National Aeronautics and
Space Administration

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

April 29, 2022

Reply to Attn of: RE-22-054

New Mexico Environment Department
Attn: Rick Shean, Bureau Chief
Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

Subject: NASA WSTF Work Plan for Abandonment of NASA WSTF NASA 9 and Replacement with Monitoring Well 400-001-GW

On April 19, 2021, NASA submitted the *NASA White Sands Test Facility (WSTF) Groundwater Monitoring Plan (GMP) Update for 2021*. On November 15, 2021, NMED approved the report with modifications, which included a requirement for NASA to replace monitoring well NASA 9 due to "damage associated with root growth". NASA plans to install new well 400-001-GW adjacent to the location of existing well NASA 9. A printed drilling work plan for new groundwater monitoring well 400-001-GW, which includes information on the plugging and abandonment of existing well NASA 9, is included as Enclosure 1. Enclosure 2 provides a CD-ROM of the drilling work plan.

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 of my staff at 575-202-5406.

AMANDA SKARSGARD
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Date: 2022.04.29 08:28:48 -06'00'

For: 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

Abbreviated Work Plan for Abandonment of NASA WSTF NASA 9 and Replacement with Monitoring Well 400-001-GW

Introduction and Background	In June of 2020, National Aeronautics and Space Administration (NASA) attempted to remove the dedicated low-flow bladder pump from White Sands Test Facility (WSTF; Figure 1) groundwater monitoring well NASA 9 to extend the tubing and lower the bladder pump intake due to declining water levels. During removal activities, the tubing bundle separated from the pump, and the pump then dropped into the 5-foot (ft) well sump. During attempts to recover the pump using special fishing tools, NASA discovered that the inside of the 2-inch stainless-steel casing was obstructed with small roots just above and below the static water level. Numerous attempts to lock onto the top of the pump with the fishing tool were unsuccessful and the pump could not be retrieved. On November 15, 2021 the New Mexico Environment Department (NMED) approved the 2021 Groundwater Monitoring Plan (GMP) with a modification stating that "Due to reported damage associated with root growth at monitoring well NASA 9, a work plan for abandonment and replacement of the monitoring well must be submitted to NMED for approval. N-nitrosodimethylamine (NDMA) has historically been reported at concentrations that exceed the respective cleanup level at the sampling location; therefore, the replacement of NASA 9 will allow for continued groundwater data collection at this location down-gradient from the 400 Area Closure." (NMED, 2021) This work plan is provided in accordance with NMED direction and outlines the plugging, abandonment, and subsequent replacement of well NASA 9 (Figure 2).
Plugging and Abandonment of Well NASA 9	NASA will plug and abandon existing groundwater monitoring well NASA 9 in accordance with WSTF Hazardous Waste Permit (Permit) Attachment 19 (Section 19.4; NMED, 2009) and 19.27.4.30.C New Mexico Administrative Code (NMAC). Well NASA 9, installed in April 1985, is equipped with 6-inch (in.) steel surface casing that extends to a depth of 5 feet (ft) below ground surface (bgs). The borehole extends from surface casing to a total depth of 180 ft bgs. Borehole diameter was not recorded during drilling and is unknown. The monitoring well consists of 2-in. schedule 80 PVC casing that extends from ground surface to 119.46 ft bgs and 2-in. stainless steel containing the screened interval from 119.46 to 154.46 ft bgs, across the alluvium/andesite bedrock contact located at 145 ft bgs. NASA plans to plug and abandon the well by fully grouting this well from total depth to surface, including the existing screened interval (Figure 3). For the abandonment of NASA 9, should any portion of the sampling system be unable to be removed, the remaining material will be pushed to the bottom of the casing. This remaining material will then be grouted in place during the well's abandonment. Grouting will be completed by use of tremie pipe to grout from the bottom of the casing

	up, including the screened interval and all blank casing. Any discharge of fluids will be managed in accordance with the Waste Characterization and Management section of this work plan. The steel surface casing will be cut at least 6 in. bgs, and a concrete surface cap will be emplaced over the borehole. A brass cap will be placed in the concrete surface completion and all pertinent well information will be stamped onto the brass cap. NASA will also prepare a well plugging plan for well NASA 9 and submit the plan to the New Mexico Office of the State Engineer (NMOSE) in accordance with 19.27.4.30 NMAC. The well drilling contractor will provide NASA and NMOSE with the required completed well plugging record. NASA will in turn provide NMED with a copy of the completed well plugging record.
Primary Purpose	NASA proposes to plug and abandon existing monitoring well NASA 9 (Figure 3) and install replacement monitoring well 400-001-GW approximately 100 ft to the east-northeast of the abandoned well. Care will be taken to maintain a location within the bedrock low, coincident with the location of the axis of the 300/400 Area Arroyo. It is common for present-day drainages to follow pre-established paleo-drainages that have often scoured relative area lows into the bedrocks surface. These bedrock scours may be significant or subtle, but drainage at the bedrock-alluvial interface will generally want to flow through these bedrock topographic lows. It is highly probable the bedrock also rises to the north underneath this alluvium. If the replacement well were located too far to the north, the alluvium/bedrock interface may be dry defeating the purpose of monitoring the bedrock/alluvium interface as was monitored at NASA-9. Well 400-001-GW is expected to be completed as a single zone conventional monitoring well installed within an 8-in. diameter borehole (Figure 4). The targeted screened interval in the replacement well will allow for monitoring of the alluvium/bedrock contact originally monitored in well NASA 9. The final placement of the screened interval within the well will be refined during drilling and/or follow-on borehole logging.
Hydrogeologic and Geochemical Objectives	NASA believes that much of the groundwater flow, and thus contaminant transport, in the 300 and 400 Areas was across the bedrock surface at the alluvium/bedrock interface. The objective of the new well is to monitor the alluvium/bedrock interface to evaluate the impact of historical discharges and potential contaminant movement resulting from natural and artificial recharge events. This location is in a critical position for monitoring NDMA and other groundwater contaminants adjacent to the 300/400 Area Arroyo and the 400 Area Closure. Currently, groundwater monitoring to the north of the surface drainage is limited to wells 400-C-118 and 400-C-143, which are located just over 400 ft to the west and downgradient of NASA 9. NDMA concentrations in these two wells were 4,949 ng/L (November 15, 2019) and 2,062 ng/L (March 25, 2020), respectively. Well 400-C-118 was installed in February of 1987 with a WL initially tagged at 130 ft. Levels remained variable until April of 2009 where after at 129.1 ft,

	water levels in well 400-C-118 then declined steadily from 135 ft to a last recorded depth of 138.25 ft in October of 2016, attempts were made to sample this well in November of 2020 and April of 2021 but water levels are now below the pump intake, and the well can currently not be sampled. As such, NASA plans to plug and abandon this well in the near future. As a replacement for NASA 9, analytical results from 400-001-GW will be used to supplement groundwater chemical analytical data from other wells within the WSTF groundwater monitoring system and also be used to aid in tracking and monitoring of the NDMA contaminant plume.
Conceptual Model	Soils in the vicinity of the 400 Area belong to the Tencee-Nickel Association and comprise shallow to deep well-drained soils, which formed in calcareous gravelly loamy alluvial sediments on old alluvial fans. The upper to 100 ft of the vadose zone is comprised of unconsolidated and relatively fine-grained alluvium. Alluvium in the vadose zone below the 400 Area Closure comprises Quaternary to Tertiary intercalated fan, interfan valley, and erosion surface veneer deposits derived from the San Andres Mountains (SAM) from Bear Canyon to the east northeast of the 400 Area. The alluvium becomes coarser-grained with depth and becomes more consolidated in the deep alluvial section. The coarse fraction of this unit consists primarily of limestone, dolomite, and quartzite clasts. The uppermost well-cemented Tertiary alluvial bedrock forms a veneer on top of volcanic bedrock. The cemented alluvium varies in thickness from approximately 1 ft (east) up to 50 ft (west) down topographic gradient across the 400 Area. Bedrock is expected to be encountered at depths of approximately 135-145 ft bgs at the targeted location. Groundwater beneath the 400 Area primarily originates from recharge in the Bear Canyon catchment area of the southern SAM. Under the effect of a steep hydraulic gradient of approximately 0.05 ft/ft, groundwater recharge infiltrates through the porous alluvium to the bedrock surface and subsequently into fractures in the cemented alluvium (conglomerate) and andesite bedrock in the 400 Area. In the absence of secondary porosity (fractures), the conglomerate and underlying andesite are very well indurated, dense, and not conducive to groundwater flow. The hydraulic gradient moves groundwater to the west, potentially following subtle depressions in lower conductivity bedrock that act as preferred pathways from the SAM towards the Southern Jornada del Muerto Basin. In the 400 Area, a subtle depression in bedrock appears to be approximately coincident and directly below the location of the 300/400 Area arroyo. Well NASA 9 is comprised of a single monitoring zone at 129.5-149.5 ft bgs, placing it across the alluvium/andesite bedrock interface. Figure 5 provides details on the lithology observed at well NASA 9. Replacement well 400-001-GW will be located approximately 100 ft to the east-northeast of the plugged and abandoned well NASA 9. Well 400-001-GW will include a single monitoring zone completed at the alluvium/bedrock contact consistent with the construction of well

	NASA 9. Lithology at this location is expected to be similar to that encountered at comparable depths in well NASA 9. Aquifer conditions at the proposed location are expected to be semiconfined to confined with groundwater in fractures in bedrock (both conglomerate and andesite) as well as the unconsolidated alluvium overlying the bedrock. The groundwater flow direction in the area is generally west-southwest. Based on last measurements at well NASA 9, NASA expects to encounter groundwater at approximately 136 ft bgs.
Drilling Approach	NASA will drill and install monitoring well 400-001-GW in accordance with the requirements of Permit Attachment 19 (NMED, 2009). The well is expected to be installed using the air rotary casing hammer (ARCH) method of drilling. NASA expects to advance an 8-in. borehole to approximately 160 ft bgs to allow for the installation of a single well string with one screened interval (Figure 4). The screened interval is expected to be installed at approximately 145 ft bgs at the alluvium/bedrock interface as a direct replacement for well NASA 9. **Air Rotary Casing Hammer Drilling** Because drilling mud has the potential to adversely affect the hydrologic properties of the aquifer and its immediately surrounding, drilling will be performed without the use of drilling fluids using the ARCH drilling method. Outer drive casing with a diameter of approximately 8-in. will be advanced behind the drill bit to prevent borehole collapse in the alluvium. Compressed air will be used to clean the boring of cuttings during bit advancement. Small amounts of non-chlorinated water may be added to the cyclone discharge at the surface when required for dust suppression. In the event that a borehole installation is unsuccessful (i.e., difficult drilling conditions), NASA may choose to install a new boring located adjacent to the original site. All drilling equipment and associated downhole tools and rigging will be decontaminated with a heated high-pressure wash prior to arrival at WSTF and again at WSTF prior to mobilization to well 400-001-GW. Activities and observations made during the installation of well will be recorded in the field logbooks and on the borehole lithologic logs.
Potential Groundwater Occurrence and Detection	The top of regional groundwater is expected to occur at a depth of approximately 135-136 ft bgs. However, the exact depth to water is uncertain as a result of the variability of testing discharge from the 400 Area, coupled with recent poor seasonal recharge.
Lithological Sampling	Lithological samples will be collected from chips discharged from the ARCH drilling rig in 10-ft intervals from the cyclone discharge. Lithological samples will then be archived in chip trays for future reference. Lithological samples will be collected at a higher frequency when approaching the bedrock contact in order to accurately identify when bedrock is intercepted. The lithology of the drill cuttings will be

	recorded by the field geologist on lithologic log forms along with other pertinent drilling information.
Groundwater Screening and Characterization Sampling	Based on groundwater monitoring performed at existing well NASA 9, the aquifer at the proposed 400-001-GW location is expected to be within the northern edge of the WSTF groundwater contaminant plume. Following well development and sampling system installation, groundwater characterization samples will be collected from the completed well for the analysis of volatile organic compounds by the current revision of SW-846 Method 8260D, semi-volatile organic compounds by the current revision of SW-846 Method 8270C, NDMA by Modified Environmental Protection Agency (EPA) Method 607M, or an acceptable low-level analytical method, and a variety of metals by the most effective laboratory-selected analytical method. Samples will be collected and managed in accordance with the WSTF GMP (NASA, 2021).
Geophysical Logging	A complete suite of open borehole geophysical logs will be performed as a single event to aid in the selection of potential monitoring zones if borehole conditions allow. Open borehole geophysical logging will be performed by a qualified geophysical contractor and is expected to include gamma, neutron porosity, formation resistivity, spontaneous potential logs, and caliper logs/borehole deviation logs.
Well Completion	Well 400-001-GW will be constructed in accordance with the requirements stated in Section 19.3.2 of the Permit (NMED, 2019) with a single string of nominal 3-in. Schedule 80 PVC casing and screen, which will allow for the use of up to a 2-in. diameter downhole pump for well development. The 8-in. drive casing will be removed to a depth of 20 ft and cut to leave surface casing in place. A single monitoring zone is planned for this well. The screened interval will be located across the alluvium/bedrock contact at approximately 145 ft bgs. A ten-foot length 0.020-in. slotted Schedule 80 PVC screen will be positioned at the location indicated as most favorable by field screening of borehole lithology and borehole geophysical logs, if performed. The annular seal for the screened interval will be comprised of bentonite chips or pellets isolating the screened interval. The general well construction configuration is presented in Figure 4 and is subject to change dependent on conditions encountered in the field or by recommendations made by the drilling contractor. NASA will prepare a final well construction diagram for the well for NMED review and approval immediately prior to well installation. Annular materials will be emplaced using a minimum 1.5-in. inner diameter tremie pipe. A 10/20 or similar silica sand filter pack will be placed to a height of 5 ft above and 5 ft below the screened interval. Five feet of fine silica sand, such as 20/40 or similar, will be used to grade from the sand pack to a 5-ft bentonite seal composed of hydrated bentonite chips or pellets. The interval above the uppermost bentonite seal will be comprised of bentonite grout with at least 30% solids. The upper 10 ft of the borehole and well pad will then be completed with

	Type II Portland cement. Figure 4 provides a diagram of the preliminary proposed well design with annular materials.
Well Development	Well 400-001-GW will be developed in accordance with the requirements of Attachment 19 (Section 19.3.5) of the Permit (NMED, 2009). Drilling subcontractor personnel will operate equipment used to develop the well under the supervision of WSTF Environmental contractor personnel. Initial development may consist of mechanical bailing, swabbing, and pumping using a submersible pump. During development activities, environmental contractor personnel will monitor discharged development water for parameters that will include pH, specific conductance (conductivity), temperature, and turbidity. Well development will be considered complete when measured water quality parameters are relatively stable (vary less than 10%) and turbidity is below 5 nephelometric turbidity units. The screened interval will be developed to ensure the well will yield representative groundwater samples. Following well development, NASA expects to install a dedicated low-flow bladder pump in the PVC well casing, with the pump intake located at or slightly above the midpoint of the screened interval.
Hydraulic Testing and Groundwater Sampling	Hydraulic testing will be considered during the development of monitoring well 400-001-GW. Additional information such as drawdown and specific capacity will be recorded if this testing is conducted. Groundwater sampling following installation and development of the well will be performed using the dedicated low-flow bladder pump. Groundwater samples will be collected and managed as described in the WSTF GMP (NASA, 2021).
Waste Characterization and Management	Waste characterization will be conducted in accordance with Section II.C (Waste Characterization) and Attachment 12 (Waste Analysis Plan) of the WSTF Hazardous Waste Permit (NMED, 2019). All waste will be properly managed and disposed of in accordance with NASA procedures and state and federal regulations. The waste streams that will be generated during drilling and installation of groundwater monitoring well 400-001-GW include: • **Drill cuttings.** Unsaturated drill cuttings are defined as soil cuttings or rock fragments generated from the vadose zone that have not come in contact with groundwater. Unsaturated cuttings are characterized as non-hazardous solid waste. Saturated drill cuttings are defined as soil cuttings or rock fragments generated from below the water table that may have come in contact with potentially contaminated groundwater. This environmental media potentially contains listed hazardous waste constituents from the WSTF groundwater plume and is initially characterized as hazardous waste. • **Drilling fluids.** Limited amounts of water may be incorporated into the circulation fluid in ARCH drilling. Any aqueous waste drilling fluid generated during drilling in the vadose zone will be impacted with added non-chlorinated native water from the

	WSTF potable water supply wells. Drilling fluid generated above the water table is characterized as non-hazardous solid waste. Drilling fluid generated below the water table will potentially contain listed hazardous waste constituents that are present in the WSTF groundwater plume and is characterized initially as hazardous waste. • **Groundwater.** Groundwater produced from within the WSTF groundwater plume during well drilling and development is characterized as environmental media containing listed hazardous waste with the F001 and F002 hazardous waste codes. • **Decontamination fluids.** Decontamination fluids such as water and soap solutions used to wash and decontaminate equipment generated during drilling above the water table are characterized as non-hazardous solid waste. Decontamination fluids generated by cleaning equipment that has contacted potentially contaminated soil, cuttings, or fluids generated when drilling below the water table is characterized as hazardous waste. • **Contact waste.** Contact waste, or debris, such as used disposable sampling equipment, personal protective equipment, plastic sheeting, and other debris generated during drilling above the water table is non-hazardous solid waste. Contact debris contaminated with soil, cuttings, or fluids that were generated when drilling below the water table is characterized as hazardous waste. • **Petroleum Contaminated Debris and Environmental Media.** Debris such as rags and wipes may be contaminated with petroleum products during routine drilling equipment maintenance. Though not expected, petroleum contaminated environmental media may also be generated during an unexpected drilling equipment failure. The petroleum contaminated debris and environmental media will be characterized as hazardous waste with the D018 hazardous waste code. Groundwater at the proposed location of well 400-001-GW may be contaminated with low concentrations of listed hazardous waste constituents that are present in the WSTF groundwater plume. Actively managed groundwater sourced from the WSTF groundwater contaminant plume is characterized as listed hazardous waste with the F001 and F002 hazardous waste codes through application of the EPA "Contained-In" Policy. The EPA "Contained-In" Policy states that groundwater, soil, and other environmental media is not solid waste but is subject to regulation as hazardous waste when it contains listed waste (EPA, 1998). Because groundwater and other environmental media is subject to regulation when it contains listed hazardous waste, waste generated after reaching the water table will be managed as hazardous waste.

	Drill cuttings and drilling fluids generated from the vadose zone will not contain listed hazardous waste and will not meet the definition of a hazardous waste. Vadose zone drill cuttings, and if necessary, drilling fluids, will be managed in intermediate bulk containers, bulk containers, or earthen pits at the surface as required for project implementation. If earthen pits are used, appropriate regulatory authorization will be obtained prior to their use and they will be backfilled at the completion of the project. Drill cuttings and drilling fluids generated below the water table will be managed as hazardous waste in intermediate bulk or bulk containers. Hazardous waste generated below the water table will be containerized and managed in accordance with 20.4.1.300 NMAC and 40 CFR 262.17. The as-generated waste from below the water table will be sampled and analytical data will be used to further characterize the waste. Waste characterization samples will be analyzed for VOC by the current revision of SW-846 Method 8260 and NDMA by Modified EPA Method 607M. NASA will request a "contained-in" determination from the NMED for waste generated below the water table if the analytical data indicate drill cuttings and drilling fluids generated below the water table do not contain listed hazardous waste or exhibit characteristics of a hazardous waste. If the analytical data indicate the presence of listed waste or the waste exhibits characteristics of a hazardous waste, the waste will be properly treated and disposed of at a RCRA permitted treatment, storage, and disposal facility (TSDF). If possible, contaminated water may be decanted from this waste stream prior to shipment off-site and transferred to the Mid-plume Interception and Treatment System (MPITS) for treatment and discharge in accordance with Discharge Permit (DP)-1255 (NMED, 2017). Contaminated groundwater generated during drilling, development, and purging, and contaminated water generated during decontamination of equipment that has come into contact with contaminated groundwater or hazardous debris from below the water table, will be accumulated in appropriately sized containers and managed as hazardous waste. The containers will be managed in accordance with requirements of 20.4.1.300 NMAC and 40 CFR 262.17. Within permissible accumulation time limits, contaminated water will be transferred to the MPITS for treatment and discharge. Contact waste, or hazardous debris, that has come into contact with contaminated groundwater will be collected at the end of each working shift and transferred to an appropriate container. All hazardous waste containers will be managed on-site in accordance with the requirements of 20.4.1.300 NMAC and 40 CFR 262.17. If analytical results from drill cuttings and fluids are favorable, this waste stream may be included in a "contained-in" determination request. If analytical results indicate the drill cuttings and fluids contain hazardous waste, or NMED determines the waste still contains hazardous waste, this debris will be shipped off-site for treatment and disposal at a RCRA permitted TSDF within the permissible accumulation time limits. As discussed

	previously, NASA may request a "contained-in" determination for individual waste streams initially characterized as containing listed hazardous wastes, should analytical data from the as-generated waste support such a request. If NMED finds contaminant concentrations do not pose an unacceptable risk, then NMED may allow the wastes included in the request to be managed as non-hazardous solid waste that no longer contains listed waste and does not exhibit the characteristic of hazardous waste. NASA understands a separate letter from NMED will be required to document such a determination. For waste that is characterized as hazardous waste, land disposal restriction notifications, disposal facility profiles, and hazardous waste manifests will be completed as required. Hazardous waste manifested off-site will be transported for treatment and disposal at a permitted RCRA TSDF. Contaminated groundwater and decontamination water generated during the project will be managed at the MPITS. If that system is not capable of receiving the waste, it will be disposed of at a permitted RCRA TSDF.
Schedule	It is anticipated that drilling of proposed well 400-001-GW will commence following NMED approval of this work plan. The final schedule for well drilling and installation may be adjusted to coincide with the drilling of other planned monitoring wells at WSTF to ensure effective and efficient project planning and implementation. The anticipated schedule for completing the well is as follows: • Eight to 10 weeks for project and procurement planning, well site preparation, and drilling contractor scheduling. • Six to eight weeks for contractor mobilization, plugging and abandonment of well NASA 9, installation of the 400-001-GW borehole, and the conventional well installation in the borehole. Additional time may be required during drilling if unexpected field or geological conditions slow the drilling process. • Six to eight weeks for well development fieldwork, sampling system design and procurement, and sampling system installation. • Eight to 12 weeks for groundwater sampling, data validation and verification, and preparation of the well completion report. The well completion report will be submitted to the NMED in accordance with Attachment 19 of the Permit (NMED, 2009).
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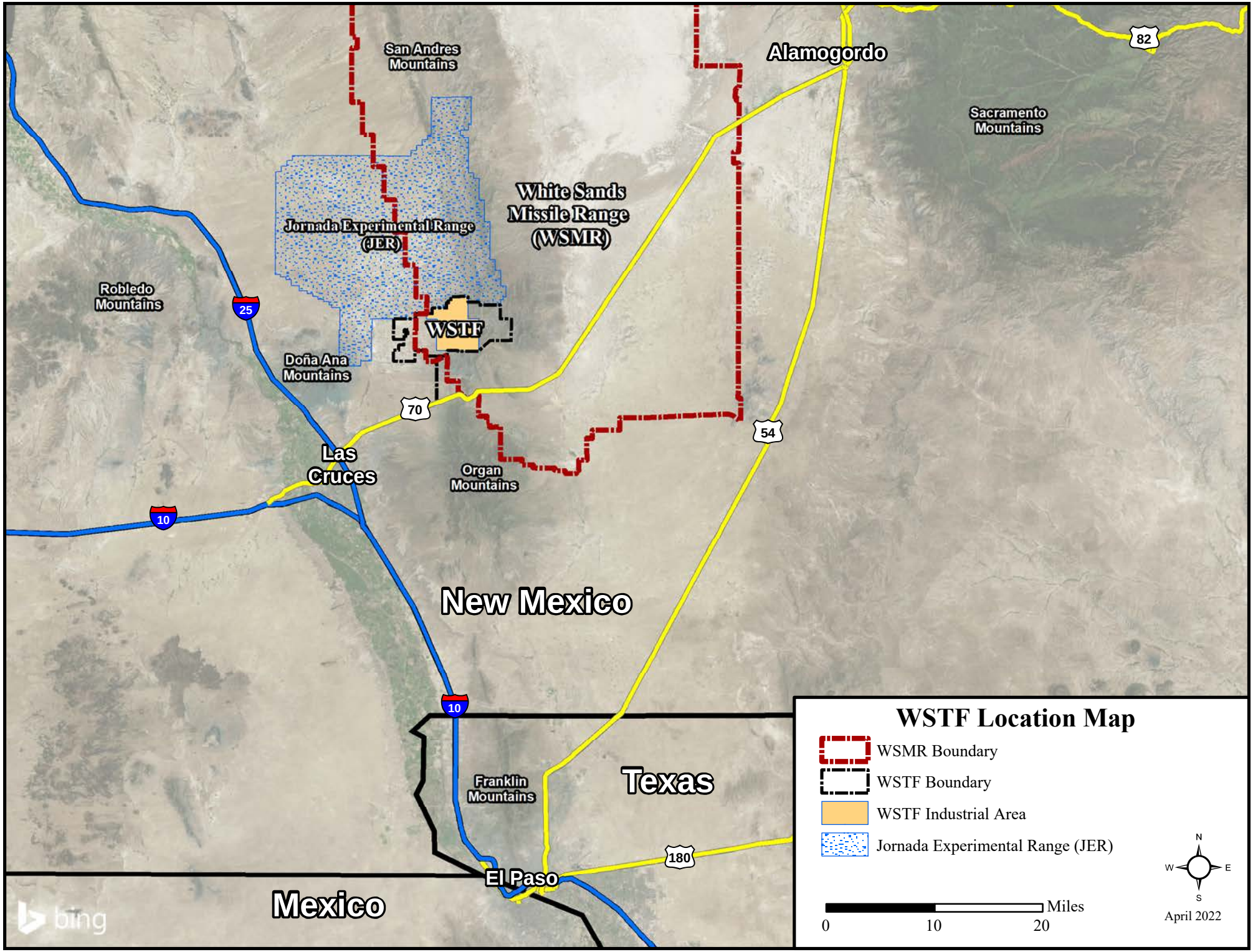
Well Drilling – Non-Artesian (Unconfined) Well Requirements, Office of the State Engineer, 19.27.4.30 NMAC (6-30-2017).

Figures

Figure 1 **WSTF Location Map**

(SEE NEXT PAGE)


San Andres Mountains
Alamogordo
82
Sacramento Mountains
White Sands Missile Range (WSMR)
Jornada Experimental Range (JER)
Robledo Mountains
25
WSTF
Doña Ana Mountains
70
54
Las Cruces
Organ Mountains
10
New Mexico
10
Franklin Mountains
Texas
180
El Paso
Mexico
bing
WSTF Location Map
WSMR Boundary
WSTF Boundary
WSTF Industrial Area
Jornada Experimental Range (JER)
Miles
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10
20
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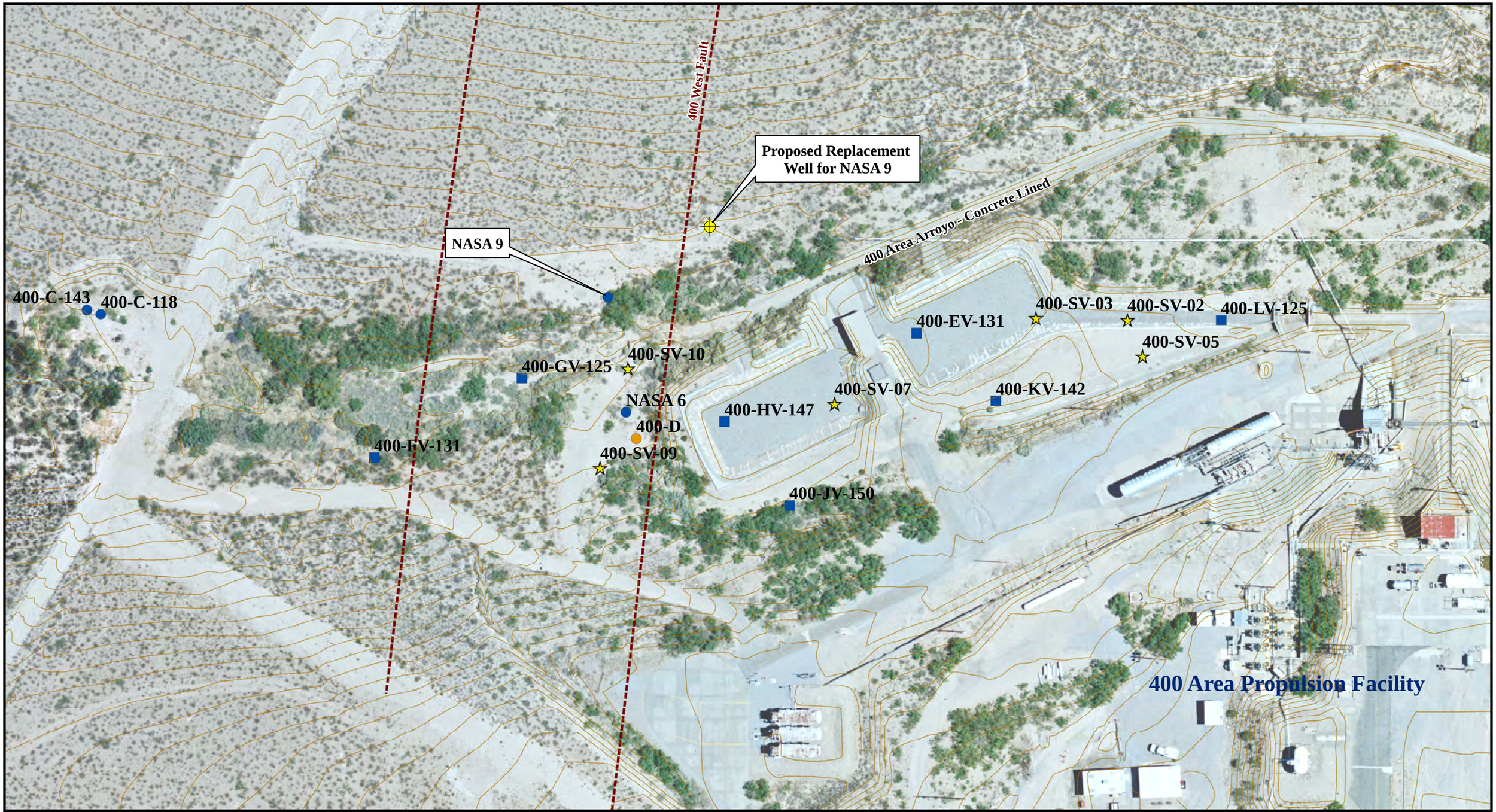
April 2022

Figure 2 **Proposed Location of 400-001-GW**

(SEE NEXT PAGE)



Proposed NASA 9 Replacement Well

- MSVGM Well
- MSVM Well
- Multiport Well
- Conventional Well
- Proposed Well Location
- Inferred Fault
- Topographic Contour (2-Ft Interval)

Feet
0 25 50 75 150 225

N
W E
S

April 2022

Figure 3 **NASA 9 Well Completion Diagram**

(SEE NEXT PAGE)

WELL COMPLETION DIAGRAM
CONVENTIONAL MONITORING

JSC - White Sands Test Facility
Las Cruces, New Mexico, USA

Location ID: **NASA-9**

Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4 NE 1/4 SW 1/4 Sec 35, T20S, R3E**
NM State Plane Coordinates (NAD 83): **169137.30N 466456.82E**
Elevation (Brass Cap): **1470.44 m AMSL**
Elevation (Top of Casing): **1470.94 m AMSL**
Drilling Contractor: **Larjon Drilling Company**
Driller: **J. Gower**
Total Depth of Borehole (bgs): **180' (54.86 m)**
Borehole Diameter: **Not Recorded**
Depth to Bedrock (bgs): **145' (44.20 m); Andesite**
Depth to Groundwater: **130.83' (39.88 m) (4/5/85)**
Total Depth Surface Casing (bgs): **~5' (~1.52 m)**
Diameter and Type Surface Casing: **Nominal 6" Steel**

Date(s) Well Installed: **4/3/85**
Date(s) Well Developed: **Not Recorded**
Field Representative(s):**M. Selke, P. Linley**
Total Depth Well Casing (bgs): **154.46' (47.08 m)**
Type of Casing: **PVC and Stainless Steel**
Diameter Well Casing: **Nominal 2"**
Casing Schedule: **80 PVC to ~119.46'; 40 Stainless Steel to 154.46'**
Screened Zone (bgs): **129.46' - 149.46' (39.46 - 45.56 m)**
Comments: **bgs = below ground surface**
TOC = Top of Casing
AMSL = Above Mean Sea Level
Borehole diameter not recorded.

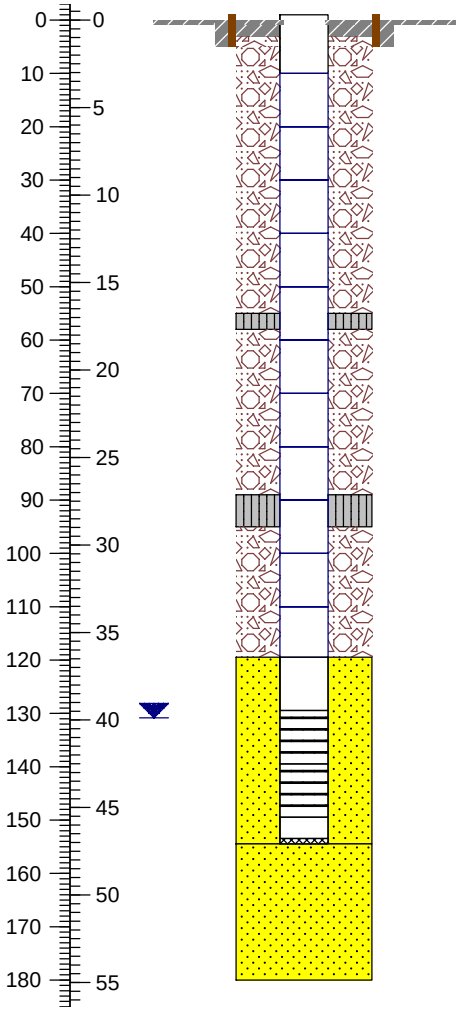
Casing Explanation:

- Surface Casing **Nominal 6" Steel**
- Conventional Casing **Nominal 2" PVC**
- Conventional Casing **Nominal 2" Stainless Steel**
- Conventional Screen **Nominal 2" Stainless Steel 0.010"-Slot (Regular Strength)**
- Conventional End Cap **Nominal 2" Stainless Steel**
- **None Listed**
- Water Table

Annular Materials Explanation:

- Cement
- Bentonite (Grout Well DF)
- Bentonite Seal
- 10/20 Sand/ Bentonite Mix
- Slough
- 8/20-16/40 Sand Mix
- 4/8 Sand
- 6/9 Sand
- 8/12 Sand
- 8/20 Sand
- 10/20 Sand
- 16/40 Sand
- 20/40 Sand
- 30/70 Sand

Feet/Meters



Well Descriptions
All depths listed are bgs (unless noted)

Conventional Well Stick-Up = Not recorded at installation. 1.66' (0.51 m) final

Surface Casing Stick-Up = ~1.15' (~0.35 m)

Well completed with ~3' x ~3' cement pad, barrier posts, and locking steel well cap surrounding the casing at ground surface

Nominal 6" Surface Casing Depth = 5'

NOTE: Casing was not tallied. Casing couplings are schedule 40 stainless steel.
All Casing Above ~119.46' (~36.41 m) = Schedule 80 PVC

All Casing and Screen Below ~119.46' (~36.41 m) = Schedule 40 Stainless Steel

Top of Screen (Regular Strength) = 129.46' (39.46 m)

Water Table = 130.83' (39.88 m); measured 4/5/85 following completion

First Occurrence of Groundwater During Drilling = Not recorded

Bottom Screen (Regular Strength) = 149.46' (45.56 m)

No Centralizers Listed

Sump consists of 5' blank riser and end cap

Nominal 2" Schedule 80 PVC / Schedule 40 Stainless Steel Casing TD = 154.46' (47.08 m)

Annular/Borehole Descriptions
All depths listed are bgs

Top of Cement Grout = 0'

Top of Backfilled Cuttings, Surface Material, and Gravel = ~3' (0.91 m)

Top of Bentonite Seal (dry) = ~55' (~16.76 m); original diagram does not have exact location, just states minimum 3' (one 50-lb bag dry bentonite installed).

Top of Backfilled Cuttings and Surface Material = 58.00' (17.68 m)

Top of Bentonite Seal (dry) = ~89' (~27.13 m); original diagram does not have exact location, just states minimum 6' (two 50-lb bags dry bentonite installed).

Top of Backfilled Cuttings and Surface Material = 95.00' (28.96 m)

Top of Sand = ~119.46' (~36.41 m); origianl diagram does not have exact location; assumed to be 10' above screen.

Santa Fe Group Alluvium from surface to 145' (44.20 m)

Volcanic Alluvium Depth Not Noted

Andesite (Orejon Andesite) Bedrock Depth = 145' (44.20 m to total depth)

Slough Not Measured

Borehole TD = 180' (54.86 m)

Figure 4 **General 400-001-GW Well Design**

(SEE NEXT PAGE)

WELL COMPLETION DIAGRAM

Groundwater Monitoring Well

Location ID: **400-001-GW**

Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range:

NM State Plane Coordinates (NAD 83)(ft):

Elevation (Brass Cap): **ft amsl**

Elevation (Top of Casing): **ft amsl**

Drilling Contractor:

Driller:

Method of Drilling: **Air Rotary Casing Hammer**

Total Depth of Borehole (bgs): **160 ft**

Borehole Diameter: **8-in.**

Depth to Bedrock (bgs): **145 ft (Anticipated)**

Depth to Groundwater: **135-136 ft (Anticipated)**

Diameter and Type Surface Casing: **8-in. nominal Carbon Steel**

Dates Borehole Drilled:

Date(s) Well Installed:

Date(s) Well Developed:

Field Representative(s):

Total Depth Well Casing (bgs): **155.25 ft**

Type of Casing: **Schedule 80 PVC**

Diameter Well Casing: **3-in. nominal**

Screened Zone (bgs): **140-150 ft**

Casing Explanation

- Completion Casing — **Schedule 80 PVC**
- Well Screen — **Slot Size 0.020-in.**
- Conductor Casing — **8-in. nominal Carbon Steel**
- **PVC End Cap**
- **Water Table**

Annular Materials Explanation

- Neat Cement
- Bentonite Grout
- Bentonite Seal
- 10/20 Filter Pack Sand
- 20/40 Sand

Depth Feet/Meters	Borehole/Well Casing Descriptions All depths are below ground surface	Annular Materials Descriptions All depths are below ground surface
0 / 0	Ground surface Elevation (ft amsl)	
	Casing stick-up will be cut off to ~3 ft above the ground surface.	Surface completion consists of a 4 ft by 4 ft by 4-in. sloping concrete pad with steel wellhead protector with locking cap.
10 / 5	0-20 ft bgs- 8-in. nominal Carbon Steel Conductor Casing	
		0-25 ft - Surface Seal. Type I Portland cement.
20 / 10	3 ft above ground surface (ags) to 140 ft below ground surface (bgs) 3-in. nominal Schedule 80 PVC or similar.	
40 / 15		25-120 ft - Annular Seal. Bentonite Grout
50 / 20		
60 / 25		
70		
80		
90		

Casing Explanation

- Completion Casing — **Schedule 80 PVC**
- Well Screen — **Slot Size 0.020-in.**
- Conductor Casing — **8-in. nominal Carbon Steel**
- **PVC End Cap**
- **Water Table**

Annular Materials Exlplanation

- Neat Cement
- Bentonite Grout
- Bentonite Seal
- 10/20 Filter Pack Sand
- 20/40 Sand

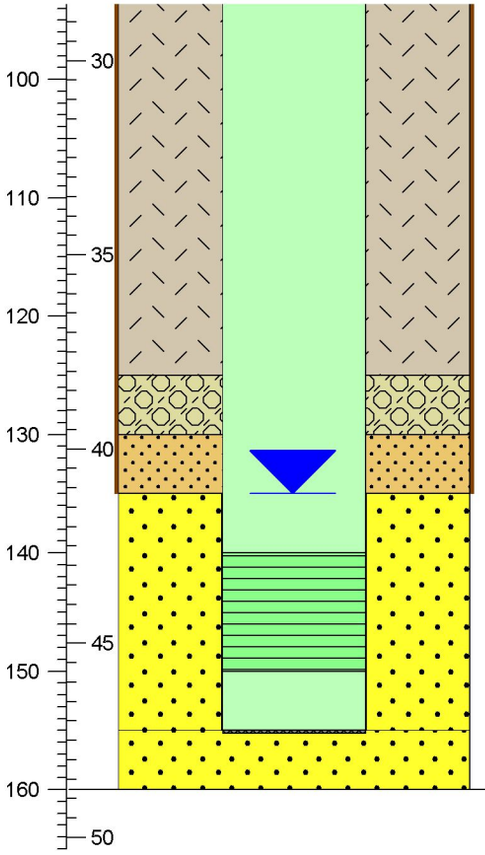
Depth Feet/Meters	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
		125-130 ft - Annular Seal. Pel-Plug Time Release ¼-in. Bentonite Pellets
		130-135 ft. - 20/40 Fine Silica Sand
	135-136 ft bgs Static Water Level (SWL)	
	140-150 ft bgs- Screened Interval 3-in. nominal .020-in. slotted Schedule 80 PVC or similar.	135-160 ft - 10/20 Silica Filter Pack Sand
	150-155 ft bgs - Sump	
	155-155.25 ft bgs - Endcap Schedule 80 PVC or similar	
	8-in. Borehole Total Depth = ~160 ft	

Figure 5 **NASA 9 Borehole Lithology Log**

(SEE NEXT PAGE)

BOREHOLE LITHOLOGIC LOG

JSC - White Sands Test Facility
Las Cruces, New Mexico, USA

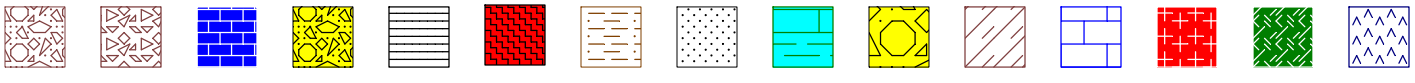
Location ID: **NASA-9**

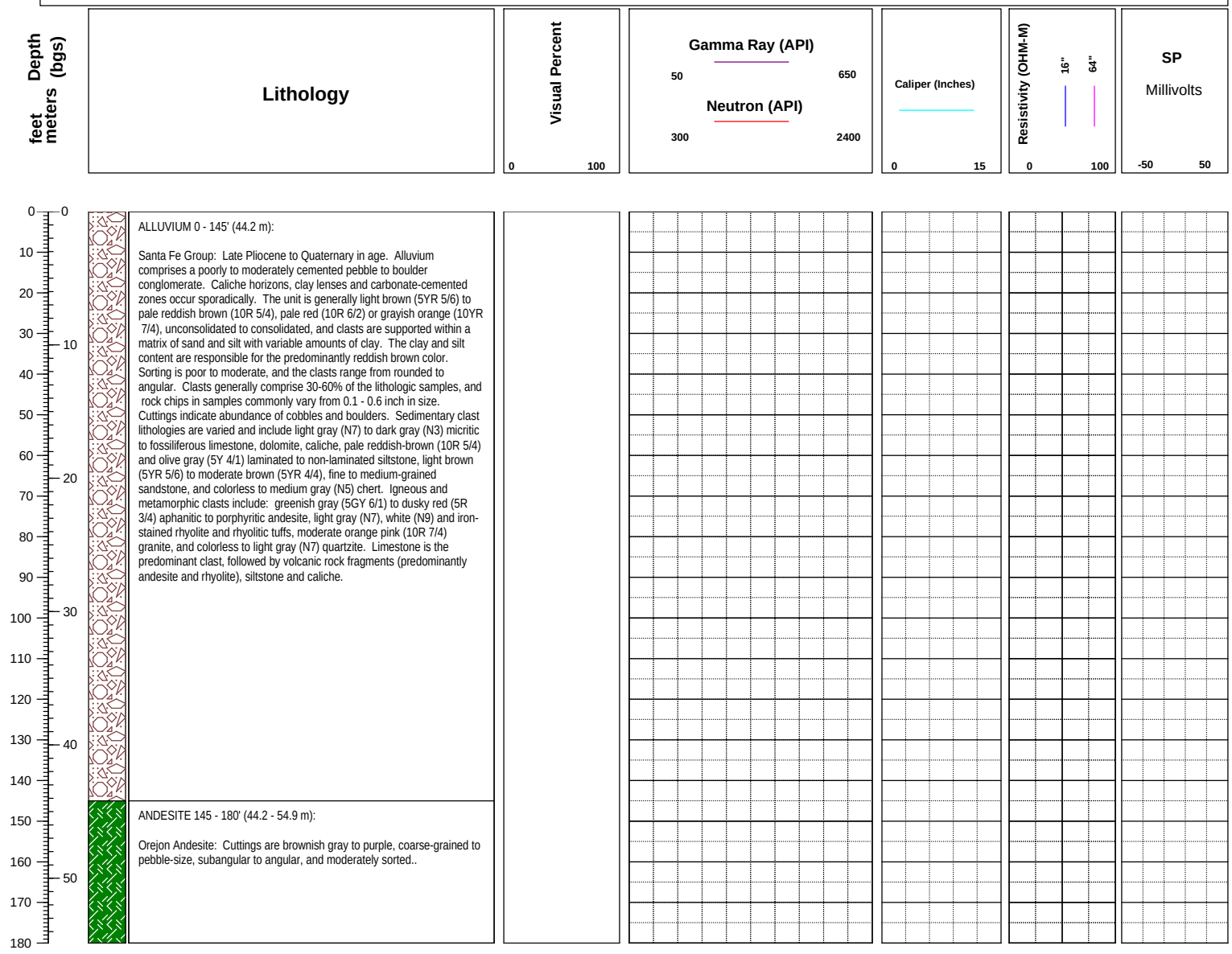
Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4 NE 1/4 SW 1/4 Section 35, T20S, R3E**
NM State Plane Coordinates (NAD 83): **169137.30N 466456.82E**
Elevation (Brass Cap): **1470.44 m AMSL**
Total Depth of Borehole (bgs): **180' (54.86 m)**
Depth to Bedrock (bgs): **145' (44.20 m); Andesite**
Drilling Method: **Air-Foam Rotary**
Drilling Contractor: **Larjon Drilling Company**
Driller: **J. Gower**

Depth to Groundwater: **130.83' (39.88 m) TOC (4/5/85)**
Surface Casing Depth and Diameter: **Nominal 6" to 5'.**
Borehole Diameter: **Not Recorded**
Geologist Field Rep: **P. Linley, M. Selke**
Dates Drilling Started and Completed: **4/1/85 to 4/2/85**
Geophysical Contractor: **Not Logged**
Logger: **Not Logged**
Comments: **AMSL = Above Mean Sea Level**
Minimal documentation exists for this well. No visual percent recorded. Borehole diameter not recorded. Original bedrock depth = 160'; changed during modeling review (5/2004).

Explanation:





ALLUVIUM 0 - 145' (44.2 m):

Santa Fe Group: Late Pliocene to Quaternary in age. Alluvium comprises a poorly to moderately cemented pebble to boulder conglomerate. Caliche horizons, clay lenses and carbonate-cemented zones occur sporadically. The unit is generally light brown (5YR 5/6) to pale reddish brown (10R 5/4), pale red (10R 6/2) or grayish orange (10YR 7/4), unconsolidated to consolidated, and clasts are supported within a matrix of sand and silt with variable amounts of clay. The clay and silt content are responsible for the predominantly reddish brown color. Sorting is poor to moderate, and the clasts range from rounded to angular. Clasts generally comprise 30-60% of the lithologic samples, and rock chips in samples commonly vary from 0.1 - 0.6 inch in size. Cuttings indicate abundance of cobbles and boulders. Sedimentary clast lithologies are varied and include light gray (N7) to dark gray (N3) micritic to fossiliferous limestone, dolomite, caliche, pale reddish-brown (10R 5/4) and olive gray (5Y 4/1) laminated to non-laminated siltstone, light brown (5YR 5/6) to moderate brown (5YR 4/4), fine to medium-grained sandstone, and colorless to medium gray (N5) chert. Igneous and metamorphic clasts include: greenish gray (5GY 6/1) to dusky red (5R 3/4) aphanitic to porphyritic andesite, light gray (N7), white (N9) and iron-stained rhyolite and rhyolitic tuffs, moderate orange pink (10R 7/4) granite, and colorless to light gray (N7) quartzite. Limestone is the predominant clast, followed by volcanic rock fragments (predominantly andesite and rhyolite), siltstone and caliche.

ANDESITE 145 - 180' (44.2 - 54.9 m):

Orejon Andesite: Cuttings are brownish gray to purple, coarse-grained to pebble-size, subangular to angular, and moderately sorted..