National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
White Sands Test Facility
P.O. Box 20
Las Cruces, NM 88004-0020

June 24, 2019

Reply to Attn of: RE-19-090

Mr. John E. Kieling, Chief
New Mexico Environment Department
Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

Subject: Response to Disapproval of Augmented Soil Background Study Abbreviated Investigation Work Plan

In 2013, NASA performed a soil background study in accordance with the NMED-approved *Soil Background Study Investigation Work Plan*, submitted on June 9, 2012. On August 26, 2015, NASA submitted the final investigation report to NMED, which provided soil background concentrations of numerous inorganic constituents at depths to 12 feet below ground surface. NMED approved that report on September 16, 2015 and NASA has subsequently used the approved soil background concentrations to support several environmental investigations at WSTF (White Sands Test Facility). In order to improve background data, NASA proposed to augment the existing soil background study with additional sampling and data collection at depths greater than 12 feet below ground surface. This additional information was submitted to NMED on July 11, 2018, in the *Augmented Soil Background Study Abbreviated Investigation Work Plan*. NMED disapproved the ASBS AIWP on March 27, 2019. NASA previously interpreted the NMED Risk Assessment Guidance for Site Investigations and Remediation (RA Guidance) to also allow for estimation of site risk and hazard for the soil-to-groundwater exposure scenario. The NMED comments to the AIWP and language included in the current RA Guidance revision (February 2019) clarified that the soil-to-groundwater pathway is not part of site hazard or risk. As a result of improved understanding of the risk assessment process, NASA has determined that the supplemental work proposed in the ASBS AIWP is not immediately required to support an evaluation of hazard and risk at WSTF SWMUs (solid waste management units). NASA plans to postpone execution of the AIWP indefinitely. NASA may recommend performing certain elements of this plan in site-specific work plans submitted to NMED. Following NMED approval and in the event that NASA chooses to implement this AIWP, NASA will notify NMED of the intent to implement the plan. When fieldwork and data management are complete, NASA will prepare and submit a separate report for the ASBS.

This submittal includes a printed and electronic cross-reference table with NMED comments and NASA responses as Enclosure 1, an electronic redline-strikeout version and final version of the AIWP on a CD-ROM as Enclosure 2, and a bound copy of the final work plan as Enclosure 3.

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 knowing violations.

If you have any questions or comments concerning this submittal, please contact Antonette Doherty at 575–524–5497.

Timothy J. Davis
Chief, Environmental Office

2 Enclosures

cc:
Mr. Gabriel Acevedo
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

Comments for Disapproval of the Augmented Soil Background Study Abbreviated Investigation Work Plan

NMED Comment Number	NMED Comments	NASA Revisions/Responses/Discussion
1	**Background, Pages 3 and 4** **Permittee Statement:** "In accordance with the guidance, constituents that are representative of background concentrations are not retained as a contaminant of potential concern (COPC) and are eliminate from the risk screening process. Investigations at WSTF [White Sands Test Facility] commonly generate soil analytical data from subsurface soils greater than 12 ft bgs [feet below ground surface]. Because the initial SBS [Soil Background Study] did not establish background soil inorganic concentrations below 12 ft bgs, any soil analytical results obtained from deeper than 12 ft bgs during site investigations cannot be compared to the established soil BTVs [background threshold values]. Therefore, inorganic constituents identified in deeper soils that may represent background conditions cannot be eliminated as COPCs and therefore a risk screening will be performed which can potentially result in overly conservative calculations of site risk and/or hazard." **NMED Comment:** Per the NMED Risk Assessment Guidance for Site Investigations and Remediation (RA Guidance) (Volumes I and II), the maximum soil exposure interval for both human health and ecological risk is 10 ft bgs. Contamination detected beyond the maximum exposure interval is not factored into site risk or hazard; therefore, BTV are not necessary for risk evaluation at depths greater than the 0 to 10 ft bgs exposure interval. The RA Guidance does require evaluation of contaminant concentrations regardless of depth for the soil-to-groundwater pathway evaluation. However, calculation of risk and hazard is not applicable to the soil-to-groundwater pathway evaluation. Only a point-to-point comparison of contaminant concentrations to soil-to-groundwater screening levels is required. Supporting lines of evidence may also be necessary	NASA understands that the maximum soil exposure interval for both human health and ecological risk is 10 ft bgs. NASA previously interpreted the RA Guidance to also allow for estimation of site risk and hazard for the soil-to-groundwater exposure pathway. The original intent of the augmented soil background study was to determine background concentrations of inorganics so that evaluation of the soil-to-groundwater pathway would consider those COPCs that originate from potential contaminant sources at WSTF, and exclude constituents that originate from natural sources. NASA continually updates internal processes to evaluate site risk and hazard in accordance with the NMED Risk Assessment Guidance for Site Investigations and Remediation (RA Guidance) (Volumes I and II). The NMED comments to this Work Plan and language included in the current RA Guidance revision (February 2019) clarified that the calculation of risk and hazard is not applicable to the soil-to-groundwater pathway evaluation, only a point-to-point comparison of contaminant concentrations to soil-to-groundwater screening levels is required. NASA will not evaluate risk and hazard for the soil-to-groundwater pathway, but will perform a point-to-point comparison of contaminant concentrations to soil-to-groundwater screening levels as required in the RA Guidance, including additional supporting lines of evidence as outlined in the RA Guidance Section 4.9, Summary of Migration to Groundwater Pathway SL-SSLs (Soil leachate-based soil screening levels).

Comments for Disapproval of the Augmented Soil Background Study Abbreviated Investigation Work Plan

NMED Comment Number	NMED Comments	NASA Revisions/Responses/Discussion
	to demonstrate that the soil-to-groundwater migration pathway is incomplete and are outlined in the RA Guidance Section 4.9, Summary of Migration to Groundwater Pathway SL-SSLs [Soil leachate-based soil screening levels]. Address the following issues in the revised Work Plan:	
1.a.	Clarify the rationale for collection of soil background data and calculation of inorganic BTVs at depths greater than the established human health and ecological exposure interval.	The intended rationale is to establish inorganic BTVs for deep soils to support the elimination of COPCs that represent background from the point-to-point comparison of COPC concentrations to soil-to-groundwater SL-SSLs. NASA revised the Background section of the Work Plan to better explain the rationale for collecting background data from soils greater than 12 ft bgs.
1.b.	Remove the statement indicating that contamination at depths greater than 12 ft bgs could potentially result in overly conservative calculations of site risk and/or hazard.	NASA removed the statement from the revised Work Plan.
1.c.	Revise the Work Plan to indicate that the soil background data collected at depths greater than the established human health and ecological risk exposure interval (0 to 10 ft bgs) would only be used for defining vertical extent and/or the evaluation of the soil-to-groundwater migration pathway.	NASA revised the Work Plan as required.

Comments for Disapproval of the Augmented Soil Background Study Abbreviated Investigation Work Plan

NMED Comment Number	NMED Comments	NASA Revisions/Responses/Discussion
1.d.	Clarify how the augmented SBS will be reported (e.g., as a separate report submittal or in an updated SBS).	NASA revised the Background section of the Work Plan to indicate that a separate report will be provided to NMED. As a result of improved understanding of the risk assessment process, NASA has determined that the supplemental work proposed in the ASBS AIWP is not immediately required to support an evaluation of hazard and risk at WSTF SWMUs. NASA plans to postpone execution of this Work Plan indefinitely. NASA may recommend performing certain elements of this plan in site-specific work plans submitted to NMED. Following NMED approval and in the event that NASA chooses to perform the ASBS, NASA will notify NMED of the intent to implement the plan. When fieldwork and data management are complete, NASA will prepare and submit a separate report for the ASBS. NASA revised the Schedule section of the Work Plan to include this information.

National Aeronautics and Space Administration

Augmented Soil Background Study
Abbreviated Investigation Work Plan

July 2018

Revised June 2019

NM8800019434

Augmented Soil Background Study

Abbreviated Investigation Work Plan

July 2018

Revised June 2019

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 knowing violations.

Timothy J. Davis
Chief, NASA Environmental Office

6/24/19
Date

National Aeronautics and Space Administration

Johnson Space Center
White Sands Test Facility
12600 NASA Road
Las Cruces, NM 88012
www.nasa.gov/centers/wstf

www.nasa.gov

Abbreviated Investigation Work Plan for Augmented Soil Background Study
NASA White Sands Test Facility

Background	The National Aeronautics and Space Administration (NASA; Figure 1) submitted the *Soil Background Study* (SBS) *Investigation Work Plan* (IWP) to the New Mexico Environment Department (NMED) on June 19, 2012 (NASA, 2012a). After an initial disapproval (NMED, 2012a) and NASA response (NASA, 2012b), NMED approved the IWP on September 28, 2012 (NMED, 2012b). NASA conducted the study at the White Sands Test Facility (WSTF) in 2013 and submitted the *Soil Background Study Investigation Report* (IR) to NMED on March 27, 2014 (NASA, 2014a). NMED disapproved the report (NMED, 2014a) and NASA responded to the disapproval with additional information on the statistical approach (NASA, 2014b). NMED disapproved the revised report (NMED, 2014b) and NASA responded with the information required by NMED (NASA, 2014c). NMED approved the report with modifications (NMED, 2015a), which required NASA to submit a revised report (NASA, 2015a). NMED disapproved the revised report (NMED, 2015b) and NASA responded with the required information and a revised report (NASA, 2015b). NMED approved the investigation report on September 16, 2015 (NMED, 2015c). Within the final approved IR, Background Threshold Values (BTVs) based on 95% upper tolerance limits (UTLs) of inorganic constituents, including metals, were determined for five background sampling areas at WSTF (Background Areas #1, #2, #3, #4, and #5; NASA, 2015b, Figure 1.2). The BTVs are used to support site investigation and risk assessment activities of hazardous waste management units (HWMUs) and solid waste management units (SWMUs). These sampling areas were chosen based on proximity to WSTF HWMUs or SWMUs, soil type associated with the HWMUs or SWMUs, and native soil conditions unaffected by site activities. The SBS evaluated inorganic constituents in soils from 0 to 4 feet (ft) below ground surface (bgs), 4 to 8 ft bgs, and 8 to 12 ft bgs. Each sample set used to statistically derive the BTVs consisted of 12 samples from each depth interval. The approved BTVs (by depth) have been used in accordance with the NMED guidance document *Risk Assessment Guidance for Site Investigations and Remediation* (Volumes I and II*;* NMED, 2017) for various site investigations at WSTF to compare with investigation-derived data at comparable depths bgs. In accordance with the guidance, constituents that are representative of background concentrations are not retained as a contaminant of potential concern (COPC) and are eliminated from the risk screening process. Investigations at WSTF commonly generate soil analytical data from subsurface soils greater than 12 ft bgs, and the soil-to-groundwater exposure scenario must be evaluated using investigation data from all depths. Because the initial SBS did not establish background soil inorganic concentrations below 12 ft bgs, any soil inorganic analytical results obtained from deeper than 12 ft bgs during site investigations cannot be compared to the established soil BTVs. Therefore, inorganic constituents identified in deeper soils that may represent background conditions cannot be eliminated as COPCs, and point-to-

	point comparison of contaminant concentrations to soil-to-groundwater screening levels may identify exceedances of the Migration to Groundwater Pathway SL-SSLs (Soil leachate-based soil screening levels) that originate from natural sources. NASA proposes to augment the previous SBS to characterize background conditions of subsurface soils from depths of 12 to 48 ft bgs. Background data from the Augmented SBS (ASBS) will then be used in conjunction with the previous SBS to perform comparisons of BTVs with contaminant concentrations to determine background inorganic constituents. The COPCs not indicative of background will then be compared point-by-point for all depths to soil-to-groundwater SL-SSLs as required in the RA Guidance (NMED, 2019), including additional supporting lines of evidence as outlined in the RA Guidance Section 4.9, Summary of Migration to Groundwater Pathway SL-SSLs.. Background Area #3 establishes background concentrations for a single WSTF site, SWMU 30, the 200 Area Small Arms Range. Soil analytical data for SWMU 30 are limited to surface soils to a depth of 6 inches bgs, and do not include analyses of soil samples from depths greater than 12 ft bgs. Therefore, Background Area #3 will not be included in the ASBS. This abbreviated investigation work plan (AIWP) details investigative activities NASA will perform to establish background inorganic concentrations for soils from 12 to 48 ft bgs within Background Areas #1, #2, #4 and #5. Further background information is provided in the *Soil Background Study Investigation Report* (NASA, 2015b). Results and conclusions of the ASBS will be provided to the NMED in a separate report.
Primary Purpose	The primary purpose of this AIWP is to describe drilling activities, soil sample collection, and statistical analyses of soil chemical analytical data that will be performed to complete the ASBS. The objective is to produce high quality analytical data that are representative of naturally occurring concentrations of inorganic constituents present in WSTF soils at depths of 12 to 48 ft bgs. For each inorganic constituent, the analytical data will be used to determine a depth dependent BTV that will be used as the background reference value for investigations and corrective actions within each Background Area.
Site Conceptual Exposure Model	Because this study will be conducted in areas unaffected by WSTF site activities, a site conceptual exposure model is not required to support the ASBS.
Investigation Approach	Background soil samples will be representative of the soil types associated with the HWMUs or SWMUs to which they will be compared. Twelve soil borings will be installed at each of the four Background Areas (#1, #2, #4, and #5; Figure 2) included in this investigation. With the exception of Background Area #3, soil borings will be installed at or immediately adjacent to the same locations previously approved for background sampling and identified in the NMED-approved IR (NASA, 2015b, Figure 1.2). Discrete soil samples will be collected from six sample depth intervals in each boring – 12 to 18 ft bgs, 18 to 24 ft bgs, 24 to 30 ft bgs, 30 to 36 ft bgs, 36 to 42 ft bgs, and 42 to 48 ft bgs.

	Subsurface drilling and sampling activities will be conducted using a hollow stem auger (HSA) drill rig with 5-ft hollow stem augers to advance the soil borings to total depth. It is expected that soil samples will be obtained from each sample depth interval within each soil boring. Soil samples will be collected by pushing a 24-inch split spoon approximately 18 inches into the formation using a drop hammer. All but one of the background sampling areas are located in the foothills of Quartzite Mountain and the San Andres Mountains, therefore, sampling conditions are expected to be impacted by a rocky subsurface and potentially shallow depth to bedrock. Due to the anticipated challenging sampling conditions, the drilling and sampling approach must be flexible. Any depth within each proposed depth interval will be acceptable for sample collections so that a sufficient number of samples can be collected for statistical evaluation. If rocky subsurface conditions compromise sample recovery at any interval in a soil boring, the drilling rig will be relocated within a radius of several feet from the designated sampling location in order to collect a soil sample from the depth interval at which sampling was previously not possible. The field geologist may attempt up to two alternate borehole locations before the borehole location and sample collection are abandoned. If this approach does not allow for the collection of adequate samples for statistical analyses required by the study, NASA will install additional soil borings in the Background Area. NASA may also consider an alternate drilling method to obtain an adequate number of soil samples. The addition of soil borings or utilization of alternate drilling methods will be reported as deviations in the ASBS investigation report. All equipment, including the drilling rig and related downhole equipment, will be decontaminated prior to mobilizing to the first Background Area, and at the completion of borehole installation at each Background Area prior to mobilizing to a new area. Downhole sampling equipment (split spoons) will be decontaminated prior to collection of each soil sample within each boring. Decontamination procedures will be performed by 40-hour Hazardous Waste Operations and Emergency Response trained personnel wearing appropriate personal protective equipment (PPE). The decontamination of the drilling rig and heavy equipment will be performed under the supervision of the site supervisor or their designee. Decontamination utilizes steam cleaning or pressurized heated water and/or detergent wash in conjunction with brushes, sprayers (as required), and a final rinse with potable water. Boring installation and soil sampling will be performed under the direction of a qualified WSTF geologist who will maintain a detailed boring log of the cuttings, core samples, and other pertinent observations encountered during drilling. Field data will be collected and managed as described in the initial NMED-approved SBS IWP (NASA, 2012b). Following the conclusion of drilling and sampling at each boring, the boring will be backfilled with soil cuttings, and if warranted, filled to the surrounding grade using bentonite grout or hydrated bentonite chips/pellets. NASA will survey each boring location with survey-grade global positioning system equipment and include location information in the ASBS investigation report.

Constituents and Analytical Methods	NASA's subcontracted analytical laboratories will analyze soil samples for the inorganic constituents identified in the initial NMED-approved SBS IWP (NASA, 2012b). The laboratories are expected to utilize standard analytical methods consistent with analyses performed during the original investigation and capable of achieving project objectives. The inorganic constituents and associated analytical method are provided in Table 1.
Soil Sampling and Characterization	Soil samples will be logged by the on-site environmental geologist or other qualified personnel. Information collected will comprise the general information name, location, dates, depths, and drilling details, a Unified Soil Classification System description, sample interval, and recovery. Soil samples will be collected by trained and qualified environmental technicians following standard WSTF soil collection and sampling protocol. Soil sample collection, management, and shipment to a contracted laboratory will be conducted in the same manner as the original SBS investigation; according to established WSTF procedures and by qualified WSTF personnel. Chemical characterization of the soil samples for inorganic constituents will be conducted at a contracted laboratory accredited by the National Environmental Laboratory Accreditation Program. Soil retrieved from the borehole will be obtained from the split-spoon sampling device provided by the contracted drilling company. A portion of the sample will be placed in pre-cleaned, laboratory-prepared sample containers for laboratory chemical analysis in accordance with prescribed laboratory procedure and the remaining portion will be used for logging. Table 2 provides the proposed sample depth intervals and sampling density for each Background Area for this ASBS. In addition to investigation soil samples, field quality control samples will be collected to ensure quality data are generated during the investigation. Field quality control samples for this investigation will be collected as follows: • Equipment blanks – An equipment (rinsate) blank will be collected from the split-spoon sampler (1) at the onset of the project prior to drilling, (2) once for each background sampling area, (3) at least a rate of 10% of samples collected, and (4) if the drill rig/split-spoon is required to leave the project site to conduct other duties, an equipment blank will be collected upon return. • Field blanks – A rate of one per day. • Field duplicates – A rate of 10%. • Matrix spikes – A rate of 5% (at least one matrix spike sample will be collected during sampling operations). The contracted laboratory will send an analytical data package to NASA and after the data quality review and compilation, the data will be ready for interpretation.

Statistical Evaluation of Results	NASA will utilize the Environmental Protection Agency's (EPA) software package ProUCL, Version 5.1 to calculate BTVs for each constituent in accordance with procedures described in the Technical Guide (EPA, 2015). The calculated BTV for each constituent will be proposed as depth-specific background levels for soil depths described above.
Investigation-Derived Waste (IDW) Management and Disposal	This investigation will be conducted in the previously approved Background Areas, which are unaffected by site contaminants. Therefore, generated IDW will be managed and disposed of as non-hazardous solid waste in accordance with NASA waste management procedures that incorporate applicable federal and state regulations and requirements. The types of IDW expected during the study include environmental media (soil), disposable sampling equipment, PPE (gloves, wipes, etc.), plastic sheeting, and decontamination water. Soil obtained from borings that is not used for sampling will be returned to the boring from which it originated. Decontamination water will be collected, managed as non-hazardous waste, and discharged to the WSTF sanitary sewer system. Disposable PPE and plastic sheeting generated during this project will be managed as non-hazardous waste and disposed of at a permitted Subtitle D landfill.
Schedule	Based on an evaluation of NMED RA Guidance (NMED, 2019) and NMED correspondence related to this AIWP, NASA determined that there this is no longer an immediate need to perform the work described in this AIWP. NASA plans to postpone execution of this AIWP at this time. NASA may recommend performing certain elements of this plan in site-specific work plans submitted to NMED. NMED approval of this AIWP is required prior to initiation of the field investigation, and NASA requests approval from NMED in the event that NASA chooses to perform the ASBS in the future. In that case, NASA will notify NMED of the intent to implement this AIWP. NASA will then initiate final planning and procurement activities required to coordinate investigation fieldwork. NASA expects to complete the planning process and initiate fieldwork within two months following notification to NMED. Fieldwork is expected to be completed within three months. Following the completion of investigation fieldwork, analytical data will be validated and verified for use in the final ASBS investigation report, which NASA expects to submit within eight months of notification of NMED that the AIWP will be implemented. 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.
References	EPA. (2015, October). ProUCL Version 5.1.00 Technical Guide. *Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations*. EPA/600/R-07/041. https://www.epa.gov/land-research/proucl-software NASA Johnson Space Center White Sands Test Facility. (2012a, June 19). *Soil Background Study Investigation Work Plan.* Las Cruces, NM.

	NASA Johnson Space Center White Sands Test Facility. (2012b, September 17). *Response to NMED Disapproval - NASA White Sands Test Facility Soil Background Study Work Plan*. Las Cruces, NM. NASA Johnson Space Center White Sands Test Facility. (2014a, March 27). *Soil Background Study Investigation Report.* Las Cruces, NM. NASA Johnson Space Center White Sands Test Facility. (2014b, August 27). *Response to NMED Disapproval – NASA WSTF Soil Background Study Investigation Report.* Las Cruces, NM. NASA Johnson Space Center White Sands Test Facility. (2014c, December 17). *Response to Second NMED Disapproval – NASA White Sands Test Facility Soil Background Study Investigation Report.* Las Cruces, NM. NASA Johnson Space Center White Sands Test Facility. (2015a, May 13). *NASA WSTF Soil Background Study Investigation Report.* Las Cruces, NM. NASA Johnson Space Center White Sands Test Facility. (2015b, August 26). *Response to Notice of Disapproval for the Soil Background Study Investigation Report*. Las Cruces, NM. NMED Hazardous Waste Bureau. (2012a, August 17). *Disapproval - Soil Background Study Investigation Work Plan*. Santa Fe, NM. NMED Hazardous Waste Bureau. (2012b, September 28). *Approval White Sands Test Facility Soil Background Study Investigation Work Plan.* Santa Fe, NM. NMED Hazardous Waste Bureau. (2014a, June 26). *Notice of Disapproval Soil Background Study Investigation Report.* Santa Fe, NM. NMED Hazardous Waste Bureau. (2014b, October 15). *Second Notice of Disapproval Soil Background Study Investigation Report.* Santa Fe, NM. NMED Hazardous Waste Bureau. (2015a, February 19). *Approval with Modifications Soil Background Study Investigation Report.* Santa Fe, NM. NMED Hazardous Waste Bureau. (2015b, August 11). *Disapproval Soil Background Study Investigation Report.* Santa Fe, NM. NMED Hazardous Waste Bureau. (2015c, September 16). *Approval Soil Background Study Investigation Report.* Santa Fe, NM. NMED Hazardous Waste Bureau. (2017, March). *Risk Assessment Guidance for Site Investigations and Remediation Volume II Soil Screening Guidance for Ecological Risk Assessments*. Santa Fe, NM. NMED Hazardous Waste Bureau and Ground Water Quality Bureau. (2019, March). *Risk Assessment Guidance for Site Investigations and Remediation Volume I Soil Screening Guidance for Human Health Risk Assessments.* Santa Fe, NM.

Figure 1 **WSTF Site Location Map**

(SEE NEXT PAGE)

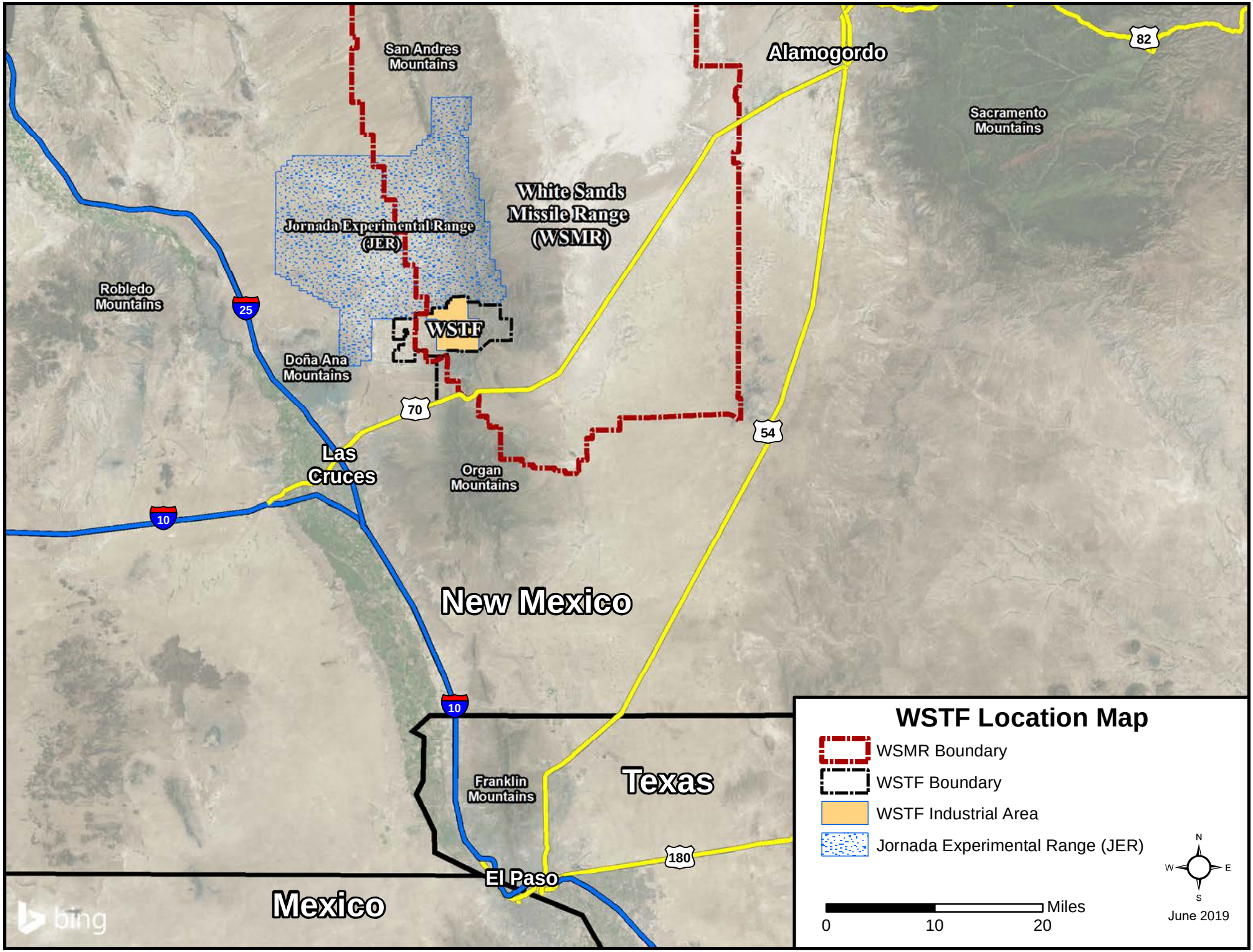
WSTF Location Map
WSMR Boundary
WSTF Boundary
WSTF Industrial Area
Jornada Experimental Range (JER)
Miles
0
10
20
June 2019
N
W
E
S
San Andres Mountains
Alamogordo
Sacramento Mountains
White Sands Missile Range (WSMR)
Jornada Experimental Range (JER)
Robledo Mountains
WSTF
Doña Ana Mountains
Las Cruces
Organ Mountains
New Mexico
Franklin Mountains
Texas
El Paso
Mexico
25
10
70
54
82
180
bing

Figure 2 **WSTF Soil Background Areas**

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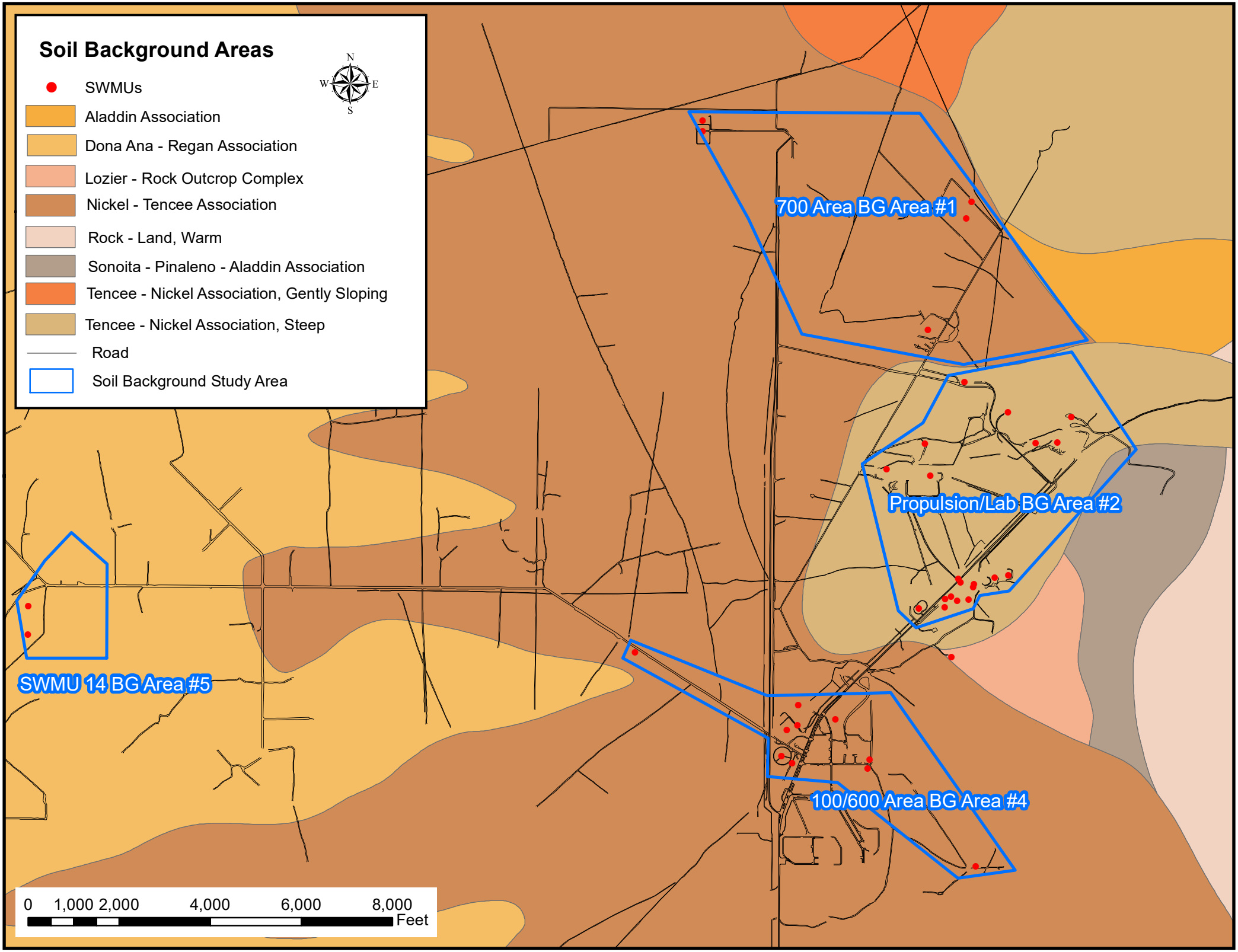
Soil Background Areas
SWMUs
Aladdin Association
Dona Ana - Regan Association
Lozier - Rock Outcrop Complex
Nickel - Tencee Association
Rock - Land, Warm
Sonoita - Pinaleno - Aladdin Association
Tencee - Nickel Association, Gently Sloping
Tencee - Nickel Association, Steep
Road
Soil Background Study Area
N
W
E
S
700 Area BG Area #1
Propulsion/Lab BG Area #2
SWMU 14 BG Area #5
100/600 Area BG Area #4
0
1,000
2,000
4,000
6,000
8,000
Feet

Table 1 Analytes and Analytical Methods List

Analyte	Class	EPA Method	Laboratory Minimum Detection Limit[4] (mg/kg)	March 2017 NMED SSL for Residential Soil Cancer/Non-cancer (mg/kg)
Aluminum, Total	Metals	6010C	5.6 – 7.0	Not Available/78,000
Antimony[1, 2]	Metals	6010 C	0.3 – 0.4	Not Available/31.3
Arsenic, Total[1, 2]	Metals	6010 C	0.29 – 0.4	7.07/13.0
Barium, Total[1, 2]	Metals	6010 C	0.2	Not Available/15,600
Beryllium, Total[1, 2]	Metals	6010 C	0.003	64,400/156
Boron, Total	Metals	6010 C	0.9 – 3.0	Not Available/15,600
Cadmium, Total[1, 2]	Metals	6010 C	0.02	85,900/70.5
Calcium, Total	Metals	6010 C	4.0 - 200	Not Available/13,000,000
Chromium, VI	Metals	7199	0.03	3.05/235
Chromium, Total[1, 2]	Metals	6010 C	0.03	96.6/45,200 (Cr Total)
Cobalt, Total[2]	Metals	6010 C	0.04	17,200/23.4
Copper, Total[2]	Metals	6010 C	0.06 – 0.3	Not Available/3,130
Iron	Metals	6010 C	3	Not Available/54,800
Lead, Total[1, 2]	Metals	6010 C	0.2	400 (EPA RSL)
Magnesium	Metals	6010 C	10	Not Available/20,900,000
Manganese	Metals	6010 C	0.1	Not Available/10,500
Mercury (elemental)[1, 2]	Metals	7471A	0.002 – 0.003	Not Available/23.6
Molybdenum, Total	Metals	7471A	0.08 – 0.09	Not Available/391
Nickel, Total[1, 2]	Metals	6010 C	0.1 – 0.2	595,000/1,560
Selenium, Total[1, 2]	Metals	6010 C	0.67 – 0.8	Not Available/391
Silver, Total[1, 2]	Metals	6010 C	0.04 – 0.05	Not Available/391
Sodium	Metals	6010 C	10	Not Available/12,000,000

Strontium, Total	Metals	6010 C	0.07 – 0.4	Not Available/46,900
Thallium[1]	Metals	6010 C	0.19 – 0.4	Not Available/0.782
Tin[2]	Metals	6010 C	0.2	47,000 (EPA RSL)
Titanium	Metals	6010 C	0.2	Not Available
Uranium (soluble salts)	Metals	6020 A	0.006 – 0.01	Not Available/234
Vanadium, Total[2]	Metals	6010 C	0.05	Not Available/394
Zinc, Total[2]	Metals	6010 C	0.5 – 2.0	Not Available/23,500
Other Analytes				
Chloride	Anion	300.0	4.0 – 5.0	Not Available/18,800,000
Potassium	Anions	6010 C	20	Not Available/15,600,000
Cyanide, Total[1, 2]	Cyanide	9012	0.14 – 0.28	Not Available/11.1
Nitrate/Nitrite	Nitrogen	353.2M	0.2	Nitrate Not Available/125,000 Nitrite Not Available/7,820
Perchlorate[3]	Perchlorate	6850	1.0	Not Available/54.8

[1]Listed in 40 CFR Part 261 Appendix VIII as a hazardous constituent
[2]Listed in 40 CFR Part 264 Appendix IX for groundwater monitoring
[3]Listed in NMAC 20.6.7 as a toxic pollutant
[4]Minimum detection limits collected from 600 Area and 300 Area Investigations soil analysis results

Table 2 Proposed Sample Densities

Background Sampling Area	# Sample Locations (Soil Borings)	# Samples Collected at Each Location	Depth Intervals Represented at Each Location	Total # Samples Collected from Each Area
#1 – 700 Area/2nd TDRSS Areas	12	6	12-18’ 18-24’ 24-30’ 30-36’ 36-42’ 42-48’	72
#2 – Propulsion/Lab/Fuel Storage Areas	12	6		72
#4 – 100/600/Active Firing Range Areas	12	6		72
#5 – JP Remote Test Area	12	6		72
Total # Samples Collected for Augmented Soil Background Study:				**288**

National Aeronautics and Space Administration

Augmented Soil Background Study
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NM8800019434

Augmented Soil Background Study

Abbreviated Investigation Work Plan

July 2018

Revised June 2019

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 knowing violations.

_____ _____

Timothy J. Davis
Chief, NASA Environmental Office

Date

National Aeronautics and Space Administration

Johnson Space Center
White Sands Test Facility
12600 NASA Road
Las Cruces, NM 88012
www.nasa.gov/centers/wstf

www.nasa.gov

Abbreviated Investigation Work Plan for Augmented Soil Background Study
NASA White Sands Test Facility

Background	The National Aeronautics and Space Administration (NASA; Figure 1) submitted the *Soil Background Study* (SBS) *Investigation Work Plan* (IWP) to the New Mexico Environment Department (NMED) on June 19, 2012 (NASA, 2012a). After an initial disapproval (NMED, 2012a) and NASA response (NASA, 2012b), NMED approved the IWP on September 28, 2012 (NMED, 2012b). NASA conducted the study at the White Sands Test Facility (WSTF) in 2013 and submitted the *Soil Background Study Investigation Report* (IR) to NMED on March 27, 2014 (NASA, 2014a). NMED disapproved the report (NMED, 2014a) and NASA responded to the disapproval with additional information on the statistical approach (NASA, 2014b). NMED disapproved the revised report (NMED, 2014b) and NASA responded with the information required by NMED (NASA, 2014c). NMED approved the report with modifications (NMED, 2015a), which required NASA to submit a revised report (NASA, 2015a). NMED disapproved the revised report (NMED, 2015b) and NASA responded with the required information and a revised report (NASA, 2015b). NMED approved the investigation report on September 16, 2015 (NMED, 2015c). Within the final approved IR, Background Threshold Values (BTVs) based on 95% upper tolerance limits (UTLs) of inorganic constituents, including metals, were determined for five background sampling areas at WSTF (Background Areas #1, #2, #3, #4, and #5; NASA, 2015b, Figure 1.2). The BTVs are used to support site investigation and risk assessment activities of hazardous waste management units (HWMUs) and solid waste management units (SWMUs). These sampling areas were chosen based on proximity to WSTF HWMUs or SWMUs, soil type associated with the HWMUs or SWMUs, and native soil conditions unaffected by site activities. The SBS evaluated inorganic constituents in soils from 0 to 4 feet (ft) below ground surface (bgs), 4 to 8 ft bgs, and 8 to 12 ft bgs. Each sample set used to statistically derive the BTVs consisted of 12 samples from each depth interval. The approved BTVs (by depth) have been used in accordance with the NMED guidance document *Risk Assessment Guidance for Site Investigations and Remediation* (Volumes I and II*;* NMED, 2017) for various site investigations at WSTF to compare with investigation-derived data at comparable depths bgs. In accordance with the guidance, constituents that are representative of background concentrations are not retained as a contaminant of potential concern (COPC) and are eliminated from the risk screening process. Investigations at WSTF commonly generate soil analytical data from subsurface soils greater than 12 ft bgs, and the soil-to-groundwater exposure scenario must be evaluated using investigation data from all depths. Because the initial SBS did not establish background soil inorganic concentrations below 12 ft bgs, any soil inorganic analytical results obtained from deeper than 12 ft bgs during site investigations cannot be compared to the established soil BTVs. Therefore, inorganic constituents identified in deeper soils that may represent background conditions cannot be eliminated as COPCs, and point-to-

	point comparison of contaminant concentrations to soil-to-groundwater screening levels may identify exceedances of the Migration to Groundwater Pathway SL-SSLs (Soil leachate-based soil screening levels) that originate from natural sources.~~therefore a risk screening will be performed which can potentially result in overly conservative calculations of site risk and/or hazard.~~ NASA proposes to augment the previous SBS to characterize background conditions of subsurface soils from depths of 12 to 48 ft bgs. Background data from the Augmented SBS (ASBS) will then be used in conjunction with the previous SBS to ~~properly~~ perform comparisons of BTVs with contaminant concentrations to determine background inorganic constituents. The COPCs not indicative of background will then be compared point-by-point for all depths to soil-to-groundwater SL-SSLs as required in the RA Guidance (NMED, 2019), including additional supporting lines of evidence as outlined in the RA Guidance Section 4.9, Summary of Migration to Groundwater Pathway SL-SSLs.~~site risk and/or hazard screening for identified constituents in soils at depths from ground surface to 48 ft bgs~~. Background Area #3 establishes background concentrations for a single WSTF site, SWMU 30, the 200 Area Small Arms Range. Soil analytical data for SWMU 30 are limited to surface soils to a depth of 6 inches bgs, and do not include analyses of soil samples from depths greater than 12 ft bgs. Therefore, Background Area #3 will not be included in the ASBS. This abbreviated investigation work plan (AIWP) details investigative activities NASA will perform to establish background inorganic concentrations for soils from 12 to 48 ft bgs within Background Areas #1, #2, #4 and #5. Further background information is provided in the *Soil Background Study Investigation Report* (NASA, 2015b). Results and conclusions of the ASBS will be provided to the NMED in a separate report.
Primary Purpose	The primary purpose of this AIWP is to describe drilling activities, soil sample collection, and statistical analyses of soil chemical analytical data that will be performed to complete the ASBS. The objective is to produce high quality analytical data that are representative of naturally occurring concentrations of inorganic constituents present in WSTF soils at depths of 12 to 48 ft bgs. For each inorganic constituent, the analytical data will be used to determine a depth dependent BTV that will be used as the background reference value for investigations and corrective actions within each Background Area.
Site Conceptual Exposure Model	Because this study will be conducted in areas unaffected by WSTF site activities, a site conceptual exposure model is not required to support the ASBS.
Investigation Approach	Background soil samples will be representative of the soil types associated with the HWMUs or SWMUs to which they will be compared. Twelve soil borings will be installed at each of the four Background Areas (#1, #2, #4, and #5; Figure 2) included in this investigation. With the exception of Background Area #3, soil borings will be installed at or immediately adjacent to the same locations previously approved for background sampling and identified in the

	NMED-approved IR (NASA, 2015b, Figure 1.2). Discrete soil samples will be collected from six sample depth intervals in each boring – 12 to 18 ft bgs, 18 to 24 ft bgs, 24 to 30 ft bgs, 30 to 36 ft bgs, 36 to 42 ft bgs, and 42 to 48 ft bgs. Subsurface drilling and sampling activities will be conducted using a hollow stem auger (HSA) drill rig with 5-ft hollow stem augers to advance the soil borings to total depth. It is expected that soil samples will be obtained from each sample depth interval within each soil boring. Soil samples will be collected by pushing a 24-inch split spoon approximately 18 inches into the formation using a drop hammer. All but one of the background sampling areas are located in the foothills of Quartzite Mountain and the San Andres Mountains, therefore, sampling conditions are expected to be impacted by a rocky subsurface and potentially shallow depth to bedrock. Due to the anticipated challenging sampling conditions, the drilling and sampling approach must be flexible. Any depth within each proposed depth interval will be acceptable for sample collections so that a sufficient number of samples can be collected for statistical evaluation. If rocky subsurface conditions compromise sample recovery at any interval in a soil boring, the drilling rig will be relocated within a radius of several feet from the designated sampling location in order to collect a soil sample from the depth interval at which sampling was previously not possible. The field geologist may attempt up to two alternate borehole locations before the borehole location and sample collection are abandoned. If this approach does not allow for the collection of adequate samples for statistical analyses required by the study, NASA will install additional soil borings in the Background Area. NASA may also consider an alternate drilling method to obtain an adequate number of soil samples. The addition of soil borings or utilization of alternate drilling methods will be reported as deviations in the ASBS investigation report. All equipment, including the drilling rig and related downhole equipment, will be decontaminated prior to mobilizing to the first Background Area, and at the completion of borehole installation at each Background Area prior to mobilizing to a new area. Downhole sampling equipment (split spoons) will be decontaminated prior to collection of each soil sample within each boring. Decontamination procedures will be performed by 40-hour Hazardous Waste Operations and Emergency Response trained personnel wearing appropriate personal protective equipment (PPE). The decontamination of the drilling rig and heavy equipment will be performed under the supervision of the site supervisor or their designee. Decontamination utilizes steam cleaning or pressurized heated water and/or detergent wash in conjunction with brushes, sprayers (as required), and a final rinse with potable water. Boring installation and soil sampling will be performed under the direction of a qualified WSTF geologist who will maintain a detailed boring log of the cuttings, core samples, and other pertinent observations encountered during drilling. Field data will be collected and managed as described in the initial NMED-approved SBS IWP (NASA, 2012b). Following the conclusion of drilling and sampling at each boring, the boring will be backfilled with soil cuttings, and if warranted, filled to the surrounding

	grade using bentonite grout or hydrated bentonite chips/pellets. NASA will survey each boring location with survey-grade global positioning system equipment and include location information in the ASBS investigation report.
Constituents and Analytical Methods	NASA's subcontracted analytical laboratories will analyze soil samples for the inorganic constituents identified in the initial NMED-approved SBS IWP (NASA, 2012b). The laboratories are expected to utilize standard analytical methods consistent with analyses performed during the original investigation and capable of achieving project objectives. The inorganic constituents and associated analytical method are provided in Table 1.
Soil Sampling and Characterization	Soil samples will be logged by the on-site environmental geologist or other qualified personnel. Information collected will comprise the general information name, location, dates, depths, and drilling details, a Unified Soil Classification System description, sample interval, and recovery. Soil samples will be collected by trained and qualified environmental technicians following standard WSTF soil collection and sampling protocol. Soil sample collection, management, and shipment to a contracted laboratory will be conducted in the same manner as the original SBS investigation; according to established WSTF procedures and by qualified WSTF personnel. Chemical characterization of the soil samples for inorganic constituents will be conducted at a contracted laboratory accredited by the National Environmental Laboratory Accreditation Program. Soil retrieved from the borehole will be obtained from the split-spoon sampling device provided by the contracted drilling company. A portion of the sample will be placed in pre-cleaned, laboratory-prepared sample containers for laboratory chemical analysis in accordance with prescribed laboratory procedure and the remaining portion will be used for logging. Table 2 provides the proposed sample depth intervals and sampling density for each Background Area for this ASBS. In addition to investigation soil samples, field quality control samples will be collected to ensure quality data are generated during the investigation. Field quality control samples for this investigation will be collected as follows: • Equipment blanks – An equipment (rinsate) blank will be collected from the split-spoon sampler (1) at the onset of the project prior to drilling, (2) once for each background sampling area, (3) at least a rate of 10% of samples collected, and (4) if the drill rig/split-spoon is required to leave the project site to conduct other duties, an equipment blank will be collected upon return. • Field blanks – A rate of one per day. • Field duplicates – A rate of 10%. • Matrix spikes – A rate of 5% (at least one matrix spike sample will be collected during sampling operations). The contracted laboratory will send an analytical data package to NASA and after the data quality review and compilation, the data will be ready for interpretation.

Statistical Evaluation of Results	NASA will utilize the Environmental Protection Agency's (EPA) software package ProUCL, Version 5.1 to calculate BTVs for each constituent in accordance with procedures described in the Technical Guide (EPA, 2015). The calculated BTV for each constituent will be proposed as depth-specific background levels for soil depths described above.
Investigation-Derived Waste (IDW) Management and Disposal	This investigation will be conducted in the previously approved Background Areas, which are unaffected by site contaminants. Therefore, generated IDW will be managed and disposed of as non-hazardous solid waste in accordance with NASA waste management procedures that incorporate applicable federal and state regulations and requirements. The types of IDW expected during the study include environmental media (soil), disposable sampling equipment, PPE (gloves, wipes, etc.), plastic sheeting, and decontamination water. Soil obtained from borings that is not used for sampling will be returned to the boring from which it originated. Decontamination water will be collected, managed as non-hazardous waste, and discharged to the WSTF sanitary sewer system. Disposable PPE and plastic sheeting generated during this project will be managed as non-hazardous waste and disposed of at a permitted Subtitle D landfill.
Schedule	Based on an evaluation of NMED RA Guidance (NMED, 2019) and NMED correspondence related to this AIWP, NASA determined that there this is no longer an immediate need to perform the work described in this AIWP. NASA plans to postpone execution of this AIWP at this time. NASA may recommend performing certain elements of this plan in site-specific work plans submitted to NMED. NMED approval of this AIWP is required prior to initiation of the field investigation, and NASA requests approval from NMED in the event that NASA chooses to perform the ASBS in the future. ~~Following NMED approval of the AIWP~~In that case, NASA will notify NMED of the intent to implement this AIWP. NASA will then initiate final planning and procurement activities required to coordinate investigation fieldwork. NASA expects to complete the planning process and initiate fieldwork within two months following notification to NMED ~~approval~~. Fieldwork is expected to be completed within three months. Following the completion of investigation fieldwork, analytical data will be validated and verified for use in the final ASBS investigation report, which NASA expects to submit within eight months of notification of NMED ~~approval of this~~that the AIWP will be implemented. 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.
References	EPA. (2015, October). ProUCL Version 5.1.00 Technical Guide. *Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations*. EPA/600/R-07/041. https://www.epa.gov/land-research/proucl-software

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Figure 1 **WSTF Site Location Map**

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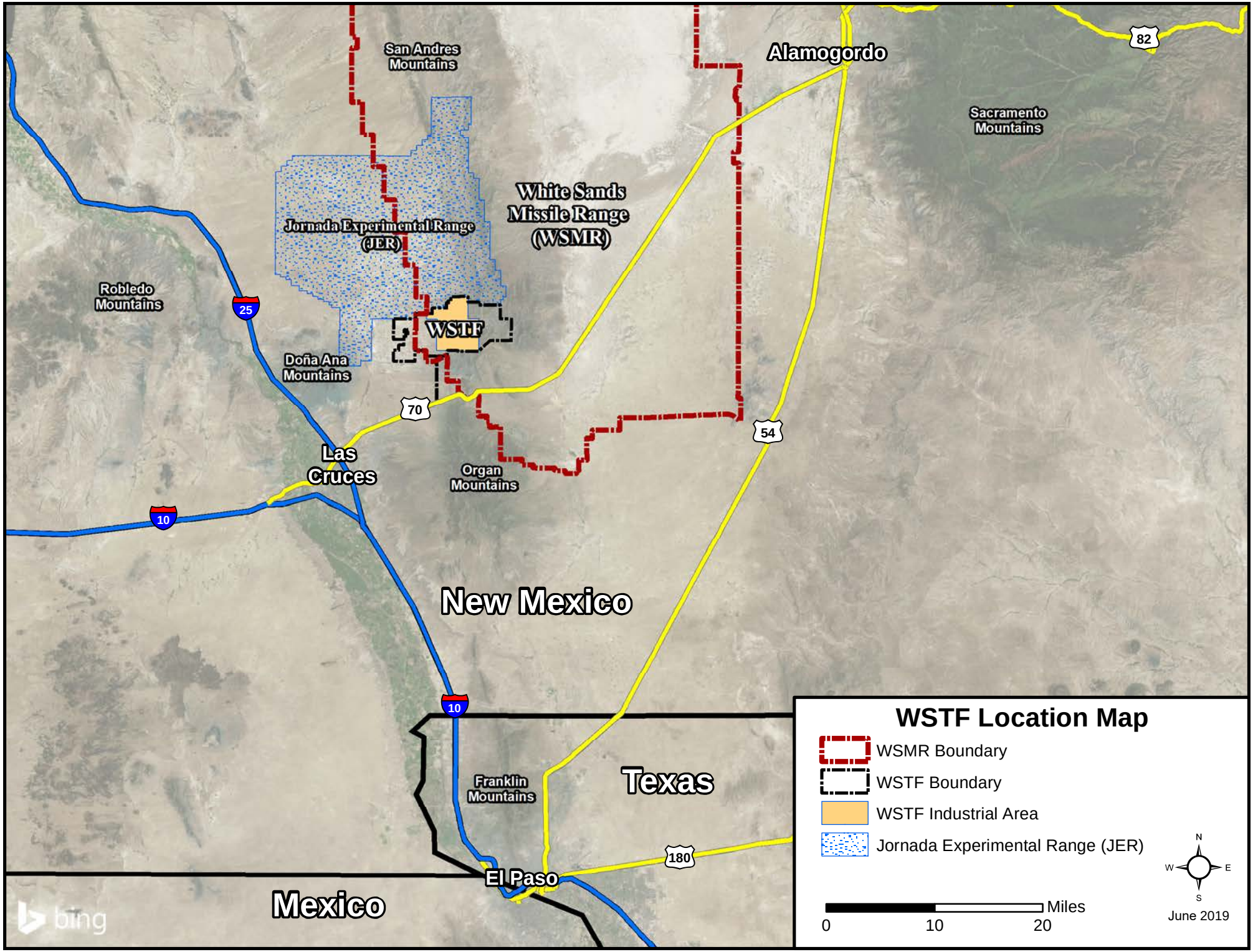
WSTF Location Map
WSMR Boundary
WSTF Boundary
WSTF Industrial Area
Jornada Experimental Range (JER)
Miles
0
10
20
June 2019
N
W
E
S
San Andres Mountains
Alamogordo
Sacramento Mountains
White Sands Missile Range (WSMR)
Jornada Experimental Range (JER)
Robledo Mountains
WSTF
Doña Ana Mountains
Las Cruces
Organ Mountains
New Mexico
Franklin Mountains
Texas
El Paso
Mexico
25
10
70
54
82
180
bing

Figure 2 **WSTF Soil Background Areas**

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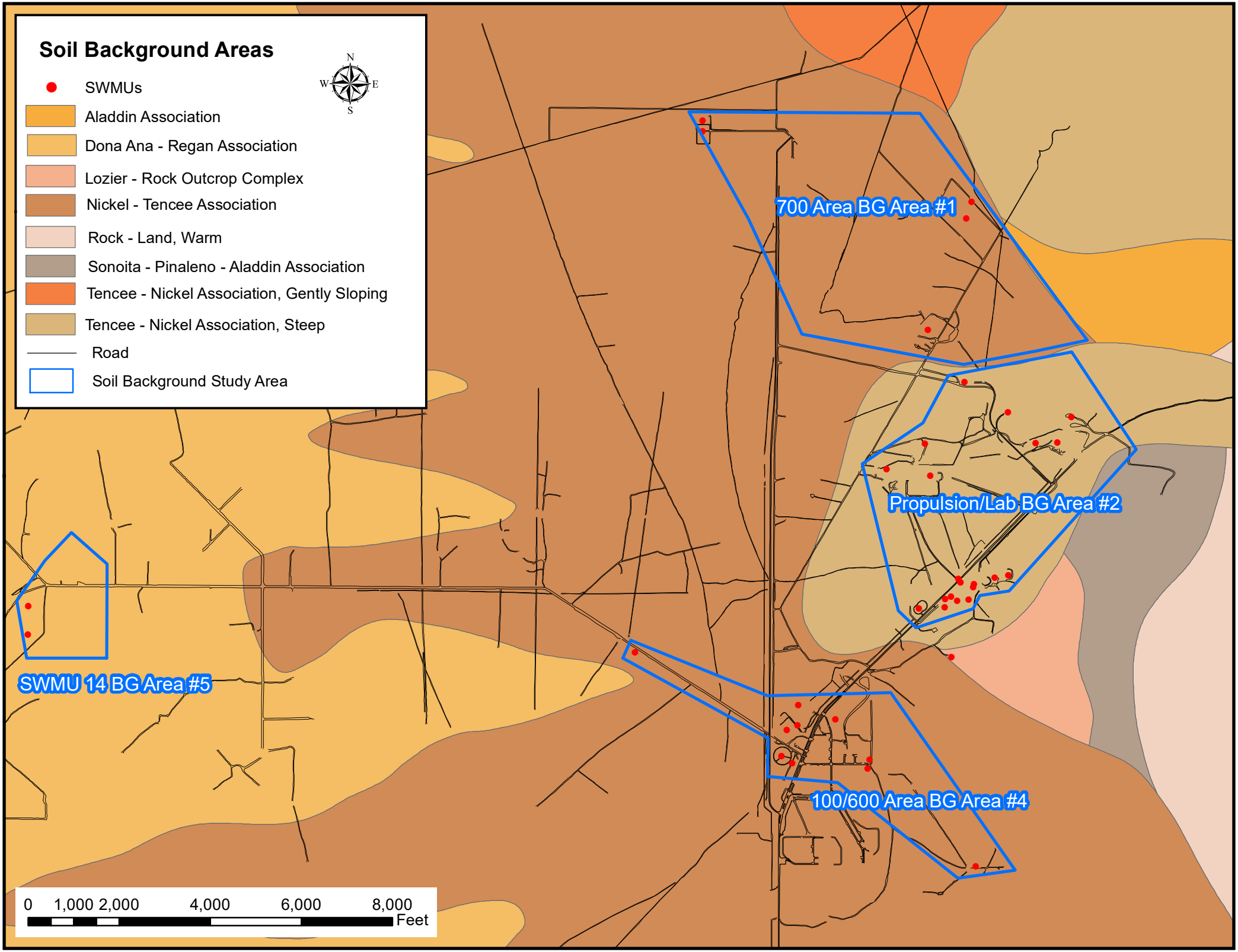
Soil Background Areas
N
W
E
S
SWMUs
Aladdin Association
Dona Ana - Regan Association
Lozier - Rock Outcrop Complex
Nickel - Tencee Association
Rock - Land, Warm
Sonoita - Pinaleno - Aladdin Association
Tencee - Nickel Association, Gently Sloping
Tencee - Nickel Association, Steep
Road
Soil Background Study Area
700 Area BG Area #1
Propulsion/Lab BG Area #2
SWMU 14 BG Area #5
100/600 Area BG Area #4
0 1,000 2,000 4,000 6,000 8,000
Feet

Table 1 Analytes and Analytical Methods List

Analyte	Class	EPA Method	Laboratory Minimum Detection Limit[4] (mg/kg)	March 2017 NMED SSL for Residential Soil Cancer/Non-cancer (mg/kg)
Aluminum, Total	Metals	6010C	5.6 – 7.0	Not Available/78,000
Antimony[1, 2]	Metals	6010 C	0.3 – 0.4	Not Available/31.3
Arsenic, Total[1, 2]	Metals	6010 C	0.29 – 0.4	7.07/13.0
Barium, Total[1, 2]	Metals	6010 C	0.2	Not Available/15,600
Beryllium, Total[1, 2]	Metals	6010 C	0.003	64,400/156
Boron, Total	Metals	6010 C	0.9 – 3.0	Not Available/15,600
Cadmium, Total[1, 2]	Metals	6010 C	0.02	85,900/70.5
Calcium, Total	Metals	6010 C	4.0 - 200	Not Available/13,000,000
Chromium, VI	Metals	7199	0.03	3.05/235
Chromium, Total[1, 2]	Metals	6010 C	0.03	96.6/45,200 (Cr Total)
Cobalt, Total[2]	Metals	6010 C	0.04	17,200/23.4
Copper, Total[2]	Metals	6010 C	0.06 – 0.3	Not Available/3,130
Iron	Metals	6010 C	3	Not Available/54,800
Lead, Total[1, 2]	Metals	6010 C	0.2	400 (EPA RSL)
Magnesium	Metals	6010 C	10	Not Available/20,900,000
Manganese	Metals	6010 C	0.1	Not Available/10,500
Mercury (elemental)[1, 2]	Metals	7471A	0.002 – 0.003	Not Available/23.6
Molybdenum, Total	Metals	7471A	0.08 – 0.09	Not Available/391
Nickel, Total[1, 2]	Metals	6010 C	0.1 – 0.2	595,000/1,560
Selenium, Total[1, 2]	Metals	6010 C	0.67 – 0.8	Not Available/391
Silver, Total[1, 2]	Metals	6010 C	0.04 – 0.05	Not Available/391
Sodium	Metals	6010 C	10	Not Available/12,000,000

Strontium, Total	Metals	6010 C	0.07 – 0.4	Not Available/46,900
Thallium[1]	Metals	6010 C	0.19 – 0.4	Not Available/0.782
Tin[2]	Metals	6010 C	0.2	47,000 (EPA RSL)
Titanium	Metals	6010 C	0.2	Not Available
Uranium (soluble salts)	Metals	6020 A	0.006 – 0.01	Not Available/234
Vanadium, Total[2]	Metals	6010 C	0.05	Not Available/394
Zinc, Total[2]	Metals	6010 C	0.5 – 2.0	Not Available/23,500
Other Analytes				
Chloride	Anion	300.0	4.0 – 5.0	Not Available/18,800,000
Potassium	Anions	6010 C	20	Not Available/15,600,000
Cyanide, Total[1, 2]	Cyanide	9012	0.14 – 0.28	Not Available/11.1
Nitrate/Nitrite	Nitrogen	353.2M	0.2	Nitrate Not Available/125,000 Nitrite Not Available/7,820
Perchlorate[3]	Perchlorate	6850	1.0	Not Available/54.8

[1]Listed in 40 CFR Part 261 Appendix VIII as a hazardous constituent
[2]Listed in 40 CFR Part 264 Appendix IX for groundwater monitoring
[3]Listed in NMAC 20.6.7 as a toxic pollutant
[4]Minimum detection limits collected from 600 Area and 300 Area Investigations soil analysis results

Table 2 Proposed Sample Densities

Background Sampling Area	# Sample Locations (Soil Borings)	# Samples Collected at Each Location	Depth Intervals Represented at Each Location	Total # Samples Collected from Each Area
#1 – 700 Area/2nd TDRSS Areas	12	6	12-18’ 18-24’ 24-30’ 30-36’ 36-42’ 42-48’	72
#2 – Propulsion/Lab/Fuel Storage Areas	12	6		72
#4 – 100/600/Active Firing Range Areas	12	6		72
#5 – JP Remote Test Area	12	6		72
Total # Samples Collected for Augmented Soil Background Study:				**288**