National Aeronautics and
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Subject: NASA WSTF Small Arms Firing Ranges (SWMUs 29 – 31) Accelerated Corrective Measures Work Plan and Historical Information Summary

This transmittal provides the Accelerated Corrective Measures Work Plan (ACMWP) and Historical Information Summary (HIS) for the WSTF Small Arms Firing Ranges (SWMUs 29 – 31). The ACMWP and HIS were prepared in accordance with the WSTF Hazardous Waste Permit.

Executive summaries of the WSTF Small Arms Firing Ranges ACMWP and HIS are provided in Enclosure 1. Bound paper copies of the ACMWP and HIS are provided as Enclosure 2. Enclosure 3 provides electronic versions of the ACMWP and HIS on a CD-ROM.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for known violations.

If you have any questions or comments concerning this submittal, please contact me at 575–524–5024.

Timothy J. Davis
Chief, Environmental Office

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National Aeronautics and
Space Administration

Small Arms Firing Ranges (SWMUs 29-31)

Accelerated Corrective Measures Work Plan

February 2015

NM8800019434
NASA Johnson Space Center White Sands Test Facility
12600 NASA Road Las Cruces, New Mexico 88012

NASA Johnson Space Center White Sands Test Facility

Small Arms Firing Ranges (SWMUs 29-31)

Accelerated Corrective Measures Work Plan

February 2015

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Timothy J. Davis
Chief, NASA Environmental Office

2/26/15
Date

Executive Summary

The National Aeronautics and Space Administration (NASA) is required by the White Sands Test Facility (WSTF) Hazardous Waste Permit (Permit; NMED, 2009) issued by the New Mexico Environment Department (NMED) to develop investigation work plans (IWPs) for identified closed hazardous waste management units (HWMUs) and solid waste management units (SWMUs) at WSTF. Three WSTF small arms ranges are identified in the Permit as SWMUs:

- SWMU 29 – Second TDRSS Ground Terminal (STGT) Small Arms Range.
- SWMU 30 – 200 Area Small Arms Range.
- SWMU 31 – Westbay (WB)-2 Small Arms Range.

In accordance with Permit Section VII.L, NASA and NMED have agreed to implement the accelerated cleanup process at these units. The accelerated corrective measures (ACM) activity proposed in this work plan is a presumptive remedy that will reduce risks to human health and the environment and achieve cleanup of the SWMUs more rapidly than the IWP process. Groundwater contamination is not a component of the proposed cleanup, the remedy is expected to be final when complete, and NASA anticipates completion of ACM fieldwork within 180 days of starting the cleanup activities.

At all three ranges, lead bullets, with and without copper jackets, were fired into targets set up in front of a designated backstop such as a berm or hillside. The purpose of these firing ranges was to provide areas where personnel performing security functions could become familiar with, practice with, and qualify for security service using small caliber handguns (.357 Magnum, .38 Special, and 9 mm). The exact amount of lead ammunition fired within these ranges is unknown, though estimated quantities are discussed in this plan. Specific information related to the use of these firing ranges is provided in the accompanying Historical Information Summary (NASA, 2015b).

This ACM work plan describes the activities required to conduct field screening at the firing ranges in order to refine the horizontal extent of each study area, to recover and recycle as many bullets and bullet fragments as possible from the soil at the firing ranges, and to concurrently perform sampling activities to confirm that concentrations of hazardous constituents in the soil at the firing ranges do not pose a continuing risk to human health or the environment. The ACM activities described in this work plan will be implemented at all three historic firing ranges (SMWUs 29-31), and will specifically target lead, the primary contaminant of potential concern. During ACM fieldwork, soil analysis will be performed at specific locations, generally on the established sampling grid to provide confirmation of successful cleanup. Site restoration will be conducted after the investigation, during which the excavated soils with concentrations of hazardous constituents below applicable regulatory criteria will be spread to grade and the land surface will be returned to its approximate original elevation and contour.

An existing technical and schedule constraint exists that complicates the performance of ACM fieldwork at the STGT firing range because of the planned investigation and closure of the STGT wastewater lagoon (Area of Concern 51). Pre-ACM field screening, however, is expected to be performed following approval of this work plan, with the exception of inaccessible portions of the STGT firing range. Cleanup activities are expected to be initiated at the 200 Area and WB-2 firing ranges following field screening. Fieldwork at the STGT lagoon will be coordinated with the wastewater lagoon project. Fieldwork at each firing range is expected to be complete within 180 days of initiation.

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List of Acronyms

ACM	Accelerated Corrective Measures
ACMWP	Accelerated Corrective Measures Work Plan
ADF-SW	Aerospace Data Facility – Southwest
AOC	Area of Concern
ASTM	ASTM International
bgs	below ground surface
CFR	Code of Federal Regulations
CLC	City of Las Cruces
CoC	Chain-of-custody
COPC	Contaminant of Potential Concern
DQOs	Data Quality Objectives
EDD	electronic data deliverable
EPA	Environmental Protection Agency
FP-XRF	Field-portable x-ray fluorescence
ft	Foot/feet
GPS	Global Positioning System
GSA	Gardner Spring Arroyo
HAZWOPER	Hazardous Waste Operations and Emergency Response
HIS	Historical Information Summary
HWMU	Hazardous Waste Management Unit
IMWP	Interim Measures Work Plan
IWP	Investigation Work Plan
JSC	Johnson Space Center
lbs	Pounds
MS	Matrix spike
MSD	Matrix spike duplicate
MWTS	Municipal wastewater treatment system
NASA	National Aeronautics and Space Administration
NMED	New Mexico Environment Department
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
QA/QC	Quality Assurance and Quality Control
RSL	Regional Screening Level
SAM	San Andres Mountains
SCEM	Site conceptual exposure model
SHP	Safety and Health Plan
SJMB	Southern Jornada del Muerto Basin
SOP	Standard Operating Procedure
SSL	Soil Screening Level
STGT	Second TDRSS Ground Terminal
SWMU	Solid Waste Management Unit
TDRSS	Tracking Data Relay Satellite System
USDA	U.S. Department of Agriculture
WB	Westbay
WMP	Waste Management Plan

WSC	White Sands Complex
WSTF	White Sands Test Facility

1.0 Introduction

The National Aeronautics and Space Administration (NASA) Johnson Space Center (JSC) White Sands Test Facility (WSTF) is located at 12600 NASA Road in central Doña Ana County, New Mexico. The site is approximately 12 miles northeast of Las Cruces, New Mexico and 65 miles north of El Paso, Texas (Figure 1.1). WSTF has supported testing of space flight equipment and materials since 1964 and continues to operate as a field installation of JSC in Houston, Texas. The WSTF U.S. Environmental Protection Agency (EPA) Facility Identification Number is NM8800019434.

The Hazardous Waste Permit (Permit; NMED, 2009) issued by the New Mexico Environment Department (NMED) requires the preparation of several investigation work plans (IWPs) to assess the potential impact of historical releases of hazardous waste or hazardous constituents. The Permit requires NASA to determine whether these releases may have the potential to serve as continuing sources of groundwater contamination. Attachment 16 of the Permit required submittal of an IWP for Solid Waste Management Unit (SWMUs) 29-31 (Second Tracking and Data Relay Satellite System [TDRSS] Ground Terminal [STGT] Small Arms Range, 200 Area Small Arms Range, and Westbay®[1] [WB]-2 Small Arms Range, respectively) by December 30, 2014.

While developing the combined IWP for these units, NASA determined that it would be more appropriate to implement interim measures at these SWMUs as indicated in Permit Section VII.G.3. On December 17, 2014, NASA proposed the development and submittal of an Interim Measures Work Plan (IMWP) for SWMUs 29-31 (NASA, 2014) rather than the IWP required by the Permit. NASA also requested additional time to develop and submit the IMWP, and proposed a new due date of January 30, 2015. In early January 2015, NMED recommended that NASA consider implementing the Accelerated Cleanup Process described in Permit Section VII.L. The cleanup activities planned for these SWMUs meet the requirements established in Permit Section VII.L, so NASA subsequently submitted a proposed outline for the Accelerated Corrective Measures Work Plan (ACMWP; NASA, 2015a).

Section VII.H.1.c of the Permit requires the submittal of a Historical Information Summary (HIS) in conjunction with each IWP. NASA committed to submittal of the ACMWP by January 30, 2015. This ACMWP and accompanying HIS (NASA, 2015b) satisfy these requirements.

1.1 Objectives and Scope

The objective of the accelerated corrective measures (ACM) is to remove and recycle spent ammunition scraps/fragments and then verify that the soils within and adjacent to SWMUs 29-31 do not contain residual contamination that presents a risk to human health and the environment. If contaminants of potential concern (COPCs) are detected at concentrations above regulatory limits, the data may be used to guide additional remedial action, if necessary. The ACM is limited in scope to soil, and not groundwater, and to the three small arms firing ranges described above. Follow-on investigatory actions required to confirm the cleanup meets the project objectives are also described in this work plan.

1.2 Approach and Implementation

The ACM implementation will consist of the following activities:

- Preparation of the sites to ensure access to soils for field screening and subsequent cleanup activities.

[1] Westbay® is a registered trademark of Schlumberger, Inc.

- Preliminary mapping of the field area with a metal detector or equivalent to define the horizontal study area for each of the three firing ranges.
- Major field activities including berm/backstop excavation and recovery of ammunition scraps/fragments for recycling.
- Confirmatory soil sampling activities including the installation of shallow soil borings and soil sample collection and analysis.
- Sample and data management followed by data verification, validation, and assessment.
- Development and submittal of a WSTF Small Arms Firing Ranges Remedy Completion Report to NMED.
- Removal and management of wastes generated during the site cleanup activities. Likely project waste includes potentially contaminated soil, ammunition scraps/fragments, and other contact waste.
- Site restoration and grading.

2.0 Background

WSTF occupies over 60,000 acres of Chihuahuan Desert environment in the western foothills of the San Andres Mountains (SAM) that border the eastern edge of the Southern Jornada del Muerto Basin (SJMB). A 6-mile paved road provides access to WSTF from U.S. Highway 70.

WSTF is a U.S. government restricted access site that was established in 1962 to support the NASA Apollo Space Program. Although the primary purpose of the facility is to provide test services and support to NASA for the U.S. Space Program, services are also provided for the Department of Defense, Department of Energy, private industry, and foreign government agencies.

2.1 Summary of Historical Information

2.1.1 SWMU 29 Historical Information

There are three historical small arms firing ranges in the NASA controlled area; two located at WSTF and one located at STGT (Figure 2.1). The operational history of each firing range is summarized below. Refer to the Small Arms Firing Ranges SWMUs 29-31 HIS for a detailed description of each firing range (NASA, 2015b).

The STGT small arms firing range (SWMU 29) was located within the north cell of the STGT wastewater (sewage) lagoon (Figure 2.2). The north lagoon cell was not originally used for wastewater due to clay liner leakage during initial lagoon construction and testing. The north cell dimensions were 256 feet (ft) by 256 ft, and the entire area was used as the firing range. The lagoon walls were approximately 7 ft high, and the west berm was used as the backstop for the STGT small arms firing range. In 1996, the south half of the north lagoon cell was synthetically lined and put into service for sanitary wastewater. However, the remaining northern half of the north cell continued use as a small arms firing range with reduced dimensions of 128 ft by 256 ft. Mostly White Sands Complex (WSC; TDRSS and STGT) personnel used the STGT small arms firing range (SWMU 29).

WSTF personnel used the STGT small arms firing range from approximately 1995 to 1999, while WSC personnel used SWMU 29 from 1992 to 1999. Approximately 23 WSTF employees (two security guards and 21 Fire Department personnel) and 22 WSC security personnel fired approximately 60 rounds per person two times annually for firearms familiarization and qualifications.

2.1.2 SWMU 30 Historical Information

The 200 Area small arms firing range (SWMU 30) was located south of the main 200 Area buildings, in between the 200 and 100 Areas at WSTF (Figure 2.2). This range was 50 ft by 50 ft, sloping up to the east, and located adjacent to an arroyo. The natural, coarse-grained hillside to the east was used as the range backstop however, the hillside proved unstable and when it rained, the firing range washed out. Excavation and repairs were required for continued use. This maintenance issue resulted in the relocation of the range and construction of the WB-2 small arms firing range. Use of the 200 Area small arms firing range ceased at WSTF when use of the WB-2 small arms firing range initiated. Both WSC and WSTF security personnel used the 200 Area small arms firing range (SWMU 30).

WSTF security personnel used the 200 Area small arms firing range from 1964 to 1990, qualifying approximately 22 personnel (one security guard and 21 Fire Department personnel) annually. WSC personnel qualified approximately 22 employees from 1977 to 1990. Each employee discharged approximately 100 rounds per person for annual firearms qualifications (NASA, 2015b).

2.1.3 SWMU 31 Historical Information

The WB-2 small arms firing range (SWMU 31) was located east of the TDRSS facility in the 100 Area, directly adjacent to groundwater monitoring wells 100-E-261 and WB-2, from which the range name was derived (Figure 2.2). This area was specifically designed to be a small arms firing range, with a flat, cleared area, and a 7 ft high by 30 ft long berm formed on the east side of the range towards the mountains. Mostly WSTF security personnel used this range.

The WB-2 small arms firing range was used periodically from September 1990 to 2000. WSTF personnel used the range from 1990 to approximately 1995; then from 1999-2000. WSC personnel used SWMU 31 from 1990 to 1992, when use of the STGT range began, then again from 1999-2000. Approximately 23 WSTF employees (two security guards and 21 Fire Department employees) and 22 WSC employees qualified two times annually discharging approximately 100 rounds per person (NASA, 2015b).

2.2 Contaminants of Potential Concern

2.2.1 Contaminants of Potential Concern

Background information collected for the firing ranges and reported in the HIS (NASA, 2015b) indicates that lead bullets, with and without copper jackets, were discharged at each of the firing ranges and allowed to accumulate on site. There was no evidence that other hazardous wastes or hazardous constituents were managed or disposed of at these sites. Therefore, COPCs consist primarily of components used in the manufacture and discharge of small arms ammunition (ITRC, 2003). The COPCs for this cleanup are provided in Table 2.1, which also provides the NMED soil screening level (SSL) or EPA regional screening level (RSL), where available. Soil samples collected during ACM field activities will be analyzed for these COPCs and compared to SSLs/RSLs.

2.2.2 Estimated Quantity of Lead

Lead is considered the primary COPC and most likely constituent to present a continuing risk to human health and the environment at the three firing ranges if not removed. Therefore, lead is the primary focus for field screening activities at the three firing ranges. Lead bullets, with and without copper jackets, were fired into targets set up in front of the berms or hillside at all three firing ranges. The exact amount of lead ammunition fired within these ranges is unknown; however, using information obtained from employees,

and assuming the bullets utilized had an average weight of 125 grains each, the approximate amount of lead discharged at each firing range is estimated as follows:

- STGT small arms firing range (SWMU 29): ~530 pounds (lbs) to ~1,370 lbs.
- The 200 Area small arms firing range (SWMU 30): ~1,500 to ~2,250 lbs (The minimum represents qualifications only and the maximum represents qualifications and estimated practice firing).
- WB-2 small arms firing range (SWMU 31): ~570 lbs.

The amount of lead estimated to be present in the STGT small arms firing range can be categorized by the area used. From 1992 to 1996, the entire STGT lagoon was used as the firing range. For that original larger firing range, approximately 240 lbs of lead was estimated discharged. From 1996 to 1999, only the northern half of the north lagoon cell was used as the firing range. For this smaller size firing range, the estimated amount of lead discharged was 290 lbs to a maximum of 1,370 lbs (if Aerospace Data Facility – Southwest [ADF-SW] estimated rounds for 1996-1998 are included). No cleanup activities have been completed at any of the historical firing ranges (SWMUs 29-31) to date (NASA, 2015b).

2.3 Regulatory Requirements

The WSTF Hazardous Waste Permit (NMED, 2009) requires that NASA investigate and address historical releases of hazardous waste and hazardous constituents that may have occurred at sites throughout WSTF as part of the Resource Conservation and Recovery Act Corrective Action Program. This work plan provides information related to the implementation of ACM in accordance with section VII.L of the Permit. When implemented, the accelerated cleanup process will reduce risks to human health and the environment by removing and recycling ammunition scraps/fragments and reducing concentrations of COPCs (Table 2.1) in soils to levels required by the Permit (i.e., SSLs/RSLs). The ACM is also expected to reduce costs associated with cleanup and long-term monitoring of the firing ranges. The Permit requires notification to NMED at least 30 days prior to commencing fieldwork associated with the ACM. This work plan provides the required notice. The Permit also requires that fieldwork be completed within 180 days after it is initiated. As indicated in the schedule (Section 9.0), NASA expects that ACM activities at the firing ranges will be completed within the allocated timeframe. Additional correspondence following submittal and approval of this work plan will ensure that NMED remains fully informed of the project schedule.

2.4 Preliminary Site Conceptual Exposure Model

Utilizing NMED guidance (NMED, 2014), a preliminary site conceptual exposure model (SCEM; Figure 2.3) was developed to provide an understanding of the potential for exposure to hazardous constituents at the sites based on the source of contamination, the release mechanism, the exposure pathway, and residential, commercial/industrial worker, and construction worker potential receptor(s).

2.4.1 Contamination Sources

The contamination source is the soil in and around each of the firing ranges that is potentially contaminated with constituents originating from the discharge of small arms ammunition, such as lead, copper, and other metals (Table 2.1). Lead accounts for more than 95% of the weight of a bullet projectile and constitutes the greatest health and environmental concern at the firing ranges (ITRC, 2003).

2.4.2 Release Mechanisms and Mobility in the Vadose Zone

Discharge of small arms at the firing ranges resulted in the deposition of bullets and bullet fragments onto the soil at these sites. COPCs, particularly the lead that comprises over 95% of traditional bullets, may be subsequently released to other environmental media. Potential release mechanisms from deposited bullets and bullet fragments include physical movement by wind and water (relocation of bullets and fragments), downslope or downwind movement of lead-contaminated soil, and infiltration of dissolved lead into the vadose zone or groundwater. The primary chemical factors affecting lead mobility at outdoor shooting ranges are rainfall quantity, rainfall quality, soil pH, precipitating agents (carbonates), and sorbents (clays and organics). Lead has very limited leaching potential into groundwater at WSTF due to the following:

- The infrequent of use of the firing ranges and limited amount of lead ammunition present (Section 2.2.2);
- The amount of lead subject to leaching is a small portion (<0.1%) of the total lead burden;
- WSTF's low average annual precipitation (typically in the range of 12 inches or less);
- No significant industrial conditions exist that could decrease the pH of the precipitation (e.g., acid rain).
- The depth to groundwater at each of the firing ranges is a significant impediment to migration:
    - STGT Firing Range (SWMU 29) – 350 ft below ground surface (bgs);
    - The 200 Area Firing Range (SWMU 30) – 150 ft bgs;
    - WB-2 Firing Range (SWMU 31) – 220 ft bgs;
- The neutral to slightly alkaline pH of WSTF soils. The Nickel-Tencee soils that characterize WSTF surficial deposits (USDA, 1976) have a pH of between 8.0 – 8.5 as a result of the significant limestone component within the alluvial clasts and matrix. pH conditions above 7.0 and below 11.0 promote the retention of cations in the soil, increases the adsorption of lead, and significantly reduce lead mobility within the vadose zone (EPA, 1992).
- The lead from fragmented bullet ammunition occurs as stable Pb2+. When exposed to the atmosphere, lead oxidizes to form lead hydroxide and lead carbonate. Although these products are essentially insoluble, they can be subject to breakdown and leaching. The precipitating lead typically complexes with organic matter and sorbs on clays. As a result, the downward movement of lead from the soil by leaching is very slow under most natural conditions and will normally be retained at the surface (EPA, 1992).
- Lead within the WSTF soil is adsorbed by clays, carbonates, and organic matter such that the solubility of lead is greatly reduced (EPA, 1992). Pb has the greatest relative affinity for the sorption into soils relative to other common metals (Elliot. Liberati & Huang, 1986).

The above conditions create a soil setting that is not considered particularly conducive to dissolution of lead and migration to groundwater. However, release mechanisms would include airborne transport of contaminated soil by wind, as well as surface transport of contaminated soil or spent bullets and fragments by precipitation runoff.

2.4.3 Exposure Pathways

There are several potential mechanisms for exposure to lead from contaminated soils, including inhalation, ingestion, and contact. As part of this cleanup activity, four potential exposure pathways were identified and evaluated: 1) ingestion of lead-contaminated soil; 2) inhalation of airborne lead-contaminated dust; 3) dermal contact with lead-contaminated soil, and 4) ingestion of lead-contaminated groundwater.

The potential for exposure of residential receptors was evaluated. There are no current or future residential land use scenarios anticipated in the vicinity of the firing ranges. WSTF is a controlled test site located on the U.S. Army White Sands Missile Range, and there are no encroaching residential areas or future scenarios in which residential encroachment could occur. Therefore, no complete exposure pathways for residential land use scenarios were identified during development of the SCEM (Figure 2.3).

The STGT firing range (SWMU 29), 200 Area firing range (SWMU 30), and WB-2 firing range (SWMU 31) are located proximal (within half a mile) to industrial buildings (Figure 2.1), and therefore present the possibility for exposure of personnel to potentially contaminated soil by ingestion, inhalation, or dermal exposure. Exposure is possible while personnel are engaged in outdoor activities when dust particles are airborne or when activities bring them in proximity to potentially contaminated soil. Pathways 1, 2, and 3 are considered complete for commercial/industrial workers and construction workers in proximity to these areas (Figure 2.3).

As previously described, infiltration of lead, and other COPCs, to the groundwater is highly unlikely at WSTF. Current groundwater chemical analytical data indicate that WSTF groundwater, including groundwater near the historical firing ranges, are not contaminated with the COPCs identified for this ACM. In addition, under current conditions, the nearest downgradient water wells are NASA WSTF water supply wells. These wells are located several miles to the west of the investigation areas (Figure 2.1) and are monitored regularly for the presence of site contaminants and for compliance with drinking water standards. Based on the immobility of lead in WSTF soil, the depth to groundwater at the sites, the relatively low COPC concentrations in WSTF groundwater, and the distance to the nearest potential receptor, ingestion of groundwater (Pathway 4) is not considered a completed exposure pathway for commercial/industrial workers, construction workers, or residential potential receptors for the firing ranges (Figure 2.3). Therefore, groundwater is not addressed by this ACM.

The preliminary SCEM includes areas of undetermined extent where the presence of lead in the surficial and shallow soils may exceed the NMED maximum contaminant concentrations. These areas will be fully defined during the initial survey described in Section 5.1.

3.0 Site Conditions

3.1 Surface Conditions

Surface conditions at WSTF are typically characterized by the U.S. Department of Agriculture (USDA) Soil Classification (USDA, 1999) Nickel-Tencee Association (60% Nickel gravelly fine sandy loam and 25% Tencee very gravelly loam). The alluvium is classified as the piedmont slope facies of the Camp Rice Formation, which forms part of the Quaternary Santa Fe Group (Seager, 1981).

3.1.1 SWMU 29 and SWMU 31 Surface Conditions

SWMU 29 and SWMU 31 are located within soils of the Nickel-Tencee Association. The Nickel series includes deep, well drained soils associated with old, coalescent alluvial fans. The soils are formed in

gravelly, medium textured alluvial sediments. The upper 5 ft are characterized by light brown to pink gravelly to fine sandy loam. Gravel content is approximately 50%.

The Nickel-Tencee unit soils are gently sloping and are in similar positions on alluvial fans. Tencee soils dominate the older, more stable areas where the source of alluvial material was limestone bedrock.

3.1.2 SWMU 30 Surface Conditions

Soils in the vicinity of SWMU 30 belong to the Lozier-Rock Outcrop Complex. The unit consists of very shallow, well drained soils which formed from weathered limestone material. The upper 5 ft are characterized by strongly calcareous brown, light brown, and pale brown stony loams. The Lozier-Rock Outcrop Complex unit is approximately 45% Lozier Stony Loam and 35% Rock Outcrop. The Lozier soils are moderately sloping to moderately steep and irregularly intermingled with limestone outcrops. Rock outcrops occur as steep scarps, breaks, and ledges in the area. Shale outcrops, arroyos, and recent alluvial deposits make up about 20% of the area (NASA, 1996).

Gardner Spring is the only natural surface water feature in the area and is located approximately 2,000 ft northeast of the nearby 200 Area industrial complex. It is an intermittent spring and ceases flow for long periods of up to several years between rare periods of heavy mountain-front rainfall. The Gardner Spring Arroyo (GSA) originates near Gardner Spring and runs south-southwest before turning west under Apollo Blvd. The GSA is located approximately 650 ft west of SWMU 30.

3.2 Subsurface Conditions

3.2.1 SWMU 29 Subsurface Conditions

No previous subsurface investigations have been conducted in the immediate area of SWMU 29. Conventional monitoring wells 700-B-510 and 700-F-455 are located approximately 2,700 ft southeast and northeast of the area, respectively. Lithology logs for these wells indicate that andesite bedrock occurs at a depth of approximately 300 ft below ground surface (bgs). Late Pliocene to Quaternary alluvium of the Santa Fe Group exists above the Tertiary andesite bedrock. The alluvium at 700-B-510 and 700-F-455 consists of coalescent alluvial fan deposits derived from the SAM to the east. Alluvium in this area is generally described as an unconsolidated to moderately cemented, poorly sorted polygenetic pebble to boulder conglomerate. Lenticular sandy to clayey gravels, sandy silt, and silty clays are interbedded with the conglomerate. Lithologies of sand to boulder size clasts include varieties of subrounded to subangular limestone, andesite, rhyolite, and siltstone.

Observed hydraulic conditions at wells 700-B-510 and 700-F-455 indicate that groundwater occurs within a confined fractured andesite bedrock aquifer in this area. Current depth to water at well 700-B-510 is 464.42 ft bgs (4,341.11 ft above mean sea level [amsl]). Well 700-F-455 is located on land controlled by the USDA and is not currently accessible for water level measurements.

3.2.2 SWMU 30 Subsurface Conditions

Paleozoic limestone bedrock occurs at ground surface at SWMU 30. Several ft of alluvium sporadically covers the bedrock throughout the area. The nearest groundwater wells to SWMU 30 are 200-SG-1 and 200-SG-2. They are located approximately 950 ft west-northwest and 350 ft northwest from SWMU 30, respectively. Both wells are completed in Quaternary alluvium, west of Gardner Spring Arroyo. The 200 Area East fault is coincident with the Gardner Spring Arroyo, which displaces the limestone bedrock 80 to 100 ft (NASA, 2013). Well 200-D-240 is screened in limestone bedrock and is located approximately 1,000 ft west of SWMU 30. Current depth to water at this well is 125 ft bgs (4662.38 ft amsl).

3.2.3 SWMU 31 Subsurface Conditions

This area is located outside the known boundaries of the WSTF groundwater contaminant plume. Late Pleistocene to Quaternary Santa Fe Group alluvium was encountered from 0 to 126 ft bgs during drilling of nearby well WB-2. The alluvium is generally described as a poorly to moderately cemented pebble to boulder conglomerate with sporadic caliche horizons, clay lenses, and carbonate cemented zones. Color ranges from light brown to pale reddish brown, pale red, and grayish orange. Clasts generally comprised 30-60% of the lithologic samples collected during drilling, and varied in size between 2 mm and 1.5 cm. Limestone was the predominant clast, followed by andesite and rhyolite volcanic rock fragments, siltstone, and caliche. Paleozoic limestone was encountered at 126 ft bgs. This unit is generally described as a dark grey micritic to fossiliferous limestone with interbedded moderate brown sandstone and light olive gray siltstone.

Hydraulic conditions appear unconfined at well WB-2. A notable water producing zone was identified during drilling between 270 and 271 ft bgs. Prior to plugging and abandonment of this well in early 2014, depth to water was measured at 216.53 ft bgs (4685.56 ft amsl). Depth to water at the adjacent conventional monitoring well 100-E-261 was 218.96 ft bgs (4,683.95 ft amsl) in August 2014.

4.0 Scope of Activities

The ACM planned for SWMUs 29-31 include a variety of activities, which are summarized in this section. The cleanup and sampling activities described in this work plan are planned in accordance with Permit Section VII.L and are based primarily on *Characterization and Remediation of Soils at Closed Small Arms Firing Ranges* (ITRC, 2003), with additional consideration of project data quality objectives (DQOs) and other requirements of Permit Attachment 17. Section 4.1 summarizes the planned project activities, while Section 4.2 presents detailed information about the DQO process as applied to this ACM.

4.1 Summary of Planned Activities

ACM activities include site preparation, field screening to determine the horizontal extent of potential contamination, excavation of potentially impacted soils, recovery and recycling of ammunition scraps/fragments to the extent practical, soil sampling and analysis, evaluation of chemical analytical data and comparison to established regulatory criteria, development and submittal of a report summarizing the cleanup and sampling project, management of waste generated during ACM activities, and site restoration based on future use. Planned activities are described in further detail in Section 5.0.

4.2 Data Quality Objective Process

The corrective measures and sampling methodology presented in this work plan were developed based on input from NMED personnel, the Accelerated Cleanup Process requirements of the Permit (NMED, 2009; Section VII.L), *Characterization and Remediation of Soils at Closed Small Arms Firing Ranges* (ITRC, 2003), Guidance on *Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006), and the investigation and sampling requirement specified in Attachment 17 of the Permit. The data acquisition plan (i.e., sampling design) is based on the DQO process.

4.2.1 Problem Statement

The problem statement is summarized in the Permit (NMED, 2009; Section VII.L), which states that "[t]he accelerated cleanup process shall be used at sites to implement presumptive remedies at small-scale and relatively simple sites where groundwater contamination is not a component of the accelerated cleanup, where the remedy is considered to be the final remedy for the site, and where field work will be

completed within 180 days of the commencement of field activities." Based on available groundwater chemical analytical data, the depth to groundwater at the three firing ranges, and the relative immobility of lead and other COPCs through WSTF soils, NASA does not believe that groundwater has been impacted by historical operations at the sites, thus groundwater cleanup at these locations is not required as part of the ACM. It is expected that, following cleanup activities and confirmatory sampling, the proposed remedy will be complete and no further investigatory or corrective actions will be required at the firing ranges. NASA expects that invasive fieldwork such as excavation and soil sampling, can be completed within 180 days of initiation.

There are known and suspected quantities of COPCs in the soil at the historical firing ranges that make up SWMUs 29-31. As summarized in the preceding section and described in later sections of this ACMWP, cleanup activities will be performed to remove as much contamination as possible from the soil at these sites. As part of ACM activities, soil sampling will be performed at each SWMU to determine if residual soil contamination presents a risk to human health or the environment. The problem statement for the investigation of SWMUs 29-31 is: Confirm that soil beneath, and where applicable downgradient, of the three historical firing ranges does not contain hazardous constituents at concentrations above regulatory limits as a result of past activities.

4.2.2 Decision Statement and Alternative Actions

The primary decision after site cleanup activities is whether ACM activities resulted in soil at the firing ranges that does not present a risk to human health or the environment. Alternative actions for the decisions include:

- Consider a "Corrective Action Complete" status determination.
- If needed, perform additional remedial activities to complete the corrective measures implementation, thus mitigating source(s) of continuing contamination or human health risk.

4.2.3 Decision Inputs

COPC concentrations measured in soil following ACM activities at the SWMUs are primary inputs to the decision. COPCs for this investigation were identified using two primary information sources:

- Available literature that provides information regarding the assessment and cleanup of small arms firing ranges.
- Detailed information pertinent to the operational history and use of materials documented in the SWMUs 29-31 HIS (NASA, 2015b) through a variety of historical documents and reports, personnel interviews, and personnel questionnaires.

4.2.4 Study Boundaries

This investigation addresses, and is limited to, the shallow surface soils beneath SWMUs 29-31 and associated areas, as applicable. This includes the Small Arms Range at STGT, the 200 Area Small Arms Range, and the WB-2 Small Arms Firing Range (Figure 2.2), as well as any nearby areas impacted by historical activities at these SWMUs. Because the extent of potential bullet impacts and transport could not be conclusively determined by historical research or site surveys, the horizontal boundaries of the study areas are not clearly defined and must be delineated prior to ACM activities as described in Section 5.2.

4.2.5 Decision Rule

The purpose of this ACM is to remove known and suspected COPCs from the shallow soil at the three SWMUs and, following the cleanup, determine if concentrations of COPCs exceed applicable regulatory criteria or represent a continued risk to human health or the environment. The strategy is to remove surface soil with known contamination as determined during field screening, then to determine if residual COPCs are present. In accordance with NMED soil screening guidance (NMED, 2014) and the Permit (NMED, 2009), validated analytical results from soil samples collected during the investigation will be compared to the appropriate risk-based screening level as described in Permit Attachment 15 (e.g., New Mexico or EPA Regional SSLs) for direct exposure of construction workers. Where multiple contaminants are detected, the cumulative effects of those contaminants will be considered as described in the guidance.

Project DQOs are summarized as follows: ACM activities will continue until cleanup levels as described in Permit Attachment 15 for direct exposure routes under the construction worker scenario are achieved for site soils as determined by field and analytical testing. At this point, consider a “Corrective Action Complete” status determination for the firing range(s). If residual COPC concentrations in excavated soils are reduced to below cleanup levels, the soil will be returned to the firing range from which it was excavated as part of the “Corrective Action Complete” process. If residual COPCs are present above cleanup levels in excavated soils after cleanup activities, alternate remedial or disposal options must be considered.

4.2.6 Study Constraints

There is a significant constraint to implementing and completing the cleanup of the STGT small arms firing range (SWMU 29). As stated in Section 2.1 and the HIS for SWMUs 29-31 (NASA, 2015b), the original firing range area of SWMU 29 was within the unused north cell and immediately adjacent to the active south cell of the STGT wastewater lagoon (Area of Concern [AOC] 51). When half of the north cell of the wastewater lagoon was placed into service, the floor and impact berm of half of the firing range were covered with a synthetic liner and became part of the active lagoon. That area of the historical firing range, and the potentially contaminated soil within the berm and range floor, are not currently accessible for cleanup. NASA is currently finalizing the construction of a sanitary sewer system to connect WSTF to the City of Las Cruces (CLC) municipal wastewater treatment system (MWTS). Upon connection to the CLC MWTS, NASA plans to investigate and close the STGT wastewater lagoon (NASA, 2012). It is necessary that the WSTF sanitary sewer will be connected to the CLC MWTS before the initiation of fieldwork for the cleanup of SWMU 29, since the wastewater and synthetic liner will need to be removed prior to any field screening for lead within the berm and under the liner for the north lagoon cell. Therefore, the cleanup of SWMU 29, and subsequently the other firing ranges, will be performed in conjunction with, or following, the investigation and closure of the STGT wastewater lagoon. However, the sanitary sewer installation project has experienced significant delays since construction began. The exact date upon which discharges to the WSTF wastewater lagoons will cease, and their closure and investigation will begin, is currently unknown. There is the potential that continued delays in the activation of the sanitary sewer system may impact the initiation of ACM fieldwork at SWMU 29. NASA will closely monitor the progress of the sanitary sewer project and notify NMED of any schedule impacts on the ACM proposed in this work plan. Additional information on project scheduling is provided in Section 9.0.

5.0 Corrective Measures Activities

This section provides detailed information regarding the planned ACM activities, including the cleanup processes to be used, soil sampling and data collection procedures, chemical analytical methods to be

utilized, the process for site grading and restoration following cleanup, and the procedures for field documentation and recordkeeping. This section also presents the field screening techniques that will be utilized to determine the horizontal extent of the study area at each firing range.

5.1 Pre-Cleanup Field Screening

Prior to initiating ACM activities at the firing ranges, the final study boundaries must be determined as indicated in Section 4.2.4. Figure 5.1, Figure 5.2 and Figure 5.3 provide current approximations of the potential horizontal extent of impacted soil at each firing range. Pre-cleanup field screening will be conducted at each site to determine the actual extent of the potentially contaminated soil at and near each firing range, and the figures will be updated accordingly. Field screening will be performed with two instruments, depending on the area of the firing range being characterized. A commercially available metal detector set appropriately to detect lead within the shallow surface soil will be used to verify horizontal extent of the study areas containing bullets and bullet fragments. These metal detectors can achieve resolution of the shallow subsurface at depths up to approximately one foot without breaking ground, allowing for more thorough delineation of the lateral extent of potential contamination. A field-portable x-ray fluorescence (FP-XRF) instrument will be used to screen soil for any additional lead content to determine if further soil removal (cleanup) is required.

Firing ranges typically consist of four main areas: the primary impact berm; range floor; lateral or side berms; and the safety fan or fallout area (ITRC, 2003). These areas are depicted in Figure 5.1, Figure 5.2 and Figure 5.3 and are described in more detail below, along with a summary of the pre-cleanup field screening that will be conducted at each area.

5.1.1 Primary Impact Berms

The primary impact berm faces the shooter. The primary impact berms at the STGT firing range (SWMU 29; Figure 5.4, Figure 5.5, and Figure 5.6) and WB-2 firing range (SWMU 31; Figure 5.7 and Figure 5.8) are well defined. These berms received the full force of impact of bullets and fragments. As a result, bullets and fragments may have penetrated a foot or more (in sandy soils), and thus may be out of the range of a commercial-grade metal detector. Additional monitoring will be required during cleanup activities to ensure bullets and fragments deeply embedded in the impact berm are removed. Because they are well-delineated, the ACM activities can be implemented at the impact berms at the STGT and WB-2 firing ranges without pre-cleanup field screening. At the 200 Area firing range (SWMU 30), an impact berm was not established. Instead, the natural, coarse-grained sloping hillside was used as a backstop (Figure 5.9 and Figure 5.10). Penetration into the rocky consolidated soils comprising the backstop at this range is expected to be fairly minimal and more consistent with that observed at fallout areas. Therefore, it is expected that the use of a commercially available metal detector will allow for a relatively thorough definition of the horizontal extent prior to ACM fieldwork at the 200 Area firing range.

5.1.2 Range Floors

The range floor is defined as the ground between the firing line and the primary impact berm, which rarely receives direct fire. The range floors of the STGT firing range, WB-2 firing range, and 200 Area firing range are shown in the photographs in Figure 5.5, Figure 5.7, and Figure 5.9, respectively. Bullets or fragments are typically those that fell short of the berm or are the result of ricochet. The resulting bullets or fragments are typically found lying on the surface or embedded in the root mass of the range floor. Live rounds, misfires, and brass shell casings may also be found on the range floor. Typically, bullets and fragments penetrate the range floor to depths of less than a foot, and are generally found in the top 6 inches or less. Smaller lead fragments, lead dust, and other COPCs may also be present in the soil of the range floor. The extent of the range floors has been established using historical information and

available knowledge of the ranges and their use. As a result, delineation with a metal detector is not required. Instead, the known extent of the range floors have been overlain with a sampling grid (Section 5.2) that will be used to direct the collection of soil samples for evaluation using the FP-XRF and chemical analysis. If the results of PF-XRF evaluation and laboratory analysis of soil samples indicate that lead or other COPCS are present at concentrations above cleanup levels, ACM will be performed at the range floor(s).

Prior to field screening at the STGT firing range, the range floor must be cleared of existing debris. As shown in Figure 5.5, the range floor at the firing range was used for the storage of roof rock ballast recovered from the roofs of the STGT power plant and main operations building (NASA, 2015b). These materials were placed within the historical firing range in 2002, after use of the firing range had ended. The range floor of the historical STGT firing range is also used to store landscaping vegetation waste. These stored materials will be removed prior to performing the field screening described above. The on-site geologist will supervise the removal of these materials to ensure that the soil comprising the range floor is not disturbed.

5.1.3 Lateral or Side Berms

Lateral berms may separate contiguous ranges or provide containment at the perimeter. They rarely receive direct impact. Penetration of bullets and fragments into these berms is typically a foot or less. There are no lateral berms at the 200 Area or WB-2 firing ranges. The lateral berms (one shown in Figure 5.11) at the STGT firing range remain well defined and should be readily confirmed using a commercially available metal detector.

5.1.4 Safety Fans/Fallout Areas and other Areas of Interest

The safety fans or fallout areas are those areas behind the impact berm and adjacent to the firing range where most bullets are the result of ricochet. Because the bullets are typically found on the surface, determining the extent of the areas will be accomplished with the metal detector. The estimated extent of fallout areas at the STGT firing range, 200 Area firing range, and WB-2 firing range is shown in Figure 5.1, Figure 5.2 and Figure 5.3, respectively. An additional area of interest was identified at the 200 Area firing range (Section 5.3.6) and will be screened in conjunction with the fallout area at that range. This area of interest is depicted in Figure 5.2 and represented by the photograph in Figure 5.12.

Data collected using the metal detector will be evaluated and utilized to determine if additional field screening is required. If any relatively concentrated areas of lead, or “hot spots”, are located using the metal detector, then soil within and surrounding these hot spots or areas of interest may be evaluated using the FP-XRF instrument. The results of field screening will be used to refine the horizontal study boundary (Section 4.2.4) for each firing range. As the actual extent of detectable metals is determined at each site, the area subject to ACM will be clearly identified in the field and Figure 5.1, Figure 5.2 and Figure 5.3 will be updated and submitted to NMED. Field screening will also be utilized to refine sample grid positioning and field sampling locations as described in Section 5.2.

5.2 Soil Sampling Procedures

5.2.1 Sampling Grid

In conjunction with approximating the horizontal extent of potential lead-contaminated soil, basic sampling grids have been established for each firing range. Figure 5.1, Figure 5.2 and Figure 5.3 provide the approximated sampling grids for the STGT firing range (SWMU 29), the 200 Area firing range (SWMU 30), and the WB-2 firing range (SMWU 31), respectively. At the 200 Area and WB-2 firing ranges, the range floors have been divided into grid cells measuring 25 ft by 25 ft, while the range floor at

the STGT firing range has been divided into grid cells measuring 50 ft by 50 ft. Refined sampling grids will be developed utilizing data obtained during the field screening described in Section 5.1, and sampling areas will be modified accordingly. Revised figures showing the final sampling grid will be submitted to NMED prior to beginning ACM fieldwork. Each grid cell will be sampled during or after ACM activities as indicated in Section 5.3. Five subsample locations will be utilized in each grid cell, spaced on an "X" pattern. Each of the four corner subsamples will be collected at a location approximately equidistant between the center and each corner of the grid cell, along each leg of the "X". The five subsamples for each grid cell will be composited as described in the applicable following sections for FD-XRF measurements and sampling for chemical analysis.

5.2.2 Composite Soil Sample Preparation

In order to obtain relatively representative soil samples from designated sampling locations, the five subsamples collected from each grid cell will be composited. Each subsample will be collected from a vertical soil column of approximately 6 inches and is expected to consist of approximately 5 lbs of soil, for a total composited sample of approximately 25 lbs. Subsamples will be collected using a standard shovel or hand auger to obtain the desired amount of soil. The subsamples will be placed on a polyethylene tarp of appropriate size and "rolled" to facilitate thorough mixing of the subsamples. The composited sample will then be spread to a depth of approximately 1 inch. Subsamples from four locations (one from each quadrant of the spread soil) will then be collected with a single-use pre-cleaned or decontaminated stainless steel or polyethylene scoop or trowel to fill sample containers for submittal to an off-site chemical analytical laboratory or for further preparation prior to analysis in the FP-XRF instrument. Unused soil will be returned to the subsample locations, and the sampling equipment will be decontaminated (Section 6.0) prior to compositing and collection of the next sample. Gloves and other disposable materials contacting the samples will be collected and managed as indicated in Section 6.0.

5.2.3 Field-Portable X-Ray Fluorescence Instrument

Soil samples collected as part of the pre-cleanup field screening and during ACM fieldwork will be analyzed *ex situ* using a properly calibrated FP-XRF instrument to obtain a field measurement of the concentration of lead in soil. Following compositing as previously described, further sample preparation is required to obtain representative results using the FP-XRF. A portion of the composited sample is first air-dried to reduce soil moisture content, which can interfere with FP-XRF analysis. The dried sample will be screened using 2 mm mesh to remove large objects. The final step is to grind and sieve the soil sample to reduce particle size to less than 0.250 mm. Following sample preparation, the required quantity of soil will be placed in the instrument's sample cup and analyzed. It is expected that FP-XRF detection limits will be less than the applicable regulatory limits, thus providing adequate characterization of specific COPC concentrations in soil. The unused portion of the composited sample (not prepared for FP-XRF analysis) will be used, as required, for the collection of a soil sample to be submitted to the off-site laboratory for analysis. In general, the results of at least 20% of samples evaluated using the FP-XRF will be confirmed with chemical analysis of the corresponding soil sample.

5.2.4 Soil Samples for Chemical Analysis

At times during, and following, the cleanup activities described in Section 5.3, soil samples will be collected for submittal to an off-site chemical analytical laboratory for analysis of COPCs (Table 2.1). After subsamples are composited and prepared as previously described, the required laboratory-provided sample containers will be filled with soil. Excess soil around the top of the sample containers will be removed to ensure proper lid fit and container closure.

All samples collected for this investigation will be handled in a manner that maintains their integrity. The following apply to soil sampling performed for this ACM:

- The inside of soil sample containers will not be touched, and dedicated chemical resistant gloves will be donned prior to sample collection at each grid cell to prevent cross-contamination.
- All samples will be collected in a manner that minimizes the introduction of foreign material (e.g., dust, rain, and snow).
- Laboratory-specified holding times, containers, and preservatives will be adhered to.
- Equipment decontamination procedures will be completed before initial use and between individual sample collection locations to prevent contamination and cross-contamination of samples.
- Sampling equipment will be either single-use pre-cleaned (per EPA protocol as with sample containers) or multiple-use decontaminated as indicated in the applicable site-specific internal procedural documentation and ASTM D5088-02 (ASTM, 2008).

Field quality control samples will be collected as described below to ensure high quality data are generated during the cleanup.

- Field rinsate (equipment) blanks will be collected from the sampling tooling, (1) at the onset of the project prior to sampling activities, (2) between each firing range project area, and (3) if the equipment tooling is required to leave the project site prior to completion of the project.
- Field duplicate samples will be collected at 10% of soil sampling locations designated for chemical analysis. Duplicate samples will be analyzed for the same parameters as the primary samples.
- Matrix spike/matrix spike duplicate (MS/MSD) samples will be collected at 5% of soil sampling locations designated for chemical analysis. MS/MSD samples will be analyzed for the same parameters as the primary samples.

NASA has developed comprehensive internal procedures for sample collection, shipping, and management. These procedures provide specific information on sample management and related documentation, including instructions for sample custody (internal to NASA and external during shipment), storage, packaging, shipment, delivery tracking, and related recordkeeping. These procedures will be utilized during this project to ensure appropriate sample management.

5.3 Cleanup Strategy and Processes

5.3.1 Mechanical Separation

It is expected that cleanup objectives can be achieved by mechanically separating bullets and bullet fragments from firing range areas identified during the initial field screening and soil sampling processes described in Sections 5.1 and 5.2. The services of an off-site contractor will be utilized to excavate and sieve range soils as required. The general approach to mechanical separation is described below. The specific approach to be implemented at the WSTF firing ranges will be determined following thorough field screening, evaluation of findings, and consultation with a qualified contractor.

A front end loader or skid steer loader is typically used to scrape off the surficial soil and deliver it to a hopper. The soil subsequently moves on conveyor belts or jigs to screening machines that screen out large particles leaving bullets, bullet fragments, and small soil particles. Blower systems then send air into the

mixture. Reclaimed material must be close to 100% pure lead. Sieved soil will be stockpiled until analyses indicate it is below cleanup levels, at which point it will be returned to the vicinity of the range.

It is expected that the removal of ammunition scraps and fragments will require the application of one or more of the following techniques:

- Hand raking and sifting of the surface layer – soil collected using shovels is typically passed through a screen to remove the larger particles. The sifted material is then passed through a fine screen to capture the lead and lead fragments. Proper personal protective equipment (PPE) is required.
- Screening machine using a mobile shaker or gravel sizer – stacked vibrating screens (two or more) of different mesh sizes allows the lead-containing soil to be sifted from the other material. The upper screen collects larger particles and the lower screen allows smaller particles to pass through.
- Vacuuming using a vacuum system to collect the lead – vacuuming takes the place of hand raking and sifting. A vacuuming device collects the materials lighter than lead, leaving bullets or bullet fragments to be easily recovered. Once collected, the lead-containing soil must be sifted through a screening system.
- Soil washing (involving wet screening, gravity separation, or pneumatic separation) – soils are mixed in a water-based wash solution. Wet screening involves moving the soil through a series of screens with collection of the lead bullets and fragments. Gravity separation allows the wet soil/wash to pass through jigging equipment that allows more dense materials to settle to the bottom of the unit. Pneumatic separation utilizes an air stream to separate the lead.

5.3.2 Impact Berms

The impact berms at the STGT firing range (SWMU 29; Figure 5.1 and Figure 5.6) and the WB-2 firing range (SWMU 31; Figure 5.3 and Figure 5.8) are well defined. NASA personnel performed site inspections at these two locations in November 2014 and identified bullets and bullet fragments on the surface and shallow subsurface of the impact berms. To remove these bullets and fragments, surficial soil will be excavated in 6-inch lifts and sieved as previously described. The lifts will be excavated from the face of the berm until no visible evidence of bullet penetration is detected by the field geologist. The metal detector will be used to verify that additional bullets or bullet fragments are not present in the shallow soil of the exposed berm surface. If the visual inspection and metal detector indicate the absence of bullets or bullet fragments, confirmatory sampling will be performed at the berm face. Samples will be collected at 10 ft horizontal intervals along the berm face, approximately 3 to 5 ft above the surface of the range floor in order to intercept the most likely impact elevation within the berm. At each sampling location, samples will be collected for evaluation by the FP-XRF instrument and for laboratory analysis, as required. If FP-XRF results indicate that lead concentrations in soil are below the cleanup level, no further excavation of the berm is required.

The 200 Area firing range (SWMU 30) does not have a clearly recognizable impact berm. Instead, the range backstop consisted of the naturally sloping, coarse-grained hillside behind the targets (Figure 5.2 and Figure 5.10). During the visual inspection of the area performed in November 2014, no bullets or bullet fragments were observed on the surface behind the historical target location. A specific portion of the hillside has not been identified for mechanical separation activities. Field screening data will be used to determine the extent of potential contamination and, if present, any hot spots that require mechanical separation. Cleanup activities planned for the range fallout areas will be utilized for the hillside at the 200 Area firing range.

5.3.3 Range Floors

If field screening activities indicate that bullets or bullet fragments are present at some or all of a range floor, the sampling grid cells (Figure 5.1, Figure 5.2 and Figure 5.3) that include soil with concentrations of lead above the cleanup level will be subject to ACM. If small, localized areas of obvious surface deposition of ammunition components, such as shell casings or bullets, are observed during field screening, the materials will be immediately removed and recovered from the location in order to mitigate the finding in that location. To address non-discrete soil contamination, 6 inches of soil will be excavated from the targeted grid cells and bullets and bullet fragments will be mechanically separated from the soil. Composite soil samples will be collected for evaluation by the FP-XRF and chemical analysis (as required) from each excavated grid cell as previously described to determine if contaminated soil has been removed to an adequate depth. Successive 6-inch lifts will be excavated until FP-XRF data indicate that the concentration of lead in each excavated grid cell is below the cleanup level.

5.3.4 Lateral Berms

If the results of field screening indicate that bullets or bullet fragments are present in the lateral berms, they will be subject to the corrective measures planned for the primary impact berm (Section 5.3.2).

5.3.5 Fallout Areas

Firing range fallout areas (Figure 5.1, Figure 5.2 and Figure 5.3) will be screened as previously described to determine if bullets or bullet fragments are present. If small, localized areas of obvious surface deposition of bullets or bullet fragments are observed during the screening, the materials will be immediately removed to mitigate the finding in that location. Larger, non-discrete areas of deposition in the fallout areas will be overlain with an extension of the applicable sampling grid to include grid cells for excavation and confirmatory sampling of the areas of interest within the fallout areas. Cleanup and sampling will be performed as described for the range floors, with 6-inch lifts of soil excavated until FP-XRF data indicate that the concentration of lead in each excavated grid cell is below the cleanup level.

5.3.6 Other Areas of Interest

In addition to the primary range areas described above, an additional area of interest exists at the 200 Area firing range. As indicated in the HIS (NASA, 2015b; Section 8.1.2), sloughing of the hillside used as a backstop likely transported bullets or bullet fragments down-slope away from the hillside. Figure 5.9 and Figure 5.10 provide photographs of the sloping hillside used as a backstop at this range, while Figure 5.12 provides a photograph of the nearby arroyo located to the south of the firing range into which runoff from the hillside likely carried bullets and bullet fragments. As with the firing range fallout areas, this area of interest (shown in Figure 5.2) will be field screened with the metal detector, and FP-XRF if required, to determine if bullets or bullet fragments are present. Cleanup activities, if necessary, will be performed as described for the range floors, with 6-inch lifts of soil excavated until FP-XRF data indicate that the concentration of lead in each excavated grid cell is below the cleanup level.

5.4 Chemical Analytical Methods

NASA contracts services from off-site analytical laboratories as required to support program and project needs. Typically, laboratories considered to support this project must be accredited by the National Environmental Laboratory Accreditation Program. The analytical tasks required to achieve the project objectives will be awarded to the laboratory that is successful in the competitive bid process. Potential laboratories must respond to a comprehensive statement of work developed to meet the project objectives defined in this ACMWP. Analytical standard operating procedures (SOPs), laboratory quality manuals,

and other laboratory-specific documentation are provided by the analytical laboratory following award of the contract and are not available in advance. These documents are retained in the project record and will be available for NMED review as required.

The overall objective for laboratory analysis is to produce data of known and sufficient quality. Appropriate procedures and quality control (QC) checks will be used so that known and acceptable levels of accuracy and precision are maintained for each data set. All samples will be analyzed by a fully qualified laboratory in accordance with the laboratory's quality plan, which ensures that the contract laboratory adheres to standardized analytical protocols and reporting requirements and is capable of producing accurate analytical data. The analytical methods required for COPCs at the firing ranges are provided in Table 2.1.

Method blanks and laboratory QC samples are prepared and analyzed in accordance with the laboratory's method-specific SOPs. The analytical results of method blanks shall be reviewed to evaluate the possibility of contamination caused by analytical procedures. At a minimum, the laboratory will analyze method blanks and laboratory control samples at a frequency of one in 20 for all batch runs.

5.5 Final Site Restoration and Grading

Final restoration and grading activities at each firing range will be performed following submittal and NMED approval of the remedy completion report. Stockpiled soil that was excavated from the firing ranges during ACM fieldwork and that meets regulatory criteria, as well as the unexcavated impact berm at the WB-2 firing range (SWMU 31), will be spread and graded to approximate the natural contours of each site. The unexcavated portions of the berms at the STGT firing range (SWMU 29) will be managed in accordance with the *Wastewater Lagoon Areas Closure Investigation Work Plan* (NASA, 2012). All site grading will be completed to prevent ponding of water at each site location. Site restoration and grading activities may also include the installation of best management controls (e.g., diversion culverts, temporary berms, silt fences, etc.) to direct storm water away from the site locations to prevent storm water runoff impacts. Site restoration activities will not include any efforts to reseed the areas. Vegetation will be allowed to return naturally at each site.

5.6 Field Documentation Procedures

The field geologist or site supervisor will ensure that details of all activities related to this corrective measures are documented using a field logbook, field data records, and/or any required site-specific procedural documentation. Generally, all field activities are recorded in bound field logbooks with sequentially numbered pages in indelible ink. Records of the field activities should be sufficient to allow an experienced individual, not associated with the sampling event, to recreate the events by reading the logbook. Logbook entries will include, as applicable, information such as:

- Standard daily header – project name, logbook number, date, weather conditions, team members present and their affiliations (including subcontractors), sample location identification, day's task(s), daily safety meeting topics, PPE to be used, equipment in use, and any calibration information, if applicable.
- Daily activities (time and observations recorded) – site arrival and departure, cleanup or investigation activities planned and completed, visitors and the purpose of their visit, field and laboratory sample information, soil type, soil conditions, decontamination (i.e., method, equipment cleaned), hazardous waste management procedures, and reference data sheets or maps, if applicable.

- Daily summary – action items, materials used, changes or deviations made from planned protocol, and a summary of plans for the next day of fieldwork.
- Signatures (field personnel and logbook reviewer) and relevant dates.

At a minimum, field records will include observations of soil conditions, location surveys using Global Positioning System (GPS), and sample documentation. For analytical samples, the date, location, depth, sample type, collection method, identification number, sampler, and any circumstances, events, or decisions that could impact sample quality will be documented by the on-site geologist in the project field logbook. Even though each case may be unique, the geologist's decision must be documented as to conditions that precipitated any decisions for the unsuitability of samples for analyses. In addition to the field logbook entries for sampling events, chain-of-custody (CoC) forms will be completed for analytical samples and maintained with project documentation.

Evidential records for the entire project will be maintained in hard copy or electronic form and will consist of:

- Project ACMWP with any deviations redlined.
- Site-specific internal procedural documentation or plans.
- Project logbooks.
- Field data records (i.e., surveyed site location).
- Sample CoC forms.
- Correspondence with NMED.
- Final analytical data packages.
- Reports.
- Miscellaneous related records such as photos, maps, drawings, etc.

6.0 Decontamination and Waste Management

All equipment, including heavy equipment used for excavation, must be decontaminated prior to commencement of ACM activities at the firing ranges. All sampling equipment will be decontaminated after completion of sampling activities within each grid cell, and heavy equipment will be decontaminated prior to leaving each firing range. General decontamination guidance available in ASTM D5088-02 (ASTM, 2008) will be followed for this project.

Decontamination procedures will be performed by personnel who have completed the Occupational Safety and Health Administration (OSHA) Standards for Hazardous Waste Operations and Emergency Response ([HAZWOPER]; 29 Code of Federal Regulations [CFR] 1910.120 [a] – [o]) 40-hour training personnel wearing appropriate PPE. The decontamination of heavy equipment will be performed under the supervision of the site supervisor or their designee.

As required in Permit Attachment 20 (Section 20.2.13), the Waste Management Plan (WMP) is provided as Appendix A. The WMP provides a description of the potential wastes that will be generated from the Small Arms Firing Ranges (SWMUs 29-31) ACM as well as procedures for waste management, waste characterization, and waste disposition. Wastes that may be generated as part of the investigation include: environmental media (soil spoils); used non-dedicated sampling equipment; PPE; plastic sheeting; rags; miscellaneous debris contaminated by soil or fluids; and, water and soap solutions used for equipment decontamination.

6.1 Decontamination Area

Decontamination of large equipment will be performed at the existing concrete decontamination pad in the 600 Area or on a large decontamination pad established at the investigation site if deemed necessary by the contractor utilized for mechanical separation activities. Individual smaller-scale decontamination areas may be constructed adjacent to each firing range to collect and contain soil brushed from the sampling equipment. Small, non-disposable sampling equipment, such as the hand tools, will be decontaminated at these small decontamination areas. All contamination reduction or decontamination activities will be performed over a properly designed pad or containment device that will retain any waste generated during the decontamination process. All waste will be managed in accordance with the WMP provided in Appendix A.

In the event that a decontamination pad or other containment requires repair or modification to effectively contain decontamination waste products, activities that require decontamination will be halted until the decontamination pad or containment is repaired.

Except for the concrete decontamination pad in the 600 Area, the decontamination area(s) will be established within the contamination reduction zone to prevent any transport of contamination outside the investigation area. The decontamination area will be located away from the potential influence of the ongoing investigation operations.

Safeguards will be implemented to ensure no cross-contamination occurs between other projects that may be simultaneously conducted with this investigation. This will include implementing appropriate dust control measures during investigation activities and modifying or delaying sampling and decontamination operations during dusty conditions, if necessary

6.2 Decontamination Methods

Decontamination methods are described below.

6.2.1 Waste Reduction of Solid Materials from Equipment

Excavation during the investigation will be performed using heavy equipment. Adherence of the soil to the heavy equipment as well as production of liquid waste will be kept to a minimum with these methods. To further reduce the generation of decontamination fluids, soil will be removed from heavy equipment and sampling equipment using scraping tools such as shovels, spatulas, wire brushes, or paint stirring sticks. Removal of solids will be performed over or inside an open-top Department of Transportation-compliant drum using underlying plastic sheeting or over plastic sheeting to collect any soils. Solid materials will be removed from any equipment prior to moving that equipment to the designated decontamination pad for further decontamination.

6.2.2 Decontamination

Following the contamination reduction described above, tools or sampling equipment will be decontaminated to minimize the potential for cross-contamination between soil borings and samples. Decontamination utilizes steam cleaning or pressurized heated water and/or detergent wash in conjunction with brushes, sprayers (as required), and a final rinse with purified water.

All heavy equipment will be decontaminated prior to excavation activities, in between excavation events at individual firing ranges, and at the end of the project. All non-disposable equipment will be decontaminated at the end of the project or before leaving WSTF for any reason. Reusable equipment that

will not directly contact soil samples will be decontaminated using a steam cleaner or high pressure heated water wash followed by thorough rinsing with WSTF potable water, as applicable. Smaller reusable equipment that will contact soil samples will be decontaminated, first by hand washing the item with non-phosphate detergent such as Alconox®[2] or by using a steam cleaner or high pressure heated water wash, then by rinsing with WSTF potable water, and finally by rinsing with purified water.

6.3 Decontamination of Field Screening Instruments

Field screening instruments, such as a metal detector and FP-XRF, will be used during this project. If the metal detector becomes contaminated with dust during field screening, soil or dust will be removed from the unit as described above. Then the detector will be wiped with a clean rag moistened with WSTF potable water before use at the next firing range. The FP-XRF will be decontaminated between sampling grid cells as directed by the manufacturer or instrument supplier. Solid waste materials removed from the equipment and the wipes used will be disposed of and managed as indicated in Appendix A.

7.0 Data Management Tasks

Data management tasks include project documentation and data review and assessment. Details are outlined below.

7.1 Project Documentation and Records

All facets of this investigation will be documented in detail by the responsible project personnel. Records are retained in the WSTF Operating Record and can be accessed at any time by authorized WSTF personnel.

7.1.1 Sample Collection and Field Measurements Data

Sample information and field measurements are recorded in the field logbook by the responsible project field personnel. These are reviewed by knowledgeable project personnel on a regular basis during the investigation and are retained in the project file. They are ultimately archived in the WSTF Records Management System as part of the Operating Record. As required for reporting, these data are also transferred to and archived in operational and historical databases.

7.1.2 Off-site Laboratory Data

Data packages from off-site analytical laboratories will consist of two primary components: comprehensive reports, to be submitted as Adobe portable document files (PDF) for review and archiving; and electronic data deliverable (EDD) files to facilitate transfer of chemical analytical data into WSTF's analytical database(s). The PDF report will include a variety of information, including laboratory name, report date, sample-specific information, analyte names and Chemical Abstract Service numbers, analytical results, QC sample results, data qualifiers and narratives, pertinent analytical notes, laboratory reviewer signatures, and a variety of other information specific to the laboratory and analytical method. The EDD will include the associated electronic data and follow the same review and approval cycle as the paper report.

[2] Alconox® is a registered trademark of Alconox, Inc.

7.2 Data Assessment, Review, and Corrective Action Procedures

A quality assurance and quality control (QA/QC) specialist will evaluate the sample data, field, and laboratory QC results for acceptability with respect to the project quality objectives. Chemical analytical data will be compared with the project quality objectives and evaluated using the data validation guidelines contained in EPA guidance documents, the latest version of SW-846, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," and industry-accepted QA/QC methods and procedures (EPA, 2013).

7.3 Assessment and Response Actions

The conformance of investigation activities to the ACMWP will be evaluated on an ongoing basis while field activities are in progress. Additional verification will be provided through oversight of the field activities by the field geologist or other responsible personnel. Significant deviation from the number and locations of samples indicated in the ACMWP will be discussed with NMED for concurrence. The assessment process will include immediate evaluation of any change to the sampling plan so that, if necessary, an alternate field procedure may be quickly established. Daily quality field assessments may be conducted during cleanup and sampling activities. Field assessments will be performed by environmental professionals who are not immediate members of the field team. Following completion of field activities, a final review of field activities will be performed. Any deviations from the ACMWP or procedures will be documented and noted in the remedy completion report.

The contract laboratory will be required to notify NASA of significant data quality exceptions within one business day of discovery. Sample re-analysis will be performed, if possible. NASA will contact NMED as soon as practical to discuss any data quality exceptions that may affect the ability to meet the objectives of the investigation.

7.4 Data Review Process

A comprehensive review of sample analytical data will be conducted. Prior to conducting the review, the following information (where required and applicable) will be compiled and provided for the review.

- The NMED-approved ACMWP.
- Field sampling and geologist logs.
- Laboratory reports.
- Statements of work and the laboratory Quality Management Plan.
- Electronic Data Deliverable Files.
- Standard Operating Procedures.
- Database tools.

7.5 Data Review Elements

Step I: Verification – Verification (review for completeness) is the confirmation by examination and provision of objective evidence that the specified requirements (sampling and analytical) have been completed (EPA, 2005).

Data verification is the process of determining whether data have been collected or generated as required by the project documents. The process consists of the following categories: 1) verifying that field

sampling operations were performed as outlined in the ACMWP; 2) verifying that the data collection procedures and protocols were followed; 3) verifying completeness to establish that sufficient data necessary to meet project objectives have been collected; and 4) checking that QC sample results meet control limits defined in the analytical methods.

Step II: Validation – Validation is the confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. Validation is a sampling and analytical process that includes evaluating compliance with method, procedure, or contract requirements and extends to evaluating against criteria based on the quality objectives developed (EPA, 2005).

The purpose of validation is to assess the performance of the sampling and analysis processes to determine the quality of specified data. Data validation consists of the following objectives: 1) verifying that measurements (field and laboratory) meet the user's needs; 2) providing information to the data user regarding data quality by assignment of individual data qualifiers based on the associated degree of variability; and 3) determining whether project quality objectives were met. Data management personnel will perform data validation in accordance with the requirements in this ACMWP and existing WSTF procedures.

Step III: Usability Assessment – Usability assessment is the determination of the adequacy of data, based on the results of validation and verification, for the decisions being made. The usability process involves assessing whether the process execution and resulting data meet project quality objectives (EPA, 2005).

The goal of the usability assessment is to determine the quality of each data point and to identify data that are not acceptable to support project quality objectives. Data may be qualified as being unusable or rejected (R), as based on established quality review protocols. Data qualified as estimated (J) are less precise, or less accurate, than unqualified data but are still acceptable for use. The data users, with support from the contractor environmental data management staff, are responsible for assessing the effect of the inaccuracy or imprecision of the qualified data on statistical procedures and other data uses. The data reporting will include a discussion of data limitations and their effect on data interpretation activities.

8.0 Safety and Health Procedures

Field activities will be conducted in accordance with requirements of HAZWOPER. The environmental contractor's Corporate-wide Safety and Health Plan (SHP) will be augmented as required with site-specific documentation to address potential hazards foreseeable for this project; and, will be followed in accordance with applicable requirements of the standards. The augmented SHP will address safety and health issues pertaining to work activities, including known and reasonably anticipated hazards associated with project scope of work as well as contingencies for unexpected conditions. The requirements of the SHP will apply to prime and sub-tier contractors as well as personnel requesting access to controlled areas of the project site. Project field personnel are required to be current in HAZWOPER training. In the event that new hazards are encountered that are not addressed by the SHP, the field team will stop work and contact the responsible WSTF health and safety personnel to develop additional guidance or means to eliminate or mitigate any new hazards. As required by 29 CFR 1910.120(b)(4), the SHP and site-specific support documentation will address:

- A safety and health risk or hazard analysis for each site task and operation found in this work plan.
- Employee training assignments.
- PPE to be used by employees for each of the site tasks and operations being conducted.

- Medical surveillance and fitness for duty requirements (based on nature of the project scope and COPCs).
- Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation to be used, including methods of maintenance and calibration of monitoring and sampling equipment to be used.
- Site control measures in accordance with the site control program.
- Decontamination procedures.
- An emergency response plan for safe and effective responses to emergencies, including the necessary PPE and other equipment.
- Confined space entry procedures.
- A spill containment program.
- Pre-entry briefing. The SHP shall provide for pre-entry briefings to be held prior to initiating any site activity, and at such other times as necessary to ensure that employees are apprised of the SHP and that this plan is being followed.
- Inspections shall be conducted by the HSM or, in the absence of that individual, another individual who is knowledgeable in occupational safety and health.

During the project, subcontractors must comply with OSHA and EPA standards applicable to this ACMWP, the SHP, and site-specific support documentation. Project subcontractor field personnel are required to be current in HAZWOPER training required under 29 CFR 1910.120(e).

Safety professionals, or their designees, will inspect subcontractor equipment prior to the commencement of work. Any significant health and safety concerns will be identified, and the subcontractor will be allowed to address the concerns. If significant concerns cannot be rectified, this may be cause for termination of the subcontract.

9.0 Schedule

The activities associated with the proposed ACM are comprised of five primary phases: 1) pre-cleanup field screening at currently accessible locations; 2) coordination of fieldwork scheduling with the forthcoming investigation of WSTF wastewater lagoons (WSTF, 2012); 3) pre-ACM planning and preparation; 4) execution of the field cleanup activities; and 5) data assessment and preparation of the remedy completion report detailing the results of the cleanup operations. The schedule for these activities is discussed below.

9.1 Pre-Cleanup Field Screening

Following NMED review and approval of this ACMWP, NASA must perform the required pre-cleanup field screening described in Section 5.1. In order to perform field screening, necessary instruments must be obtained and required training and familiarization offered to field personnel. The services of an off-site chemical analytical laboratory must be secured to provide for the analysis of soil samples collected during field screening. WSTF internal access and resource requirements must be determined and coordinated. NASA anticipates that field screening can be completed within 120 days of approval of this work plan, with the exception of the portion of the STGT firing range that currently lies beneath the STGT wastewater lagoon (Section 4.2.6). Completing the field screening to the extent practical prior to initiating ACM fieldwork will allow NASA to more quickly execute ACM fieldwork at each firing, ensuring that cleanup activities at each site will be completed with 180 days as required.

9.2 Fieldwork Schedule Coordination

Accelerated corrective measures will be difficult to fully implement at the STGT firing range until investigation fieldwork at the STGT wastewater lagoon (NASA, 2012) has been completed (Section 4.2.6). In order to ensure that ACM fieldwork is completed as quickly as possible at each unit and within 180 days as required by the Permit (Section VII.L; NMED, 2009), fieldwork may be performed at the 200 Area firing range (SWMU 30) and the WB-2 firing range (SWMU 31) on a separate schedule than fieldwork at the STGT firing range (SWMU 29). ACM fieldwork at the STGT firing range must be closely coordinated with the investigation of the STGT wastewater lagoon (AOC 51) to minimize schedule and logistical conflicts between the two projects. The exact date upon which discharges to the WSTF wastewater lagoons will cease, and their closure and investigation will begin, is currently unknown. NASA will closely monitor the progress of the sanitary sewer project and coordinate firing range ACM fieldwork accordingly. NASA will continue to provide regular updates on the progress of the sanitary sewer project and its impacts on planned firing range cleanup work in the Monthly Environmental Activity Report.

9.3 Pre-ACM Planning and Preparation

Following NMED review and approval of this ACMWP, NASA must complete several important activities prior to the initiation of ACM fieldwork. First, as described in the preceding section, schedule issues associated with the closure and investigation of the STGT wastewater lagoon (AOC 51) must be resolved. NASA expects to begin pre-ACM planning and preparation at the 200 Area and WB-2 firing ranges following completion of pre-cleanup field screening (Section 9.1). Resource requirements must be clearly identified and scheduled using the established NASA process for planning, funding, and executing work at WSTF. The required off-site resources must be coordinated. NASA expects to perform these activities within 90 days of completion of pre-cleanup field screening. Pre-ACM planning activities at the STGT firing range will be coordinated with the investigation of the STGT wastewater lagoon. As closure and investigation of the lagoon nears completion, NASA will begin pre-ACM planning and preparation. Any remaining field screening activities must be performed, and specific elements of this plan updated accordingly. In addition, further support from off-site resources must be coordinated. NASA expects these activities to be complete approximately 90 days following closure of the STGT wastewater lagoon.

9.4 ACM Fieldwork

Accelerated corrective measures will be initiated following completion of the planning and preparation activities described above. As with planning and preparation, ACM fieldwork at the STGT firing range may be performed on a slightly delayed schedule because of potential conflicts with the planned investigation and closure of the STGT wastewater lagoon. NASA anticipates that ACM fieldwork will be completed within 180 days of initiation at each unit as required by the Permit (NMED, 2009; Section VII.L). Unforeseen field conditions, off-site resource availability, delays in completion of final field screening and planning activities, or other complications possibly impacting this schedule will be discussed with NMED as they arise to determine the best resolution.

9.5 Data Assessment and Reporting

NASA expects to complete ACM fieldwork within 180 days of initiation at each unit. NASA will notify NMED when ACM fieldwork is complete at each unit. Chemical analytical data from samples collected at each unit during the investigation should be fully available for verification and validation by NASA scientists within 30 days of the completion of field activities at the respective SWMU. These data will be evaluated as previously described, a process that typically requires up to two months. Additional resources, guidance, or supporting data will also be assessed and utilized to support the investigation. The

results of these evaluations will be incorporated into a final remedy completion report for submittal to NMED within 120 days of completion of ACM fieldwork at the final firing range. Unforeseen delays in the completion of field investigation activities or data evaluation may adversely impact the completion of the report on this schedule and will be discussed with NMED as soon as possible upon NASA becoming aware of a problem.

10.0 References

ASTM. (2008). *ASTM D5088-02(2008), Standard Practice for Decontamination of Field Equipment Used at Waste Sites*. ASTM International, West Conshohocken, PA.

Elliot, H. A., Liberati, M. R., & Huang, C. P. (1986). Competitive adsorption of heavy metals by soils. *Journal of Environmental Quality*, 15: 214 – 219.

EPA. (1992, October). Behavior of Metals in Soils. EPA/540/S-92/018.

EPA. (2005, March). Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs. Final Version 1. Uniform Federal Policy for Quality Assurance Project Plans. Part 1: UFP-QAPP Manual. United States Environmental Protection Agency Publication Number EPA-505-B-04-900A. Intergovernmental Data Quality Task Force. http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf

EPA. (2006, February). Guidance on Systematic Planning Using the Data Quality Objectives Process. Environmental Protection Agency QA/G-4. Washington, DC.

EPA. (2013, September). SW-846-Test Methods for Evaluating Solid Wastes Physical/Chemical Methods. Environmental Protection Agency. Accessed from: http://www.epa.gov/osw/hazard/testmethods/sw846/online/

ITRC. (2003, January). *Characterization and Remediation of Soils at Closed Small Arms Firing Ranges*. Interstate Technology and Regulatory Council, Washington, DC.

NASA. (1996, March 1). *Submittal of Draft RCRA Facility Investigation (RFI) and Corrective measures Study (CMS) Reports*. NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (2012, October 15). *NASA White Sands Test Facility (WSTF) Wastewater Lagoon Areas Closure Investigation Work Plan and Wastewater Lagoon Areas Historical Information Summary*. NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (2013, January). *200 Area Phase I Investigation Report.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (2014, December 17). *NASA-Initiated Interim Measures at SWMUs 29-31*. NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (2015a, January 14). *NASA-Initiated Accelerated Cleanup Process at SWMUs 29-31*. NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (2015b, February). *Small Arms Firing Ranges (SWMUs 29-31) Historical Information Summary*. NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NMED. (2009, November). *Hazardous Waste Permit, EPA ID No. NM8800019434, to United States National Aeronautics and Space Administration for the White Sands Test Facility Located in Doña Ana County, New Mexico*. Prepared by the New Mexico Environment Department Hazardous Waste Bureau, Santa Fe, NM.

NMED. (2014, December 24). *Risk Assessment Guidance for Site Investigations and Remediation*. New Mexico Environment Department, Santa Fe, NM.

Occupational Safety and Health Standards, 29 C.F.R. § 1910.120 (2015).

Seager, W. (1981, May). *Geology of Organ Mountains and Southern San Andres Mountains, New Mexico, Memoir 36*, New Mexico Bureau of Mines & Mineral Resources, Socorro, NM.

USDA. (1976). *Soil Survey of White Sands Missile Range, New Mexico*. United States Department of Agriculture Natural Resources Conservation Service, Washington DC.

USDA. (1999). *Soil Taxonomy, A Basic System of Soil Classification for Making and Interpreting Soil Surveys*. United States Department of Agriculture Natural Resources Conservation Service, Washington DC.

Figures

Figure 1.1 **WSTF Location Map**

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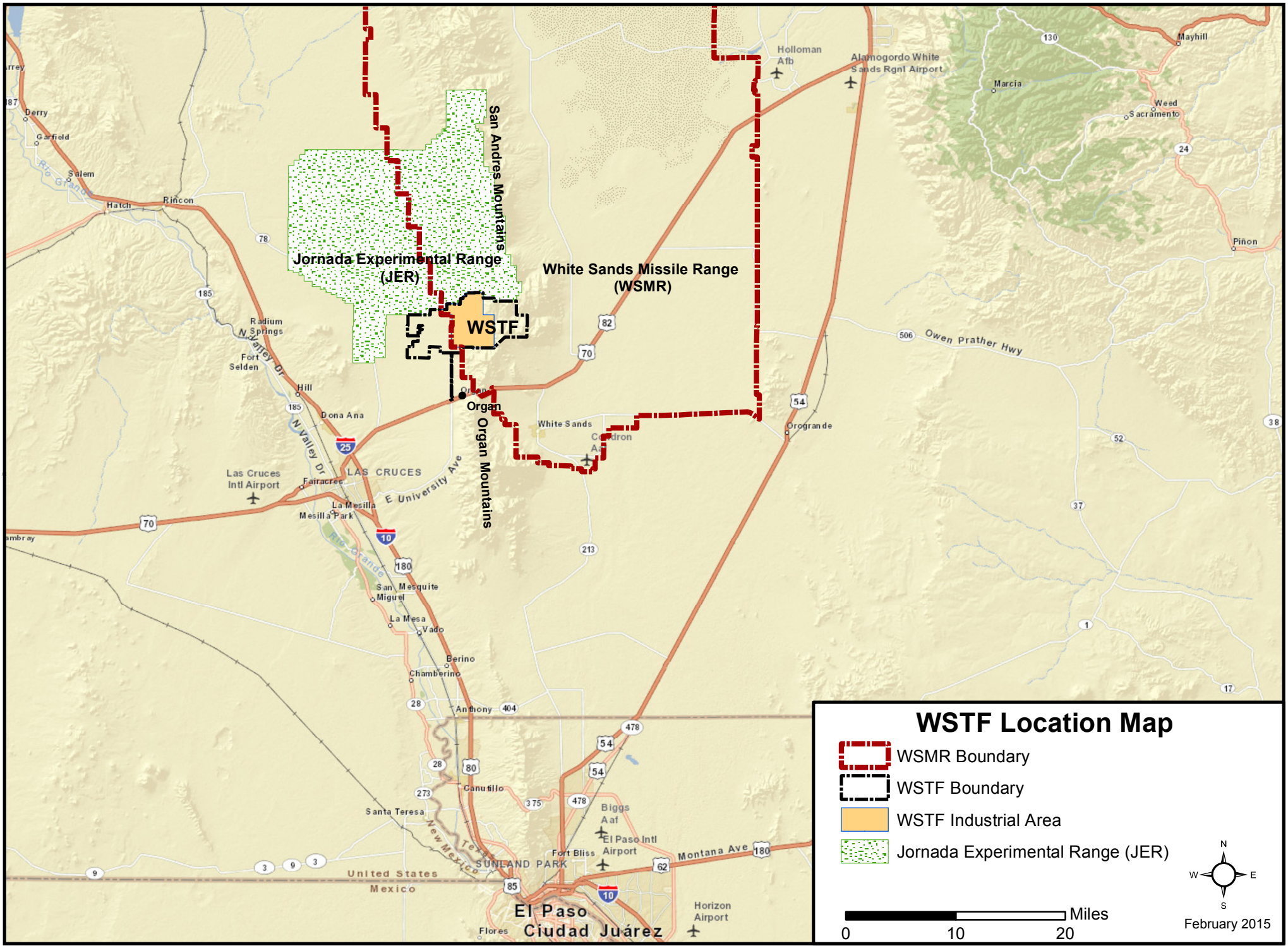
WSTF Location Map
WSMR Boundary
WSTF Boundary
WSTF Industrial Area
Jornada Experimental Range (JER)
Miles
0
10
20
N
S
E
W
February 2015
Jornada Experimental Range (JER)
San Andres Mountains
White Sands Missile Range (WSMR)
WSTF
Organ
Organ Mountains
Holloman Afb
Alamogordo White Sands Rgnl Airport
Mayhill
Marcia
Weed
Sacramento
Piñon
Owen Prather Hwy
Orogrande
White Sands
Cloudcroft
Derry
Garfield
Salem
Hatch
Rincon
Radium Springs
Fort Selden
N Valley Dr
Hill
Dona Ana
Las Cruces Intl Airport
LAS CRUCES
Fairacres
La Mesilla
Mesilla Park
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Rio Grande
San Miguel
Mesquite
La Mesa
Vado
Berino
Chamberino
Anthony
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Santa Teresa
New Mexico
Texas
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Fort Bliss
SUNLAND PARK
Montana Ave
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Flores
Horizon Airport

Figure 2.1 Locations of WSTF and STGT Firing Ranges Relative to Other WSTF Features

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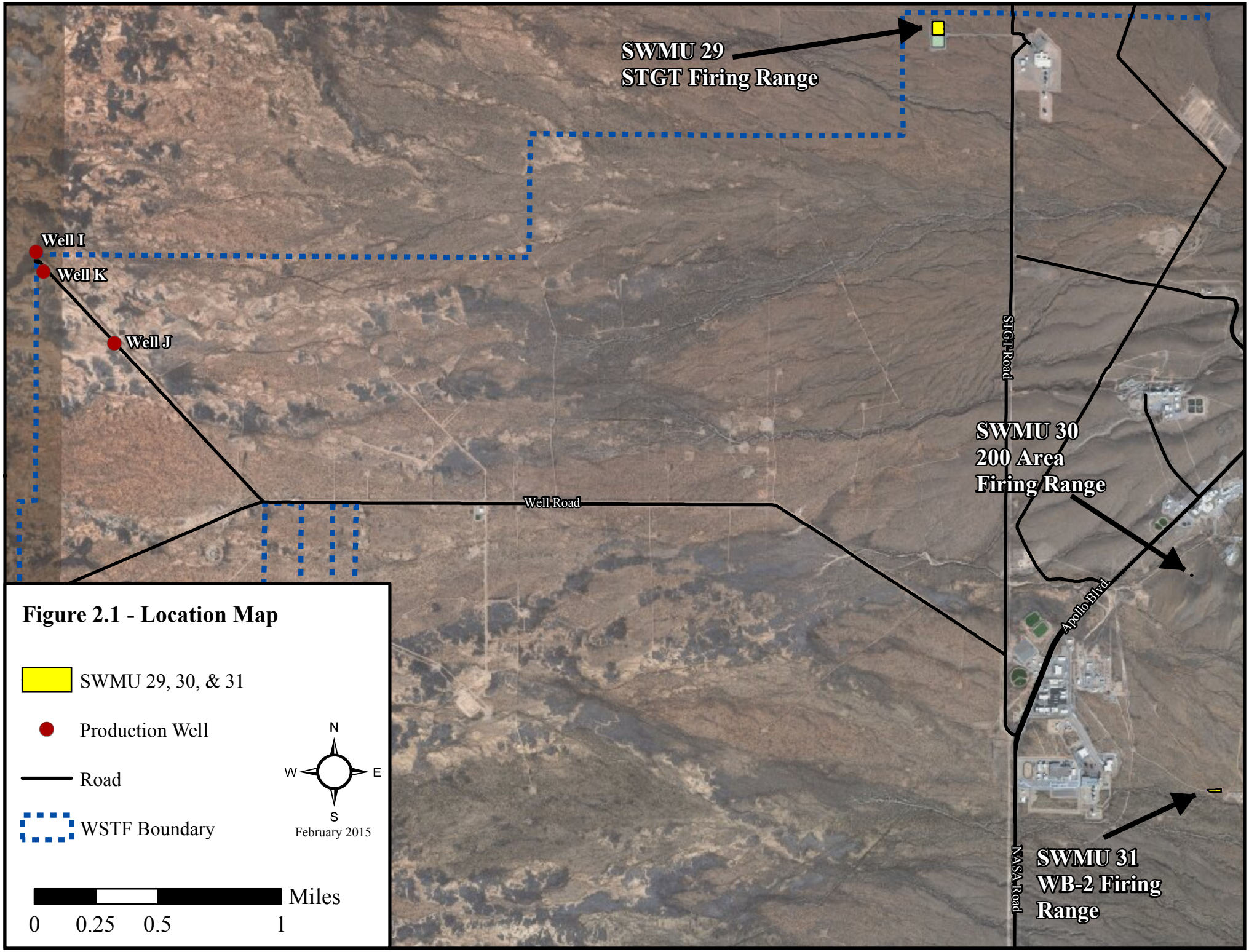

Figure 2.1 - Location Map

Figure 2.2 WSTF and STGT Firing Range Features

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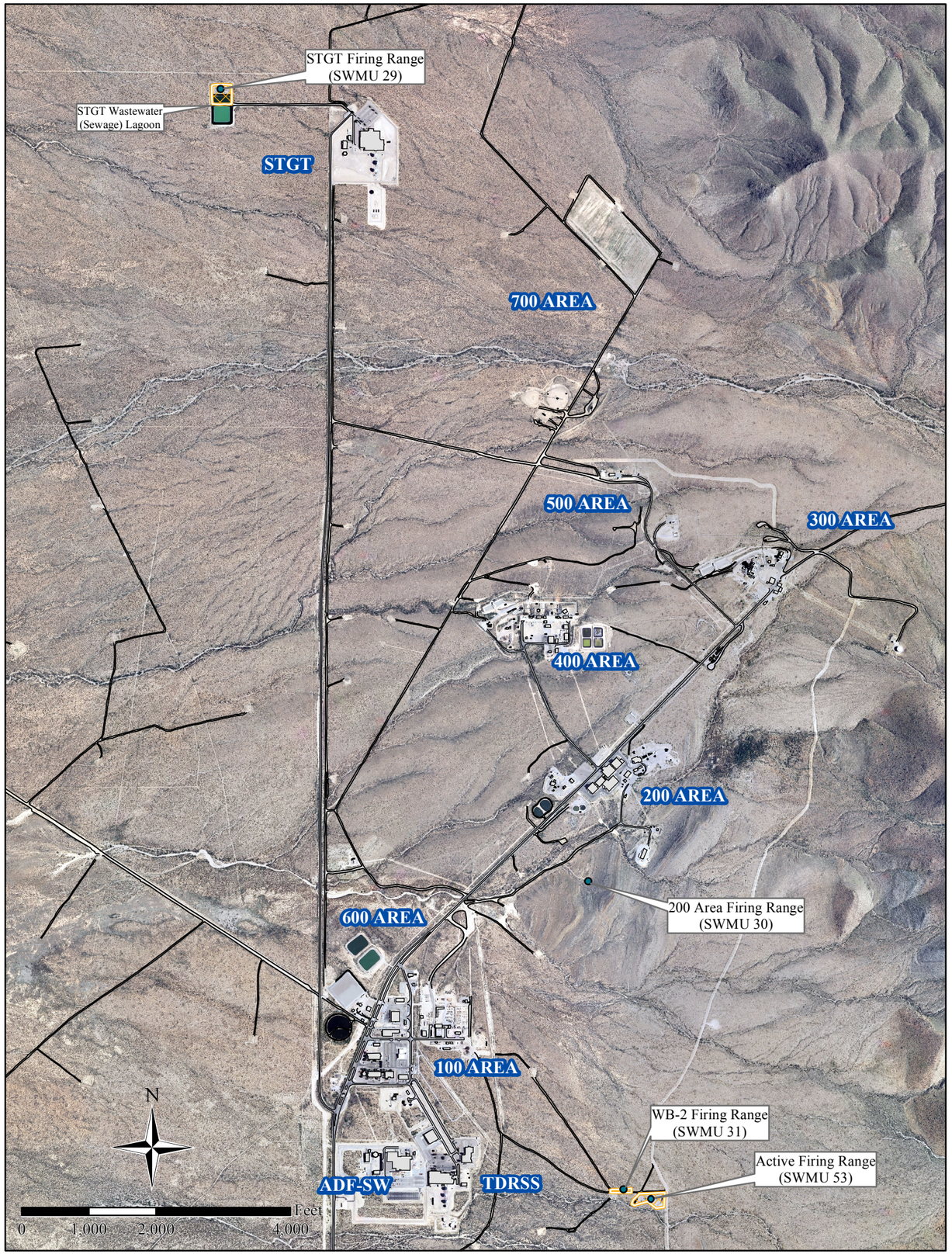
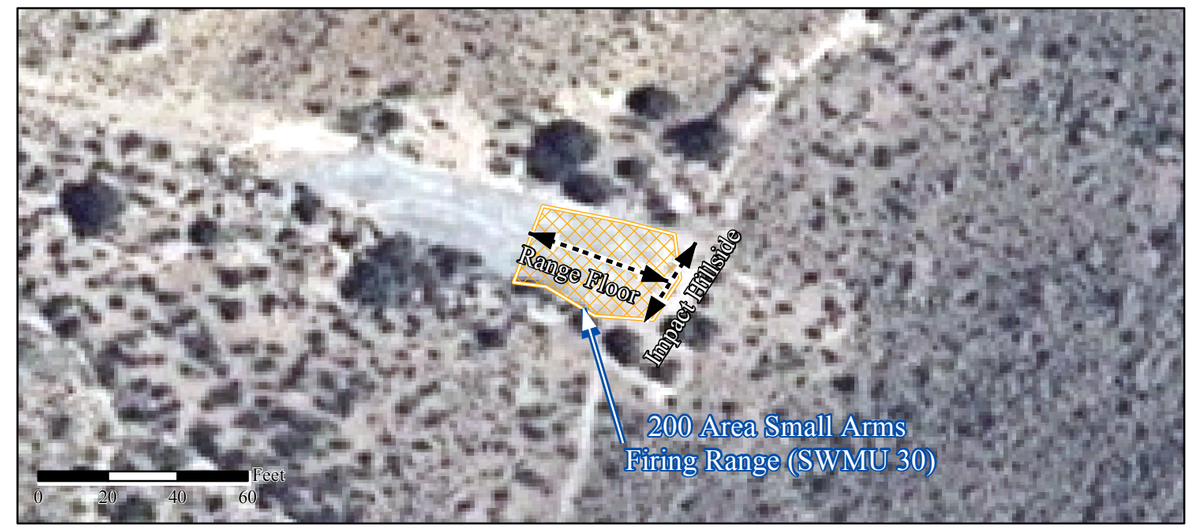

STGT Firing Range
(SWMU 29)
STGT Wastewater
(Sewage) Lagoon
STGT
700 AREA
500 AREA
300 AREA
400 AREA
200 AREA
200 Area Firing Range
(SWMU 30)
600 AREA
100 AREA
WB-2 Firing Range
(SWMU 31)
Active Firing Range
(SWMU 53)
ADF-SW
TDRSS
N
0
1,000
2,000
4,000
Feet


Impact Berm
Range Floor
STGT Small Arms Firing
Range (SWMU 29)
0
100
200
300
Feet


Range Floor
Impact Berm/side
200 Area Small Arms
Firing Range (SWMU 30)
0
20
40
60
Feet

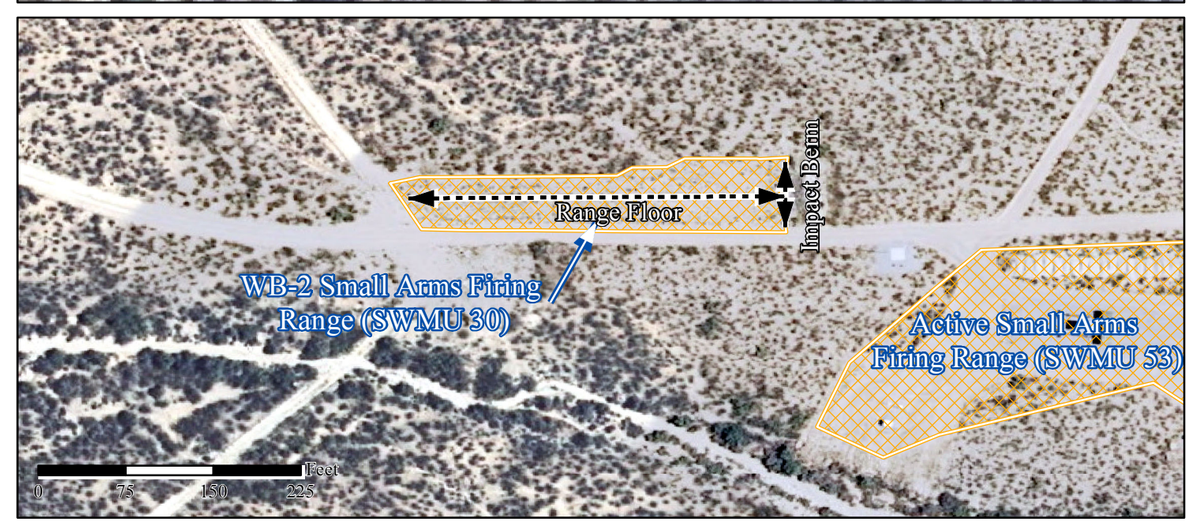

Range Floor
Impact Berm
WB-2 Small Arms Firing
Range (SWMU 30)
Active Small Arms
Firing Range (SWMU 53)
0
75
150
225
Feet

Figure 2.3 Site Conceptual Exposure Model (SCEM)

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Figure 2.3 Site Conceptual Exposure Model (SWMUs 29-31)

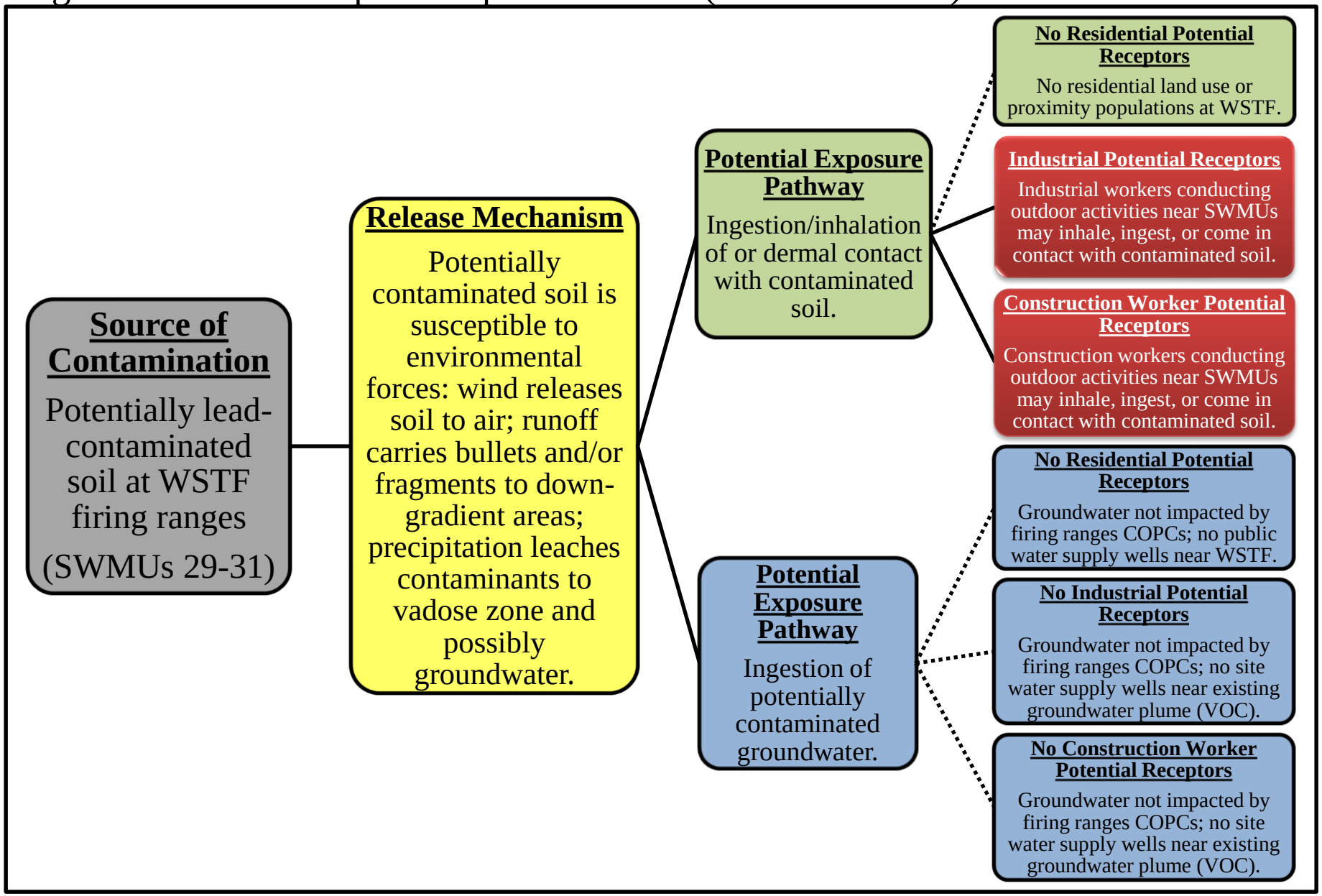

Figure 5.1 STGT Firing Range (SWMU 29) Field Screening and Sampling Locations

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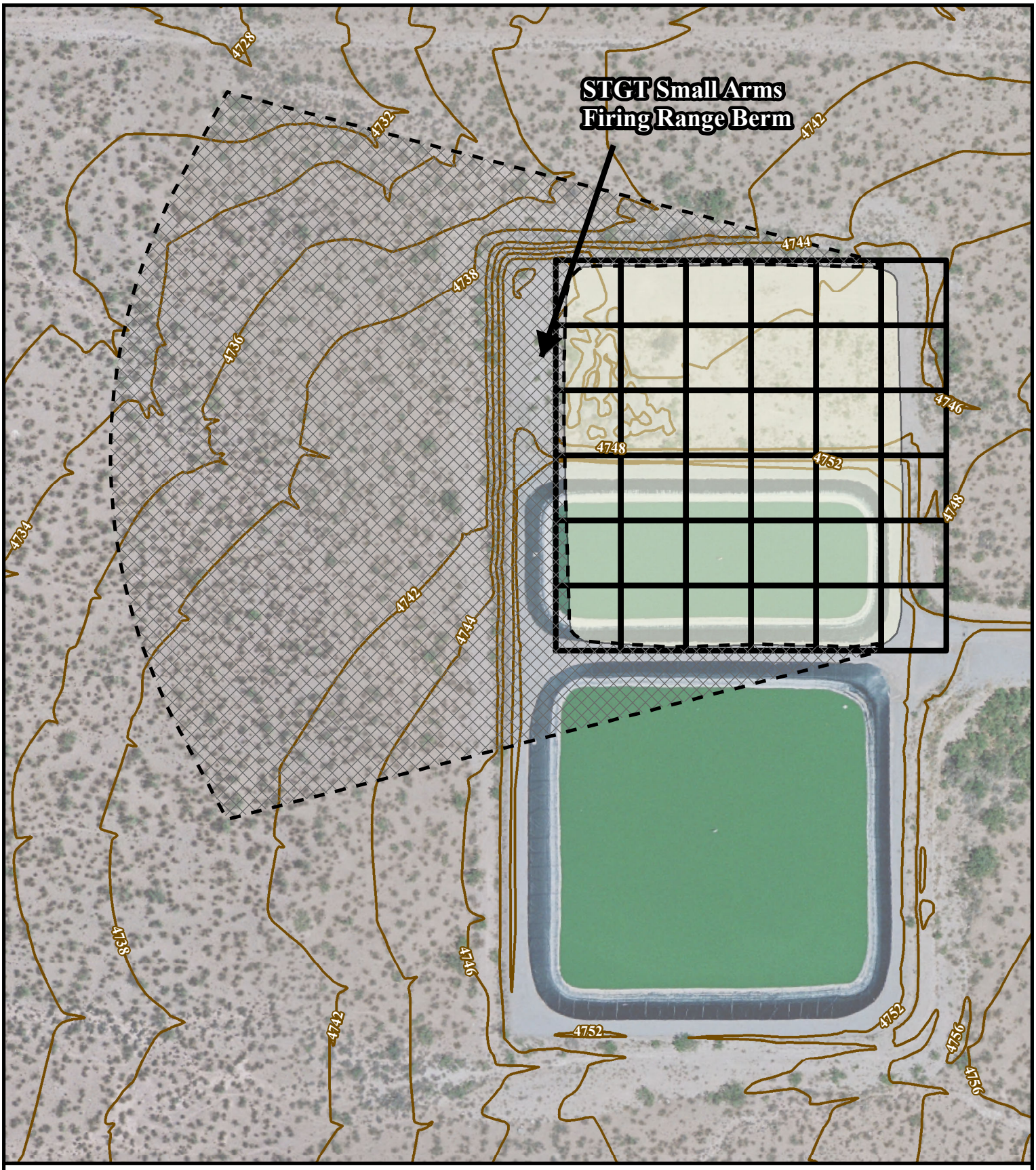

Figure 5.1 - STGT Small Arms Firing Range (SWMU 29)

Preliminary Sampling Grid 50' x 50'

Potential Fallout Area

STGT Firing Range Extent

Topographic Contour (2 ft. Interval)

0 75 150 300 Feet

N W E S

February 2015

Figure 5.2 200 Area Firing Range (SWMU 30) Field Screening and Sampling Locations

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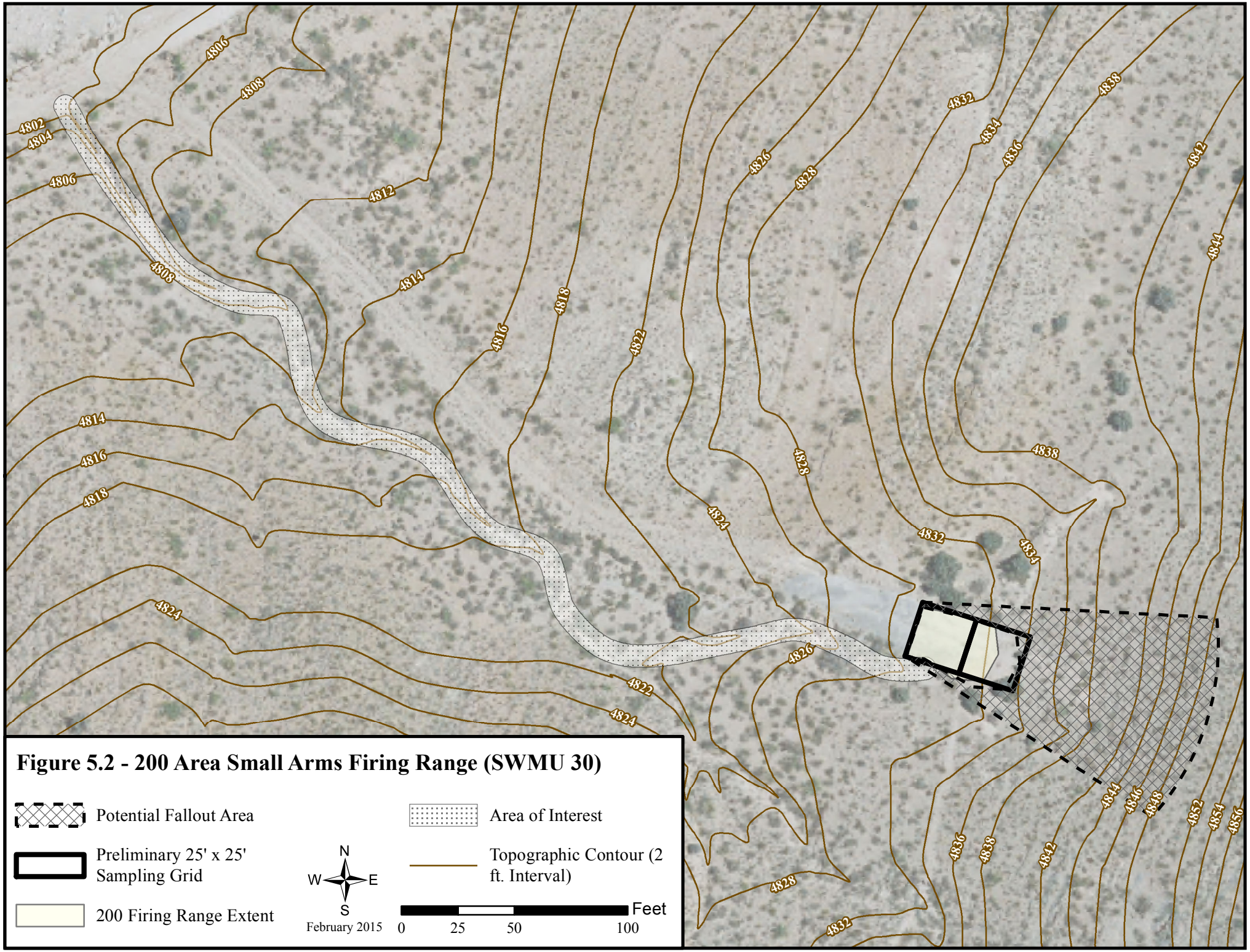

Figure 5.2 - 200 Area Small Arms Firing Range (SWMU 30)

Figure 5.3 WB-2 Firing Range (SWMU 31) Field Screening and Sampling Locations

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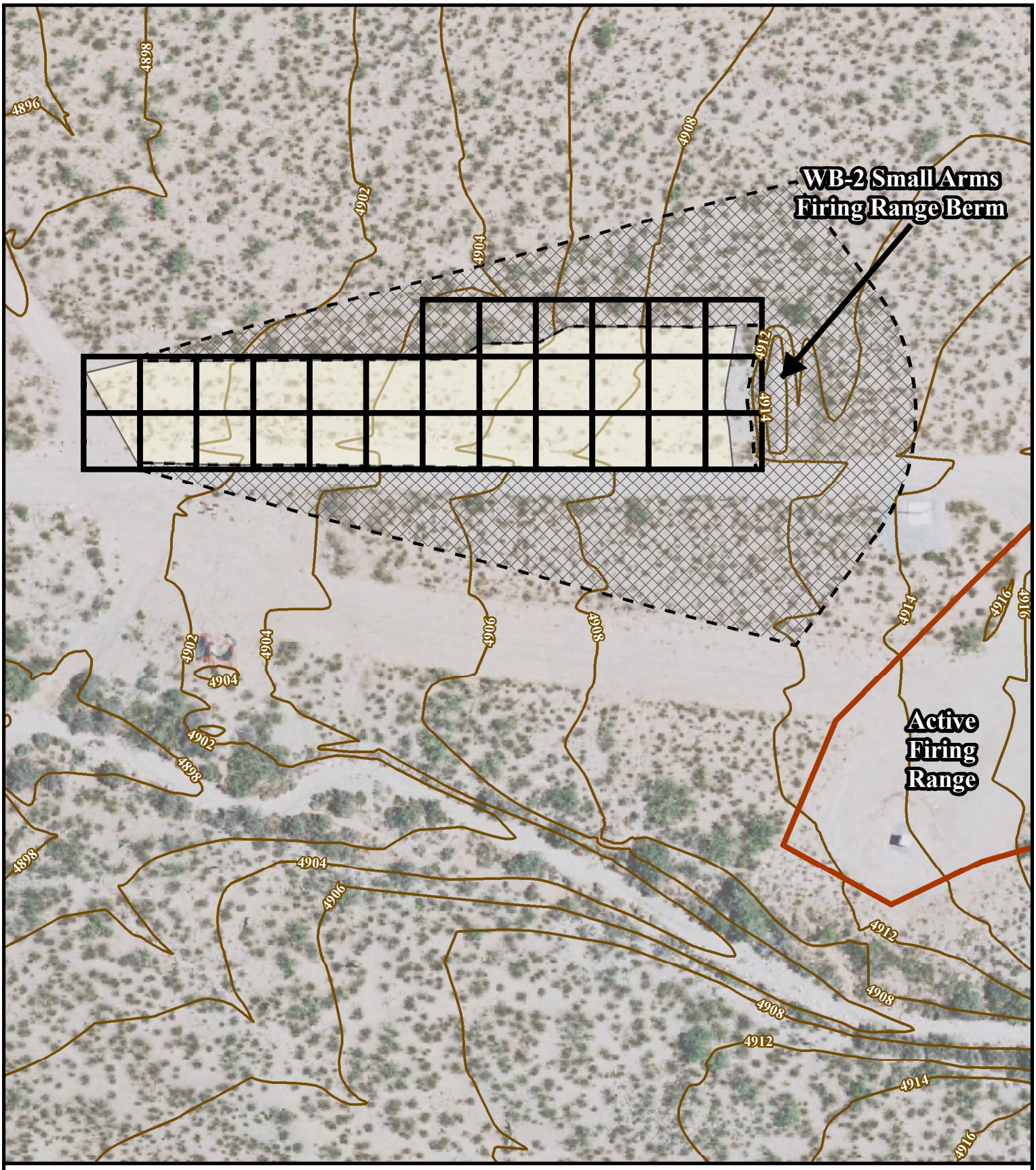

WB-2 Small Arms Firing Range (SWMU 31)

Preliminary 25' x 25' Sampling Grid

WB-2 Firing Range Extent

Potential Fallout Area

Active Firing Range Extent

Topographic Contour (2 ft. Interval)

Feet
0 25 50 100

N
W E
S

February 2015

Figure 5.4 STGT Firing Range Impact Berm Currently within Wastewater Lagoon (view to the west)

Figure 5.5 STGT Firing Range Impact Berm and Range Floor (view to the west)

Figure 5.6 STGT Firing Range Impact Berm (Close-up, view to the west)

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Table 2.1 Contaminants of Potential Concern (COPC) Regulatory Criteria, and Analytical Methods

COPC	NMSSL (2014) Industrial/Occupational (mg/kg)	NMSSL (2014) Construction Worker (mg/kg)	Anticipated Analytical Method
Lead	800	800	SW 846 Method 6010C
Antimony	519	142	SW 846 Method 6010C
Arsenic	21.5	57.4	SW 846 Method 6010C
Copper	51,900	14,200	SW 846 Method 6020A
Zinc	389,000	106,000	SW 846 Method 6010C
Iron	908,000	248,000	SW 846 Method 6010C
Tin	70,000 (EPA RSL, Jan 2015)	None Listed	SW 846 Method 6010C

Appendix A
Waste Management Plan

National Aeronautics and
Space Administration

Small Arms Firing Ranges

(SWMUs 29-31)

Waste Management Plan

January 2015

NM8800019434
NASA Johnson Space Center White Sands Test Facility
12600 NASA Road Las Cruces, New Mexico 88012

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List of Acronyms

ACM	Accelerated corrective measures
CFR	Code of Federal Regulations
COPC	Contaminants of potential concern
DOT	Department of Transportation
EPA	Environmental Protection Agency
FR	Federal Register
HIS	Historical Information Summary
IDW	Investigation-Derived Waste
MSDS	Material safety data sheets
NASA	National Aeronautics and Space Administration
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
PPE	Personal protective equipment
RCRA	Resource Conservation and Recovery Act
STGT	Second TDRSS Ground Terminal
SWMU	Solid Waste Management Unit
TCLP	Toxicity Characteristic Leaching Procedure
TDRSS	Tracking Data Relay Satellite System
WMP	Waste Management Plan
WSTF	White Sands Test Facility

1.0 Waste / Activity Description

The National Aeronautics and Space Administration (NASA) Johnson Space Center (JSC) White Sands Test Facility (WSTF) will perform accelerated corrective measures (ACM) at three small arms firing ranges at WSTF or adjacent complexes. Solid Waste Management Units (SWMU) 29 (Small Arms Range at Second Tracking and Data Relay Satellite System [TDRSS] Ground Terminal [STGT]), 30 (200 Area Small Arms Range), and 31 (WB-2 Small Arms Firing Range) will be cleaned up in accordance with the *NASA WSTF Small Arms Firing Ranges (SWMUs 29-31) Accelerated Corrective Measures Work Plan* (NASA, 2015). The objective of the ACM is to remove and recycle spent ammunition scraps/fragments and then verify that the soils within and adjacent to SWMUs 29-31 do not contain residual contamination that presents a risk to human health and the environment. At SWMUs 29-31, NASA will perform field screening and soil sampling to characterize the extent of potential contamination and to confirm that planned ACM activities successfully meet project objectives. In accordance with the WSTF Hazardous Waste Permit (NMED, 2009) Attachment 20, section 20.2.13, a discussion of Investigation-Derived Wastes (IDW) shall be provided with every work plan submitted. However, since the ACM activities do not constitute an investigation, a Waste Management Plan (WMP) will be submitted in lieu of the IDW management plan. This WMP will address the characterization, management, and disposal of wastes that will be generated from ACM activities.

Various types of wastes are expected to be generated from ACM activities at SWMUs 29-31. For the purpose of this WMP, the types of waste anticipated are identified as:

- Metal ammunition scraps/fragments.
- Environmental media – soil spoils from mechanical separation of bullets and bullet fragments from soils at the firing ranges.
- Decontamination water.
- Sampling debris:
    - Non-dedicated sampling equipment.
    - PPE.
    - Plastic tarps or sheeting.
    - Rags.
    - Other debris contaminated by soil or fluids.
    - Equipment maintenance wastes (e.g., grease, contaminated rags, oil, diesel, soil contaminated with hydraulic fluids, etc.)

2.0 Waste Characterization (Acceptable Knowledge)

The metal ammunition scraps/fragments will be characterized using acceptable knowledge and representative material safety data sheets (MSDS) and/or safety data sheets (SDS). NASA intends to recycle the metal ammunition per 40 CFR§261.6(a)(3)(ii) which states: "…any hazardous scrap metal that is sent for recycling/reclamation is exempt from the hazardous waste management requirements, including storage prior to reclamation, manifesting, and the land disposal restrictions." Additionally, as outlined in 62 FR 25998 (1997), processed scrap metal is exempted from RCRA regulation (i.e., is not a RCRA solid waste) when it is being recycled. Furthermore, the exemption is viewed prospectively. In other words, as long as the generator intends to recycle the scrap metal at some point in the future, the

scrap metal is exempt from the hazardous waste regulations (McCoy, 2013). Therefore NASA will manage the metal ammunition scraps/fragments as solid waste for recycle.

Based on regulatory guidance (McCoy, 2013), environmental media (soil or sand) that remains from the mechanical separation of bullets and bullet fragments, is to be addressed similarly to military ranges in the military munitions rule 62 FR 6622 (1997). In this rule, EPA noted that range clearing activities such as recovering lead shot/bullets as an intrinsic part of the range use and are therefore excluded from RCRA Subtitle C regulation. In addition, environmental media (soil or sand) or debris shipped off range would have the potential to be subject to RCRA Subtitle C requirements. In other words, as long as NASA replaces the environmental media (soil or sand) onto the firing ranges, and does not remove it off range or off site, the environmental media (soil or sand) is not subject to RCRA Subtitle C requirements. Therefore, NASA will manage to environmental media as unregulated material.

Decontamination water generated during the decontamination activities of tools, non-disposable sampling equipment, and excavation equipment will be characterized and managed as non-hazardous solid waste with the knowledge that the typical leaching agent used to extract metals from soils would require a pH of 5.0 or lower. The water used for decontamination activities is a pH neutral media that could not leach metal from the soils or from the equipment. Thus, the decontamination water could not contain metal concentrations which exceed the maximum concentration of contaminants for the contaminants of potential concern (COPC) metal constituents found in Table 1 of 40 CFR 261.24 (lead [D008]: 5.0 mg/L; arsenic [D004]: 5.0 mg/L). Therefore, the debris generated will be generator declared non-hazardous, solid waste.

Other wastes generated such as non-dedicated disposable sampling equipment, personal protective equipment, plastic sheeting, rags, and other debris will be characterized using acceptable knowledge. The debris generated will be characterized and managed as non-hazardous, solid waste with the knowledge that even when coming into contact with the ammunition fragments/scraps or environmental media, the debris will not exhibit the characteristic of toxicity and could not exceed the maximum concentration of contaminants for the COPC metal constituents found in Table 1 of 40 CFR 261.24 (lead [D008]: 5.0 mg/L; arsenic [D004]: 5.0 mg/L).

3.0 Waste Management

During the implementation of ACM, all waste generated will be accumulated and immediately placed into compatible, appropriately-sized containers which meet the Department of Transportation (DOT) container specifications. As a best management practice, the waste containers will be managed in accordance with WSTF Standard Instruction (WSI) 22-SW-0005.E (or most recent version) Waste Management Procedures. This includes, but is not limited to, container content labels, waste profile sheets, container logbooks, and designated accumulation areas.

4.0 Waste Disposal

Waste ammunition scraps/fragments will be sent off site to a coordinated recycling agent.

Decontamination water and debris (non-dedicated disposable sampling equipment, personal protective equipment, etc.) will be disposed of in accordance with New Mexico Solid Waste Regulations.

Any materials, equipment, and structures associated with the ACM (e.g., plastic sheeting) will be evaluated for potential recycling or reuse.

5.0 References

Identification and Listing of Hazardous Waste, 40 C.F.R. §261 (2014). Retrieved from http://www.ecfr.gov/

Land Disposal Restrictions Phase IV: Treatment Standards for Wood Preserving Wastes, Paperwork Reduction and Streamlining, Exemptions from RCRA for Certain Processed Materials, and Miscellaneous Hazardous Waste Provisions, 62 Fed. Reg. 25998 (05/12/1997).

McCoy's RCRA Reference. (2013 ed.). *Lead Shot Reclaimed from Shooting Ranges*. Lakewood, CO.

Military Munitions Rule: Hazardous Waste Identification and Management; Explosives Emergencies; Manifest Exemption for Transport of Hazardous Waste on Right-of-Ways on Contiguous Properties, 62 Fed. Reg. 6622 (02/12/1997).

NASA. (2015, February). *NASA WSTF Small Arms Firing Ranges (SWMUs 29-31) Accelerated Corrective Measures Work Plan.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NMED. Hazardous Waste Bureau. (2009, November). *Hazardous Waste Permit EPA ID No. NM8800019434 to United States National Aeronautics and Space Administration for the White Sands Test Facility Location in Doña Ana County, New Mexico. Permit Attachment 12.* Santa Fe, NM.

National Aeronautics and
Space Administration

Small Arms Firing Ranges (SWMUs 29-31)

Historical Information Summary

February 2015

NM8800019434
NASA Johnson Space Center White Sands Test Facility
12600 NASA Road Las Cruces, New Mexico 88012

This report summarizes information regarding historical site operations, facilities, and security management practices in order to identify any releases of hazardous substances to the environment from three historical small arms firing ranges used at the National Aeronautics and Space Administration (NASA) White Sands Test Facility (WSTF). This summary facilitated the development of the Small Arms Firing Ranges (SWMUs 29-31) Accelerated Corrective Measures Work Plan (SWMUs 29-31 ACMWP; NASA, 2015b), required on or before February 28, 2015 by the New Mexico Environment Department (NMED).

There are three existing small arms firing ranges: two at WSTF and one at the White Sands Complex (WSC; consisting of the Tracking and Data Relay Satellite System [TDRSS] and Second TDRSS Ground Terminal [STGT] facilities). Firearms usage was not well documented at WSTF and WSC. However, NASA has researched existing historical records and conducted interviews of both former and current long-term employees in order to determine usage details. The historical small arms firing ranges, operational periods, and associated Solid Waste Management Unit (SWMU) numbers as listed in the Permit are:

- Second Tracking and Data Relay Satellite System (TDRSS) Ground Terminal (STGT) firing range: 1992-1999, designated as SWMU 29
- 200 Area firing range: 1964-1990, designated as SWMU 30
- Westbay (WB)-2 firing range: 1990-1995; 1999-2000, designated as SWMU 31

The STGT small arms firing range (SWMU 29) was located within the north cell of the STGT wastewater (sewage) lagoon. The north lagoon cell was not originally used for wastewater due to clay liner leakage during initial lagoon construction and testing. The north cell dimensions were 256 feet (ft) by 256 ft, and the entire area was used as the firing range. The lagoon walls were approximately 7 ft high, and the west wall/berm was used as the backstop for the STGT small arms firing range. In 1996, the south half of the north lagoon cell was synthetically lined and put into service for sanitary wastewater. However, the remaining northern half of the north cell continued use as a small arms firing range with reduced dimensions of 128 ft by 256 ft. Mostly White WSC, TDRSS and STGT personnel used the STGT small arms firing range (SWMU 29).

The 200 Area small arms firing range (SWMU 30) was located south of the main 200 Area buildings, in between the 200 and 100 Areas at WSTF. This range was 50 ft by 50 ft, sloping up to the east, and located adjacent to an arroyo. The natural, coarse-grained hillside to the east was used as the range backstop. However, the hillside would slough when it rained, causing the firing range to wash out and requiring excavation prior to continued range use. This maintenance issue resulted in the construction of the WB-2 small arms firing range. Use of the 200 Area small arms firing range ceased at WSTF when use of the WB-2 small arms firing range initiated. Both WSC and WSTF security personnel used the 200 Area small arms firing range (SWMU 30).

The WB-2 small arms firing range (SWMU 31) was located east of the TDRSS facility in the 100 Area, directly adjacent to groundwater monitoring wells 100-E-261 and WB-2, from which the range name was derived. This area was specifically designed to be a small arms firing range, with a flat, cleared area, and a 7 ft high by 30 ft long berm formed on the east side of the range towards the mountains. Mostly WSTF security personnel used this range.

For all the firing ranges, lead bullets, with and without copper jackets, were fired into targets set up in front of the berms or hillside. The purpose of these firing ranges was to provide areas where personnel performing security functions could become familiar with, practice, and qualify for security service using handguns with small caliber bullets (.357 Magnum, .38 Special, and 9 mm). The exact amount of lead

ammunition fired within these ranges is unknown; however, using information obtained from employees, the approximate amount of lead estimated at each firing range is:

- STGT small arms firing range (SWMU 29): ~1,370 lbs;
- 200 Area small arms firing range (SWMU 30): ~1,500 to ~2,250 lbs (The minimum represents qualifications only and the maximum represents qualifications and estimated practice firing); and
- WB-2 small arms firing range (SWMU 31): ~570 lbs.

The amount of lead estimated to be present in the STGT small arms firing range can be categorized by the area used. From 1992 to 1996, the entire STGT lagoon was used as the firing range. For that original larger firing range, approximately 240 lbs of lead was estimated discharged. From 1996 to 1999, only the northern half of the north lagoon cell was used as the firing range; however 31,000 rounds from ADF-SW qualifications are included for a larger amount of ~1,130. No clean-up activities have been completed at any of the historical firing ranges (SWMUs 29-31) to date.

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List of Acronyms

ACMWP	Accelerated Corrective Measures Work Plan
ADF-SW	Aerospace Data Facility – Southwest
amsl	Above mean sea level
AOC	Area of Concern
BLM	Bureau of Land Management
DoD	Department of Defense
DP	Discharge Plan
DR	Discrepancy Report
EPA	Environmental Protection Agency
ETU	Evaporative Tank Unit
ft	Foot or feet
gal.	Gallon(s)
HIS	Historical Information Summary
HWMU	Hazardous Waste Management Unit
In.	Inch(es)
JER	Jornada Experimental Range
JSC	Johnson Space Center
lbs	pounds
MSDS	Material Safety Data Sheet(s)
n.t.	No title
N_2O_4	Nitrogen tetroxide
NASA	National Aeronautics and Space Administration
NMED	New Mexico Environment Department
NMEID	New Mexico Environmental Improvement Division
NMSLO	New Mexico State Land Office
NOD	Notice of Disapproval
Permit	Hazardous Waste Operating Permit
PVC	Polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SAM	San Andres Mountains
STGT	Second TDRSS Ground Terminal
SWMU(s)	Solid Waste Management Unit(s)
TDRSS	Tracking and Data Relay Satellite System
TPS	Test Preparation Sheet
UST	Underground Storage Tank
WB	Westbay
WSC	White Sands Complex
WSMR	White Sands Missile Range
WSTF	White Sands Test Facility

1.0 Introduction

1.1 Purpose

The National Aeronautics and Space Administration (NASA) Johnson Space Center (JSC) White Sands Test Facility (WSTF) Hazardous Waste Permit (Permit; NMED, 2009) issued by the New Mexico Environment Department (NMED) requires the preparation and submittal of a historical information summary (HIS) for each solid waste management unit (SWMU) or Area of Concern (AOC) to be investigated (NMED, 2009, Section VII.H.1.c). The purpose of this HIS is to evaluate past site operations and waste management practices to identify known or potential releases of hazardous waste or hazardous substances to the environment in or around SWMUs 29-31, the Second Tracking and Data Relay Satellite System (TDRSS) Ground Terminal (STGT), the 200 Area, and the Westbay (WB)-2 firing ranges. The information gathered during preparation of the HIS is usually used to aid the development of an Investigation Work Plan. Both the HIS and Investigation Work Plan for SWMUs 29-31 were required by the Permit to be submitted on or before December 30, 2014; however, NASA chose to submit an Interim Measures Work Plan for SWMUs 29-31, and requested an extension for the work plan and HIS submittal to February 28, 2015. NMED granted the extension, but suggested NASA proceed with the accelerated cleanup process described in the Permit (Section VII.L). The resulting SWMUs 29-31 Accelerated Corrective Measures Work Plan (SWMUs 29-31 ACMWP; NASA, 2015b) will be submitted concurrently with this HIS prior to February 28, 2015.

1.2 Scope

Information compiled in this summary was obtained from review of historical documentation and information gathered from interviews with current and former WSTF employees. NASA collected and reviewed the information in the HIS between October and December 2014.

The observations and interpretations presented in this document are strictly limited in time and scope to the information obtained during the review process. No subsurface exploratory drilling, sampling, or chemical analyses were performed during the course of this evaluation.

1.3 Limitations and Assumptions

WSTF historical operations and waste management practices were not well documented from the inception of the site in 1963 through the mid-1980s. Long-term WSTF personnel stated that historical firearms qualifications records were originally generated describing the number of personnel qualified, the weapons used, the number of rounds expended, and the percent of rounds that struck targets. Purchasing records for ammunition were also historically generated at WSTF. However, none of these records were retained in the permanent WSTF record. For this HIS, NASA relied on a limited assortment of documents, correspondence, and mostly the recollections of long-term WSTF employees to provide history and waste estimates for SWMUs 29-31. The information is subject to the limitations of historical documentation, availability and accuracy of pertinent records, and the personal recollection of the individuals interviewed. In many cases, there is insufficient information available to provide a complete history of the SWMUs or independent verification that the information is accurate and correct.

2.0 Site Description

2.1 Location

WSTF is located in Doña Ana County, 18 miles northeast of Las Cruces, New Mexico and 65 miles north of El Paso, Texas. Figure 2.1 provides a WSTF location map. Access to the site is provided via a paved

road (NASA Road) that intersects U.S. Highway 70, one mile west of Organ, New Mexico. The installation occupies approximately 60,500 acres.

2.2 Land Ownership

WSTF administrative and testing facilities are located on White Sands Missile Range (WSMR), owned by the U.S. Department of the Defense, Department of the Army (DoD; U.S. Army). NASA operates the facility under an inter-agency agreement with the U.S. Army. NASA also maintains land-use agreements with the Bureau of Land Management (BLM; a right-of-way agreement), the New Mexico State Land Office (NMSLO; a water exploration/development easement), and the U.S. Department of Agriculture, Agricultural Research Service Jornada Experimental Range (JER; an easement deed) for the use of lands located to the west of the industrial facility. Figure 2.2 provides an ownership overview of lands used by NASA.

2.3 Land Use

All of the WSTF industrial areas are strictly for industrial use. Security and firefighting personnel staff the facility 24-hours per day, seven days per week; however, there are no full-time residents at WSTF. WSTF is a restricted access area closed to the public, and visitor access is provided only in accordance with NASA JSC policies.

Cattle are grazed on BLM, NMSLO, and JER lands to the south and west of the industrial facilities; however, fences prohibit the cattle from entering the industrial portions of the facility. The DoD U.S. Army, on behalf of NASA, maintains an inter-agency agreement with the BLM to provide a safety or buffer zone adjacent to WSTF that limits land use to ensure public safety due to the dangers involved with using hydrazine-based propellants and nitrogen tetroxide (N_2O_4), an oxidizer. WSMR occupies the area to the north and east of WSTF.

The land designated for WSTF and occupied by NASA and NASA contractors remains vested with the DoD U.S. Army. All permanent buildings, structures, and other related facilities erected in this land area will become the property of the DoD U.S. Army upon termination of their use by NASA (DoD, 1982).

2.4 General Physical Setting

WSTF is located on soil composed of coalescent alluvial fans that are locally dissected by arroyos. The facility is bordered on the east by the north-south trending San Andres Mountains (SAM) that ascend over 6,000 feet (ft) above mean sea level (amsl). The WSTF site is bordered on the west by a broad uniformly sloping alluvial pediment plain extending into the Jornada del Muerto Basin and to the Doña Ana Mountains. The major alluvial fan systems originate from Bear Canyon to the northeast and Loman Canyon to the southeast of WSTF. Foothills on the western pediment of the SAM at WSTF are typically 4,800 to 5,000 ft amsl, are moderately sloping (15 to 25%), and consist of thin layers of alluvium covering fractured limestone and volcanic bedrock. The numerous dissecting arroyos only flow during periods of heavy rainfall. Figure 2.3 provides a topographic map of WSTF and surrounding areas.

3.0 Firing Range Areas Background

3.1 Location and Current Use of the Firing Range Areas

3.1.1 STGT Area

The STGT facility is part of the White Sands Complex (WSC), which includes the TDRSS facility (adjacent to the WSTF 100 Area) and STGT. STGT is located within Sections 26 and 27 of T.20.S., R.3.E. Access to the facility is via NASA Road to the STGT Access Road (Figure 3.1). The WSC (including STGT) comprises part of the Space Network data communication system consisting of satellites in geosynchronous low earth orbit and ground terminals with high-gain microwave antennas that provide telecommunications, tracking and command services between low-Earth orbit spacecraft and customer control and data processing facilities 24 hours per day, 365 days per year (NASA, 2014c 2014b). Buildings, structures, and SWMUs located at the STGT are described in Section 3.3.1.

3.1.2 200 Area

The 200 Area is located within Section 35 of T.20.S., R.3.E., and Section 2 of T.21.S., R.3.E., and access is via Apollo Boulevard, the main access through WSTF (Figure 3.2). Personnel in the 200 Area provide support for the Propulsion Test Department at WSTF, including preparing test articles, performing analytical services, and fabrication and cleaning of aerospace program articles. Personnel in the 200 Area also conduct materials and component testing in hazardous environments, including materials properties determination, materials compatibility and toxicity analyses, detonation studies, flight article outgassing characterization, systems analysis, orbital debris impact simulation testing, and propellant characterization. Five core areas are tested: oxygen systems, propellant systems, hypervelocity impact testing, composite pressure vessels, and standard materials testing (NASA, 2013c). Buildings, structures, and SWMUs located in the 200 Area are described in Section 3.3.2.

3.1.3 100 Area

The 100 Area is located in Section 2 of T.21.S., R.3.E. Access to the 100 Area is via Apollo Boulevard, the main access through WSTF (Figure 3.3). The 100 Area provides administration and support facilities for WSTF. Services provided include printing and drafting services, computer maintenance, emergency and security services, food services, shipping and receiving services, and various maintenance and fabrication services. Buildings, structures, and SWMUs located in the 100 Area are described in Section 3.3.3.

3.2 Physical Setting at the Property

The surface and subsurface conditions for SWMUs 29-31, historical small arms firing ranges, are described within the SWMUs 29-31 ACMWP, Section 3.0 (Site Conditions; NASA, 2015b).

3.3 Description of Structures

Structures located within the three areas containing historical firing ranges are discussed below.

3.3.1 STGT Area

The STGT is part of the TDRSS ground terminal system. The STGT area and SWMUs are illustrated in Figure 3.1. Buildings consist of a main operations building, a power plant, a vehicle maintenance building, a security guard building, and various storage and support buildings. Structures include two

15,000-gallon (gal.) capacity fuel underground storage tanks (USTs), a 300,000-gal. capacity potable water tank, and large antennas for satellite communications.

Facilities are located on concrete or asphalt. Utilities received from the main WSTF industrial areas consist of electrical, communications (fiber optic), gas, and water. The power plant contains heating and cooling systems. Permit Attachment 22 of the NASA WSTF Permit (NMED, 2009) identifies SWMUs and AOCs. There is one SWMU located within the STGT Area, the STGT small arms firing range (SWMU 29). In addition to the SWMU, there are also two AOCs, the STGT wastewater (sewage) lagoon (AOC 51) and the STGT fuel USTs (SWMU 52). The fuel USTs are still in use, and the STGT wastewater lagoon is currently managed in accordance with Discharge Plan (DP)-584 (NMED, 2009).

3.3.2 200 Area

Buildings, structures, and SWMUs located within the 200 Area are illustrated in Figure 3.2. There are three distinct areas within the 200 Area: the laboratory and test preparation complex, the 250 Area, and the 270/272 Area.

The laboratory and test preparation complex consists of Buildings 200 and 201 (including the north and south highbays), Building 203, and surrounding support buildings and structures. These buildings contain offices, storage space, preparation rooms, clean rooms, shops, test facilities, various laboratories (including photography, fuel, oxidizer, chemistry, metallurgy, molecular desorption analytical, gas and spectroscopy, x-ray, vacuum, and calibration laboratories), and support areas for testing activities. The laboratory and test preparation complex also contain systems for the storage and handling of many types of propellants, corrosive chemicals, flammable solvents, and compressed gases.

The 250 Area is located west of the laboratory and test preparation complex across Apollo Boulevard (Figure 3.2). This area currently contains the Gaseous Oxygen High Temperature and Flow Test Facility (Building 250), the 200 Materials Processing Facility (Building 255), and various support structures. Liquid hydrogen and liquid oxygen are also stored for use in the area.

The 270/272 Area is located southeast of the 200 laboratory complex (Figure 3.2). This area consists of the Detonation Test Facility (Building 270), including composite overwrapped pressure vessel testing in Building 270A, the Hypervelocity Impact Facility (Building 272), and various support structures.

Personnel in the 200 Area provide support for the Propulsion Test Department at WSTF, including preparing test articles, performing analytical service, and fabrication and cleaning of test articles. Personnel also conduct materials and component testing in hazardous environments, including materials properties determination, materials compatibility and toxicity analyses, detonation studies, flight article outgassing characterization, systems analysis, orbital debris impact simulation testing, and propellant characterization. Five core areas are tested: oxygen systems, propellant systems, hypervelocity impact testing, composite pressure vessels, and standard materials testing (NASA, 2013c).

Although most of the facilities are located on concrete or asphalt surfaces, some natural soil surfaces are present. There are both paved and unpaved service roads and employee parking lots. Most buildings contain heating/cooling systems and utilities servicing the areas, including electrical, gas, fiber optic, and water.

SWMUs located within the 200 Area include the clean room discharge pipe (SWMU 4), the scape room discharge pipe (SWMU 5), the Building 203 discharge pipe (SWMU 6), the south highbay discharge pipe (SWMU 7), the 200 Area wastewater lagoon (SWMU 8), the 200 Area main burn pit (SWMU 9), the hazardous waste transmission line (SWMU 10), three septic tanks located adjacent to Building 272

(SWMU 23), and the 200 Area small arms firing range (SWMU 30; NMED, 2009; Figure 3.2). The 200 Area wastewater lagoon (SWMU 8) and the Building 272 septic tanks (SWMU 23) are managed in accordance with DP-392.

The 200 Area also contains two closed hazardous waste management units (HWMUs; Figure 3.2). The closed HWMUs consist of two separate sites that historically contained four hazardous waste USTs. The 200 Area West Closure consisted of two steel USTs for storing hazardous wastes derived from the clean room. The 200 Area East Closure consisted of two USTs, one steel and one concrete, for storing hazardous wastes derived from the 200 Area laboratories complex (other than the clean room). All four of these USTs were excavated and removed, and the areas were closed as interim landfills in 1986. New Mexico Environmental Improvement Division (NMEID) approved the closures in 1989 (NMEID, 1989).

There was another permitted waste treatment unit in the 200 Area that has also been closed. The Evaporation Treatment Unit (ETU) treated aqueous wastes by evaporation and consisted of two circular, flat-bottomed, open-top, carbon steel tanks lined with two 30-mil polyvinyl chloride (PVC) liners in each tank. Closure activities were initiated in July 2012. A Closure Certification Report for the 200 Area ETU was submitted to NMED in August 2013 (NASA, 2013b). The ETU was clean closed with NMED approval of the Certification of Closure Report on September 5, 2014 (NMED, 2014).

A vadose zone investigation of the entire 200 Area has been on-going since September 2012. Phase I of the investigation utilized seismic, soil resistivity, and shallow soil gas surveys to evaluate groundwater flow, bedrock location, and remaining volatile organic carbon contaminant concentrations in soil vapor of the vadose zone. Phase II of the investigation evaluated the vadose zone at specified targets: the two HWMU closures, five SWMUs, six areas of interest identified in the Phase I investigation, and additional targets identified by NMED in the Notice of Disapproval (NOD; NMED, 2013) for the original 200 Area Phase I Status Report (NASA, 2013a). Soil borings and multi-port soil vapor monitoring wells were installed. Results will be provided to NMED in the 200 Area Phase II Investigation Report (NASA, 2015a).

3.3.3 100 Area

Buildings, structures, and SWMUs in the 100 Area are illustrated in Figure 3.3. This area contains administration and WSTF support buildings, including a fire department and medical clinic, WSTF security offices, a cafeteria, a fueling station for government vehicles, a gymnasium, an auditorium, heavy equipment facilities, vehicle maintenance facilities, warehouse facilities, communication facilities, storage buildings, and many types of maintenance and fabrication facilities. The warehouse and support buildings house all materials, supplies, and substances entering WSTF. Distribution of goods/substances to the appropriate industrial area is accomplished following receipt at the warehouse.

Most facilities are located on concrete or asphalt surfaces; however, some natural soil surfaces are present. There are both paved and unpaved service roads. Most buildings contain heating/cooling systems and utilities servicing the area, including electrical, gas, fiber optic, and water.

SWMUs within the 100 Area include the 100 Area burn pit (SWMU 1), the 100 Area wastewater lagoon (SWMU 2), the 100 Area container storage area (SWMU 3), and two 100 Area septic tanks (SWMUs 21 [the tank located at Building 116, Main Guard Gate] and SWMU 22 [the tank located at Building 114]), the WB-2 small arms firing range (SWMU 31), and the WSTF active firing range (SWMU 53; Figure 3.3).

3.4 Current Uses of Adjoining Properties

Figure 3.4 is a map showing the WSTF industrial areas and STGT. The locations of adjoining properties are discussed below in relation to the nearest small arms firing range area.

3.4.1 800 Area

The 800 Area is located to the east of the main 200 Area complex and to the northeast of the 200 Area small arms firing range (SWMU 30). Buildings, structures, and SWMUs located in the 800 Area are shown on Figure 3.2. The 800 Area contains a control building, eight reinforced concrete test cells, various test support structures, and test support systems for the pressurization, storage, and handling of cryogenic materials and oxygen.

SWMUs located within the 800 Area include a below grade storage tank (SWMU 19) for temporary storage of diluted and residual testing fuels and an oxidizer burner (SWMU 20). The area also contains a septic tank for Buildings 802 and 803. This septic tank has no SWMU designation, but it is managed under DP-392.

3.4.2 700 Area

The location of the 700 Area relative to the other industrial areas at WSTF is shown on Figure 3.4. Located southeast of the STGT small arms firing range, the 700 Area consists of a remote testing area and the closed WSTF landfill. Both areas are SWMUs included in the Permit (NMED, 2009). The 700 Area high energy blast facility has been designated as SWMU 18, and the closed 700 Area landfill has been designated as SWMU 49.

Buildings and structures in the 700 Area include a control building, three temporary buildings/shelters, and several steel pole remnants at the 700 Area high energy blast facility, ten methane gas wells at the perimeter of the 700 Area landfill, four groundwater monitoring wells located adjacent to the landfill, and three groundwater monitoring wells located to the south of STGT, downgradient of the 700 Area.

4.0 Historical Records Review

4.1 Record Sources

Reasonably ascertainable and practically reviewable records relevant to the history, operations, and environmental conditions of SWMUs 29-31, the historical small arms firing ranges, were selected and reviewed. The type and location of these records are as follows:

- NASA Environmental Records – Located on site in the WSTF Environmental Department and available in both paper copy and electronic form. They include:
    - Reports (Resource Conservation and Recovery Act [RCRA] Facility Investigation [RFI; NASA, 1996], Part B Permit Application, SWMU Notification).
    - Correspondence (NASA, contractor, NMED).
    - Internal WSTF documents (correspondence, memoranda, reports, e-mail communications, records of communication, internal inspections, environmental resource documents).
- WSTF Internal Records – Located on site in the Quality Assurance Office available in electronic form including:
    - WSTF test preparation sheets (TPSs).
    - Discrepancy records (DRs).

- NASA Photographs – Located on site in the WSTF Photography Laboratory; negative logs were reviewed and pertinent photographs were obtained for review.

4.2 Interviews and Questionnaires

In addition to a historical records review, interviews with current and former long-term WSTF personnel were also conducted. A summary of information obtained from interviews is provided in Appendix A.

5.0 WSTF History

5.1 Pre-WSTF History

From the early 1800s to approximately 1935, the Organ Mountains and the SAM were mined for gold, silver, zinc, copper, and lead. There were several established mines and numerous prospect mines located in the SAM. The nearest established mine to WSTF was the Smith Mine located approximately 1 mile southeast of WSTF within the Loman Canyon area. The Smith Mine produced approximately $30,000 of silver ore during its operation. Deposits of galena (lead sulfide) and barite (barium sulfate) were also mined just north of the eastern mouth of Bear Canyon (Seager, 1981).

Lands now occupied by WSTF were historically open-range grazing lands. The ruins of a historic ranch house (Gardner Ranch, dates of operation unknown) is located just east of the current 200 Area laboratory facilities, and Love Ranch (believed to be in operation from the early 1900s until the 1950s) is located approximately 2.5 miles northeast of the 200 Area. These properties were acquired by the federal government to become a part of WSMR.

5.2 Inception of WSTF

NASA Headquarters announced selection of a testing site in south-central New Mexico on July 6, 1962. The site was chosen for the isolated location and topography, which minimize the inherent hazards of aerospace propulsion testing to the general population. From the date of the official announcement until January 1965, the site was known as the Propulsion Systems Development Facility. From January to June 1965, the official designation was White Sands Operations. On June 16, 1965, the official name of the installation was changed to White Sands Test Facility (NASA, 1986).

Site planning activities began in August 1962. Exploratory drilling to locate a water supply source began in December 1962, and drilling of water supply wells was completed in May 1963. Development of the site location began in May 1963 with construction of the access road (NASA Road) from U.S. Highway 70. The access road was completed in October 1963 (NASA, 1980). The first increment of the 300 Propulsion Test Area was completed in January 1964, and the second 300 Propulsion Test Area increment was completed by June 1964. Construction of the 200 Area Preparation Buildings (200 and 201 in December 1964 and 203 in March 1965) and the 400 Propulsion Test Area, in November 1965 followed. The 100 Area was constructed to be the project control area. Building 100 was completed in March 1964, followed by Building 101 in January 1965. Other support buildings (such as the cafeteria and warehouse) were also constructed during 1964 to 1965. The 800 Area was completed between January 1974 and December 1979 (NASA, 1986). The 200 Area laboratory consolidation facility addition to Building 200 was constructed from 1989 to 1990, and the 250 and 270 testing areas were completed between 1987 and 1991 (NASA, 1994).

TDRSS was constructed in 1977, with expansions built in 1982 and 1996. STGT was constructed in 1988 (NASA, 1994) with additions in 1994 (NASA, 2014b). According to a long-term employee, the Aerospace Data Facility – Southwest (ADF-SW) was constructed in 1983 and 1984, with expansions in

1991 and 2004. Modifications and expansions are currently on-going and planned for the future (Appendix A).

Locations for the specific areas of WSTF were chosen in order to minimize the potential impact and hazards in one area from affecting any other areas. Hazardous test and storage areas were located downwind from administration areas, the 300 and 400 propulsion areas were positioned so that they were not in line with respect to the prevailing wind direction, and the 200 Area was located far enough from the 300 and 400 propulsion areas for sufficient acoustic attenuation, blast pressure decay, and adequate reduction of fragment impingement hazards, but close enough for easy transport of test articles to and from the test areas (NASA, 1980). The land use buffer zone surrounding WSTF was designed to ensure a safe distance for diffusion of vapors or other hazards to avoid impacts to off-site inhabitants, livestock, and agriculture (NASA, 1994).

5.3 WSC Security History

The history of WSC security forces is not as well known as WSTF security history. For this HIS, no WSC long-term employee could be located that could provide history back to 1977, the initiation of WSC and the TDRSS facility at WSTF. However, several long-term WSTF employees remembered WSC security personnel qualifying at the 200 Area small arms firing range. The WSTF employees could not provide many security details, such as the years WSC used the 200 Area firing range, the number of security personnel, the type of bullets used, the number of rounds expended per qualification, and whether any practice rounds were expended in addition to qualifications.

Several long-term site personnel stated that WSTF and WSC security forces were consolidated to form one security unit approximately in 1998 or 1999, and were consolidated for several years. One employee interviewed in 1998 as part of the SWMU identification process stated that the first qualification the employee had participated in had been just the WSTF personnel; however, the second qualification had been after consolidation (NASA, 1999c). This constrains the time of consolidation of the WSTF and WSC security forces. Since a long-term employee identified the timing of annual qualifications as April and October, the WSTF and WSC consolidation had occurred between April and October 1998. Consolidation of the WSTF and WSC security forces did not alter the number of personnel qualifying at the WB-2 (SWMU 31) and STGT (SWMU 29) historical small arms firing ranges (Appendix A).

There is an inconsistency in employee statements regarding when WSC security personnel began using the new active firing range with a bullet containment system. Long-term employees agree that at the latest, when WSC began using the new active firing range (with bullet containment), personnel ceased using the STGT small arms firing range (SWMU 29). The inconsistency between employee statements is whether this was when the new firing range was completed, or several years later. One long-term WSC employee stated that it was several years after the new range was in use by WSTF security personnel that WSC personnel began using the range. However, several long-term WSTF employees stated that WSC personnel began using the new firing range as soon as it became operational, and at the same time as WSTF personnel began using the range. Refer to Section 6.3.5 for details regarding the new active firing range.

5.4 ADF-SW Security History

A long-term ADF-SW employee stated that a security force was established at the facility “since opening in 1984.” The employee stated that the security force did not historically use any of the WSTF small arms firing ranges (SWMUs 29-31), but instead used a firing range located on WSMR for firearms familiarization and qualifications. This employee was part of the ADF-SW security force since 1998, and

was certain that the WSMR firing range was used from 1998 to 2010. The employee related that other ADF-SW personnel did not use the WSTF or WSC site firing ranges prior to 1998 either (Appendix A).

This statement contradicts other employee statements from 1998. As part of the initial investigation of the small arms firing ranges (SWMUs 29-31), WSTF, WSC, and ADF-SW personnel were contacted. In 1998, a WSTF employee stated, "[I] was reminded that the Air Force guards also qualify 2 times a year at the TDRSS 2 range…" and from a hand-written note regarding interviews conducted in 1998, "…from Air Force …Air Force 31,000 Rds total in two years" (NASA, 1999c). The employee who wrote the interview note was contacted to clarify the original interview. This employee stated that in 1998, ADF-SW personnel fired the 31,000 rounds at the STGT small arms firing range (SWMU 29) over the previous two years (1996-1998). Use of the STGT firing range by the ADF-SW personnel is corroborated by another long-term WSC employee that stated that ADF-SW personnel may have used the STGT small arms firing range (SWMU 29) briefly, "not more than four or five times for their qualifications" (Appendix A). These statements provide evidence that ADF-SW personnel did use the STGT small arms firing range for approximately two years, since qualifications for ADF-SW personnel were required every six months (Appendix A).

6.0 Historical Firing Ranges Operational History

The following section provides formation history, descriptions, operational dates, and usage summaries of the three historical small arms firing ranges used at WSTF and WSC prior to the 100 Area active firing range (SWMU 53). These units were determined to be SWMUs and reported to NMED in March 1999. "Three new SWMU's have been identified at WSTF: The Second TDRSS Ground Terminal (STGT), 200 Area, and WB-2 small arms firing ranges" (NASA, 1999f). From an internal WSTF memorandum to the head of the WSTF Security Department, it was stated:

"The Environmental Department recently conducted site investigations at three firing ranges (STGT, 200 Area and WB-2). It was determined these ranges are considered solid waste management units and are subsequently subject to State and Federal hazardous waste regulations….these units must be closed and no longer used" (NASA, 1999a).

Figure 6.1 shows the locations of all the firing ranges, and Table 6.1 provides a summary for each SWMU of location, operation dates, design, size, modifications, personnel usage, qualification frequency, rounds fired per qualification, firearms used, bullet types used, estimated lead, possible other contaminants, and any additional pertinent information.

6.1 SWMU 29 (STGT Small Arms Firing Range)

Long-term employees stated that the STGT northern wastewater lagoon cell was used as a small arms firing range (SWMU 29; Appendix A). Details of SWMU 29 are provided in this section. Appendix B provides historical photographs of the STGT northern wastewater lagoon cell and small arms firing range (SWMU 29).

6.1.1 STGT Lagoon Construction

STGT initial site construction began in 1988 on land located approximately 3 miles north of the WSTF 100 Area (NASA, 1994). The last structures built were completed in April 1994 (NASA, 2014b). For sanitary sewage waste at the STGT, NASA proposed to construct a wastewater (sewage) lagoon. A DP was required, submitted, and approved by NMEID (NMEID, 1988). Construction of the STGT wastewater lagoon began in October 1988. The lagoon consisted of two cells with a total capacity of 4,316,800 gallons (NASA, 1996). The original design for the STGT wastewater lagoon comprised a 6-

inch (in.) clay liner for both cells of the wastewater lagoon. According to both long-term WSTF and STGT personnel, water was added to the north cell to maintain ballast for the original clay liner (Appendix A). Historical photographs in 1988 and 1989 appear to show this ballast water (Appendix B).

Modifications to the original design were necessary due to wastewater lagoon leakage, discovered during testing with the uncontaminated WSTF site water (ballast water). As a result, the south cell clay liner was increased, and the south lagoon cell was put into service as a wastewater lagoon in August 1991 (NASA, 1991). The north cell was not modified at that time.

6.1.2 Firing Range Formation

Due to the presence of an unused lagoon cell, and the need for WSC security personnel to familiarize and qualify with firearms, the "empty" northern half of the STGT wastewater lagoon was used as a small arms firing range (SWMU 29). Appendix B provides photographs of the STGT site and the wastewater lagoon.

6.1.3 Description

The dimensions of the original northern cell of the STGT wastewater lagoon, which became the boundaries of the STGT small arms firing range (SWMU 29), were 256 ft by 256 ft. The lagoon design contained 7-ft high berms around all the lagoon edges. Figure 6.2 provides the STGT wastewater lagoon plan diagram showing the elevations of the lagoon base and berms. According to long-term STGT personnel, the west lagoon cell wall became the backstop for the STGT small arms firing range. Bullets were fired at targets in front of the west berm, away from the STGT buildings (Appendix A; Figure 3.1). Subsequent to 1996, the STGT small arms firing range (SWMU 29) dimensions were decreased by half, to 128 ft by 256 ft due to the use of half the range/north lagoon cell for wastewater treatment. Refer to Section 6.1.6 for details.

6.1.4 Dates of Operation

Dates of operation of the STGT small arms firing range (SWMU 29) were derived from statements from long-term employees and a limited number of documents. During the initial SWMU identification process in 1998, it was reported that SWMU 29 began use in 1992 (NASA, 1999c). This information was based on an interview with the firearms instructor at WSC. In a hand-written note, it was stated, "Since 1992 to 96 in unmodified; 1996-present in modified" (NASA, 1999c). This statement is referring to the use of the original northern STGT wastewater lagoon cell as a small arms firing range, and then continuing to use the reduced cell as a firing range after 1996, when half of the northern cell was synthetically lined and put into wastewater service. The same information was provided to NMED in the Notification of Newly Identified SWMU (NASA, 1999f).

In an internal WSTF memorandum, ceasing use of the STGT firing range was discussed. "It is recommended the STGT Firing Range be closed due to the possibility of lead contamination on BLM land" (NASA, 1999d). This statement indicates that in March 1999, the STGT small arms firing range (SWMU 29) was still in use. "These recommendations include closure of the STGT range, transfer of the operations to the WB-2 area on-site, and upgrading the range with bullet traps and/or berm covers." Long-term WSTF personnel stated that all WSTF and WSC security personnel did transfer operations and qualifications back to the WB-2 firing range (SWMU 31) in 1999, and the STGT range was abandoned at that time.

It is believed that WSTF personnel used the STGT small arms firing range (SWMU 29) from 1995 to 1999. Long-term WSTF personnel described qualifying at the STGT small arms firing range (SWMU 29) in 1993 and 1996/1997 (Appendix A). Even though one employee described using the STGT firing range

in 1993, it is believed that WSTF personnel mostly used this range from 1995. WSC personnel used the STGT firing range (SWMU 29) from 1992 to 1999.

6.1.5 Usage

Table 6.1 provides a summary of SWMUs 29-31 and includes the frequencies of firearms qualifications, number of rounds expended per person, types of ammunition fired, and the types of firearms used. The STGT small arms firing range (SWMU 29) was used mostly by WSC security personnel. However, WSTF personnel also used the firing range. From an internal WSTF document, "There is a firing range of sorts at WSC that both the WSC and WSTF guard force uses for weapons familiarization/qualification. This range also gets used for practice firing on an infrequent basis" (NASA, 1999c). No further information was located discussing firearms practice in addition to semi-annual qualifications.

Bullet types used and number of personnel qualifying at SWMU 29 in 1998 was provided by a WSTF security guard employed at the time. "We are firing 38 special wad cutters, semi wad cutters and the full metal jacket…The first range was …just me and the fire dept guys…there would have been about 20 of us also firing 60 rounds…That was before the consolidation, so on the last range we fired about 40 people…60 rounds per person on that one." This statement indicates that .38 Special and 9 mm handguns were used at SWMU 29.

Regarding WSC usage of the STGT small arms firing range (SWMU 29), it was hand-written, "WSC fires 20 people at 2400 Rds annually." This information had been obtained from the firing range instructor in 1998 (NASA, 1999c). Refer to Section 8.2 for a discussion of calculations conducted for this HIS of estimated lead quantities present in the historical WSTF and WSC firing ranges.

As discussed in Section 5.4, there is a discrepancy between employee statements regarding whether ADF-SW personnel ever used the STGT small arms firing range (SWMU 29). Refer to Section 5.4 for details. It is believed that ADF-SW personnel fired 31,000 rounds at the SWMU 29 over two years prior to 1998.

6.1.6 Northern Lagoon Cell and SWMU 29 Modification

Long-term STGT personnel stated that the northern cell of the STGT wastewater lagoon was modified in 1996. The south half of the northern lagoon cell (located directly adjacent to the south STGT wastewater lagoon cell) was synthetically lined and then used as an addition to the wastewater lagoon (Appendix A). This was corroborated in a letter to NMED in 1996:

> "…we have elected to modify the north lagoon or Lagoon #2…Modification of the existing unused lagoon is presently underway…The modified lagoon is about half the size of the south lagoon and will have a Geomembrane liner…the lagoon will be placed into service upon completion of the construction effort" (AlliedSignal, 1996).

With the southern half of the original STGT northern wastewater lagoon cell in use as a wastewater lagoon, the STGT small arms firing range (SWMU 29) was halved in size. The remaining northern half of the west berm continued to be used as a backstop. Refer to Section 6.5 for a discussion regarding cleanup of SWMUs 29-31.

6.1.7 Storage

Besides usage as a small arms firing range, the north cell of the STGT wastewater lagoon/STGT small arms firing range (SWMU 29) area has also been used for storage. According to long-term STGT personnel, in 2002, when the roof was replaced on the power plant and main operations buildings at

STGT, the original roof rock ballast (approximately 500 tons; NASA, 2001) was placed in the dry northern half of the northern STGT lagoon cell/STGT small arms firing range. The area was not being actively used as a small arms firing range at the time, since use of the firing range ended approximately in 1999. (Refer to Section 6.1.4 for SWMU 29 operational dates.) The rock ballast is currently still stored in this area (Appendix A; NASA, 2001). The dry north half of the northern lagoon cell/STGT small arms firing range area is also currently used for storing landscaping vegetation waste, referred to by one employee as “a brush pile” (Appendix A).

6.2 SWMU 30 Operational History (200 Area Small Arms Firing Range)

The 200 Area small arms firing range (SWMU 30) was located south of the main 200 Area buildings, in between the 200 and 100 Areas (Figure 3.2; Figure 6.1). Details of SWMU 30 are provided in this section, and Appendix B provides historical photographs of the 200 Area small arms firing range (SWMU 30).

6.2.1 Formation

The 200 Area small arms firing range (SWMU 30) was established in either 1964 or 1971. There are no primary documents (e.g., work authorizing documents, TPS) regarding the formation of SWMU 30. Therefore, historical information was initially gathered from interviews conducted of site personnel, and reported to NMED in the Notification of Newly Identified SWMUs document (NASA, 1999f).

WSTF was initially established to test engines and support the Apollo space program. Therefore, when work for that program ended in 1971, WSTF underwent a significant change in personnel and scope. Personnel dropped an order of magnitude from approximately 1,200 to 200 full-time employees at WSTF (NASA, 2003). The date discrepancy between beginning use of the 200 Area firing range in 1971 to beginning use in 1964 may have been a result of pre-Apollo security practices being unknown to post-Apollo program personnel at the time the original interviews regarding SWMUs 29-31 were conducted.

It is believed that use of the 200 Area small arms firing range (SWMU 30) began in 1964. Evidence for this earlier date includes statements made (in an interview conducted for this HIS) by the former Fire Department Chief, who had worked at WSTF since 1963 and worked closely with personnel in all areas at WSTF. The employee stated that the major industrial areas (100, 200, 300, and 400 Areas) were built with small security stations. Approximately 20 security personnel were hired and manned these security stations in 8-hour shifts, 24 hours per day during the Apollo program.

When the need for firearms familiarization and qualification arose, security personnel began using an accessible, but remote area for firearms use. From photographs in 1964 and 1965, the area was cleared of vegetation, as shown by the tan soil and gray limestone bedrock colors, and a road was visible through the area and continuing into the 200 main complex area. In the 1964 photograph, soil piles and gray rock piles can be seen adjacent to the south highbay (still under construction; Appendix B). It is probable that the area was cleared southeast of the 200 Area main complex in order to provide soil and rock for use in construction. Since this cleared area was remote, had an available hillside (facing away from any populated areas) to use as a backstop, and already contained a road for easier access, it was a suitable place to practice using firearms. This area became the 200 Area small arms firing range (SWMU 30; Figure 3.2; Appendix A). Appendix B provides additional historical photographs of the 200 Area small arms firing range.

When the Apollo program ended at WSTF in 1971, only one (and later two) full-time security employee(s) remained. Of the original security stations at WSTF, only the main gate, Building 116, continued to be manned, and only during the daytime. The WSTF Fire Department (approximately 20 to

21 personnel) then assumed all after hours security functions at WSTF from 1971 through September 2001, after which a full-time security force of approximately 20 personnel were hired due to increased security concerns. Regardless of what department performed security functions at WSTF, the overall number of personnel practicing, familiarizing, and qualifying with firearms using the historical small arms firing ranges at WSTF remained approximately constant over time (Appendix A).

6.2.2 Description

The 200 Area small arms firing range is approximately 50 ft by 50 ft, located at the base of a hill, with the topography sloping upward to the east, and adjacent to an arroyo to the south (Figure 3.2). According to a long-term WSTF employee, the firing range was unimproved originally, with personnel using the natural hillside as a backstop. Personnel used portable tables for loading guns and holding equipment and portable poles made of 2-in. by 4-in. wood for setting up targets. Used targets (paper) and wooden poles, no longer sturdy enough for continued use, were burned for firefighting training in the Fire Department training area, located east of the 100 Area and the 100 Area burn pit (SWMU 1). Refer to the SWMUs 1, 3, and 15 HIS for details of this Fire Department training area (NASA, 2014a).

Improvements were completed through time consisting of:

- Grading the firing range area (to be more level),
- Installing and cementing into the ground two or three steel pipes, approximately 10 ft apart, to hold wooden target stands, and
- Installing gray-colored gravel.

Based on photographic evidence, the gravel was installed between May 1988 and June 1991, as identified by a color change in the soil/road from the natural tan to brown color in 1988 to a gray color from the rock gravel in 1991 (Appendix B). This is likely the same time that the area was graded and the steel pipes were installed. A berm for use as a backstop was never constructed at this site. No photographs were located of the 200 Area small arms firing range (SWMU 30) between May 1988 and June 1991.

A long-term WSTF employee stated that the 200 Area small arms firing range (SWMU 30) was not an ideal location, due to erosion of the hillside used as a backstop and the sloping terrain. “The mountain would slough in the rain, and we would have to dig out the range before we could use it the next time.” The removed rocks/soil were deposited adjacent to the 200 Area firing range. This frequent erosion and burying of the 200 Area small arms firing range (SWMU 30) prompted the WSTF Fire Department personnel to request that NASA design and construct another firing range (the WB-2 small arms firing range [SWMU 31]) that would be better designed (flat with better bullet containment) and not require maintenance after rains (Appendix A).

6.2.3 Dates of Operation

The dates of operation of the 200 Area small arms firing range (SWMU 30) were previously reported as 1971 to 1990 in an internal WSTF memorandum (NASA, 1999c). However, as described in Section 6.2.1, it is believed that use of the 200 Area small arms firing range (SWMU 30) began in 1964. This range was used for WSTF site security personnel for firearms familiarization and qualification from 1964 until September 1990, and for WSC security firearms usage from 1977 to September 1990, when the WB-2 range was completed. Refer to Section 6.3.2 for details of the formation of the WB-2 small arms firing range (SWMU 31; Appendix A; NASA, 1990).

6.2.4 Usage

Table 6.1 provides a summary of SWMUs 29-31 and includes the frequencies of firearms qualifications, number of rounds expended per person, types of ammunition fired, and the types of firearms used. Long-term WSTF and WSC personnel stated that this was the first small arms firing range used at WSTF. Prior to using the STGT small arms firing range (SWMU 29), WSC used this 200 Area small arms firing range (SWMU 30). One long-term WSTF employee stated that firearms qualifications were conducted once a year at the 200 Area small arms firing range by City of Las Cruces police department personnel, who were certified small arms trainers. WSTF personnel qualifying and using the 200 Area small arms firing range consisted of the one or two security guards and the approximately 20 to 21 Fire Department personnel (Appendix A).

In addition to the annual firearms qualification, a long-term WSTF employee stated that the Fire Department also practiced shooting on a quarterly basis at the 200 Area small arms firing range (SWMU 30). The employee could not provide estimates of the quantity of rounds discharged (Appendix A).

Types of handguns used at the 200 Area small arms firing range were .38 Specials and .357 Magnums (Appendix A). An estimate of the approximate quantity of ammunition used at the 200 Area small arms firing range (SWMU 30) was provided by WSTF security personnel in 1998, as part of the initial SWMU identification process. “This range was used from 1971 to 1990. The approximate ammunition used was 15,000 rounds. The type of ammunition used was of 38 caliber at both sites [SWMU 30 and SWMU 31]” (NASA, 1999c). It is believed that this value underestimates the quantity of rounds discharged, given that the range was used from 1964 to 1971 as well. Refer to Section 8.2 for a discussion of calculations conducted for this HIS of estimated lead quantities present in the historical WSTF and WSC firing ranges.

The number of WSC personnel qualifying using the 200 Area small arms firing range (SWMU 30) is unknown; however, it is assumed that WSC security personnel remained constant over time. A long-term WSTF employee identified 22 WSC security officers completing qualifications during the 1990s; therefore, it is assumed that 22 WSC personnel used SWMU 30 from the inception of the TDRSS facility in 1977 until use of the range ended in 1990.

According to a long-term employee, brass casings were “generally picked up,” but bullets remained in the hillside or in the environment where they landed. Firearms qualifications were always performed with “wadcutters” (Appendix A). Refer to Section 6.4 for a description of wadcutter bullets.

6.3 SWMU 31 Operational History (WB-2 Small Arms Firing Range)

The WB-2 small arms firing range (SWMU 31) was located east of the TDRSS facility and approximately 400 ft west of the 100 Area active firing range with bullet containment (Figure 3.2; Figure 6.1). Figure 6.4 provides a close view of the WB-2 small arms firing range (SWMU 31) and the 100 Area active firing range (SWMU 53). Details of SWMU 30 are provided in this section, and Appendix B provides historical photographs of the WB-2 firing range and area.

6.3.1 Formation

The WB-2 small arms firing range (SWMU 31) was constructed specifically to be a replacement firing range for the 200 Area small arms firing range (SWMU 30). One employee described the need for a firing range that personnel would not “have to dig out” after a rain (Appendix A). Long-term WSTF employees could not recall when the WB-2 small arms firing range (SWMU 31) had been constructed. However, a TPS was located describing the formation of the unit and providing details regarding construction (NASA, 1990). Details are provided in Section 6.3.2.

6.3.2 Description

A TPS was located describing the construction of the WB-2 small arms firing range (SWMU 31). The WB-2 small arms firing range (SWMU 31) consisted of a 40 ft wide by 100 ft long cleared area oriented with the long side east-west. A 30 ft long by 7 ft high soil berm was constructed on the eastern edge of the range as a backstop. Three 2-in. diameter 24-in. long steel pipes were cemented 16 in. into the ground to hold shooting targets. These pipes were placed approximately 10 ft apart in front of the berm backstop (NASA, 1990). Figure 6.3 provides a schematic diagram of the WB-2 firing range with dimensions. Long-term WSTF personnel stated that the berm at the WB-2 small arms firing range (SWMU 31) needed to be built up occasionally with a grader, due to weathering of the berm (Appendix A).

6.3.3 Dates of Operation

The dates of operation for the WB-2 small arms firing range (SWMU 31) were also determined from long-term employee statements and a limited number of documents. As determined by a WSTF TPS, the WB-2 firing range was constructed in September 1990. There were no documents located discussing use of this range, after the initial construction of the unit, and statements by long-term WSTF personnel regarding range operational dates were contradictory at times.

The operational dates for SWMU 31 were reported as 1990 to 1995, during initial research during the SWMU identification process in 1998 (NASA, 1999c). This 1995 date is likely more accurate than dates provided in interviews for this HIS, conducted 14 years after the initial interviews. In an internal memorandum in March 1999, it was stated, “Firing range training operations should be moved to the WB-2 Firing Range” (NASA, 1999d), suggesting that the WB-2 small arms firing range (SWMU 31) was not in use at that time.

Based on integrating all available information, it is estimated that the WB-2 small arms firing range (SWMU 31) was used from September 1990 (NASA, 1990) to approximately 1995, and then again from approximately mid-1999 until late 2000, when the new active firing range with bullet containment system became operational. Statements of long-term security personnel suggested that WSC personnel only used the WB-2 small arms firing range (SWMU 31) from 1990 to 1992, when the STGT small arms firing range (SWMU 29) began use, and then again from 1999 to 2000.

6.3.4 Usage

Table 6.1 provides a summary of SWMUs 29-31 and includes the frequencies of firearms qualifications, number of rounds expended per person, types of ammunition fired, and the types of firearms used. The WB-2 small arms firing range (SWMU 31) was used mostly by WSTF security personnel; however, WSC personnel also used the range (Appendix A).

The types of handguns used at SWMU 31 were reported by one WSTF security employee as 38-caliber handguns, and over time, WSTF personnel transitioned to “Glock 9 mm” (Appendix A). A casual visual inspection of the WB-2 small arms firing range (SWMU 31) backstop berm shows both 38-caliber and 9 mm bullets weathering out of the berm. The employee did not know a date when the 9 mm handguns began being used at WSTF. Qualifications were conducted every six months.

A WSTF security supervisor stated that when the employee worked at WSTF (1991-2005), the number of WSTF security personnel had remained basically constant. Until 2001, WSTF personnel qualifying using firearms comprised “21 firefighters and 2 security officers” and for WSC, there were 22 security officers. Each WSTF or WSC security employee “shot per the NASA requirements [NASA Security Program Procedural Requirements Responsible Office: Office of Protective Services NPR 1600.0-TOC],” which

listed 100 rounds per person per qualification (NASA, 2004). The employee had no information regarding ADF-SW (Appendix A).

Estimates of the approximate amount of ammunition used at the WB-2 small arms firing range were obtained from security personnel in 1998. It was stated, "Approximate ammunition used from 1990 to 1995 is 5000 rounds…The type of ammunition used was of 38 caliber…" (NASA, 1999c). It is believed that the estimated ammunition quantity is a low estimate. Refer to Section 8.2 for a discussion of calculations conducted for this HIS of estimated lead quantities present in the historical WSTF and WSC firing ranges.

As reported in the Notification of Newly Identified SWMUs in March 1999, "The WB-2 firing range has been used since 1990…This range is bermed and will be upgraded and maintained as the sole active firing range on WSTF" (NASA, 1999f). NMED personnel suggested installing upgrades to the range NASA chose to continue using "to minimize releases of lead to the environment" and "minimize the future cleanup requirements" (NASA, 1999b). NASA began reviewing bullet containment systems in response to NMED's statement.

6.3.5 100 Area Active Small Arms Firing Range

The active small arms firing range (SWMU 53) is located approximately 400 ft to the east of the WB-2 small arms firing range (SWMU 31) in the 100 Area at WSTF. Figure 6.4 shows both the WB-2 small arms firing range (SWMU 31) and the active small arms firing range (SWMU 53).

As stated in Section 6.3.3, the use of this new active small arms firing range (SWMU 53) coincided with ceasing the use of the WB-2 small arms firing range (SWMU 31). The design of this firing range resulted from research to upgrade the WB-2 small arms firing range (SWMU 31). From an internal memorandum in March 1999, it was stated, "the WB-2 Firing Range…should be upgraded to facilitate lead removal and preclude future liability" (NASA, 1999d). It was decided to construct a new firing range instead of upgrading the WB-2 small arms firing range (SWMU 31). This 100 Area new active firing range was installed in 2000 with a bullet and dust containment system in an attempt to minimize the environmental impacts of using outdoor firing ranges.

6.4 Ammunition Details

Long-term WSTF personnel stated that flat-shaped wadcutter and semi-wadcutter bullets were used historically for firearms qualifications at each of the three firing ranges. Wadcutter bullets are composed primarily of lead and will tear easily visible holes in paper targets. The purpose of using wadcutter bullets was to quickly determine if and where a target was struck.

Semi-wadcutter bullets are a wadcutter bullet with a conical portion added to the front. The addition of the cone reduces drag in flight and makes the bullet easier to load. The flat point at the top of the cone and the bullet shoulder will cut round visible holes in paper targets like the wadcutter (Chastain, 2014).

A round bullet with a full metal jacket means a round bullet encased in another, harder metal, usually copper (Jacobs, 2014). These bullets were used with 9 mm handguns at SWMUs 29 and 31.

6.5 Previous Cleanup Activities

Options for cleaning up the historical small arms firing ranges at WSTF and WSC were researched as part of the initial SWMU identification process in 1999. WSTF personnel sent a memorandum to the head of the Security Department in February 1999, stating that the three historical small arms firing ranges

(SWMUs 29-31) "must be closed and no longer used…The Environmental Department is currently working on sampling and remediation work plans for NASA submittal to NMED" (NASA, 1999a). This statement suggests that NASA submitted a firing range cleanup work plan to NMED. However, no work plan was located during research for this HIS.

A record of communication between WSTF personnel and NMED provided this information, "NASA was reviewing clean-up options and sampling techniques for the lead at each firing range" (NASA, 1999b). In a document discussing potential upgrade options for the WB-2 small arms firing range (SWMU 31), it was stated, "Visible lead currently present at this range [the WB-2 firing range (SWMU 31)] will be removed by hand prior to any construction activities…" (NASA, 1999d). Additionally, in an internal WSTF weekly report, it was stated, "Department personnel are continuing efforts regarding the clean-up of the existing ranges" (NASA, 1999e).

Several long-term WSTF personnel reported that NASA had not submitted a work plan and that no cleanup of any of the historical firing ranges (SWMUs 29-31) had been conducted to date (Appendix A).

7.0 Evidence of Hazardous Substances

The bullets historically used at the three small arms firing ranges were composed primarily of lead (Appendix A). In an internal document discussing the STGT small arms firing range (SWMU 29), it was stated, "Lead rounds are typically used due to the lower cost of such rounds. This type of activity has been shown to have contaminated military property in the past" (NASA, 1999c). There were no documents located regarding ammunition historically used at the three firing ranges (SWMUs 29-31); however, historical bullets used were likely similar to modern bullets, since similar handguns are still used in firearms familiarization and qualifications. Material Safety Data Sheets (MSDS) for ammunition currently used at WSTF are provided in Appendix C. From these MSDS, hazardous ingredients are:

Handguns

- Bullets: lead, with smaller amounts of copper, zinc, aluminum, antimony, molybdenum disulfide, and nyclad coating (some with copper jackets).
- Bullet casing: copper, lead, zinc, nickel, and tin.
- Smokeless powder or propellant: nitrocellulose, nitroglycerin, dibuthyl phthalate, 2,4-dinitrotoluene, and graphite powder.
- Primer: copper, zinc, diazodinitrophenol, tetrazene (or tetracene), potassium nitrate, borosilicate, barium, bismuth, antimony, aluminum, nitrocellulose, nitroglycerine, and propellant (fine powder).

8.0 Indication of Releases to the Environment

The nature of an outdoor firing range without engineering controls means there will be releases to the environment of lead bullets, metal jackets, and potentially brass bullet casings. A preliminary site inspection showed evidence of many bullets, some with copper metal jackets, within the berms of SWMUs 29 and 31, and some metal (likely) brass bullet casings on the ground where the guns were fired. No bullets, metal jackets, or brass casings were visible at the 200 Area small arms firing range (SWMU 30) with casual visual inspection.

8.1 Cleanup Potential

The WB-2 small arms firing range (SWMU 31) presents a straightforward release to the environment and clean-up potential. The other two historical small arms firing ranges, however, were more complicated releases and present more challenges for potential cleanup.

8.1.1 STGT Range (SWMU 29)

Since the location of the STGT small arms firing range (SWMU 29) was not designed for use as a firing range, several factors contribute to a more complicated environmental release and cleanup potential. The original firing range area was located immediately adjacent to the active south cell of the STGT wastewater (sewage) lagoon. The wastewater and firing range were only separated by a lagoon berm made of soil a similar thickness as the west berm (used as the firing range backstop; Figure 3.1; Figure 6.2). Stray bullets discharged during firearms qualifications likely entered that south berm, especially near the west berm backstop. Then, in 1996 when the south half of the original north STGT lagoon cell was synthetically lined and put into service as a wastewater lagoon, a portion of the original STGT small arms firing range was incorporated into the active wastewater area. The new smaller firing range was again only separated from the active wastewater lagoon by a soil berm. Again, it is probable that stray bullets entered that new south berm, especially near the west soil berm backstop.

Long-term WSTF and WSC personnel stated that no cleanup actions have ever been conducted for any of the historical small arms firing ranges (SWMUs 29, 30, and 31; Appendix A). Therefore, any bullets that were located in the original STGT firing range area are still present within the soil of the lagoon berms or lagoon base under the synthetic liner. With the wastewater lagoon still in active use, cleanup of the area cannot be accomplished at this time, and eventual cleanup may be complicated by requirements for wastewater lagoon closure.

The potential cleanup of the STGT small arms firing range (SWMU 29) is further complicated by the presence of the roof ballast rock piles and vegetation pile currently located within the STGT small arms firing range (SWMU 29) boundaries (Appendix A). (Refer to Section 6.1.7 for details.) This rock and brush will need to be removed prior to any cleanup activities.

8.1.2 200 Area Range (SWMU 30)

Like the STGT small arms firing range (SWMU 29), the 200 Area small arms firing range (SWMU 30) was not specifically designed for use as a firing range, which contributed to a more complicated environmental release and cleanup potential. Refer to Section 6.2.1 for the probable rationale for choosing the location for the 200 Area small arms firing range.

As stated in Section 6.2.2, the 200Area small arms firing range (SWMU 29) was originally unimproved (e.g., no grading or installation of targets, etc.) and used a natural hillside as a backstop. The area was not flat, but sloped up to the east, towards the backstop. The hillside was very coarse-grained, with limestone bedrock weathering out of the hill in large pebbles, cobbles, and boulders. Bullets would ricochet more frequently off these larger clasts in the hillside than in a soil berm, resulting in a larger bullet discharge area. Also, as stated in Section 6.2.2, “The mountain would slough in the rain,” and personnel “would have to dig out the range before we could use it the next time” (Appendix A). This common sloughing likely washed bullets and unrecovered casings down-slope and into the adjacent arroyo to the south. From a casual visual inspection of the 200 Area small arms firing range (SWMU 30), it is evident that erosion of the hillside during rains has washed the gray-colored gravel (that was installed between 1988 and 1991) into the arroyo and also hundreds of ft down-slope. These factors will make locating and recovering any lead bullets or brass casings difficult and complicated for the 200 Area small arms firing range (SWMU 30).

8.1.3 WB-2 Range (SWMU 31)

Unlike the STGT and 200 Area small arms firing ranges (SWMUs 29 and 30), the WB-2 small arms firing range (SWMU 31) was specifically designed as a firing range. This design contributed to a simple

environmental release and potentially easy cleanup. The WB-2 firing range is located in a remote, flat, and easily accessed area, with no buildings or structures located close enough to the range to cause interference with original bullet discharge or potential cleaning procedures. The firing range was designed to retain bullets in the berm and was graded flat to discourage potential migration of bullets or casings off-site. In a casual visual inspection of the area, spent casings were visible in the flat area near where the guns were fired, just where spent casings would be expected. Bullets were also weathering out of the backstop berm and clearly visible, again, located in the area where bullets would be expected per the design. As a result, bullets and casings are expected to be easily recoverable.

8.2 Lead Estimates

As stated in Section 7.0, the bullets used at the historical small arms firing ranges were primarily composed of lead, thus lead is the constituent that will be utilized to estimate releases to the environment from SWMUs 29-31. The "total official quantity fired annually is approximately 4,800 125 grain wadcutters or a total of 86 pounds of lead," This quantity was estimated using information obtained from long-term employees in 1998, as part of the initial SWMU identification process (NASA, 1999c). There were no records retained at WSTF or WSC of actual bullet usage at the historical firing ranges, so the amount of potential lead currently present in each SWMU was estimated as part of this HIS. Combining information obtained from initial interviews in 1998 with interviews of long-term WSTF, ADF-SW, and WSC employees presently, the following estimates were generated:

- STGT small arms firing range (SWMU 29): total of ~1,370 pounds (lbs);
- 200 Area small arms firing range (SWMU 30): ~1,500 to ~2,250 lbs; and
- WB-2 small arms firing range: ~570 lbs

The amount of lead estimated in the STGT small arms firing range (SWMU 29) can be further categorized. From 1992 to 1996, the entire STGT lagoon was used as the firing range. For that original larger firing range, approximately 240 lbs of discharged lead was estimated. From 1996 to 1999, only the northern half of the north lagoon cell was used as the firing range. For this smaller firing range, the estimated amount of lead discharged was approximately 1,130 lbs. The greater amount of lead in the smaller size range is a result of including the ADF-SW estimated 31,000 rounds for 1996-1998, reported by ADF-SW personnel in 1998 (NASA, 1999c). Refer to Section 5.4 for more details. The minimum amount of lead estimated (~1,500 lbs) for the 200 Area small arms firing range (SWMU 30) represents estimating only rounds from qualifications for 26 years. The maximum amount (~2,250 lbs) represents including the addition of another estimated 100 rounds per Fire Department employee per year assumed for quarterly firearms practice. Refer to Section 6.2.4 for a discussion of firearms practice conducted at SWMU 30.

8.2.1 Previous Estimates

The amount of lead discharged to the three small arms firing ranges (SWMW 29-31) was estimated in 1998 during the initial SWMU identification and reporting process. STGT was split into two units; reporting the amount of lead for the larger range (256 ft by 256 ft) range, and the amount of lead for the smaller range (128 ft by 256 ft).

- STGT larger range: 257 lbs;
- STGT smaller range: 810 lbs;
- 200 Area range: 168 lbs; and
- WB-2 range: 90 lbs.

These lead amounts were obtained from employee's estimated rounds of lead discharged to each SWMU (See Sections 6.2.4 and 6.3.4) and using 125 grain weight per round, with 7000 rounds per lb of lead. These estimates are considered low, based on the number of personnel qualifying at each SWMU and the amount of years that qualifications have been conducted at each SWMU.

8.2.2 Calculations

Calculations consisted of multiplying the number of personnel qualifying, the number of qualifications conducted per year, the number of rounds discharged per person per qualification, and the number of years the range was in operation. This provided the total number of rounds estimated for the life of the SWMU. Then, that total number of rounds discharged over the life of the SWMU was multiplied by the weight of the bullets used in grains. Employees interviewed for this HIS did not remember the weight of the bullets used; however, during the SWMU identification process in 1998, it was reported that 38-caliber ammunition was used with 125-grain wadcutters for all historical firing ranges (NASA, 1999c). Therefore, in calculations for estimating the amount of lead discharged from each historical small arms firing range, this value of 125 grains per round was used for all calculations. The final step in calculating the estimated amount of lead in pounds (lbs) that had historically been discharged at each SWMU was to divide the weight in grains of the lifetime rounds expended by 7,000 grains per lb.

8.2.3 Assumptions

- Upon casual visual inspection of the WB-2 and STGT small arms firing ranges, bullets identified were: 9 mm, 357-caliber, and 38-caliber. It is assumed for these calculations that all bullets in all three firing ranges (SWMUs 29-31) weighed 125 grains;
- No extra practice rounds were included in calculations, except for the Fire Department personnel for the 200 Area small arms firing range (SWMU 30), because the Fire Department employee interviewed specifically stated that quarterly practice was also conducted. Practice rounds discharged per year were assumed to be the same amount per person as the amount used for qualifications;
- The number of personnel qualifying each year remained constant over time; and
- The number of rounds expended for firearms qualifications remained constant over time, unless specifically identified by an employee.

9.0 Other Uncertainty

Since statements from long-term WSTF, ADF-SW, and WSC personnel were the primary source for information in this HIS, the accuracy of the information is uncertain. Many employee statements contradicted one another. In order to perform calculations to estimate the amount of lead historically discharged at each SWMU, actual numbers were needed for each parameter. With employee statements providing contradictory information for operational years, rounds of ammunition used, number of qualifications per year, and number of personnel qualified, judgments and choices had to be made. This also introduces uncertainty.

10.0 References

AlliedSignal. (1996, August 8). *Reconstruction of Sewage Lagoon #2 at the NASA White Sands Complex.* AlliedSignal Technical Services Corporation, Las Cruces, NM.

Chastain, R. (2014). *Definition of Semi-Wadcutter (SWC) Bullet.* From: http://hunting.about.com/od/ammo/g/definition-of-semi-wadcutter-bullet.htm

DoD. (Original 1976, February; Addendum No. 1, 1982). *Agreement Between the Department of Defense and the National Aeronautics and Space Administration for Operation of the NASA White Sands Test Facility at White Sands Missile Range, New Mexico-Contract No. DACA47-9-75-145.* United States Department of Defense, Department of the Army, White Sands Missile Range NM.

Jacobs, S. (retrieved 2014). *Ammo.net – Full Metal Jacket (FMJ) Bullets Explained.* From: http://ammo.net/bullet-type/full-metal-jacket-fmj

NASA. (1980, November 21). *Environmental Resources Document.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (1986, March 4). *Part B Permit Application for Hazardous Waste Facilities at the NASA JSC White Sands Test Facility Las Cruces, New Mexico 88004 EPA ID Number NM8800019434.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (1990, September 17). *NASA JSC WSTF Test Preparation Sheet TPS-1-2FAC-90-2936 – Firing Range.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (1991, August 23). *Memorandum – Meeting to Coordinate Filling of Sewage Lagoon.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (1994, September). *Facilities Master Plan.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (1996, March 1). *Draft RCRA Facility Investigation (RFI) and Corrective Measures Study (CMS) Reports*. NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (1999a, February 19). *Memorandum: Firing Ranges.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (1999b, February 22). *Record of Communication: Firing Ranges and Annual Unit Audit; Major Modification Submittal; Pilot Scale Vendors and Plume-Front Work Plan Review Schedules and Fees.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (1999c, March 1). *Firing Range Regulations.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (1999d, March 11). *Memorandum – Firing Ranges.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (1999e, March 12). *Memorandum – Weekly Activity Report for Week Ending March 12, 1999.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (1999f, March 30). *Notification of Newly Identified Solid Waste Management Units (SWMU's) at NASA White Sands Test Facility (WSTF).* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (2001, September 28). *Record of Environmental Consideration – STGT Main Building and Powerhouse Roofing Project.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (2003, February 26). *NASA Johnson Space Center Oral History Project – Kenneth B. Gilbreath.* NASA Johnson Space Center, Houston, TX. Retrieved from: http://www.jsc.nasa.gov/history/oral_histories/GilbreathKB/gilbreathkb.htm

NASA. (2004, November 3). *NASA Security Program Procedural Requirements Responsible Office: Office of Protective Services NPR 1600.0-TOC.* Retrieved from: http://nodis3.gsfc.nasa.gov/search_ft.cfm

NASA. (2013a, January 30). *200 Area Phase I Status Report.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (2013b, August 1). *Certification of Closure Report for the Evaporation Treatment Unit (ETU).* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (updated 2013c, September 13). *White Sands Test Facility Materials and Components Laboratories Office.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM. http://www.nasa.gov\centers\wstf\laboratories\index.html

NASA. (2014a, July 30). *SWMUs 1, 3, and 15 Historical Information Summary (100 Area Burn Pit, 100 Container Storage Area, and 600 Area Burn Pit).* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (updated 2014b, October 2). *Space Network (SN).* NASA Goddard Space Flight Center. Retrieved from http://esc.gsfc.nasa.gov/space-communications/sn-sne.html

NASA. (updated 2014c, October 29). *Space Network (SN).* NASA. Retrieved from https://www.spacecomm.nasa.gov/spacecomm/programs/space_network.cfm

NASA. (2015a, February). *200 Area Phase II Investigation Report.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NASA. (2015b, February). *Small Arms Firing Ranges (SWMUs 29-31) Accelerated Corrective Measures Work Plan.* NASA Johnson Space Center White Sands Test Facility, Las Cruces, NM.

NMED. Hazardous Waste Bureau. (2009, November). *Hazardous Waste Permit EPA ID No. NM8800019434 to United States National Aeronautics and Space Administration for the White Sands Test Facility Location in Doña Ana County, New Mexico.* New Mexico Environment Department, Santa Fe, NM.

NMED. Hazardous Waste Bureau. (2013, May 8). *Notice of Disapproval 200 Area Investigation – Phase I Status Report National Aeronautics Space Administration (NASA) Johnson Space Center White Sands Test Facility Doña Ana County, New Mexico EPA ID #NM08800019434 HWB-NASA-13-002.* New Mexico Environmental Department, Santa Fe, NM.

NMED. Hazardous Waste Bureau. (2014, September 5). *Approval Certification of Closure Report for the Evaporation Treatment Unit (ETU) National Aeronautics Space Administration (NASA) Johnson Space Center (JSC) White Sands Test Facility (WSTF) Doña Ana County, New Mexico EPA ID #NM08800019434 HWB-NASA-14-007.* New Mexico Environment Department, Santa Fe, NM.

NMEID. (1988, October 24). n.t. regarding approval of DP-584 for STGT wastewater lagoon construction. New Mexico Environmental Improvement Division, Santa Fe, NM.

NMEID. (1989, November 1). *NM8800019434 200, 300, 400, 600 Area Closure.* New Mexico Environmental Improvement Division, Santa Fe, NM.

Seager, W. R. (1981). *Geology of Organ Mountains and southern San Andres Mountains, New Mexico.* In New Mexico Bureau of Mines & Mineral Resources Memoir 36. New Mexico Institute of Mining & Technology, Socorro, NM.

Figures

Figure 2.1 **WSTF Location Map**

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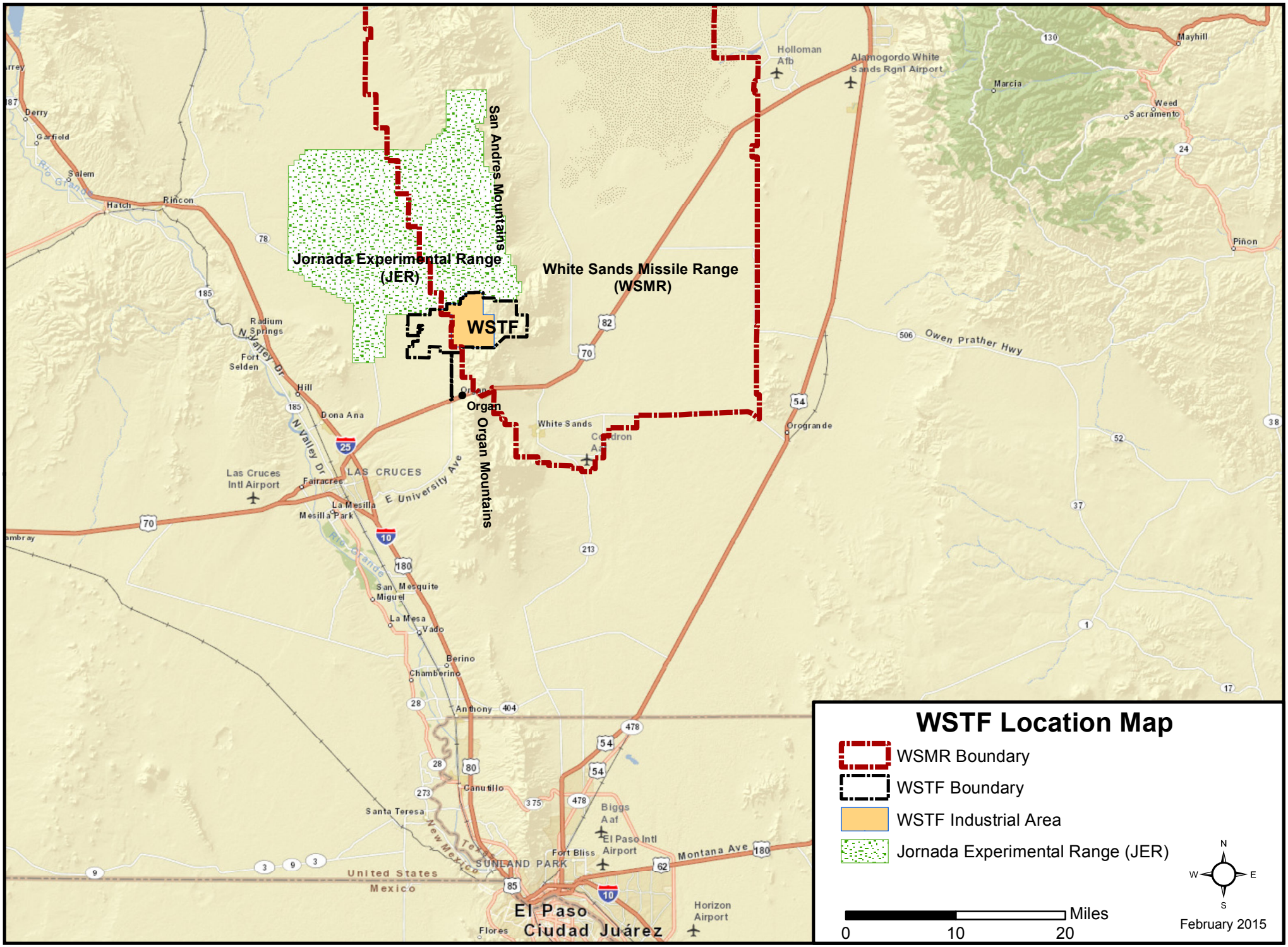
WSTF Location Map
WSMR Boundary
WSTF Boundary
WSTF Industrial Area
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February 2015
Jornada Experimental Range (JER)
White Sands Missile Range (WSMR)
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Alamogordo White Sands Rgnl Airport
Mayhill
Marcia
Weed
Sacramento
Piñon
Owen Prather Hwy
Orogrande
White Sands
Cloudcroft
Derry
Garfield
Salem
Hatch
Rincon
Radium Springs
Fort Selden
Hill
Dona Ana
N Valley Dr
Las Cruces Intl Airport
LAS CRUCES
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Rio Grande
San Miguel
Mesquite
La Mesa
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Berino
Chamberino
Anthony
Canutillo
Santa Teresa
New Mexico
Texas
SUNLAND PARK
Fort Bliss
Biggs Aaf
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Mexico
El Paso
Ciudad Juárez
Flores
Horizon Airport

Figure 2.2 **Land Ownership Map**

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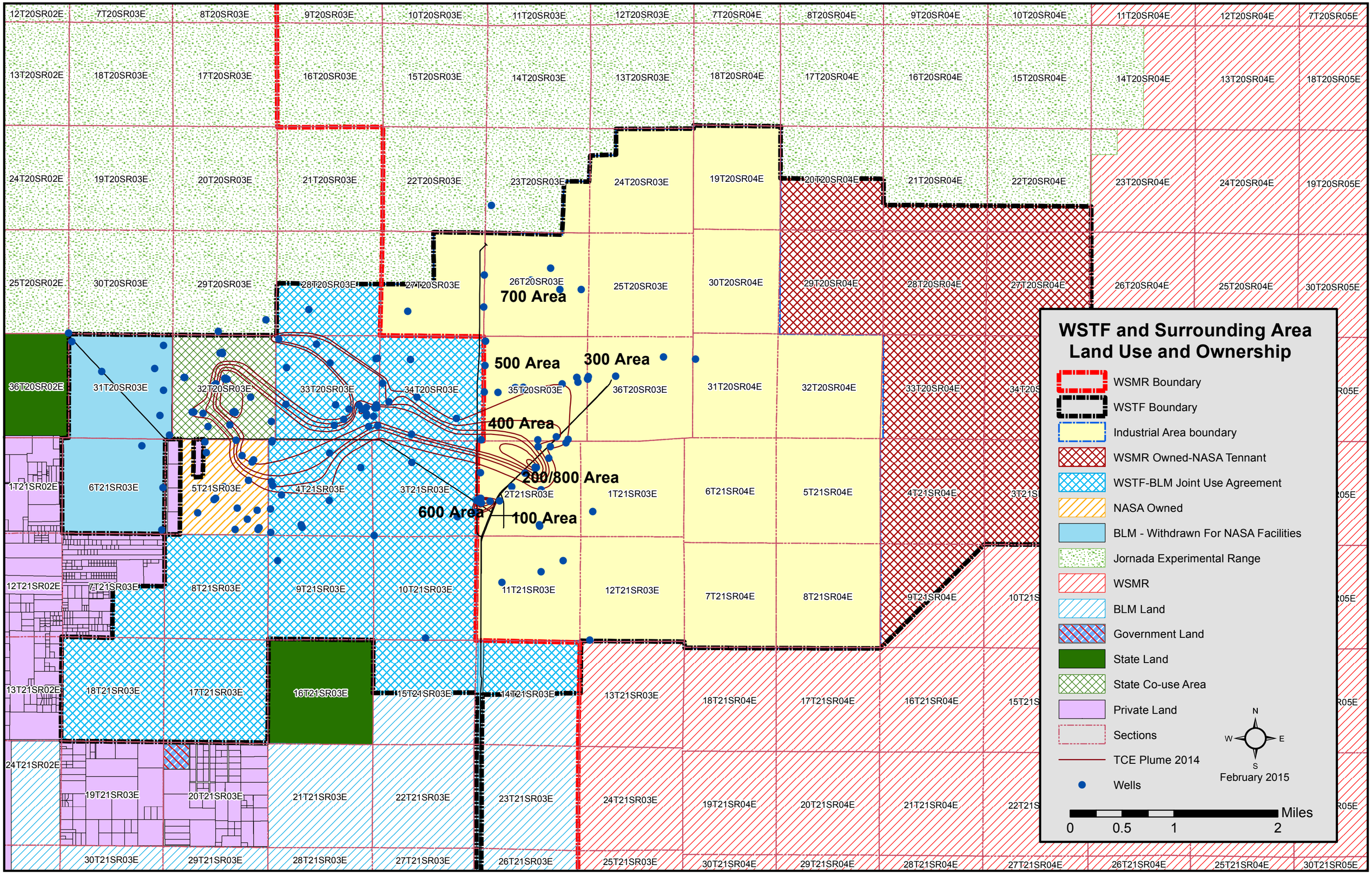
WSTF and Surrounding Area
Land Use and Ownership
WSMR Boundary
WSTF Boundary
Industrial Area boundary
WSMR Owned-NASA Tennant
WSTF-BLM Joint Use Agreement
NASA Owned
BLM - Withdrawn For NASA Facilities
Jornada Experimental Range
WSMR
BLM Land
Government Land
State Land
State Co-use Area
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7T20SR05E
13T20SR02E
18T20SR03E
17T20SR03E
16T20SR03E
15T20SR03E
14T20SR03E
13T20SR03E
18T20SR04E
17T20SR04E
16T20SR04E
15T20SR04E
14T20SR04E
13T20SR04E
18T20SR05E
24T20SR02E
19T20SR03E
20T20SR03E
21T20SR03E
22T20SR03E
23T20SR03E
24T20SR03E
19T20SR04E
20T20SR04E
21T20SR04E
22T20SR04E
23T20SR04E
24T20SR04E
19T20SR05E
25T20SR02E
30T20SR03E
29T20SR03E
28T20SR03E
27T20SR03E
26T20SR03E
25T20SR03E
30T20SR04E
29T20SR04E
28T20SR04E
27T20SR04E
26T20SR04E
25T20SR04E
30T20SR05E
36T20SR02E
31T20SR03E
32T20SR03E
33T20SR03E
34T20SR03E
35T20SR03E
36T20SR03E
31T20SR04E
32T20SR04E
33T20SR04E
1T21SR02E
6T21SR03E
5T21SR03E
4T21SR03E
3T21SR03E
2T21SR03E
1T21SR03E
6T21SR04E
5T21SR04E
4T21SR04E
12T21SR02E
7T21SR03E
8T21SR03E
9T21SR03E
10T21SR03E
11T21SR03E
12T21SR03E
7T21SR04E
8T21SR04E
9T21SR04E
13T21SR02E
18T21SR03E
17T21SR03E
16T21SR03E
15T21SR03E
14T21SR03E
13T21SR03E
18T21SR04E
17T21SR04E
16T21SR04E
24T21SR02E
19T21SR03E
20T21SR03E
21T21SR03E
22T21SR03E
23T21SR03E
24T21SR03E
19T21SR04E
20T21SR04E
21T21SR04E
30T21SR03E
29T21SR03E
28T21SR03E
27T21SR03E
26T21SR03E
25T21SR03E
30T21SR04E
29T21SR04E
28T21SR04E
27T21SR04E
26T21SR04E
25T21SR04E
30T21SR05E

Figure 2.3 **WSTF Topographic Map**

(SEE NEXT PAGE)

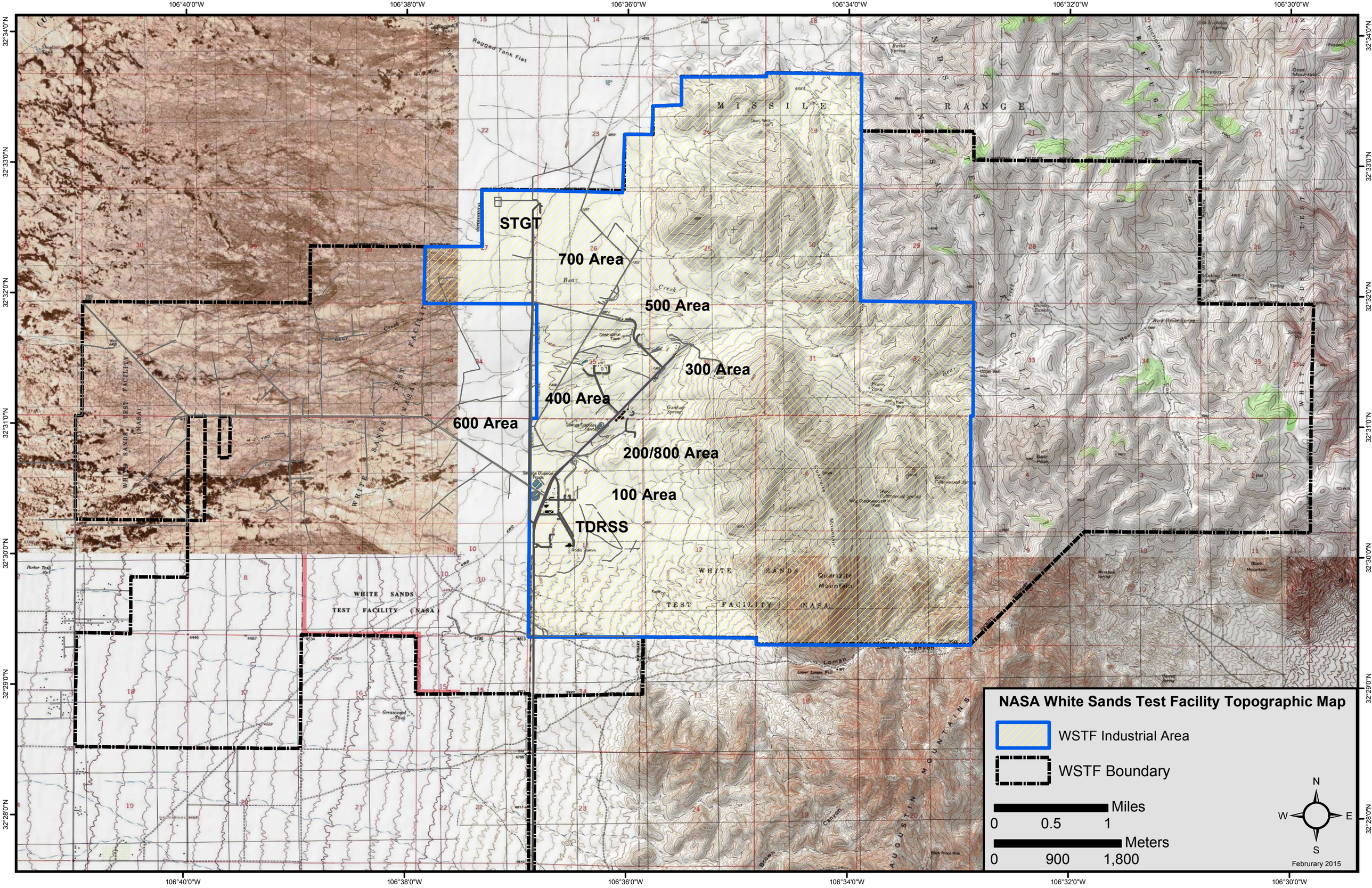

NASA White Sands Test Facility Topographic Map
WSTF Industrial Area
WSTF Boundary
Miles
0 0.5 1
Meters
0 900 1,800
N
W
E
S
Februrary 2015
STGT
700 Area
500 Area
300 Area
400 Area
600 Area
200/800 Area
100 Area
TDRSS
106°40'0"W
106°38'0"W
106°36'0"W
106°34'0"W
106°32'0"W
106°30'0"W
32°34'0"N
32°33'0"N
32°32'0"N
32°31'0"N
32°30'0"N
32°29'0"N
32°28'0"N

Figure 3.1 **STGT Area Structures**

(SEE NEXT PAGE)

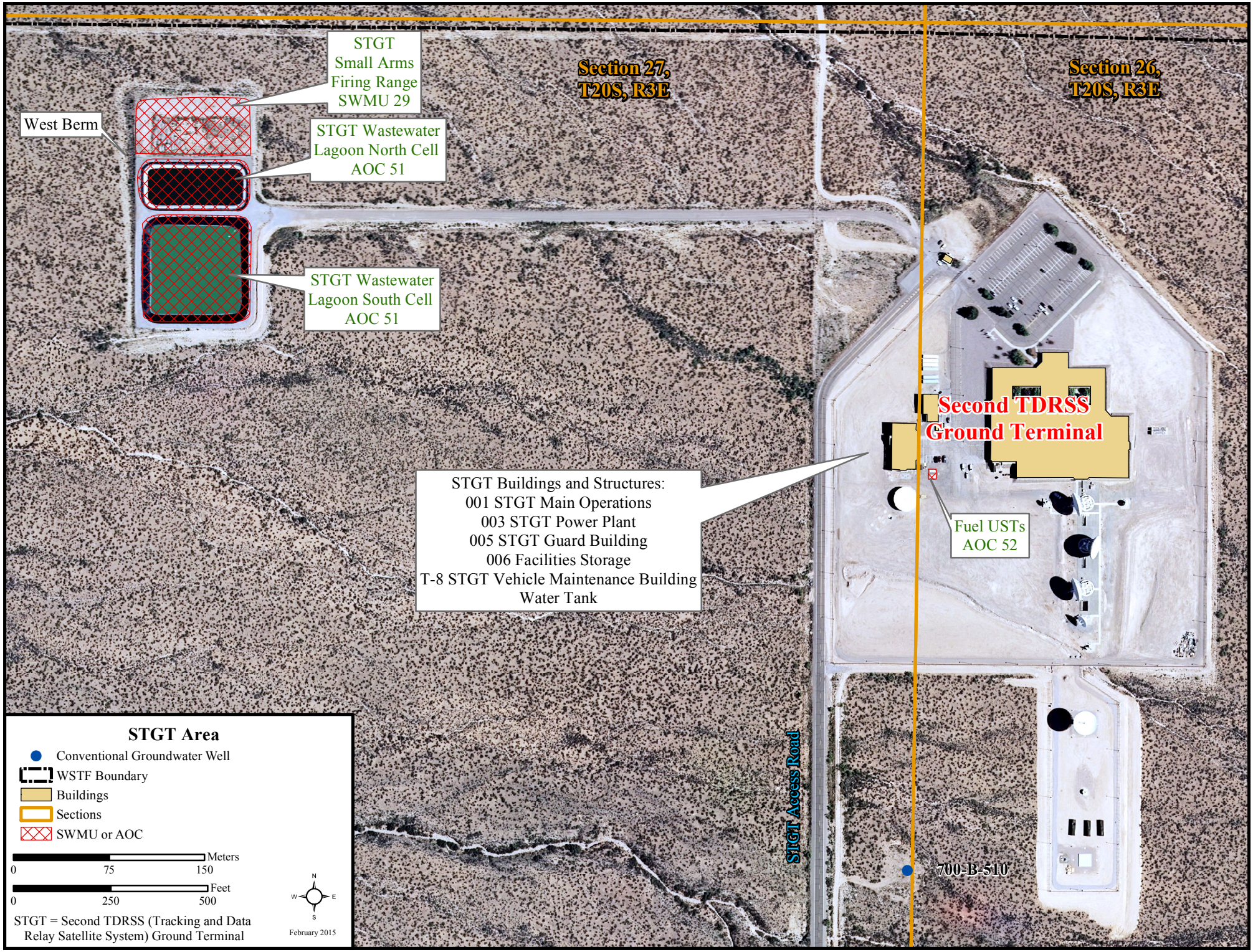

STGT Small Arms Firing Range SWMU 29
West Berm
STGT Wastewater Lagoon North Cell AOC 51
STGT Wastewater Lagoon South Cell AOC 51
Section 27, T20S, R3E
Section 26, T20S, R3E
Second TDRSS Ground Terminal
Fuel USTs AOC 52
STGT Buildings and Structures:
001 STGT Main Operations
003 STGT Power Plant
005 STGT Guard Building
006 Facilities Storage
T-8 STGT Vehicle Maintenance Building
Water Tank
STGT Access Road
700-B-510
STGT Area
Conventional Groundwater Well
WSTF Boundary
Buildings
Sections
SWMU or AOC
Meters
0 75 150
Feet
0 250 500
STGT = Second TDRSS (Tracking and Data Relay Satellite System) Ground Terminal
N
W
E
S
February 2015

Figure 3.2 **200 Area Structures**

(SEE NEXT PAGE)

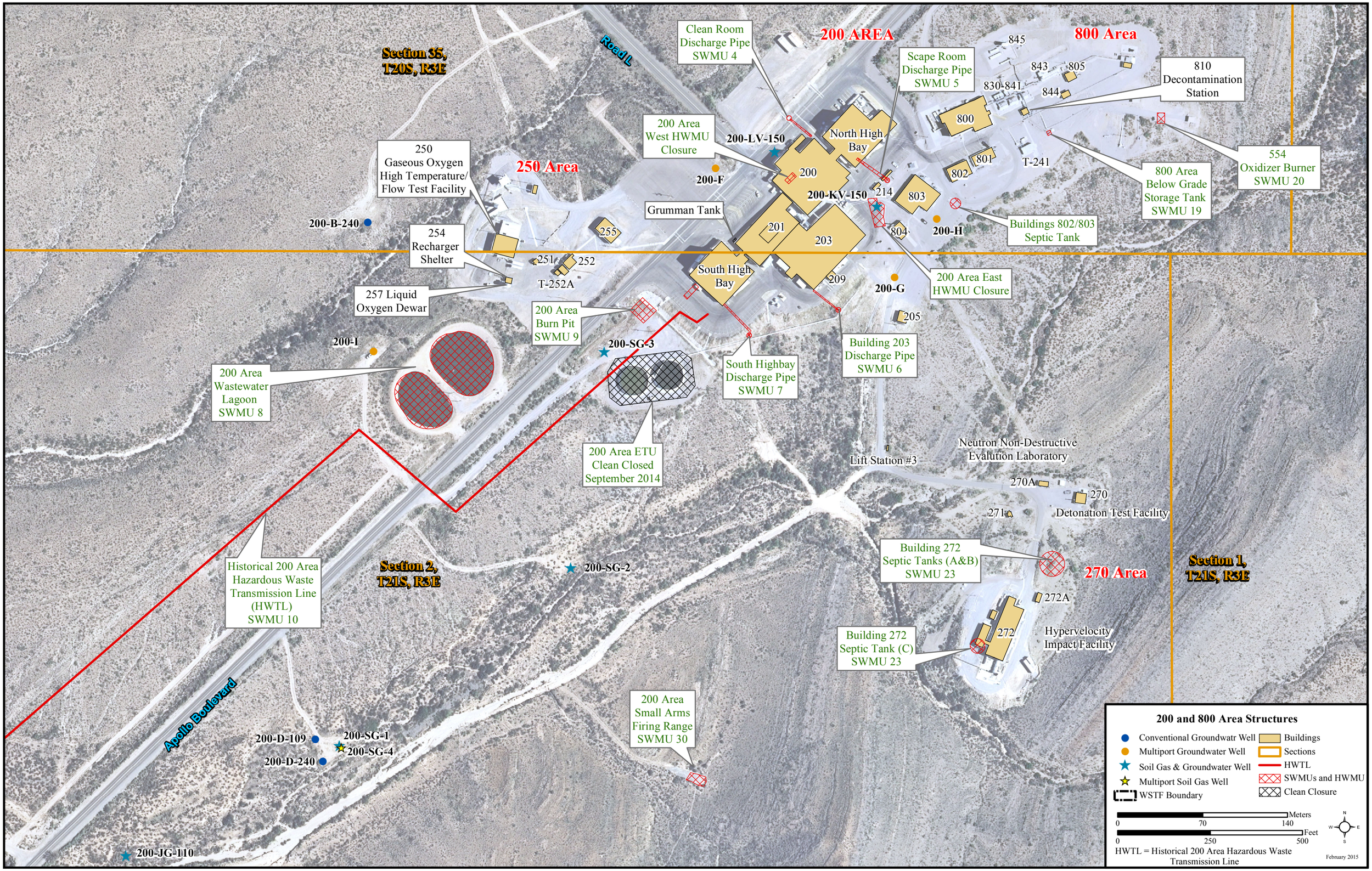

Section 35, T20S, R3E
Road L
Clean Room Discharge Pipe SWMU 4
200 AREA
800 Area
Scape Room Discharge Pipe SWMU 5
845
843
805
830-841
844
810 Decontamination Station
800
801
802
T-241
554 Oxidizer Burner SWMU 20
800 Area Below Grade Storage Tank SWMU 19
200 Area West HWMU Closure
200-LV-150
North High Bay
200
200-F
200-KV-150
214
803
Buildings 802/803 Septic Tank
250 Area
250 Gaseous Oxygen High Temperature/ Flow Test Facility
Grumman Tank
201
203
804
200-H
200-B-240
254 Recharger Shelter
255
251
252
T-252A
South High Bay
209
200-G
200 Area East HWMU Closure
257 Liquid Oxygen Dewar
200 Area Burn Pit SWMU 9
205
200-I
200-SG-3
Building 203 Discharge Pipe SWMU 6
South Highbay Discharge Pipe SWMU 7
200 Area Wastewater Lagoon SWMU 8
200 Area ETU Clean Closed September 2014
Neutron Non-Destructive Evalution Laboratory
Lift Station #3
270A
270
271
Detonation Test Facility
Building 272 Septic Tanks (A&B) SWMU 23
270 Area
Section 1, T21S, R3E
Historical 200 Area Hazardous Waste Transmission Line (HWTL) SWMU 10
Section 2, T21S, R3E
200-SG-2
272A
272
Hypervelocity Impact Facility
Building 272 Septic Tank (C) SWMU 23
Apollo Boulevard
200 Area Small Arms Firing Range SWMU 30
200-D-109
200-SG-1
200-SG-4
200-D-240
200-JG-110
200 and 800 Area Structures
Conventional Groundwatr Well
Multiport Groundwater Well
Soil Gas & Groundwater Well
Multiport Soil Gas Well
WSTF Boundary
Buildings
Sections
HWTL
SWMUs and HWMU
Clean Closure
Meters
0
70
140
Feet
0
250
500
HWTL = Historical 200 Area Hazardous Waste Transmission Line
February 2015

Figure 3.3 **100 Area Structures**

(SEE NEXT PAGE)

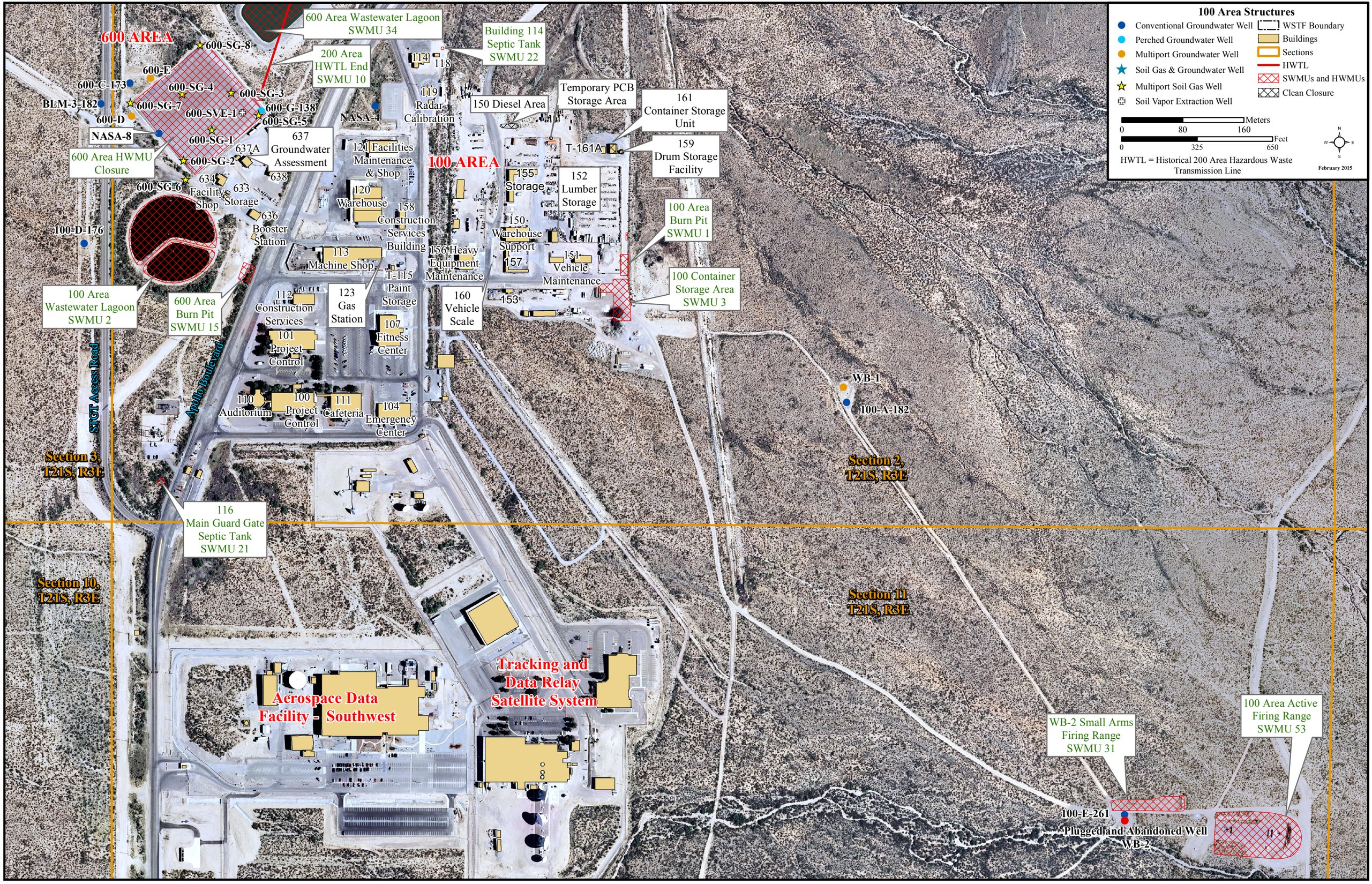

100 Area Structures
Conventional Groundwater Well
Perched Groundwater Well
Multiport Groundwater Well
Soil Gas & Groundwater Well
Multiport Soil Gas Well
Soil Vapor Extraction Well
WSTF Boundary
Buildings
Sections
HWTL
SWMUs and HWMUs
Clean Closure
Meters
0 80 160
Feet
0 325 650
HWTL = Historical 200 Area Hazardous Waste Transmission Line
February 2015
600 AREA
600 Area Wastewater Lagoon SWMU 34
200 Area HWTL End SWMU 10
Building 114 Septic Tank SWMU 22
600-SG-8
600-E
600-C-173
600-SG-4
600-SG-3
BLM-3-182
600-SG-7
600-SVE-1
600-G-138
600-D
600-SG-5
NASA-8
600-SG-1
637A
637 Groundwater Assessment
600 Area HWMU Closure
600-SG-2
634
638
600-SG-6
Facility Shop
633 Storage
636 Booster Station
100-D-176
100 Area Wastewater Lagoon SWMU 2
600 Area Burn Pit SWMU 15
114
118
119 Radar Calibration
NASA-4
121 Facilities Maintenance & Shop
120 Warehouse
158 Construction Services Building
113 Machine Shop
123 Gas Station
T-115 Paint Storage
112 Construction Services
101 Project Control
107 Fitness Center
110 Auditorium
100 Project Control
111 Cafeteria
104 Emergency Center
SR-17 Access Road
Apollo Boulevard
Section 3, T21S, R3E
116 Main Guard Gate Septic Tank SWMU 21
Section 10, T21S, R3E
100 AREA
150 Diesel Area
Temporary PCB Storage Area
161 Container Storage Unit
T-161A
159 Drum Storage Facility
155 Storage
152 Lumber Storage
100 Area Burn Pit SWMU 1
150 Warehouse Support
157
156 Heavy Equipment Maintenance
151 Vehicle Maintenance
100 Container Storage Area SWMU 3
160 Vehicle Scale
153
Section 2, T21S, R3E
Section 11 T21S, R3E
WB-1
100-A-182
Aerospace Data Facility - Southwest
Tracking and Data Relay Satellite System
WB-2 Small Arms Firing Range SWMU 31
100 Area Active Firing Range SWMU 53
100-E-261
Plugged and Abandoned Well WB-2

Figure 3.4 **WSTF Industrial Areas**

(SEE NEXT PAGE)

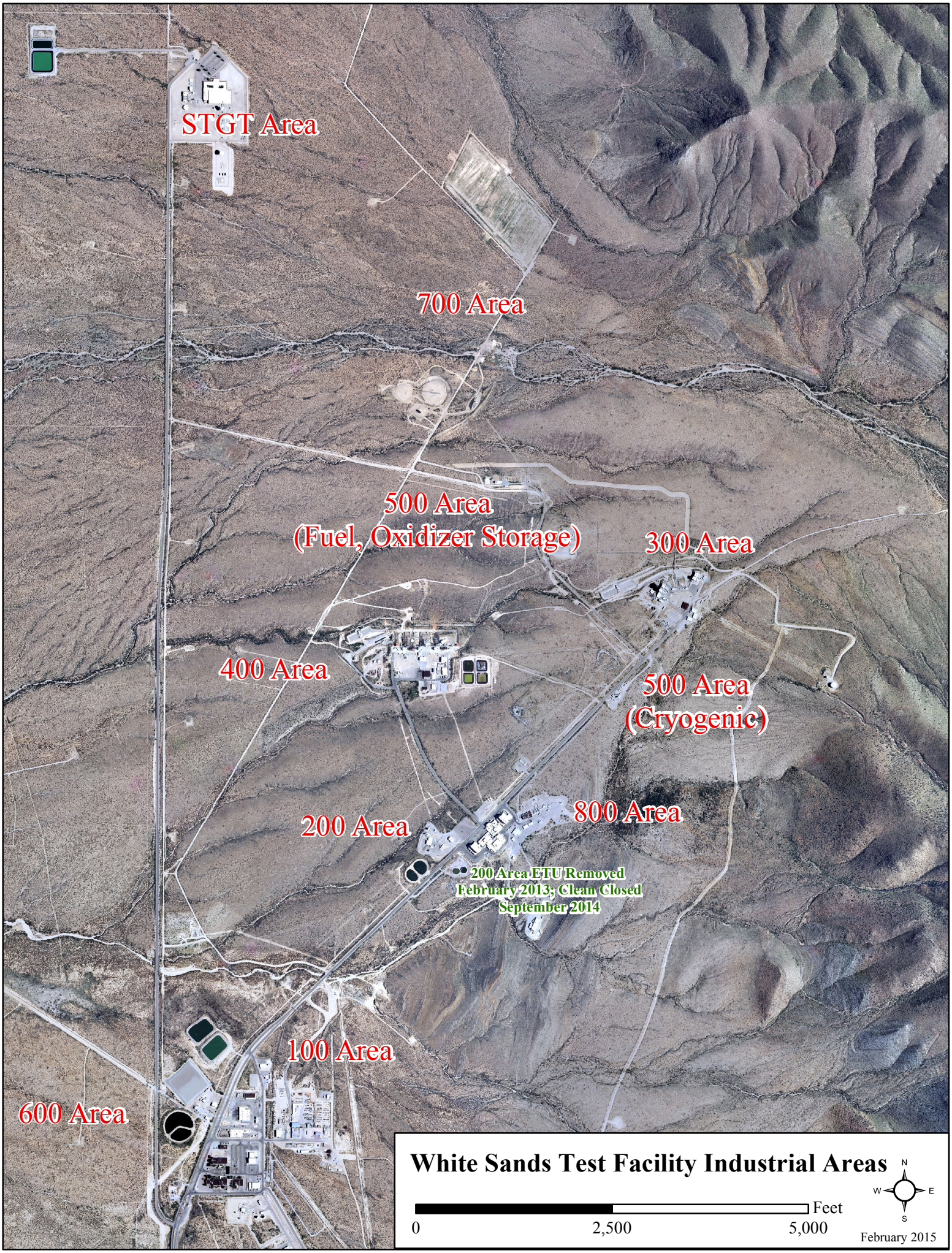

STGT Area
700 Area
500 Area
(Fuel, Oxidizer Storage)
300 Area
400 Area
500 Area
(Cryogenic)
800 Area
200 Area
200 Area ETU Removed
February 2013; Clean Closed
September 2014
100 Area
600 Area
White Sands Test Facility Industrial Areas
Feet
0
2,500
5,000
N
W
E
S
February 2015

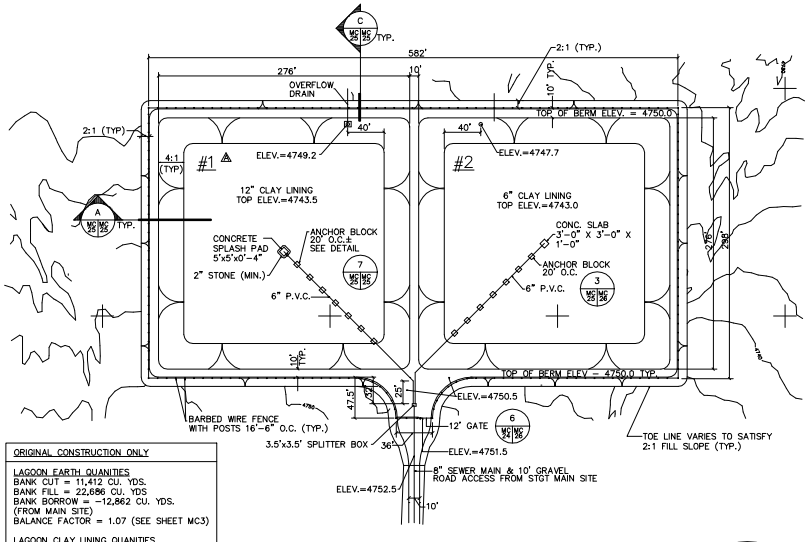
Figure 6.1 WSTF Small Arms Firing Ranges Locations

(SEE NEXT PAGE)


STGT Firing Range
SWMU 29
STGT Wastewater
(Sewage) Lagoon
STGT
700 AREA
500 AREA
300 AREA
400 AREA
200 AREA
WSTF Well Road
200 Area Firing Range
SWMU 30
600 AREA
100 AREA
N
WB-2 Firing Range
SWMU 31
Active Firing Range
SWMU 53
ADF-SW
TDRSS
Feet
0
1,000
2,000
4,000

Figure 6.2 STGT Wastewater Lagoon Plan Diagram

(SEE NEXT PAGE)

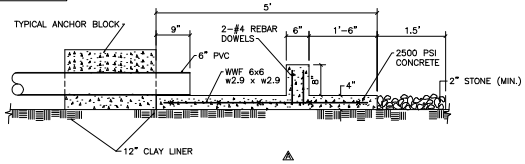


ORIGINAL CONSTRUCTION ONLY

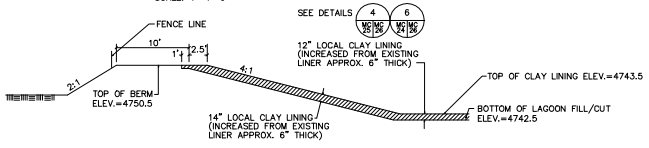
LAGOON EARTH QUANITIES
BANK CUT = 11,412 CU. YDS.
BANK FILL = 22,686 CU. YDS
BANK BORROW = -12,862 CU. YDS.
(FROM MAIN SITE)
BALANCE FACTOR = 1.07 (SEE SHEET MC3)

LAGOON CLAY LINING QUANITIES
BANK FILL = 2880 CU.YDS.
(FROM WELL ROAD CLAY SITE)
SEE SHT. MC1

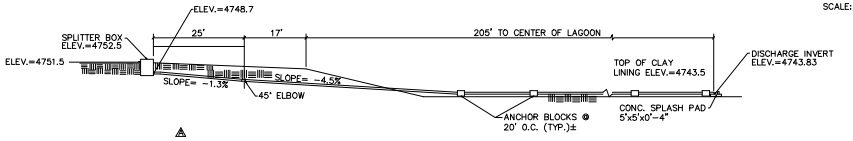
LAGOON PLAN



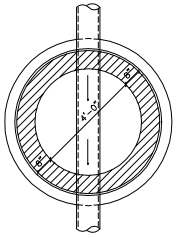
SPLASH PAD SECTION LAGOON #1 (D)
SCALE: 1"=1'-0"

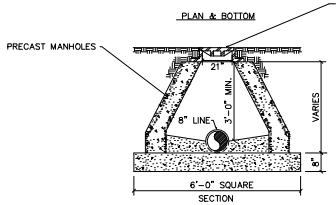


BERM SECTION LAGOON #1 (A TYP.)
N.T.S.

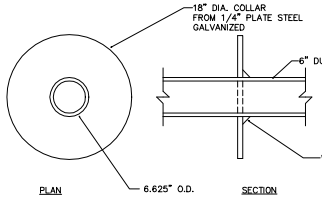


SPLITTER BOX TO LAGOON DISCHARGE PROFILE LAGOON #1
N.T.S.

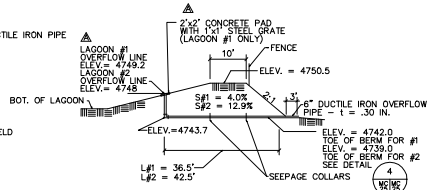




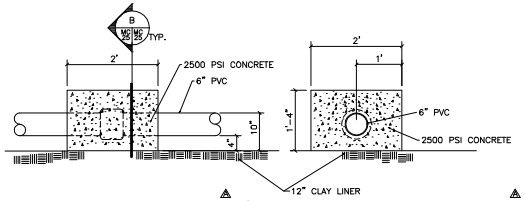
STANDARD SEWER MANHOLE SECTION (5)
N.T.S.



SEEPAGE COLLAR DETAIL (4)
N.T.S. LAGOON #1 AND #2

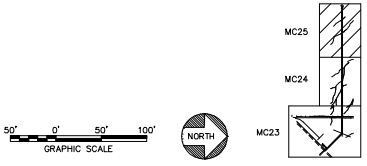


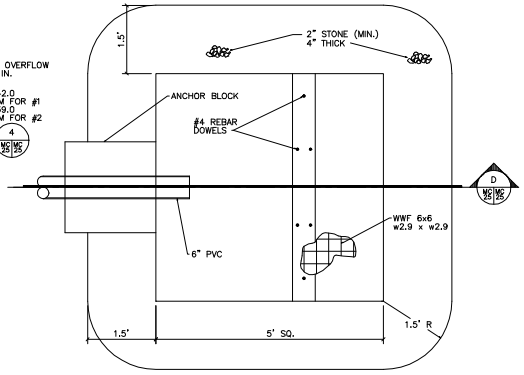
OVERFLOW DRAIN SECTION (C)
N.T.S. LAGOON #1 AND #2



ANCHOR BLOCK DETAIL LAGOON #1 (7) TYP.
SCALE: 1"=1'-0"

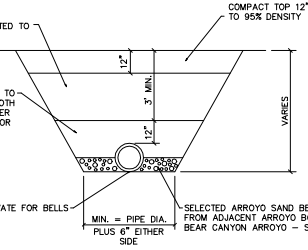
ANCHOR BLOCK SECTION LAGOON #1 (8) TYP.
SCALE: 1"=1'-0"





SPLASH PAD PLAN LAGOON #1 (D)
SCALE: 1"=1'-0"

SUPERSEDES DWG. GF-14284 & SK-534-SGT-13L-0102



TYPICAL SEWER LAGOON ROAD SECTION (3)
N.T.S.

TYPICAL PIPE TRENCH BEDDING SECTION (6)
N.T.S.

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED
	A	REVISED TO AS-BUILT STATUS - MODIFICATIONS TO LAGOON #1 PER FCR NO. SGT-13L-010		
GEN	A	REV TO AS-BUILT CONFIGURATION		

A NOTE:
ORIGINAL LAGOON CONSTRUCTION FAILED TO HOLD WATER. LAGOON #1 MODIFIED PER FCR NO. SGT-13L-010 IN 1991 AND USED FOR SEWAGE TREATMENT. LAGOON #2 IS NOT TO BE USED.

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ARCHITECTURAL & ENGINEERING SERVICES DEPARTMENT
CONTRACT NO. NAS5-31000
CAGE CODE NO. 15151

Original Design By: Stevens, Mallory, Pearl, and Campbell
Contract No. NAS5-28827
Cage Code No. 00K44

	NAME	DATE	CODE
REVISED BY			
CHECKED			
APPROVED			
APPROVED			
NASA APPROVAL			

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
SECOND TDRSS GROUND TERMINAL (STGT)
WHITE SANDS, NEW MEXICO

MAIN BUILDING
SEWAGE LAGOON
PLAN AND MISCELLANEOUS DETAILS

SIZE	CAGE CODE	DRAWING NUMBER
H	25306	GH- 1485592

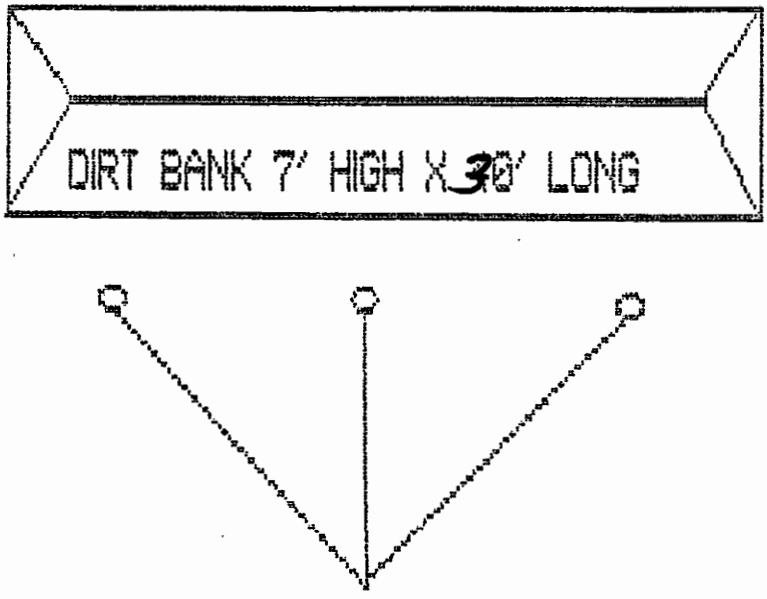
SCALE: NONE LOAD FILE MC25592 SHEET

MC25

GH-1485592 REV B

Figure 6.3 WB-2 Firing Range (SWMU 31) Dimensions

(SEE NEXT PAGE)



2" PIPE 24" LONG IN GROUND
16". FOR TARGETS TO BE PLACED,
TARGETS WILL BE 10' APART.

AREA OF PISTOL RANGE WILL BE
100' LONG AND 40' WIDE CLEAR
OF BRUSH AND LEVELED.

P 3 of 4

NASA Z Gordon 9-17-90

LESC [illegible]

1-2-FAC-2936

"QC LOG COPY"
IF THIS STAMP IS IN RED

Figure 6.4 WB-2 Firing Range and 100 Area Active Firing Range

(SEE NEXT PAGE)


WB-2 Firing Range
(SWMU 31)
Berm
100-E-261
WB-2
Active Firing Range
(SWMU 53)
Bullet Containment
and Dust Collector
Berm
Targets and
Railroad Ties
WB-2 and Active Firing Ranges
Conventional
Groundwater
Well
Plugged and
Abandoned
Well
N
Feet
0
40
80
160
February 2015

Tables

Table 6.1 Historical Small Arms Firing Ranges Summary

Parameter	STGT Range (SWMU 29)	200 Area Range (SWMU 30)	WB-2 Range (SWMU 31)
Location	Within the northern cell of the STGT wastewater (sewage) lagoon	South of the main 200 Area buildings, in between the 200 and 100 Areas	East of the Tracking and Data Relay Satellite System Facility and adjacent to groundwater monitoring well 100-E-261 and plugged and abandoned groundwater well WB-2
Operation Dates	1992-1999	1964-1990	1990-1995; 1999-2000
Design	Not designed as a firing range; Used the northern cell of the STGT wastewater (sewage) lagoon; lagoon cell was square; Used west berm of lagoon cell as backstop	No berm built; Fired east, directly into the rocky hillside as backstop; Not a leveled range – sloped down to the west; Range adjacent to several arroyos	Built specifically as a firing range; Contained a berm at the east boundary of the range used as backstop
Size	256 ft x 256 ft originally; 128 ft x 256 ft halved	50 ft x 50 ft	100 ft x 40 ft
Modifications	In 1996; range was halved (synthetically lined south half of SWMU; used since for wastewater)	Range initially unimproved; modified between 1998 and 1991: graded area, added gray gravel, installed two to three steel pipes to hold targets	No modifications
Organization and Dates Used	WSTF: 1995-1999; WSC: 1992-1999; perhaps ADF-SW: 1996-1998	WSTF: 1964-1990; WSC: 1977-1990	WSTF: 1990-1995 and 1999-2000; WSC: 1990-1992
Personnel Using Range	WSTF: 23 (2 security; 21 Fire Department); WSC: 22; ADF-SW: possibly 28	WSTF: 20 Apollo program; 22 after Apollo (1 security; 21 Fire Department); WSC: assumed to initiate a security force in 1977 when TDRSS was built. Number 22 assumed to be constant over time	WSTF: 23 (2 security; 21 Fire Department); WSC: 22
Familiarizations/ Practice	None identified	WSTF: Quarterly; rounds expended unknown; assumed to be same as qualification annually	Listed as “infrequently”

Parameter	STGT Range (SWMU 29)	200 Area Range (SWMU 30)	WB-2 Range (SWMU 31)
Qualifications	Every 6 months	WSTF: Yearly; WSC: assumed to be Yearly	Every 6 months
Estimated Rounds per Qualification	WSTF: 60 per person; WSC: 60 per person; ADF-SW: Reported as 31,000 over 2 years	WSTF and WSC: unknown, but assumed to be 100 per person based on NASA requirements.	WSTF: 1990-1993 assumed to be 100 per person; 1999-2000 assumed to be 60 rounds per person; WSC: assumed to be 100 rounds per person
Firearms Used	WSTF: 38-caliber; WSC: 38-caliber and 9 mm ADF-SW: 9 mm	WSTF: 38-caliber mostly; also 357-caliber reported; WSC: 38-caliber	WSTF and WSC: 38-caliber, 357-caliber, and 9 mm
Bullets Used	WSTF and WSC: wadcutters, semi-wadcutters, and full metal jacket; ADF-SW: unknown, but assumed to be the same as WSTF and WSC	WSTF: mostly wadcutters, but a few semi-wadcutters; WSC: unknown, but assumed to be wadcutters	WSTF and WSC: assumed to be wadcutters, semi-wadcutters, and jacketed
Bullet Weight	Assumed to be 125 grain for all; and 7,000 grains per pound (lb)		
Estimated Lead Amount	Original, larger: ~240 lbs; After 1996 for smaller: ~290 lbs to possibly 1,370 lbs (assuming ADF-SW usage 1996-1998)	~1500 to ~2250 lbs (assuming practice rounds)	570 lbs
Other Possible Contaminants	Based on MSDS for current bullets: Bullets: lead, with smaller amounts of copper, zinc, aluminum, antimony, molybdenum disulfide, and nyclad coating (some with copper jackets); Bullet casing: copper, lead, and zinc, nickel, and tin; Smokeless powder or propellant: nitrocellulose, nitroglycerin, dibuthyl phthalate, and 2,4-dinitrotoluene, and graphite powder; and Primer: copper, zinc, diazodinitrophenol, tetrazene (or tetracene), potassium nitrate, borosilicate, barium, bismuth, antimony, aluminum, nitrocellulose, nitroglycerine, and propellant (fine powder)		
Sampling	Never sampled to date	Never sampled to date	Never sampled to date
Previous Clean-Up	Never cleaned up; neither larger range nor smaller range to employee knowledge	Never cleaned up to employee knowledge	Never cleaned up to employee knowledge

Parameter	STGT Range (SWMU 29)	200 Area Range (SWMU 30)	WB-2 Range (SWMU 31)
Comments	Casual visual inspection of the SWMU showed bullets weathering out of west berm (where not blocked by current half sewage cell) and some brass bullet casings in bottom of cell	Backstop hill is very coarse-grained; Long-term personnel stated range "washed out" every time it rained and had to be "dug out" prior to using after a rain; No bullets were visible with a casual visual inspection of the SWMU; Gravel installed between 1988 and 1991 at the SWMU has washed west and south into adjacent arroyos	Casual visual inspection of the SWMU showed bullets weathering out of east berm and some brass casing in flat area; Active firing range located adjacent to the east of WB-2 range

Appendix A
Small Arms Firing Ranges (SWMUs 29-31) Interview Summaries

Appendix A
Small Arms Firing Ranges (SWMUs 29-31) Summary of Findings from Employee Interviews

Position/ Location	Significant Small Arms Firing Range Information	Other Information or Comments
Aerospace Data Facility-Southwest 1995-present (2014)	• The facility was constructed in 1983/1984. An addition to Building 10 was added in 1991, along with the gymnasium and warehouse. In 2004, another addition was constructed onto Building 10. Further modifications are planned in the future. • "ADF-SW has had a security force since opening in 1984." • During the time of operation of the historical WSTF small arms firing ranges, ADF-SW security personnel qualified on a firing range located at the White Sands Missile Range. • The employee stated that at least back to 1998, when the employee was part of the ADF-SW security force, the ADF-SW personnel did not use any historical WSTF firing range, and the employee had been told that ADF-SW personnel also did not use historical WSTF firing ranges prior to 1998 either.	• Employee was interviewed in 2012 and 2014. • Also discussed potential historical discharges to the 100 Area wastewater (sewage) lagoon.
Tracking and Data Relay Satellite System (TDRSS) 1989-present (as of 2012) and Second TDRSS Ground Terminal (STGT) 1997-present (as of 2012)	• New roofs for STGT were installed in 2002. Roof ballast (from the original roofs) was removed from the T-2 Main Operations Building and the T-3 Power Plant Building and placed in the north half (dry half) of the north STGT lagoon cell for storage. • The employee thought that water had been added to the north cell to maintain ballast for the original clay liner; and "We can't assume that the north cell was never used for sewage." • In 1996, the lagoon was cut in half and the south half was synthetically lined. • The north cell of the STGT lagoon was used historically as a small arms firing range, but the employee did not remember the exact dates. Bullets were fired into the west berm of the lagoon.	• Employee was interviewed in 2012. • Also discussed potential historical discharges to the 100 Area and STGT wastewater (sewage) lagoons and a historical underground diesel storage tank spill.
TDRSS and STGT 1997-present (as of 2012)	• This employee also stated that the north cell of the STGT wastewater lagoon may have had water added to maintain ballast. • The north cell of the STGT lagoon was used as a small arms firing range, but the employee did not know the exact dates. • Half of the lagoon was later lined with a synthetic liner and is currently used as a sewage lagoon. • Roof rock and a brush pile are currently located in the north half (dry half) of the north cell of the STGT lagoon.	• Employee was interviewed in 2012. • Also discussed potential historical discharges to the STGT wastewater (sewage) lagoon.

Appendix A
Small Arms Firing Ranges (SWMUs 29-31) Summary of Findings from Employee Interviews

Position/ Location	Significant Small Arms Firing Range Information	Other Information or Comments
~25 Years TDRSS and STGT	• The north cell of the STGT wastewater lagoon was used as a small arms firing range, mostly for White Sands Complex personnel. The employee did not remember the exact dates. • "Prior to using the lagoon the firearms qualifications were conducted near the hypervelocity – to the southeast of the 200 Area." • The STGT small arms firing "range was used primarily by WSC personnel." The employee stated that the Air Force personnel may have used it briefly, "not more than four or five times for their qualifications." • The employee stated that the WSC and WSTF security personnel were consolidated in approximately 1998. WSTF managed the security force at that time. • The employee believed that the north cell of the STGT lagoon may have been used for sewage (but could not be sure) prior to the installation of the synthetic liner in half of the cell. • The employee stated that the smaller north cell half was used as a firing range approximately 5 years after STGT began use and was used for approximately six to eight years, until WSC personnel began using the new firing range at WSTF (with bullet containment). • The employee stated that the WSC personnel did not use the new WSTF firing range at first, but continued using the STGT range (for several years).	• Employee was interviewed in 2012.
WSTF Security Supervisor 1991-2005	• The employee stated that originally there was one security guard that manned the main WSTF gate. Later, there were two security officers that worked at the main gate. "The firefighters used to provide back-up for site security needs and also performed roving security duties. The firefighters used to qualify with weapons." • After September 11, 2001, security forces at WSTF were increased to approximately 21 personnel, staffing WSTF 24 hours per day, 7 days per week. The firefighters then ceased security functions at WSTF. • Use of the 200 Area small arms firing range "occurred before I ever came to WSTF". "We never used this range during my time at WSTF" [1991-2005]. • "WSTF typically fired at the 100 Area range and I know that we also fired at the STGT range a few times over the years prior to our creating a more formal range." The employee believed the current firing range was built in 2002. [2000, provided by work authorizing documents.] • Personnel always fired into berms (STGT and 100 Area ranges). "We occasionally had to get a grader to build up our berms as they wore down with time and weather."	• No additional comment

Appendix A
Small Arms Firing Ranges (SWMUs 29-31) Summary of Findings from Employee Interviews

Position/ Location	Significant Small Arms Firing Range Information	Other Information or Comments
	• WSTF, WSC and Air Force security forces all used to train separately. "WSTF used the range adjacent to the current bullet catcher in the WSTF 100 Area, and WSC used the range within the north sewage lagoon at STGT. Prior to my arrival I know that they used to qualify at the 200 area range." • Always used lead bullets. • "We didn't get rifles until after we had the bullet catcher in place." • "All three organizations used smaller caliber pistols." WSTF used 0.38 caliber pistols then transitioned to Glock 9 mm. • "The Air Force always had 12 gauge shotguns" as well as small caliber pistols. • "Ranges were used every 6 months for qualifications." • The employee stated that for WSTF, there were 21 firefighters and 2 security officers that qualified with weapons and WSC had approximately 22 security officers qualifying as well. The employee did not know Air Force employee qualification information. • Each qualifying employee shot per the NASA requirements [which listed 100 rounds]. • The WSTF and WSC security forces were combined for several years (perhaps in 1999 to 2001 or 2002, the employee believed); however, "This change did not affect the number of times that we went to the range or the total number of officers." • The entire north cell of the STGT lagoon was used as a firing range. Then when the synthetic liner was placed in half of the lagoon, the remaining portion of the lagoon cell continued use as a small arms firing range. • The employee believed that use of the STGT small arms firing range ended when the WSTF and WSC security forces were consolidated. Then both groups (and the Air Force) used the firing range at the 100 Area [WB-2 range, SWMU 31]. "We transitioned all of the security force qualifications onto the WSTF range." • The employee stated that use of SWMU 31 ended when the current firing range with bullet containment began use.	
WSTF Security/ Firefighting 1994-present (2014)	• The employee used the small arms firing range at STGT when he was hired at WSTF for several qualifications (at least one year). • Then later, qualifications had been conducted at the WB-2 small arms firing range (SWMU 31).	• Employee was interviewed in 2012.

Appendix A
Small Arms Firing Ranges (SWMUs 29-31) Summary of Findings from Employee Interviews

Position/ Location	Significant Small Arms Firing Range Information	Other Information or Comments
	• The employee stated that qualifications were conducted in April and October of each year.	
WSTF Security 1996-present (as of 2012)	• "I qualified on that range [STGT small arms firing range] in December 1996, and I believe the last time we used it was sometime in June 2000 but I am sure it was the same time that the new WSTF range was opened." • "Theres burms [sic] which were used as the barrier for down range." • "As far as I know that range had always been there."	• Employee was interviewed in 2012.
WSTF Security 1993-2011	• The employee was a firing range instructor from late 2000 until 2011. • When the employee began working at WSTF, qualifications for fire arms were conducted at the STGT small arms firing range (SWMU 29) in the empty northern lagoon cell. • Bullets were fired into a berm at the far end of the range/lagoon. The berm was approximately 15-20 ft high. • The employee did not know when the STGT small arms firing range began use, but at least from 1993 (when the employee began working at WSTF) until 1999 (when use of the WB-2 firing range began). • Then qualifications were performed for WSTF personnel at the WB-2 small arms firing range (SWMU 31). • The firing ranges were used sequentially, and not concurrently. Once use of the 100 Area range began, use of the STGT range ended. • Only used the SWMU 31 small arms firing range approximately 2 years from 1999 to 2001. Then the new firing range began use (with the bullet containment system). • Only Smith and Wesson 0.38 caliber revolvers were fired at the small arms firing ranges with lead bullets. • WSC personnel began using the active new firing range with bullet containment system when the firing range first became operational (at the same time as WSTF personnel).	• No additional comment
WSTF Engineering 1974-2003	• There was always just one security guard historically. • The WSTF Fire Department provided back-up and after-hours security functions. • The firing ranges were never cleaned up to the employee's knowledge.	• No additional comment
WSTF 200 Area and	• The employee estimated that the STGT firing range stopped use "around the time the liner was put in." [There were two liners installed. One in 1996 and one in 2006.]	• No additional comment

Appendix A
Small Arms Firing Ranges (SWMUs 29-31) Summary of Findings from Employee Interviews

Position/ Location	Significant Small Arms Firing Range Information	Other Information or Comments
Environmental Department 1978-present (2014)		
Environmental Department 1999-present (2014)	• The employee believed that no clean-up activities have been conducted at any of the small arms firing ranges to date.	• No additional comment
WSTF Facilities 1978-present (2014)	• "A lot of ballast water" had been added to the STGT wastewater lagoon historically. Personnel "had heard" that the north cell was not used for wastes prior to synthetic liner installation. • The employee had not performed or heard of any clean-up activities at any of the historical small arms firing ranges.	• No additional comment
WSTF Facilities and Engineering 1976-present (2014)	• "Before the current firing range was built, there was a firing range south of Apollo Blvd between the 100 & 200 Areas. As I recall, it had no improvements, and portable targets were set up in front of a hillside so that the firing was to the southeast into the hillside." • "…this firing range may have been abandoned when the current firing range was constructed." • The employee never saw any lead recovery efforts for any of the firing ranges since he began working at WSTF in 1976.	• No additional comment
Environmental Department 1985-2005	• The north STGT lagoon cell "was never used as a lagoon while I supported STGT" [from the inception of STGT in 1988 to 2005]. • "You should be able to verify the use as a firing range by sifting the west bank of the unit for bullets" [the entire west bank, not just the empty northern half]. • The employee stated that to estimate the amount of lead in the small arms firing ranges, use the number of bullets fired and the bullet weight (in grains) of the type of bullet fired. "There are 7000 grains in a pound." • In 1998, ADF-SW personnel stated that 15,000 rounds were fired in the STGT small arms firing range (SWMU 29) over the two previous years.	• 200 Area history and wastewater lagoon was also discussed.
WSTF 400 Area 1985-1992; Environmental Manager	• The employee stated that WSC, Air Force, and WSTF security personnel began using the new firing range with bullet containment as soon as the range was ready for use, "since the ADF and WSC requirements drove the design."	• No additional comment

Appendix A
Small Arms Firing Ranges (SWMUs 29-31) Summary of Findings from Employee Interviews

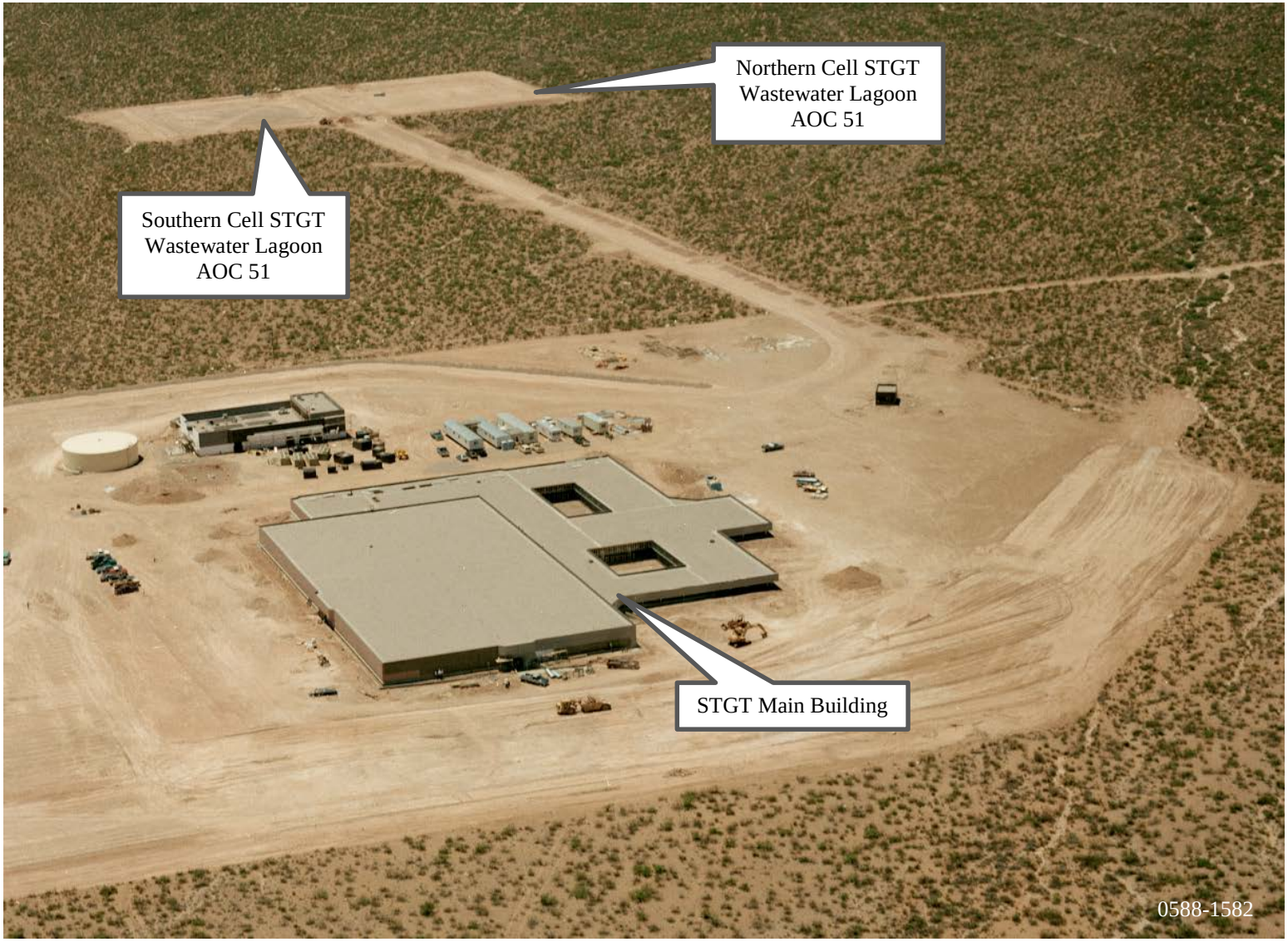
Position/ Location	Significant Small Arms Firing Range Information	Other Information or Comments
1992-2001		
WSTF Fire Department late 1963-1996	• The employee stated that beginning in 1964 with the full use of the WSTF site, there were approximately 20 security personnel that worked for the Zia Company (contractor). • There were "guard shacks" in most of the WSTF industrial areas (200, 300, 400, main gate-Building 116). Security personnel occupied the guard posts in 8-hour shifts, 24-hours per day. • These security personnel practiced and qualified for small arms use at the 200 Area small arms firing range (SWMU 30). The employee did not know how often or how many rounds these security personnel used; however, the employee guessed that it was similar to what was later conducted in 1971. • When the Apollo program was completed and the Zia Company departed WSTF in 1971, only one full-time security employee remained. This employee provided security for the WSTF main gate (Building 116) during the daytime. • All the WSTF Fire Department personnel were security personnel after hours beginning in 1971 and continuing at least until the employee retired in 1996. There were approximately 20 Fire Department personnel. Therefore, the overall number of personnel performing security activities at WSTF remained approximately constant. • Each Fire Department employee was required to qualify once per year, but practiced at the 200 Area small arms firing range (SWMU 30) quarterly. The employee did not know the quantity of rounds expended in quarterly firearms practice per employee. • Qualifications records were not retained, and no records were generated regarding how many bullets/rounds were used for quarterly small arms practice. Originally, there were purchase records for bullets. [However, no records were located.] • For qualification, a Las Cruces police department and certified small arms trainer came to WSTF and certified the Fire Department (and the one or two security) personnel. • The 200 Area small arms firing range (SWMU 30) was originally unimproved. It was located at the base of a hill, and bullets were fired to the east, using the hillside as a backstop. No berm was ever constructed. • The brass casings were generally picked up, but the bullets remained in the hillside. • "Wadcutters," flat lead bullets, were used so that the bullet would tear a hole in the target so a "hit" would be easily visible.	• No additional comment

Appendix A
Small Arms Firing Ranges (SWMUs 29-31) Summary of Findings from Employee Interviews

Position/ Location	Significant Small Arms Firing Range Information	Other Information or Comments
	• Personnel used portable tables to load guns, and hold equipment when setting up. Portable poles made of wooden 2x4s were used to set up targets. • Used targets and wooden poles were burned for fire-fighting training in the fire training area (east 100 Area). • Fire arms used were .357 magnums and .38 Specials. Bullets were lead "with brass coatings." Qualifications were always performed with flat "wadcutters." • Use of the 200 Area small arms firing range began in 1964 and continued until the WB-2 firing range (SWMU 31) was constructed. Once the 200 Area range was abandoned, it was not used again. • "The mountain would slough in the rain, and we would have to dig out the range before we could use it the next time." Removed soil/rock was placed adjacent to the firing range. • Use of the 200 Area small arms firing range (SWMU 30) ended due to the desire of the Fire Department personnel for a flatter, better designed firing range that would not need maintenance after every rain. • The employee believed that the TDRSS guards used the range (and maybe the WB-2 range) until STGT was built, then began using that small arms firing range (SWMU 29). • The WSC and WSTF guard forces were not consolidated while the employee worked at WSTF (up to 1996). WSC, WSTF and Air Force security personnel trained separately.	

Appendix B
Small Arms Firing Ranges (SWMUs 29-31) Historical Photographs

Figure B.1 STGT Area Under Construction (1988) – view to the west

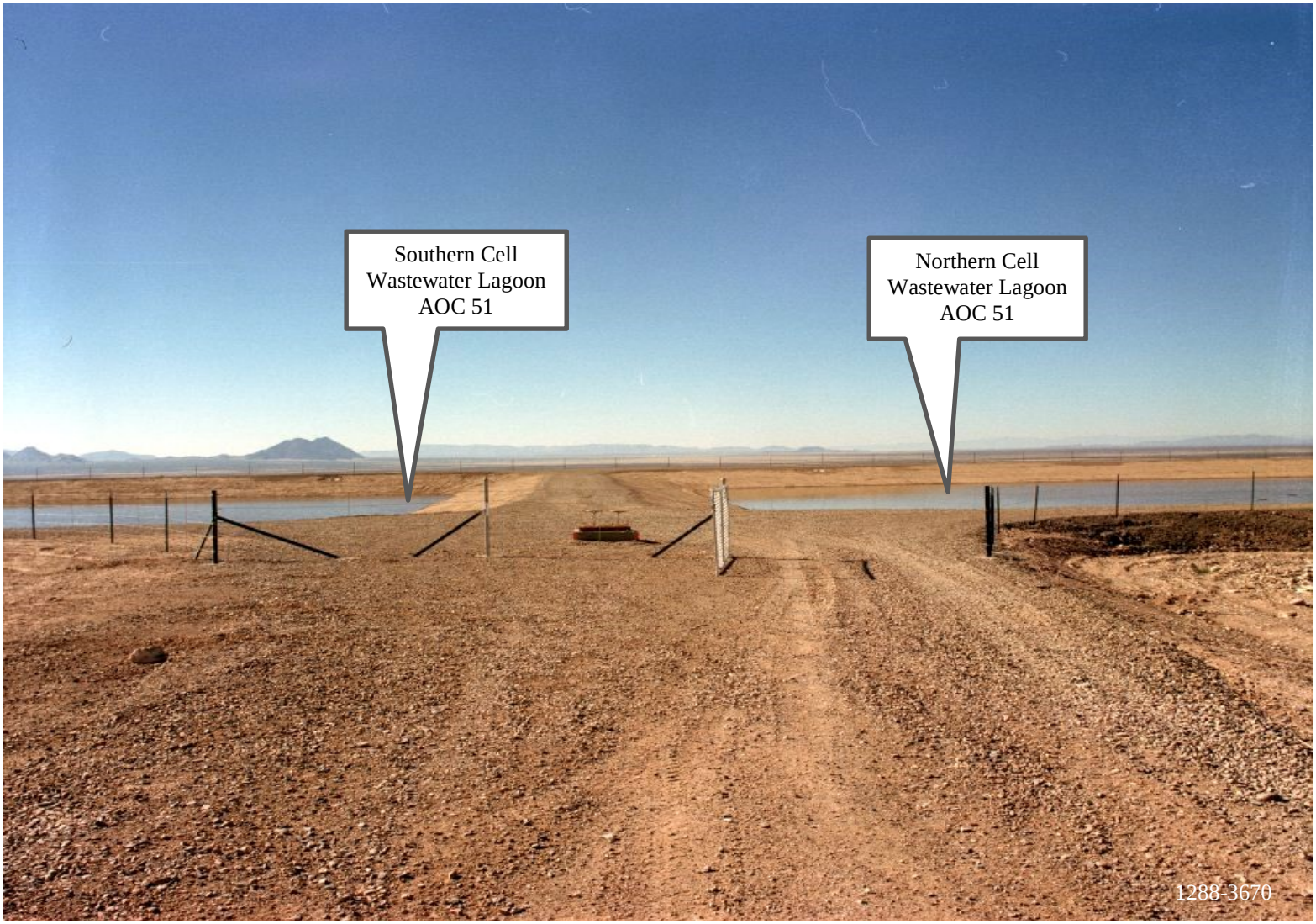


This photograph shows the STGT Area still under-going construction in 1988. Notice the wastewater (sewage) lagoon is also under construction.

Figure B.2 STGT Wastewater Lagoon (1988) – view to the west

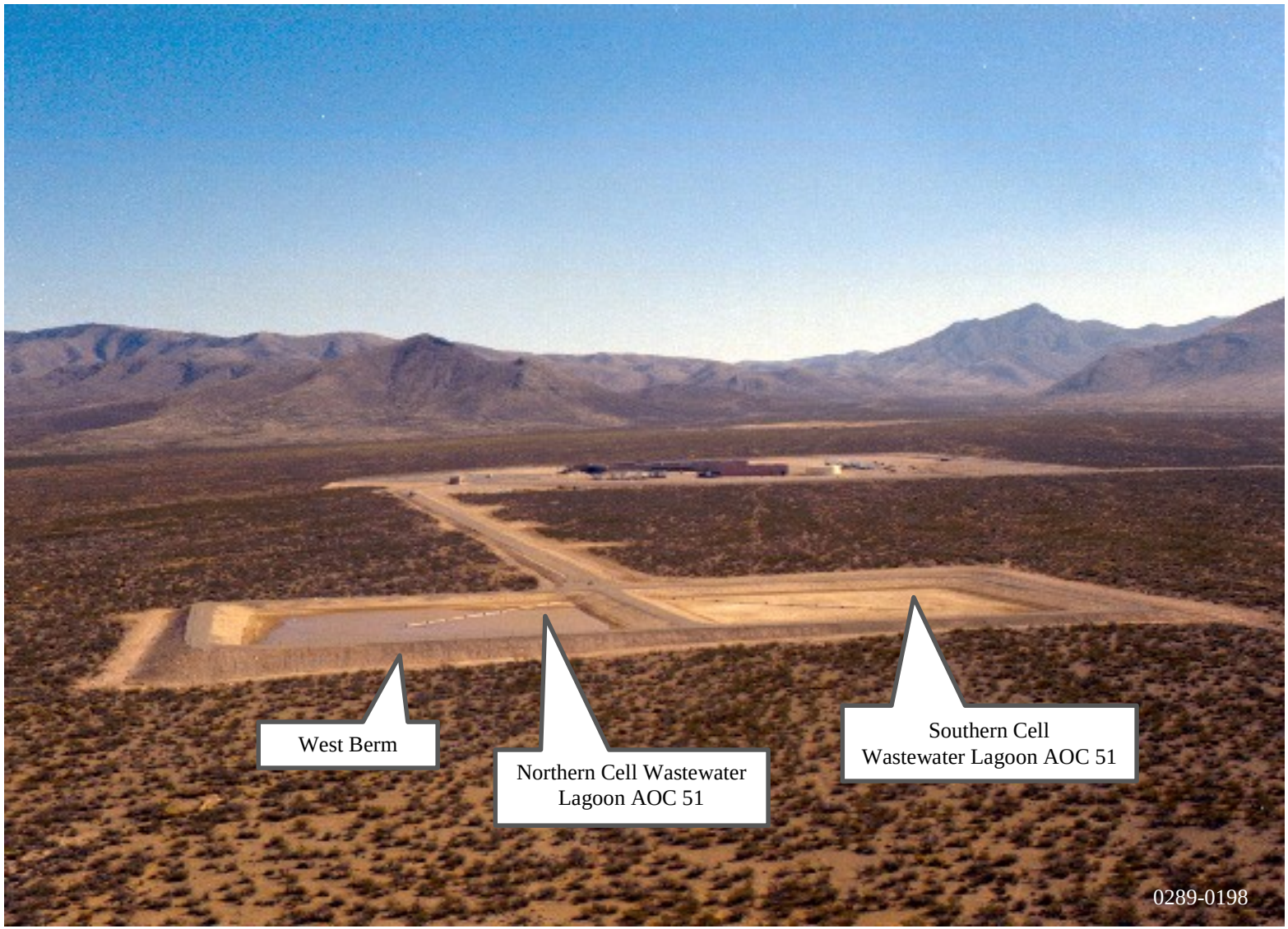
This photograph shows the STGT wastewater lagoon under construction in May 1988.

Figure B.3 STGT Wastewater Lagoon (1988) – view to the west



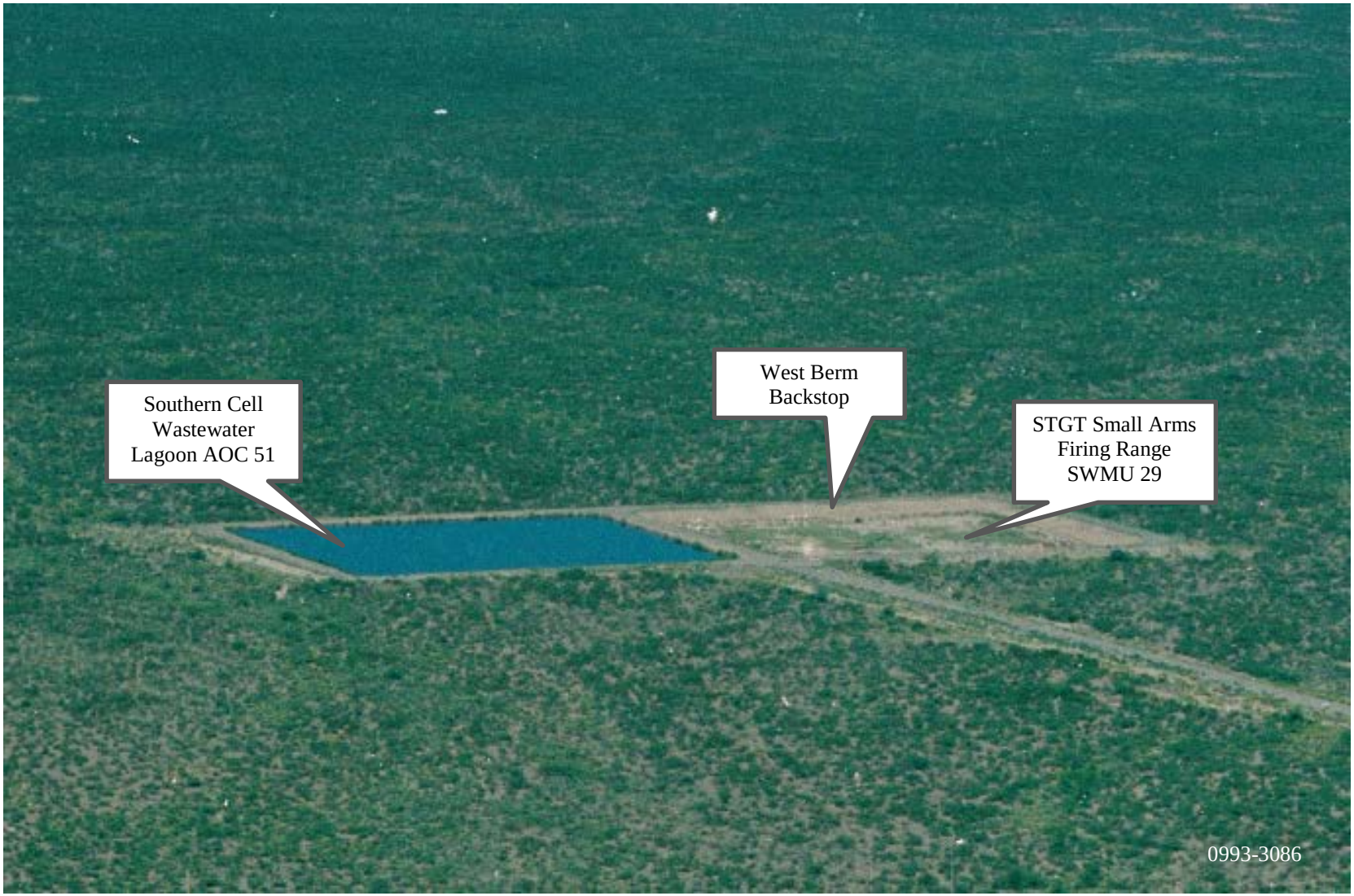
This photograph shows the STGT wastewater lagoon in December 1988. This photograph is believed to be showing potable ballast water within the cells during leak testing after initial construction.

Figure B.4 STGT Wastewater Lagoon (1989) – view to the east



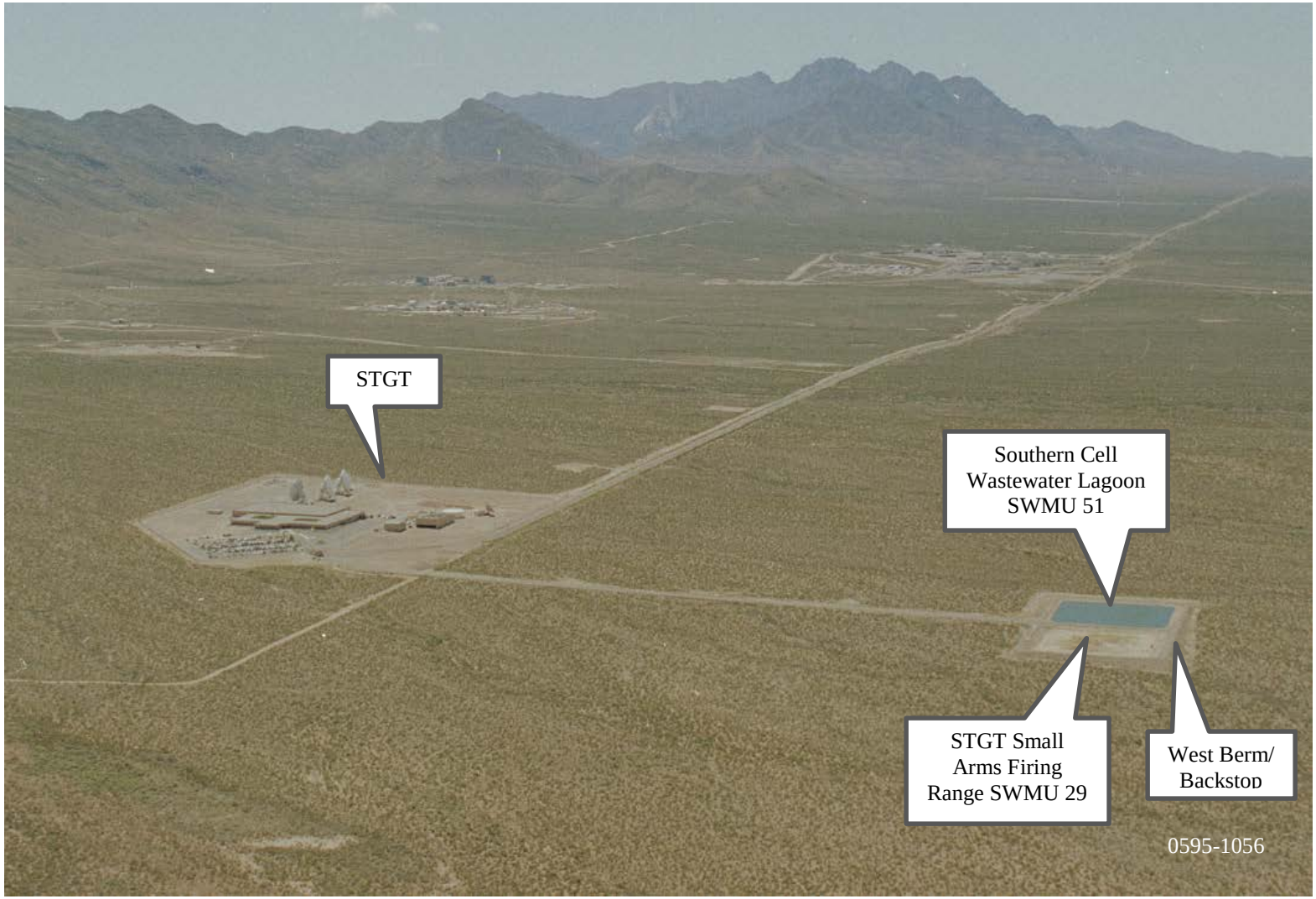
This photograph shows the STGT wastewater lagoon in February 1989. Notice the northern cell contains water, which is likely ballast water during lagoon testing. Original piping is still present in both cells of the lagoon.

Figure B.5 STGT Wastewater Lagoon and Firing Range (1993) – view to the west



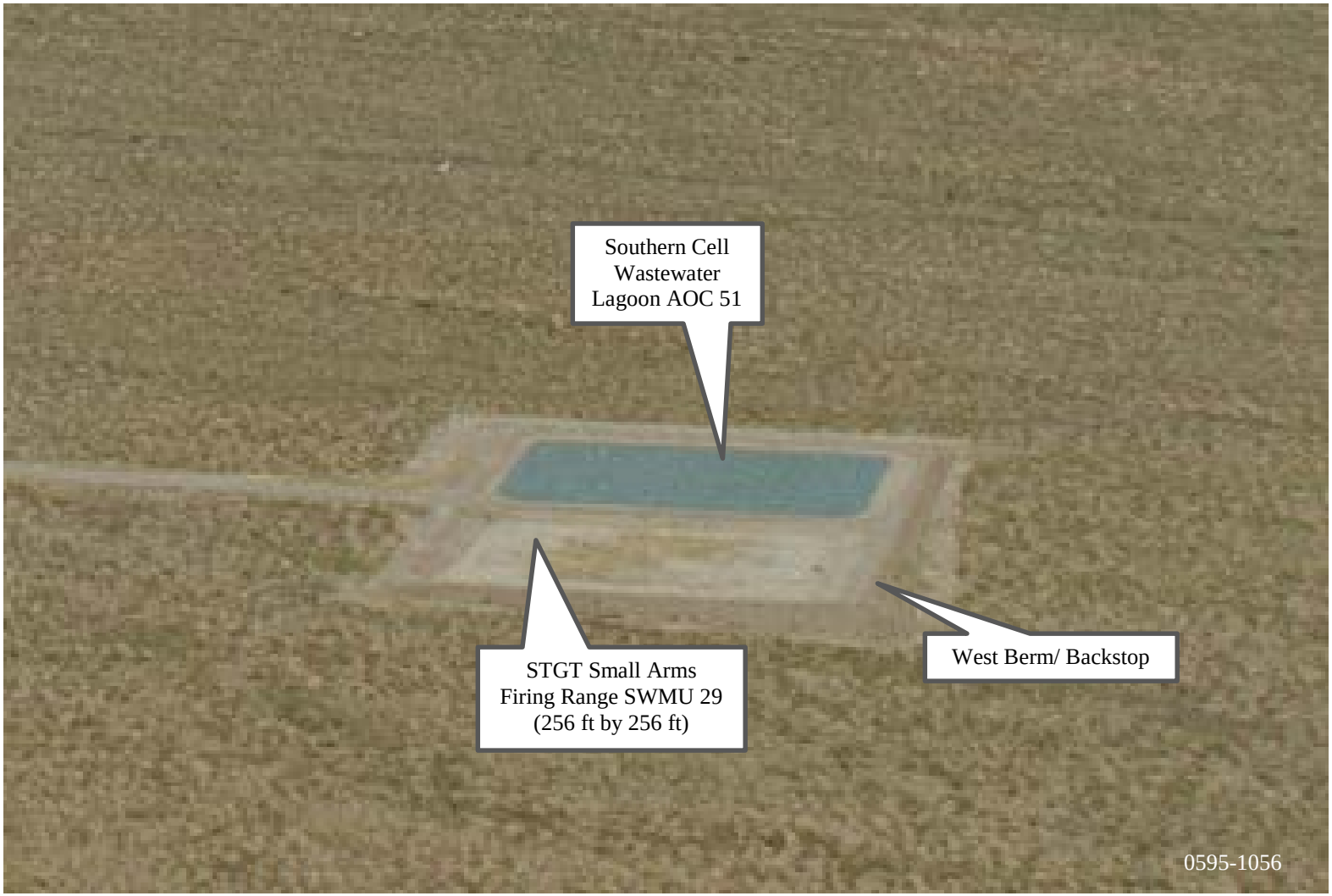
This photograph shows the STGT wastewater lagoon and the STGT small arms firing range (SWMU 29) in September 1993. Notice the southern cell of the wastewater lagoon is in service. The west berm backstop of the firing range is visible.

Figure B.6 STGT Area (1995) – view to the southeast



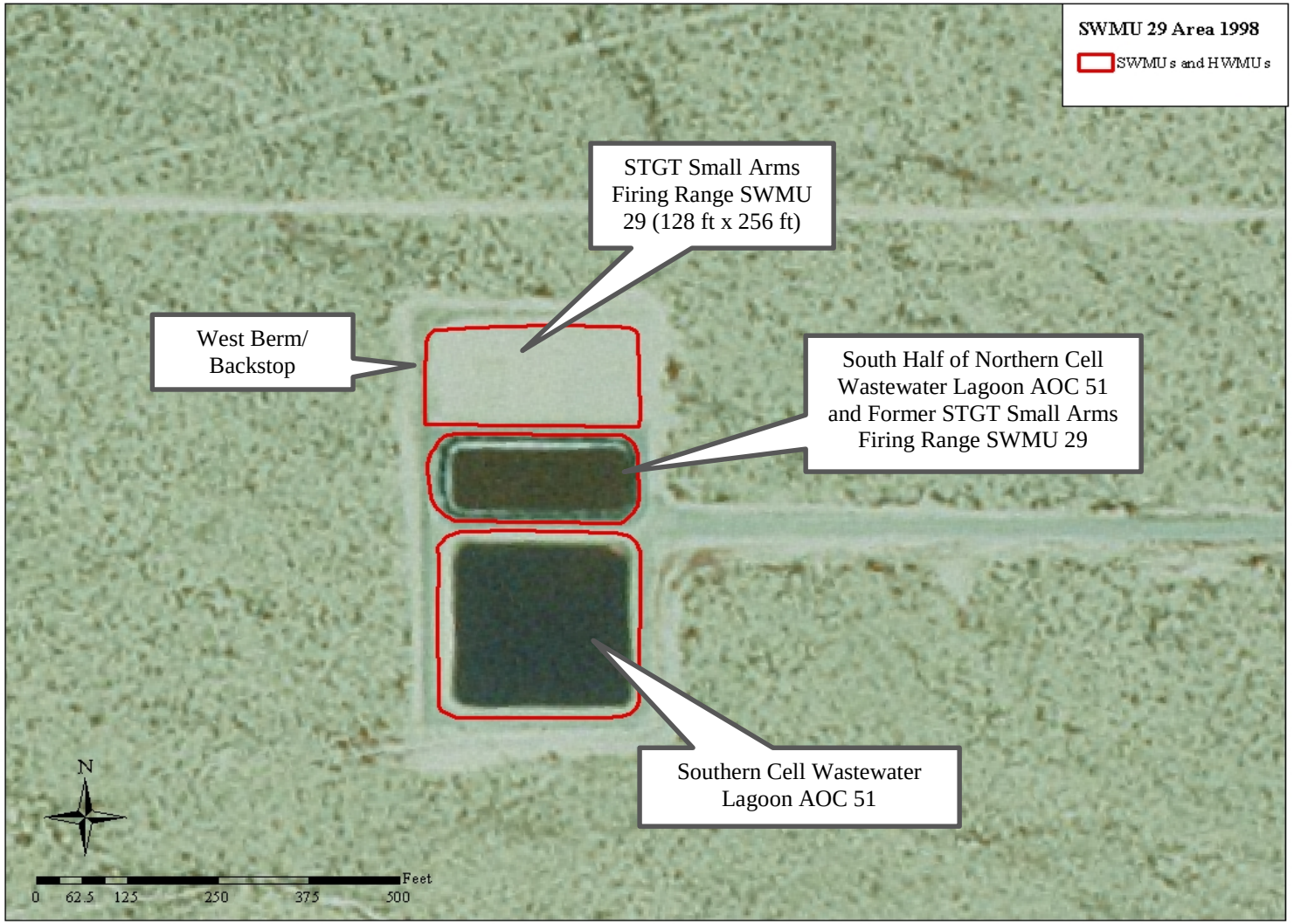
This photograph shows the STGT wastewater lagoon (south cell) and the STGT small arms firing range (SWMU 29) in May 1995. Notice the west berm of the former lagoon cell that was used as a firing range backstop.

Figure B.7 STGT Small Arms Firing Range (1995) – view to the south



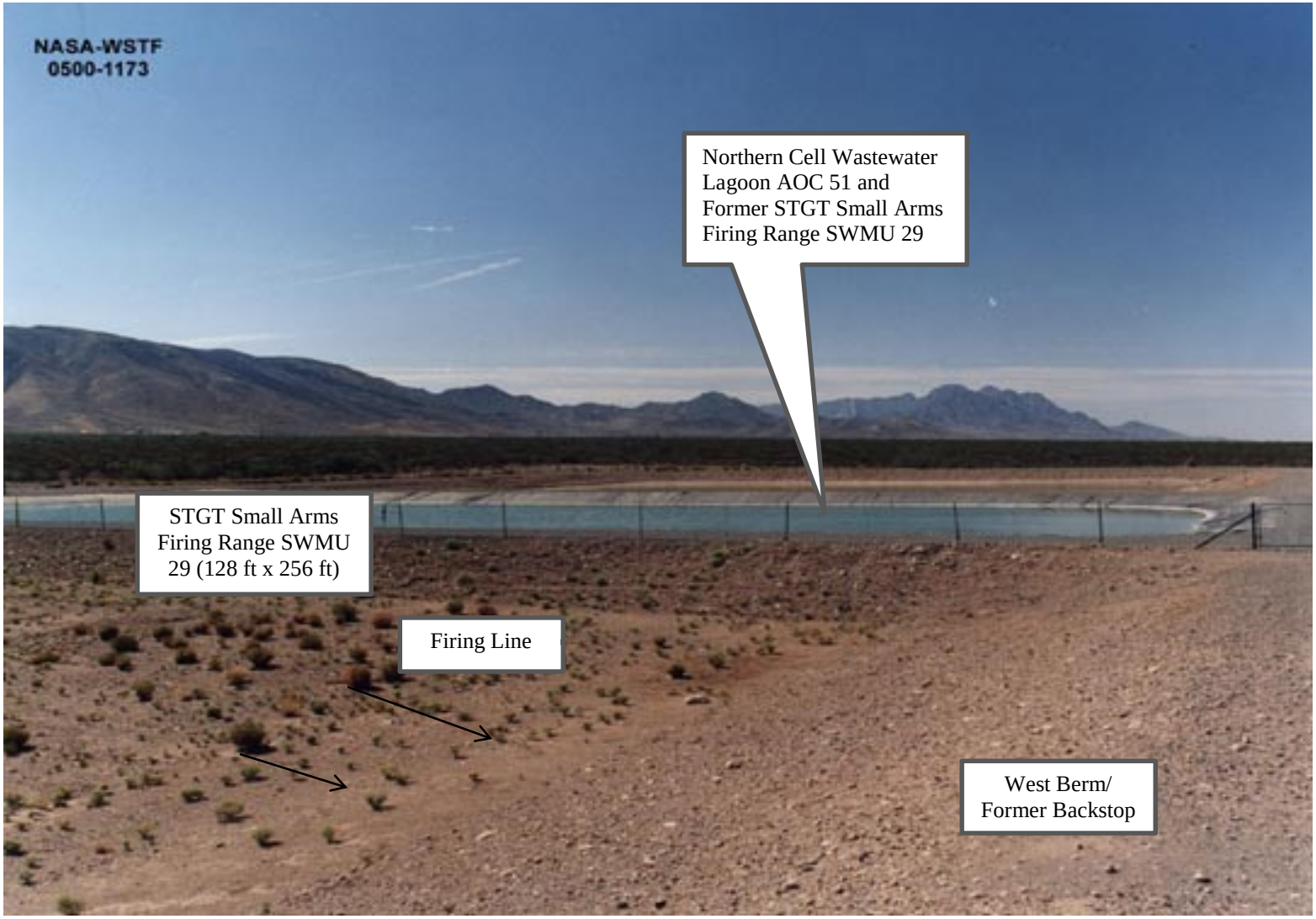
This photograph shows the STGT southern cell of the wastewater lagoon and the STGT small arms firing range in May 1995. Security personnel stood in the small arms firing range facing west and fired handguns toward the west berm/backstop.

Figure B.8 STGT Small Arms Firing Range (SWMU 29; 1998)



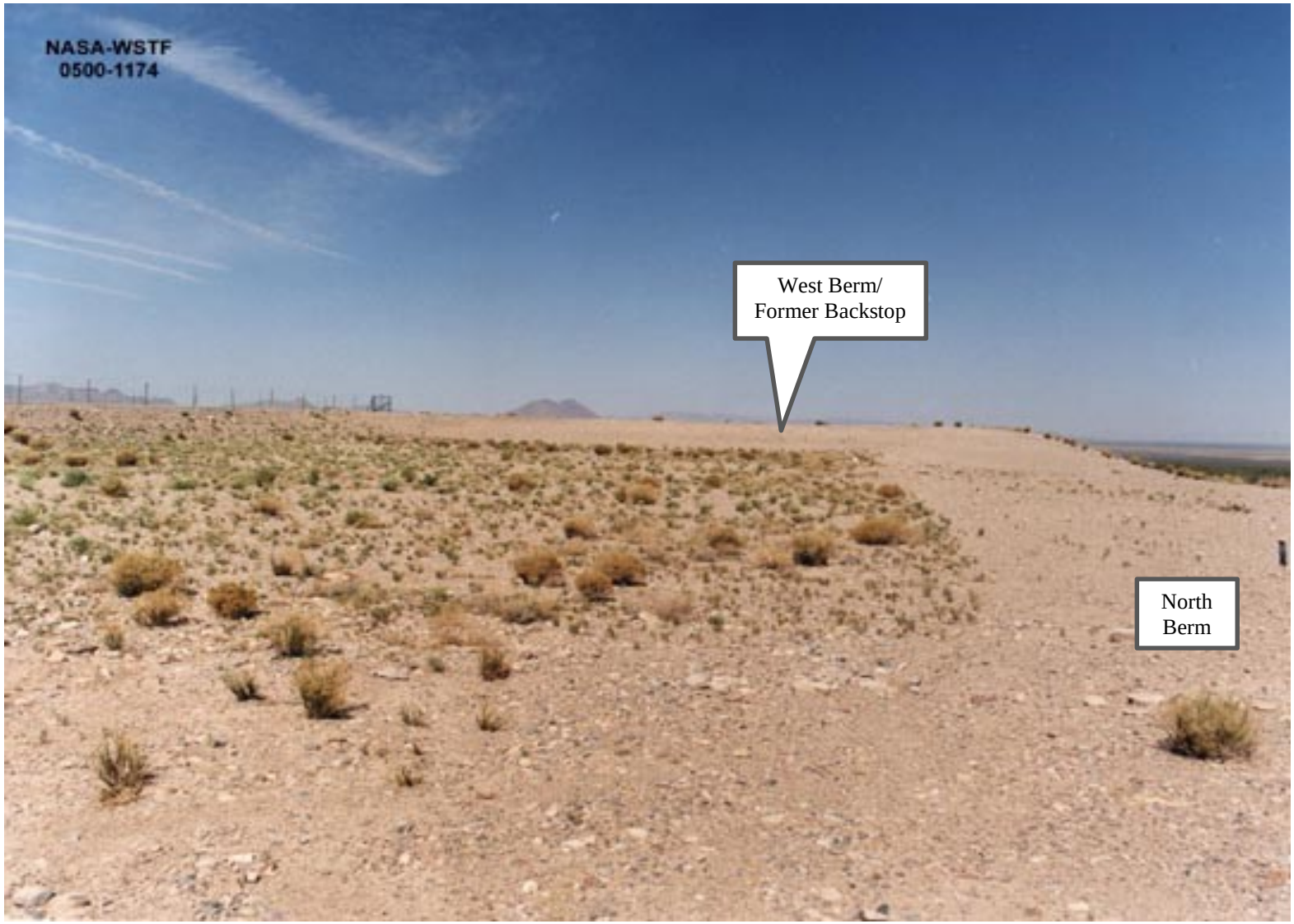
This photograph shows the STGT small arms firing range (SWMU 29) in 1998. The firing range is now half of the original size, and the northern cell wastewater lagoon was installed over a portion of the former firing range.

Figure B.9 STGT Small Arms Firing Range (SWMU 29; 2000) – view to the southeast



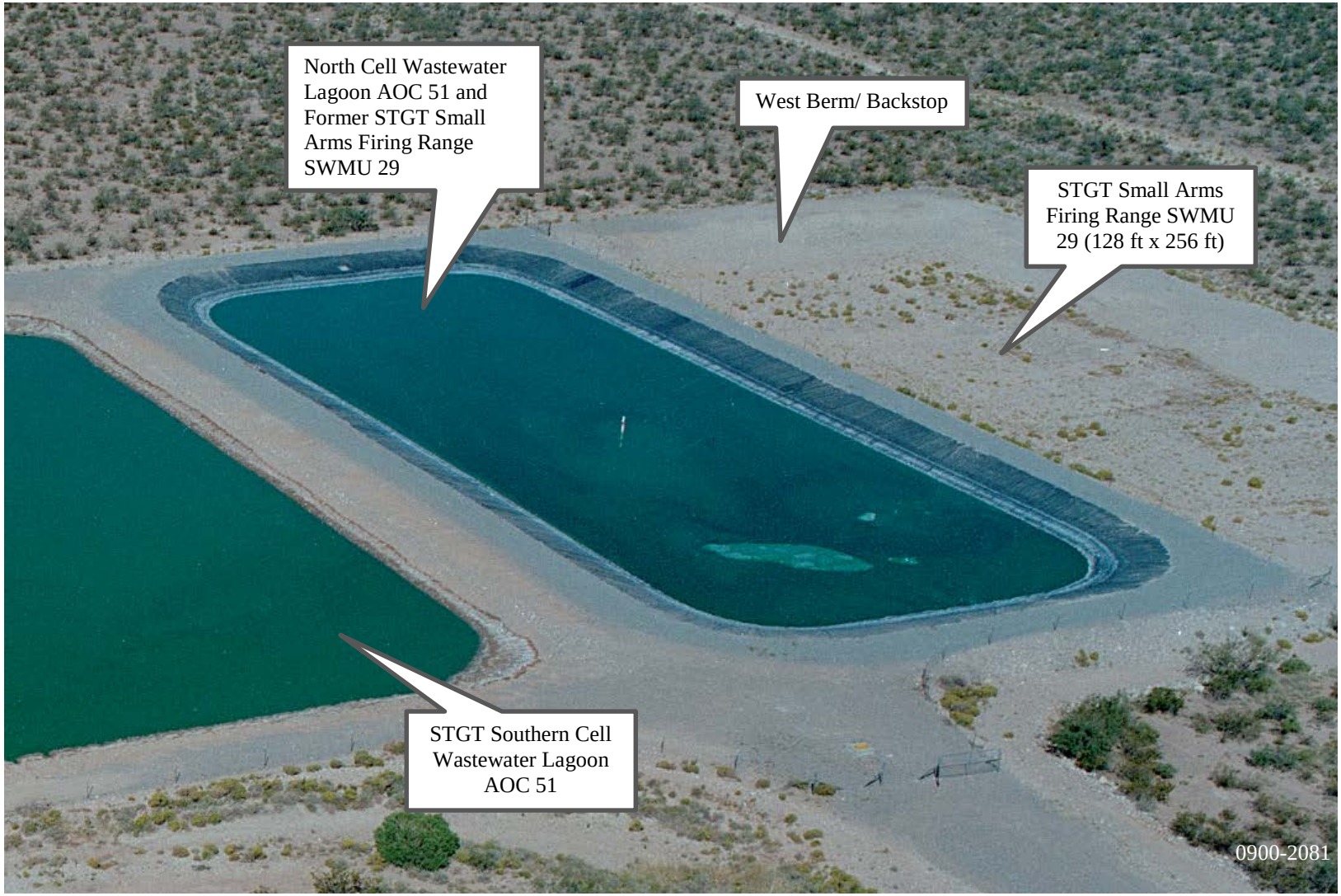
This photograph is a close view inside the STGT small arms firing range (SWMU 29) in May 2000. The range was no longer in use (Operation dates: 1992 to mid-1999), but it shows the firing direction towards the west berm.

Figure B.10 STGT Small Arms Firing Range (SWMU 29; 2000) – view to the west



This photograph is a close view inside the STGT small arms firing range (SWMU 29) in May 2000. The range was no longer in use (Operation dates: 1992 to mid-1999). The view is down the range toward the west berm/backstop.

Figure B.11 STGT Small Arms Firing Range (SWMU 29; 2000) – view to the west

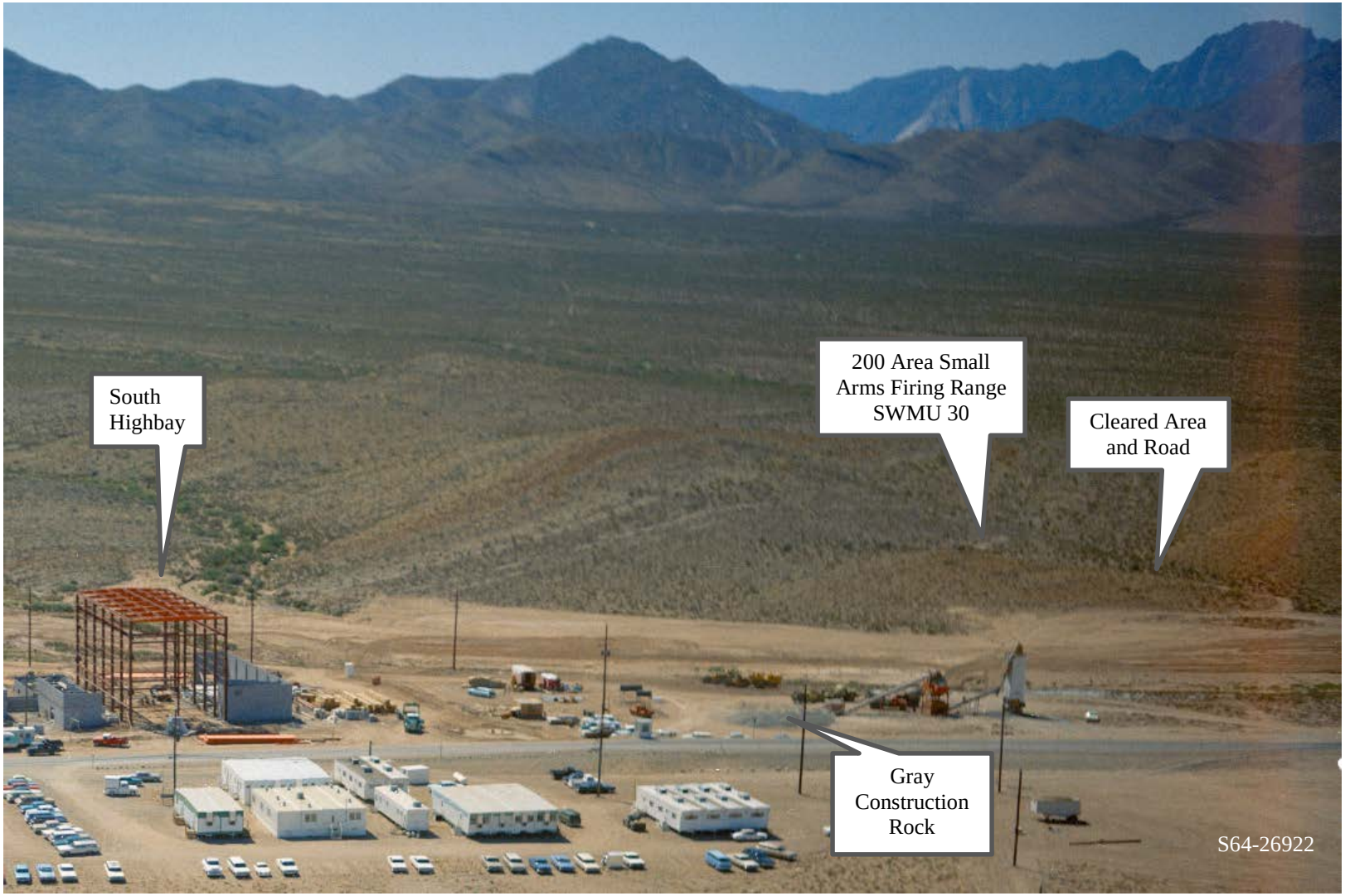


This photograph shows the STGT small arms firing range in September 2000. The range was no longer in use (Operation dates: 1992 to mid-1999). The smaller northern cell of the wastewater lagoon was installed over the STGT small arms firing range. Notice there is no roof rock ballast or vegetation waste stored in the firing range at this time.

Figure B.12 STGT Area (2006) – view to the west

This photograph shows the STGT wastewater lagoon and the STGT small arms firing range (SWMU 29). Notice the southern cell is dry in preparation to install a synthetic liner. Also notice the roof rock ballast present in the small arms firing range area, as shown by the dark color.

Figure B.13 200 Area (1964) – view to the southeast

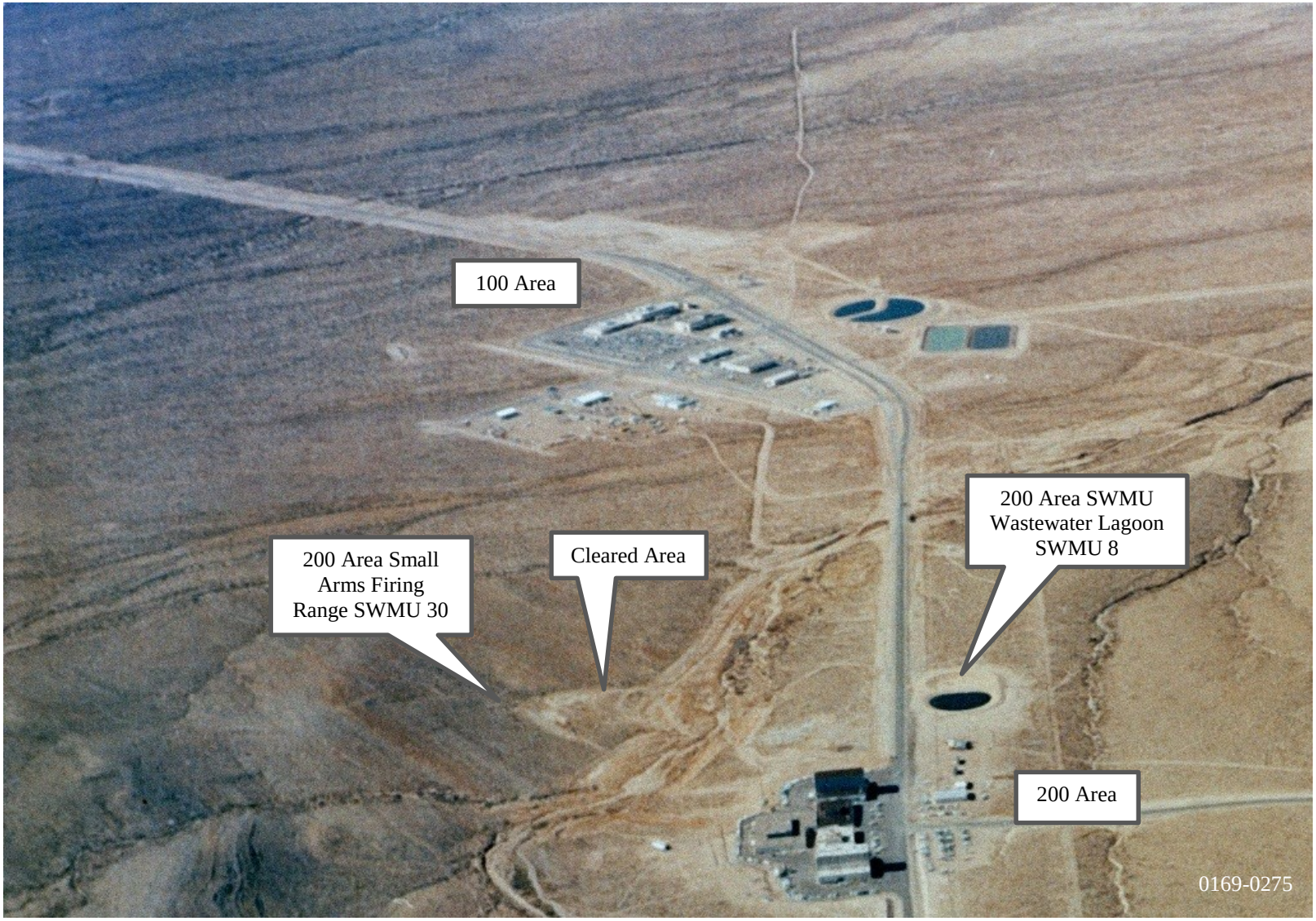


This photograph shows the 200 Area and the small arms firing range (SWMU 30) in 1964. Notice the gray rock pile and construction equipment in the cleared area between the south highbay (still under construction) and the firing range. This may be limestone and soil obtained from the cleared area adjacent to the 200 Area small arms firing range.

Figure B.14 200 Area and Firing Range (1965) – view to the northwest

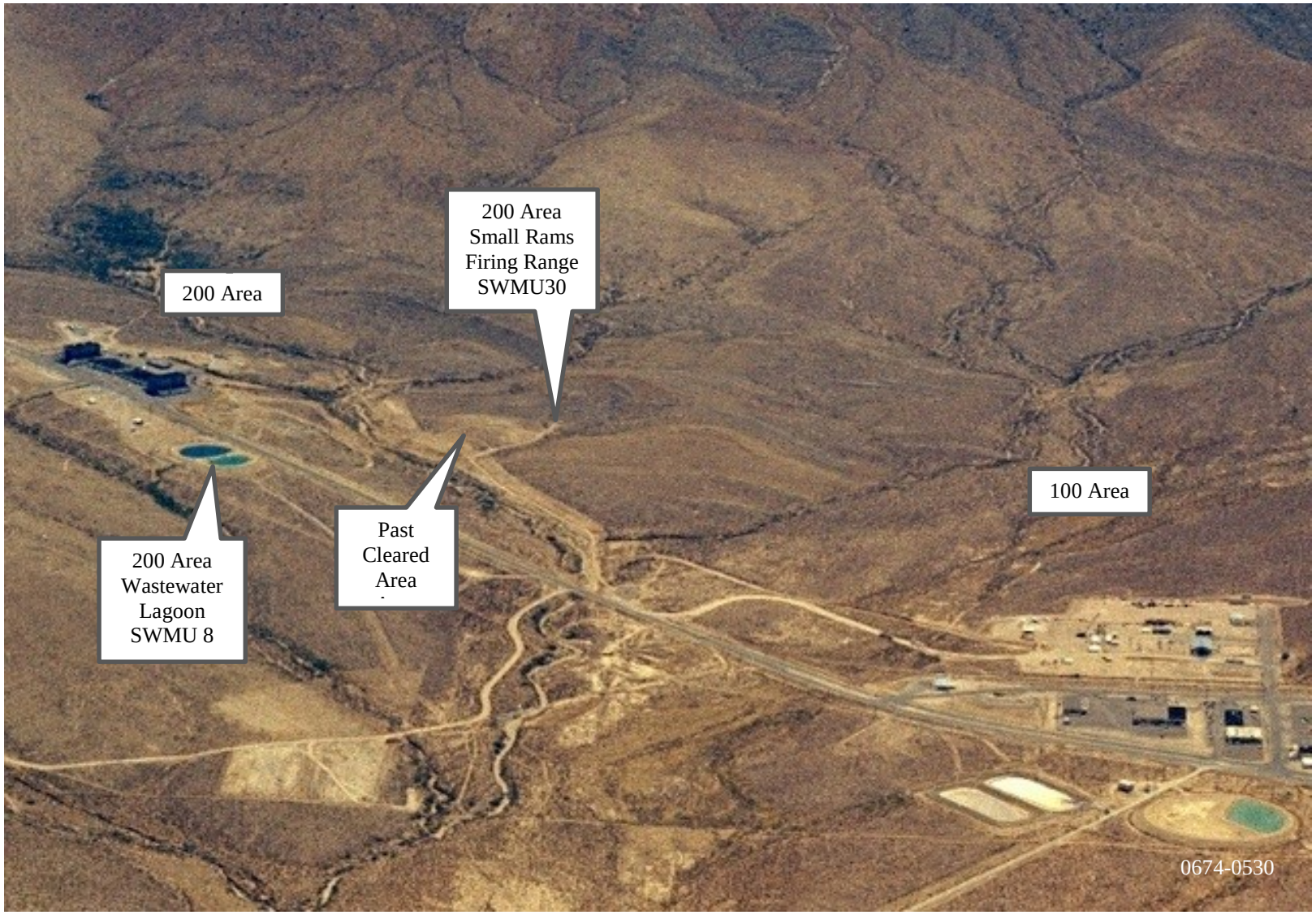
This photograph shows the 200 Area small arms firing range (SWMU 30) in 1965. Notice the cleared area, road, and gray rock (limestone) exposed adjacent to the firing range. This cleared area may represent a borrow area for soil and rock for construction purposes. The cleared areas and road possibly provided an easily accessible but remote place for a firing range. Notice there is an arroyo located immediately south of the 200 Area small arms firing range (SWMU 30).

Figure B.15 100 and 200 Areas (1969) – view to the southwest



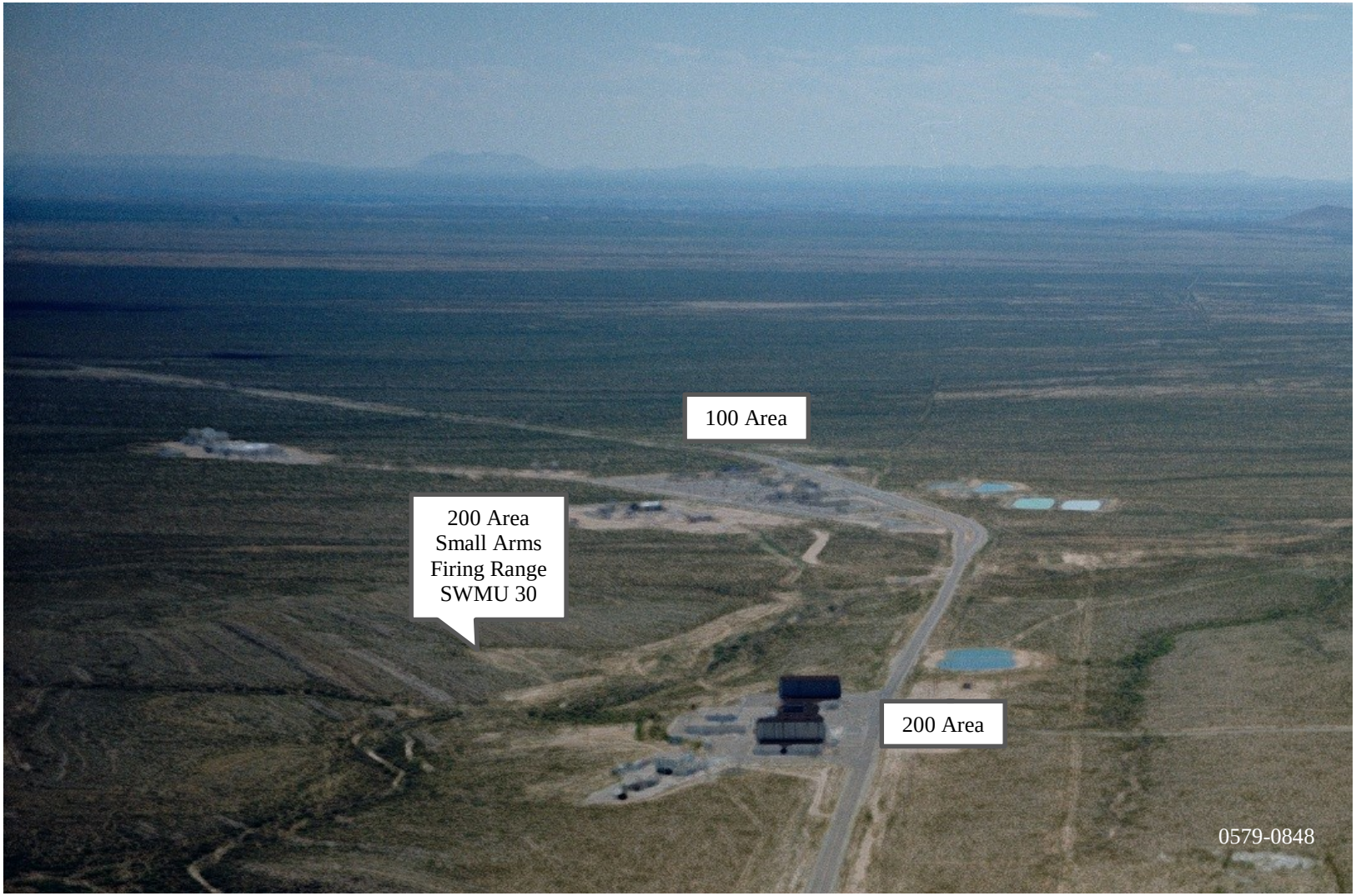
This photograph shows the 100 and 200 Areas in January 1969. Notice vegetation has grown on the cleared area, suggesting that it is no longer used as a soil/rock borrow area.

Figure B.16 200 Area (1974) – view to the east



This photograph shows the 200 Area small arms firing range (SWMU 30) in June 1974. Vegetation has continued to cover the past cleared area, making the road to the firing range more visible.

Figure B.17 200 Area (1979) – view to the south



This photograph shows the 200 Area and the small arms firing range in May 1979.

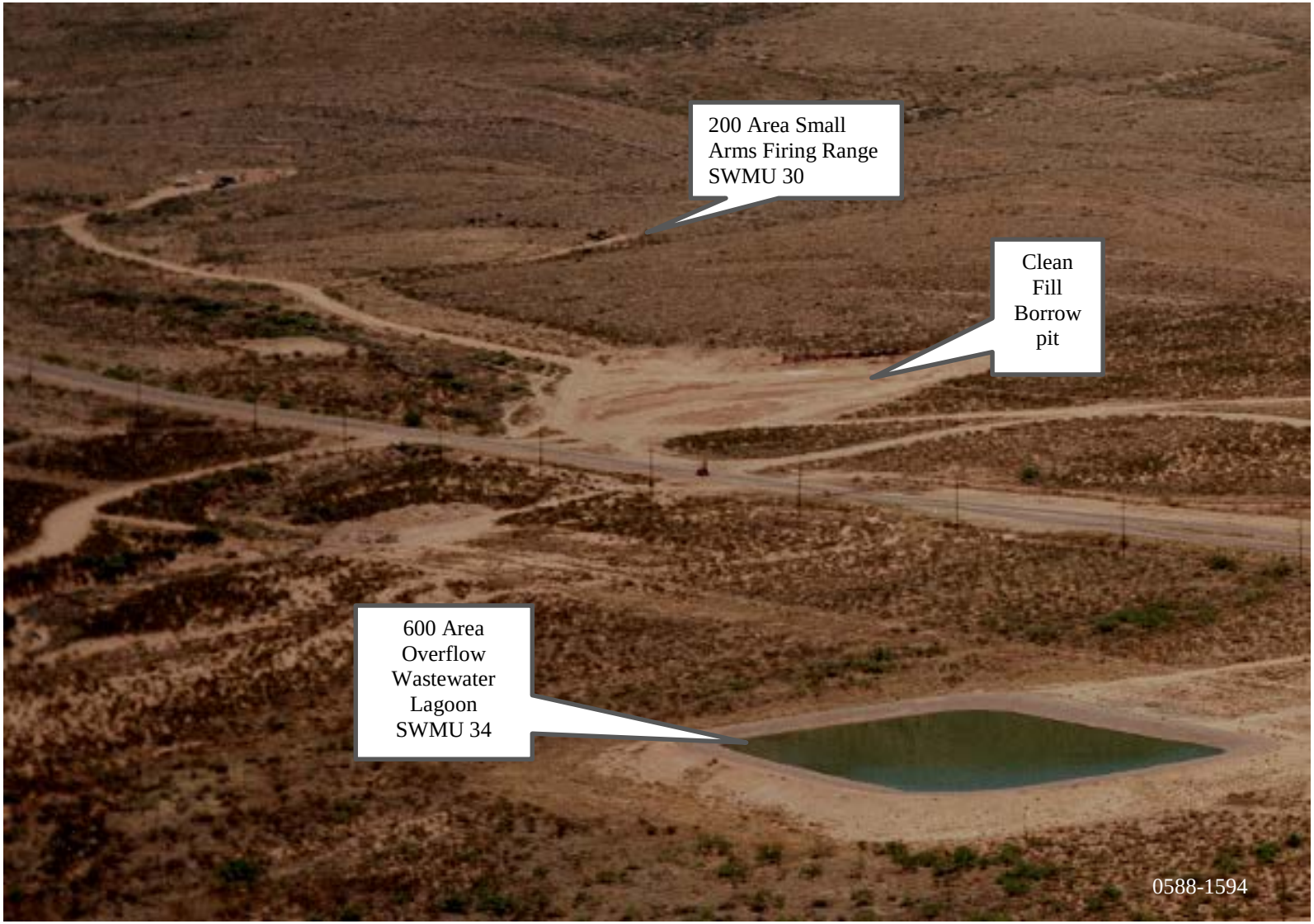
Figure B.18 200 Area (1981) – view to the southwest

This is a photograph of the 200 Area in March 1981. Notice that the 200 Area small arms firing range (SWMU 30) appears to be still un-improved. There is no gravel or grading at the site to date. The site is the natural soil tan/brown color.

Figure B.19 200 Area Small Arms Firing Range (SWMU 30; 1986) – view to the northeast

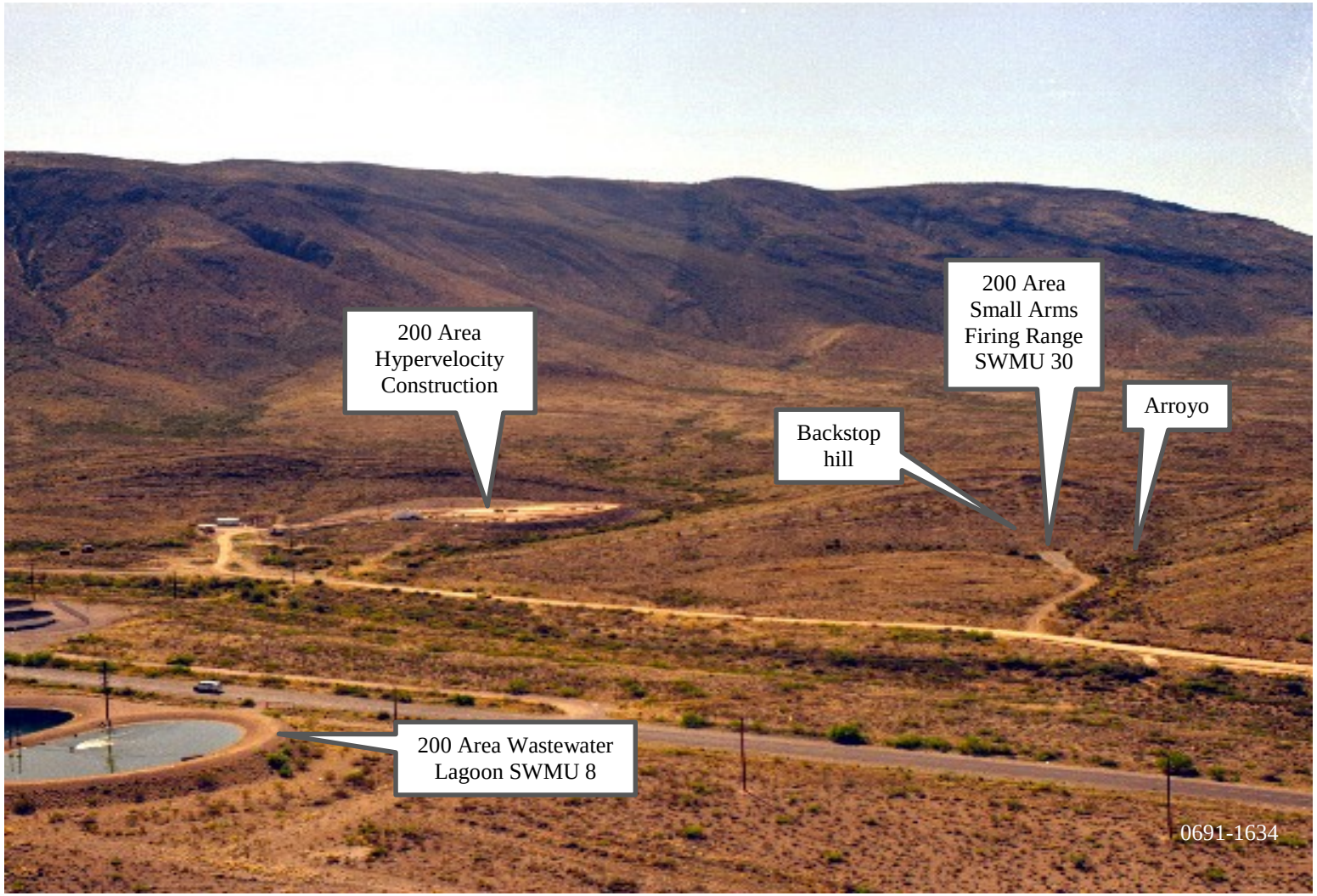
This photograph shows the 200 Area small arms firing range (SWMU 30) in September 1986. Notice the area of the firing range appears to have been graded. The road appears to be wider at the terminus in the firing range area. Also notice the adjacent arroyo.

Figure B.20 200 Small Arms Firing Range Area (1988) – view to the northeast



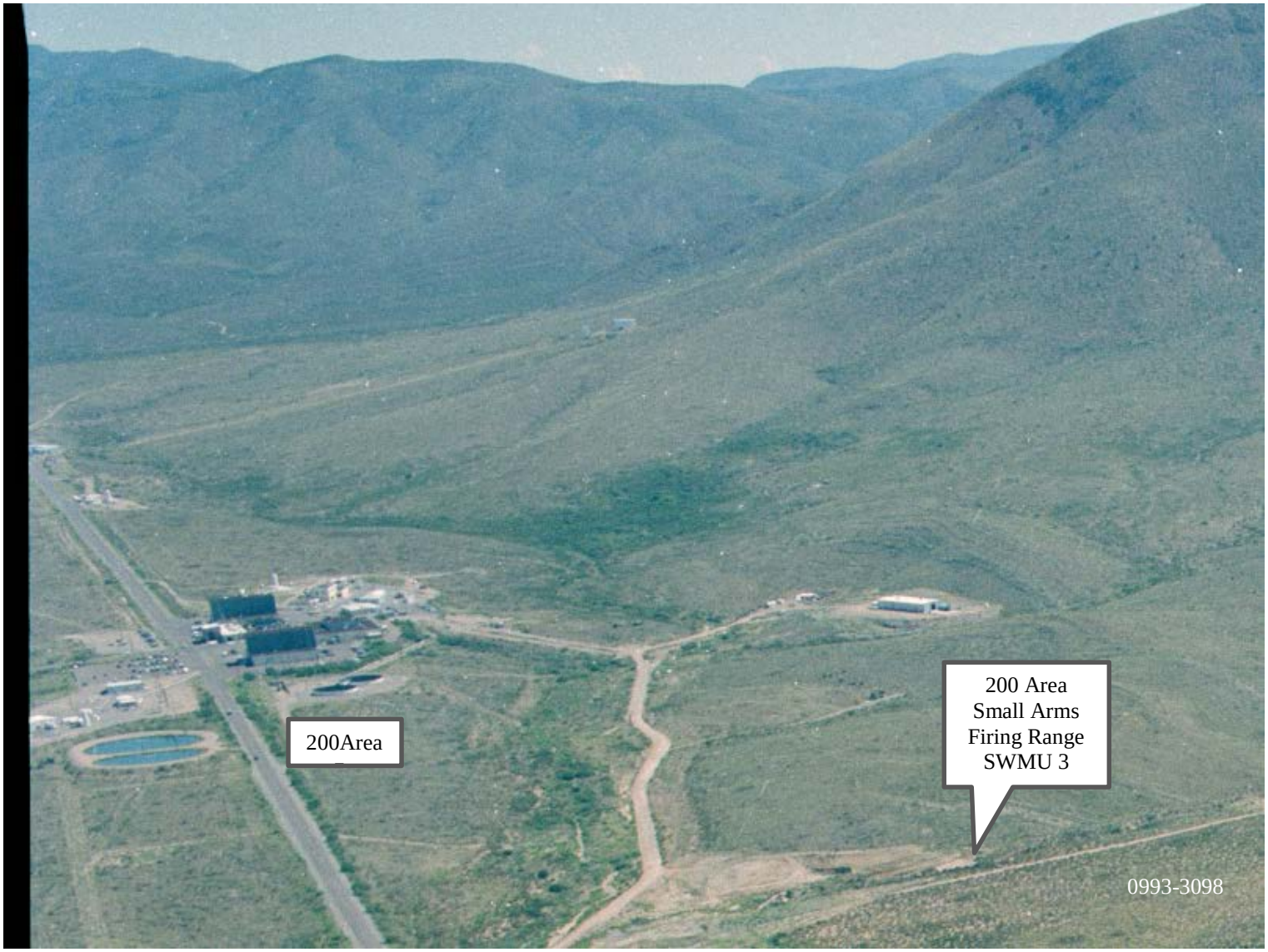
This photograph shows the 100/200 Area in May 1988. Notice the road to the 200 Area small arms firing range is still tan/brown in color, suggesting that the gray gravel and likely the other improvements had not been completed to date.

Figure B.21 200 Area (1991) – view to the east



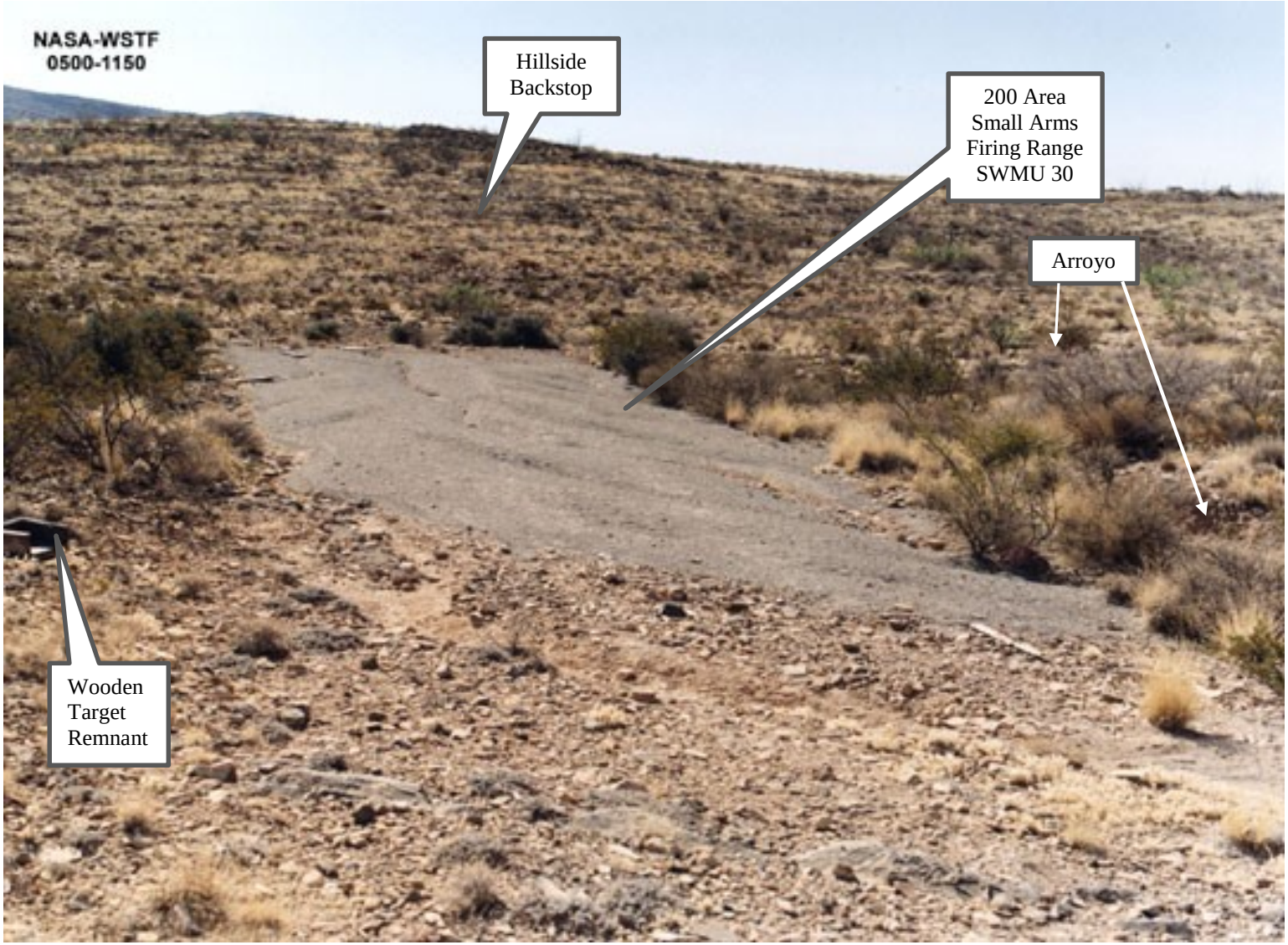
This photograph shows the 200 Area in June 1991 (no longer in use. Used 1964-1990). Notice the color change to gray at the 200 Area small arms firing range from the tan/brown road. This indicates that the few small improvements to the 200 Area small arms firing range have been completed by June 1991 (grading the range, installing steel pipes to hold temporary targets in place). Also notice the natural hill used as a backstop and the arroyo located to the right (south) of the firing range.

Figure B.22 200 Area (1993) – view to the north



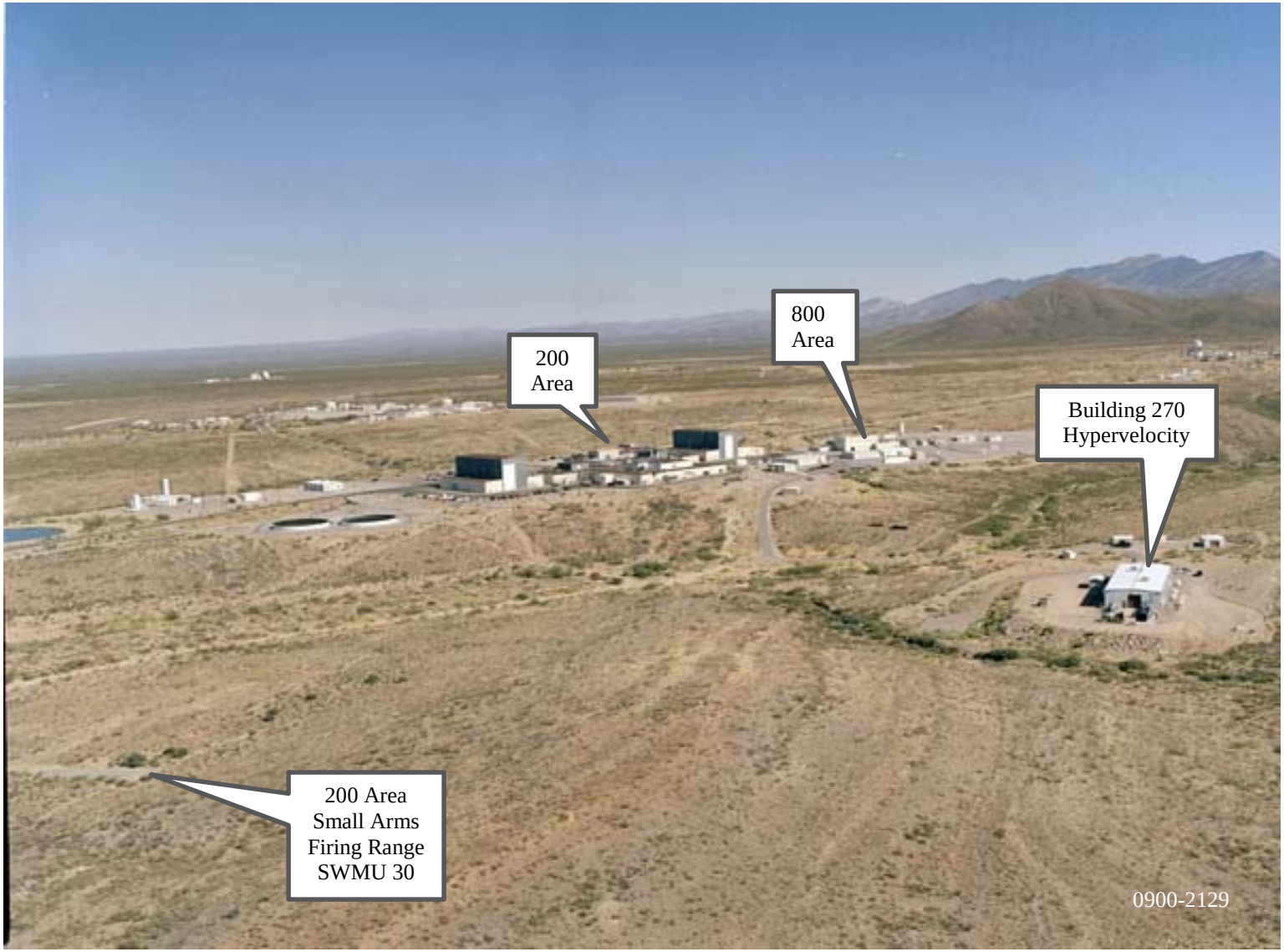
This photograph shows the 200 Area small arms firing range in September 1993 (no longer in use).

Figure B.23 200 Area Small Arms Firing Range (SWMU 30; 2000) – view to the east



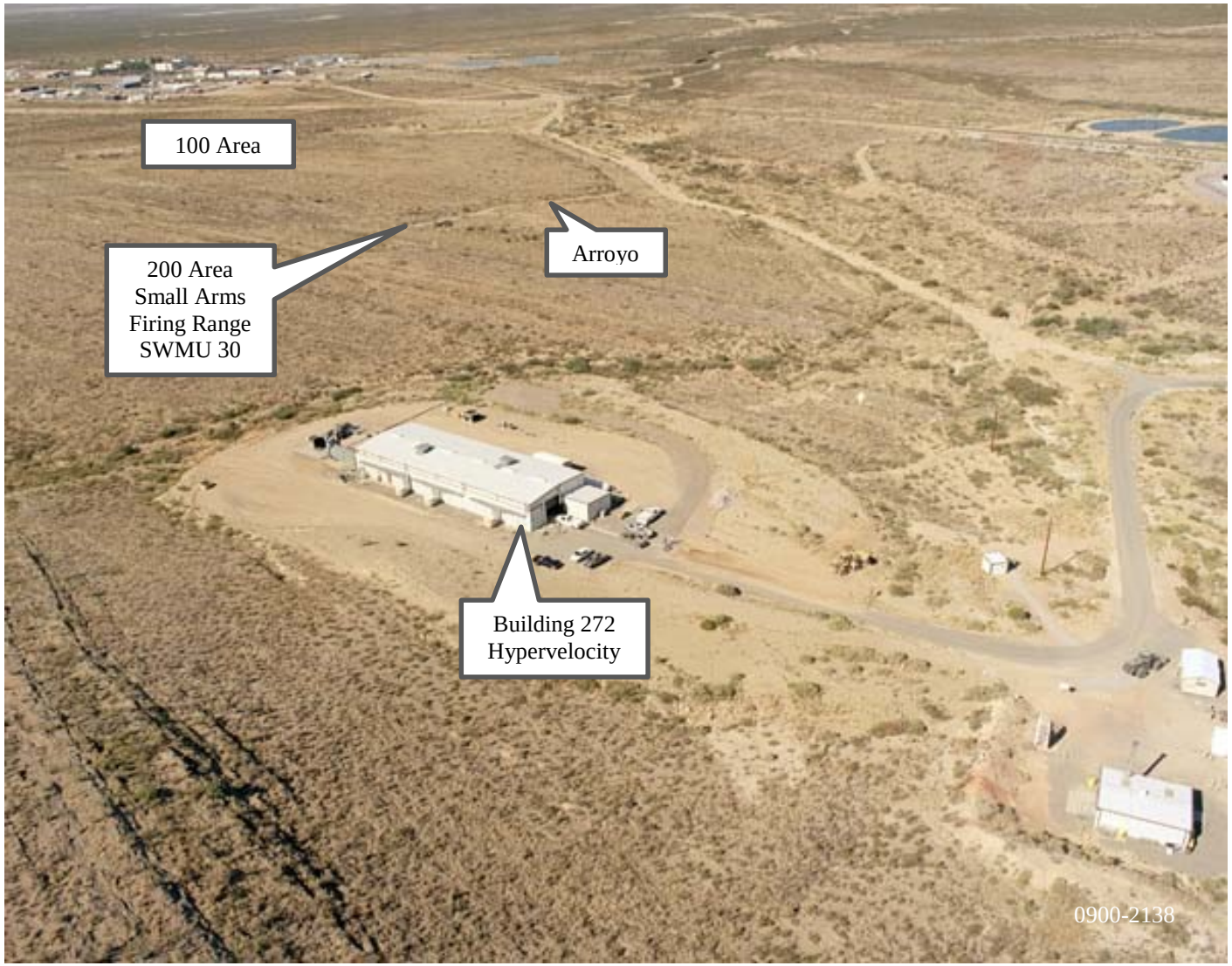
This photograph shows a close view of the 200 Area small arms firing range in May 2000. Notice the erosion of the gravel area (with rills where water has run-off) and the gray gravel being washed downslope and into the adjacent arroyo.

Figure B.24 200 Area (2000) – view to the north



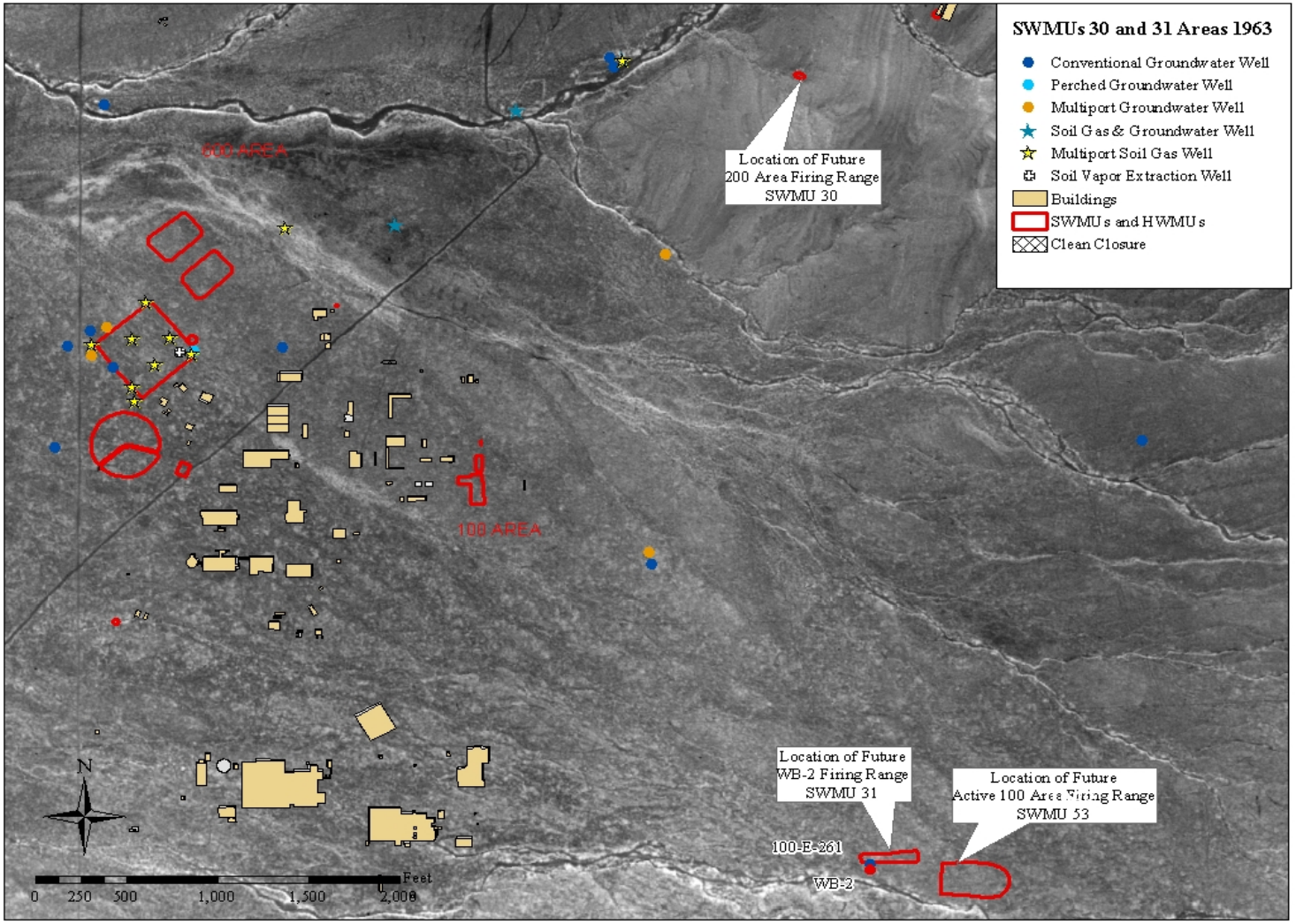
This photograph shows the 200 Area and small arms firing range in September 2006.

Figure B.25 200 Area (2000) – view to the southwest



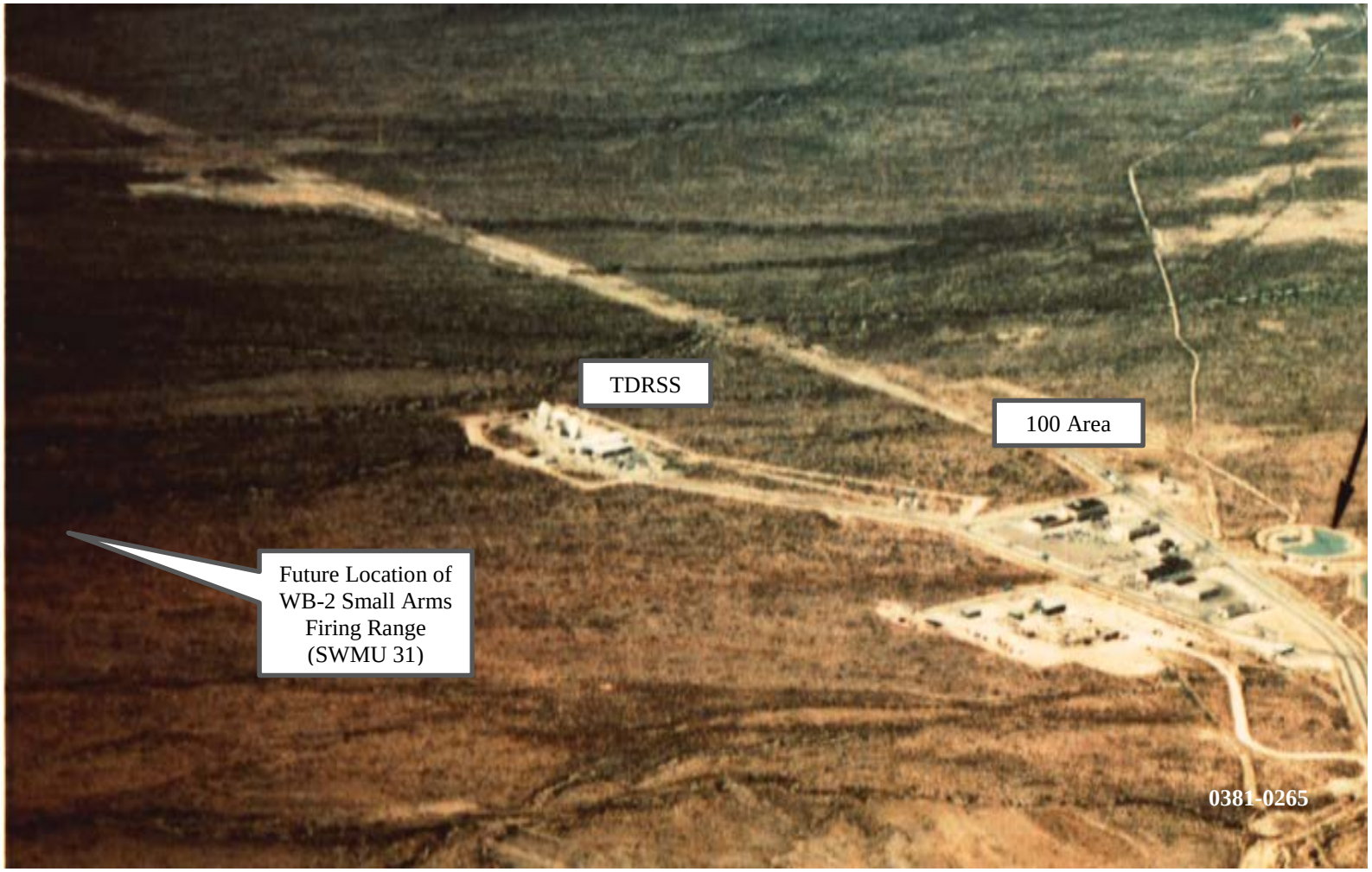
This photograph shows the 200 Area small arms firing range (SWMU 30) in September 2000. Notice the arroyo adjacent to the 200 Area small arms firing range to the south.

Figure B.26 200 and 100 Area Firing Range Locations (1963)



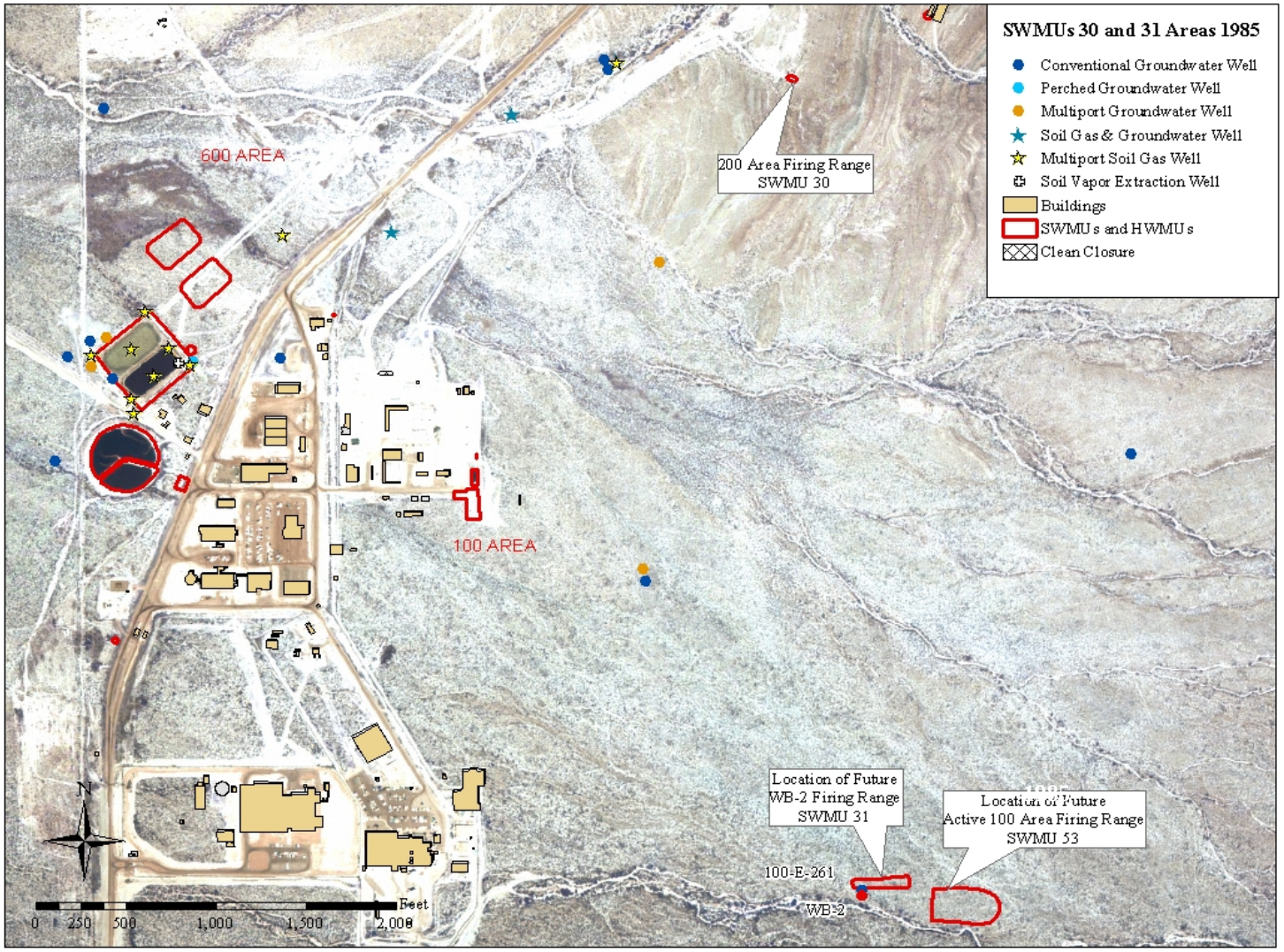
This photograph shows the location of the 200 Area and WB-2 Small Arms Firing Ranges and other WSTF structures superimposed. Photograph is from 1963, just prior to the establishment of WSTF.

Figure B.27 WB-2 Firing Range Location (1981) – view to the southwest



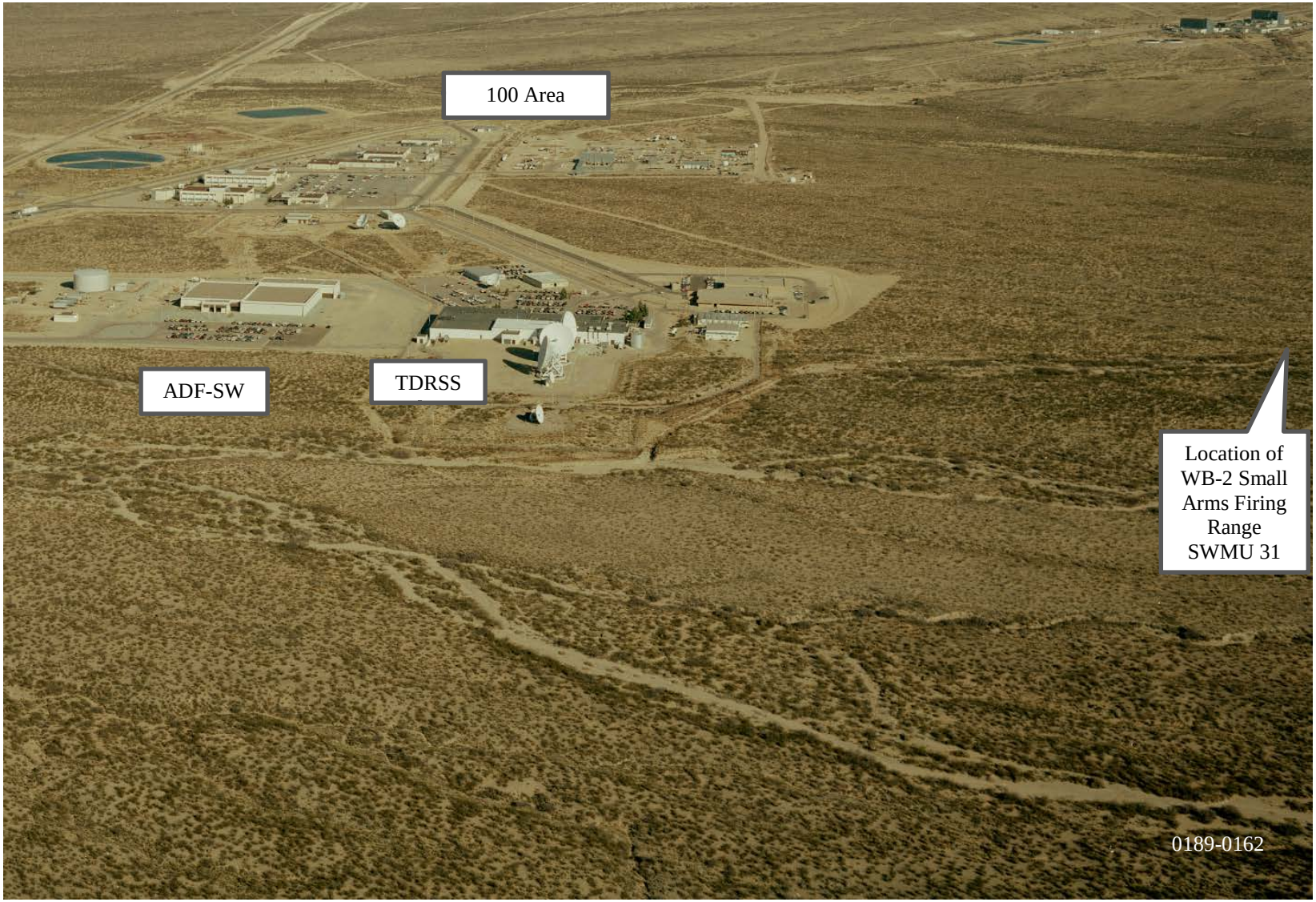
This photograph shows the location of the future WB-2 small arms firing range (SWMU 31).

Figure B.28 WB-2 and 200 Area Firing Range Locations (1985)



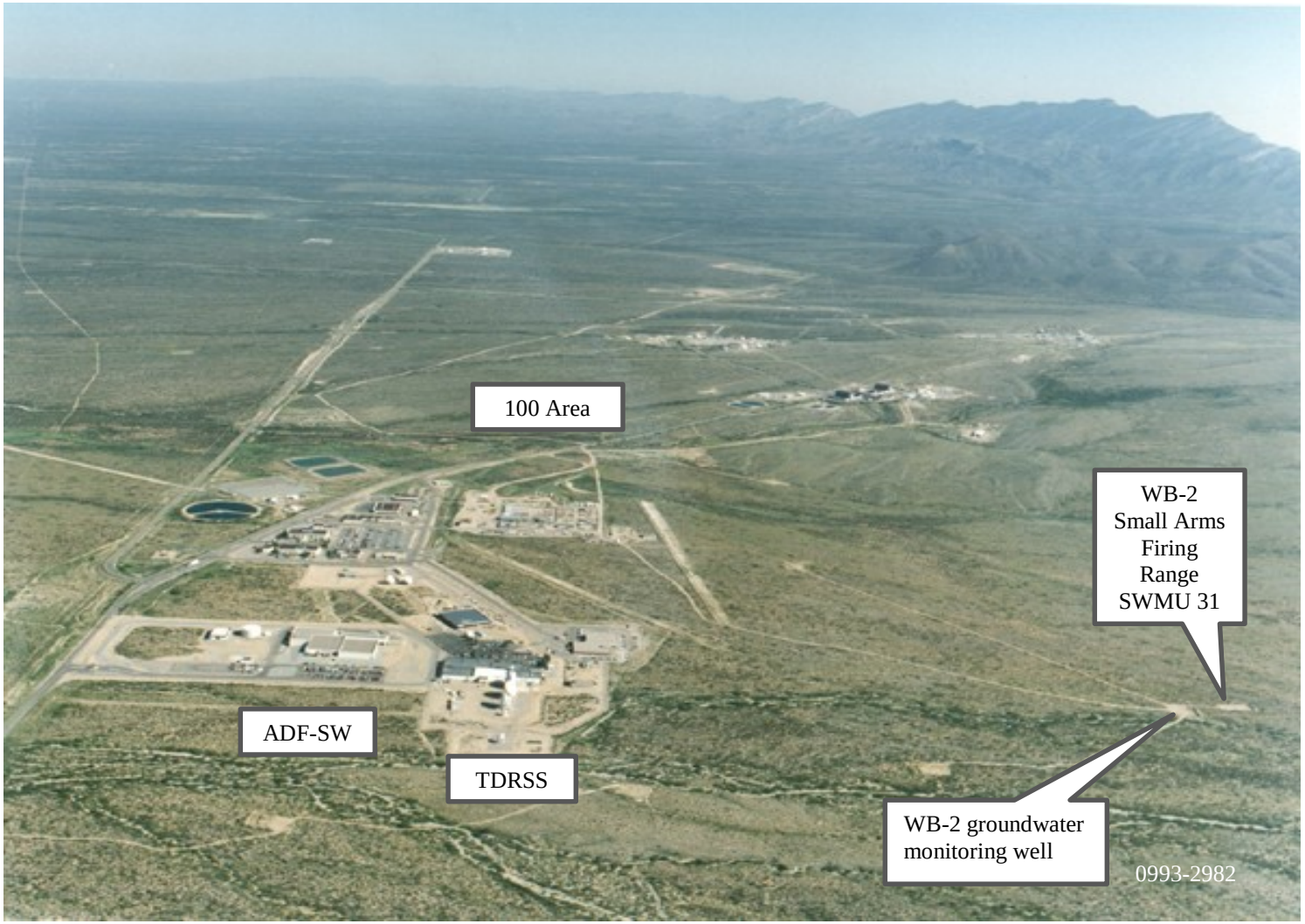
This photograph shows the 200 Area small arms firing range in 1985 and the location of where the WB-2 small arms firing range will be located. WSTF structures have been superimposed on the photograph.

Figure B.29 WB-2 Small Arms Firing Range (SWMU 31) Location (1989) – view to the north



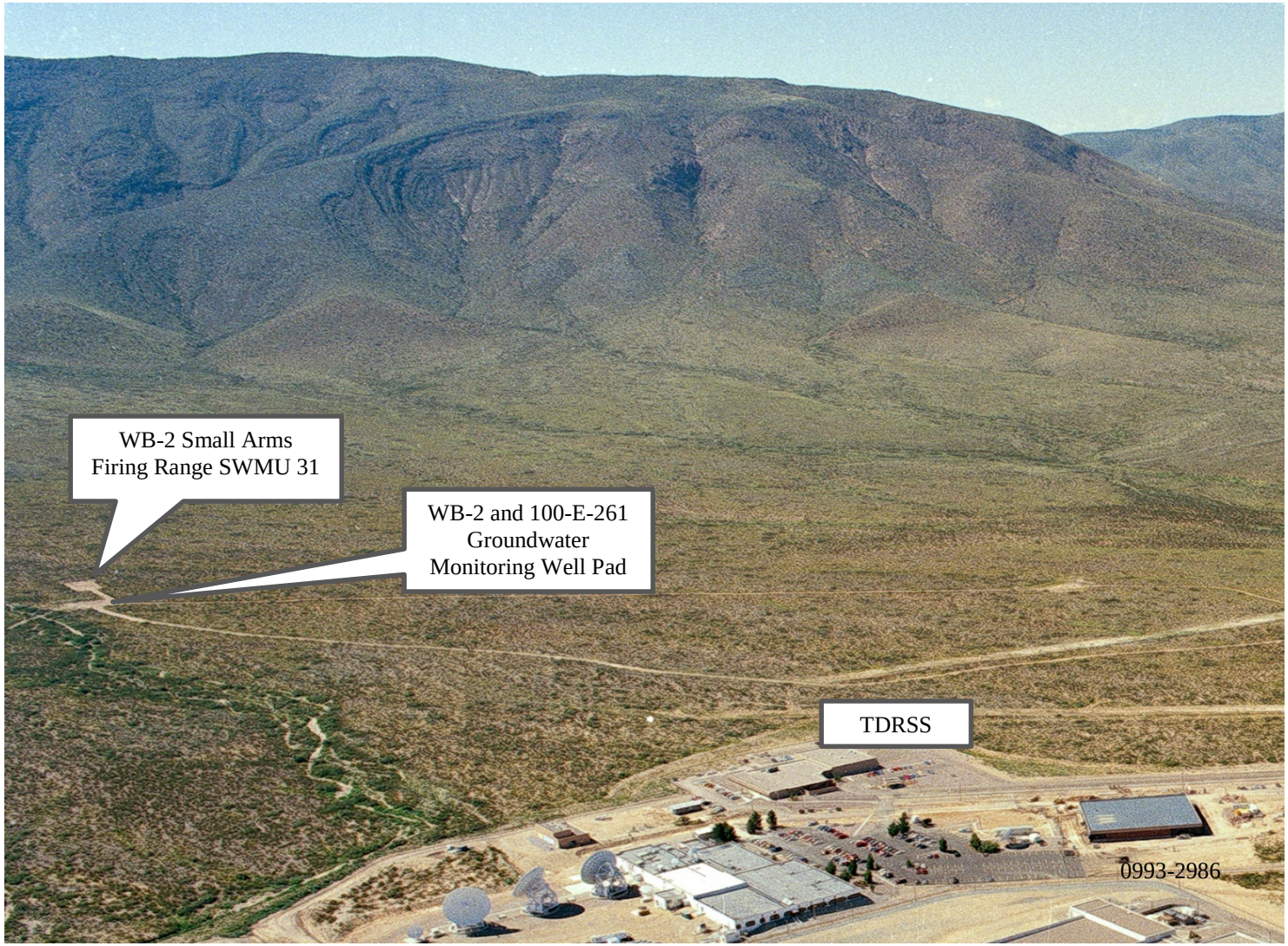
This photograph shows the WB-2 small arms firing range future location. The WB-2 range was constructed in 1990. This photograph provides additional evidence that the initial date of use for the WB-2 small arms firing range is valid.

Figure B.30 WB-2 Small Arms Firing Range (SWMU 31; 1993) – view to the north



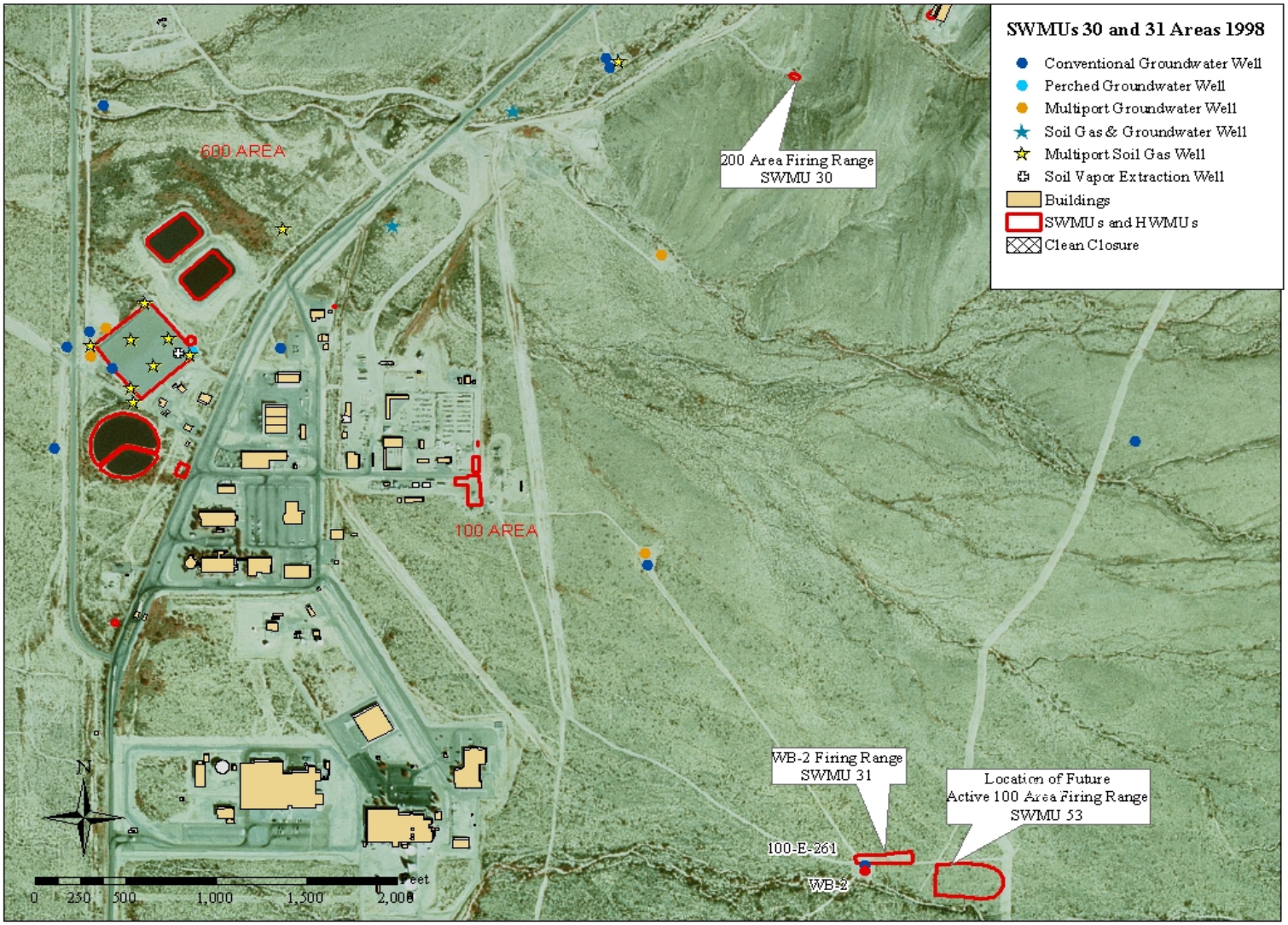
This photograph shows the 100 Area and the WB-2 small arms firing range in September 1993.

Figure B.31 100 Area and WB-2 Firing Range (1993) – view to the southeast



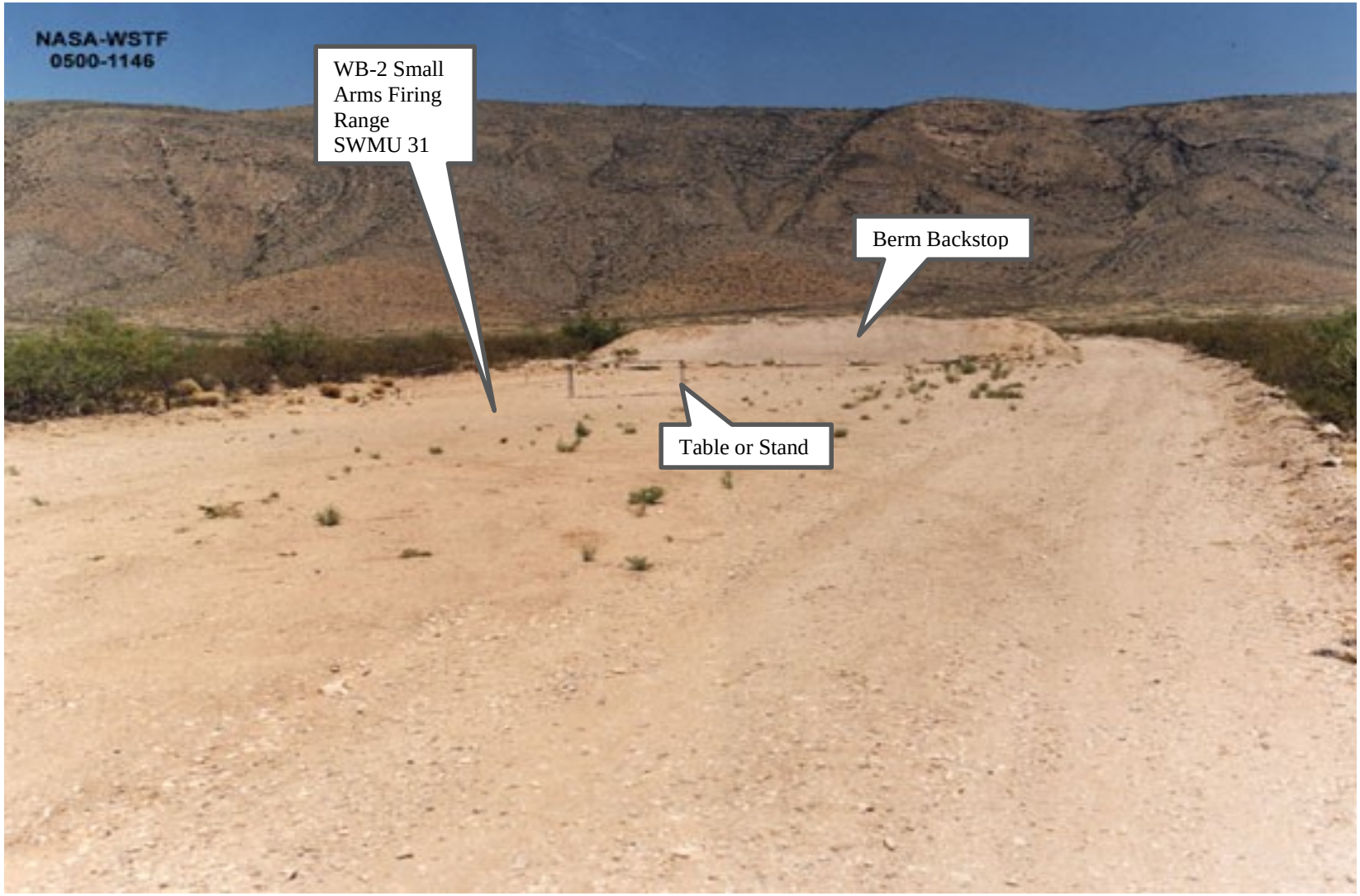
This photograph shows the WB-2 small arms firing range (SWMU 31) and the 100 Area in September 1993 (prior to the installation of the bullet containment system firing range in 2000).

Figure B.32 200 Area and WB-2 Small Arms Firing Ranges (SWMUs 30-31; 1998)



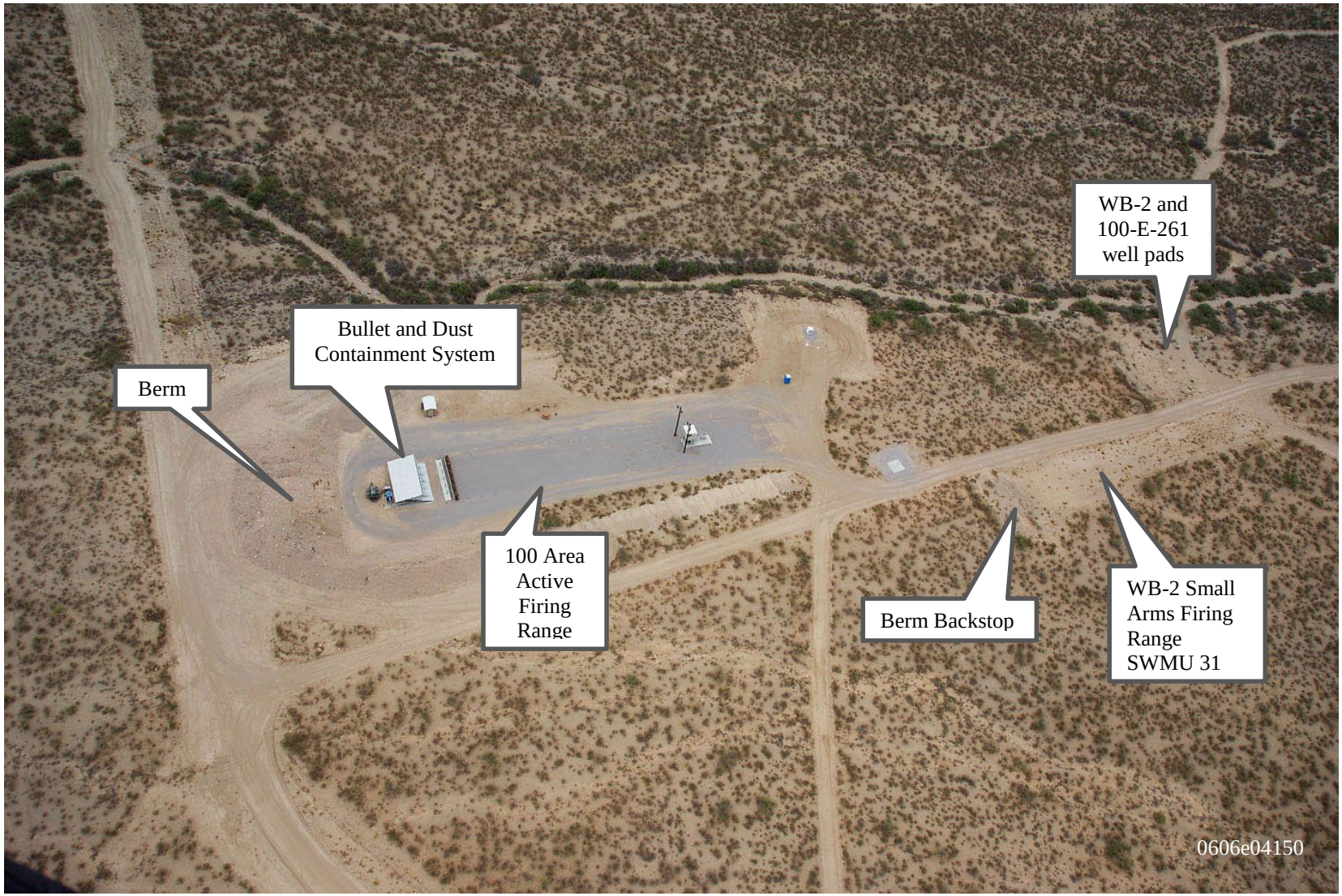
This photograph shows the WB-2 (and 200 Area) small arms firing ranges (SWMUs 30-31) in 1998. WSTF structures have been superimposed. Notice the 100 Area active firing range has not been installed yet (2000).

Figure B.33 WB-2 Small Arms Firing Range (SWMU 31; 2000) – view to the east



This photograph shows a close view of the WB-2 small arms firing range (SWMU 31) in May 2000. This photograph was taken when the range was still in use. Notice a table or stand in the range near the berm.

Figure B.34 WB-2 Small Arms Firing Range and Active Range (2006) – view to the south



This photograph shows the WB-2 small arms firing range (SWMU 31; inactive: operated 1990-1995 and 1999-2000) and the adjacent 100 Area active firing range with bullet containment system in June 2006.

Figure B.35 WB-2 Small Arms Firing Range (SWMU 31; 2006) – view to the southeast

This photograph shows a closer view of the WB-2 small arms firing range (SWMU 31) in June 2006.

Appendix C
Small Arms Firing Ranges (SWMUs 29-31) MSDS

Federal Cartridge Company
900 Bob Ehlen Drive
Anoka, MN 55303

Material Safety Data Sheet

Revision: B
Prepared: September 8, 2010

TELEPHONE: 763-323-2300
PRODUCT SERVICE: 763-323-3706
EMERGENCY PHONE NUMBER: 800-424-9300 or 703-527-3887 (CHEMTREC)

Revised/Reviewed Date: April 18, 2014

Section 1. Product Information

Product Name: Small Arms Ammunition – Centerfire Rifle & Pistol Ammunition
MSDS Number: F3001
Product ID#: See Table Below
Preparation Date: 8 September 2010

Business Phone/Hours: 763-323-2510 / 24 Hours a Day, 7 Days a Week
24 Hr. Spill (Chemtrec): 1-800-424-9300

CENTERFIRE – PRODUCT FAMILY		
.222 Remington	.30-30 Winchester	.300 Savage
.22-250 Remington	.32 Automatic	.32 Winchester Special
.223 Remington	.32 S&W Long	.338 Winchester Magnum
6mm Remington	.32 H&R Magnum	.35 Remington
.243 Winchester	.380 Automatic	8mm Mauser
.257 Roberts +P	.38 Special	.45-70 Government
.25-06 Remington	.357 Magnum	.280 Remington
.270 Winchester	9mm Luger Auto	7-30 Waters
7mm Remington Magnum	9mm Ball (M-822)	7.62X39 Soviet
7mm Mauser	9mm Federal	.303 British
.300 Winchester Magnum	.41 Rem Magnum	.375 H&H Magnum
.308 Winchester	.44 S&W Special	.300 H&H Magnum
.30-06 Springfield	.44 Rem Magnum	.458 Winchester Magnum
.30 Caliber Carbine	.45 Automatic	.416 Rigby
.25 Automatic	.45 Colt	.470 Nitro Express
10mm Automatic	9mm Subsonic	.38 Special +P+
.40 S&W	6.5X55 Swedish	7X64 Brenneke
5.56 Limited Range	9mm Limited Range	.38 Special +P
.356 TS&W	.270 Weatherby Magnum	.300 Weatherby Magnum
7mm Weatherby Magnum	.357 SIG	.38 Super
9X18 Makarov	.257 Weatherby Magnum	.416 Remington Magnum

CENTERFIRE – PRODUCT FAMILY		
.220 Swift	.35 Whelen	.340 Weatherby Magnum
7mm STW	7mm-08 Remington	.260 Remington
.300 Rem Ultra Mag.	.338 Rem Ultra Mag.	.454 Casull
.300 Win Short Mag.	.270 Win Short Mag	7mm Win Short Mag.
.223 Win Super Short Mag.	.243 Win Super Short Mag.	.45 Glock Automatic
.404 Jeffery	.458 Lott	.338 Federal
.325 Win Short Mag.	.204 Ruger	.22 Hornet
.480 Ruger	.500 S&W	.460 S&W
9.3x62	9.3x74R	370 Sako Mag.
500 Nitro Express	.338 Lapua Mag.	6.8mm Rem SPC
7.62x51	300 BLK	

Section 2. Composition/Information On Ingredients

Chemical Name	Common Name	CAS Number	Weight. % Range
Bullet			
*Lead or Lead Core	Lead	7439-92-1	30 – 60%
*Copper Jacket	Copper	7440-50-8	0 – 1%
*Zinc (As Zinc Oxide)	Zinc	7440-66-6 1314-13-2	0 -0.25%
*Antimony	Antimony	7440-36-0	0 – 3%
Nyclad Coating	Nyclad Coating	Not established	0 – 1%
Cartridge Case			
*Brass (As Zinc & Copper) (see above)	Copper Zinc	See above	25 – 40% 1 – 15%
*Nickel Plated Brass (As Nickel)	Nickel	7440-02-0	0 – 1%
*Tin Plated Brass (As Tin)	Tin	7440-31-5	0 – 1%
*Lead	Lead	See above	<0.1%
Propellant			
Nitrocellulose	Cellulose Nitrate Nitrocotton Gun Cotton	9004-70-0	0.5 – 12%
*Nitroglycerine	Trinitroglycerin Glyceryl Trinitrate	55-63-0	0 – 7%
Graphite – synthetic	Graphite Powder	7782-42-5	0 – 0.25%
Primer			
*Lead Styphnate (As Lead)	Basic Lead Styphnate	12403-82-6	<0.1%
Tetracene	Tetracene	109-27-3	<0.1%
*Barium Nitrate (As Barium)	Barium Salt Nitrobarite Barium Dinitrate	7440-39-3	<0.1%
Bismuth Trioxide (as Bismuth)	Bismuth oxide, Bismuth yellow	1304-76-3	<0.1%
*Antimony Sulfide (As Antimony)	Antimonous Sulfide Diantimony Trisulfide	7440-36-0	<0.1%
*Aluminum	Aluminum	7429-90-5	<0.1%
Nitrocellulose (see above)	See above	See above	<0.1%
*Nitroglycerine (see above)	See above	See above	<0.1%

* Indicates toxic chemical(s) subject to the reporting requirements of section 313 of title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986 and 40 CFR 372.

Section 3. Hazard Identification

CAUTION! Explosive. Keep away from heat. Do not subject to mechanical shock. Particles from firing may be harmful if inhaled. Do not take internally.

Eye: Contact with large volumes of smoke may cause minor eye irritation.

Skin: Elemental and inorganic lead compounds are not absorbed through the skin.

Ingestion: Acute ingestion of lead may occur from poor personal hygiene associated with the handling of lead bearing materials. The effects of lead ingestion would be similar to those listed under acute inhalation in addition to gastrointestinal irritation. Chronic ingestion of lead may occur from poor personal hygiene associated with the handling of lead bearing materials. The effects of lead ingestion would be similar to those listed under chronic inhalation. Note: Wash hands thoroughly with soap and water before eating or smoking.

Inhalation: Inhalation of gases and particulates produced while firing ammunition may result in mild throat, eye, upper respiratory and lung irritation. The irritant effects may lead to lung symptoms such as bronchitis. An over exposure to gases or particulates, as a result of lead in the particulates, may also cause: anemia; nervous system symptoms which may include irritability, headache, restlessness, fatigue, muscle weakness, muscle tremor, convulsions, loss of memory, visual and hearing disturbances, loss of coordination; gastrointestinal effects such as vomiting, colic, diarrhea or constipation; circulatory symptoms such as a drop in blood pressure; reproductive effects including fertility problems, birth defects, miscarriages and possible kidney damage. Prolonged repeated over exposure to fired cartridge gases and particulates, as a result of lead in the particulates, may result in elevated blood lead levels and elevated zinc protoporphyrin levels. Symptoms of chronic overexposure to lead may include: anemia; lead lines on the gums; nervous system symptoms which may include irritability, headache, restlessness, fatigue, muscle weakness (i.e. wrist drop), muscle tremor, convulsions, loss of memory, visual and hearing disturbances, loss of coordination; gastrointestinal effects such as weight loss, vomiting, colic, diarrhea, constipation; circulatory symptoms such as a drop in blood pressure; reproductive effects including fertility problems, birth defects, miscarriages and possible kidney damage. If acute or chronic symptoms should appear, contact a physician. Blood lead and zinc protoporphryn levels are recommended and should be monitored as per OSHA 1910.1025.

Exposure Symptoms: See above.

Target Organs: See above.

Chronic Effects: See above.

Other: Lead and barium are toxic metals that may be released during the firing of primers. Care should be taken in the cleaning of range facilities to minimize the exposure potential to lead and barium. Persons engaged in these activities should wear protective clothing with an appropriate respirator. Range operators should consult OSHA 1910.1025 for details pertaining to the handling of lead in the work environment.

Severe lead intoxication has been associated in the past with sterility, abortion, and stillbirth. Modern information confirming that lead poisoning affects birth rates or cause injury to the fetus in man is not conclusive.

Exposure to lead can aggravate pre-existing anemia, cardiovascular and respiratory diseases and conditions related to the gastrointestinal, reproductive, renal (kidney), and central nervous systems.[1]

[1]Reference: Industrial Toxicology, Safety and Health Applications in the Workplace; Williams/B.

Cancer Information:	**NTP:** No	**OSHA:** No	**IARC:** Group 2B, possibly carcinogenic in humans

Section 4. First Aid Measures

Eyes: Remove person to fresh air. If foreign body is suspected, wash eyes in fresh water for 15 minutes, contact physician.

Skin: Wash exposed areas thoroughly with soap and water

Ingestion: Ingestion is not a likely route of exposure. In case of ingestion, contact physician.

Inhalation: Remove person to fresh air. Seek medical attention.

Doctor Notes: NA

Section 5. Fire Fighting Measures

Flammable Properties: No

Hazardous Decomposition Products: Oxides of Barium, Lead, Antimony, Aluminum, Magnesium, Nitrogen, Carbon, and Sulfur. Lead and Antimony fumes may also be produced.

Extinguishing Media: Water

Protective Equipment: In all cases, full fire fighter personal protection gear, including face shield and SCBA should be utilized.

Unusual Fire and Explosion Hazards: May ignite if heated to 250 degrees F, independent of air. Unconfined ignited cartridges can produce low velocity metallic fragments, which may cause eye injury or skin wounds if unprotected by standard fire-fighter turnout gear.

Wear full fire-fighter protective gear including face shield or SCBA. Use wide fog pattern nozzle to stop any low velocity fragments. Use water to cool ordinary combustibles below ignition temperature.

Section 6. Accidental Release Measures

Spills and Leaks: Avoid conditions detailed in Section #10. If container should rupture, place all loose cartridges from broken shipping cases into a sturdy container. Secure container carefully.

Waste Disposal: Contact Manufacturer - Product Service (763) 323-3706

Section 7. Handling Information

Store in a dry, cool area in the original container to assure performance. Keep out of the reach of children. Avoid striking the primer of unchambered cartridges. Remove ammunition from service if any of the following conditions have occurred:

1. Evidence of corrosion
2. Physical damage
3. Exposure to oil or spray type lubricants.

Avoid prolonged storage in leather cartridge carriers.

Section 8. Exposure Control Measures / Personal Protection

			Applicable Exposure Limits		
Chemical Name	**CAS #**	**Wt. %**	**OSHA PEL**	**ACGIH TLV**	**Other**
Bullet					
Lead or Lead Core	7439-92-1	30 – 60%	0.05 mg/m^3	0.05 mg/m^3	
Copper Jacket	7440-50-8	0 – 1%	1 mg/m^3 Fume: 0.1 mg/m^3	1 mg/m^3 Fume: 0.2 mg/m^3	
Zinc (As Zinc Oxide)	7440-66-6 1314-13-2	0 - 0.25%	10 mg/m^3 (5 mg/m^3 as respirable dust) Fume: 5 mg/m^3	10 mg/m^3 Fume: 5 mg/m^3	
Antimony	7440-36-0	0 – 3%	0.5 mg/m^3	0.5 mg/m^3	
Nyclad Coating	Not established	0 – 1%	Not established	Not established	
Cartridge Case					

Brass (As Zinc & Copper) (see above)	See above	25 – 40% 1 – 15%	See above	See above
Nickel Plated Brass (As Nickel)	7440-02-0	0 – 1%	1 mg/m^3	1 mg/m^3
Tin Plated Brass (As Tin)	7440-31-5	0 – 1%	0.1 mg/m^3	2 mg/m^3
Lead	See above	<0.1%	See above	See above
Propellant				
Nitrocellulose	9004-70-0	0.5 – 12%	Not established	Not established
Nitroglycerine	55-63-0	0 – 7%	0.2 mg/m^3 STEL	0.46 mg/m^3 (Skin)
Graphite – synthetic	7782-42-5	0 – 0.25%	15 mg/m^3 (5 mg/m^3 as respirable dust)	2 mg/m^3
Primer				
Lead Styphnate (As Lead)	12403-82-6	<0.1%	0.05 mg/m^3	0.05 mg/m^3
Tetracene	109-27-3	<0.1%	Not established	Not established
Barium Nitrate (As Barium)	7440-39-3	<0.1%	0.5 mg/m^3	0.5 mg/m^3
Bismuth Trioxide (as Bismuth)	1304-76-3	<0.1%	15 mg/m^3 (5 mg/m^3 as respirable dust)	10 mg/m^3 (3 mg/m^3 as respirable dust)
Antimony Sulfide (As Antimony)	7440-36-0	<0.1%	0.5 mg/m^3	0.5 mg/m^3
Aluminum	7429-90-5	<0.1%	15 mg/m^3 (5mg/m^3 as respirable dust)	10 mg/m^3
Nitrocellulose (see above)	See above	<0.1%	See above	See above
Nitroglycerine (see above)	See above	<0.1%	See above	See above

Engineering Controls: Use in a well-ventilated area. Consult the current edition of ACGIH Industrial Ventilation Manual and/or NRA ventilation recommendations.

Respiratory Protection: Use an approved respirator while cleaning range facilities. Consult OSHA 1910.1025 for exact requirements.

Hand Protection: Not generally required

Eye Protection: Recommend protective eyewear conforming to ANSI Z-87

Hearing Protection: Hearing protection recommended while discharging cartridges.

Section 9. Physical And Chemical Properties

Boiling Point:	Not applicable	**Solubility:**	None
Melting Point:	Not applicable	**Specific Gravity:**	3.1-8.0 g/cc
Vapor Pressure:	Not applicable	**pH:**	Not applicable

Vapor Density:	Not applicable	**Odor:**	None
Flash Point:	Not applicable	**Appearance:**	Brass or nickel or tin plated brass case with plastic, lead, copper jacketed lead, or nylon clad lead bullet.
Ignition Temp.:	Not applicable		
UEL:	Not applicable		
LEL:	Not applicable		

Section 10. Stability and Reactivity

Stability: Stable under normal use conditions

Incompatibilities: Oils, Acids, Alkalies, Ammonia, and other corrosive materials

Conditions to Avoid: Individual cartridges may ignite if the primer is struck or if the cartridge is exposed to excess heat.

Hazardous Decomposition Products: Oxides of Barium, Lead, Antimony, Aluminum, Magnesium, Nitrogen, Carbon, and Sulfur. Lead and Antimony fumes may also be produced.

Section 11. Toxicological Information

No available data

Section 12. Ecological Data

No available data.

Section 13. Disposal Considerations

This material as a waste meets the criteria of hazardous waste, D003 and D008. Dispose of in accordance with all federal, state and local regulations for the disposal of hazardous waste.

Section 14. Transportation Information

U.S. DOT Proper Shipping Name: Cartridges, small arms
UN ID No.: UN0012
Class & Division: 1.4S
Packing Group.: II
*Latest edition of the U.S. Department of Transportation's Emergency Response Guidebook

Section 15. Regulatory Information

OSHA: **Explosive**

TSCA: **Listed: Yes** **Unlisted:** **Exempt:**

CERCLA: **Reportable Quantities: Antimony compounds = 5,000 lbs; Copper = 5,000 lbs; Lead = 10 lbs; Nickel = 100 lbs; Nitroglycerin = 10 lbs; Zinc = 1,000 lbs**

Section 16. Information Sources

Label Information:

Abbreviation Key:

OSHA PEL: Federal Occupational Safety and Health Administration's Permissible Exposure Limit. Some states and jurisdictions have limits other than those listed. Contact your local authorities for Permissible Exposure Limits in your jurisdiction.

ACGIH TLV: American Conference of Governmental Industrial Hygienists' Threshold Limit Values.

TWA: Time Weighted Average.

STEL: Short Term Exposure Limit, the 15 minute exposure which should not be exceeded at any time during a workday.

CEILING: The concentration which is not to be exceeded at any time during a workday.

CAS: Chemical Abstracts Service number

Disclaimer:
Although the information contained in this material safety data sheet has been compiled from sources believed to be reliable, no warranty, guaranty or representation is made as to the accuracy or completeness of the information contained herein and no responsibility or liability is assumed regarding the suitability of this information for the user's intended purpose or the consequences of its use. The user of this product must decide what safety measures are necessary to safely use this product, either alone or in combination with other products, and determine its obligations under any applicable federal, state, or local law or regulation.

Corporate MSDS Template Version I.doc
ANSI Z-400.2003
11/30/05

MATERIAL SAFETY DATA SHEET

Bullets, Slugs, Buckshot and Muzzleloader Projectiles

MSDS REV. DATE: 06/08/10

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: **Hornady Bullets, Slugs, Buckshot and Muzzleloader Projectiles**

TRADE NAMES: **InterBond®, SST®, V-MAX™, Varmint™, InterLock®, A-MAX®, XTP®, XTP®-MAG™, Frontier™, HAP®, Great Plains®, L-N-L® Speed Sabot®, FPB®, FTX®, Cowboy™, DGS®, DGX®**

SYNONYMS AND VARIATIONS: Bullets, projectiles, slugs, FMJ, SWC, HBWC, SWC, RN, HP, FP, ENC, BTHP, BTSP, BT, SP, SJ, Match, Moly, Buckshot, PA Conical, Round Ball, Hard Ball, lead test cylinders.

MANUFACTURER: Hornady Manufacturing Company
ADDRESS: 3625 W. Old Potash Hwy
Grand Island, NE 68803

EMERGENCY PHONE: 800-338-3220
CHEMTREC PHONE: 800-424-9300 **CHEMTREC INTERNATIONAL:** +703-527-3887
OTHER CALLS: (308) 382-1390

PRODUCT USE: Firearm projectiles
PREPARED BY: M. Spencer

HMIS® Ratings

HEALTH	1
FLAMMABILITY	0
REACTIVITY	0
PERSONAL PROTECTION	A

SECTION 2: COMPOSITION/INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENTS:

NAME	CAS#	%WT	313	OSHA PEL TWA (mg/m^3)	ACGIH TLV TWA (mg/m^3)
Aluminum	7429-90-5	0-7	Yes	5.0 (dust/fume)	5.0 (dust/fume)
Antimony	7440-36-0	0-5	Yes	0.5	0.5
Copper	7440-50-8	0-45	Yes	1.0 (Dust)	1.0 (Dust)
Lead	7439-92-1	25-100	Yes	0.05	0.05
Molybdenum Disulfide	1317-33-5	0-<1	No	15 (as Mo)	5.0
Zinc	7440-66-6	0-20	Yes	15 (dust)	N/A

SECTION 2 NOTES:

SECTION 3: HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: Do not take internally. Keep away from sources of ignition. Byproducts of use may be harmful if inhaled. Avoid long-term contact between exposed lead and skin/ clothing.

ROUTES OF ENTRY: Inhalation, ingestion, eyes

POTENTIAL HEALTH EFFECTS

EYES: None during normal handling. Firing projectiles may result in airborne particles/fragments. Particles/fragments may cause irritation or eye injury if safety glasses are not used.

SKIN: Minimal irritation. Wash hands after handling and before eating, drinking or smoking to reduce chances of ingestion.

INGESTION: Ingestion of lead dust or fume can eventually lead to damage to central and peripheral nerves, blood and kidneys. It may also cause damage to male reproductive system and, in females, to the unborn fetus. Damage to nerves can cause reduced motor nerve and muscle function. May cause anemia. Lead has been identified as an animal carcinogen and may produce cancer in humans. Ingestion of molybdenum in sufficient quantities may cause gastrointestinal irritation, diarrhea, coma and death from cardiac failure. See section 11 for toxic quantities.

INHALATION: Inhalation of dust/fume may lead to the effects described above (Ingestion), as well as respiratory irritation.

ACUTE HEALTH HAZARDS: **Lead** Ingestion/Inhalation may cause irritation to nose, throat, upper respiratory tract and lungs. The irritant effects may lead to bronchitis, headache, fall in blood pressure, weakness, convulsions, and collapse. Severe poisoning may impair vision by damaging the optic nerve. Particulates from firing: Eye irritation or injury, skin irritation. Inhaling large amounts of **copper** dust may cause nasal and respiratory irritation as well as nausea and vomiting. **Zinc** ingestion may cause headache, nausea, fever. Acute **molybdenu**m poisoning can lead to gastrointestinal irritation, diarrhea, coma and death from cardiac failure.

CHRONIC HEALTH HAZARDS: Ingestion or inhalation of **lead** may have effects on the blood , bone marrow , central nervous system , peripheral nervous system and kidneys , resulting in anemia, encephalopathy (e.g., convulsions), peripheral nerve disease, abdominal cramps and kidney impairment. Causes toxicity to human reproduction or development. Chronic **molybdenum** poisoning may cause loss of weight, anemia, reproductive harm, osteoporosis and joint deformity.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: Respiratory conditions easily aggravated by airborne dust or particulates.

CARCINOGENICITY
OSHA: No **IARC:** Possible (group 2b) (lead)
OTHER: EPA: Probable human carcinogen (lead)

SECTION 3 NOTES: The physical form of these products makes it unlikely that exposure of any significant amount will occur. Exposure is most likely during ammunition loading operations and can easily be mitigated by sensible hygiene practices; always wash hands after handling projectiles, especially before eating or using tobacco. Firing ammunition will produce small particles that could contain minute amounts of the chemicals listed in section 1. Greatest exposure will occur if firing takes place indoors. See section 8 for exposure controls.

SECTION 4: FIRST AID MEASURES

EYES: Immediately flush out fume or particles with large amounts of water for at least 15 minutes. If irritation develops, call physician.

SKIN: Wash affected skin thoroughly with soap and water.

INGESTION: If ingested, call physician immediately.

INHALATION: If signs of lung irritation occur, remove victim to fresh air immediately. If breathing has stopped, give CPR and get medical attention immediately.

SECTION 4 NOTES:

SECTION 5: FIRE-FIGHTING MEASURES

FLAMMABLE LIMITS IN AIR, UPPER: N/A
(% BY VOLUME) LOWER: N/A

FLASH POINT:
F: N/A
C: N/A
METHOD USED: N/A

AUTOIGNITION TEMPERATURE:
F: N/A
C: N/A

HMIS HAZARD CLASSIFICATION
HEALTH: 1 **FLAMMABILITY:** 0 **Physical:** 0
OTHER:

EXTINGUISHING MEDIA: Not relavent to this product. Choose extinguishing media suitable to surrounding materials.

SPECIAL FIRE FIGHTING PROCEDURES: Use SCBA.

UNUSUAL FIRE AND EXPLOSION HAZARDS: None

HAZARDOUS DECOMPOSITION PRODUCTS: Oxides, fumes and dusts from metals listed in section 1.

SECTION 5 NOTES:

SECTION 6: ACCIDENTAL RELEASE MEASURES

ACCIDENTAL RELEASE MEASURES: Spills will not normally require emergency response. If spill is large or other assistance is required, call 800-338-3220 or CHEMTREC at 800-424-9300.

SECTION 6 NOTES: See section 15 for reportable quantities of spilled material.

SECTION 7: HANDLING AND STORAGE

HANDLING AND STORAGE: Store in a cool, dry area. Wash hands after handling.

SECTION 7 NOTES:

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS: Use of proper range filtration and airflow when firing projectiles indoors.

VENTILATION: None required during normal handling and loading. Use mechanical ventilation when firing projectiles indoors to maintain exposures below PEL. Ventilation should not be required outdoors.

RESPIRATORY PROTECTION: Not normally needed.

EYE PROTECTION: Safety glasses

SKIN PROTECTION: Not normally needed, wash hands after handling.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT: Use adequate hearing protection when firing projectiles.

WORK HYGIENIC PRACTICES: Wash hands thoroughly after handling and before eating, drinking or using tobacco.

SECTION 8 NOTES:

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE: Cylindrical projectile. May be pointed, flat tipped, hollow point or polymer point. Projectile may be lead only (grey) or may be fully or partially jacketed in copper or brass. Moly coated bullets will be dark grey.

ODOR: None

PHYSICAL STATE: Solid

pH AS SUPPLIED: N/A
pH (Other): N/A
BOILING POINT: N/A
MELTING POINT: N/A
FREEZING POINT: N/A
VAPOR PRESSURE (mmHg): N/A
VAPOR DENSITY (AIR = 1): N/A
SPECIFIC GRAVITY (H2O = 1): N/A
EVAPORATION RATE: N/A

SOLUBILITY IN WATER: Insoluble

PERCENT SOLIDS BY WEIGHT: 100%

PERCENT VOLATILE: N/A

VOLATILE ORGANIC COMPOUNDS (VOC): N/A
MOLECULAR WEIGHT: N/A, Mixture
VISCOSITY: N/A
SECTION 9 NOTES:

SECTION 10: STABILITY AND REACTIVITY

STABILITY: Stable under normal conditions.

CONDITIONS TO AVOID (STABILITY): Open flame/high heat (melting).
INCOMPATIBILITY (MATERIAL TO AVOID): Acids and caustics
HAZARDOUS DECOMPOSITION OR BY-PRODUCTS: Oxides, fume and dusts from metals listed in section I.

HAZARDOUS POLYMERIZATION: Will not occur

SECTION 11: TOXICOLOGICAL INFORMATION

TOXICOLOGICAL INFORMATION:

	Lead	Antimony	Copper	Molybdenum	Aluminum	Zinc
LD-50 (oral)	N/A	7 g/Kg (rat)	1,000 mg/m^3	N/A	N/A	7,950 mg/Kg (mouse)
LC-50 (inhalation)	N/A	N/A	>2,000 mg/m^3	N/A	N/A	2,500 mg/m^3 (mouse)
IDLH	100 mg/m^3	50 mg/m^3	100 mg/m^3	5,000 mg/m^3	N/A	500 mg/ m^3

SECTION 11 NOTES: Under conditions of intended use and expected incidental exposure, greatest potential toxicity is from lead.

SECTION 12: ECOLOGICAL INFORMATION

ECOLOGICAL INFORMATION: This product has no ecological information available. Individual component information is as follows:

Lead: Toxic to waterfowl, high concentrations may be toxic to other aquatic species. Lead may migrate through soil and surface/ground water. Lead will accumulate in the environment through decomposition or fragmentation of projectile. Will not biodegrade.

Copper: Toxic to aquatic species. Concentration required for toxicity varies with water chemistry, light transmittance and other factors. Generally accepted level for aquatic toxicity is >1.0mg/L.

Aluminum: 1-5ppm for some species may be toxic.

Zinc: Depending on conditions, as little as .13mg/L may be toxic to some species.

SECTION 13: DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHOD: Recycle product if at all possible. Product that has become waste may be considered hazardous and must be disposed of accordingly. The user of this product is responsible for seeing that it is disposed of in accordance with all federal, state and local laws. For more information regarding disposal or recycling of this product contact the manufacturer.

RCRA HAZARD CLASS: D008

SECTION 14: TRANSPORT INFORMATION

U.S. DEPARTMENT OF TRANSPORTATION
NOT REGULATED AS HAZARDOUS MATERIAL

AIR TRANSPORTATION
NOT REGULATED AS HAZARDOUS MATERIAL

SECTION 15: REGULATORY INFORMATION

U.S. FEDERAL REGULATIONS

TSCA (TOXIC SUBSTANCE CONTROL ACT): Components are listed on the Toxic Substances Control Act Inventory.

CERCLA (COMPREHENSIVE RESPONSE COMPENSATION, AND LIABILITY ACT): CERCLA RQ's: Lead= 10 lbs., Copper= 5,000 lbs., Antimony= 5,000 lbs., Zinc= 1,000 lbs. Reporting is not required for metals (lead, copper, antimony and zinc) if the mean diameter of the particle is greater than .004 inches.

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT):
311/312 HAZARD CATEGORIES: None
313 REPORTABLE INGREDIENTS: see section 1

STATE REGULATIONS (Right-To-Know):
New Jersey: Copper, Lead, Antimony, Zinc
Pennsylvania: Copper, Lead, Antimony,
Massachusetts: Copper, Lead, Antimony, Zinc
Michigan: Copper, Lead, Antimony, Zinc

CA. PROPOSITION 65: Lead

SECTION 15 NOTES: *Not intended to be all-inclusive, only selected regulations represented.*

SECTION 16: OTHER INFORMATION

DISCLAIMER: Hornady Manufacturing Company believes the information contained in this MSDS to be accurate and complete as of the date of publication, however no responsibility is assumed for the suitability of this data to the end user or for omissions or errors in its content. This sheet should be provided to all who use, handle, transport or store the material in question.

Extruded Rifle Powders

MATERIAL SAFETY DATA SHEET

April 2009

The following smokeless powders are distributed by Hodgdon Powder Company.

H4227® (also known as AR2205)
H4895® (also known as AR2206H)
H4198® (also known as AR2207)
Varget® (also known as AR2208)
H4350® (also known as AR2209)
H50MBG® (also known as AR2218)
H4831® (also known as AR2213)
H4831SC® (also known as AR2213SC)
H1000® (also known as AR2217)
Retumbo® (also known as AR2225)
H322® (also known as AR2210 & AR2219)
Benchmark® (also known as BM2)

6231 Robinson Street * Shawnee Mission, KS 66202 * Phone (913) 362-9455 * Fax (913-362-1307
www.Hodgdon.com * www.IMRpowder.com * www.WWpowder.com

Section 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME
ADI SPORTING POWDER AR 2205

PROPER SHIPPING NAME
POWDER, SMOKELESS

PRODUCT USE
Propellant for use in centrefire small arms ammunition.

SUPPLIER

Company: Thales, Australia, Mulwala
Address:
Private Bag 1
Mulwala
NSW, 2647
AUS

Company: Thales, Australia, Mulwala Ltd
Address:
Bayly Street
Mulwala
NSW, 2647
AUS
Telephone: +61 2 5742 2200
Emergency Tel: +61 2 5742 2200
Fax: +61 2 5744 1873

Section 2 - HAZARDS IDENTIFICATION

STATEMENT OF HAZARDOUS NATURE
HAZARDOUS SUBSTANCE. DANGEROUS GOODS. According to the Criteria of NOHSC, and the ADG Code.

POISONS SCHEDULE
None

RISK

Risk Codes	Risk Phrases
R01	» Explosive when dry.
R02	» Risk of explosion by shock friction fire or other sources of ignition.
R05	» Heating may cause an explosion.
R20/21/22	» Harmful by inhalation in contact with skin and if swallowed.
R45(2)	» May cause CANCER.
R52/53	» Harmful to aquatic organisms may cause long- term adverse effects in the aquatic environment.
R62(3)	» Possible risk of impaired fertility.
R68(3)	» Possible risk of irreversible effects.

SAFETY

Safety Codes	Safety Phrases
S01	» Keep locked up.
S38	» In case of insufficient ventilation wear suitable respiratory equipment.
S51	» Use only in well ventilated areas.
S09	» Keep container in a well ventilated place.
S53	» Avoid exposure - obtain special instructions before use.
S401	» To clean the floor and all objects contaminated by this material use water and detergent.
S35	» This material and its container must be disposed of in a safe way.
S13	» Keep away from food drink and animal feeding stuffs.
S60	» This material and its container must be disposed of as hazardous waste.

Section 3 - COMPOSITION / INFORMATION ON INGREDIENTS

NAME	CAS RN	%
nitrocellulose	9004-70-0	> 85
2, 4- dinitrotoluene	121-14-2	<10
additives nonhazardous		<10

continued...

Section 4 - FIRST AID MEASURES

SWALLOWED
» - For advice, contact a Poisons Information Centre or a doctor at once.
- Urgent hospital treatment is likely to be needed.
- If swallowed do NOT induce vomiting.
- If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration.

EYE
» If this product comes in contact with the eyes:
- Immediately hold eyelids apart and flush the eye continuously with running water.
- Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.
- Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes.
- Transport to hospital or doctor without delay.

SKIN
» If skin contact occurs:
- Immediately remove all contaminated clothing, including footwear.
- Flush skin and hair with running water (and soap if available).
- Seek medical attention in event of irritation.

INHALED
» - If fumes or combustion products are inhaled remove from contaminated area.
- Lay patient down. Keep warm and rested.
- Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures.
- Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary.

NOTES TO PHYSICIAN
» Symptoms of vasodilation and reflex tachycardia may present following organic nitrate overdose; most organic nitrates are extensively metabolised by hydrolysis to inorganic nitrites. Organic nitrates and nitrites are readily absorbed through the skin, lungs, mucosa and gastro-intestinal tract. Delayed pulmonary oedema may result following exposure to nitrous oxides formed on thermal decomposition of the propellant.

Section 5 - FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA
» DANGER: Deliver media remotely.
- For minor fires: Flooding quantities only.
- For large fires: Do not attempt to extinguish.

FIRE FIGHTING
» WARNING: EXPLOSIVE MATERIALS / ARTICLES PRESENT!
- Evacuate all personnel and move upwind.
- Prevent re-entry.
- Alert Fire Brigade and tell them location and nature of hazard.
- May be explosively reactive, detonate and release much heat.

FIRE/EXPLOSION HAZARD
» WARNING: HIGH EXPLOSION HAZARD!
- Combustible.
- Will burn with rapidly increasing intensity of fire.
- Dry material is extremely sensitive to shock, friction, heat and sparks.
- Avoid metal to metal contact.

FIRE INCOMPATIBILITY
» - Avoid contact with other explosives, pyrotechnics, solvents, adhesives, paints, cleaners and unauthorized metals, plastics, packing equipment and materials.
- Avoid contamination with acids, alkalis, reducing agents, amines and phosphorus.

HAZCHEM: None

Personal Protective Equipment
Gas tight chemical resistant suit.
Limit exposure duration to 1 BA set 30 mins.

Section 6 - ACCIDENTAL RELEASE MEASURES

EMERGENCY PROCEDURES

continued...

MINOR SPILLS
» Clean up all spills immediately.
Avoid contact with skin and eyes.
Wear impervious gloves and safety glasses.
Use spark-free tools when handling.
Remove all ignition sources.
Place spilled material in clean, dry, sealable, labelled container.
Flush spill area with water.

MAJOR SPILLS
» Clear area of personnel.
Restrict access to area.
Alert Fire Brigade and tell them location and nature of hazard.
- May be violently or explosively reactive.
- Wear full body protective clothing with breathing apparatus.
- Prevent, by any means available, spillage from entering drains and water course.
- Consider evacuation (or protect in place).
No smoking or naked lights within area.
Shut off all possible sources of ignition and increase ventilation.
Stop leak if safe to do so.
Environmental hazard - contain spillage.
Collect, using a spark-free shovel, and seal in labelled drums for disposal.
Wash spill area with large quantities of water.
Protective clothing and equipment should be washed down after use and laundered separately from non-contaminated materials.
In the case of a transport accident notify the State Police, State
Explosives Inspector and the Manufacturer, Thales Mulwala Facility
Collect recoverable packages and segregate from loose, spilled material

Personal Protective Equipment advice is contained in Section 8 of the MSDS.

Section 7 - HANDLING AND STORAGE

PROCEDURE FOR HANDLING
» Use good occupational work practice. Observe manufacturer's storing and handling recommendations.
Avoid all personal contact, including inhalation.
Wear protective clothing when risk of exposure occurs.
Avoid smoking, naked lights, heat or ignition sources.
Must not be struck by metal implements.
Avoid shock and friction.
Avoid thermal shock.
Use in a well-ventilated area.
Avoid contact with incompatible materials.
When handling, DO NOT eat, drink or smoke.
Avoid physical damage to containers.
Always wash hands with soap and water after handling. Work clothes should be laundered separately.

SUITABLE CONTAINER
» Check containers are clearly labelled.
- Packaging as recommended by manufacturer.
Explosives Code Packing Instruction P114(b) or 114(b)
General packaging provisions of 4.1.1, 4.1.3 and special provision 4.1.5 are to be met.
For UN 0160, 0161 - If outer packaging is drum then inner packaging is not required.
For UN 0160, 0161 - If outer packaging is 1A2 or 1B2 metal drums then drum construction shall be that risk of explosion, by reason of increase by internal pressure from internal or external causes, is prevented.
For UN 0077, 0132, 0234, 0235, 0236, packagings are to be lead free, otherwise:
Inner Packagings:
Bags: Paper Kraft, Plastics, Textiles - sift proof, Woven Plastic - sift proof
Receptacles: Fibreboard, Metal, Paper, Plastic, Woven Plastic - sift proof
Intermediate Packagings:
Not necessary
Outer Packagings:
Boxes: Natural Wood (4C1), Natural Wood -sift proof (4C2), Plywood (4D), Reconstituted Wood (4F), Fibreboard (4G)
Drums: Steel, Removable Head (1A2), Aluminium, removable head (1B2), Plywood (1D), Fibre (1G), Plastic, removable head (1H2).

STORAGE INCOMPATIBILITY
» Segregate from strong acids strong alkalis and strong oxidisers.
- Avoid contact with other explosives, pyrotechnics, solvents, adhesives, paints, cleaners and unauthorized metals, plastics, packing equipment and materials.
- Avoid contamination with acids, alkalis, reducing agents, amines and phosphorus.

STORAGE REQUIREMENTS
» - Store in original containers.
- Keep containers securely sealed.
- Store in a cool, dry area protected from environmental extremes.
- Store away from incompatible materials and foodstuff containers.
Store in original containers.
No smoking, naked lights, heat or ignition sources.
Keep dry.

continued...

Keep storage area free of debris, waste and combustibles.
Protect containers against physical damage.
- Check regularly for spills and leaks.
Store cases in a well ventilated magazine licensed for IMCO class 1.3C Explosives.
NOTE: If deterioration of the explosive occurs or large quantities of explosive need to be destroyed notify the Manager, Thales Mulwala Facility or State Explosives Department.

Section 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE CONTROLS

Source	Material	TWA mg/m³
Australia Exposure Standards	nitrocellulose (Inspirable dust (not otherwise classified))	10
Australia Exposure Standards	2, 4- dinitrotoluene (Dinitrotoluene (h))	1.5

PERSONAL PROTECTION

RESPIRATOR
Particulate

EYE
» - Safety glasses with side shields.
- Chemical goggles.
- Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lens or restrictions on use, should be created for each workplace or task. This should include a review of lens absorption and adsorption for the class of chemicals in use and an account of injury experience. Medical and first-aid personnel should be trained in their removal and suitable equipment should be readily available. In the event of chemical exposure, begin eye irrigation immediately and remove contact lens as soon as practicable. Lens should be removed at the first signs of eye redness or irritation - lens should be removed in a clean environment only after workers have washed hands thoroughly. [CDC NIOSH Current Intelligence Bulletin 59].

HANDS/FEET
» Wear protective gloves, eg. PVC.
- Protective footwear.

OTHER
» Overalls.
- Eyewash unit.
Ensure ready access to a burns first aid kit.
- Impervious apron.
Ensure there is ready access to a safety shower.
- Barrier cream.
Manufacture may require:
Non-static clean room clothing

ENGINEERING CONTROLS
» General exhaust is adequate under normal operating conditions. Local exhaust ventilation may be required in specific circumstances.

Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE
Dark grey tubules.
Bulk density range 850-950 g/L. Insoluble in water.
WARNING: SEVERE EXPLOSION HAZARD. Detonation may occur from heavy impact or excessive heating. Avoid all contact with other chemicals.

PHYSICAL PROPERTIES
Solid.
Does not mix with water.
Sinks in water.

Molecular Weight: Not applicable.
Melting Range (℃): Not available.
Solubility in water (g/L): Immiscible
pH (1% solution): Not applicable.
Volatile Component (%vol): Negligible
Relative Vapour Density (air=1): Not applicable
Lower Explosive Limit (%): Not applicable.
Autoignition Temp (℃): 170

Boiling Range (℃): Not available.
Specific Gravity (water=1): > 1 approx
pH (as supplied): Not applicable
Vapour Pressure (kPa): Negligible
Evaporation Rate: Not applicable
Flash Point (℃): Not applicable
Upper Explosive Limit (%): Not applicable.
Decomposition Temp (℃): Explosive.

continued...

State: Divided solid

Viscosity: Not Applicable

Section 10 - CHEMICAL STABILITY AND REACTIVITY INFORMATION

CONDITIONS CONTRIBUTING TO INSTABILITY
» - Product is considered stable under normal handling conditions.
- Stable under normal storage conditions.
- Hazardous polymerization will not occur.
For incompatible materials - refer to Section 7 - Handling and Storage.

Section 11 - TOXICOLOGICAL INFORMATION

POTENTIAL HEALTH EFFECTS
ACUTE HEALTH EFFECTS
» Harmful by inhalation, in contact with skin and if swallowed.

CHRONIC HEALTH EFFECTS
» May cause CANCER.

» Possible risk of impaired fertility.
» Possible risk of irreversible effects.
» Possible respiratory sensitiser*.
» Possible skin sensitiser*.
» Cumulative effects may result following exposure*.
» * (limited evidence).

TOXICITY AND IRRITATION
» Not available. Refer to individual constituents.

NITROCELLULOSE:
» No significant acute toxicological data identified in literature search.

2,4-DINITROTOLUENE:
» unless otherwise specified data extracted from RTECS - Register of Toxic Effects of Chemical Substances.

TOXICITY
Oral (rat) LD50: 268 mg/kg
Oral (Mouse) LD50: 790 mg/kg
Subcutaneous (Cat) LD: 25 mg/kg

IRRITATION
Skin (rabbit): 500 mg/24h - Mild

» The material may cause skin irritation after prolonged or repeated exposure and may produce a contact dermatitis (nonallergic). This form of dermatitis is often characterised by skin redness (erythema) and swelling epidermis.
WARNING: This substance has been classified by the IARC as Group 2B: Possibly Carcinogenic to Humans.

CARCINOGEN

2, 4- dinitrotoluene	International Agency for Research on Cancer (IARC) Carcinogens	Group	2B

SKIN

2, 4- dinitrotoluene	Australia Exposure Standards - Skin	Notes	Sk

Section 12 - ECOLOGICAL INFORMATION

Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
This material and its container must be disposed of as hazardous waste.

Section 13 - DISPOSAL CONSIDERATIONS

» - Recycle wherever possible. Special hazards may exist - specialist advice may be required.
- Consult manufacturer for recycling options.
- Consult State Land Waste Management Authority for disposal.
- Incinerate residue at an approved site.
Explosives which are surplus, deteriorated or considered unsafe for transport, storage or use shall be destroyed and the statutory authorities shall be notified. Explosive must not be thrown away, buried, discarded or placed with garbage. This material may be disposed of by burning but the operation must be performed under the control of a person competent in the destruction of explosives.

continued...

Section 14 - TRANSPORTATION INFORMATION

Labels Required: EXPLOSIVE
HAZCHEM: None (ADG7)

Land Transport UNDG:

Class or division:	1.3C	Subsidiary risk:	None
UN No.:	0161	UN packing group:	None
Shipping Name:POWDER, SMOKELESS†			

Air Transport IATA:

ICAO/IATA Class:	1.3C	ICAO/IATA Subrisk:	None
UN/ID Number:	0161	Packing Group:	None
Special provisions:	None		
Cargo Only			
Packing Instructions:	Forbidden	Maximum Qty/Pack:	Forbidden
Passenger and Cargo		Passenger and Cargo	
Packing Instructions:	Forbidden	Maximum Qty/Pack:	Forbidden
Passenger and Cargo		Passenger and Cargo	
Limited Quantity		Limited Quantity	
Packing Instructions:	-	Maximum Qty/Pack:	-
Shipping Name: POWDER, SMOKELESS †			

Maritime Transport IMDG:

IMDG Class:	1.3C	IMDG Subrisk:	None
UN Number:	0161	Packing Group:	None
EMS Number:	F- B, S- Y	Special provisions:	None
Limited Quantities:	None		
Shipping Name: POWDER, SMOKELESS			

Section 15 - REGULATORY INFORMATION

POISONS SCHEDULE: None

REGULATIONS
Regulations for ingredients
ADI Sporting Powder AR 2205 (CAS: None):
No regulations applicable

nitrocellulose (CAS: 9004-70-0) is found on the following regulatory lists;
- Australia Dangerous Goods Code (ADG Code) - Goods Too Dangerous To Be Transported
- Australia Exposure Standards
- Australia High Volume Industrial Chemical List (HVICL)
- Australia Inventory of Chemical Substances (AICS)
- OECD Representative List of High Production Volume (HPV) Chemicals

2,4-dinitrotoluene (CAS: 121-14-2) is found on the following regulatory lists;
- Australia Exposure Standards
- Australia Hazardous Substances
- Australia Inventory of Chemical Substances (AICS)
- IMO IBC Code Chapter 17: Summary of minimum requirements
- IMO MARPOL 73/78 (Annex II) - List of Noxious Liquid Substances Carried in Bulk
- International Agency for Research on Cancer (IARC) Carcinogens
- International Chemical Secretariat (ChemSec) REACH SIN* List (*Substitute It Now!) 1.0
- International Council of Chemical Associations (ICCA) - High Production Volume List
- OECD Representative List of High Production Volume (HPV) Chemicals
- OSPAR List of Substances of Possible Concern

Section 16 - OTHER INFORMATION

» Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.
A list of reference resources used to assist the committee may be found at:
www.chemwatch.net/references.

» The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings.

continued...

permission from CHEMWATCH. TEL (+61 3) 9572 4700.

Issue Date: 6-Mar-2009
Print Date: 6-Mar-2009

This is the end of the MSDS.

Clays® Family

MATERIAL SAFETY DATA SHEET

April 2009

The following smokeless powders are distributed by Hodgdon Powder Company.

Clays® (Also known as AS30N)
Universal Clays® (Also known as AP70N)
International Clays® (Also known as AS50N)

6231 Robinson Street * Shawnee Mission, KS 66202 * Phone (913) 362-9455 * Fax (913-362-1307
www.Hodgdon.com * www.IMRpowder.com * www.WWpowder.com

Section 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME
MULWALA PISTOL POWDER AP70N

PROPER SHIPPING NAME
POWDER, SMOKELESS

PRODUCT USE
Porous double-base smokeless powders or propellant for pistol ammunition.

SUPPLIER

Company: Thales, Australia, Mulwala	Company: Thales, Australia, Mulwala Ltd
Address:	Address:
Private Bag 1	Bayly Street
Mulwala	Mulwala
NSW, 2647	NSW, 2647
AUS	AUS
	Telephone: +61 2 5742 2200
	Emergency Tel: +61 2 5742 2200
	Fax: +61 2 5744 1873

Section 2 - HAZARDS IDENTIFICATION

STATEMENT OF HAZARDOUS NATURE
HAZARDOUS SUBSTANCE. DANGEROUS GOODS. According to the Criteria of NOHSC, and the ADG Code.

POISONS SCHEDULE
None

RISK

Risk Codes	Risk Phrases
R01	» Explosive when dry.
R03	» Extreme risk of explosion by shock fire friction or other sources of ignition.
R26/27/28	» Very toxic by inhalation in contact with skin and if swallowed.
R33	» Danger of cumulative effects.
R52/53	» Harmful to aquatic organisms may cause long- term adverse effects in the aquatic environment.

SAFETY

Safety Codes	Safety Phrases
S01	» Keep locked up.
S36	» Wear suitable protective clothing.
S38	» In case of insufficient ventilation wear suitable respiratory equipment.
S51	» Use only in well ventilated areas.
S401	» To clean the floor and all objects contaminated by this material use water and detergent.
S35	» This material and its container must be disposed of in a safe way.
S13	» Keep away from food drink and animal feeding stuffs.
S45	» In case of accident or if you feel unwell IMMEDIATELY contact Doctor or Poisons Information Centre (show label if possible).
S60	» This material and its container must be disposed of as hazardous waste.

Section 3 - COMPOSITION / INFORMATION ON INGREDIENTS

NAME	CAS RN	%
nitrocellulose	9004-70-0	>85
nitroglycerin	55-63-0	10
additives nonhazardous		<10

continued...

Section 4 - FIRST AID MEASURES

SWALLOWED
» - For advice, contact a Poisons Information Centre or a doctor at once.
- Urgent hospital treatment is likely to be needed.
- If swallowed do NOT induce vomiting.
- If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration.

EYE
» If this product comes in contact with the eyes:
- Immediately hold eyelids apart and flush the eye continuously with running water.
- Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.
- Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes.
- Transport to hospital or doctor without delay.

SKIN
» If skin contact occurs:
- Immediately remove all contaminated clothing, including footwear.
- Flush skin and hair with running water (and soap if available).
- Seek medical attention in event of irritation.

INHALED
» - If fumes or combustion products are inhaled remove from contaminated area.
- Lay patient down. Keep warm and rested.
- Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures.
- Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary.

NOTES TO PHYSICIAN
» Symptoms of vasodilation and reflex tachycardia may present following organic nitrate overdose; most organic nitrates are extensively metabolised by hydrolysis to inorganic nitrites. Organic nitrates and nitrites are readily absorbed through the skin, lungs, mucosa and gastro-intestinal tract. Delayed pulmonary oedema may result following exposure to nitrous oxides formed on thermal decomposition of the propellant.

Section 5 - FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA
» DANGER: Deliver media remotely.
- For minor fires: Flooding quantities only.
- For large fires: Do not attempt to extinguish.

FIRE FIGHTING
» WARNING: EXPLOSIVE MATERIALS / ARTICLES PRESENT!
- Evacuate all personnel and move upwind.
- Prevent re-entry.
- Alert Fire Brigade and tell them location and nature of hazard.
- May be explosively reactive, detonate and release much heat.

FIRE/EXPLOSION HAZARD
» WARNING: HIGH EXPLOSION HAZARD!
- Combustible.
- Will burn with rapidly increasing intensity of fire.
- Dry material is extremely sensitive to shock, friction, heat and sparks.
- Avoid metal to metal contact.

FIRE INCOMPATIBILITY
» - Avoid contact with other explosives, pyrotechnics, solvents, adhesives, paints, cleaners and unauthorized metals, plastics, packing equipment and materials.
- Avoid contamination with acids, alkalis, reducing agents, amines and phosphorus.

HAZCHEM: None

Personal Protective Equipment
Gas tight chemical resistant suit.
Limit exposure duration to 1 BA set 30 mins.

Section 6 - ACCIDENTAL RELEASE MEASURES

EMERGENCY PROCEDURES

continued...

MINOR SPILLS
» Clean up all spills immediately.
Avoid contact with skin and eyes.
Wear impervious gloves and safety glasses.
Use spark-free tools when handling.
Remove all ignition sources.
Place spilled material in clean, dry, sealable, labelled container.
Flush spill area with water.

MAJOR SPILLS
» Clear area of personnel.
Restrict access to area.
Alert Fire Brigade and tell them location and nature of hazard.
- May be violently or explosively reactive.
- Wear full body protective clothing with breathing apparatus.
- Prevent, by any means available, spillage from entering drains and water course.
- Consider evacuation (or protect in place).
No smoking or naked lights within area.
Shut off all possible sources of ignition and increase ventilation.
Stop leak if safe to do so.
Collect, using a spark-free shovel, and seal in labelled drums for disposal.
Wash spill area with large quantities of water.
Protective clothing and equipment should be washed down after use and laundered separately from non-contaminated materials.
In the case of transport accident notify the State Police, State
Explosives Inspector and the Manufacturer, Thales Mulwala Facility.
Collect recoverable packages and segregate from loose, spilled material

Personal Protective Equipment advice is contained in Section 8 of the MSDS.

Section 7 - HANDLING AND STORAGE

PROCEDURE FOR HANDLING
» Use good occupational work practice. Observe manufacturer's storing and handling recommendations.
Avoid all personal contact, including inhalation.
Wear protective clothing when risk of exposure occurs.
Avoid smoking, naked lights, heat or ignition sources.
Must not be struck by metal implements.
Avoid shock and friction.
Avoid thermal shock.
Use in a well-ventilated area.
Avoid contact with incompatible materials.
When handling, DO NOT eat, drink or smoke.
Avoid physical damage to containers.
Always wash hands with soap and water after handling. Work clothes should be laundered separately.

SUITABLE CONTAINER
» Explosives Code Packing Instruction P114(b) or 114(b)
General packaging provisions of 4.1.1, 4.1.3 and special provision 4.1.5 are to be met.
For UN 0160, 0161 - If outer packaging is drum then inner packaging is not required.
For UN 0160, 0161 - If outer packaging is 1A2 or 1B2 metal drums then drum construction shall be that risk of explosion, by reason of increase by internal pressure from internal or external causes, is prevented.
For UN 0077, 0132, 0234, 0235, 0236, packagings are to be lead free, otherwise:
Inner Packagings:
Bags: Paper Kraft, Plastics, Textiles - sift proof, Woven Plastic - sift proof
Receptacles: Fibreboard, Metal, Paper, Plastic, Woven Plastic - sift proof
Intermediate Packagings:
Not necessary
Outer Packagings:
Boxes: Natural Wood (4C1), Natural Wood -sift proof (4C2), Plywood (4D), Reconstituted Wood (4F), Fibreboard (4G)
Drums: Steel, Removable Head (1A2), Aluminium, removable head (1B2), Plywood (1D), Fibre (1G), Plastic, removable head (1H2).
Check containers are clearly labelled.
- Packaging as recommended by manufacturer.

STORAGE INCOMPATIBILITY
» Segregate from strong acids strong alkalis and strong oxidisers.
- Avoid contact with other explosives, pyrotechnics, solvents, adhesives, paints, cleaners and unauthorized metals, plastics, packing equipment and materials.
- Avoid contamination with acids, alkalis, reducing agents, amines and phosphorus.

STORAGE REQUIREMENTS
» Store in original containers.
No smoking, naked lights, heat or ignition sources.
Keep dry.
Keep storage area free of debris, waste and combustibles.
Protect containers against physical damage.
- Check regularly for spills and leaks.
Store cases in a well ventilated magazine licensed for IMCO Class 1.3C
Explosives.

continued...

NOTE: If deterioration of the explosive occurs or large quantities of explosive need to be destroyed notify the Manager, Thales Mulwala Facility or State Explosives Department.

Section 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE CONTROLS

Source	Material	TWA ppm	TWA mg/m³
Australia Exposure Standards	nitrocellulose (Inspirable dust (not otherwise classified))		10
Australia Exposure Standards	nitroglycerin (Nitroglycerin (NG))	0.05	0.46

PERSONAL PROTECTION

RESPIRATOR
Type A-P Filter of sufficient capacity

EYE
» - Safety glasses with side shields.
- Chemical goggles.
- Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lens or restrictions on use, should be created for each workplace or task. This should include a review of lens absorption and adsorption for the class of chemicals in use and an account of injury experience. Medical and first-aid personnel should be trained in their removal and suitable equipment should be readily available. In the event of chemical exposure, begin eye irrigation immediately and remove contact lens as soon as practicable. Lens should be removed at the first signs of eye redness or irritation - lens should be removed in a clean environment only after workers have washed hands thoroughly. [CDC NIOSH Current Intelligence Bulletin 59].

HANDS/FEET
» Wear protective gloves, eg. PVC.
- Protective footwear.

OTHER
» Overalls.
- Eyewash unit.
- Impervious apron.
Ensure there is ready access to a safety shower.
- Barrier cream.
Manufacture may require:
Non-static clean room clothing

ENGINEERING CONTROLS
» Use in a well-ventilated area.
General exhaust is adequate under normal operating conditions. Local exhaust ventilation may be required in specific circumstances.

Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE
Small grey, green-grey or orange-grey disc shaped granules. Insoluble in water.
WARNING: SEVERE EXPLOSION HAZARD. Detonation may occur from heavy impact or excessive heating. Avoid all contact with other chemicals.

PHYSICAL PROPERTIES
Solid.
Does not mix with water.
Floats on water.

Molecular Weight: Not applicable.
Melting Range (℃): >170 decomposes
Solubility in water (g/L): Immiscible
pH (1% solution): Not applicable.
Volatile Component (%vol): Negligible
Relative Vapour Density (air=1): Not applicable
Lower Explosive Limit (%): Not applicable.
Autoignition Temp (℃): 170
State: Divided solid

Boiling Range (℃): Not available.
Specific Gravity (water=1): Approx. 0.6
pH (as supplied): Not applicable
Vapour Pressure (kPa): Negligible
Evaporation Rate: Not applicable
Flash Point (℃): Not applicable
Upper Explosive Limit (%): Not applicable.
Decomposition Temp (℃): Explosive.
Viscosity: Not Applicable

continued...

Section 10 - CHEMICAL STABILITY AND REACTIVITY INFORMATION

CONDITIONS CONTRIBUTING TO INSTABILITY
» - Product is considered stable under normal handling conditions.
- Stable under normal storage conditions.
- Hazardous polymerization will not occur.
For incompatible materials - refer to Section 7 - Handling and Storage.

Section 11 - TOXICOLOGICAL INFORMATION

POTENTIAL HEALTH EFFECTS
ACUTE HEALTH EFFECTS
» Very toxic by inhalation, in contact with skin and if swallowed.

CHRONIC HEALTH EFFECTS
» Danger of cumulative effects.

TOXICITY AND IRRITATION
» Not available. Refer to individual constituents.

NITROCELLULOSE:
» No significant acute toxicological data identified in literature search.

NITROGLYCERIN:
» unless otherwise specified data extracted from RTECS - Register of Toxic Effects of Chemical Substances.

» The material may produce severe irritation to the eye causing pronounced inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.
The material may cause skin irritation after prolonged or repeated exposure and may produce a contact dermatitis (nonallergic). This form of dermatitis is often characterised by skin redness (erythema) and swelling epidermis.
Substance has been investigated as a tumorigen, mutagen and reproductive effector.
Equivocal tumorigen by RTECS criteria.
Reproductive effector in rats.

SKIN

nitroglycerin	Australia Exposure Standards - Skin	Notes	Sk

Section 12 - ECOLOGICAL INFORMATION

Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
This material and its container must be disposed of as hazardous waste.

Section 13 - DISPOSAL CONSIDERATIONS

» - Recycle wherever possible. Special hazards may exist - specialist advice may be required.
- Consult manufacturer for recycling options.
- Consult State Land Waste Management Authority for disposal.
- Incinerate residue at an approved site.
Explosives which are surplus, deteriorated or considered unsafe for transport, storage or use shall be destroyed and the statutory authorities shall be notified. Explosives must not be thrown away, buried, discarded or placed with garbage. This material may be disposed of by burning but the operation must be performed under the control of a person competent in the destruction of explosives.

Section 14 - TRANSPORTATION INFORMATION

Labels Required: EXPLOSIVE
HAZCHEM: None (ADG7)

continued...

Land Transport UNDG:

Class or division:	1.3C	Subsidiary risk:	None
UN No.:	0161	UN packing group:	None
Shipping Name:POWDER, SMOKELESS†			

Air Transport IATA:

ICAO/IATA Class:	1.3C	ICAO/IATA Subrisk:	None
UN/ID Number:	0161	Packing Group:	None
Special provisions:	None		
Cargo Only			
Packing Instructions:	Forbidden	Maximum Qty/Pack:	Forbidden
Passenger and Cargo		Passenger and Cargo	
Packing Instructions:	Forbidden	Maximum Qty/Pack:	Forbidden
Passenger and Cargo		Passenger and Cargo	
Limited Quantity		Limited Quantity	
Packing Instructions:	-	Maximum Qty/Pack:	-
Shipping Name: POWDER, SMOKELESS †			

Maritime Transport IMDG:

IMDG Class:	1.3C	IMDG Subrisk:	None
UN Number:	0161	Packing Group:	None
EMS Number:	F- B, S- Y	Special provisions:	None
Limited Quantities:	None		
Shipping Name: POWDER, SMOKELESS			

Section 15 - REGULATORY INFORMATION

POISONS SCHEDULE: None

REGULATIONS
Regulations for ingredients
Mulwala Pistol Powder AP70N (CAS: None):
No regulations applicable

nitrocellulose (CAS: 9004-70-0) is found on the following regulatory lists;
- Australia Dangerous Goods Code (ADG Code) - Goods Too Dangerous To Be Transported
- Australia Exposure Standards
- Australia High Volume Industrial Chemical List (HVICL)
- Australia Inventory of Chemical Substances (AICS)
- OECD Representative List of High Production Volume (HPV) Chemicals

nitroglycerin (CAS: 55-63-0) is found on the following regulatory lists;
- Australia - Victoria Occupational Health and Safety Regulations - Schedule 9: Materials at Major Hazard Facilities (And Their Threshold Quantity) Table 2
- Australia Dangerous Goods Code (ADG Code) - Goods Too Dangerous To Be Transported
- Australia Explosives Code (AE Code)
- Australia Exposure Standards
- Australia Hazardous Substances
- Australia Inventory of Chemical Substances (AICS)
- Australia Standard for the Uniform Scheduling of Drugs and Poisons (SUSDP) - Appendix G
- Australia Standard for the Uniform Scheduling of Drugs and Poisons (SUSDP) - Schedule 2
- Australia Standard for the Uniform Scheduling of Drugs and Poisons (SUSDP) - Schedule 3
- Australia Standard for the Uniform Scheduling of Drugs and Poisons (SUSDP) - Schedule 4
- International Air Transport Association (IATA) Dangerous Goods Regulations
- International Air Transport Association (IATA) Dangerous Goods Regulations - Prohibited List
- OECD Representative List of High Production Volume (HPV) Chemicals

Section 16 - OTHER INFORMATION

» Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.
A list of reference resources used to assist the committee may be found at:
www.chemwatch.net/references.

» The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings.

Issue Date: 19-Mar-2009
Print Date: 19-Mar-2009

This is the end of the MSDS.

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Seoul 100-705, Korea

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Fax. : (82 2) 3406 5415
Internet : http://www.Poongsan.co.kr

MATERIAL SAFETY DATA SHEET

1. PRODUCT AND COMPANY IDENTIFICATION

Item	Completed Cartridge
Manufacture's Name	POONGSAN CORPORATION Keukdong Building #1101, 60-1, 3KA, Chungmu-Ro, Chung-Ku, Seoul 100-705, Korea
Telephone No	82 2 3406 5114
Date of Preparation	July 3, 2006
Information Telephone	82 54 760 6114

2. COMPONENT DATA

CONSIST OF FOUR COMPONENT AS FOLLOW;

Component	Percent
Bullet	60 ~ 70%
Case	25 ~ 35%
Propellant	1 ~ 3%
Primer	1 ~ 5%

A. BULLET

Chemical Name	Lead		
CAS Number	7439 - 92 - 1		
Percentage Range	50 ~ 70%		
Hazardous Per 29 CFR 1910.1200	Yes		
Exposure Standard		OSHA(PEL)	ACGIH(TLV)
	Unit	mg/m^3	mg/m^3
	TWA	0.05	0.15
	CEILING	None	None
	STEL	None	None

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Chemical Name	Copper		
CAS Number	7440 - 50 - 8		
Percentage Range	0 ~ 15%		
Hazardous Per 29 CFR 1910.1200	Yes		
Exposure Standard		OSHA(PEL)	ACGIH(TLV)
	Unit	mg/m^3	mg/m^3
	TWA	1	1
	Dust	1	1
	CEILING	None	None
	STEL	None	None

Chemical Name	Zinc		
CAS Number	7440 - 66 - 6		
Percentage Range	0 ~ 5%		
Hazardous Per 29 CFR 1910.1200	Yes		
Exposure Standard		OSHA(PEL)	ACGIH(TLV)
	Unit	mg/m^3	mg/m^3
	TWA	5(respirable) 10(total)	10
	CEILING	None	None
	STEL	None	None

Chemical Name	Antimony		
CAS Number	7429 - 36 - 0		
Percentage Range	0.1 ~ 5%		
Hazardous Per 29 CFR 1910.1200	Yes		
Exposure Standard		OSHA(PEL)	ACGIH(TLV)
	Unit	mg/m^3	mg/m^3
	TWA	0.5	0.5
	CEILING	None	None
	STEL	None	None

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B. CASE

Chemical Name	Copper		
CAS Number	7440 - 50 - 8		
Percentage Range	15 ~ 30%		
Hazardous Per 29 CFR 1910.1200	Yes		
Exposure Standard		OSHA(PEL)	ACGIH(TLV)
	Unit	mg/m^3	mg/m^3
	TWA	1	1
	Dust	1	1
	CEILING	None	None
	STEL	None	None

Chemical Name	Lead		
CAS Number	7439 - 92 - 1		
Percentage Range	0 ~ 1%		
Hazardous Per 29 CFR 1910.1200	Yes		
Exposure Standard		OSHA(PEL)	ACGIH(TLV)
	Unit	mg/m^3	mg/m^3
	TWA	0.05	0.15
	CEILING	None	None
	STEL	None	None

Chemical Name	Zinc		
CAS Number	7440 - 66 - 6		
Percentage Range	5 ~ 20%		
Hazardous Per 29 CFR 1910.1200	Yes		
Exposure Standard		OSHA(PEL)	ACGIH(TLV)
	Unit	mg/m^3	mg/m^3
	TWA	5(respirable) 10(total)	10
	CEILING	None	None
	STEL	None	None

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C. PROPELLANT

Chemical Name	Nitrocellulose		
CAS Number	9004 - 70 - 0		
Percentage Range	0.1 ~ 1		
Hazardous Per 29 CFR 1910.1200	Yes		
Exposure Standard		OSHA(PEL)	ACGIH(TLV)
	Unit	mg/m^3	mg/m^3
	TWA	None	None
	CEILING	None	None
	STEL	None	None

Chemical Name	Nitroglycerin		
CAS Number	55 - 63 - 0		
Percentage Range	0.1 ~ 1%		
Hazardous Per 29 CFR 1910.1200	Yes		
Exposure Standard		OSHA(PEL)	ACGIH(TLV)
	Unit	mg/m^3	mg/m^3
	TWA	0.1	0.05
	CEILING	None	None
	STEL	None	None

Chemical Name	Dibuthyl Phthalate		
CAS Number	84 - 74 - 2		
Percentage Range	0.1 ~ 1%		
Hazardous Per 29 CFR 1910.1200	Yes		
Exposure Standard		OSHA(PEL)	ACGIH(TLV)
	Unit	mg/m^3	mg/m^3
	TWA	5	5
	CEILING	None	None
	STEL	None	None

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D. PRIMER

Chemical Name	Copper		
CAS Number	7440 - 50 - 8		
Percentage Range	0.1 ~ 3%		
Hazardous Per 29 CFR 1910.1200	Yes		
Exposure Standard		OSHA(PEL)	ACGIH(TLV)
	Unit	mg/m^3	mg/m^3
	TWA	1	1
	Dust	1	1
	CEILING	None	None
	STEL	None	None

Chemical Name	Zinc		
CAS Number	7440 - 66 - 6		
Percentage Range	0 - 1%		
Hazardous Per 29 CFR 1910.1200	Yes		
Exposure Standard		OSHA(PEL)	ACGIH(TLV)
	Unit	mg/m^3	mg/m^3
	TWA	5(respirable) 10(total)	10
	CEILING	None	None
	STEL	None	None

Chemical Name	Diazodinitrophenol		
CAS Number	87- 31 -0		
Percentage Range	0 ~ 1%		
Hazardous Per 29 CFR 1910.1200	Yes		
Exposure Standard		OSHA(PEL)	ACGIH(TLV)
	Unit	mg/m^3	mg/m^3
	TWA	0.05	0.15
	CEILING	None	None
	STEL	None	None

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Chemical Name	Tetrazene
CAS Number	109 - 27 - 3
Percentage Range	0 ~ 1%
Hazardous Per 29 CFR 1910.1200	Yes
Exposure Standard	Not Applicable

Chemical Name	Potassium Nitrate
CAS Number	7757 - 79 - 1
Percentage Range	0 ~ 1%
Hazardous Per 29 CFR 1910.1200	Yes
Exposure Standard	Not Applicable

Chemical Name	Borosilicate
CAS Number	NA
Percentage Range	0 ~ 1%
Hazardous Per 29 CFR 1910.1200	Yes
Exposure Standard	Not Applicable

Chemical Name	Propellant(Fine Powder)
CAS Number	NA
Percentage Range	0 ~ 1%
Hazardous Per 29 CFR 1910.1200	Yes
Exposure Standard	Not Applicable

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3. HAZARDS IDENTIFICATION

A. FLAMMABILITY DATA

Explosive	Yes
Flammable	Not Applicable
Combustible	Not Applicable
Pyrophoric	No
Flash Point	Not Applicable
Autoignition Temperature	No data
Flammable Limits(LEL/UEL)	Not Applicable

B. HMIS RATINGS

Health	0
Flammability	2
Reactivity	4

C. EXTINGUISHING METHODS

Extinguish using mass water, carbon dioxide. If failed extinguish at first fire, evacuate all person from fired area

4. FIRST AID MEASURE

A. INHALATION

Not a likely route of exposure as a completed cartridge

B. SKIN

Not a likely route of exposure as a completed cartridge

C. EYE

Not a likely route of exposure as a completed cartridge

D. INGESTION

Not a likely route of exposure as a completed cartridge

5. SPILL AND LEAKAGE PROCEDURES

A. SPILL MITIGATION PROCEDURES

This product does represent an explosion hazard from heat, shock, friction, etc. Remove all sources of ignition. Stop source of spill as soon as possible and notify appropriate personnel.

B. PERSONAL PROTECTION FOR EMERGENCY SPILL

No extra protection required beyond that listed in section 6. In case of fire, use normal fire fighting equipment.

6. PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS

A. PERSONAL PROTECTION FOR ROUTINE USE OF PRODUCT

Respiratory Protection	Not normally needed.
Ventilation	Local exhaust ventilation is recommended if significant dusting occurs. Otherwise, use general exhaust ventilation
Skin and eye protection	Use gloves and safety glasses.

B. EQUIPMENT SPECIFICATION

Respirator Type	Approved respirator by NIOSH
Protective Clothing Type	Gloves, protective suit are impervious

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7. PRECAUTION FOR SAFE STORAGE

A. STORAGE CONDITION

Store in a cool, dry, well ventilated place. Away from all source of ignition. Do not subject to mechanical shock

B. PRODUCT STABILITY AND COMPATIBILITY

Incompatible materials for storage or transport; Acids, strong oxidizers and caustics

8. PHYSICAL AND CHEMICAL DATA

Appearance	Completed Cartridge
Freezing Point	Not Applicable
Boiling Point	Not Applicable
Decomposition Temperature	Not Applicable
Specific Gravity	Not Applicable
Bulk Density	Not Applicable
PH at 25℃	Not Applicable
Vapor Pressure at 25℃	Not Applicable
Solubility in Water	Not Applicable
Volatile, Percent by Volume	Not Applicable
Evaporation Rate	Not Applicable
Vapor Density	Not Applicable
Molecular Weight	Not Applicable

9. REACTIVITY INFORMATION

A. CONDITIONS UNDER WHICH THIS PRODUCT MAY BE UNSTABLE

Temperature Above	Not Applicable
Mechanical Shock or Impact	Yes
Electrical (Static) Discharge	Yes
Hazardous Polymerization	Not Applicable
Incompatible Materials	Acids, Caustics, strong oxidizers
Hazardous Decomposition	Nitrogen oxides, carbon monoxide
Other conditions to avoid	Unknown

B. REACTIVITY PROPERTIES

Explosive	Yes
Pyrophoric	No
Organic Peroxide	No
Oxidizer	No
Water Reactive	No

10. TOXICOLOGY AND HEALTH INFORMATION

A. ROUTES OF ABSORPTION

Ingestion, eye and skin contact

B. WARNING STATEMENT

Ingestion, eye and skin may be harmful, if ingested or contact

C. SIGNS, SYMPTOMS AND EFFECTS OF EXPOSURE

▶ INHALATION

Acute	Inhalation of lead dust or metal fume may cause irritation to nose, throat, upper respiratory tract and lung. The irritant effect may lead to bronchitis, headache, a fall in blood pressure, weakness, convulsions and collapse may occur. Severe poisoning may impair vision by damaging the optic nerve.
Chronic	Chronic inhalation of lead dust or metal fume may cause damage to central and peripheral nerves, blood, kidneys and the fetus. Male reproductive function may be impaired. Damage to nerves can result in reduction in motor nerve and muscle function. Anemia may result due to interference by lead of hemoglobin synthesis Lead has been identified as lead poisoning, known as "plumbism" causing gingival lead line and an accumulation in body tissues.

▶ SKIN

Acute	Lead can be absorbed through the skin to produce effects similar to those listed under acute inhalation exposure.
Chronic	Lead can be absorbed through the skin to produce effects similar to those listed under chronic inhalation exposure.

▶ EYE

Lead dust and fume can be irritate the eyes with conjunctival redness and discharge.

▶ INGESTION

Acute	The effects of lead ingestion would be similar to those listed under acute inhalation exposure in addition to gastrointestinal tract irritation.
Chronic	The effects of lead ingestion would be similar to those listed under chronic inhalation exposure.

▶ MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE

Exposure to lead can aggravate anemia, cardiovascular and respiratory disease. There are no medical conditions known to be aggravated by exposure to this product, due to its physical nature and use.

▶ ACUTE TARGET ORGAN TOXICITY

Lead dust and fume can cause damage to central nervous system, blood, lungs and eyes.

▶ CHRONIC TARGET ORGAN TOXICITY

Lead can cause damage to the blood, central and peripheral nervous systems, and kidney. Lead inhibits the production of hemoglobin, the material in the blood which carries oxygen. Anemia may result. Lead also causes damage to peripheral nerves resulting in a decrease in motor nerve and muscle function. It is judged that the low percentage of these substances in, and the physical nature of, the product would preclude the development of these effects.

▶ REPRODUCTIVE AND DEVELOPMENTAL TOXICITY

Lead has been shown to affect fetal development and reduce male reproductive function. Lead crosses the placenta and may affect the fetus causing birth defects, mental retardation, behavioral disorders and death during the first year of childhood. It is judged that the physical nature of and use of product would preclude the development of these effects.

▶ CARCINOGENICITY

This product is not known or reported to be carcinogenic.

▶ MUTAGENICITY

This product is not known or reported to be mutagenic

11. TRANSPORTATION INFORMATION

UN No	UN 0012
Hazard class	1.4S

12. WASTE DISPOSAL

When this product becomes a waste, it will be a hazardous waste and should be treated as such when the user will dispose this material. Care must be taken to protect personnel from hazards described in this MSDS and to prevent environmental contamination in accordance with all relevant local, state or federal laws and regulations.

Federal Cartridge Company
900 Bob Ehlen Drive
Anoka, MN 55303

Material Safety Data Sheet

Revision: B
Prepared: September 8, 2010

TELEPHONE: 763-323-2300
PRODUCT SERVICE: 763-323-3706
EMERGENCY PHONE NUMBER: 800-424-9300 or 703-527-3887 (CHEMTREC)

Revised/Reviewed Date: April 18, 2014

Section 1. Product Information

Product Name: Small Arms Ammunition – Centerfire Rifle & Pistol Ammunition
MSDS Number: F3001
Product ID#: See Table Below
Preparation Date: 8 September 2010

Business Phone/Hours: 763-323-2510 / 24 Hours a Day, 7 Days a Week
24 Hr. Spill (Chemtrec): 1-800-424-9300

CENTERFIRE – PRODUCT FAMILY		
.222 Remington	.30-30 Winchester	.300 Savage
.22-250 Remington	.32 Automatic	.32 Winchester Special
.223 Remington	.32 S&W Long	.338 Winchester Magnum
6mm Remington	.32 H&R Magnum	.35 Remington
.243 Winchester	.380 Automatic	8mm Mauser
.257 Roberts +P	.38 Special	.45-70 Government
.25-06 Remington	.357 Magnum	.280 Remington
.270 Winchester	9mm Luger Auto	7-30 Waters
7mm Remington Magnum	9mm Ball (M-822)	7.62X39 Soviet
7mm Mauser	9mm Federal	.303 British
.300 Winchester Magnum	.41 Rem Magnum	.375 H&H Magnum
.308 Winchester	.44 S&W Special	.300 H&H Magnum
.30-06 Springfield	.44 Rem Magnum	.458 Winchester Magnum
.30 Caliber Carbine	.45 Automatic	.416 Rigby
.25 Automatic	.45 Colt	.470 Nitro Express
10mm Automatic	9mm Subsonic	.38 Special +P+
.40 S&W	6.5X55 Swedish	7X64 Brenneke
5.56 Limited Range	9mm Limited Range	.38 Special +P
.356 TS&W	.270 Weatherby Magnum	.300 Weatherby Magnum
7mm Weatherby Magnum	.357 SIG	.38 Super
9X18 Makarov	.257 Weatherby Magnum	.416 Remington Magnum

CENTERFIRE – PRODUCT FAMILY		
.220 Swift	.35 Whelen	.340 Weatherby Magnum
7mm STW	7mm-08 Remington	.260 Remington
.300 Rem Ultra Mag.	.338 Rem Ultra Mag.	.454 Casull
.300 Win Short Mag.	.270 Win Short Mag	7mm Win Short Mag.
.223 Win Super Short Mag.	.243 Win Super Short Mag.	.45 Glock Automatic
.404 Jeffery	.458 Lott	.338 Federal
.325 Win Short Mag.	.204 Ruger	.22 Hornet
.480 Ruger	.500 S&W	.460 S&W
9.3x62	9.3x74R	370 Sako Mag.
500 Nitro Express	.338 Lapua Mag.	6.8mm Rem SPC
7.62x51	300 BLK	

Section 2. Composition/Information On Ingredients

Chemical Name	Common Name	CAS Number	Weight. % Range
Bullet			
*Lead or Lead Core	Lead	7439-92-1	30 – 60%
*Copper Jacket	Copper	7440-50-8	0 – 1%
*Zinc (As Zinc Oxide)	Zinc	7440-66-6 1314-13-2	0 -0.25%
*Antimony	Antimony	7440-36-0	0 – 3%
Nyclad Coating	Nyclad Coating	Not established	0 – 1%
Cartridge Case			
*Brass (As Zinc & Copper) (see above)	Copper Zinc	See above	25 – 40% 1 – 15%
*Nickel Plated Brass (As Nickel)	Nickel	7440-02-0	0 – 1%
*Tin Plated Brass (As Tin)	Tin	7440-31-5	0 – 1%
*Lead	Lead	See above	<0.1%
Propellant			
Nitrocellulose	Cellulose Nitrate Nitrocotton Gun Cotton	9004-70-0	0.5 – 12%
*Nitroglycerine	Trinitroglycerin Glyceryl Trinitrate	55-63-0	0 – 7%
Graphite – synthetic	Graphite Powder	7782-42-5	0 – 0.25%
Primer			
*Lead Styphnate (As Lead)	Basic Lead Styphnate	12403-82-6	<0.1%
Tetracene	Tetracene	109-27-3	<0.1%
*Barium Nitrate (As Barium)	Barium Salt Nitrobarite Barium Dinitrate	7440-39-3	<0.1%
Bismuth Trioxide (as Bismuth)	Bismuth oxide, Bismuth yellow	1304-76-3	<0.1%
*Antimony Sulfide (As Antimony)	Antimonous Sulfide Diantimony Trisulfide	7440-36-0	<0.1%
*Aluminum	Aluminum	7429-90-5	<0.1%
Nitrocellulose (see above)	See above	See above	<0.1%
*Nitroglycerine (see above)	See above	See above	<0.1%

* Indicates toxic chemical(s) subject to the reporting requirements of section 313 of title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986 and 40 CFR 372.

Section 3. Hazard Identification

CAUTION! Explosive. Keep away from heat. Do not subject to mechanical shock. Particles from firing may be harmful if inhaled. Do not take internally.

Eye: Contact with large volumes of smoke may cause minor eye irritation.

Skin: Elemental and inorganic lead compounds are not absorbed through the skin.

Ingestion: Acute ingestion of lead may occur from poor personal hygiene associated with the handling of lead bearing materials. The effects of lead ingestion would be similar to those listed under acute inhalation in addition to gastrointestinal irritation. Chronic ingestion of lead may occur from poor personal hygiene associated with the handling of lead bearing materials. The effects of lead ingestion would be similar to those listed under chronic inhalation. Note: Wash hands thoroughly with soap and water before eating or smoking.

Inhalation: Inhalation of gases and particulates produced while firing ammunition may result in mild throat, eye, upper respiratory and lung irritation. The irritant effects may lead to lung symptoms such as bronchitis. An over exposure to gases or particulates, as a result of lead in the particulates, may also cause: anemia; nervous system symptoms which may include irritability, headache, restlessness, fatigue, muscle weakness, muscle tremor, convulsions, loss of memory, visual and hearing disturbances, loss of coordination; gastrointestinal effects such as vomiting, colic, diarrhea or constipation; circulatory symptoms such as a drop in blood pressure; reproductive effects including fertility problems, birth defects, miscarriages and possible kidney damage. Prolonged repeated over exposure to fired cartridge gases and particulates, as a result of lead in the particulates, may result in elevated blood lead levels and elevated zinc protoporphyrin levels. Symptoms of chronic overexposure to lead may include: anemia; lead lines on the gums; nervous system symptoms which may include irritability, headache, restlessness, fatigue, muscle weakness (i.e. wrist drop), muscle tremor, convulsions, loss of memory, visual and hearing disturbances, loss of coordination; gastrointestinal effects such as weight loss, vomiting, colic, diarrhea, constipation; circulatory symptoms such as a drop in blood pressure; reproductive effects including fertility problems, birth defects, miscarriages and possible kidney damage. If acute or chronic symptoms should appear, contact a physician. Blood lead and zinc protoporphryn levels are recommended and should be monitored as per OSHA 1910.1025.

Exposure Symptoms: See above.

Target Organs: See above.

Chronic Effects: See above.

Other: Lead and barium are toxic metals that may be released during the firing of primers. Care should be taken in the cleaning of range facilities to minimize the exposure potential to lead and barium. Persons engaged in these activities should wear protective clothing with an appropriate respirator. Range operators should consult OSHA 1910.1025 for details pertaining to the handling of lead in the work environment.

Severe lead intoxication has been associated in the past with sterility, abortion, and stillbirth. Modern information confirming that lead poisoning affects birth rates or cause injury to the fetus in man is not conclusive.

Exposure to lead can aggravate pre-existing anemia, cardiovascular and respiratory diseases and conditions related to the gastrointestinal, reproductive, renal (kidney), and central nervous systems.[1]

[1]Reference: Industrial Toxicology, Safety and Health Applications in the Workplace; Williams/B.

Cancer Information:	**NTP:** No	**OSHA:** No	**IARC:** Group 2B, possibly carcinogenic in humans

Section 4. First Aid Measures

Eyes: Remove person to fresh air. If foreign body is suspected, wash eyes in fresh water for 15 minutes, contact physician.

Skin: Wash exposed areas thoroughly with soap and water

Ingestion: Ingestion is not a likely route of exposure. In case of ingestion, contact physician.

Inhalation: Remove person to fresh air. Seek medical attention.

Doctor Notes: NA

Section 5. Fire Fighting Measures

Flammable Properties: No

Hazardous Decomposition Products: Oxides of Barium, Lead, Antimony, Aluminum, Magnesium, Nitrogen, Carbon, and Sulfur. Lead and Antimony fumes may also be produced.

Extinguishing Media: Water

Protective Equipment: In all cases, full fire fighter personal protection gear, including face shield and SCBA should be utilized.

Unusual Fire and Explosion Hazards: May ignite if heated to 250 degrees F, independent of air. Unconfined ignited cartridges can produce low velocity metallic fragments, which may cause eye injury or skin wounds if unprotected by standard fire-fighter turnout gear.

Wear full fire-fighter protective gear including face shield or SCBA. Use wide fog pattern nozzle to stop any low velocity fragments. Use water to cool ordinary combustibles below ignition temperature.

Section 6. Accidental Release Measures

Spills and Leaks: Avoid conditions detailed in Section #10. If container should rupture, place all loose cartridges from broken shipping cases into a sturdy container. Secure container carefully.

Waste Disposal: Contact Manufacturer - Product Service (763) 323-3706

Section 7. Handling Information

Store in a dry, cool area in the original container to assure performance. Keep out of the reach of children. Avoid striking the primer of unchambered cartridges. Remove ammunition from service if any of the following conditions have occurred:

1. Evidence of corrosion
2. Physical damage
3. Exposure to oil or spray type lubricants.

Avoid prolonged storage in leather cartridge carriers.

Section 8. Exposure Control Measures / Personal Protection

			Applicable Exposure Limits		
Chemical Name	**CAS #**	**Wt. %**	**OSHA PEL**	**ACGIH TLV**	**Other**
Bullet					
Lead or Lead Core	7439-92-1	30 – 60%	0.05 mg/m^3	0.05 mg/m^3	
Copper Jacket	7440-50-8	0 – 1%	1 mg/m^3 Fume: 0.1 mg/m^3	1 mg/m^3 Fume: 0.2 mg/m^3	
Zinc (As Zinc Oxide)	7440-66-6 1314-13-2	0 - 0.25%	10 mg/m^3 (5 mg/m^3 as respirable dust) Fume: 5 mg/m^3	10 mg/m^3 Fume: 5 mg/m^3	
Antimony	7440-36-0	0 – 3%	0.5 mg/m^3	0.5 mg/m^3	
Nyclad Coating	Not established	0 – 1%	Not established	Not established	
Cartridge Case					

Brass (As Zinc & Copper) (see above)	See above	25 – 40% 1 – 15%	See above	See above
Nickel Plated Brass (As Nickel)	7440-02-0	0 – 1%	1 mg/m^3	1 mg/m^3
Tin Plated Brass (As Tin)	7440-31-5	0 – 1%	0.1 mg/m^3	2 mg/m^3
Lead	See above	<0.1%	See above	See above
Propellant				
Nitrocellulose	9004-70-0	0.5 – 12%	Not established	Not established
Nitroglycerine	55-63-0	0 – 7%	0.2 mg/m^3 STEL	0.46 mg/m^3 (Skin)
Graphite – synthetic	7782-42-5	0 – 0.25%	15 mg/m^3 (5 mg/m^3 as respirable dust)	2 mg/m^3
Primer				
Lead Styphnate (As Lead)	12403-82-6	<0.1%	0.05 mg/m^3	0.05 mg/m^3
Tetracene	109-27-3	<0.1%	Not established	Not established
Barium Nitrate (As Barium)	7440-39-3	<0.1%	0.5 mg/m^3	0.5 mg/m^3
Bismuth Trioxide (as Bismuth)	1304-76-3	<0.1%	15 mg/m^3 (5 mg/m^3 as respirable dust)	10 mg/m^3 (3 mg/m^3 as respirable dust)
Antimony Sulfide (As Antimony)	7440-36-0	<0.1%	0.5 mg/m^3	0.5 mg/m^3
Aluminum	7429-90-5	<0.1%	15 mg/m^3 (5mg/m^3 as respirable dust)	10 mg/m^3
Nitrocellulose (see above)	See above	<0.1%	See above	See above
Nitroglycerine (see above)	See above	<0.1%	See above	See above

Engineering Controls: Use in a well-ventilated area. Consult the current edition of ACGIH Industrial Ventilation Manual and/or NRA ventilation recommendations.

Respiratory Protection: Use an approved respirator while cleaning range facilities. Consult OSHA 1910.1025 for exact requirements.

Hand Protection: Not generally required

Eye Protection: Recommend protective eyewear conforming to ANSI Z-87

Hearing Protection: Hearing protection recommended while discharging cartridges.

Section 9. Physical And Chemical Properties

Boiling Point:	Not applicable	**Solubility:**	None
Melting Point:	Not applicable	**Specific Gravity:**	3.1-8.0 g/cc
Vapor Pressure:	Not applicable	**pH:**	Not applicable

Vapor Density:	Not applicable	**Odor:**	None
Flash Point:	Not applicable	**Appearance:**	Brass or nickel or tin plated brass case with plastic, lead, copper jacketed lead, or nylon clad lead bullet.
Ignition Temp.:	Not applicable		
UEL:	Not applicable		
LEL:	Not applicable		

Section 10. Stability and Reactivity

Stability: Stable under normal use conditions

Incompatibilities: Oils, Acids, Alkalies, Ammonia, and other corrosive materials

Conditions to Avoid: Individual cartridges may ignite if the primer is struck or if the cartridge is exposed to excess heat.

Hazardous Decomposition Products: Oxides of Barium, Lead, Antimony, Aluminum, Magnesium, Nitrogen, Carbon, and Sulfur. Lead and Antimony fumes may also be produced.

Section 11. Toxicological Information

No available data

Section 12. Ecological Data

No available data.

Section 13. Disposal Considerations

This material as a waste meets the criteria of hazardous waste, D003 and D008. Dispose of in accordance with all federal, state and local regulations for the disposal of hazardous waste.

Section 14. Transportation Information

U.S. DOT Proper Shipping Name: Cartridges, small arms
UN ID No.: UN0012
Class & Division: 1.4S
Packing Group.: II
*Latest edition of the U.S. Department of Transportation's Emergency Response Guidebook

Section 15. Regulatory Information

OSHA: **Explosive**

TSCA: **Listed: Yes** **Unlisted:** **Exempt:**

CERCLA: **Reportable Quantities: Antimony compounds = 5,000 lbs; Copper = 5,000 lbs; Lead = 10 lbs; Nickel = 100 lbs; Nitroglycerin = 10 lbs; Zinc = 1,000 lbs**

Section 16. Information Sources

Label Information:

Abbreviation Key:

OSHA PEL: Federal Occupational Safety and Health Administration's Permissible Exposure Limit. Some states and jurisdictions have limits other than those listed. Contact your local authorities for Permissible Exposure Limits in your jurisdiction.

ACGIH TLV: American Conference of Governmental Industrial Hygienists' Threshold Limit Values.

TWA: Time Weighted Average.

STEL: Short Term Exposure Limit, the 15 minute exposure which should not be exceeded at any time during a workday.

CEILING: The concentration which is not to be exceeded at any time during a workday.

CAS: Chemical Abstracts Service number

Disclaimer:
Although the information contained in this material safety data sheet has been compiled from sources believed to be reliable, no warranty, guaranty or representation is made as to the accuracy or completeness of the information contained herein and no responsibility or liability is assumed regarding the suitability of this information for the user's intended purpose or the consequences of its use. The user of this product must decide what safety measures are necessary to safely use this product, either alone or in combination with other products, and determine its obligations under any applicable federal, state, or local law or regulation.

Corporate MSDS Template Version I.doc
ANSI Z-400.2003
11/30/05

Federal Cartridge Company
900 Bob Ehlen Drive
Anoka, MN 55303

Material Safety Data Sheet

Revision: 1
Prepared: September 13, 2013

TELEPHONE: 763-323-2300
PRODUCT SERVICE: 763-323-3706
EMERGENCY PHONE NUMBER: 800-424-9300 or 703-527-3887 (CHEMTREC)

Revised/Reviewed Date: September 13, 2013

Section 1. Product Information

Product Name: Small Arms Ammunition – Shotshell Ammunition
MSDS Number: F1001
Product ID#: See Table Below
Preparation Date: 13 September 2013

Business Phone/Hours: 763-323-2510 / 24 Hours a Day, 7 Days a Week
24 Hr. Spill (Chemtrec): 1-800-424-9300

SHOTSHELL – PRODUCT FAMILY	
Paper and plastic shotshell cartridges of 2.5, 2.75, 3.0, and 3.5 inch length including the following:	
.410 Bore	16 Gauge
28 Gauge	12 Gauge
20 Gauge	10 Gauge

Section 2. Composition/Information On Ingredients

Chemical Name	Common Name	CAS Number	Weight. % Range
Shot/Slug			
*Lead Shot/Slug (As Lead)	Lead	7439-92-1	0 – 75%
*Antimony	Antimony	7440-36-0	0 – 5%
*Copper Plated Lead Shot/Slug (As Copper)	Copper	7440-50-8	0 – 1%
*Copper Slug (As Copper) (see above)	Copper	7440-50-8	0 – 75%
Steel Shot (As Iron)	Iron	1309-37-1	0 – 75%
Ferro Tungsten (As Tungsten)	Tungsten	12604-57-8	0 – 60%

*Nickel	Nickel	7440-02-0	0 – 6%
Tin	Tin	7440-31-5	0 – 6%
Cartridge Case			
HD Polyethylene Plastic with Inert Coloring	HDPE	9002-88-4	4 – 11%
*Brass (As Zinc, Copper and Lead)	Zinc	7440-66-6 1314-13-2	0 – 5%
	Copper	7440-50-8	0 – 10%
	Lead	7439-92-1	<0.1%
Brass Plated Steel (As Iron)	Iron	1309-37-1	0 – 10%
Nickel Zinc Plated Steel or Zinc Plated Steel (As Nickel)	Nickel	7440-02-0	<0.1%
Propellant			
Nitrocellulose	Cellulose Nitrate Nitrocotton Gun Cotton	9004-70-0	0.5 – 2%
*Nitroglycerine	Trinitroglycerin Glyceryl Trinitrate	55-63-0	2 – 5%
Graphite – synthetic	Graphite Powder	7782-42-5	0.01 – 0.2%
Primer			
*Lead Styphnate (As Lead)	Basic Lead Styphnate	12403-82-6	0.01 – 0.2%
Tetracene	Tetracene	109-27-3	<0.1%
*Barium Nitrate (As Barium)	Barium Salt Nitrobarite Barium Dinitrate	7440-39-3	0.01 – 0.2%
*Antimony Sulfide (As Antimony)	Antimonous Sulfide Diantimony Trisulfide	7440-36-0	<0.1%
*Aluminum	Aluminum	7429-90-5	<0.1%
Nitrocellulose (see above)	See above	See above	<0.1%
*Nitroglycerine (see above)	See above	See above	<0.1%

* Indicates toxic chemical(s) subject to the reporting requirements of section 313 of title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986 and 40 CFR 372.

Section 3. Hazard Identification

CAUTION! Explosive. Keep away from heat. Do not subject to mechanical shock. Particles from firing may be harmful if inhaled. Do not take internally.

Eye: Contact with large volumes of smoke may cause minor eye irritation.

Skin: Elemental and inorganic lead compounds are not absorbed through the skin.

Ingestion: Acute ingestion of lead may occur from poor personal hygiene associated with the handling of lead bearing materials. The effects of lead ingestion would be similar to those listed under acute inhalation in addition to gastrointestinal irritation. Chronic ingestion of lead may occur from poor personal hygiene associated with the handling of lead bearing materials. The effects of lead ingestion would be similar to those listed under chronic inhalation. Note: Wash hands thoroughly with soap and water before eating or smoking.

Inhalation: Inhalation of gases and particulates produced while firing ammunition may result in mild throat, eye, upper respiratory and lung irritation. The irritant effects may lead to lung

symptoms such as bronchitis. An over exposure to gases or particulates, as a result of lead in the particulates, may also cause: anemia; nervous system symptoms which may include irritability, headache, restlessness, fatigue, muscle weakness, muscle tremor, convulsions, loss of memory, visual and hearing disturbances, loss of coordination; gastrointestinal effects such as vomiting, colic, diarrhea or constipation; circulatory symptoms such as a drop in blood pressure; reproductive effects including fertility problems, birth defects, miscarriages and possible kidney damage. Prolonged repeated over exposure to fired cartridge gases and particulates, as a result of lead in the particulates, may result in elevated blood lead levels and elevated zinc protoporphyrin levels. Symptoms of chronic overexposure to lead may include: anemia; lead lines on the gums; nervous system symptoms which may include irritability, headache, restlessness, fatigue, muscle weakness (i.e. wrist drop), muscle tremor, convulsions, loss of memory, visual and hearing disturbances, loss of coordination; gastrointestinal effects such as weight loss, vomiting, colic, diarrhea, constipation; circulatory symptoms such as a drop in blood pressure; reproductive effects including fertility problems, birth defects, miscarriages and possible kidney damage. If acute or chronic symptoms should appear, contact a physician. Blood lead and zinc protoporphryn levels are recommended and should be monitored as per OSHA 1910.1025.

Exposure Symptoms: See above.

Target Organs: See above.

Chronic Effects: See above.

Other: Lead and barium are toxic metals that may be released during the firing of primers. Care should be taken in the cleaning of range facilities to minimize the exposure potential to lead and barium. Persons engaged in these activities should wear protective clothing with an appropriate respirator. Range operators should consult OSHA 1910.1025 for details pertaining to the handling of lead in the work environment.

Severe lead intoxication has been associated in the past with sterility, abortion, and stillbirth. Modern information confirming that lead poisoning affects birth rates or cause injury to the fetus in man is not conclusive.

Exposure to lead can aggravate pre-existing anemia, cardiovascular and respiratory diseases and conditions related to the gastrointestinal, reproductive, renal (kidney), and central nervous systems.[1]

[1]Reference: Industrial Toxicology, Safety and Health Applications in the Workplace; Williams/B.

Cancer Information:	**NTP:** No	**OSHA:** No	**IARC:** Group 2B, possibly carcinogenic in humans

Section 4. First Aid Measures

Eyes: Remove person to fresh air. If foreign body is suspected, wash eyes in fresh water for 15 minutes, contact physician.

Skin: Wash exposed areas thoroughly with soap and water

Ingestion: Ingestion is not a likely route of exposure. In case of ingestion, contact physician.

Inhalation: Remove person to fresh air. Seek medical attention.

Doctor Notes: NA

Section 5. Fire Fighting Measures

Flammable Properties: No

Hazardous Decomposition Products: Oxides of Barium, Lead, Antimony, Aluminum, Magnesium, Nitrogen, Carbon, and Sulfur. Lead and Antimony fumes may also be produced.

Extinguishing Media: Water

Protective Equipment: In all cases, full fire fighter personal protection gear, including face shield and SCBA should be utilized.

Unusual Fire and Explosion Hazards: May ignite if heated to 250 degrees F, independent of air. Unconfined ignited cartridges can produce low velocity metallic fragments, which may cause eye injury or skin wounds if unprotected by standard fire-fighter turnout gear.

Wear full fire-fighter protective gear including face shield or SCBA. Use wide fog pattern nozzle to stop any low velocity fragments. Use water to cool ordinary combustibles below ignition temperature.

Section 6. Accidental Release Measures

Spills and Leaks: Avoid conditions detailed in Section #10. If container should rupture, place all loose cartridges from broken shipping cases into a sturdy container. Secure container carefully.

Waste Disposal: Contact Manufacturer - Product Service (763) 323-3706

Section 7. Handling Information

Store in a dry, cool area in the original container to assure performance. Keep out of the reach of children. Avoid striking the primer of unchambered cartridges. Remove ammunition from service if any of the following conditions have occurred:

1. Evidence of corrosion
2. Physical damage

3. Exposure to oil or spray type lubricants.

Avoid prolonged storage in leather cartridge carriers.

Section 8. Exposure Control Measures / Personal Protection

Chemical Name	CAS #	Wt. %	Applicable Exposure Limits OSHA PEL	ACGIH TLV	Other
Shot/Slug					
Lead Shot/Slug (As Lead)	7439-92-1	0 – 75%	0.05 mg/m^3	0.05 mg/m^3	
Antimony	7440-36-0	0 – 5%	0.5 mg/m^3	0.5 mg/m^3	
Copper Plated Lead Shot/Slug (As Copper)	7440-50-8	0 – 1%	1 mg/m^3 Fume: 0.1 mg/m^3	1 mg/m^3 Fume: 0.2 mg/m^3	
Copper Slug (As Copper) (see above)	See above	0 – 75%	See above	See above	
Steel Shot (As Iron)	1309-37-1	0 – 75%	10 mg/m^3 (as iron oxide fume)	5 mg/m^3 (as iron oxide dust and fume)	
Ferro Tungsten (As Tungsten)	12604-57-8	0 – 60%	Not established	5 mg/m^3 10 mg/m^3 STEL	
Nickel	7440-02-0	0 – 6%	1 mg/m^3	1 mg/m^3	
Tin	7440-31-5	0 – 6%	0.1 mg/m^3	2 mg/m^3	
Cartridge Case					
HD Polyethylene Plastic with Inert Coloring	9002-88-4	4 – 11%	Not established	Not established	
Brass (As Zinc, Copper and Lead)	7440-66-6 1314-13-2	0 – 5%	10 mg/m^3 (5 mg/m^3 as respirable dust) Fume: 5 mg/m^3	10 mg/m^3 Fume: 5 mg/m^3	
	7440-50-8	0 – 10%	See above	See above	
	7439-92-1	<0.1%	See above	See above	
Brass Plated Steel (As Iron) (see above)	See above	0 – 10%	See above	See above	
Nickel Zinc Plated Steel or Zinc Plated Steel	Not Available	<0.1%	Not established	Not established	
Propellant					
Nitrocellulose	9004-70-0	0.5 – 2%	Not established	Not established	
Nitroglycerine	55-63-0	2 – 5%	0.2 mg/m^3 STEL	0.46 mg/m^3 (Skin)	

Graphite – synthetic	7782-42-5	0.01 – 0.2%	15 mg/m^3 (5 mg/m^3 as respirable dust)	2 mg/m^3
Primer				
Lead Styphnate (As Lead)	12403-82-6	0.01 – 0.2%	0.05 mg/m^3	0.05 mg/m^3
Tetracene	109-27-3	<0.1%	Not established	Not established
Barium Nitrate (As Barium)	7440-39-3	0.01 – 0.2%	0.5 mg/m^3	0.5 mg/m^3
Antimony Sulfide (As Antimony)	7440-36-0	<0.1%	0.5 mg/m^3	0.5 mg/m^3
Aluminum	7429-90-5	<0.1%	15 mg/m^3 (5mg/m^3 as respirable dust)	10 mg/m^3
Nitrocellulose (see above)	See above	<0.1%	See above	See above
Nitroglycerine (see above)	See above	<0.1%	See above	See above

Engineering Controls: Use in a well-ventilated area. Consult the current edition of ACGIH Industrial Ventilation Manual and/or NRA ventilation recommendations.

Respiratory Protection: Use an approved respirator while cleaning range facilities. Consult OSHA 1910.1025 for exact requirements.

Hand Protection: Not generally required

Eye Protection: Recommend protective eyewear conforming to ANSI Z-87

Hearing Protection: Hearing protection recommended while discharging cartridges.

Section 9. Physical And Chemical Properties

Boiling Point:	Not applicable	**Solubility:**	None
Melting Point:	Not applicable	**Specific Gravity:**	2.4-3.7 g/cc
Vapor Pressure:	Not applicable	**pH:**	Not applicable
Vapor Density:	Not applicable	**Odor:**	None
Flash Point:	Not applicable	**Appearance:**	Brass, brass plated steel or nickel/zinc plated steel head with a red, yellow, purple, blue or brown plastic or paper tube.
Ignition Temp.:	Not applicable		
UEL:	Not applicable		
LEL:	Not applicable		

Section 10. Stability and Reactivity

Stability: Stable under normal use conditions

Incompatibilities: Oils, Acids, Alkalies, Ammonia, and other corrosive materials

Conditions to Avoid: Individual cartridges may ignite if the primer is struck or if the cartridge is exposed to excess heat.

Hazardous Decomposition Products: Oxides of Barium, Lead, Antimony, Aluminum, Magnesium, Nitrogen, Carbon, and Sulfur. Lead and Antimony fumes may also be produced.

Section 11. Toxicological Information

No available data

Section 12. Ecological Data

No available data.

Section 13. Disposal Considerations

This material as a waste meets the criteria of hazardous waste, D003 and D008. Dispose of in accordance with all federal, state and local regulations for the disposal of hazardous waste.

Section 14. Transportation Information

U.S. DOT Proper Shipping Name: Cartridges, small arms
UN ID No.: UN0012
Class & Division: 1.4S
Packing Group.: II
*Latest edition of the U.S. Department of Transportation's Emergency Response Guidebook

Section 15. Regulatory Information

OSHA: **Explosive**

TSCA: **Listed: Yes** **Unlisted:** **Exempt:**

CERCLA: **Reportable Quantities: Antimony compounds = 5,000 lbs; Copper = 5,000 lbs; Lead = 10 lbs; Nickel = 100 lbs; Nitroglycerin = 10 lbs; Zinc = 1,000 lbs**

Section 16. Information Sources

Label Information:

Abbreviation Key:

OSHA PEL: Federal Occupational Safety and Health Administration's Permissible Exposure Limit. Some states and jurisdictions have limits other than those listed. Contact your local authorities for Permissible Exposure Limits in your jurisdiction.

ACGIH TLV: American Conference of Governmental Industrial Hygienists' Threshold Limit Values.

TWA: Time Weighted Average.

STEL: Short Term Exposure Limit, the 15 minute exposure which should not be exceeded at any time during a workday.

CEILING: The concentration which is not to be exceeded at any time during a workday.

CAS: Chemical Abstracts Service number

Disclaimer:
Although the information contained in this material safety data sheet has been compiled from sources believed to be reliable, no warranty, guaranty or representation is made as to the accuracy or completeness of the information contained herein and no responsibility or liability is assumed regarding the suitability of this information for the user's intended purpose or the consequences of its use. The user of this product must decide what safety measures are necessary to safely use this product, either alone or in combination with other products, and determine its obligations under any applicable federal, state, or local law or regulation.

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ANSI Z-400.2003
11/30/05