with the SRC.

Climate

Snowfall is infrequent at the SRC, although heavy snows have occurred. With an average annual rainfall of only 10.8 inches, mostly occurring during late summer as thunderstorms often accompanied by hail, the area is considered semi-arid. Intense localized thunderstorms have caused flash flooding in the past. The average summer high temperature is 92 °F with lows of about 65 °F. During the winter months (December, January and February), the average high is 57 °F, with lows of about 36 °F. Average annual humidity readings are approximately 37 percent. Westerly winds can reach approximately 40 miles per hour, and wind is a climatic factor from February to about May.

3. Scope of Activities

Activities performed to complete the field sample collection effort and data evaluation are described in this section.

3.1 Field Activities

3.1.1 Utility Clearance

Zia Engineering and Environmental Consultants (Zia) performed a utility clearance of the FFTA prior to initiation of field activities. Zia marked the proposed boring locations at the FFTA with wooden stakes and obtained WSMR clearance for the proposed soil sampling locations. WSMR personnel marked the location of a fiber optic line that parallels the dirt roadway.

~~On January 8, 2010,~~ Ground Penetrating Radar (GPR) was used to field verify the locations of underground utilities at the FFTA. Soil boring locations were adjusted, as necessary, to avoid anomalies identified by the GPR. The actual locations of the borings are shown in Figure 4 and a copy of the GPR report is provided in Appendix A.

~~After receiving the results of the investigation conducted in January, Zia prepared to return to the site to complete additional borings in the vicinity of SB-006 to delineate affected soils at that location. On February 8, 2011, WSMR personnel again marked the location of the fiber optic line that parallels the roadway near the FFTA, prior to the additional investigation near boring location SB-006.~~

3.1.2 Soil ~~Sample Collection~~Borings and Field Screening Procedures, 2010

Soil samples were collected and screened following the general guidance of Sections 5.2.2.b and 5.2.2.d of Appendix 5 of the Permit. Soil samples were collected from three background boring locations (BG-001 through BG-003) and eight boring locations within the FFTA (SB-001 through SB-008) on January 20 ~~and 21~~, 2010. The background soil sample locations were selected in unimpacted areas located in the primarily upwind direction from the FFTA. The eight borings located within the FFTA were spaced at approximately equal distances throughout the FFTA in an approximate grid pattern. Soil samples were collected from two additional borings (SB-008 and SB-009) within the FFTA on April 8, 2010, to provide additional delineation of Total Petroleum Hydrocarbon (TPH) Diesel Range Organics (DRO) concentrations detected in samples from SB-006 in the January ~~borings~~.

During the January sampling event, soil samples were collected using both a hand auger and a hollow stem auger drill rig. A hand auger was used to collect the surface soil sample and remove the upper 3 feet of soil at each location to verify that no utility lines or debris were located in the vicinity of the borings. Soil was observed for lithology and for visual or olfactory indications of the potential presence of hydrocarbons every 6 inches throughout the upper 3 feet of soil. When visual or olfactory indications of hydrocarbons were present, or at pre-determined intervals, soil was collected from the bottom of the auger, at the cutting blades, for PID screening or for laboratory sample collection. Information from the upper 3 feet of soil was recorded on the boring logs in Appendix B.

Beneath the hand-augered portion of each boring, soil samples were collected by advancing 5-foot long core barrels ahead of the hollow stem augers. Soil cores were collected continuously to the total depth drilled at each location. The soil cores were examined visually and described according to the Unified Soil Classification System (USCS), ASTM Standard D 2487-83 (ASTM, 1985). A copy of the USCS chart summarizing the classification system is provided in Appendix B. The sampling tools used, depth of soil core, amount of soil recovered, soil classification, and other visual observations were recorded on a lithologic boring log for each sampling location. The boring logs are provided in Appendix B. The drilling and sample collection procedures were supervised by a qualified geologist.

Field screening was performed on each of the soil cores collected from the borings using a photoionization detector (PID). The PID used was a MultiRAE Plus Monitor with a 10.6 electron Volt (eV) lamp, with a detection range of 0 to 2000 parts per million

(ppm) and a 0.1 ppm resolution. The PID was calibrated daily using the “fresh air calibration”, which zeroes the unit, followed by a single sensor calibration for VOCs using 100 ppm isobutylene. Aliquots of soil from each soil core were placed into glass sample jars and covered with aluminum foil, and then the jars were placed in the cab of the truck and allowed to equilibrate for approximately 10 minutes. The heater in the truck was set to run on high to warm the samples. After a period of approximately 10 minutes, the foil on the top of the jar was pierced with the probe portion of a photoionization detector (PID) and the highest PID measurement from each aliquot of soil was recorded on the boring logs, along with the depth from which the aliquot was obtained. The air temperature within the truck cab at the time each of PID reading was measured using a handheld digital thermometer and recorded on the boring log.

Soil samples were collected from a separate aliquot of the soil core than that used to record headspace readings with the PID. Each aliquot of soil was placed into laboratory provided sample jars. The jars were labeled with the location, depth interval, date, time and requested analyses. Samples were then placed into a cooler with ice for later shipment to the laboratory.

Soil samples were planned to be collected from each boring at depths of 0.5 to 1 feet, 4 to 5 feet, 9 to 10 feet and 14 to 15 feet, unless field observations (such as elevated PID readings) indicated that a different interval should be sampled. Actual depths of samples collected are shown in Table 1 and are also indicated on the boring logs in Appendix B.

During the April 2010 sampling event, soil samples were collected using a hand auger. The borings were advanced to the maximum depth that could be done with the hand auger, approximately 13 to 13.5 ft bgs and a soil sample was collected at the bottom of each boring. The soil borings were advanced with the hand auger in approximately 1 foot increments. The soil was inspected and observations recorded on boring logs. The sample intervals for the April 2010 borings are shown in Table 1. The same procedures were followed for field screening of volatiles in headspace and the same information was recorded on the boring logs.

3.1.3 Exploratory Trenches

In March 2011, exploratory trenches were dug in the vicinity of boring location SB-006 using a John Deere 310E backhoe with front end loader attachment. The purpose of these trenches was to investigate the potential debris identified by the GPR during

initial utility clearance prior to installation of soil borings in order to address comments in the January 2011 letter from the NMED (Bearzi, 2011).

The first two exploratory trenches were located approximately 10 feet south and approximately 10 feet west of location SB-006. As shown in Figure 5, each of these trenches was approximately 10 feet long and 3 feet wide. The trenches extended to a total depth of 6 ft bgs. No stained soil, debris or odors were noted in these two trenches and the soil appeared to be native to the area, with no prior disturbance. Both of these trenches were backfilled with the excavated soil.

The third exploratory trench was centered on the location SB-006. Debris was encountered between 0.5 and 1 ft bgs and included plastic trash, a section of pipe, cardboard and an oil filter. Grout from the 2010 soil sampling effort was also encountered. The excavation centered on SB-006 was approximately 5 feet by 5 feet and was approximately 10 feet deep. Based on field observations of discolored soil and odors, the excavation was extended approximately 6 feet to the north, 3 feet to the east and 5 feet to the south. The depths of the excavation in the extended areas ranged from 2 feet to 8 feet deep, as shown in Figure 5. In each area, the excavation was extended until no further discoloration of soil was encountered.

Approximately 60 cubic yards of impacted soil and debris were removed from the exploratory trench centered on SB-006 and shipped off-site as non-hazardous waste, as discussed in Section 3.1.9.

Confirmation soil samples were collected from the floor of the excavation in two locations: near SB-006 (STRC-0162-BASE-10.0) and near the northern side wall in the center of the excavation extension to the north (STRC-0162-N-2.0). Side wall samples were collected from the east (STRC-0162-ESW-7.0), south (STRC-0162-SSW-7.0), west (STRC-0162-WSW-7.0) and north (STRC-0162-NSW-7.0) side walls, at the locations depicted on Figure 5. The confirmation samples were collected by having the backhoe operator obtain a bucket of soil from the desired location within the excavation. A stainless steel spoon was then used to collect soil from various locations within the bucket. The soil was mixed in a stainless steel bowl to create a composite sample. The soil was then placed directly into glass jars, labeled and placed into coolers with ice. Samples were shipped via overnight courier to the laboratory for analysis, as described in Section 3.1.5.

The stainless steel spoon and bowl were washed in water with water and a laboratory-grade detergent solution and a brush, rinsed with clean potable water and rinsed again with distilled water.

The excavation surrounding SB-006 was backfilled using clean soil obtained from Rhino Environmental. Documentation of the source of the clean soil is provided in Appendix D.

~~3.1.33.1.4~~ Decontamination Procedures

All field equipment, including hand augers, core barrels, sampling utensils and other non-disposable equipment was decontaminated between each sample and each location, and in accordance with Section 5.2.3 of Appendix 5 of the Permit.

~~Decontamination included washing the equipment with a laboratory-grade detergent solution and a brush, rinsing with clean potable water and a final rinse with distilled water.~~

The flight augers were decontaminated prior to use at each sampling location. Decontamination of large equipment, such as the flight augers, and other down-hole equipment, and the backhoe bucket was performed using a high-pressure washer to wash off the equipment over a portable stock tank. Wash water collected in the stock tank was allowed to evaporate in order to minimize waste requiring disposal.

Decontamination of smaller equipment, such as the hand augers and knives, included washing the equipment with a solution of potable water and laboratory-grade detergent, scrubbing with a brush, rinsing with potable water, rinsing with distilled water, then allowed to air dry. Any soil that collected in the bottom of the stock tank was placed into the waste soil container, as discussed in Section 3.1.9. The decontamination procedures used during the RFI were consistent with the Standard Practices for Decontamination of Field Equipment Used at Non-Radioactive Waste Sites (ASTM 05088-02).

The liquids generated were collected in a 5-gallon open-top bucket and allowed to evaporate in order to minimize the waste generated. Decontamination water that did not evaporate was collected and stored in a closed-top 55-gallon drum, labeled and disposed of as discussed in Section 3.1.9.

~~During the April 2010 event, decontamination water was stored in spray bottles and as a result, very little decontamination water was generated. The liquids generated were collected in a 5-gallon open-top bucket and allowed to evaporate in order to minimize the waste generated.~~

3.4.43.1.5 Field Quality Control Samples

Field quality control (QC) samples were collected according to the work plan to evaluate the data quality, **except that field duplicates were collected at a frequency of 10 percent pursuant to Comment 8 in the NMED's NOD letter of January 25, 2010 (Bearzi, 2010). The field QC samples were collected in accordance with Section 5.2.2e of Appendix 5 of the Permit.** A total of two equipment rinsate blanks, one field blank, five trip blanks, and five field duplicate samples were collected during the January and April 2010 sampling events.

The equipment rinsate blanks were collected by pouring distilled water over a piece of previously decontaminated sampling equipment (such as the hand auger) and catching the rinsate in a laboratory container. Specifically, equipment blank STRC-0162-RB-001-0110 was collected from the core barrel prior to starting drilling at location SB-003 and equipment blank STRC-0162-RB-001-0410 was collected from the hand auger after the 4.5 to 5.0 ft sample was collected at boring SB-009. The equipment rinsate blanks were analyzed for the same parameters as the primary soil samples.

The field blank was collected by pouring distilled water directly into sample containers, while working at the site. The field blank is intended to detect any airborne constituents that might affect sampling results. The field blank was analyzed for the same parameters as the primary soil samples.

One trip blank was included with each laboratory cooler that included VOC samples. The trip blanks were analyzed for the same VOCs parameters as the primary samples.

Field duplicates were obtained by collecting an aliquot of soil from the same portion of the soil core as a parent sample. **Each soil sample was a discrete sample and no field compositing of soil was performed prior to collection of the field duplicate samples.** The field duplicate samples were analyzed for the same parameters as the parent sample.

3.4.53.1.6 Sampling Handling and Shipping

Sample handling procedures were in general accordance with Section 5.2.2.j and 5.2.6.b of Appendix 5 of the Permit. Samples were handled with new disposable gloves that were replaced prior to use with each sample. After each sample was placed into the appropriate container and labeled, it was placed into a cooler with ice. The ice was double-bagged using plastic zipper bags. Each sample was recorded on a chain-of-custody form with the requested analyses for that sample.

All of the soil samples collected from the soil borings within the FFTA were submitted to the laboratory under proper chain-of-custody. **The chain-of-custody form was sealed inside the cooler prior to shipment to the laboratory. A copy of the chain-of-custody forms is provided in Appendix C.** Shipping containers were sealed with a custody seal, and then shipped to the laboratory via overnight courier. None of the custody seals had been broken upon receipt at the laboratory. Copies of the container custody seals and the shipping labels are included in the analytical laboratory reports in Appendix **CD**.

3.4.63.1.7 Analytical Tests Requested

The samples were submitted to DHL Analytical of Austin Texas, a laboratory accredited by the National Environmental Laboratory Accreditation Conference (NELAC) and Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP).

Samples collected from the investigation area during the initial mobilization in January (Borings SB-001 through SB-008) were analyzed for the following:

- Total petroleum hydrocarbons (TPH) gasoline range organics (GRO) by USEPA Method 8015 Modified;
- TPH diesel range organics (DRO) by USEPA Method 8015 Modified;
- Volatile organic compounds (VOCs) by USEPA Method 8260B;
- Polycyclic aromatic hydrocarbons (PAHs) by USEPA Method 8270C; and
- RCRA 8 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver) by USEPA Methods 6020 and 7471A.

Samples collected from the investigation area in April (Borings SB-009 through SB-010) were intended to delineate TPH DRO detected during the initial mobilization and were only tested for TPH DRO.

Samples from the background borings located outside the FFTA (Borings BG-001 through BG-003) were analyzed for the following:

- RCRA 8 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver) by USEPA Methods 6020 and 7471A.

Confirmatory soil samples collected from the excavations in 2011 were analyzed for the following:

- TPH diesel range organics (DRO) by USEPA Method 8015 Modified;
- Polycyclic aromatic hydrocarbons (PAHs) by USEPA Method 8270C; and
- RCRA 8 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver) by USEPA Methods 6020 and 7471A.

The confirmatory soil samples were not analyzed for VOCs because with the exception of three very low, estimated detections of acetone, VOCs were not detected in any of the soil samples collected during the 2010 RFI activities. The estimated acetone concentrations were well below SSLs and DAF20 values.

3.4.73.1.8 Abandonment of Borings

Boring abandonment was performed in general accordance with Section 6.4 of Appendix 6 of the Permit. The boreholes drilled in January 2010 were plugged with a grout mixture composed of 2 bags of type III Portland cement, ½ bag of bentonite gel, and 30 gallons of potable water. Grout was placed into the boring using a tremie pipe set at the bottom of the borehole to ensure adequate plugging of each hole.

The two borings advanced using hand augers in April 2010 were backfilled with bentonite chips and then hydrated.

~~Exploratory Trenches~~

~~In March 2011, exploratory trenches were dug in the vicinity of boring location SB-006 using a John Deere 310E backhoe with front end loader attachment. The purpose of these trenches was to investigate the potential debris identified by the GPR during initial utility clearance prior to installation of soil borings.~~

~~The first two exploratory trenches were located approximately 10 feet south and approximately 10 feet west of location SB-006. As shown in Figure 5, each of these trenches was approximately 10 feet long and 3 feet wide. The trenches extended to a~~

~~total depth of 6 ft bgs. No stained soil, debris or odors were noted in these two trenches and the soil appeared to be native to the area, with no prior disturbance. Both of these trenches were backfilled with the excavated soil.~~

~~The third exploratory trench was centered on the location SB-006. Debris was encountered between 0.5 and 1 ft bgs and included plastic trash, a section of pipe, cardboard and an oil filter. Grout from the 2010 soil sampling effort was also encountered. The excavation centered on SB-006 was approximately 5 feet by 5 feet and was approximately 10 feet deep. Based on field observations of discolored soil and odors, the excavation was extended approximately 6 feet to the north, 3 feet to the east and 5 feet to the south. The depths of the excavation in the extended areas ranged from 2 feet to 8 feet deep, as shown in Figure 5. In each area, the excavation was extended until no further discoloration of soil was encountered.~~

~~Approximately 60 cubic yards of impacted soil and debris were removed from the exploratory trench centered on SB-006 and shipped off-site as non-hazardous waste, as discussed in Section 3.1.9.~~

~~Confirmation soil samples were collected from the floor of the excavation in two locations: near SB-006 (STRC-0162-BASE-10.0) and near the northern side wall in the center of the excavation extension to the north (STRC-0162-N-2.0). Side wall samples were collected from the east (STRC-0162-ESW-7.0), south (STRC-0162-SSW-7.0), west (STRC-0162-WSW-7.0) and north (STRC-0162-NSW-7.0) side walls, at the locations depicted on Figure 5. The confirmation samples were collected by having the backhoe operator obtain a bucket of soil from the desired location. A stainless steel spoon was then used to collect soil from various locations within the bucket. The soil was mixed in a stainless steel bowl to create a composite sample. The soil was then placed directly into glass jars, labeled and placed into coolers with ice. Samples were shipped via overnight courier to the laboratory for analysis, as described in Section 3.1.5.~~

~~The stainless steel spoon and bowl were washed in water with water and a laboratory-grade detergent solution and a brush, rinsed with clean potable water and rinsed again with distilled water.~~

~~The excavation surrounding SB-006 was backfilled using clean soil obtained from Rhino Environmental. Documentation of the source of the clean soil is provided in Appendix D.~~

3.4.83.1.9 Waste Handling

All wastes generated during the investigation described in this report were handled in general accordance with Section 5.2.2.b.iv of Appendix 5 of the Permit.

Miscellaneous trash (drinking water bottles, shipping boxes, paper trash, etc.) that did not come into contact with soil or decontamination equipment was containerized and disposed of as solid waste.

Investigation derived waste (IDW) generated during the sampling events included soil cuttings, decontamination fluids, disposable gloves, plastic sheeting, aluminum foil, and other materials that came into contact with either the soil or decontamination equipment and liquids. IDW solids generated during the January 2010 event were placed into a one-cubic yard pallet box, while decontamination liquids were placed into a 55-gallon closed-top drum. The IDW generated during the April 2010 event were placed into a 55-gallon open-top drum. Each container was labeled with the date, contents and point of contact information and left at the FFTA for later transportation to the WSMR ~~W~~waste ~~M~~management center (WMC).

To ~~provide~~ supplement the data collected from the borings and provide additional waste characterization ~~data~~, two soil samples collected during the January 2010 sampling event ~~{(SB-001-(0.5-1.0) and SB-001-(9.0-10.0))}~~ were analyzed for the full semi-volatile organic compounds (SVOC) list by USEPA Method 8270C and for ignitability by Method 1010. The analytical data were provided to the WMC, who characterized the waste as D008. This characterization was based on the maximum reported ~~total~~ concentration of lead in the soil samples. The pallet box of soil and drum of water generated during the January 2010 event were transported to the WSMR ~~hazardous waste center (HWC) WMC~~ on January 28, 2010 and were disposed of off-site as hazardous waste on April 28, 2010.

A separate composite sample of the IDW solids was collected during the April 2010 sampling event and this sample was submitted to the laboratory under a separate chain of custody for waste characterization analyses. The composite sample was collected by obtaining three aliquots of soil from the drum using a clean stainless steel auger. The aliquots were obtained from near the top of the drum, near the center of the drum and near the bottom of the drum. The three aliquots of soil were placed in a clean stainless steel bowl and mixed with a clean trowel to composite the soil. Because no VOCs were present in the previous samples, compositing the soil sample for waste characterization was deemed appropriate. The drum of IDW generated

during the April 2010 event was transported to the WMC on April 13, 2010. The laboratory report for the composite waste characterization sample was provided to WSMR personnel on May 18, 2010. According to subsequent communication with WMC personnel, the IDW ~~was been~~ classified as non-regulated and ~~is scheduled for~~ was shipped off-site for disposal in July 2010.

In February 2011, an additional waste characterization sample was collected from near location SB-006 in anticipation of the exploratory trench work scheduled for March 2011. This sample was collected from 0.5 to 1 ft bgs and analyzed for TCLP lead, polychlorinated biphenyls (PCBs), and ~~for~~ radioactivity because these analytical tests were required by the disposal company. ~~These analyses were performed in order to completely characterize the soil for potential off-site disposal.~~ The analytical report for this sample is provided in Appendix C. Based on the analytical data obtained from soil samples collected from SB-006 in 2010 and in 2011, the soil from this area was characterized as non-hazardous.

Approximately 60 cubic yards of soil and debris was removed from the excavations centered on SB-006. This soil was shipped off-site for disposal as non-hazardous waste. A copy of the waste disposal records is provided in Appendix E.

~~3.4.93.1.10~~ Survey

In accordance with Section 5.2.2.f of Appendix 5 of the Permit, ~~F~~following completion of ~~each~~ the 2010 field efforts, the physical coordinates and ground surface elevation ~~was~~ere measured at each boring. The borings advanced in January 2010 were surveyed on February 12, 2010. The borings advanced ~~d~~in April 2010 were surveyed on April 30, 2010.

All of the locations were surveyed in relation to a control point. Northing and easting data were measured to the nearest 0.001 meter and elevation was measured to the nearest 0.001 foot. A copy of the survey data is provided in Appendix ~~G~~F.

During the 2011 excavation activities, the locations of the trenches were referenced to SB-006 and the dimensions of the excavations were measured manually in the field.

3.2 Data Evaluation

3.2.1 Regulatory Criteria

Data developed during the RFI were evaluated according to the NMED risk-based soil screening guidance document *Technical Background Document for Development of Soil Screening Levels Revision 5.0* (NMED, 2009). SSLs are presented in Table A-1 of that document (SSG Table A-1) for various exposure scenarios.

Additional screening values were obtained from the combined USEPA Regional Screening Levels (RSLs), found on the USEPA website, which is located on the internet at <http://www.epa.gov/region09/superfund/prg/index.html>. The RSL summary table includes soil screening values for both Residential Soil and for Industrial Soil.

The SSLs and RSLs apply only to the upper 10 feet of soil. Soil between 0 and 10 ft bgs and were screened according to the following hierarchy:

- Data were compared to the residential soil screening levels (SSL) established by the NMED;
- If no NMED SSL exists for a constituent, the data were compared to the EPA RSLs;
- For metals, data were also compared to the background UTLs (described in Appendix G). The resultant screening criterion for metals in the upper 10 feet of soil was the greater of either the NMED SSL/EPA RSL or the UTL (in all cases the NMED SSLs were higher than the UTLs); and
- Data were also screened against the DAF20 values established by NMED.

~~Soil data collected from depths greater than 10 ft bgs were screened against the applicable DAF20 screening values.~~

The NMED guidance document for evaluation of TPH (NMED, 2006) provides several screening levels for TPH, depending on the source of the petroleum product. Because the exact nature of the fuels used at the FFTA is unknown, the SSL for unknown oil was used for evaluation of TPH DRO. No screening level is provided for TPH GRO in the NMED guidance document. However, as described in Section 3.1.6, the samples

were also tested for VOCs and SVOCs, constituents that would generally constitute the TPH GRO.

The Site is located within the ~~Stallion Range Center SRC~~ of WSMR and access to the Site is limited to personnel approved to enter the area. Although this would imply that an industrial/occupational exposure would be appropriate, the Residential SSLs were used in order to provide a conservative evaluation of potential impacts.

In addition to the Residential SSLs, the SSL for protection of groundwater due to leaching was used to screen the samples. Because the samples showed no indication of saturation, depth to groundwater in the vicinity is greater than 190 ft bgs, and the source area is less than 0.5 acres, a dilution attenuation factor of 20 (DAF 20) was used to evaluate leaching potential.

3.2.2 Data Quality Evaluation

The primary data quality objectives (DQOs) for this investigation were to provide representative data usable to characterize site conditions, delineate the nature and extent of affected media (if present), and to support corrective action decisions as appropriate. Analytical data reports were reviewed and evaluated in accordance with Appendix 5 of the Permit and in accordance with applicable USEPA SW-846 method requirements as described in the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (USEPA, October 1999), USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA, July 2002). The analytical data were validated using Level II QA/QC criteria. A copy of the analytical data reports and the data validation summary reports are provided in Appendix C. Samples that did not meet the project DQOs are discussed in the data validation reports in Appendix C~~5~~. All data were deemed usable for the purposes of this evaluation.

~~3.2.3 Risk Assessments~~

~~Human health and ecological risk assessments were performed using data collected during both the January and April 2010 sampling events.~~

~~The human health risk assessment (HHRA) was performed to evaluate potential risks associated with human exposure to constituents of potential concern (COPCs) at the FFTA. The HHRA was conducted following the approach provided in the NMED guidance and USEPA guidance for risk assessments (see Appendix E for references).~~

~~Both a screening-level ecological risk assessment (SLERA) and a baseline ecological risk assessment (BERA) were performed for the FFTA. These assessments evaluated potential risks associated with ecological receptors that may be exposed to constituents of potential ecological concern (COPECs). The SLERA and BERA were performed using an approach based on NMED and USEPA guidance (see Appendix E for references).~~

~~For purposes of the risk assessment, the soil data were divided by sample depth interval based on the exposure pathways identified for the site. In brief, the soil data were categorized as follows:~~

- ~~• Surface soil data, including soil samples collected from depths of 0 to 2 ft bgs, were used to evaluate potential exposure of human (current/future site worker; hypothetical future resident) and ecological receptors;~~
- ~~• Surface and subsurface soil data (0 to 10 ft bgs) were used to evaluate potential exposure of human (future construction worker) and ecological receptors that could be exposed to subsurface soil (e.g., burrowing wildlife); and~~
- ~~• Total soil data (vadose zone) were used to evaluate potential exposure of human receptors through the vapor intrusion exposure pathway.~~

~~Detailed procedures followed for the risk assessments are provided in Appendix E.~~

~~3.2.43.2.3~~ Statistical Evaluation to Determine Background Metals Values

~~Statistical evaluations were performed on the soil data collected from the background borings. A background concentration for six of the RCRA metals was computed by constructing a tolerance interval that would contain 95% of the background concentrations with 95% confidence. The upper limit of this interval is called the "95-95 Upper Tolerance Interval" (UTL). UTLs were calculated for arsenic, barium, cadmium, chromium, lead and selenium. UTLs for mercury and silver were not calculated because with the exception of one estimated value detected below the sample quantitation limit for silver in sample SB-006 (0.5 – 1' below ground surface) these two metals were not detected in any of the investigation samples. All of the calculated UTLs were above the residential SSLs for these metals. Therefore, the investigation metals results were compared to the residential SSLs rather than the UTLs. However, as discussed in Section 4.3.4, the UTLs were above the DAF 20 value for arsenic. A summary of the development of the background UTLs is provided in Appendix G.~~

~~background values for metals for naturally occurring arsenic (upper tolerance limit ((UTLs)) that could be the basis of comparison for a statistical evaluation of the RFI data set (upper confidence levels ((UCLs)). The statistical evaluation was performed to determine whether the concentrations of metals arsenic reported in the investigation area are similar to the reported concentrations of metals arsenic in the background area. This statistical analysis was performed according to USEPA guidance and is described in detail in Appendix FG.~~

4. Investigation Results

Results of the field investigation and data evaluation activities are discussed in this section.

4.1 Subsurface Conditions

The boring logs (Appendix B) indicate that the upper 15 feet of soils consist primarily of poorly graded sand with intervals of well-graded fine to medium sand throughout the area of the investigation. None of the borings extended more than 15 ft bgs.

As shown in the boring logs, the soils were dry throughout the depth of the investigation. As discussed in Section 2.5, the depth to groundwater in the area is approximately 190 ft bgs. No saturated soil was encountered during this investigation and would not be expected to be present.

~~The GPR used for utility clearance prior to the initiation of the investigation indicated the potential presence of debris near boring location SB-006. Exploratory trenches were excavated in the area and minor amounts of debris and stained soil were encountered at depths between 0 and 10 ft bgs. The debris and stained soil was removed as described in Section 3.1.8 and the excavation was backfilled with clean soil.~~

4.2 Soil Sampling Field Screening Results

The PID measurements collected during field screening are presented in the soil boring logs (Appendix B). The only soil sample that contained organic vapors as measured by the PID was from the 4 to 5 ft bgs interval at Boring SB-010. No measureable organic vapors were recorded from the samples collected from the remaining soil borings.

4.3 Soil Sampling Analytical Results

The analytical results for soil samples collected during the RFI are provided in Table 2. Analytical results for confirmation samples collected from the excavation near SB-006 are also provided in Table 2. Analytical laboratory reports are provided in Appendix DC.

As described in Section 3.2.1, the reported concentrations from the soil samples were compared to the Residential SSL and the DAF 20 SSL for each constituent, where available. As shown in Table 2, reported concentrations that exceed the Residential SSL are highlighted in yellow while reported concentrations that exceed the DAF 20 SSL are shown in italics.

Figures 6 through 8 graphically depict concentrations reported for the constituents of concern for samples collected from the soil borings. Figure 9 graphically depicts the concentrations reported for the constituents of concern in the confirmation samples collected from the excavation.

4.3.1 TPH Analytical Results

TPH GRO was not detected in any of the soil samples, as shown in Table 2.

TPH DRO was detected in six samples: SB-004 (0.5-1), SB-006 (0.5-1), SB-006 (4-5), SB-006 (8-9), SB-008 (0.5-1), and SB-010 (0.5-1). Of these samples, concentrations of TPH DRO in samples SB-006 (0.5-1), SB-006 (4-5) and SB-006 (8-9) exceeded the Residential SSL. Samples from surrounding borings (SB-001 through SB-005 and SB-007 through SB-010) provide lateral delineation of the TPH DRO. The sample collected from the 14 to 15 ft bgs interval from SB-006 did not contain detectable amounts of TPH DRO, providing vertical delineation of the TPH DRO. The distribution of TPH DRO concentrations in the soils is shown on Figure 56. The data are summarized in Table 2.

The soil from location SB-006 was excavated as part of the additional investigation that was performed based on NMED comments regarding the initial submittal of the RFI Report. The excavation centered on SB-006 extended to a depth of 10 ft bgs. Thus, the soil associated with samples SB-006 (0.5-1), SB-006 (4-5) and SB-006 (8-9) was removed and disposed of off-site as non-hazardous waste. The two bottom samples and one of the side wall samples (west side wall) contained detectable concentrations of DRO ranging from 14.2 to 31.8 mg/kg; however, these concentrations are well below

the SSL of 200 mg/kg. The samples from the north, east and south side walls were below the laboratory detection limits. The results and locations of the confirmation samples collected after affected soils were excavated are shown on Figure 9.

4.3.2 VOC Analytical Results

With the exception of three estimated detections (SB-001 9-10 ft, SB-006 14-15 ft, and SB007 9-10 ft) of acetone, No VOCs were detected at reportable concentrations in any of the soil samples collected and analyzed for VOCs. The concentrations of acetone reported are well below the NMED SSL and DAF20 standard. Acetone is not a constituent of concern associated with this SWMU and is likely attributable to laboratory contamination.

4.3.3 PAH Analytical Results

The following PAH compounds were present at concentrations above the reporting limits in at least one sample, as follows:

- 2-Methylnaphthalene: SB-006 (0.5-1)
- Anthracene: SB-006 (0.5-1); SB-006 (4-5) ; SB-008 (0.5-1)
- Benzo(g,h,i)perylene: SB-006 (4-5); SB-008 (0.5-1)
- Chrysene: SB-001 (4-5)
- Fluoranthene: SB-006 (0.5-1)
- Phenanthrene: SB-006 (0.5-1)
- Pyrene: SB-006 (0.5-1); SB-006 (4-5)

All other PAH compounds were not present above their respective reporting limits in any of the samples collected. As shown in Table 2, none of the reported concentrations were above either the Residential SSL or the DAF 20 SSL. The distribution of PAHs for the constituents shown above is shown on Figure 67.

The confirmation samples collected from the bottoms and side walls of the excavation centered on SB-006 were also analyzed for PAHs. None of the PAHs were detected in these samples, as shown in Table 2.

4.3.4 Metals Analytical Results

Arsenic, barium, chromium, lead and selenium were detected in 44 of the soil samples. Cadmium was detected in 41 of the soil samples. Silver was detected in one of the soil samples. Mercury was not detected in any of the soil samples.

The reported concentrations of these metals ranged in value, as follows:

- Arsenic: 1.09 to 11.4 mg/kg
- Barium: 50.5 to 338 mg/kg
- Cadmium: 0.0966 to 0.491 mg/kg
- Chromium: 4.57 to 13.3 mg/kg
- Lead: 3.64 to 371 mg/kg
- Selenium: 0.825 to 2.53 mg/kg
- Silver: 0.132 mg/kg

As shown in Table 2, none of the reported concentrations for barium, cadmium, chromium, lead, selenium or silver exceeded either the Residential SSL and none of the reported concentrations of barium, cadmium, selenium or silver exceeded or the DAF20 SSL (there are no DAF20 SSLs for chromium and lead). All of the reported concentrations of arsenic exceeded the DAF20 SSL, but of these samples only two SB-002 (0.5 – 1) and SB-006 (0.5-1) also exceeded the UTL. Only one sample SB-006 (0.5 – 1) exceeded the Residential SSL. The arsenic concentration in SB-002 (0.5 – 1) was 3.1, only slightly above the UTL of 3.0 and well below the SSL. The arsenic concentration in SB-006 (0.5 – 1) was 11.4. Samples from borings surrounding SB-006 (SB-001 -through SB-005, SB-007 and SB-008) provide lateral delineation of the arsenic. Deeper samples from SB-006 provide vertical delineation of the arsenic. The distribution of metals concentrations are shown in Figure 8.

The soil containing arsenic above the SSL at SB-006 was excavated and disposed of off site. The confirmation samples collected from the bottoms and side walls of the excavation centered on SB-006 were analyzed for arsenic and lead. Arsenic was analyzed because the concentration of arsenic in the sample collected from SB-006 (0.5-1) exceeded the SSL. Although the reported concentration for lead in the sample collected from SB-006 (0.5-1) was below the SSL, the concentration was sufficiently elevated that lead was also considered to pose a potential concern. As seen in Table 2, the arsenic and lead concentrations reported for all of the confirmation samples were below the Residential SSLs. Arsenic concentrations exceeded the DAF20 SSL, but were below the background UTL for arsenic; thus, these concentrations are considered to be representative of naturally occurring conditions and no further action is recommended.

4.3.5 Waste Characterization Analytical Results

Table 3 contains a summary of the waste characterization sample analytical results. The analytical data were provided to the WMC, as discussed in Section 3.1.89.

~~4.4 — Statistical Evaluation Results~~

~~The purpose of the statistical evaluation was to establish the 95-95 UTL for each inorganic constituent, such that 95 percent of the background concentrations are less than the UTL with 95 percent confidence. In order to calculate the UTL, the data were grouped into various data sets and was tested for normality of distribution and for outliers.~~

~~The background data set was evaluated as a whole as well as by the separate sampling depth intervals to determine if a significant difference existed between the depth intervals. It was determined that no significant differences exist between the sampling intervals and thus all of the background data were treated as one set of data. UTLs were then calculated for six of the eight metal constituents using the background data set. UTLs were not calculated for mercury or silver due to the large number of non-detected results.~~

~~The RFI data set, which included samples collected from within the FFTA, was evaluated as a whole as well as in separate sampling depth intervals. It was determined that the shallow soil interval (0.5 — 1 ft bgs) was significantly different than the other sample depth intervals, but that the three lower sampling intervals were similar and were combined (greater than 4 ft bgs) for the purpose of the statistical~~

evaluation. Additionally, the reported concentrations for arsenic, barium, cadmium and lead in sample SB-006 (0.5-1) and lead in sample SB-005 (4-5) were considered to be outliers and were removed from UCL data sets, consistent with USEPA guidance, as described in Appendix F. An UCL was calculated for six of the eight metals constituents for the compliance data set as a whole, for the shallow soil interval (0.5 to 1 ft bgs) and for the three deeper intervals combined (greater than 4 ft bgs). No UCLs were calculated for mercury or silver due to the large number of non-detected results.

The UCLs for the RFI data sets were compared to the background UTLs to evaluate whether the reported concentrations within the FFTA are similar to the background or naturally occurring concentrations.

Table 4 provides a summary of the calculated UTLs as well as the calculated UCLs for the various data sets. As shown, in Table 4, arsenic and lead in the shallow soil data set (0.5 to 1 ft bgs) are statistically elevated compared to the background concentrations.

4.5 Risk Assessment Results

4.5.1 Human Health Risk Assessment Results

A HHRA was conducted to evaluate exposure to COPCs in surface soil (0 to 2 ft bgs), combined surface and subsurface soil (0 to 10 ft bgs), and total soil (0 to 20 ft bgs) for site workers under current and future land use conditions, and construction workers and residents (adult and child) under hypothetical future land use conditions. Appendix E provides additional details of the procedures and results of the HHRA, which are summarized in this subsection.

In accordance with NMED guidance (NMED, 2009), constituent concentrations in surface soil and in combined surface and subsurface soil were compared to health-based screening levels and the calculated ratios summed. The ratios were multiplied by 1×10^{-5} for carcinogens and by 1 for non-carcinogens. The results of this data screening process indicate that, after comparison to health-based soil screening levels for industrial worker exposure, residential exposure, and construction worker exposure, thirteen COPCs were selected for surface soil for the residential scenario and no COPCs were selected for combined surface and subsurface soil at the FFTA.

The total excess lifetime cancer risk (ELCR) value for the direct contact exposure pathway for the hypothetical future resident scenario is within the target risk range of

~~10⁻⁶ to 10⁻⁴ for carcinogenic effects. The total hazard index (HI) value for the direct contact exposure pathway for the hypothetical future resident scenario is below the benchmark of 1 for non-cancer hazard. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at the FFTA are unlikely to result in adverse health impacts to current and future site workers, future residents and future construction workers via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal).~~

~~All the VOCs detected in total soil were selected as COPCs for the vapor intrusion evaluation. The findings of the vapor intrusion evaluation indicate that potential future industrial or residential development of the site would result in indoor air exposures that are below the regulatory benchmarks for cancer risks and non-cancer hazards.~~

~~This demonstrates that the constituent concentrations in soil at the FFTA are unlikely to result in adverse health impacts to future site workers or future residents via inhalation of indoor air.~~

~~4.5.2 Ecological Risk Assessment Results~~

~~A SLERA and BERA were completed for the FFTA to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents detected in surface soil and subsurface soil, and to conduct food chain modeling for the COPECs identified as bioaccumulative. Appendix E provides additional details of the procedures and results of the HHRA, which are summarized in this subsection.~~

~~The results of the SLERA and BERA for direct contact exposure and for food chain modeling indicate that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in soil. Therefore, no further ecological evaluation of the FFTA is warranted.~~

5. Conclusions

An RFI of the FFTA was performed to characterize subsurface conditions and evaluate whether historical operations resulted in impacts to soil and/or groundwater beneath the site. The investigation was performed according to the requirements of the WSMR Permit. Soil samples were collected from 10 borings within the FFTA as well as from three background locations. The analytical reports were reviewed and the data were determined to meet the data quality objectives.

The following conclusions are based on ~~the~~ evaluation of the RFI data:

- Shallow soil impacts were identified within the FFTA, as follows:
 - TPH DRO was present above the Residential SSL in the samples collected from boring SB-006 in the 0.5 to 1 ft bgs, 4 to 5 ft bgs, and 8 to 9 ft bgs intervals.
 - Arsenic was present above the Residential SSL in the sample collected from boring SB-006 in the 0.5 to 1 ft bgs interval.
- The lateral and vertical extents of the shallow soil impacts were fully delineated.
- The affected soils and debris in the area around SB-006 were excavated and removed. Confirmation samples collected from the floor and side walls of the excavation indicated that the extent of the excavation was adequate to remove impacted soils from the area surrounding SB-006 and all remaining constituents of concern are below the residential SSLs.
- There is no evidence to suggest that groundwater at the site has been impacted by activities at the SRC FFTA. The vertical extent of the impacted soils was fully delineated and there was no evidence of contamination below a depth of 10 ft bgs, while the depth to groundwater is approximately 190 feet bgs.
- There is no evidence to suggest that groundwater is threatened by the affected soils. With the exception of arsenic, no constituents were detected in the soils at concentrations exceeding the DAF 20 values. While arsenic concentrations in all of the soil samples exceeded the DAF 20 values, only two surface samples (the 0.5 – 1ft samples from Borings SB-002 and SB-006) exceeded the site-specific background UTL. All of the other soil samples, including deeper samples from Borings SB-002 and SB-006 were below the site-specific background value of 3.0 ug/kg. The arsenic concentration in the surface sample from SB-002 was only slightly above the UTL. The affected soils around SB-006 were excavated and removed from the site.
- ~~An evaluation of the data was performed to determine whether the affected soils represent a risk of potential future leaching to groundwater. The only constituent detected at concentrations above the DAF 20 value was arsenic. Based on the very shallow exceedances of DAF 20 and UTL relative to the very deep~~

~~occurrence of groundwater at approximately 190 feet, there is little or no risk that the arsenic in the shallow soils represents a threat to the groundwater.~~

- ~~● A HHRA was performed using the data collected within the FFTA. Based on the HHRA, constituent concentrations in soils at the FFTA are unlikely to result in adverse health impacts to current and future site workers, future residents and future construction workers via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal).~~
 - ~~● Based on a vapor intrusion evaluation, constituent concentrations in soil at the FFTA are unlikely to result in adverse health impacts to future site workers or future residents via inhalation of indoor air.~~
- ~~The results of the SLERA and BERA for direct contact exposure and for food chain modeling indicate that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in soil.~~
- ~~Exploratory trenches were excavated in the vicinity of SB-006 to evaluate the potential presence of debris, based on information obtained from the GPR during utility clearance and comments made by NMED in response to the initial submittal of the RFI Report in August 2010. Impacted soil and debris encountered during the trenching were excavated from the excavation and disposed of off-site as non-hazardous waste.~~
- ~~● Confirmation samples collected from the floor and side walls of the excavation indicated that the extent of the excavation was adequate to remove impacted soils from the area surrounding SB-006 and all remaining constituents of concern are below the residential SSLs.~~

6. Recommendations

The RFI for the FFTA was successfully completed and meets the RFI requirements described in the permit. ~~Corrective action has been completed and potentially impacted soil has been removed from the Site. No further investigation is recommended. WSMR requests concurrence from the NMED that the RFI is complete and that the site is eligible for Corrective Action Complete with Controls.~~

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**Revised RCRA Facility
Investigation Report for
the Stallion Range
Center Former Firefighter
Training Area
(SWMU 162)**

White Sands Missile Range,
New Mexico

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Appendix A

GPR Report

ARCADIS

Appendix **B**

Boring Logs

ARCADIS

| Appendix **GC**

| Data Validation Reports and
Laboratory Analytical Reports

| Appendix **GD**

| ~~Survey Data-Clean~~ Backfill
Documentation

| Appendix **DE**

~~Waste Disposal Records Data-
Validation Reports and Laboratory-
Analytical Reports~~

| Appendix EF

| Risk Assessment Reports Survey
Data -

ARCADIS

| Appendix **FG**

| Statistical Evaluations