National Aeronautics and
Space Administration

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

July 23, 2024

Reply to Attn of: RE-24-097

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

Subject: NASA WSTF Remediation System Monitoring Plan Annual Update for 2024

Enclosed is the NASA WSTF Remediation System Monitoring Plan (RSMP) Annual Update for 2024 as required by Section 3.4 of the NASA Resource Conservation and Recovery Act Permit No. NM8800019434. The updated plan provides monitoring requirements for the Mid-plume Interception and Treatment System and the Plume Front Treatment System. This submittal includes an Executive Summary as Enclosure 1, a complete bound paper copy of the RSMP as Enclosure 2, and a CD-ROM with the complete RSMP in PDF 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 of my staff at 575-202-5406.

Timothy Davis

Digitally signed by Timothy Davis
Date: 2024.07.23 12:23:18 -06'00'

Timothy J. Davis
Chief, NASA Environmental Office

3 Enclosures

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

Ms. Melanie Sandoval
Electronic submittal through NASA Box

Executive Summary

This National Aeronautics and Space Administration (NASA) Johnson Space Center White Sands Test Facility (WSTF) Remediation System Monitoring Plan (RSMP) includes current information relative to the operation and monitoring of the Plume Front Treatment System (PFTS) and Mid-plume Interception and Treatment System (MPITS) as of July 2024. PFTS monitoring is conducted in accordance with the NASA WSTF Resource Conservation and Recovery Act (RCRA) Permit (Permit), issued by the New Mexico Environment Department (NMED) in March 2023 (NMED, 2023a). Permit Section 3.4 requires that NASA submit a comprehensive update to the RSMP to NMED each year by August 1. The RSMP update must set forth detailed methods, procedures, and schedules for groundwater monitoring to determine the progress and effectiveness of the PFTS and MPITS. This plan is used in conjunction with the updated WSTF Groundwater Monitoring Plan (GMP; NASA, 2024) to ensure adequate monitoring of groundwater remediation systems at WSTF.

Significant activities at the PFTS and changes that impacted the PFTS since the 2023 RSMP Update (NASA, 2023) include the following.

- NASA reactivated well PFE-1 in July 2023 following the completion of work to install a new submersible pump and motor, new power supply cable, and a new motor protection unit.
- NASA reactivated well PFI-2 in August 2023 following the completion of work to install a new submersible pump and motor and power supply cable.
- NASA reactivated well PFE-3 in September 2023 following the completion of work to install a new submersible pump and motor and power supply cable, and to replace a failed air compressor used to monitor water levels in the well.
- NASA shut down well PFE-2 between October 16 and November 7, 2023 to address false leak detection alarms caused by condensate in a section of dual wall piping.

Significant activities at the MPITS and changes that impacted the MPITS since the 2023 RSMP Update include the following.

- In September and October 2022, NASA investigated the source of fine rust particles entrained in the groundwater entering the MPITS and determined it to be extraction well MPE-8. During October 2022, system technicians pulled the pump, motor and Boreline hose from MPE-8 and noted that the hose had indications of heavy rust being present in the well. NASA performed a video inspection of MPE-8 on January 22, 2024 as part of ongoing work to evaluate options for well rehabilitation, repair, and/or replacement.
- In January 2023, NASA began shutting the MPITS down over weekends due to reduced groundwater extraction resulting from operational constraints and slow aquifer recovery. NASA continues to follow this practice to prevent excessive cycling of the MPE wells.
- NASA shut the MPITS down from November 28 to December 7, 2023 to perform scheduled maintenance of the UV photolysis reactor.
- On December 7, 2023, a component in the UV reactor chamber developed a leak of a vegetable oil based hydraulic fluid, which required the reactor to be disassembled, cleaned, and then reassembled. NASA restarted the MPITS back on January 11, 2024.

NASA completed the installation of a new totalizing flow meter for the infiltration basin on April 18, 2024 to improve system operations and monitoring.

National Aeronautics and Space Administration



Remediation System Monitoring Plan

July 2024

NM8800019434

NASA Johnson Space Center White Sands Test Facility

Remediation System Monitoring Plan

July 2024

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Timothy Davis Digitally signed by Timothy Davis
Date: 2024.07.23 12:23:44 -06'00'

Timothy J. Davis
Chief, NASA Environmental Office

See Electronic Signature
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

Executive Summary

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The use of trademarks or names of manufacturers is for accurate reporting and does not constitute an official endorsement either expressed or implied of such products or manufacturers by the National Aeronautics and Space Administration.

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µm	Micrometer
CAA	Central Accumulation Area
CFR	Code of Federal Regulations
COC	Contaminant of Concern
DP	Discharge Permit
EPA	Environmental Protection Agency
ft	Foot/feet
GMP	Groundwater Monitoring Plan
gpm	Gallons per minute
HDPE	High-density Polyethylene
HMI	Human-Machine Interface
HWB	Hazardous Waste Bureau
I&C	Instrumentation and Control
IDW	Investigation-derived Waste
mi	Mile(s)
MPCA	Mid-plume Constriction Area
MPE	Mid-plume Extraction
MPITS	Mid-plume Interception and Treatment System
NASA	National Aeronautics and Space Administration
NDMA	N-Nitrosodimethylamine
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
P&A	Plug and abandon
PFE	Plume Front Extraction
PFI	Plume Front Injection
PFTS	Plume Front Treatment System
PLC	Programmable Logic Controller
PMR	Periodic Monitoring Report
psi	Pounds per square inch
PVC	Polyvinyl Chloride
QA	Quality Assurance
RCRA	Resource Conservation and Recovery Act
RSMP	Remediation System Monitoring Plan
SAA	Satellite Accumulation Area
SCADA	Supervisory Control and Data Acquisition
scfm	Standard cubic feet per minute
T-C	Time-Concentration
TCE	Trichloroethene
TMRP	Targeted Mobile Remediation Process
TSDF	Treatment, Storage, and Disposal Facility
UV	Ultraviolet
VOC	Volatile Organic Compound
WSTF	NASA Johnson Space Center White Sands Test Facility

History of Revisions and Related Documents

Date	Revision or Document
January 20, 1999	Plume Front Stabilization Work Plan (PFSWP) submitted to NMED
March 15, 2000	PFSWP approved by NMED
May 16, 2002	Modification of PFSWP submitted to NMED - Plan was not approved by NMED
March 3, 2004	Plume Front Treatment System Project Plan (PFTSPP) submitted to NMED - Plan discussed technical issues raised in NMED Request for Supplemental Information dated April 4, 2003
July 15, 2004	Revised PFTSPP submitted to NMED
November 8, 2006	Revised PFTSPP submitted to NMED
May 14, 2007	Revised PFTS approved by NMED (Approval also included March 3, 2004 submittal)
October 30, 2008	Mid-plume Interception and Treatment System Monitoring Plan submitted to NMED
June 8, 2010	Plume Front Treatment System Monitoring Plan submitted to NMED
August 26, 2010	PFTSMP approved by NMED
July 29, 2011	2011 PFTSMP Update submitted to NMED
September 22, 2011	2011 PFTSMP update approved by NMED
July 31, 2012	Remediation System Monitoring Plan submitted to NMED (RSMP includes monitoring requirements for the PFTS and the MPITS)
September 11, 2012	RSMP approved by NMED
July 31, 2013	2013 RSMP Update submitted to NMED
September 27, 2013	2013 RSMP Update approved by NMED
July 30, 2014	2014 RSMP Update submitted to NMED
December 9, 2014	2014 RSMP Update approved by NMED
July 29, 2015	2015 RSMP Update submitted to NMED
September 16, 2015	2015 RSMP Update approved by NMED
July 28, 2016	2016 RSMP Update submitted to NMED
December 9, 2016	2016 RSMP Update approved by NMED
July 27, 2017	2017 RSMP Update submitted to NMED
December 1, 2017	2017 RSMP Update approved by NMED
August 14, 2018	2018 RSMP Update submitted to NMED
February 5, 2019	2018 RSMP Update approved by NMED
July 30, 2019	2019 RSMP Update submitted to NMED
December 11, 2019	2019 RSMP Update approved by NMED
August 3, 2020	2020 RSMP Update submitted to NMED
January 25, 2021	2020 RSMP Update approved by NMED

Date	Revision or Document
June 29, 2021	2021 RSMP Update submitted to NMED
November 15, 2021	2021 RSMP Update approved by NMED
July 29, 2022	2022 RSMP Update submitted to NMED
November 16, 2022	2022 RSMP Update approved by NMED with modifications that did not require a NASA response or revised RSMP
July 27, 2023	2023 RSMP Update submitted to NMED
February 6, 2024	2023 RSMP Update approved by NMED

1.0 Introduction

The White Sands Test Facility (WSTF) currently operates as a field test installation under the National Aeronautics and Space Administration (NASA) Lyndon B. Johnson Space Center. WSTF is a restricted access site, and all activities are industrial in nature. Although the primary purpose of the facility is to provide test services and support to NASA for the United States space program, services are also provided for the Department of Defense, Department of Energy, private industry, and foreign government agencies. WSTF operates several laboratory facilities that conduct simulated use tests for space vehicles and space station materials and compatibility testing.

WSTF is located approximately 18 miles (mi) northeast of Las Cruces, New Mexico. Figure 1.1 provides a vicinity map that shows the general location of WSTF relative to other dominant features and major properties in southern Doña Ana County. Groundwater at WSTF is contaminated as a result of historical operations at the site. Currently, there are no complete exposure pathways or human or ecological receptors. Downgradient public and WSTF water supply wells comprise potential future pathways for exposure to groundwater contamination. Under current conditions the nearest downgradient water use wells are WSTF water supply well K (Lower Rio Grande [LRG] 6369-S-2), WSTF water supply well M (LRG 6369-POD 4), WSTF water supply well J2 (LRG 6369-POD 5), and a private water well (LRG 6393) located downgradient of the plume and outside the westernmost WSTF boundary. Routine sampling of drinking water source water from well K and well M indicates that the WSTF water supply wells have not been impacted by WSTF groundwater contaminants. NASA has constructed and currently operates two voluntary interim measures that were designed to stabilize migration of the groundwater plume and to remove hazardous constituents from the groundwater. Figure 1.2 shows the conceptualized trichloroethene (TCE) and N-Nitrosodimethylamine (NDMA) plumes (the most extensive contaminants in WSTF groundwater) in relation to relevant site features.

The Plume Front Treatment System (PFTS) is a voluntary interim measure implemented to control threats to human health and the environment through stabilization and mass removal of groundwater contamination encountered at the leading (westernmost) edge of the WSTF groundwater contaminant plume. The plume is approximately 4 mi long and 1 mi wide at its widest point and has an average depth of 700 feet (ft). The PFTS is an ex-situ pump and treat system that includes six Plume Front extraction (PFE) wells and three Plume Front injection (PFI) wells. The six extraction wells (PFE-1, PFE-2, PFE-3, PFE-4A, PFE-5, and PFE-7) are located within and immediately west of the Western Boundary Fault Zone that separates the fractured bedrock pediment aquifer (east) from the southern Jornada del Muerto Basin alluvial aquifer (west). Groundwater from the extraction well system is treated by air stripping to remove volatile organic compounds (VOCs), filtration for particulate removal, and ultraviolet (UV) photolysis for NDMA oxidation. Remediated groundwater is injected using up to three PFI wells (PFI-2, PFI-3, and PFI-4) located to the west and south of the contaminant plume in accordance with Discharge Permit (DP) Renewal and Modification, DP-1255, issued by the New Mexico Environment Department (NMED) Ground Water Quality Bureau on May 17, 2023 (NMED, 2023b). The injection well locations are designed to mitigate future southern migration of the plume by creating a localized groundwater mound. This groundwater mound supports confinement of the groundwater plume to the northeast and counteracts the effects of drawdown from current and planned domestic and municipal supply wells to the south. Figure 1.2 shows the location of PFTS components in relation to the facility and geological features at WSTF.

The Mid-plume Interception and Treatment System (MPITS) is also a voluntary interim measure. The objective of the MPITS is to intercept and treat contaminated groundwater moving from the source areas in the WSTF industrial area toward the Plume Front area. The MPITS is installed within the Mid-plume Constriction Area (MPCA), a unique hydrogeological feature that constricts the flow of contaminated groundwater between the source areas and the Plume Front. The MPITS is an ex-situ pump and treat

system that operates with up to five Mid-plume extraction (MPE) wells (MPE-1, MPE-8, MPE-9, MPE-10, and MPE-11) to remove contaminated groundwater from the fractured bedrock aquifer in the MPCA. NASA plans to add wells MPE-3 and MPE-4 to the system; increasing the number of MPE wells to seven (Section 3.3). Extracted groundwater is treated by air stripping to remove VOCs, filtration for particulate removal, and UV photolysis for the oxidation of NDMA. Remediated groundwater is discharged to an infiltration basin located near the PFI wells in accordance with DP-1255. Figure 1.2 shows the location of MPITS components in relation to the facility and geological features at WSTF.

2.0 Treatment System Regulatory Requirements

This Remediation System Monitoring Plan (RSMP) was developed and will be updated annually in accordance with Section 3.4 of NASA's Resource Conservation and Recovery Act (RCRA) Permit (Permit), issued by the NMED Hazardous Waste Bureau (NMED; 2023a). The Permit requires the submittal of an updated RSMP to set forth detailed methods, procedures, and schedules for groundwater monitoring to determine the progress and effectiveness of the PFTS and MPITS.

NMED-issued DP-1255 (NMED, 2023b) provides the regulatory requirements for discharging treated groundwater from WSTF groundwater remediation systems. DP-1255 specifies that the treatment standards for groundwater contaminants of concern (COCs): NDMA, TCE, tetrachloroethene, and chloroform shall not exceed the concentrations for tap water from the most recent version of NMED's Risk Assessment Guidance for Site Investigations and Remediation Volume I, Table A-1 Soil Screening Levels (NMED, 2022). Table 2.1 provides the current effluent standards that must be achieved prior to the discharge of treated groundwater to the PFI wells or MPITS infiltration basin.

3.0 Treatment System Descriptions

The locations of the PFTS and MPITS are shown in Figure 3.1.

3.1 Plume Front Treatment System

The PFTS was designed to pump and treat VOC- and nitrosamine-contaminated groundwater. Original design flow rates for each extraction well were determined based on groundwater modeling that estimated the lowest sustained groundwater extraction rate capable of containing the plume and preventing significant movement in the westward direction. Original design injection well flow rates were determined in the same manner. Subsequent refinements to the groundwater model have shown that the response of the aquifer to continued pumping justifies lower extraction flow rates than those identified during PFTS design. NASA has reduced PFTS flow rates to optimize system performance while maintaining plume capture.

The system currently utilizes extraction wells to remove contaminated groundwater. The PFE wells are secured in concrete vaults with associated piping, equipment, and instrumentation. Appendix A provides the completion diagrams for the active PFE wells. Contaminated groundwater is transported from the PFE wells to the treatment plant via sub-grade, dual-wall, high-density polyethylene (HDPE) piping. A leak detection system monitors the annular space of the dual-wall piping, the well vaults, and the pipeline manholes. This system notifies operators with a local alarm and initiates a system shutdown if a water leak is detected.

The HDPE carrier pipeline transitions to single-wall carbon steel piping at the PFTS facility (Building 650). Polyphosphate is injected at this point to inhibit scale formation in the process equipment. The groundwater flow is split equally into the two air strippers for VOC removal. Water is pumped from

each air stripper sump and combined into a single steel header, which conveys the water through a cartridge filter set and then through the UV reactor to remove NDMA.

Following UV photolysis, the treated effluent is conveyed to the Injection Manifold Building (Building 651) via single walled HDPE pipe. There the flow is split into three streams that carry it to each of the respective injection wellheads. Like the PFE wells, the PFI wells are secured in concrete vaults with associated piping, equipment, and instrumentation. Appendix A provides the completion diagrams for the active PFI wells.

Building 650 is designed with a dropped floor and a floor sump that will contain significant leakage (approximately 9,120 gallons) from the piping, components, and/or treatment skids that could occur under emergency conditions. In addition, the finished floor of the electrical and control rooms is higher in elevation than the process area to prevent water from entering those rooms. A float switch in the sump triggers a system shutdown and operator notification in the event of leakage. A second higher float switch triggers a complete shutdown of power to all wells and buildings associated with the system. A pressure relief valve and rupture disc are installed in the piping upstream of the UV reactor to protect it from over-pressurization.

The following sections provide specific information about individual PFTS components or elements. The general PFTS layout is represented in Figure 3.2.

3.1.1 Air Stripper Information

Two sieve tray air strippers operate in a parallel configuration to treat VOCs in WSTF groundwater when the system runs at greater than half of the design flow capacity. A single air stripper can be used when the system operates at half design flow or less. Air enters the sump and travels upward through trays and water, exiting the top cover through a condensate trap. The air is discharged through vent stacks on the roof of Building 650. The air strippers must maintain an air flow rate between 3,600 standard cubic feet per minute (scfm) and 4,680 scfm in accordance with manufacturer's recommendations to ensure treatment of VOCs. Design parameters and target treatment goals are presented in Table 3.1. Historical monitoring has shown that all VOCs of interest, including those not regulated by DP-1255, are effectively removed by the air strippers. High-pressure washing, using potable water, is used to remove scale from the air stripper. The existing air stripper acid descaling system is no longer used but remains in place. The water and removed scale are collected in the air stripper sumps and subsequently removed by a portable vacuum pump. Scale cleaning is performed approximately semi-annually during scheduled PFTS maintenance events.

3.1.2 Water Filtration Unit

The water filtration unit consists of a pair of cylindrical stainless-steel vessels mounted on a skid located between the air strippers and the UV reactor in the treatment process. The filter vessels are operated using 1 micrometer (µm) filter elements. Each of the two filter vessels includes its own isolation valves and can accommodate full design flow of the plant. A single filter is in operation at any given time while the other remains isolated but ready for operation. Pressure transducers upstream and downstream of the filter vessels measure the differential pressure across the filters. Automated switchover control valves activate at 25 pounds per square inch (psi), and the system shuts down if the differential pressure exceeds 35 psi.

3.1.3 UV Reactor Information

The PFTS includes a Rayox®[1] UV reactor that uses UV photolysis to destroy nitrosamine compounds (specifically NDMA) in groundwater. The UV reactor is a vertical, cylindrical, stainless-steel vessel with 12 horizontally oriented UV lamps. It is designed to operate at a minimum hydraulic flow rate of 200 gallons per minute (gpm) and a maximum flow rate of 3,000 gpm. Contaminated groundwater enters at the bottom of the vessel, flows upward past the UV lamps, and exits the top of the reactor. The UV reactor contains four irradiance sensors placed at different elevations to measure irradiance in the vessel. The sensors initiate an alarm and then a shutdown if the average of these four irradiance sensor values drops below a specified set point required for complete treatment of NMDA. UV reactor design parameters are presented in Table 3.2. Historical monitoring has demonstrated that NDMA concentrations in groundwater are effectively reduced to levels below the DP-1255 treatment standards (NMED, 2023b) by the UV reactor.

3.1.4 Instrumentation and Control System

The treatment system is operated and monitored using a supervisory control and data acquisition (SCADA) system. The human-machine interface (HMI) consists of a Rockwell Automation®[2] FactoryTalk®[3] software program running on a Rockwell Automation server and stations. System operating and power usage data are collected by Rockwell Automation Historian and visualized with VantagePoint®[4]. The FactoryTalk Site Edition software displays operation information, allows operator adjustment to operational set points and configuration (with administrative privileges), provides alarm notifications, and performs data logging and reporting. Each programmable logic controller (PLC) on the control network is programmed in relay ladder logic to control independent operations of a particular skid or subset of the treatment system. Conventional hand controls are located on equipment skids, at well vaults, and in the injection manifold building for emergency and maintenance purposes. The control system also includes electrical power monitoring and metering capabilities. A summary of specific features, components, and operational capabilities is provided in Appendix B.

3.1.5 Alarms

The control system has a number of alarm conditions to identify and safeguard against malfunctions. Depending on the severity of the situation, the system may go into an amber or red alarm mode. During the amber alarm mode, the treatment system continues to function with the alarm condition(s) displayed. In the red alarm mode, a system shutdown is immediately initiated. Amber alarm conditions can transition into red alarm conditions based on the duration and alarm set points configured for the sensors. PFTS alarm conditions are presented in Appendix C.

3.2 Mid-plume Interception and Treatment System

The MPITS is a pump and treat facility designed to provide groundwater contaminant mass removal of the relatively high concentration of NDMA between the WSTF source areas and the Plume Front. The removal of the contaminants at the MPCA is intended to minimize migration of contaminants from the

[1] Rayox is a registered trademark of Calgon Carbon UV Technologies LLC.
[2] Rockwell Automation is a registered trademark of Rockwell Automation, Inc.
[3] FactoryTalk is a registered trademark of Rockwell Automation, Inc.
[4] VantagePoint is a registered trademark of Rockwell Automation, Inc.

source areas to the Plume Front area. The MPITS consists of groundwater extraction, treatment (for VOC and NDMA), and infiltration.

The system utilizes up to five extraction wells to remove contaminated groundwater from the MPCA. Appendix A provides the completion diagrams for the MPE wells, which are secured in above-ground enclosures. Contaminated groundwater is transported from the MPE wells to the MPITS facility (Building 655) through sub-grade dual-wall polyvinyl chloride (PVC) piping. A leak detection system monitors the well vaults and the pipeline manholes. This system notifies operators with a local alarm and initiates a system shutdown if a water leak is detected.

The PVC pipeline continues into the facility, where it transitions to single-wall PVC piping. Polyphosphate is injected into the influent for scale control in proportion to the flow rate and a static mixer is used to blend the polyphosphate with the groundwater. The groundwater is then directed to a surge tank that equalizes the flow rate prior to filtration. After passing through the filtration unit, the groundwater flow is routed through the air stripper to remove VOCs, through a second filtration unit, and through the UV reactor to destroy NDMA. Treated groundwater flows from the UV reactor to the infiltration basin through a single-wall HDPE pipeline.

The floor of Building 655 is provided with secondary containment for a volume equivalent to that in the treatment equipment and tanks installed in the building. In addition, the finished floor of the electrical and control rooms is higher in elevation than the process area to prevent water from entering those rooms. A float switch in the building's containment trench triggers a system shutdown and operator notification in the event of leakage.

The following sections provide specific information for individual MPITS components or elements. The general MPITS layout is represented in Figure 3.3.

3.2.1 Air Stripper Information

The MPITS includes a sieve tray air stripper designed to treat VOCs in WSTF groundwater. Air enters the sump and travels upward through trays and water, exiting the top cover through a condensate trap. The air is discharged through a vent stack on the roof of Building 655. Design parameters of the air stripper and its target treatment goals are presented in Table 3.3. Historical and ongoing monitoring shows that all VOCs of interest, including those not regulated by DP-1255, are effectively removed by the air stripper.

High pressure washing, using potable water, is used to remove scale from the air stripper. An existing air stripper acid descaling system is no longer used but remains in place. The water and removed scale are collected in the air stripper sump and subsequently removed by a portable vacuum pump. Scale cleaning is generally completed once a year, during scheduled MPITS maintenance events.

3.2.2 Water Filtration Unit

The MPITS includes three water filtration units. One is used to filter investigation derived waste, such as untreated groundwater, before it is placed in the MPITS surge tank and processed through the system. This unit consists of one stainless steel filtration canister with 20 µm filter elements.

Two additional water filtration units filter investigation-derived waste (IDW) and groundwater through the MPITS system using inline filter units. First, the flow is directed through a canister of 5 µm filters located between the surge tank and air stripper. After passing through the air stripper, groundwater is filtered by a second canister of 1 µm filters located between the air stripper and the UV reactor. Each of the two process filter units consists of two stainless-steel filter canisters. Only one canister is used at a

time. Flow is automatically switched to a clean canister when the pressure differential between filter influent and filter effluent exceeds preset limits. Automated switchover control valves activate at 25 (psi), and the system shuts down if the air stripper inlet pressure exceeds 67.5 psi.

3.2.3 UV Reactor Information

The MPITS includes a TrojanUVPhox®[5] reactor that uses UV photolysis to destroy nitrosamine compounds (specifically NDMA) in groundwater. The UV reactor is a horizontal, cylindrical, stainless-steel vessel with 72 horizontally oriented UV lamps. It is designed to operate at a minimum hydraulic flow rate of 20 gpm, which is maintained by periodic recirculation of treated water to supplement a lower volume of extraction well water at the system surge tank. The UV reactor contains one irradiance sensor to measure irradiance in the vessel. The UV system monitors physical parameters (flow, irradiance, transmittance, ballast power, number of operational lamps, age of lamps, etc.) to perform calculations that characterize NDMA destruction. The UV system can be operated in manual mode by adjusting the percentage of UV output, or in automatic mode where the control system automatically adjusts UV output to achieve adequate NDMA oxidation. UV reactor design parameters are presented in Table 3.4. Historical and ongoing monitoring has demonstrated that NDMA concentrations in groundwater are effectively reduced to levels below the DP-1255 treatment standards by the UV reactor.

3.2.4 Instrumentation and Control System

The treatment system is operated and monitored using a Rockwell Automation SCADA system. The HMI consists of a Rockwell Automation FactoryTalk software program running on a Rockwell Automation server and workstation. The system displays equipment and treatment system operation information, allows operator adjustment to a limited range of operational set points and configuration, provides alarm notifications, and performs data logging. The main PLC on the control network is programmed in Rockwell Automation RSLogix 5000®[6] relay ladder logic to control all functions of the process and interact with any subset of the treatment system even if the HMI is offline. Separate site-specific software applications and equipment are used to monitor electrical power. A summary of specific features, components, and operational capabilities is provided in Appendix D.

3.2.5 Alarms

The system is configured to monitor the process and activate an alarm when events outside of control parameters occur. Depending on the severity rating of the events, the system will log minor, major, or critical status with the process responding appropriately. All alarms are displayed on the HMI in addition to an event log that is used to troubleshoot the alarms and related sequence of events. A system shutdown is immediate when a major or critical alarm is activated. All other alarms provide advanced warning of an out of operational range event that requires attention but does not immediately affect treatability. MPITS alarm conditions are presented in Appendix E.

3.3 Planned PFTS Upgrades

NASA is performing and/or planning PFTS upgrade projects that will improve the operation and maintenance of the system. The currently approved groundwater treatment process (air stripping and UV

[5] TrojanUVPhox is a registered trademark of Trojan Technologies.
[6] RSLogix 5000 is a registered trademark of Rockwell Automation, Inc.

photolysis) will not be changed during the upgrade projects. Planned upgrades are summarized in this section.

3.3.1 PFTS UV Reactor

NASA plans to replace the existing UV reactor with a new UV reactor. The objective of this project is to replace old equipment with modern, energy efficient equipment. NASA is currently developing specifications for the new equipment and plans to begin the procurement process in August 2024. Manufacturing and delivery of the new equipment is expected to take approximately 48 weeks.

NASA anticipates the new equipment will be similar in design and operation to the UV equipment currently used in the MPITS. The fundamentals of the UV treatment process will not change. NASA will perform a treatment validation process on the new UV reactor prior to decommissioning the existing UV reactor.

3.3.2 Plugging and Abandonment of Injection Well PFI-1

NASA plans to plug and abandon (P&A) injection well PFI-1. This well discharged a large quantity of filter pack sand in December 2019. NASA discontinued use of the well and investigated the source of the filter pack sand. Two attempts were made to remove the pump, motor, and drop pipe, to facilitate a camera inspection of the well casing. Neither attempt was successful, leading NASA to conclude the pump and motor are sand locked within the casing. NASA concluded this failure is not repairable and plans to P&A the well.

A plugging plan will be submitted to the Office of the State Engineer (OSE), prior to beginning the P&A work. NASA will attempt to pump grout down the drop pipe, through the pump, and into the screened zone below the pump. The annular space between the casing and drop pipe will also be grouted. NASA plans to complete this work by December 2024.

NASA does not initially plan to replace PFI-1 with a new injection well. NASA recently lowered the overall PFTS flowrate; the three remaining injection wells (PFI-2, PFI-3, and PFI-4) have the capacity to handle the total flowrate at which the PFTS is currently operating.

3.3.3 PFTS Instrumentation and Control (I&C) System

NASA plans to upgrade the PFTS I&C system. The objectives of this project are to replace obsolete PLCs with modern equipment, simplify the design and operation of the I&C system, and improve its resilience to hot and dusty operating conditions. This will involve the replacement of components such as:

- Programmable Logic Controllers (PLCs) and associated input/output (I/O) modules
- Optical fiber modems
- Instrumentation cabinets or enclosures
- Other instruments and controls, as determined during the design process

This project is in the early stage of design. NASA anticipates completing the design in mid-2025 and completing the installation by mid-2026.

3.3.4 PFTS Effluent Equalization Tank

NASA plans to install an equalization tank (20,000 to 100,000 gallons, capacity to be determined) at the PFTS effluent upstream of the PFI wells to independently distribute effluent to each PFI well using the hydraulic pressure created by treated groundwater in the tank. The objectives of the effluent equalization tank are to ensure that PFI wellhead pressures remain constant, to deliver a consistent, uninterrupted flow of treated groundwater for injection at each PFI well, and to reduce injection well pressure influence at the treatment facility. This project is currently in the conceptual design phase.

3.3.5 PFI Wellhead Piping Improvements

Current PFI wellhead piping is enclosed in below-grade vaults, which require special access procedures that complicate maintenance and operation activities. NASA plans to reconstruct the PFI wellhead piping in above-grade enclosures to eliminate the need for confined space entry, co-locate injection well and backwash flow meters, and add equipment to improve and automate backwashing operations. Additionally, well control and monitoring instrumentation will be secure and protected from the environment. Because the PFI wellheads will be at ground level, maintenance and repair activities can be performed more quickly and safely than current operations performed in below-grade vaults. This project is currently in the conceptual design phase.

3.3.6 PFTS Influent Equalization Tank

NASA is considering installation of an influent equalization tank. The objectives of this tank include more consistent flow through the treatment process and more flexibility in starting and shutting down the treatment process (when needed). This project is currently in the conceptual design phase.

3.4 Planned MPITS Upgrades

NASA is planning two MPITS upgrade projects that are expected to increase the flow of contaminated groundwater through the MPITS and improve the pretreatment of MPITS influent. The currently approved groundwater treatment process (air stripping and UV photolysis) will not be changed during these projects. Planned upgrades are summarized in this section.

3.4.1 Addition of Well MPE-3 and MPE-4 to the MPITS

The original design of the MPITS included wells MPE-1, MPE-8, MPE-9, MPE-10, and MPE-11, with a predicted total flowrate of 83 gpm. NASA has determined the total sustainable yield of these five wells is approximately 10 gpm. Recognizing the difficulty in predicting the sustainable yield of wells in the MPCA, NASA plans to take a conservative approach in adding wells MPE-3 and MPE-4 to the MPITS. Initially, the wells will be equipped with submersible pumps and motors, powered by photovoltaic panels. Groundwater will be pumped into tank trailers, then transported to the MPITS building for unloading and treatment. The initial configuration of MPE-3 and MPE-4 will not have permanent electrical power, or a permanent connection to the existing pipeline. Instrumentation and controls will include totalizing flowmeters, water level sensors in the well and tank, and tank overfill protection. Water samples will be collected from each well, on the same frequency as the existing five MPE wells and analyzed for WSTF groundwater contaminants. NASA anticipates installing the pumping equipment in MPE-3 and MPE-4 by January 2025.

NASA plans to operate wells MPE-3 and MPE-4 in this initial configuration for up to 2 years. During that period, pumping rates and aquifer water levels will be measured to develop an estimate of the sustainable yield of these wells. The contaminant mass removal from each well will also be evaluated. Upon

completion of this evaluation period, NASA will determine whether the well's sustainable yield and mass removal are sufficient to justify the installation of permanent electrical power and/or a pipeline.

NASA is not planning further bench or pilot scale testing because the original MPITS design easily accommodates the additional groundwater flow anticipated from wells MPE-3 and MPE-4. The existing air stripping and UV photolysis equipment will not be modified or replaced.

3.4.2 Addition of Solids Separation Pre-treatment Process to the MPITS

Currently, NASA uses approved polymers to partially remove solids from IDW managed at the MPITS prior to its introduction into the system. Final solids removal is completed through the use of the existing filtration system. NASA plans to improve the solids removal process by adding pre-treatment of IDW. NASA performed engineering studies of extraction well and IDW solids accumulation and developed a conceptual design of a solids separator to accommodate IDW. The design includes a potential inclined settler that would require the addition of approved polymers to enhance separation. Additionally, NASA reviewed optional centrifugal and flat-plate separators for potential use at the MPITS. Further research is required due to the variability of solids concentration and composition. This project is currently in the conceptual design phase.

4.0 Remediation System Operational Procedures

Procedures for the operation of the PFTS and MPITS are contained in site-specific documents. These documents contain instruction for routine start-up, operation, inspection, and maintenance of the facilities, as well as emergency shutdown and contingency procedures. The documents are updated regularly to reflect changes in operation due to lessons learned during system operations, updated system configurations or control system upgrades, and to add or remove information to keep the documents current. Remediation system operations, anomalies, and related information are recorded in the appropriate system logs and retained as part of the operational record. All documents and records are managed in accordance with established NASA procedures.

5.0 Waste Management Practices

Non-hazardous, hazardous, and universal wastes are generated during operation and maintenance of the PFTS and MPITS. Groundwater IDW generated during well installation, maintenance, and sampling activities at WSTF is accumulated in either a Central Accumulation Area (CAA) or a Satellite Accumulation Area (SAA) prior to treatment and discharge in accordance with DP-1255 (NMED, 2023b). All wastes are properly managed per 20.4 or 20.9 New Mexico Administrative Code (NMAC) and the applicable parts of 40 Code of Federal Regulations (CFR), Subchapter I. Additionally, the procedures for waste management at WSTF are contained in the most current version of the WSTF Waste Management Manual. Any off-site contractor-generated wastes will be managed in accordance with site waste management practices and all applicable federal, state, and local regulations. New waste streams will be characterized prior to generation in accordance with applicable state and federal regulations.

The basic management practices for current hazardous and universal waste streams are provided below.

- Contaminated groundwater IDW generated from site-wide well and remediation system activities is accumulated in Department of Transportation-compliant containers and managed in SAAs (20.4.1.300 NMAC and 40 CFR 262.15) or CAAs (20.4.1.300 NMAC and 40 CFR 262.17). Field-portable "empty-daily" waste containers used during well sampling activities are managed within an SAA and the container is emptied at the end of the work shift at a CAA. Containerized contaminated groundwater is transported to, processed through the MPITS, and discharged in accordance with DP-1255 (NMED, 2023b).

- Environmental investigation decontamination rinsate is containerized and managed as hazardous waste and managed under the SAA or CAA provisions before being transported to and processed through the MPITS in accordance with DP-1255 (NMED, 2023b).
- Gloves, wipes, and other debris (40 CFR 268.2(g)) that has contacted contaminated groundwater or other materials contaminated with IDW residues are managed as hazardous waste. Contaminated debris is managed at an SAA and transferred to a CAA pending off-site shipment and disposal at a permitted RCRA Treatment, Storage, and Disposal Facility (TSDF).
- Spent water filters exposed to VOC-contaminated groundwater are managed at the point of generation in an SAA or CAA and subsequently shipped off-site for disposal at a permitted RCRA TSDF.
- Spent UV lamps are managed as universal waste for eventual off-site disposal in accordance with 40 CFR 273. Damaged UV lamps are managed as characteristic hazardous waste (D009) and properly managed and disposed at a permitted RCRA TSDF.
- Spent scale cleaning solution is managed as a hazardous waste and processed through the MPITS. This waste stream may be subject to elementary neutralization under 40 CFR 260.10 prior to introduction to the MPITS in accordance with DP-1255 (NMED, 2023b).
- Wastewater from pressure washing remediation system air strippers is stored in appropriate accumulation container(s) and managed under the SAA or CAA provisions before being transported to and processed through the MPITS. Solids generated from cleaning the air strippers are managed as a hazardous waste and disposed of properly at a permitted RCRA TSDF.
- Discarded groundwater samples containing chemical preservative or reagent not permitted to be discharged in accordance with DP-1255 are managed as a hazardous waste in an SAA or CAA prior to being sent off-site for disposal at a permitted RCRA TSDF.

Non-hazardous wastes generated at the remediation systems are managed as described below.

- Debris that has not contacted contaminated groundwater or other materials contaminated with groundwater residues is managed onsite in accordance with the New Mexico State-approved Solid Waste Management Program and is disposed of at a RCRA Subtitle D landfill.
- Spent water filters used downstream of the air-strippers at the PFTS that have not been exposed to VOC-contaminated groundwater are allowed to air dry and are then disposed of at a RCRA Subtitle D landfill.
- Water produced from the uncontaminated aquifer during PFTS injection well backwashing or from other maintenance activities downstream of the treatment process. This water may be discharged to grade in accordance with DP-1255 (NMED, 2023b) or other regulatory approval documents.

6.0 Treatment System Monitoring

The following sections describe monitoring activities that are used to characterize the performance of the PFTS and MPITS and to demonstrate their effectiveness.

6.1 Treatment System Well Performance

The instrumentation and control systems for the PFTS and MPITS continually monitor and intermittently log pertinent operational parameters related to the performance of the extraction and injection wells. These parameters include extraction and injection volumetric flow rates, extraction pump power-related

parameters (including current and voltage), and the water level in each extraction and injection well. The specific capacity for each extraction and injection well is calculated utilizing water levels and flow rates. The long-range trending of the specific capacities is reviewed and evaluated as an indicator of overall extraction and injection well health. Decreases in specific capacity that cannot be corrected by simple backwashing operations may warrant consideration of well rehabilitation or replacement.

6.1.1 Well Operational Parameters

Extraction and injection well performance and conditions are monitored routinely using two primary methods:

- Flow rate versus drawdown or mounding measurements (specific capacity).
- Power parameters related to the operation of pumps (current, voltage).

6.1.2 Miscellaneous "On Demand" Parameters

When operational problems occur, additional operations may be performed to better diagnose the nature of the problems and to determine subsequent remedial actions. For example:

- Downhole video logs may be performed (when practical) to provide visual verification of a well's condition.
- Physicochemical parameters may be collected to predict scaling and corrosive conditions and plot environmental change (when practical).
- Water level measurements may be obtained from groundwater monitoring wells and/or piezometers to help determine the impact of the remediation systems on the surrounding aquifer.
- Biological testing may be performed to determine the nature and abundance of microorganisms associated with biofouling.

6.2 Extraction and Injection Well Maintenance and Rehabilitation

NASA has developed and uses internal procedural documentation to address remediation well performance evaluation, rehabilitation, and repair if necessary. This procedural documentation presents decision points and corrective actions related to the well performance decline.

During normal operations, clogging of the aquifer around the wellbore may occur due to the alignment of formation fines, buildup of biological encrustation or slime, air entrainment (injection wells), or scaling (injection wells). Remediation system engineers regularly monitor the water level during injection. When a high water level set point is reached, a backwashing event is scheduled. The high water level set point ranges from 280 to 302 ft below ground surface in the injection wells. A second set point would be invoked if the water level was to rise to within 140 to 162 ft of ground surface, in which case all of the extraction and injection wells automatically shut down. These set points provide a factor of safety for injection well operation, independent of specific capacity. NASA continues to inject all water extracted and treated by the PFTS (with the exception of backwash water discharged to grade). This is the primary measure of injection well effectiveness.

Backwashing is used at the injection wells to break up and/or dislodge potential blockages. This is accomplished by taking the well offline and backwashing with the dedicated pump installed in the well. Backwashing requires a day or less to perform per well and typically results in only short-term benefits. Backwashing addresses only the area in the wellbore immediately adjacent to the pump intake; however,

it has shown to be an effective means of maintaining well capacity in between more comprehensive well rehabilitation events. Backwashing, or over-pumping, at the extraction wells has not been necessary because clogging of the aquifer around the extraction wells has not been detected. This technique may be utilized at extraction wells in the future to alleviate clogging, if necessary.

When well backwashing maintenance ceases to be effective in restoring production capabilities due to more widespread or intense aquifer clogging, well rehabilitation may be required. Well rehabilitation involves removing the existing piping, equipment, and pumps from an affected well so that specialized equipment can be utilized to impact the aquifer throughout the entire screened section of the well. This more intense maintenance typically requires several days to weeks to perform and utilizes a specialized set of rehabilitation equipment supplied and operated by subcontractors. The most recent comprehensive rehabilitation of the injection wells was conducted in September 2021. The motors in wells PFI-2 and PFI-4 were replaced, and a limited rehabilitation was performed in those wells in April 2023. With the exception of well PFI-1 previously discussed, NASA does not anticipate the need to abandon and replace extraction or injection wells.

6.3 MPITS Infiltration Basin Maintenance

Major scheduled maintenance is not required at the MPITS infiltration basin. Visual inspection of sediment accumulation, slope stability, and overall basin condition is conducted monthly. Trash and debris are removed, and periodic weed control is performed when required. Solid removal and scarification may be conducted if ponding reaches unacceptable levels.

6.4 Remediation System Groundwater Monitoring

To ensure adequate treatment of contaminated groundwater as specified in this Plan and DP-1255 (NMED, 2023b), groundwater is sampled at various points in the PFTS and MPITS and analyzed for appropriate COCs. The overall performance of the systems is monitored by collecting and analyzing groundwater samples from the remediation system influent and effluent, PFE wells, and MPE wells.

6.4.1 Remediation System Influent and Effluent

The PFTS and MPITS are equipped with sampling ports to facilitate collection of groundwater samples at various points in the treatment processes. At both systems, influent sampling ports (B650-INF-1 and B655-INF-1, respectively) are located on the influent piping immediately upstream of treatment system components to monitor influent characteristics. Effluent sampling ports (B650-EFF-1 and B655-EFF-2, respectively) are located immediately downstream of the UV reactors to monitor effluent characteristics. These sampling ports are located directly on the process piping and consist of stainless-steel manual valves with stainless steel discharge tubing. Remediation system influent and effluent are sampled monthly for the analysis of NDMA and VOC by the most appropriate analytical method as described in the Groundwater Monitoring Plan (GMP; NASA, 2024).

6.4.2 Remediation System Extraction Wells

Individual extraction wells are also equipped with sampling ports, which are constructed in a manner similar to the influent and effluent ports. Extraction well sampling ports are installed on the process piping in the PFE well vault or MPE well housing downstream of the wellhead. PFE and MPE wells are sampled at least quarterly for analysis of NDMA and VOC by the most appropriate analytical method as described in the GMP (NASA, 2024). More frequent sampling may be performed during periods of system reconfiguration, troubleshooting, or other testing to monitor system performance and ensure adequate treatment of contaminated groundwater.

6.5 Related Groundwater Monitoring

Groundwater monitoring is also performed outside the PFTS and MPITS as part of NASA's comprehensive groundwater monitoring program. This sampling supports remediation system monitoring and evaluation. Groundwater monitoring is directed by the GMP, which identifies the groundwater monitoring wells, the frequency of sampling, and the analyses to be performed.

6.5.1 Groundwater Monitoring Wells

Groundwater monitoring wells used to determine the effectiveness of the PFTS and MPITS are described in detail in the GMP (NASA, 2024). Plume Front and sentinel monitoring wells/zones are sampled at varying frequencies depending on their location in the plume, proximity to the PFTS, and intended use in the groundwater monitoring and remediation program. Most MPCA monitoring wells/zones are sampled at least semi-annually in accordance with the GMP (NASA, 2024). As with PFE and MPE wells, more frequent sampling may be performed during periods of system reconfiguration, troubleshooting, or other testing to monitor system performance and ensure adequate groundwater treatment. At a minimum, groundwater monitoring wells used for PFTS and MPITS monitoring are sampled for analysis of NDMA and VOC by the most appropriate analytical method as described in the GMP (NASA, 2024).

6.5.2 Groundwater Elevations

Groundwater elevations measured at monitoring wells and piezometers provide information required to evaluate the potentiometric surface, contaminant plume geometry, and groundwater model calibration. Groundwater elevations collected from monitoring wells at the westernmost edge of the monitoring well network also provide information that is used to evaluate the potential impact of regional aquifer pumping that may affect WSTF groundwater contaminant plume migration. At a minimum, groundwater elevations are measured each time a monitoring well is sampled. Additional measurements are collected as required to ensure adequate groundwater elevation data are available to support ongoing remediation system monitoring and performance evaluations.

The potentiometric surface map is used to interpret the effects of remediation system pumping on the Plume Front alluvial aquifer and the localized MPCA fractured rock aquifer. Individual extraction well drawdown and radii of influence are evaluated when the remediation system operational configuration allows for the collection of the data required to perform this analysis.

In general, performance will be evaluated as recommended in Environmental Protection Agency (EPA) guidance stressing "multiple lines of evidence" (EPA, 2002, 2008). A summary of plume capture evaluation exercises is provided in routine Periodic Monitoring Reports (PMR) as specified in Section 8.0. A more detailed evaluation of plume capture is provided in the comprehensive PMR, submitted annually to the NMED Hazardous Waste Bureau (HWB). Additional information related to the collection and use of groundwater elevations for evaluating remediation system performance is provided in the GMP (NASA, 2024).

7.0 Remediation System Performance Evaluation

Remediation system performance is evaluated on a regular basis to assess whether adjustments to operational parameters and configurations are warranted to maintain or improve system operation.

7.1 Interim Measures Treatment System Goals

The goal of the PFTS is the stabilization of contaminant plume migration and COC mass reduction. Numerical flow and transport modeling extrapolated for over 40 years indicate that further migration of the plume is being arrested. Due to the anticipated duration of this corrective action, NASA and NMED have not agreed to a specific exit strategy. Future progress will assist in the formulation of an effective strategy based on contemporary operational data.

The current primary objective of the MPITS is to intercept and treat contaminated groundwater moving from the source areas in the WSTF industrial area towards the Plume Front area, effectively cutting off the continued supply of contaminated groundwater to the Plume Front. Data from MPITS operation thus far indicates that a hydraulic sink has been created in the area near the MPITS extraction wells. This is evident by measured water level elevations downgradient of the extraction wells that have declined up to 30 ft since MPITS operation began. The presence of this hydraulic sink is favorable evidence that the MPITS is intercepting and treating contaminated groundwater at the MPCA. The MPITS is also used to treat and dispose of IDW generated during well sampling and testing activities.

7.2 Definition of Capture Zone

NASA continues to use groundwater modeling and particle tracking simulations to evaluate the PFTS capture zone. The three-dimensional target capture zone for the COCs that drive the Plume Front health risk assessment has historically been defined by the location of the TCE plume, which is the most extensive groundwater contaminant at WSTF. The current capture zone is defined as the furthest extent of the TCE and NDMA groundwater contaminant plumes. The extent of each plume is defined by the iso-concentration line that corresponds to the cleanup up level for each contaminant.

Over time, the dimensions and extent of the plume will change due to PFTS operation and changes in the groundwater gradient caused by off-site pumping. As the plume evolves, the target capture zone may be adjusted to prevent increases in risk to human health and the environment. As part of this process, ongoing analyses and potentiometric surface evaluations are performed to maintain current estimates of plume position, contaminant mass, and rates of removal.

7.3 Remediation System Effectiveness

PFTS and MPITS effectiveness is evaluated by comparing the results of effluent sampling and analysis described in Section 6.3, to the DP-1255 treatment standards in Table 2.1. Fundamentally, the PFTS is considered effective if effluent concentrations meet discharge requirements and a plume capture evaluation indicates continued stability of the contaminant plume. The MPITS is considered effective if effluent concentrations meet treatment standards.

In addition to direct comparisons of analytical data to treatment standards, contaminant mass removal is estimated by comparing average influent and effluent concentrations for select COCs over time. Average concentrations in the influent and effluent will be combined with the measured volume of treated groundwater to estimate mass removal during a specific time interval. Although not a specific measurement of remediation system effectiveness, concentrations of COCs in groundwater samples collected from individual extraction wells and system influent are also periodically evaluated as an indicator of plume dynamics.

Several techniques are utilized to determine the effects of the operation of the remediation systems on the aquifer and contaminant plume. These techniques include a comprehensive evaluation of groundwater elevations through the use of potentiometric surface maps, a thorough assessment of groundwater

chemical analytical data using time-concentration (T-C) plots and plume iso-concentration maps, the preparation and interpretation of a numerical groundwater model, and where practical, the evaluation of tracer test results. These tools are described in the sections below.

7.3.1 Potentiometric Surface Map

Measured groundwater depths are converted to piezometric elevations and plotted on a base map for the purpose of evaluating the effect of extraction wells on local groundwater flow paths. Piezometric elevations are determined for selected PFTS and MPITS groundwater monitoring wells by manually measuring the water level in conventional monitoring wells, calculating the piezometric elevation of target monitoring zones within Westbay®[7] multiport wells based on the groundwater formation pressures measured at those zones, and obtaining groundwater depth data from pressure transducers installed within Water FLUTe™ multiport wells. Groundwater elevations from Westbay and Water FLUTe wells are calculated using pressure data from the uppermost sampling ports proximal to the water table using Westbay pressure profile equipment and pressure transducers. These operations are conducted in accordance with the site-specific procedural documentation previously identified.

The potentiometric surface map is hand contoured by a qualified geologist. Automated contouring software may also be used to help develop the map. The results of the automated method are analyzed and modified or replaced by hand contouring if appropriate. The method used to produce the potentiometric surface is identified on the potentiometric surface map.

7.3.2 Time-Concentration Plots

Groundwater analytical data are presented as T-C plots for targeted groundwater monitoring wells or zones in the Plume Front area or MPCA. Historical analytical data used to populate the time-concentration plots are available through the WSTF groundwater analytical database, generally included with each PMR. The following guidelines and considerations will be observed during the construction of T-C plots:

- Groundwater monitoring wells used for the development of T-C plots are designed in accordance with the applicable EPA/NMED point source monitoring guidance.
- T-C plots for the monitoring wells use each sampling dataset collected following installation of the well through the most recent available data.
- Analytical data are typically evaluated for hazardous constituents regulated under DP-1255.
- The selection protocol for analytical data includes using the highest concentration for qualifying samples collected during a sampling event at each well. Analytical results for use in a T-C plot are selected giving priority to analytical methods with greater accuracy and consider any qualified data.
- Non-detect results are reported at one half of the method detection limit concentration and plotted with a different symbol than detections for plume evaluation functionality, a visualization not intended for risk assessment or statistics. Non-detects in the latter context would be reported as less than limit of detection.

Due to changes in the off-site laboratory utilized to analyze groundwater samples, method detection limits for some analytes may change over reporting periods. Some of the subtle fluctuations in T-C plots may be

[7] Westbay is a registered trademark of Nova Metrix Ground Monitoring (Canada) Ltd.

the result of changing analytical technology. Other trends in contaminant concentrations may be identified as irregular responses to WSTF operations. Trends or patterns in the data will meet the general criteria that: several T-C plots (using data from several sampling events) supported the trend; the change in concentration is significant (typically an order of magnitude); and several contaminants within the location responded with similar trends. Irregularities in T-C plots that are not identified as responses to operations typically require additional data points and a greater change between recent concentrations and historical data.

7.3.3 Plume Iso-concentration Maps

Iso-concentration maps for COCs are primarily developed manually but may also use automated contouring software with the most recent analytical data available for each well. Automated contouring methods are not used for maps generated for the MPCA. Hand drawn contour maps are provided for the MPCA to allow for technical interpretation of hydrogeological features. Consideration of hydrogeological conditions, such as differing hydrostratigraphic units or significant structural features that cause the juxtaposition of variable hydraulic conductivities, may provide a more realistic representation of the contaminant plume.

Guidelines recommended for the selection and presentations of analytical data are as follows:

- The analytical data from MPCA monitoring wells are reviewed for the analytes regulated by DP-1255 (NMED, 2023b). NDMA data are evaluated at the nanograms per liter concentration level based on its toxicity and importance relative to health risk evaluation. The remaining contaminants will be evaluated at the microgram per liter concentration level.
- Data processed through the WSTF quality assurance (QA) system during each reporting period are utilized for contouring. Priority is given to analytical methods with greater accuracy, and flagged data points are considered individually. The selection protocol uses the highest concentration for qualifying samples.
- The most recent analytical results available are utilized for contouring (including any wells for which no analytical data were available during the reporting period).
- When duplicate samples or multiple sampling results are available for a specific monitoring well or sampling point, the maximum concentration is utilized in accordance with WSTF convention for contouring using the most conservative approach.
- For multiport monitoring wells, the maximum contaminant concentration from any sampling zone within the well is used in accordance with WSTF convention for contouring using the most conservative approach.
- For conventional well clusters or closely adjacent monitoring wells, the most recent maximum contaminant concentration for the well group is used in accordance with WSTF convention for contouring using the most conservative approach.
- Analytical data from extraction wells may be considered for the plume evaluation even though these wells are non-compliant for point source monitoring purposes due to the extended screened intervals. In general, data obtained from extraction wells are utilized for engineering purposes only.
- Automated and manually constructed maps utilize the same analytical data sets.
- Contaminant plume iso-concentration plots do not represent a single horizontal layer or horizon within the contaminant plume, but a cumulative representation of the maximum values recorded over the sampling period at all depths.

7.3.4 Groundwater Modeling

Groundwater modeling simulations comprise an essential component of presenting the conceptual model of the contaminant plume. Particle tracking analyses are conducted for NDMA and TCE to evaluate the ability of the PFTS to achieve its design objectives. Particle tracking is performed using MODPATH software in conjunction with the WSTF groundwater flow model.

Due to the complexity of fractured bedrock and the proximity between flow pathways, the flow model was not developed to support the design of the MPITS relative to optimizing remediation well placement and system flow rates. However, it can be utilized to obtain generalized information on the effect of the MPITS as it relates to the behavior of the conceptualized plume on a larger scale at WSTF. With respect to the MPCA and MPITS operation, the WSTF groundwater model is used primarily as a support tool that assists with understanding large-scale plume behavior and contaminant movement through the fractured bedrock aquifer using the equivalent porous media approach.

7.4 Activity and Changes at Sentinel Wells

Monitoring wells utilized as sentinel wells for evaluation of plume capture are described in the GMP (NASA, 2024). As indicated in that plan, routine monitoring supports the evaluation of PFTS effectiveness. Anomalies detected at sentinel wells may trigger additional sampling for confirmation purposes. If contaminant increases are verified through multiple sampling events, then changes to PFTS operation or even additional extraction wells to arrest plume migration will be considered. Due to the slow rate of groundwater migration in the Plume Front area, any proposed action to address contaminant increases at sentinel wells will proceed after thorough consideration and consultation with NMED.

7.5 Plume Capture Evaluation Methodologies

A comprehensive plume capture evaluation is performed annually to determine if the remediation systems are achieving the overall objectives of plume stabilization and interception. An effective plume capture evaluation is based on the six steps described in “Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems” (EPA, 2008). These steps are:

- Review site data, site conceptual model, and remedy objectives.
- Define site-specific Target Capture Zone(s).
- Interpret water levels.
- Perform calculations and groundwater modeling.
- Evaluate concentration trends.
- Interpret actual capture based on steps 1-5, compare to Target Capture Zone(s), and assess uncertainties and data gaps.

The scope of the EPA document is limited to evaluating capture in porous media (PFTS) and not necessarily fractured rock (MPITS), but the methods and techniques described in the EPA guidance are applied towards the evaluation of the effectiveness of MPITS contaminant interception, where possible. Results of plume capture evaluations are provided in the comprehensive PMR described below.

8.0 Reporting

Information related to remediation system operation and monitoring is provided to NMED in the scheduled correspondence described below. The GMP provides the schedule for the submittal of these reports, along with more detailed descriptions (NASA, 2024).

- Monthly Environmental Activity Report, which summarizes remediation system operation, maintenance, and significant activities.
- "Routine" PMR, which includes chemical analytical data that were processed through the WSTF QA system during the reporting period. These PMRs also include brief discussions of groundwater monitoring and remediation activities and summarize the results of groundwater and remediation system monitoring.
- Comprehensive PMR, which includes additional data and a more comprehensive evaluation of corrective measures. This PMR includes a complete evaluation of contaminant plume capture and detailed results of remediation system monitoring.

9.0 Schedule for Review and Revision of the Plan

The RSMP will be reviewed and revised annually. Annual revisions will be submitted to the HWB on or before August 1 and are not considered Permit modifications.

10.0 References

Adoption of 40 CFR Part 262, Environmental Improvement Board, 20.4.1.300 NMAC (12/1/18).

EPA. (2002, December). *Elements for Effective Management of Operating Pump and Treat Systems*. EPA/542/R-02/009.

EPA. (2008, January). *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat System*. EPA/600/R-08/003.

Hazardous Waste, Environmental Improvement Board, 20.4 NMAC (12-1-18).

NASA Johnson Space Center White Sands Test Facility. (2022, March 8). *NASA WSTF Targeted Mobile Remediation Process Pilot Test Report*. Las Cruces, NM.

NASA Johnson Space Center White Sands Test Facility. (2023, July 27). *NASA WSTF Remediation System Monitoring Plan Annual Update for 2023.* Las Cruces, NM.

NASA Johnson Space Center White Sands Test Facility. (2024, April 29). *NASA WSTF Groundwater Monitoring Plan Update for 2024*. Las Cruces, NM.

NMED Hazardous Waste Bureau and Ground Water Quality Bureau. (2022, November). *Risk Assessment Guidance for Site Investigations and Remediation Volume I Soil Screening Guidance for Human Health Risk Assessments*. Santa Fe, NM.

NMED Hazardous Waste Bureau. (2023a, March 28). *RCRA Permit EPA ID # NM8800019434*. Santa Fe, NM.

NMED Ground Water Quality Bureau. (2023b, May 17). *Discharge Permit Renewal and Invoice, DP-1255, NASA White Sands Test Facility, Plume Front Treatment System (PFTS) and Mid-plume Interception and Treatment System (MPITS)*. Santa Fe, NM.

Solid Waste, Environmental Improvement Board, 20.4 NMAC (12-1-18).

Tables

Table 2.1 DP-1255 Discharge Standards

Contaminant	Standard
NDMA	4.2 ng/L
TCE	5 µg/L
PCE	1.1 µg/L
Chloroform	1.9 µg/L

Table 3.1 PFTS Air Stripper Performance Specifications		
Criteria	**Specification**	
Total Hydraulic Flow Rate	1,250 gpm	
Hydraulic Flow Rate per Air Stripper	625 gpm	
Maximum Run Time	24 hours per day 365 days per year	
Design Life	>15 years	
Air Temperature	Minimum Annual Average Maximum	-13 ºC 17 ºC 44 ºC
Influent Water Temperature	15 to 20 ºC	
Site Elevation	4,500 ft above mean sea levels (AMSL)	
Expected Influent Concentrations	TCE PCE Chloroform	130 µg/L 4.2 µg/L <1 µg/L
Effluent Standards	See Table 2.1	

Table 3.2 PFTS UV System Performance Specifications		
Criteria	**Specification**	
Total Hydraulic Flow Rate	200-3,000 gpm	
Maximum Run Time	24 hours per day 365 days per year	
Design Life	>15 years	
Maximum System Pressure	100 psig	
Maximum Pressure Drop	10 psig	
Site Elevation	4,500 ft AMSL	
Expected Influent Concentrations	NDMA	2,000 ng/L
Effluent Standards	NDMA	See Table 2.1

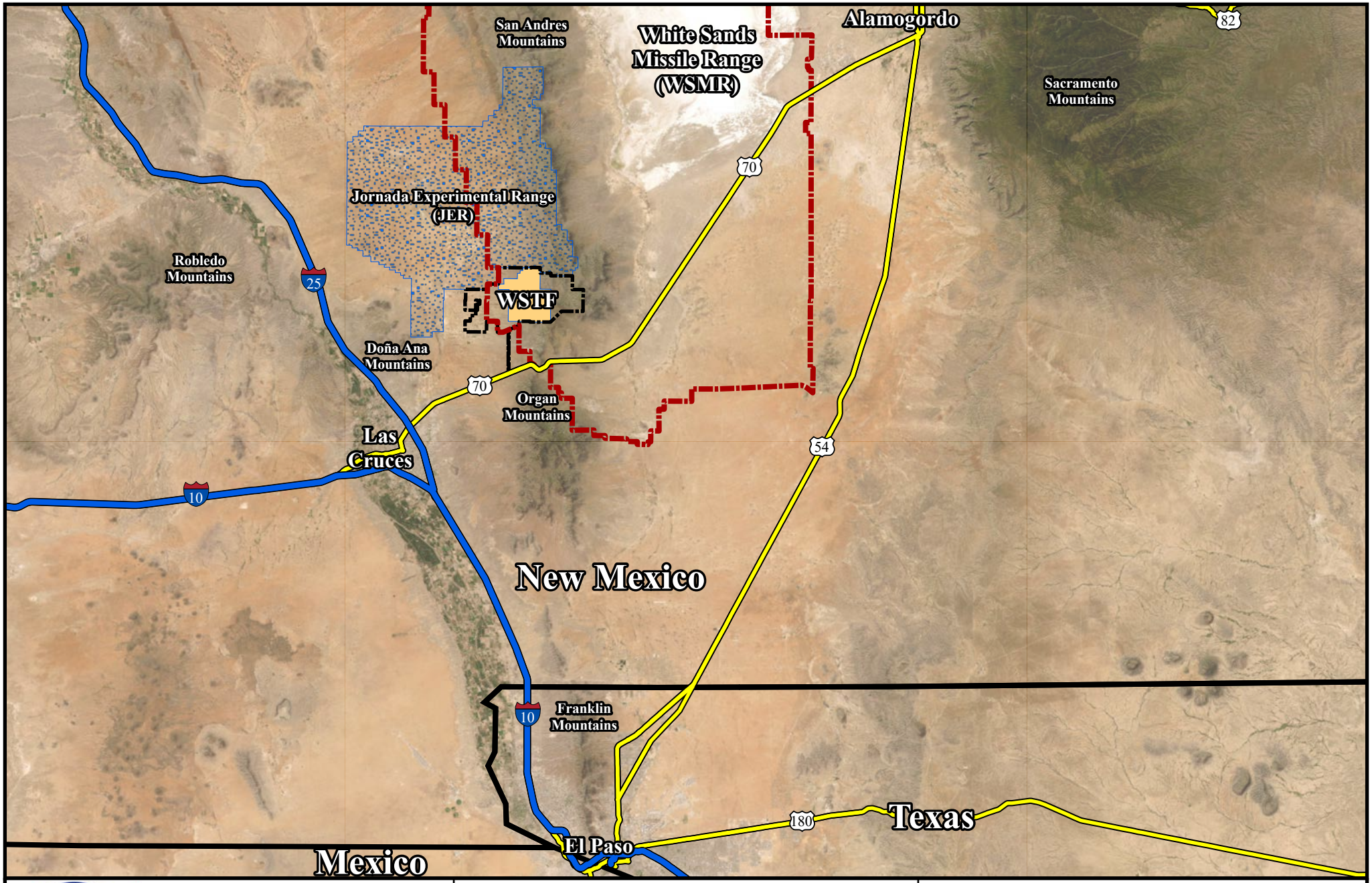
Table 3.3 MPITS Air Stripper Performance Specifications		
Criteria	**Specification**	
Total Hydraulic Flow Rate	20-125 gpm	
Maximum Run Time	24 hours per day 365 days per year	
Design Life	>15 years	
Air Temperature	Minimum Annual Average Maximum	-13 ºC 17 ºC 44 ºC
Influent Water Temperature	15 ºC	
Site Elevation	4,500 ft AMSL	
Expected Influent Concentrations	TCE PCE Chloroform	140 µg/L 6.4 µg/L <1 µg/L
Effluent Standards	See Table 2.1	

Table 3.4 MPITS UV System Performance Specifications		
Criteria	**Specification**	
Total Hydraulic Flow Rate	20-125 gpm	
Minimum Flow Rate	20 gpm	
Maximum Run Time	24 hours per day 365 days per year	
Design Life	>15 years	
Maximum System Pressure	65 psig	
Maximum Pressure Drop	10 psig	
Site Elevation	4,500 ft AMSL	
Expected Influent Concentrations	NDMA	25,500 ng/L
Effluent Standards	NDMA	See Table 2.1

Figures

Figure 1.1 **WSTF Location Map**

(SEE NEXT PAGE)



N
W E
S

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July 2024

Edited by: srees

- WSMR Boundary
- WSTF Boundary
- Jornada Experimental Range (JER)
- WSTF Industrial Area

WSTF Location Map

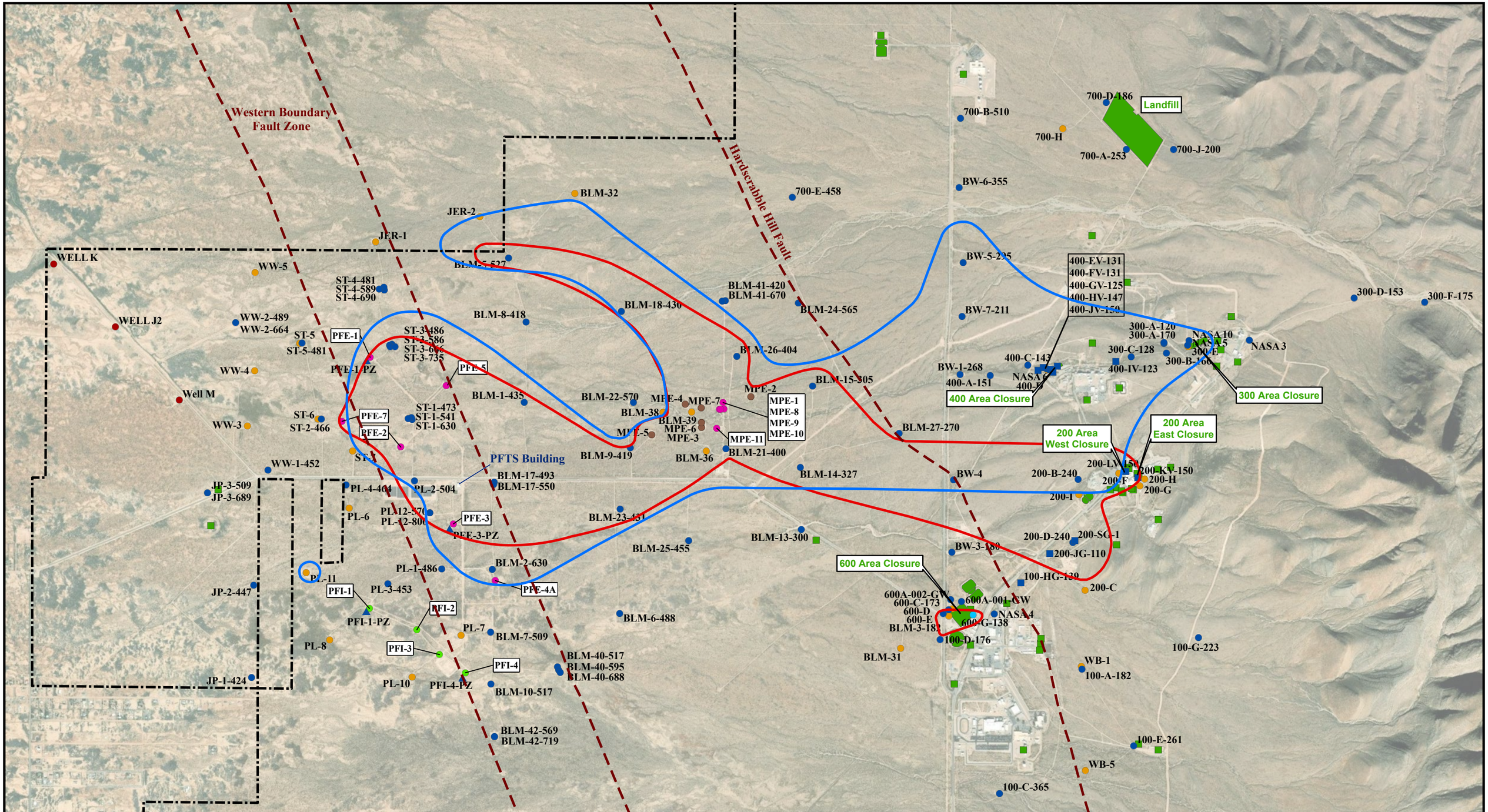
NASA Johnson Space Center
White Sands Test Facility
Las Cruces, New Mexico

Coordinate System:
NAD 1983 StatePlane New Mexico Central FIPS 3002 Feet

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Figure 1.2 WSTF Conceptualized TCE and NDMA Plumes and WSTF Features

(SEE NEXT PAGE)



NASA-WSTF Site Features

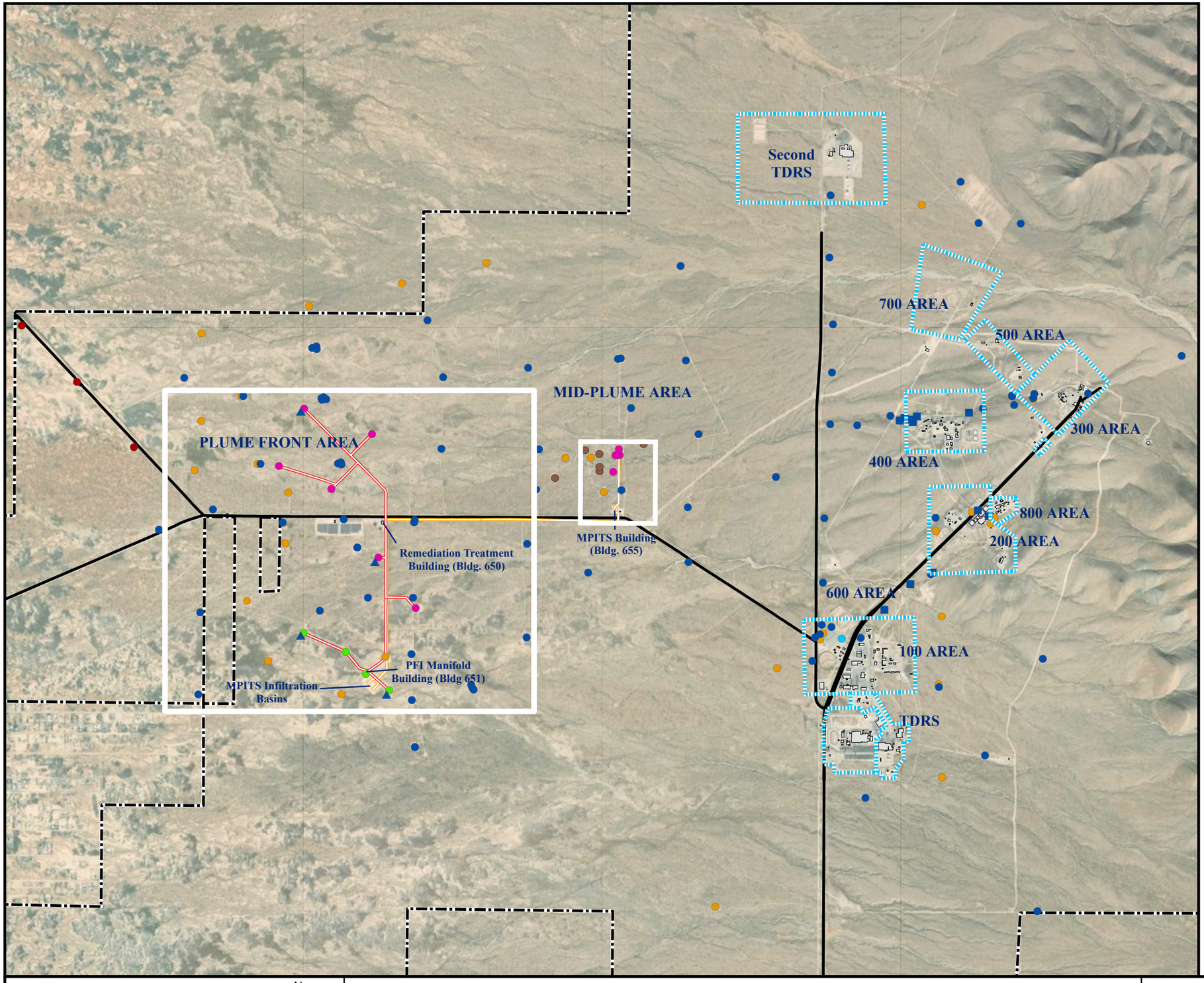
NASA Johnson Space Center
White Sands Test Facility Las Cruces, New Mexico

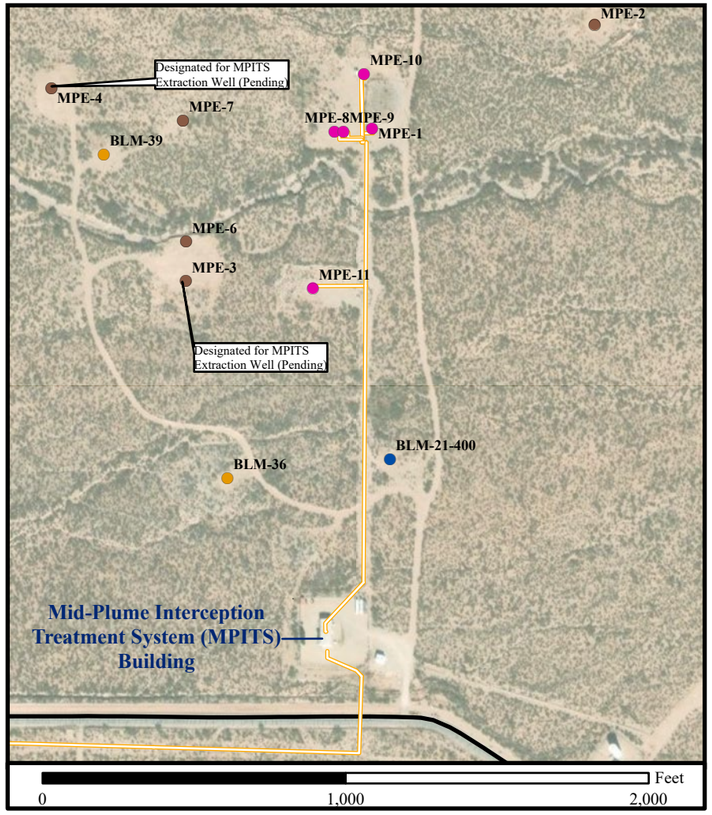
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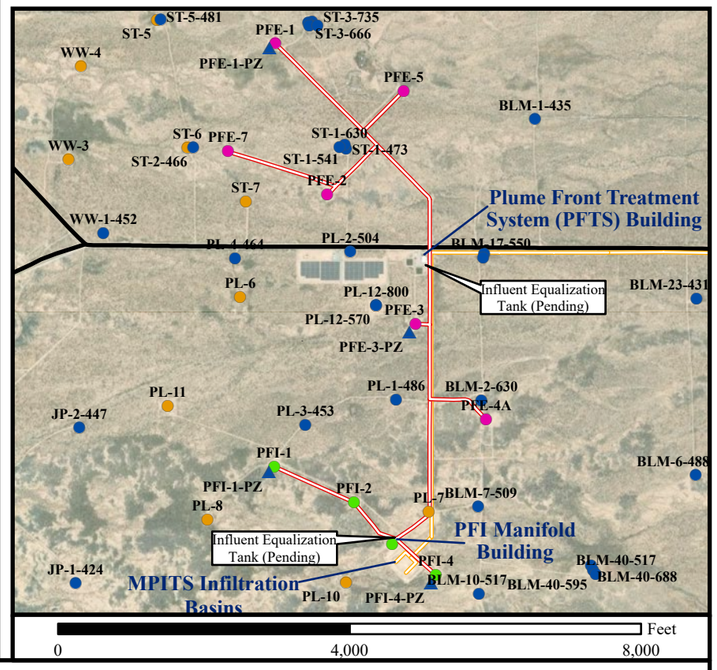
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Figure 3.1 WSTF Remediation System Locations

(SEE NEXT PAGE)







NASA

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0 2,600 5,200 Feet

N W E S

July 2024

- Multiport
- Conventional Well
- Perched Well
- MSVGM Well
- Extraction Well
- Injection Well
- Piezometer
- Exploration Well
- Production Well
- MPITS Pipeline
- PFTS Pipeline
- Road
- Areas
- Building
- WSTF Boundary

WSTF Remediation System Locations

NASA Johnson Space Center
White Sands Test Facility Las Cruces, New Mexico

Coordinate System:
NAD 1983 HARN StatePlane New Mexico Central FIPS 3002

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Figure 3.2 **General PFTS Layout**

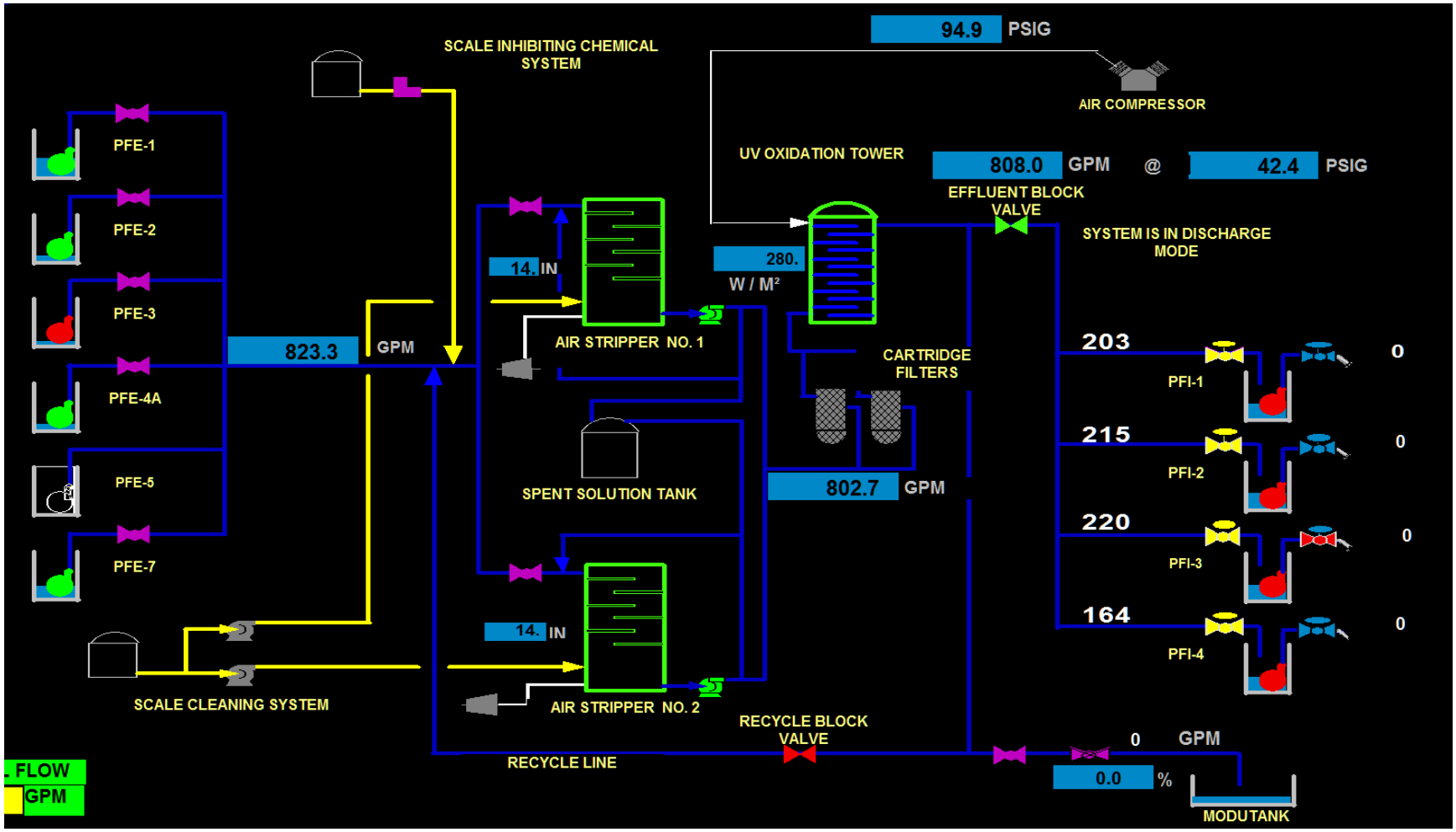
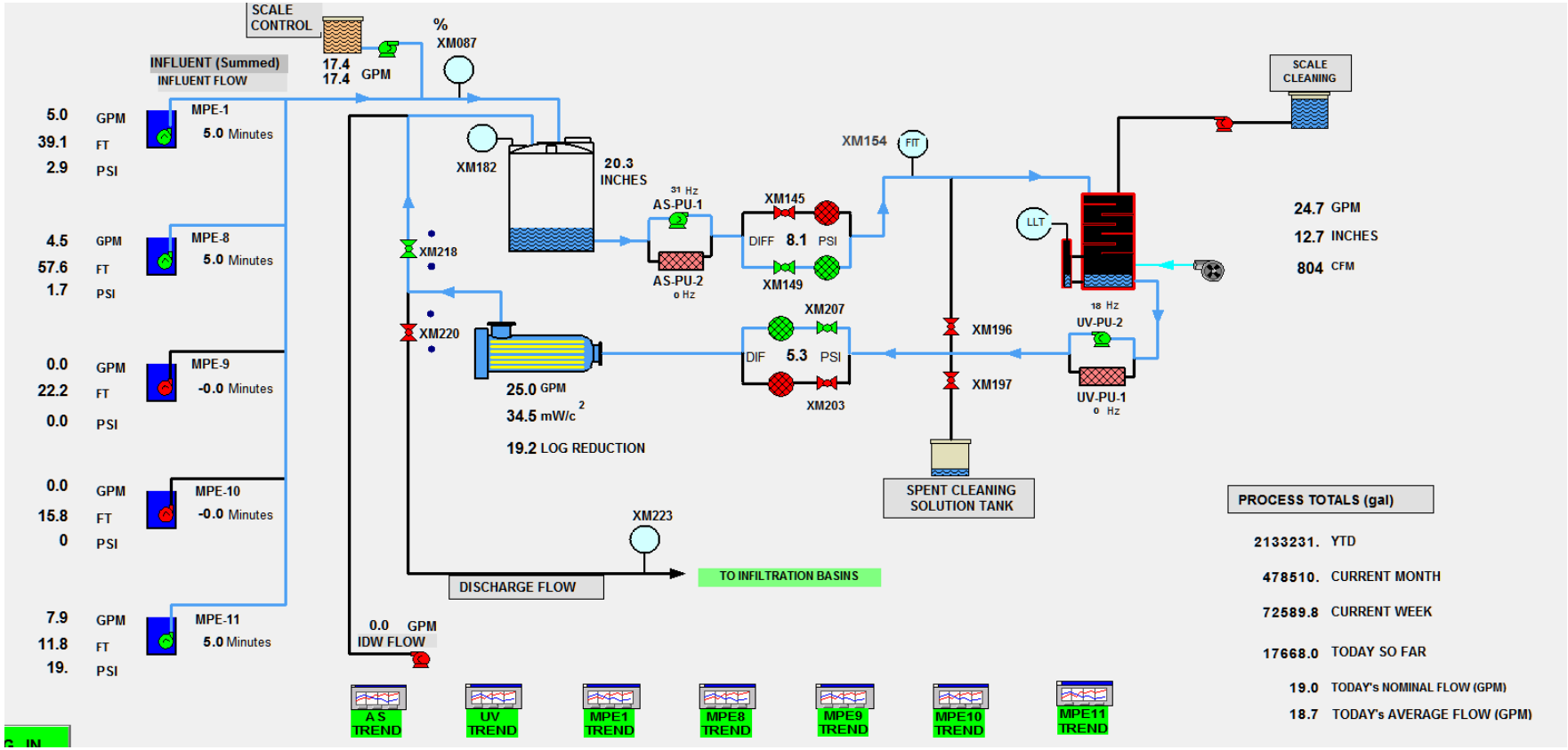


Figure 3.3 **General MPITS Layout**



Appendix A
Remediation System Well Completion Diagrams

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-1** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 NE 1/4 SE 1/4, Sec 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553886.945 N, 1522912.689 E**
Elevation (Brass Cap): **4652.476 ft.**
Elevation (Top of Casing): **4654.018 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **560 ft.**
Borehole Diameter: **Reamed 17 1/2" to 120 ft.; 12 1/4" to 560 ft.**
Depth to Bedrock (bgs): **~250 ft;**
Depth to Groundwater: **327.59 ft. TOC (2/15/2007)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **6/23 - 7/9/99**
Date(s) Well Installed: **1/05 - 1/07/07**
Date(s) Well Developed: **7/14/99 - 8/6/99 (Initial)**
Field Representative(s): **J. Pearson**
Total Depth Well Casing (bgs): **522.72 ft.**
Type of Casing: **316L Stainless Steel**
Diameter Well Casing: **6" Nominal**
Screened Zone (bgs): **362.46 - 512.70 ft.**
Comments: **Well is located on MPCA structure identified from seismic data**

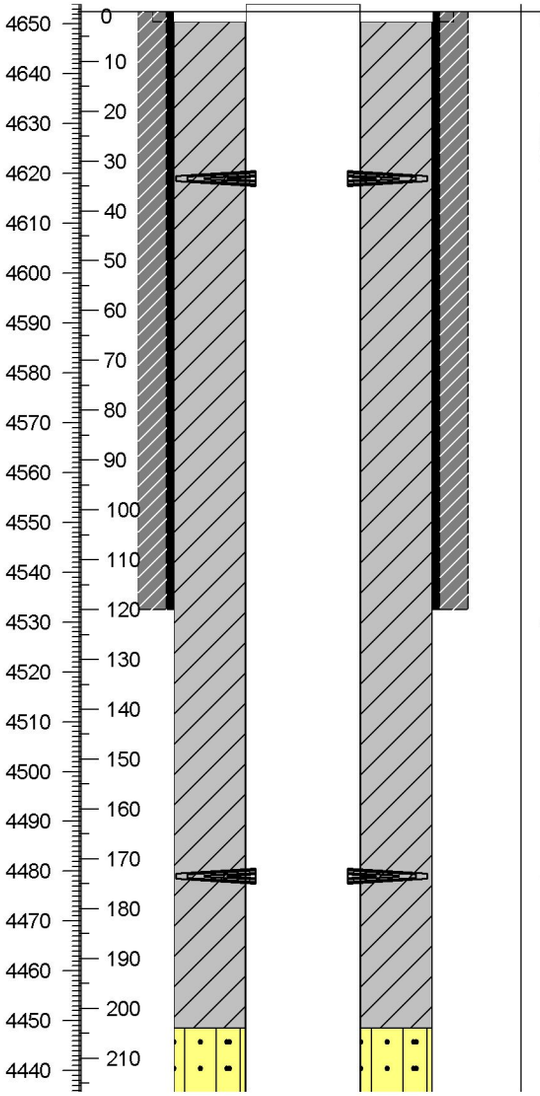
bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

- Surface Casing — **14" OD Carbon Steel**
- Completion Casing — **Steel**, **316L Schedule**
- Well Screen — **Steel**, **Wire-Wrapped 0.020"-Slot Screen**
- Steel Centralizer
- Steel End Cap
- Water Table

Annular Materials Explanation

- Neat Cement
- 12/20 Filter Pack Sand
- Bentonite Grout
- 12/20 Sand Bentonite Mix
- Bentonite Seal
- Slough



Elevation (ft amsl) / Depth (ft bgs)

Borehole/Well Casing Descriptions (All depths are below ground surface)	Annular Materials Descriptions (All depths are below ground surface)
Stick-Up = 1.54 ft. ags	
The well was completed with a 3' x 3' cement pad, barrier posts, and a locking steel well cap surrounding the casing at ground surface.	Top of Cement Grout (Portland II Cement with 5% Bentonite) = 2.0 ft.
Three steel centralizers welded to casing at 32 ft.	
14" OD Carbon Steel Surface Casing Depth = 120.0 ft.	17 1/2" Borehole cemented to 120.0 ft.
Three steel centralizers welded to casing at 172 ft.	
	Top of 10/20 Sand/Bentonite Mix= 204 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-1** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 NE 1/4 SE 1/4, Sec 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553886.945 N, 1522912.689 E**
Elevation (Brass Cap): **4652.476 ft.**
Elevation (Top of Casing): **4654.018 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **560 ft.**
Borehole Diameter: **Reamed 17 1/2" to 120 ft.; 12 1/4" to 560 ft.**
Depth to Bedrock (bgs): **~250 ft;**
Depth to Groundwater: **327.59 ft. TOC (2/15/2007)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **6/23 - 7/9/99**
Date(s) Well Installed: **1/05 - 1/07/07**
Date(s) Well Developed: **7/14/99 - 8/6/99 (Initial)**
Field Representative(s): **J. Pearson**
Total Depth Well Casing (bgs): **522.72 ft.**
Type of Casing: **316L Stainless Steel**
Diameter Well Casing: **6" Nominal**
Screened Zone (bgs): **362.46 - 512.70 ft.**
Comments: **Well is located on MPCA structure identified from seismic data**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
Steel
316L Schedule

Well Screen
Steel
Wire-Wrapped 0.020"-Slot Screen

Steel Centralizer

Steel End Cap

Water Table

Annular Materials Explanation

Neat Cement

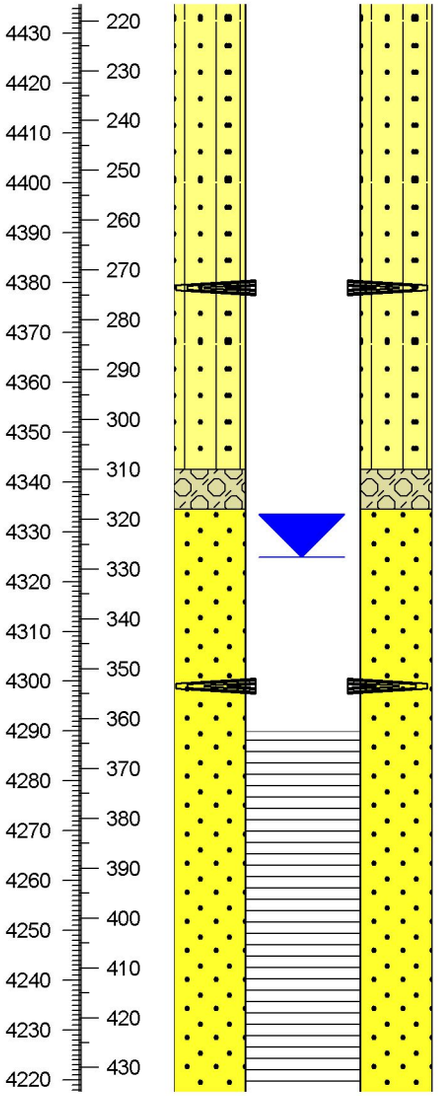
Bentonite Grout

Bentonite Seal

12/20 Filter Pack Sand

12/20 Sand Bentonite Mix

Slough



Elevation (ft amsl) / Depth (ft bgs)

Borehole/Well Casing Descriptions
All depths are below ground surface

Three steel centralizers welded to casing at 272 ft.

Water Table Depth = 327.59 ft. TOC (12/2006)

Three steel centralizers welded to casing at 352 ft.

Top of (6" ID) 316L Schedule 5 Wire-Wrapped Stainless Steel 0.020"-Slot Screen (Extra Strength) = 362.46 ft.

Annular Materials Descriptions
All depths are below ground surface

Volcanic bedrock (Rhyolite) depth = 250 ft.

Top of Upper Bentonite Seal = 310 ft.

Top of 10/20 Sand = 318 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-1** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 NE 1/4 SE 1/4, Sec 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553886.945 N, 1522912.689 E**
Elevation (Brass Cap): **4652.476 ft.**
Elevation (Top of Casing): **4654.018 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **560 ft.**
Borehole Diameter: **Reamed 17 1/2" to 120 ft.; 12 1/4" to 560 ft.**
Depth to Bedrock (bgs): **~250 ft;**
Depth to Groundwater: **327.59 ft. TOC (2/15/2007)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **6/23 - 7/9/99**
Date(s) Well Installed: **1/05 - 1/07/07**
Date(s) Well Developed: **7/14/99 - 8/6/99 (Initial)**
Field Representative(s): **J. Pearson**
Total Depth Well Casing (bgs): **522.72 ft.**
Type of Casing: **316L Stainless Steel**
Diameter Well Casing: **6" Nominal**
Screened Zone (bgs): **362.46 - 512.70 ft.**
Comments: **Well is located on MPCA structure identified from seismic data**
bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation
Surface Casing
14" OD Carbon Steel
Completion Casing
Steel
316L Schedule
Well Screen
Steel
Wire-Wrapped 0.020"-Slot Screen
Steel Centralizer
Steel End Cap
Water Table

Annular Materials Explanation
Neat Cement
Bentonite Grout
Bentonite Seal
12/20 Filter Pack Sand
12/20 Sand Bentonite Mix
Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4210 / 440 4200 / 450 4190 / 460 4180 / 470 4170 / 480 4160 / 490 4150 / 500 4140 / 510 4130 / 520 4120 / 530 4110 / 540 4100 / 550 4090 / 560	Bottom of (6" ID) 316L Schedule 5 Wire-Wrapped Stainless Steel 0.020"-Slot Screen (Extra Strength) = 512.70 ft. Three steel centralizers welded to casing at 515 ft. (6" ID) 316L Schedule 5 Stainless Steel Casing TD = 522.72 ft. Sump consists of 10' blank riser and end cap	Top of Lower Bentonite Seal = 538 ft. Top of Slough = 546 ft. 12 1/4" Borehole TD= 560.0 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-3** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4 SE 1/4 SE 1/4 Sec 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553466.571 N, 1522392.385 E**
Elevation (Brass Cap): **4641.01 ft.**
Elevation (Top of Casing): **4641.16 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **D. Gaddy**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **644 ft.**
Borehole Diameter: **17 1/2-in to 117 ft; 12 1/4-in to 644 ft.**
Depth to Bedrock (bgs): **355 ft; Rhyolite**
Depth to Groundwater: **372.85 ft. TOC (6/13/01)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **6/2 - 6/12/01**
Date(s) Well Installed: **6/14/01**
Date(s) Well Developed: **6/17/01 - 7/13/01; 5/7 - 5/8/03**
Field Representative(s): **J. Pearson**
Total Depth Well Casing (bgs): **639.1 ft.**
Type of Casing: **SDR 17 PVC**
Diameter Well Casing: **5.75-in ID, 6.54-in OD**
Screened Zone (bgs): **479 - 619 ft.**
Comments: **Well is located on MPCA structure identified from seismic data**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

- Surface Casing: **14" OD Carbon Steel**
- Completion Casing: **Steel** / **SDR 17 PVC**
- Well Screen: **Steel** / **Wire-Wrapped 0.020"-Slot Screen**
- Steel Centralizer
- Steel End Cap
- Water Table

Annular Materials Explanation

- Neat Cement
- Bentonite Grout
- Bentonite Seal
- 12/20 Filter Pack Sand
- 12/20 Sand Bentonite Mix
- Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4640 / 0	Stick-Up = 1 ft. ags	
4630 / 10	The well was completed with a 3' x 3' cement pad, barrier posts, and a locking steel well cap surrounding the casing at ground surface.	Top of Cement Grout (Portland II Cement with 5% Bentonite) = 3.0 ft.
4620 / 20	Three steel centralizers welded to casing at 19 ft.	
4610 / 30		
4600 / 40		
4590 / 50		
4580 / 60		
4570 / 70		
4560 / 80		
4550 / 90		
4540 / 100	Three steel centralizers welded to casing at 99 ft.	
4530 / 110		
4520 / 120	14" OD Carbon Steel Surface Casing Depth = 112.0 ft.	17 1/2-in Borehole cemented to 117 ft
4510 / 130		
4500 / 140		
4490 / 150		
4480 / 160		
4470 / 170		
4460 / 180		
4450 / 190		
4440 / 200	Three steel centralizers welded to casing at 199 ft.	Top of 10/20 Sand/Bentonite Mix= 204 ft.
4430 / 210		

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-3** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4 SE 1/4 SE 1/4 Sec 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553466.571 N, 1522392.385 E**
Elevation (Brass Cap): **4641.01 ft.**
Elevation (Top of Casing): **4641.16 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **D. Gaddy**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **644 ft.**
Borehole Diameter: **17 1/2-in to 117 ft; 12 1/4-in to 644 ft.**
Depth to Bedrock (bgs): **355 ft; Rhyolite**
Depth to Groundwater: **372.85 ft. TOC (6/13/01)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **6/2 - 6/12/01**
Date(s) Well Installed: **6/14/01**
Date(s) Well Developed: **6/17/01 - 7/13/01; 5/7 - 5/8/03**
Field Representative(s): **J. Pearson**
Total Depth Well Casing (bgs): **639.1 ft.**
Type of Casing: **SDR 17 PVC**
Diameter Well Casing: **5.75-in ID, 6.54-in OD**
Screened Zone (bgs): **479 - 619 ft.**
Comments: **Well is located on MPCA structure identified from seismic data**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

- Surface Casing: **14" OD Carbon Steel**
- Completion Casing: **Steel** / **SDR 17 PVC**
- Well Screen: **Steel** / **Wire-Wrapped 0.020"-Slot Screen**
- Steel Centralizer
- Steel End Cap
- Water Table

Annular Materials Explanation

- Neat Cement
- Bentonite Grout
- Bentonite Seal
- 12/20 Filter Pack Sand
- 12/20 Sand Bentonite Mix
- Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4420 – 220 4410 – 230 4400 – 240 4390 – 250 4380 – 260 4370 – 270 4360 – 280 4350 – 290 4340 – 300 4330 – 310 4320 – 320 4310 – 330 4300 – 340 4290 – 350 4280 – 360 4270 – 370 4260 – 380 4250 – 390 4240 – 400 4230 – 410 4220 – 420 4210 – 430	Three steel centralizers welded to casing at 299 ft. Water Table Depth = 372.85 ft. TOC (4/30/07) Three steel centralizers welded to casing at 399 ft.	Top of Upper Bentonite Seal = 315 ft. Top of 10/20 Sand = 320 ft. Volcanic bedrock (Rhyolite) depth = 355 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-3** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4 SE 1/4 SE 1/4 Sec 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553466.571 N, 1522392.385 E**
Elevation (Brass Cap): **4641.01 ft.**
Elevation (Top of Casing): **4641.16 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
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Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **644 ft.**
Borehole Diameter: **17 1/2-in to 117 ft; 12 1/4-in to 644 ft.**
Depth to Bedrock (bgs): **355 ft; Rhyolite**
Depth to Groundwater: **372.85 ft. TOC (6/13/01)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **6/2 - 6/12/01**
Date(s) Well Installed: **6/14/01**
Date(s) Well Developed: **6/17/01 - 7/13/01; 5/7 - 5/8/03**
Field Representative(s): **J. Pearson**
Total Depth Well Casing (bgs): **639.1 ft.**
Type of Casing: **SDR 17 PVC**
Diameter Well Casing: **5.75-in ID, 6.54-in OD**
Screened Zone (bgs): **479 - 619 ft.**
Comments: **Well is located on MPCA structure identified from seismic data**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

- Surface Casing: **14" OD Carbon Steel**
- Completion Casing: **Steel** / **SDR 17 PVC**
- Well Screen: **Steel** / **Wire-Wrapped 0.020"-Slot Screen**
- Steel Centralizer
- Steel End Cap
- Water Table

Annular Materials Explanation

- Neat Cement
- Bentonite Grout
- Bentonite Seal
- 12/20 Filter Pack Sand
- 12/20 Sand Bentonite Mix
- Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4200 / 440		
4190 / 450		
4180 / 460		
4170 / 470		
4160 / 480	Top of 5.75-in ID CertainTeed SDR 17 0.020-in - Slot PVC Screen = 479 ft.	
4150 / 490		
4140 / 500	Steel cage centralizer bolted together around casing at 499 ft.	
4130 / 510		
4120 / 520		
4110 / 530		
4100 / 540		
4090 / 550		
4080 / 560		
4070 / 570		
4060 / 580		
4050 / 590		
4040 / 600		
4030 / 610		
4020 / 620	Steel cage centralizer bolted together around casing coupling at 619 ft.	
4010 / 630	Bottom of 5.75-in ID CertainTeed SDR 17 0.020-in - Slot PVC Screen = 619 ft.	Top of Lower Bentonite Seal = 631 ft.
4000 / 640	Sump consists of 20 ft blank riser and end cap	
650	5.75-in ID CertainTeed SDR 17 PVC Casing TD = 639.1 ft.	12 3/4-in Borehole TD= 644 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-4** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SW 1/4 NE 1/4 SE 1/4 Sec 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **554002.96 N, 1522019.57 E**
Elevation (Brass Cap): **4633.03 ft.**
Elevation (Top of Casing): **4632.71 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **D. Gaddy**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **641 ft.**
Borehole Diameter: **17 1/2-in to 117 ft; 12 1/4-in to 641 ft.**
Depth to Bedrock (bgs): **375 ft; Rhyolite**
Depth to Groundwater: **369.11 ft. TOC (6/28/01)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **5/13 - 5/22/01**
Date(s) Well Installed: **5/24/01**
Date(s) Well Developed: **5/29/01 - 6/29/01**
Field Representative(s): **J. Pearson**
Total Depth Well Casing (bgs): **639.15 ft.**
Type of Casing: **SDR 17 PVC**
Diameter Well Casing: **5.75-in ID, 6.54-in OD**
Screened Zone (bgs): **499 - 619 ft.**
Comments: **Well is located on MPCA structure identified from seismic data**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

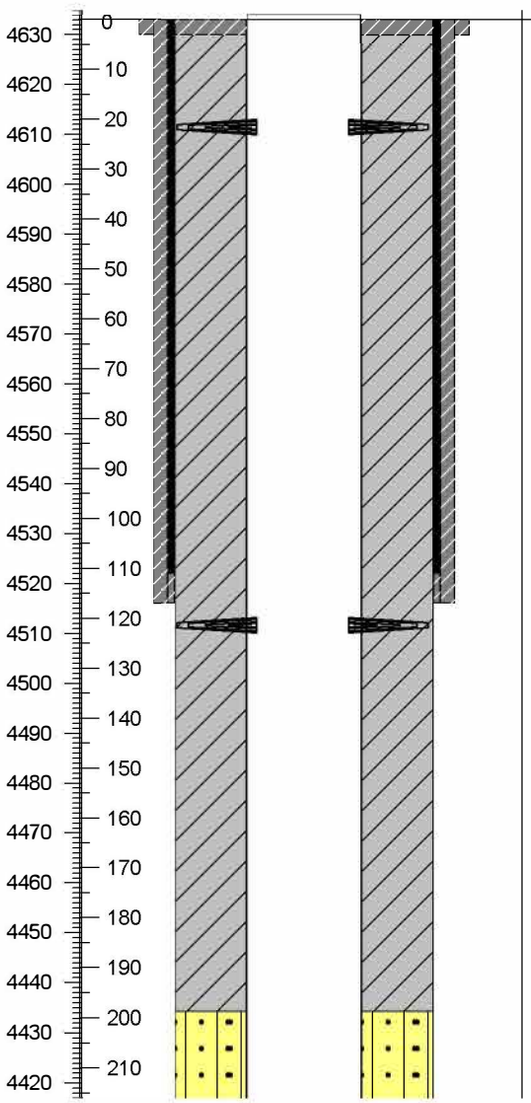
Casing Explanation

- Surface Casing: **14" OD Carbon Steel**
- Completion Casing: **Steel** / **SDR 17 PVC**
- Well Screen: **Steel** / **Wire-Wrapped 0.020"-Slot Screen**
- Steel Centralizer
- Steel End Cap
- Water Table

Annular Materials Explanation

- Neat Cement
- 12/20 Filter Pack Sand
- Bentonite Grout
- 12/20 Sand Bentonite Mix
- Bentonite Seal
- Slough

Elevation (ft amsl) / Depth (ft bgs)



Borehole/Well Casing Descriptions
All depths are below ground surface

Stick-Up = 1 ft. ags

The well was completed with a 3' x 3' cement pad, barrier posts, and a locking steel well cap surrounding the casing at ground surface.

Three steel centralizers welded to casing at 19 ft.

14" OD Carbon Steel Surface Casing Depth = 111.0 ft.

Three steel centralizers welded to casing at 119 ft.

Annular Materials Descriptions
All depths are below ground surface

Top of Cement Grout (Portland II Cement with 5% Bentonite) = 3.0 ft.

17 1/2-in Borehole cemented to 117 ft

Top of 10/20 Sand/Bentonite Mix= 199 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-4** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SW 1/4 NE 1/4 SE 1/4 Sec 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **554002.96 N, 1522019.57 E**
Elevation (Brass Cap): **4633.03 ft.**
Elevation (Top of Casing): **4632.71 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **D. Gaddy**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **641 ft.**
Borehole Diameter: **17 1/2-in to 117 ft; 12 1/4-in to 641 ft.**
Depth to Bedrock (bgs): **375 ft; Rhyolite**
Depth to Groundwater: **369.11 ft. TOC (6/28/01)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **5/13 - 5/22/01**
Date(s) Well Installed: **5/24/01**
Date(s) Well Developed: **5/29/01 - 6/29/01**
Field Representative(s): **J. Pearson**
Total Depth Well Casing (bgs): **639.15 ft.**
Type of Casing: **SDR 17 PVC**
Diameter Well Casing: **5.75-in ID, 6.54-in OD**
Screened Zone (bgs): **499 - 619 ft.**
Comments: **Well is located on MPCA structure identified from seismic data**

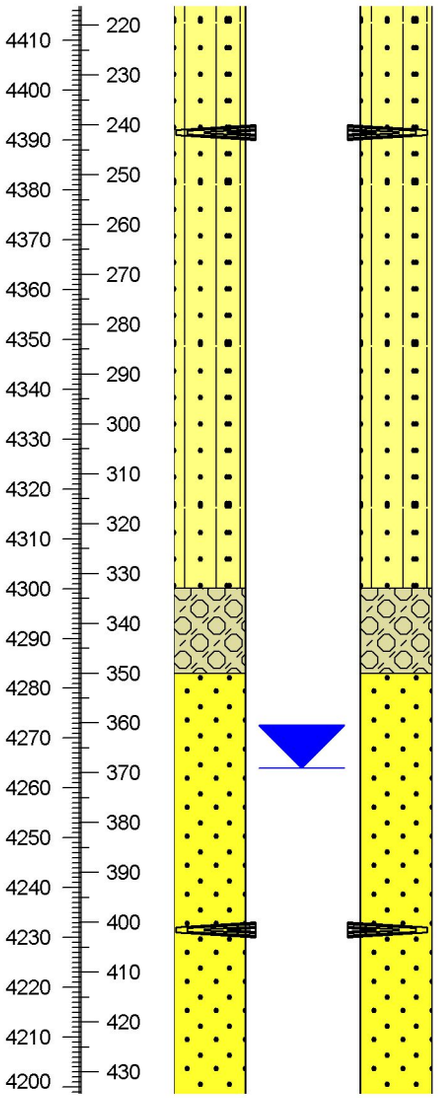
bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

- Surface Casing: **14" OD Carbon Steel**
- Completion Casing: **Steel** / **SDR 17 PVC**
- Well Screen: **Steel** / **Wire-Wrapped 0.020"-Slot Screen**
- Steel Centralizer
- Steel End Cap
- Water Table

Annular Materials Explanation

- Neat Cement
- Bentonite Grout
- Bentonite Seal
- 12/20 Filter Pack Sand
- 12/20 Sand Bentonite Mix
- Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
	Three steel centralizers welded to casing at 239 ft. Water Table Depth = 369.11 ft. TOC (6/28/01) Three steel centralizers welded to casing at 399 ft.	Top of Upper Bentonite Seal = 333 ft. Top of 10/20 Sand = 350 ft. Volcanic bedrock (Rhyolite) depth = 375 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-4** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SW 1/4 NE 1/4 SE 1/4 Sec 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **554002.96 N, 1522019.57 E**
Elevation (Brass Cap): **4633.03 ft.**
Elevation (Top of Casing): **4632.71 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **D. Gaddy**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **641 ft.**
Borehole Diameter: **17 1/2-in to 117 ft; 12 1/4-in to 641 ft.**
Depth to Bedrock (bgs): **375 ft; Rhyolite**
Depth to Groundwater: **369.11 ft. TOC (6/28/01)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **5/13 - 5/22/01**
Date(s) Well Installed: **5/24/01**
Date(s) Well Developed: **5/29/01 - 6/29/01**
Field Representative(s): **J. Pearson**
Total Depth Well Casing (bgs): **639.15 ft.**
Type of Casing: **SDR 17 PVC**
Diameter Well Casing: **5.75-in ID, 6.54-in OD**
Screened Zone (bgs): **499 - 619 ft.**
Comments: **Well is located on MPCA structure identified from seismic data**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
14" OD Carbon Steel
Completion Casing
Steel
SDR 17 PVC
Well Screen
Steel
Wire-Wrapped 0.020"-Slot Screen
Steel Centralizer
Steel End Cap
Water Table

Annular Materials Explanation

Neat Cement
Bentonite Grout
Bentonite Seal
12/20 Filter Pack Sand
12/20 Sand Bentonite Mix
Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4190 / 440 4180 / 450 4170 / 460 4160 / 470 4150 / 480 4140 / 490 4130 / 500 4120 / 510 4110 / 520 4100 / 530 4090 / 540 4080 / 550 4070 / 560 4060 / 570 4050 / 580 4040 / 590 4030 / 600 4020 / 610 4010 / 620 4000 / 630 3990 / 640	Three steel centralizers welded to casing at 499 ft. Top of 5.75-in ID CertainTeed SDR 17 0.020-in - Slot PVC Screen = 499 ft. Steel cage centralizer bolted together around casing coupling at 619 ft. Bottom of 5.75-in ID CertainTeed SDR 17 0.020-in - Slot PVC Screen = 619 ft. Sump consists of 20 ft blank riser and end cap 5.75-in ID CertainTeed SDR 17 PVC Casing TD = 639.15 ft.	Top of Lower Bentonite Seal = 625 ft. 12 3/4-in Borehole TD= 641 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-8** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 NE 1/4 SE 1/4 Sec 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553879.497 N, 1522807.9 E**
Elevation (Brass Cap): **4650.98 ft.**
Elevation (Top of Casing): **4654 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **L. Pasquale, L. P. Garcia, and W. Chamberlain**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **620 ft.**
Borehole Diameter: **9 7/8" to 406 ft. ; 6 3/4" to 620 ft.**
Depth to Bedrock (bgs): **~296 ft; Rhyolite**
Depth to Groundwater: **322.47 ft. TOC (6/24/05)**
Diameter and Type Surface Casing: **6 7/8" ID, 7 5/8" to 403 ft.**

Dates Borehole Drilled: **2/6/03 to 3/4/03**
Date(s) Well Installed: **3/5/03-3/7/03**
Date(s) Well Developed: **4/8/03 to 4/28/03**
Field Representative(s): **M. Canavan, L. Hunnicutt-Mack, and M. Stepro**
Total Depth Well Casing (bgs): **601.31 ft.**
Type of Casing: **Flush-Threaded Carbon Steel**
Diameter Well Casing: **5 7/8" ID, 6 5/8" OD**
Screened Zone (bgs): **380.02-490.56 ft. (wide); 490.56-600.50 ft. (close)**
Comments: **Located on a MPCA structure identified from seismic data**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

- Surface Casing: **7 5/8" OD Steel**
- Completion Casing: **Steel** **Carbon Steel 6 5/8" OD**
- Well Screen: **Steel** **Cut 1" to 1 1/2" Long x 1/4" Wide**
- Bolted Steel Centralizer
- **PVC End Cap**
- **Water Table**

Annular Materials Explanation

- Neat Cement
- 10/20 Filter Pack Sand
- Bentonite Grout
- Slough
- 12/20 Sand Bentonite Mix

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4650 / 0	Stick-Up = 3.02 ft. ags	
4640 / 10		
4630 / 20	This well ultimately completed with a well vault.	No Annular Materials Installed
4620 / 30		
4610 / 40		Alluvium formation from is surface Santa to Fe 296 ft. Group
4600 / 50		
4590 / 60		
4580 / 70		
4570 / 80		During hydrofracturing process, 16/30 sand was injected into formation to prop open any fractures created
4560 / 90		
4550 / 100	No Centralizers used.	
4540 / 110	6 7/8" ID, 7 5/8" OD Steel Steel Surface Casing Depth = 403 ft.	
4530 / 120		
4520 / 130		
4510 / 140		
4500 / 150		
4490 / 160		
4480 / 170		
4470 / 180		
4460 / 190		
4450 / 200		
4440 / 210		

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-8** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 NE 1/4 SE 1/4 Sec 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553879.497 N, 1522807.9 E**
Elevation (Brass Cap): **4650.98 ft.**
Elevation (Top of Casing): **4654 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **L. Pasquale, L. P. Garcia, and W. Chamberlain**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **620 ft.**
Borehole Diameter: **9 7/8" to 406 ft. ; 6 3/4" to 620 ft.**
Depth to Bedrock (bgs): **~296 ft; Rhyolite**
Depth to Groundwater: **322.47 ft. TOC (6/24/05)**
Diameter and Type Surface Casing: **6 7/8" ID, 7 5/8" to 403 ft.**

Dates Borehole Drilled: **2/6/03 to 3/4/03**
Date(s) Well Installed: **3/5/03-3/7/03**
Date(s) Well Developed: **4/8/03 to 4/28/03**
Field Representative(s): **M. Canavan, L. Hunnicutt-Mack, and M. Stepro**
Total Depth Well Casing (bgs): **601.31 ft.**
Type of Casing: **Flush-Threaded Carbon Steel**
Diameter Well Casing: **5 7/8" ID, 6 5/8" OD**
Screened Zone (bgs): **380.02-490.56 ft. (wide); 490.56-600.50 ft. (close)**
Comments: **Located on a MPCA structure identified from seismic data**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
7 5/8" OD Steel

Completion Casing
Steel
Carbon Steel 6 5/8" OD

Well Screen
Steel
Cut 1" to 1 1/2" Long x 1/4" Wide

Bolted Steel Centralizer

PVC End Cap

Water Table

Annular Materials Explanation

Neat Cement

10/20 Filter Pack Sand

Bentonite Grout

Slough

12/20 Sand Bentonite Mix

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4430 / 220 4420 / 230 4410 / 240 4400 / 250 4390 / 260 4380 / 270 4370 / 280 4360 / 290 4350 / 300 4340 / 310 4330 / 320 4320 / 330 4310 / 340 4300 / 350 4290 / 360 4280 / 370 4270 / 380 4260 / 390 4250 / 400 4240 / 410 4230 / 420 4220 / 430	Water Table Depth = 322.47 ft. (measured post development 6/24/05) Top of 5 7/8" ID, 6 5/8" OD, 1" to 1 1/2" Long x 1/4" Wide Slotted Screen = 398.50 ft.	Rhyolite Bedrock Depth = 296 ft. 9 7/8" Borehole Cemented to 406 ft 6 3/4" Borehole 406.00 - 620.00 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-8** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 NE 1/4 SE 1/4 Sec 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553879.497 N, 1522807.9 E**
Elevation (Brass Cap): **4650.98 ft.**
Elevation (Top of Casing): **4654 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **L. Pasquale, L. P. Garcia, and W. Chamberlain**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **620 ft.**
Borehole Diameter: **9 7/8" to 406 ft. ; 6 3/4" to 620 ft.**
Depth to Bedrock (bgs): **~296 ft; Rhyolite**
Depth to Groundwater: **322.47 ft. TOC (6/24/05)**
Diameter and Type Surface Casing: **6 7/8" ID, 7 5/8" to 403 ft.**

Dates Borehole Drilled: **2/6/03 to 3/4/03**
Date(s) Well Installed: **3/5/03-3/7/03**
Date(s) Well Developed: **4/8/03 to 4/28/03**
Field Representative(s): **M. Canavan, L. Hunnicutt-Mack, and M. Stepro**
Total Depth Well Casing (bgs): **601.31 ft.**
Type of Casing: **Flush-Threaded Carbon Steel**
Diameter Well Casing: **5 7/8" ID, 6 5/8" OD**
Screened Zone (bgs): **380.02-490.56 ft. (wide); 490.56-600.50 ft. (close)**
Comments: **Located on a MPCA structure identified from seismic data**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
7 5/8" OD Steel

Completion Casing
Steel
Carbon Steel 6 5/8" OD

Well Screen
Steel
Cut 1" to 1 1/2" Long x 1/4" Wide

Bolted Steel Centralizer

PVC End Cap

Water Table

Annular Materials Explanation

Neat Cement

10/20 Filter Pack Sand

Bentonite Grout

Slough

12/20 Sand Bentonite Mix

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4210 – 440 4200 – 450 4190 – 460 4180 – 470 4170 – 480 4160 – 490 4150 – 500 4140 – 510 4130 – 520 4120 – 530 4110 – 540 4100 – 550 4090 – 560 4080 – 570 4070 – 580 4060 – 590 4050 – 600 4040 – 610 4030 – 620	Bottom of 5 7/8" ID, 6 5/8" OD, 1" to 1 1/2" Long x 1/4" Wide Slotted Screen = 490.56 ft. Top of 5 7/8" ID, 6 5/8" OD, 1" to 1 1/2" Long x 1/4" Close Slotted Screen = 490.56 ft. Bottom of 5 7/8" ID, 6 5/8" OD, 1" to 1 1/2" Long x 1/4" Close Slotted Screen = 600.5 ft. End cap was tapered and welded to screen 5 7/8" ID Steel Casing TD = 601.31 ft.	Volcanic Rhyolite Tuff Bedrock Depth = 455 ft. Volcanic Flow Banded Rhyolite to Rhyolite Bedrock Depth = 485 ft. 6 3/4" Borehole TD = 620.00 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-9** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 NE 1/4 SE 1/4 Sec 33 T20S R3E**
NM State Plane Coordinates (NAD 83)(ft): **553879.92 N 1522832.67 E**
Elevation (Brass Cap): **4650.7 ft.**
Elevation (Top of Casing): **~1.5 ft. ags (~4652.2 ft.)**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **G. Cardenas, D. Ward**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **625 ft.**
Borehole Diameter: **17 1/2" 0-100 ft; 12 1/4" 100-625 ft.**
Depth to Bedrock (bgs): **296 ft; Rhyolite**
Depth to Groundwater: **322.9 ft. TOC (1/5/05)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **6/30/04 to 7/26/04**
Date(s) Well Installed: **7/28/04 to 8/4/04**
Date(s) Well Developed: **8/4/04 bail; 8/6/04-8/23/04 pump**
Field Representative(s): **G. Giles; L. Hunnicutt-Mack; J. Pearson**
Total Depth Well Casing (bgs): **618.46 ft.**
Type of Casing: **CertainTeed SDR 17 PVC**
Diameter Well Casing: **6 1/4" ID; 6 9/10" OD**
Screened Zone (bgs): **398.50· 598.50 ft**

Comments:
bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation
Surface Casing
14" OD Carbon Steel
Completion Casing
6 9/10" OD Certain Teed SOR 17 PVC
Well Screen
Certain Teed SOR 17 PVC 0.025"
Bolted Steel Centralizer
PVC End Cap
Water Table

Annular Materials Explanation
Neat Cement
10/20 Filter Pack Sand
Bentonite Grout
Slough
12/20 Sand Bentonite Mix

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4650 / 0	Stick-Up = 1.5 ft. ags	Top of Bentonite Grout (Grout Well DF)
4640 / 10	Surface Casing Stick-Up= 2.0 ft. ags	
4630 / 20	This well ultimately completed with a well vault.	Alluvium formation from is surface Santa to Fe Group = 296 ft.
4620 / 30		
4610 / 40		
4600 / 50		
4590 / 60		
4580 / 70		
4570 / 80		
4560 / 90		
4550 / 100	Steel cage centralizer bolted together around casing coupling at 98.5 ft. 14" OD Carbon Steel Surface Casing Depth = 100 ft.	17 1/2" Borehole cemented to 100 ft.
4540 / 110		
4530 / 120		
4520 / 130		
4510 / 140		
4500 / 150		
4490 / 160		
4480 / 170		
4470 / 180	Steel cage centralizer bolted together around casing coupling at 178.5 ft.	
4460 / 190		
4450 / 200		Top of 10/20 Sand/Bentonite Mix= 198 ft.
4440 / 210		

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-9** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 NE 1/4 SE 1/4 Sec 33 T20S R3E**
NM State Plane Coordinates (NAD 83)(ft): **553879.92 N 1522832.67 E**
Elevation (Brass Cap): **4650.7 ft.**
Elevation (Top of Casing): **~1.5 ft. ags (~4652.2 ft.)**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **G. Cardenas, D. Ward**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **625 ft.**
Borehole Diameter: **17 1/2" 0-100 ft; 12 1/4" 100-625 ft.**
Depth to Bedrock (bgs): **296 ft; Rhyolite**
Depth to Groundwater: **322.9 ft. TOC (1/5/05)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **6/30/04 to 7/26/04**
Date(s) Well Installed: **7/28/04 to 8/4/04**
Date(s) Well Developed: **8/4/04 bail; 8/6/04-8/23/04 pump**
Field Representative(s): **G. Giles; L. Hunnicutt-Mack; J. Pearson**
Total Depth Well Casing (bgs): **618.46 ft.**
Type of Casing: **CertainTeed SDR 17 PVC**
Diameter Well Casing: **6 1/4" ID; 6 9/10" OD**
Screened Zone (bgs): **398.50· 598.50 ft**

Comments:

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
6 9/10" OD Certain Teed SOR 17 PVC

Well Screen
Certain Teed SOR 17 PVC 0.025"

Bolted Steel Centralizer

PVC End Cap

Water Table

Annular Materials Explanation

Neat Cement

10/20 Filter Pack Sand

Bentonite Grout

Slough

12/20 Sand Bentonite Mix

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4430 / 220 4420 / 230 4410 / 240 4400 / 250 4390 / 260 4380 / 270 4370 / 280 4360 / 290 4350 / 300 4340 / 310 4330 / 320 4320 / 330 4310 / 340 4300 / 350 4290 / 360 4280 / 370 4270 / 380 4260 / 390 4250 / 400 4240 / 410 4230 / 420 4220 / 430	Steel cage centralizer bolted together around casing coupling at 298.5 ft. Water Table Depth = 322.9 ft. (measured post development 1/5/05) Steel cage centralizer bolted together around casing coupling at 398.5 ft. Top of 6 1/4" ID CertainTeed SDR 17 0.025"-Slot PVC Screen =398.50 ft.	Top of 10/20 Sand= 278 ft. (Exact depth not measured) Volcanic Flow Banded Rhyolite to Rhyolite Bedrock Depth = 296 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-9** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 NE 1/4 SE 1/4 Sec 33 T20S R3E**
NM State Plane Coordinates (NAD 83)(ft): **553879.92 N 1522832.67 E**
Elevation (Brass Cap): **4650.7 ft.**
Elevation (Top of Casing): **~1.5 ft. ags (~4652.2 ft.)**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **G. Cardenas, D. Ward**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **625 ft.**
Borehole Diameter: **17 1/2" 0-100 ft; 12 1/4" 100-625 ft.**
Depth to Bedrock (bgs): **296 ft; Rhyolite**
Depth to Groundwater: **322.9 ft. TOC (1/5/05)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **6/30/04 to 7/26/04**
Date(s) Well Installed: **7/28/04 to 8/4/04**
Date(s) Well Developed: **8/4/04 bail; 8/6/04-8/23/04 pump**
Field Representative(s): **G. Giles; L. Hunnicutt-Mack; J. Pearson**
Total Depth Well Casing (bgs): **618.46 ft.**
Type of Casing: **CertainTeed SDR 17 PVC**
Diameter Well Casing: **6 1/4" ID; 6 9/10" OD**
Screened Zone (bgs): **398.50· 598.50 ft**

Comments:
bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation
Surface Casing
14" OD Carbon Steel
Completion Casing
6 9/10" OD Certain Teed SOR 17 PVC
Well Screen
Certain Teed SOR 17 PVC 0.025"
Bolted Steel Centralizer
PVC End Cap
Water Table

Annular Materials Explanation
Neat Cement
Bentonite Grout
12/20 Sand Bentonite Mix
10/20 Filter Pack Sand
Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4210 — 440		
4200 — 450		Volcanic Rhyolite Crystal-Lithic Tuff Bedrock Depth= 450 ft.
4190 — 460		
4180 — 470		
4170 — 480		Volcanic Altered Ash-Flow Tuff Bedrock Depth= 480 ft.
4160 — 490		
4150 — 500		
4140 — 510		Volcanic Rhyolite Bedrock Depth = 510 ft.
4130 — 520	Steel cage centralizer bolted together around casing coupling at 518.5 ft.	
4120 — 530		
4110 — 540		
4100 — 550		
4090 — 560		
4080 — 570		
4070 — 580		
4060 — 590	Steel cage centralizer bolted together around casing coupling at 598.5 ft.	
4050 — 600	Bottom of 61/4" ID CertainTeed SDR 17 0.025"-Slot PVC Screen = 598.50 ft.	
4040 — 610	Sump consists of 20 ft. blank riser and end cap; end cap attached with spline and bolted on	
4030 — 620	6 1/4" ID; 6 9/10" OD CertainTeed SDR 17 PVC Casing TD = 618.46 ft.	Top of Slough= 624 ft. (sounded 7/28/04)
4020 — 630		12 1/4" Borehole TD= 625 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-10 (2nd Installation)** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4 NE 1/4 SE 1/4 Sec. 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **554038.454 N, 1522890.51 E**
Elevation (Brass Cap): **4650.16 ft.**
Elevation (Top of Casing): **4651.21 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **G. Cardenas**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **601.41 ft.**
Borehole Diameter: **24" to 9.0 ft.; 17 1/2" to 355.0 ft.; 12 1/4" to 601.4 ft.**
Depth to Bedrock (bgs): **235 ft; Rhyolite**
Depth to Groundwater: **318.48 ft. TOC (2/15/07)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **8/6 - 8/25/04**
Date(s) Well Installed: **12/9 - 12/10/06**
Date(s) Well Developed: **12/11 - 12/22/06**
Field Representative(s): **G. Giles**
Total Depth Well Casing (bgs): **597.40 ft.**
Type of Casing: **CertainTeed SDR 17 PVC**
Diameter Well Casing: **6" ID, 6 9/10" OD**
Screened Zone (bgs): **397.20 - 597.30 ft.**
Comments: **Located on a MPCA structure identified from seismic data**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
CertainTeed SDR 17 PVC

Well Screen
CertainTeed SDR 17 0.032"-Slot PVC

Bolted Steel Centralizer

PVC End Cap

Water Table

Annular Materials Explanation

Neat Cement

Bentonite Grout

12/20 Sand Bentonite Mix

8/12 Filter Pack Sand

Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4650 / 0	Stick-Up = 1.04 ft. ags	
4640 / 10	20" Steel Conductor pipe installed and cemented to 9.00 ft. bgs	24" borehole cemented to 9.00 ft.
4630 / 20	Steel cage centralizer bolted together around casing coupling at 17.01 ft.	
4620 / 30		Top of Bentonite Grout (Grout Well DF) = 33.45 ft.
4610 / 40		
4600 / 50		
4590 / 60		
4580 / 70		
4570 / 80		
4560 / 90		
4550 / 100	Steel cage centralizer bolted together around casing coupling at 97.05 ft.	
4540 / 110		
4530 / 120		
4520 / 130		
4510 / 140		
4500 / 150		
4490 / 160		
4480 / 170		
4470 / 180		
4460 / 190		
4450 / 200	Steel cage centralizer bolted together around casing coupling at 197.10 ft.	Top of 8/12 Sand = 200 ft.
4440 / 210		

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-10 (2nd Installation)** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4 NE 1/4 SE 1/4 Sec. 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **554038.454 N, 1522890.51 E**
Elevation (Brass Cap): **4650.16 ft.**
Elevation (Top of Casing): **4651.21 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **G. Cardenas**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **601.41 ft.**
Borehole Diameter: **24" to 9.0 ft.; 17 1/2" to 355.0 ft.; 12 1/4" to 601.4 ft.**
Depth to Bedrock (bgs): **235 ft; Rhyolite**
Depth to Groundwater: **318.48 ft. TOC (2/15/07)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **8/6 - 8/25/04**
Date(s) Well Installed: **12/9 - 12/10/06**
Date(s) Well Developed: **12/11 - 12/22/06**
Field Representative(s): **G. Giles**
Total Depth Well Casing (bgs): **597.40 ft.**
Type of Casing: **CertainTeed SDR 17 PVC**
Diameter Well Casing: **6" ID, 6 9/10" OD**
Screened Zone (bgs): **397.20 - 597.30 ft.**
Comments: **Located on a MPCA structure identified from seismic data**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
CertainTeed SDR 17 PVC

Well Screen
CertainTeed SDR 17 0.032"-Slot PVC

Bolted Steel Centralizer

PVC End Cap

Water Table

Annular Materials Explanation

Neat Cement

8/12 Filter Pack Sand

Bentonite Grout

Slough

12/20 Sand Bentonite Mix

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4430 – 220 4420 – 230 4410 – 240 4400 – 250		Volcanic bedrock (Rhyolite) depth = 235 ft. Volcanic bedrock (Flow-Banded Rhyolite) depth = 250 ft.
4390 – 260 4380 – 270 4370 – 280 4360 – 290 4350 – 300	Steel cage centralizer bolted together around casing coupling at 297.15 ft.	
4340 – 310 4330 – 320	Water Table Depth = 318.48 ft. (measured post development 2/15/07)	
4320 – 330 4310 – 340 4300 – 350 4290 – 360	14" OD Carbon Steel Surface Casing Depth = 355.0 ft.	17 1/2" borehole cemented to 355.0 ft. 12 1/4" borehole 355.00' - 601.41 ft. (TD)
4280 – 370 4270 – 380 4260 – 390 4250 – 400	Steel cage centralizer bolted together around casing coupling at 397.20 ft. Top of 6" ID CertainTeed SDR 17 0.032"-Slot PVC Screen = 397.20 ft.	Altered volcanic bedrock depth = 400 ft.
4240 – 410 4230 – 420 4220 – 430		

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-10 (2nd Installation)** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4 NE 1/4 SE 1/4 Sec. 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **554038.454 N, 1522890.51 E**
Elevation (Brass Cap): **4650.16 ft.**
Elevation (Top of Casing): **4651.21 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **G. Cardenas**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **601.41 ft.**
Borehole Diameter: **24" to 9.0 ft.; 17 1/2" to 355.0 ft.; 12 1/4" to 601.4 ft.**
Depth to Bedrock (bgs): **235 ft; Rhyolite**
Depth to Groundwater: **318.48 ft. TOC (2/15/07)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **8/6 - 8/25/04**
Date(s) Well Installed: **12/9 - 12/10/06**
Date(s) Well Developed: **12/11 - 12/22/06**
Field Representative(s): **G. Giles**
Total Depth Well Casing (bgs): **597.40 ft.**
Type of Casing: **CertainTeed SDR 17 PVC**
Diameter Well Casing: **6" ID, 6 9/10" OD**
Screened Zone (bgs): **397.20 - 597.30 ft.**
Comments: **Located on a MPCA structure identified from seismic data**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
CertainTeed SDR 17 PVC

Well Screen
CertainTeed SDR 17 0.032"-Slot PVC

Bolted Steel Centralizer

PVC End Cap

Water Table

Annular Materials Explanation

Neat Cement

8/12 Filter Pack Sand

Bentonite Grout

Slough

12/20 Sand Bentonite Mix

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4210 – 440 4200 – 450 4190 – 460 4180 – 470 4170 – 480 4160 – 490 4150 – 500 4140 – 510 4130 – 520 4120 – 530 4110 – 540 4100 – 550 4090 – 560 4080 – 570 4070 – 580 4060 – 590 4050 – 600	Steel cage centralizer bolted together around casing coupling at 497.25 ft. Bottom of 6" ID CertainTeed SDR 17 0.032"-Slot PVC Screen = 597.30 ft. Steel cage centralizer bolted together around casing at 597.40 ft. 6" ID; 6 9/10" OD CertainTeed SDR 17 PVC Casing TD = 597.40 ft.	Volcanic bedrock (Dacite) depth = 460 ft. Volcanic bedrock (Rhyolite) depth = 515 ft. 12 1/4" Borehole TD= 601.41 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-11 (2007 Reinstallation)** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4 SE 1/4 SE 1/4 Sec. 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553445.278 N, 1522746.287 E**
Elevation (Brass Cap): **4648.8 ft.**
Elevation (Top of Casing): **4650.66 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **G. Cardenas**
Method of Drilling: **Reverse Mud Rotary**
Total Depth of Borehole (bgs): **609.0 ft.**
Borehole Diameter: **24" to 10 ft.; 17 1/2" to 423 ft.; 12 1/4" to 609 ft.**
Depth to Bedrock (bgs): **~310 ft; Rhyolite**
Depth to Groundwater: **494.80 ft. TOC (2/15/2007)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **9/17 - 10/4/04**
Date(s) Well Installed: **1/05, 1/07/07**
Date(s) Well Developed: **Bail/Swab (1/8 - 6/07); Pump (1/10 - 16/07)**
Field Representative(s): **M. Canavan, J. Pearson**
Total Depth Well Casing (bgs): **600.0 ft.**
Type of Casing: **CertainTeed SDR 17 PVC**
Diameter Well Casing: **6" ID, 6 9/10" OD**
Screened Zone (bgs): **499.75 - 599.96 ft.**
Comments: **Casing pulled 11/13-11/14/07, Reamed 1/4/07, Completed (PVC) 1/7/07**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
CertainTeed SDR 17 PVC

Well Screen
CertainTeed SDR 17 0.032"-Slot PVC

Bolted Steel Centralizer

PVC End Cap

Water Table

Annular Materials Explanation

Neat Cement

8/12 Filter Pack Sand

Bentonite Grout

Slough

12/20 Sand Bentonite Mix

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4650 / 0	Stick-Up = 1.83 ft. ags	
4640 / 10	20" Steel Conductor pipe installed and cemented to 9.00 ft. bgs	24" borehole cemented to 10.0 ft.
4630 / 20	This well ultimately completed with a well vault.	Top of Bentonite Grout (Grout Well DF) = 11.70 ft.
4620 / 30		
4610 / 40		
4600 / 50	Note: Original carbon steel well casing installed 10/15/04 was pulled, borehole reamed, and PVC well casing installed for potential use as Mid-Plume extraction well.	
4590 / 60		
4580 / 70		
4570 / 80		
4560 / 90		
4550 / 100	Steel cage centralizer bolted together around casing coupling at 100.75 ft.	
4540 / 110		
4530 / 120		
4520 / 130		
4510 / 140		
4500 / 150		
4490 / 160		
4480 / 170		
4470 / 180		
4460 / 190		
4450 / 200	Steel cage centralizer bolted together around casing coupling at 200.50 ft.	
4440 / 210		

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-11 (2007 Reinstallation)** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4 SE 1/4 SE 1/4 Sec. 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553445.278 N, 1522746.287 E**
Elevation (Brass Cap): **4648.8 ft.**
Elevation (Top of Casing): **4650.66 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **G. Cardenas**
Method of Drilling: **Reverse Mud Rotary**
Total Depth of Borehole (bgs): **609.0 ft.**
Borehole Diameter: **24" to 10 ft.; 17 1/2" to 423 ft.; 12 1/4" to 609 ft.**
Depth to Bedrock (bgs): **~310 ft; Rhyolite**
Depth to Groundwater: **494.80 ft. TOC (2/15/2007)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **9/17 - 10/4/04**
Date(s) Well Installed: **1/05, 1/07/07**
Date(s) Well Developed: **Bail/Swab (1/8 - 6/07); Pump (1/10 - 16/07)**
Field Representative(s): **M. Canavan, J. Pearson**
Total Depth Well Casing (bgs): **600.0 ft.**
Type of Casing: **CertainTeed SDR 17 PVC**
Diameter Well Casing: **6" ID, 6 9/10" OD**
Screened Zone (bgs): **499.75 - 599.96 ft.**
Comments: **Casing pulled 11/13-11/14/07, Reamed 1/4/07, Completed (PVC) 1/7/07**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
CertainTeed SDR 17 PVC

Well Screen
CertainTeed SDR 17 0.032"-Slot PVC

Bolted Steel Centralizer

PVC End Cap

Water Table

Annular Materials Explanation

Neat Cement

Bentonite Grout

12/20 Sand Bentonite Mix

8/12 Filter Pack Sand

Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4430 / 220 4420 / 230 4410 / 240 4400 / 250 4390 / 260 4380 / 270 4370 / 280 4360 / 290 4350 / 300 4340 / 310 4330 / 320 4320 / 330 4310 / 340 4300 / 350 4290 / 360 4280 / 370 4270 / 380 4260 / 390 4250 / 400 4240 / 410 4230 / 420 4220 / 430	Steel cage centralizer bolted together around casing coupling at 300.25 ft. Steel cage centralizer bolted together around casing coupling at 400.0 ft. 14" OD Carbon Steel Surface Casing Depth = 420.0 ft.	Volcanic bedrock (Rhyolite) depth = 310 ft. Top of 8/12 Sand = 350 ft. Altered volcanic bedrock depth = 400 ft. 17 1/2" borehole cemented to 423.0 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **MPE-11 (2007 Reinstallation)** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4 SE 1/4 SE 1/4 Sec. 33, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553445.278 N, 1522746.287 E**
Elevation (Brass Cap): **4648.8 ft.**
Elevation (Top of Casing): **4650.66 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **G. Cardenas**
Method of Drilling: **Reverse Mud Rotary**
Total Depth of Borehole (bgs): **609.0 ft.**
Borehole Diameter: **24" to 10 ft.; 17 1/2" to 423 ft.; 12 1/4" to 609 ft.**
Depth to Bedrock (bgs): **~310 ft; Rhyolite**
Depth to Groundwater: **494.80 ft. TOC (2/15/2007)**
Diameter and Type Surface Casing: **13 1/2" ID; 14" OD**

Dates Borehole Drilled: **9/17 - 10/4/04**
Date(s) Well Installed: **1/05, 1/07/07**
Date(s) Well Developed: **Bail/Swab (1/8 - 6/07); Pump (1/10 - 16/07)**
Field Representative(s): **M. Canavan, J. Pearson**
Total Depth Well Casing (bgs): **600.0 ft.**
Type of Casing: **CertainTeed SDR 17 PVC**
Diameter Well Casing: **6" ID, 6 9/10" OD**
Screened Zone (bgs): **499.75 - 599.96 ft.**
Comments: **Casing pulled 11/13-11/14/07, Reamed 1/4/07, Completed (PVC) 1/7/07**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
CertainTeed SDR 17 PVC

Well Screen
CertainTeed SDR 17 0.032"-Slot PVC

Bolted Steel Centralizer

PVC End Cap

Water Table

Annular Materials Explanation

Neat Cement

8/12 Filter Pack Sand

Bentonite Grout

Slough

12/20 Sand Bentonite Mix

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4210 – 440 4200 – 450 4190 – 460 4180 – 470 4170 – 480 4160 – 490 4150 – 500 4140 – 510 4130 – 520 4120 – 530 4110 – 540 4100 – 550 4090 – 560 4080 – 570 4070 – 580 4060 – 590 4050 – 600 4040 – 610	Water Table Depth = 494.8 ft. (measured post development 2/15/07) Steel cage centralizer bolted together around casing coupling at 499.75 ft. Top of 6" ID CertainTeed SDR 17 0.032"-Slot PVC Screen = 499.75 ft. Bottom of 6" ID CertainTeed SDR 17 0.032"-Slot PVC Screen = 599.96 ft. 6" ID; 6 9/10" OD CertainTeed SDR 17 PVC Casing TD = 600.0 ft.	12 1/4" Borehole TD= 601.41 ft. 12 1/4" borehole 355.00' - 609.0 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-1** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 SE 1/4 NW 1/4 Sec 32, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **555085.114 N, 1514732.944 E**
Elevation (Brass Cap): **4486.2 ft.**
Elevation (Top of Casing): **4490.894 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **788 ft.**
Borehole Diameter: **17 1/2" 0 - 100 ft. (reamed to 26"); 17 1/2" 100 - 788 ft.**
Depth to Bedrock (bgs): **~652 ft; (Andesite)**
Depth to Groundwater: **422.63 ft. post development ~(6/30/00)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **1/10 - 1/24/00**
Date(s) Well Installed: **1/26/00 - 2/3/00**
Date(s) Well Developed: **2/9 - 2/10/00 (bail); 6/12 - 6/29/00 (pump)**
Field Representative(s): **M. Canavan, G. Giles, L. H-Mack, J. Kirby,...**
Total Depth Well Casing (bgs): **768.4 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **9.31" ID; 10.75" OD**
Screened Zone (bgs): **389.0 - 748.4 ft.**
Comments: **Field Reps. cont'd: J. Pearson, M. Rivera, R. Weaver**
bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

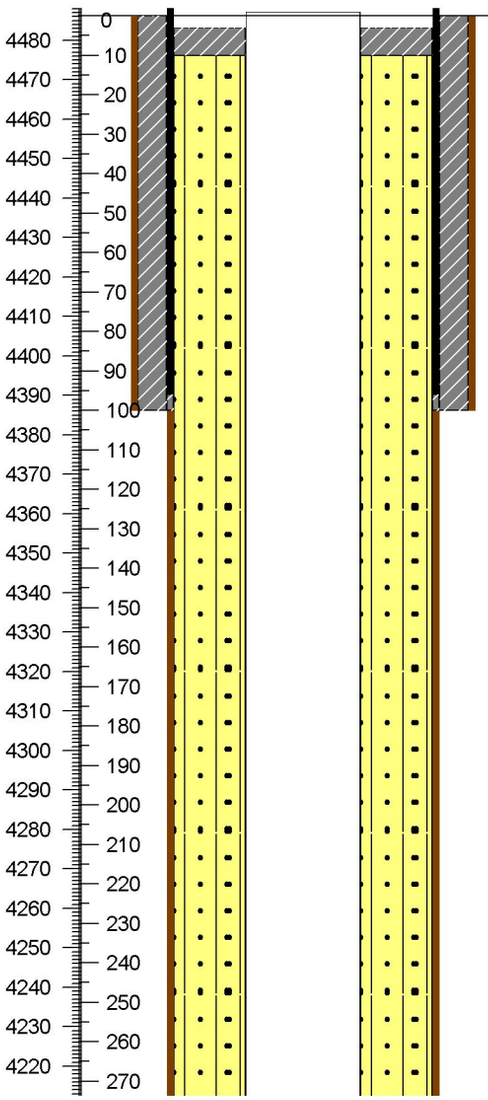
Casing Explanation

Surface Casing
14" OD Carbon Steel
Completion Casing
CertainTeed PVC
CertainTeed PVC
Well Screen
CertainTeed PVC
0.085"-Slot
Steel Centralizer
Steel End Cap
Water Table

Annular Materials Explanation

Neat Cement
Bentonite Grout
Bentonite Seal
4/8 Filter Pack Sand
12/20 Sand Bentonite Mix
Slough

Elevation (ft amsl) / Depth (ft bgs)



Borehole/Well Casing Descriptions
All depths are below ground surface

Stick-Up = 1.0 ft. ags at installation.
Surface Casing Stick-Up = 2 ft. ags at installation

The well was completed as an Extraction well below grade in a cement vault.

NOTE: Individual casing joints not measured at installation. Average joint length approximately 19.95' based on measurements at PFE-4 installation.

20" OD Carbon Steel Surface Casing Depth = 96.0 ft.

Annular Materials Descriptions
All depths are below ground surface

Top of Cement Grout (Portland II) = 3 ft.
Top of 4/8 Sand/Bentonite Mix = 10 ft.

Alluvium formation from surface is Santa Fe Group to 500.0 ft.

17 1/2" (reamed 26") borehole cemented to 100 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-1** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 SE 1/4 NW 1/4 Sec 32, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **555085.114 N, 1514732.944 E**
Elevation (Brass Cap): **4486.2 ft.**
Elevation (Top of Casing): **4490.894 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **788 ft.**
Borehole Diameter: **17 1/2" 0 - 100 ft. (reamed to 26"); 17 1/2" 100 - 788 ft.**
Depth to Bedrock (bgs): **~652 ft; (Andesite)**
Depth to Groundwater: **422.63 ft. post development ~(6/30/00)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **1/10 - 1/24/00**
Date(s) Well Installed: **1/26/00 - 2/3/00**
Date(s) Well Developed: **2/9 - 2/10/00 (bail); 6/12 - 6/29/00 (pump)**
Field Representative(s): **M. Canavan, G. Giles, L. H-Mack, J. Kirby,...**
Total Depth Well Casing (bgs): **768.4 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **9.31" ID; 10.75" OD**
Screened Zone (bgs): **389.0 - 748.4 ft.**
Comments: **Field Reps. cont'd: J. Pearson, M. Rivera, R. Weaver**
bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

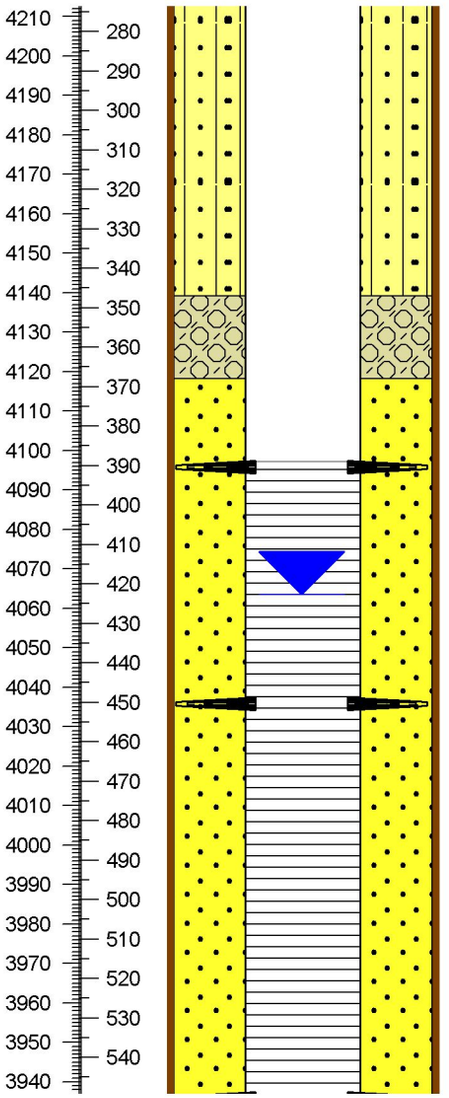
Casing Explanation

Surface Casing
14" OD Carbon Steel
Completion Casing
CertainTeed PVC
CertainTeed PVC
Well Screen
CertainTeed PVC
0.085"-Slot
Steel Centralizer
Steel End Cap
Water Table

Annular Materials Explanation

Neat Cement
Bentonite Grout
Bentonite Seal
4/8 Filter Pack Sand
12/20 Sand Bentonite Mix
Slough

Elevation (ft amsl) / Depth (ft bgs)



Borehole/Well Casing Descriptions
All depths are below ground surface

Steel cage centralizer bolted together around casing coupling at 389.0 ft.
Top of Screen = 389.0 ft. (9.31" minimum ID/ 10.75" OD CertainTeed SDR 17 0.085" - Slot PVC)

Water Table Depth = 422.63 ft. post-development 6/30/00

Steel cage centralizer bolted together around casing coupling 448.9 ft.

Annular Materials Descriptions
All depths are below ground surface

Top of Upper Bentonite Seal = 347 ft.

Top of 4/8 Sand = 368 ft.

Volcanic-Rich Alluvium Depth = 500 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-1** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 SE 1/4 NW 1/4 Sec 32, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **555085.114 N, 1514732.944 E**
Elevation (Brass Cap): **4486.2 ft.**
Elevation (Top of Casing): **4490.894 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **788 ft.**
Borehole Diameter: **17 1/2" 0 - 100 ft. (reamed to 26"); 17 1/2" 100 - 788 ft.**
Depth to Bedrock (bgs): **~652 ft; (Andesite)**
Depth to Groundwater: **422.63 ft. post development ~(6/30/00)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **1/10 - 1/24/00**
Date(s) Well Installed: **1/26/00 - 2/3/00**
Date(s) Well Developed: **2/9 - 2/10/00 (bail); 6/12 - 6/29/00 (pump)**
Field Representative(s): **M. Canavan, G. Giles, L. H-Mack, J. Kirby,...**
Total Depth Well Casing (bgs): **768.4 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **9.31" ID; 10.75" OD**
Screened Zone (bgs): **389.0 - 748.4 ft.**
Comments: **Field Reps. cont'd: J. Pearson, M. Rivera, R. Weaver**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
14" OD Carbon Steel

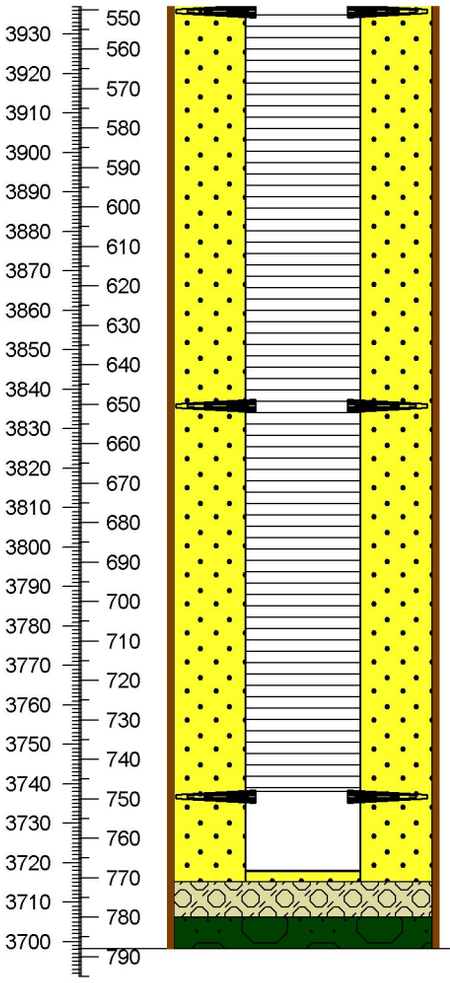
Completion Casing
CertainTeed PVC
CertainTeed PVC

Well Screen
CertainTeed PVC
0.085"-Slot

Steel Centralizer
Steel End Cap
Water Table

Annular Materials Explanation

Neat Cement
Bentonite Grout
Bentonite Seal
4/8 Filter Pack Sand
12/20 Sand Bentonite Mix
Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
	Steel cage centralizer bolted together around casing coupling 548.6 ft.	
	Steel cage centralizer bolted together around casing coupling 648.4 ft.	Volcanic Andesite Bedrock Depth = 652 ft.
	Bottom of Screen = 748.10 ft. (9.31" minimum ID/ 10.75" OD CertainTeed SDR 17 0.085" - Slot PVC)	
	Steel cage centralizer bolted together around casing coupling at 748.1 ft.	
	Sump consists of 20' blank riser and end cap	
	Casing TD = 768.40 ft.; 9.31" minimum ID; 10.75" OD CertainTeed SDR 17 PVC	Top of Lower Bentonite Seal = 771 ft.
		Top of Slough = 780 ft.
		17 1/2" Borehole TD = 788 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-2** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SW 1/4, SW 1/4, SE 1/4, Sec 32, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553009.753 N, 1515441.771 E**
Elevation (Brass Cap): **4499.307 ft.**
Elevation (Top of Casing): **4502.57 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **912 ft.**
Borehole Diameter: **17 1/2" 0-100 ft.; reamed 26"; 17 1/2" 100-912 ft.**
Depth to Bedrock (bgs): **700 ft; (Andesite)**
Depth to Groundwater: **434.02 ft. post development ~(6/30/00)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled:
Date(s) Well Installed: **1/26/00 - 2/3/00**
Date(s) Well Developed:
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **768.4 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **9.31" ID; 10.75" OD**
Screened Zone (bgs): **397.5-875.8 ft.**
Comments: **Field Reps. cont'd: Jack Kirby, John Pearson, Murry Stepro**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
CertainTeed PVC
CertainTeed PVC

Well Screen
CertainTeed PVC
0.085"-Slot

Steel Centralizer
Steel End Cap
Water Table

Annular Materials Explanation

Neat Cement
Bentonite Grout
Bentonite Seal
4/8 Filter Pack Sand
12/20 Sand Bentonite Mix
Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4500 / 0	Stick-Up = 1.0 ft. ags at installation. Surface Casing Stick-Up = 2 ft. ags at installation	
4490 / 10		Top of Cement Grout (Portland II) = 10 ft.
4480 / 20	The well was completed as an Extraction well below grade in a cement vault.	
4470 / 30		Top of 4/8 Sand/Bentonite Mix = 21 ft.
4460 / 40		
4450 / 50		
4440 / 60		Alluvium formation from surface is Santa Fe Group to 525.0 ft.
4430 / 70		
4420 / 80		
4410 / 90		
4400 / 100	20" OD Carbon Steel Surface Casing Depth = 100.0 ft.	17 1/2" (reamed 26") borehole cemented to 100 ft.
4390 / 110		
4380 / 120		
4370 / 130		
4360 / 140		
4350 / 150		
4340 / 160		
4330 / 170		
4320 / 180		
4310 / 190		
4300 / 200		
4290 / 210		
4280 / 220		
4270 / 230		
4260 / 240		
4250 / 250		
4240 / 260		

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
CertainTeed PVC
CertainTeed PVC

Well Screen
CertainTeed PVC
0.085"-Slot

Bolted Steel Centralizer

PVC End Cap

Water Table

Annular Materials Exlplanation

Neat Cement

Bentonite Grout

12/20 Sand Bentonite Mix

10/20 Filter Pack Sand

Slough

Depth **Feet/Meters**	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4230 270 4220 280 4210 290 4200 300 4190 310 4180 320 4170 330 4160 340 4150 350 4140 360 4130 370 4120 380 4110 390 4100 400 4090 410 4080 420 4070 430 4060 440 4050 450 4040 460 4030 470 4020 480 4010 490 4000 500 3990 510 3980 520 3970 530 3960 540 3950 550 3940 560 3930 570 3920 580 3910 590 3900 600 3890 610 3880 620 3870 630 3860 640 3850 650	Steel cage centralizer bolted together around casing coupling at 397.5 ft. Top of Screen = 397.5 ft. (9.31" minimum ID/ 10.75" OD CertainTeed SDR 17 0.085" - Slot PVC) Water Table Depth = 434.02 ft. post-development 7/21/00 Steel cage centralizer bolted together around casing coupling 477.2 ft. Steel cage centralizer bolted together around casing coupling 576.8 ft.	Top of Upper Bentonite Seal = 361 ft. Top of 4/8 Sand = 381 ft. Volcanic-Rich Alluvium Depth = 525 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

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

Location ID: **PFE-2** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SW 1/4, SW 1/4, SE 1/4, Sec 32, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553009.753 N, 1515441.771 E**
Elevation (Brass Cap): **4499.307 ft.**
Elevation (Top of Casing): **4502.57 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **912 ft.**
Borehole Diameter: **17 1/2" 0-100 ft.; reamed 26"; 17 1/2" 100-912 ft.**
Depth to Bedrock (bgs): **700 ft; (Andesite)**
Depth to Groundwater: **434.02 ft. post development ~(6/30/00)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled:
Date(s) Well Installed: **1/26/00 - 2/3/00**
Date(s) Well Developed:
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **768.4 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **9.31" ID; 10.75" OD**
Screened Zone (bgs): **397.5-875.8 ft.**
Comments: **Field Reps. cont'd: Jack Kirby, John Pearson, Murry Stepro**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
CertainTeed PVC
CertainTeed PVC

Well Screen
CertainTeed PVC
0.085"-Slot

Steel Centralizer
Steel End Cap
Water Table

Annular Materials Explanation

Neat Cement
Bentonite Grout
Bentonite Seal
4/8 Filter Pack Sand
12/20 Sand Bentonite Mix
Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
3840 660 3830 670 3820 680 3810 690 3800 700 3790 710 3780 720 3770 730 3760 740 3750 750 3740 760 3730 770 3720 780 3710 790 3700 800 3690 810 3680 820 3670 830 3660 840 3650 850 3640 860 3630 870 3620 880 3610 890 3600 900 3590 910	Steel cage centralizer bolted together around casing coupling 676.5 ft. Steel cage centralizer bolted together around casing coupling 776.2 ft. Bottom of Screen = 875.8 ft. (9.31" minimum ID/ 10.75" OD CertainTeed SDR 17 0.085" - Slot PVC) Steel cage centralizer bolted together around casing coupling at 875.8 ft. Sump consists of 20' blank riser and end cap Casing TD = 896.2 ft.; 9.31" minimum ID; 10.75" OD CertainTeed SDR 17 PVC	Volcanic Andesite Bedrock Depth = 700 ft. Top of Lower Bentonite Seal = 900 ft. Top of Slough = 906 ft. 17 1/2" Borehole TD = 912 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-3** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SW 1/4, NE 1/4, NE 1/4, Sec 5, T21S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **551232.555 N, 1516656.499 E**
Elevation (Brass Cap): **4525.42 ft.**
Elevation (Top of Casing): **4523.92 ft.**
Drilling Contractor: **Larjon Drilling Company**
Driller: **Tommy Crawford; Jim Gower**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **856 ft.**
Borehole Diameter: **16" 0-79 ft.; 7 7/8" pilot; reamed 17 7/8" 79-856 ft; cored**
Depth to Bedrock (bgs): **844 ft. (Andesite)**
Depth to Groundwater: **459 ft. (measured 1/16/03)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **9/21 - 12/18/89**
Date(s) Well Installed: **O = 12/19 - 1/5/90; I = 1/22 - 1/24/03**
Date(s) Well Developed: **O = 1/9 - 1/12/90; 3/29/90; I = 1/25 - 1/29/03**
Field Representative(s): **Greg Contaldo, Robert Cooper, Pam Egan...**
Total Depth Well Casing (bgs): **O= 838.5 ft.; I= 836.1 ft.**
Type of Casing: **O = Carbon Steel; I = CertainTeed PVC**
Diameter Well Casing: **O = 10.5 OD; I = 6.90" OD**
Screened Zone (bgs): **O= 507.7-828.4 ft.; I= 477.1-816 ft.**
Comments: **Field Reps. cont'd: Jack Kirby, Earl Morse**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface O = Outer I = Inner
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing **Removed**

O I Completion Casing
O = 10.5 OD; I = 6.90" OD
O= Carbon Steel; I= CertainTeed PVC

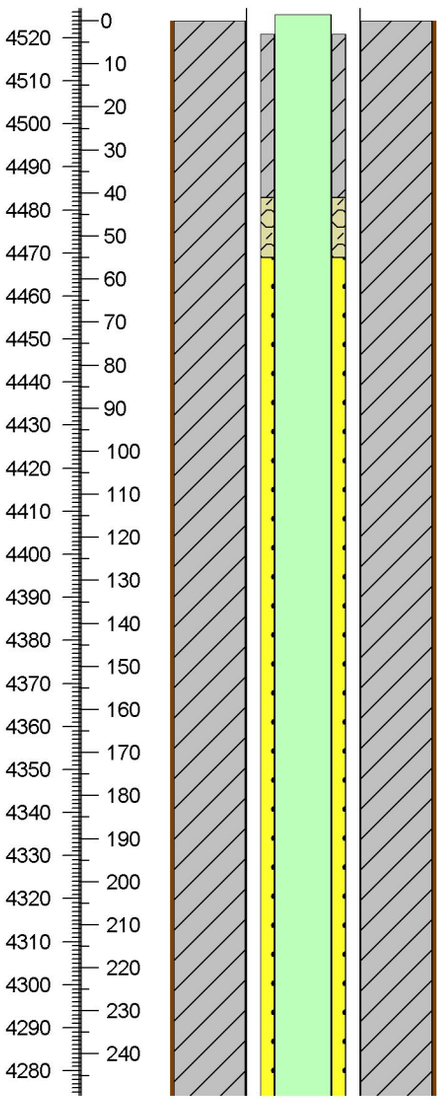
O I Well Screen
O = 10.5 OD; I = 6.90" OD
0.080"-Slot

Steel Centralizer
Steel End Cap
Water Table

Annular Materials Explanation

Neat Cement
Bentonite Grout
Bentonite Seal
4/8 Filter Pack Sand
8/20 Sand
Slough
16/40 Sand

Elevation (ft amsl) / Depth (ft bgs)



Borehole/Well Casing Descriptions
All depths are below ground surface

Surface Casing Removed
Outer Casing Stick-Up = 1.5 ft. ags at installation.

Inner Casing Stick-Up = 3.11 ft. ags installed at installation to sit level on flange of carbon steel well. Casing was later cut below ground surface as well was completed within a cement well vault.

Carbon steel casing welded together. Schedule of casing not recorded.

Annular Materials Descriptions
All depths are below ground surface

Top of Cement Grout (Portland II) = 0 ft.

Alluvium formation from surface is Santa Fe Group to 500.0 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-3** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SW 1/4, NE 1/4, NE 1/4, Sec 5, T21S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **551232.555 N, 1516656.499 E**
Elevation (Brass Cap): **4525.42 ft.**
Elevation (Top of Casing): **4523.92 ft.**
Drilling Contractor: **Larjon Drilling Company**
Driller: **Tommy Crawford; Jim Gower**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **856 ft.**
Borehole Diameter: **16" 0-79 ft.; 7 7/8" pilot; reamed 17 7/8" 79-856 ft; cored**
Depth to Bedrock (bgs): **844 ft. (Andesite)**
Depth to Groundwater: **459 ft. (measured 1/16/03)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **9/21 - 12/18/89**
Date(s) Well Installed: **O = 12/19 - 1/5/90; I = 1/22 - 1/24/03**
Date(s) Well Developed: **O = 1/9 - 1/12/90; 3/29/90; I = 1/25 - 1/29/03**
Field Representative(s): **Greg Contaldo, Robert Cooper, Pam Egan...**
Total Depth Well Casing (bgs): **O= 838.5 ft.; I= 836.1 ft.**
Type of Casing: **O = Carbon Steel; I = CertainTeed PVC**
Diameter Well Casing: **O = 10.5 OD; I = 6.90" OD**
Screened Zone (bgs): **O= 507.7-828.4 ft.; I= 477.1-816 ft.**
Comments: **Field Reps. cont'd: Jack Kirby, Earl Morse**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface O = Outer I = Inner
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing **Removed**

O I Completion Casing
O = 10.5 OD; I = 6.90" OD
O= Carbon Steel; I= CertainTeed PVC

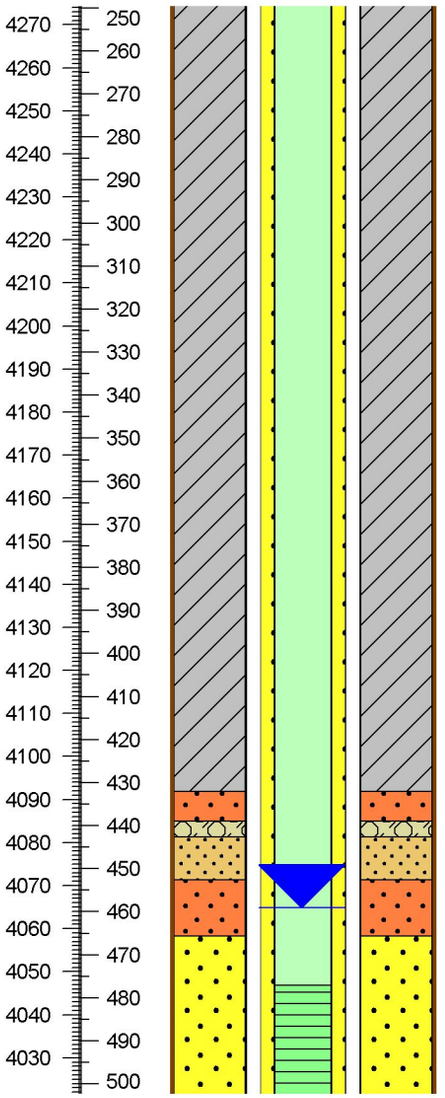
O I Well Screen
O = 10.5 OD; I = 6.90" OD
0.080"-Slot

Steel Centralizer
Steel End Cap
Water Table

Annular Materials Explanation

Neat Cement
Bentonite Grout
Bentonite Seal
4/8 Filter Pack Sand
8/20 Sand
Slough
16/40 Sand

Elevation (ft amsl) / Depth (ft bgs)



Borehole/Well Casing Descriptions
All depths are below ground surface

Water Table Depth = 459 ft. bgs; (from camera logcounter 1/16/03)

6.9" OD PVC casing Inner Screened zone made up of one 20 ft.screen, one 20 ft. blank, then three 20 ft. screens separated by20 ft. blanks.

Top of 6.13" minimum ID (6.05" ID measured); 6.9" OD CertainTeed SDR 21 0.050"-Slot PVC Inner Screen = 477.1

Annular Materials Descriptions
All depths are below ground surface

Top of 8/20 Sand = 432 ft. (Exact depth not measured due to malfunctioning probe)
Top of Bentonite Seal = 439 ft. (Exact depth not measured due to malfunctioning probe)
Top of 16/40 Sand = 442.6 ft. (Exact depth not measured due to malfunctioning probe)
Top of 8/20 Sand = 452.6 ft. (Exact depth not measured due to malfunctioning probe)

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-3** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SW 1/4, NE 1/4, NE 1/4, Sec 5, T21S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **551232.555 N, 1516656.499 E**
Elevation (Brass Cap): **4525.42 ft.**
Elevation (Top of Casing): **4523.92 ft.**
Drilling Contractor: **Larjon Drilling Company**
Driller: **Tommy Crawford; Jim Gower**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **856 ft.**
Borehole Diameter: **16" 0-79 ft.; 7 7/8" pilot; reamed 17 7/8" 79-856 ft; cored**
Depth to Bedrock (bgs): **844 ft. (Andesite)**
Depth to Groundwater: **459 ft. (measured 1/16/03)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **9/21 - 12/18/89**
Date(s) Well Installed: **O = 12/19 - 1/5/90; I = 1/22 - 1/24/03**
Date(s) Well Developed: **O = 1/9 - 1/12/90; 3/29/90; I = 1/25 - 1/29/03**
Field Representative(s): **Greg Contaldo, Robert Cooper, Pam Egan...**
Total Depth Well Casing (bgs): **O= 838.5 ft.; I= 836.1 ft.**
Type of Casing: **O = Carbon Steel; I = CertainTeed PVC**
Diameter Well Casing: **O = 10.5 OD; I = 6.90" OD**
Screened Zone (bgs): **O= 507.7-828.4 ft.; I= 477.1-816 ft.**
Comments: **Field Reps. cont'd: Jack Kirby, Earl Morse**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface O = Outer I = Inner
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing **Removed**

O I Completion Casing
O = 10.5 OD; I = 6.90" OD
O= Carbon Steel; I= CertainTeed PVC

O I Well Screen
O = 10.5 OD; I = 6.90" OD
0.080"-Slot

Steel Centralizer
Steel End Cap
Water Table

Annular Materials Explanation

Neat Cement
Bentonite Grout
Bentonite Seal
4/8 Filter Pack Sand
8/20 Sand
Slough
16/40 Sand

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4020 / 510		Top of 4/8 Sand = 465.6 ft.
4010 / 520	10.02" ID Carbon Steel Outer Screened zone made up of 20 ft. screens welded to 10 ft. blank sections.	
4000 / 530		
3990 / 540		
3980 / 550		Volcanic-Rich Alluvium Depth = 550 ft.
3970 / 560		
3960 / 570		
3950 / 580		
3940 / 590		
3930 / 600		
3920 / 610		
3910 / 620		
3900 / 630	Three stainless steel centralizers welded to casing at 623.5 ft.	
3890 / 640		
3880 / 650		
3870 / 660		
3860 / 670		
3850 / 680		
3840 / 690		
3830 / 700		
3820 / 710		
3810 / 720	Three stainless steel centralizers welded to casing at 713.5 ft.	
3800 / 730		
3790 / 740		
3780 / 750		
3770		

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-3** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SW 1/4, NE 1/4, NE 1/4, Sec 5, T21S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **551232.555 N, 1516656.499 E**
Elevation (Brass Cap): **4525.42 ft.**
Elevation (Top of Casing): **4523.92 ft.**
Drilling Contractor: **Larjon Drilling Company**
Driller: **Tommy Crawford; Jim Gower**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **856 ft.**
Borehole Diameter: **16" 0-79 ft.; 7 7/8" pilot; reamed 17 7/8" 79-856 ft; cored**
Depth to Bedrock (bgs): **844 ft. (Andesite)**
Depth to Groundwater: **459 ft. (measured 1/16/03)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **9/21 - 12/18/89**
Date(s) Well Installed: **O = 12/19 - 1/5/90; I = 1/22 - 1/24/03**
Date(s) Well Developed: **O = 1/9 - 1/12/90; 3/29/90; I = 1/25 - 1/29/03**
Field Representative(s): **Greg Contaldo, Robert Cooper, Pam Egan...**
Total Depth Well Casing (bgs): **O= 838.5 ft.; I= 836.1 ft.**
Type of Casing: **O = Carbon Steel; I = CertainTeed PVC**
Diameter Well Casing: **O = 10.5 OD; I = 6.90" OD**
Screened Zone (bgs): **O= 507.7-828.4 ft.; I= 477.1-816 ft.**
Comments: **Field Reps. cont'd: Jack Kirby, Earl Morse**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface O = Outer I = Inner
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing **Removed**

O I Completion Casing
O = 10.5 OD; I = 6.90" OD
O= Carbon Steel; I= CertainTeed PVC

O I Well Screen
O = 10.5 OD; I = 6.90" OD
0.080"-Slot

Steel Centralizer
Steel End Cap
Water Table

Annular Materials Explanation

Neat Cement
Bentonite Grout
Bentonite Seal
4/8 Filter Pack Sand
8/20 Sand
Slough
16/40 Sand

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
3760 760 3750 770 3740 780 3730 790 3720 800 3710 810 3700 820 3690 830 3680 840 3670 850 3660 860 870	Three stainless steel centralizers welded to casing at 803.5 ft. Bottom of 6.13" minimum ID (6.05" ID measured); 6.9" OD CertainTeed SDR 21 0.050"-Slot PVC Inner Screen = 816.0 ft. Bottom of 10.02" ID; 10.75" OD Carbon Steel Continuous Wire Wound 0.080"-Slot Outer Screen = 828.4 ft. 6.13" minimum ID (6.05" ID measured); 6.9" OD CertainTeed SDR 21 PVC Inner Casing TD = 836.1 ft. Inner Sump consists of 20 ft. blank riser with end cap attached with spline. Outer Sump consists of 10 ft. blank riser with end cap tapered and welded on. 10.02" ID; 10.75" OD Carbon Steel Outer Casing TD = 838.5 ft.	Top of Slough = 838 ft. Volcanic Andesite Bedrock Depth = 844 ft. 17 7/8" Borehole TD = 856 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-4a** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SW 1/4, SW 1/4, NW 1/4, Sec 4, T21S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **549921.892 N, 1517625.132 E**
Elevation (Brass Cap): **4537.02 ft.**
Elevation (Top of Casing): **4538.02 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **D. Gaddy**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **720 ft.**
Borehole Diameter: **17 1/2-in 0-117 ft.; reamed 26-in; 17 1/2-in 117-720 ft.**
Depth to Bedrock (bgs): **630 ft. (Andesite)**
Depth to Groundwater: **469.58 ft. (measured 9/4/01)**
Diameter and Type Surface Casing: **19.5-in ID; 20-in OD**

Dates Borehole Drilled: **8/2 - 8/12/01**
Date(s) Well Installed: **8/15 - 8/22/01**
Date(s) Well Developed: **8/23-24/01 jetted; 8/25/ - 9/5/01 pumping**
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **697.3 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **9.31-in ID; 10.75-in OD**
Screened Zone (bgs): **398.0-677.3 ft.**
Comments: **Field Reps. cont'd: John Pearson, Murry Stepro, Ron Weaver**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
20" OD Carbon Steel

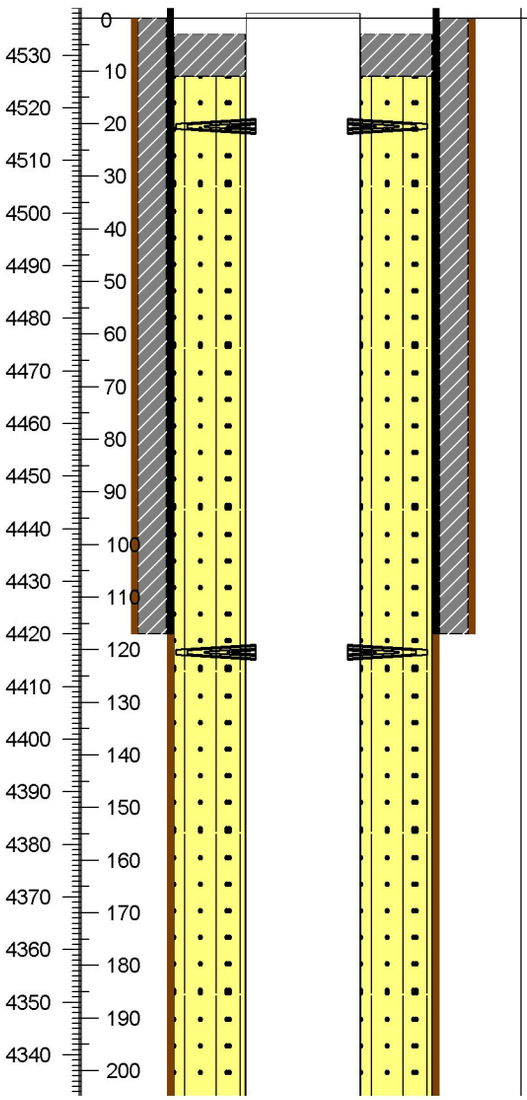
Completion Casing
9.31-in ID; 10.75-in OD
CertainTeed PVC

Well Screen
9.31-in ID; 10.75-in OD
0.085-in Slot CertainTeed PVC

Steel Centralizer
Steel End Cap
Water Table

Annular Materials Explanation

Neat Cement
Bentonite Grout
Bentonite Seal
4/8 Filter Pack Sand
4/8 Sand Bentonite Mix
Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
	Stick-Up = 1.0 ft. ags at installation. Surface Casing Stick-Up = 2 ft. ags at installation Steel cage centralizer bolted together around casing coupling at 19 ft. The well was completed as an Extraction well below grade in a cement vault. 20-in OD Carbon Steel Surface Casing Depth = 100.0 ft. Steel cage centralizer bolted together around casing coupling at 118.8 ft.	Top of Cement Grout (Portland II) = 3 ft. Top of 4/8 Sand/Bentonite Mix = 11 ft. Alluvium formation from surface is Santa Fe Group to 480.0 ft. 17 1/2-in (reamed to 26-in) borehole cemented to 117 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-4a** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SW 1/4, SW 1/4, NW 1/4, Sec 4, T21S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **549921.892 N, 1517625.132 E**
Elevation (Brass Cap): **4537.02 ft.**
Elevation (Top of Casing): **4538.02 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **D. Gaddy**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **720 ft.**
Borehole Diameter: **17 1/2-in 0-117 ft.; reamed 26-in; 17 1/2-in 117-720 ft.**
Depth to Bedrock (bgs): **630 ft. (Andesite)**
Depth to Groundwater: **469.58 ft. (measured 9/4/01)**
Diameter and Type Surface Casing: **19.5-in ID; 20-in OD**

Dates Borehole Drilled: **8/2 - 8/12/01**
Date(s) Well Installed: **8/15 - 8/22/01**
Date(s) Well Developed: **8/23-24/01 jetted; 8/25/ - 9/5/01 pumping**
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **697.3 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **9.31-in ID; 10.75-in OD**
Screened Zone (bgs): **398.0-677.3 ft.**
Comments: **Field Reps. cont'd: John Pearson, Murry Stepro, Ron Weaver**
bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
20" OD Carbon Steel

Completion Casing
9.31-in ID; 10.75-in OD
CertainTeed PVC

Well Screen
9.31-in ID; 10.75-in OD
0.085-in Slot CertainTeed PVC

Steel Centralizer
Steel End Cap
Water Table

Annular Materials Explanation

Neat Cement
Bentonite Grout
Bentonite Seal
4/8 Filter Pack Sand
4/8 Sand Bentonite Mix
Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4330 / 210 4320 / 220 4310 / 230 4300 / 240 4290 / 250 4280 / 260 4270 / 270 4260 / 280 4250 / 290 4240 / 300 4230 / 310 4220 / 320 4210 / 330 4200 / 340 4190 / 350 4180 / 360 4170 / 370 4160 / 380 4150 / 390 4140 / 400 4130 / 410	Steel cage centralizer bolted together around casing coupling at 238.3 ft. Steel cage centralizer bolted together around casing coupling at 297.9 ft. Steel cage centralizer bolted together around casing coupling 358.0 ft. Top of Screen = 358.0 ft. (9.31-in minimum ID/ 10.75-in OD CertainTeed SDR 17 0.085-in - Slot PVC)	Top of Upper Bentonite Seal = 364 ft. Top of 4/8 Sand = 378 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-4a** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SW 1/4, SW 1/4, NW 1/4, Sec 4, T21S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **549921.892 N, 1517625.132 E**
Elevation (Brass Cap): **4537.02 ft.**
Elevation (Top of Casing): **4538.02 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **D. Gaddy**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **720 ft.**
Borehole Diameter: **17 1/2-in 0-117 ft.; reamed 26-in; 17 1/2-in 117-720 ft.**
Depth to Bedrock (bgs): **630 ft. (Andesite)**
Depth to Groundwater: **469.58 ft. (measured 9/4/01)**
Diameter and Type Surface Casing: **19.5-in ID; 20-in OD**

Dates Borehole Drilled: **8/2 - 8/12/01**
Date(s) Well Installed: **8/15 - 8/22/01**
Date(s) Well Developed: **8/23-24/01 jetted; 8/25/ - 9/5/01 pumping**
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **697.3 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **9.31-in ID; 10.75-in OD**
Screened Zone (bgs): **398.0-677.3 ft.**
Comments: **Field Reps. cont'd: John Pearson, Murry Stepro, Ron Weaver**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

- Surface Casing: **20" OD Carbon Steel**
- Completion Casing: **9.31-in ID; 10.75-in OD CertainTeed PVC**
- Well Screen: **9.31-in ID; 10.75-in OD 0.085-in Slot CertainTeed PVC**
- Steel Centralizer
- Steel End Cap
- Water Table

Annular Materials Explanation

- Neat Cement
- Bentonite Grout
- Bentonite Seal
- 4/8 Filter Pack Sand
- 4/8 Sand Bentonite Mix
- Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4120 / 420 4110 / 430 4100 / 440 4090 / 450 4080 / 460 4070 / 470 4060 / 480 4050 / 490 4040 / 500 4030 / 510 4020 / 520 4010 / 530 4000 / 540 3990 / 550 3980 / 560 3970 / 570 3960 / 580 3950 / 590 3940 / 600 3930 / 610 3920	Water Table Depth = 469.58 ft. (measured during development 9/4/01) Steel cage centralizer bolted together around casing coupling 477.8 ft. Steel cage centralizer bolted together around casing coupling 577.5 ft.	Volcanic-Rich Alluvium Depth = 480 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-4a** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SW 1/4, SW 1/4, NW 1/4, Sec 4, T21S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **549921.892 N, 1517625.132 E**
Elevation (Brass Cap): **4537.02 ft.**
Elevation (Top of Casing): **4538.02 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **D. Gaddy**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **720 ft.**
Borehole Diameter: **17 1/2-in 0-117 ft.; reamed 26-in; 17 1/2-in 117-720 ft.**
Depth to Bedrock (bgs): **630 ft. (Andesite)**
Depth to Groundwater: **469.58 ft. (measured 9/4/01)**
Diameter and Type Surface Casing: **19.5-in ID; 20-in OD**

Dates Borehole Drilled: **8/2 - 8/12/01**
Date(s) Well Installed: **8/15 - 8/22/01**
Date(s) Well Developed: **8/23-24/01 jetted; 8/25/ - 9/5/01 pumping**
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **697.3 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **9.31-in ID; 10.75-in OD**
Screened Zone (bgs): **398.0-677.3 ft.**
Comments: **Field Reps. cont'd: John Pearson, Murry Stepro, Ron Weaver**
bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

- Surface Casing: **20" OD Carbon Steel**
- Completion Casing: **9.31-in ID; 10.75-in OD CertainTeed PVC**
- Well Screen: **9.31-in ID; 10.75-in OD 0.085-in Slot CertainTeed PVC**
- Steel Centralizer
- Steel End Cap
- Water Table

Annular Materials Explanation

- Neat Cement
- 4/8 Filter Pack Sand
- Bentonite Grout
- 4/8 Sand Bentonite Mix
- Bentonite Seal
- Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
3910 / 620 3900 / 630 3890 / 640 3880 / 650 3870 / 660 3860 / 670 3850 / 680 3840 / 690 3830 / 700 3820 / 710 720	Bottom of Screen = 677.3 ft. (9.31-in minimum ID/ 10.75-in OD CertainTeed SDR 17 0.085-in - Slot PVC) Steel cage centralizer bolted together around casing coupling 677.3 ft. Sump consists of 20 ft. blank riser and end cap Casing TD = 697.3 ft.; 9.31-in minimum ID; 10.75-in OD CertainTeed SDR 17 PVC	Volcanic Andesite Bedrock Depth = 630 ft. Top of Lower Bentonite Seal = 711 ft. Top of Slough = 719 ft. 17 1/2-in Borehole TD = 720 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-5** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4, SW 1/4, SW 1/4, Sec 32, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **554429.994 N, 1516493.434 E**
Elevation (Brass Cap): **4516.707 ft.**
Elevation (Top of Casing): **4520.808 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **940 ft.**
Borehole Diameter: **17 1/2" 0-100 ft.; reamed 26"; 17 1/2" 100-940 ft.**
Depth to Bedrock (bgs): **590 ft. (Latite)**
Depth to Groundwater: **451.30 ft. (measured 5/11/00)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **7/12 - 7/25/01**
Date(s) Well Installed: **11/30 - 12/5/99**
Date(s) Well Developed: **2/1-5/00 bailing; 4/20 - 5/11/00 pumping**
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **817 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **7.85" ID; 9.05" OD**
Screened Zone (bgs): **418.0-797.0 ft.**
Comments: **Field Reps. cont'd: John Pearson, Murry Stepro, Ron Weaver**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

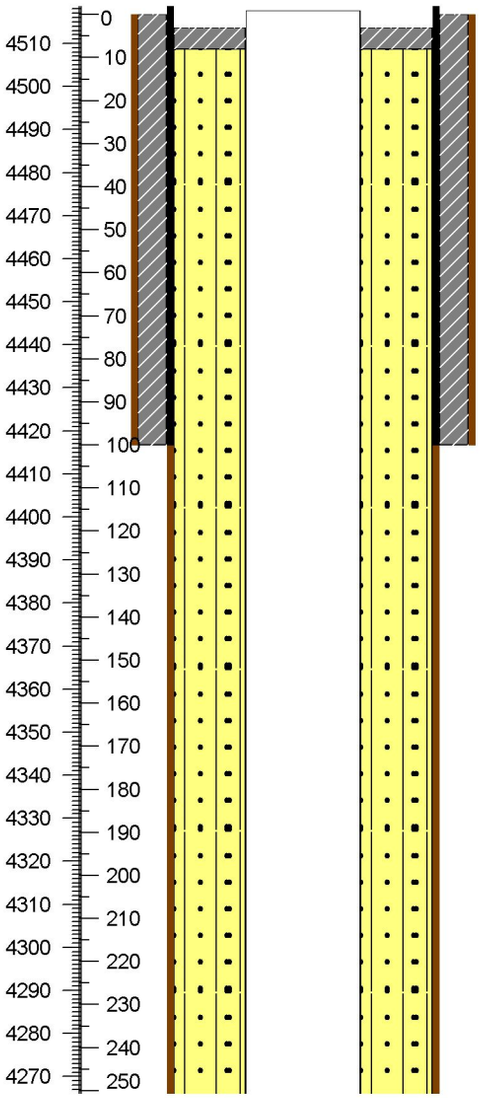
Casing Explanation

- Surface Casing — **19.5" OD Carbon Steel**
- Completion Casing — **7.85" ID; 9.05" OD CertainTeed PVC**
- Well Screen — **7.85" ID; 9.05" OD 0.085"-Slot**
- Steel Centralizer
- Steel End Cap
- Water Table

Annular Materials Explanation

- Neat Cement
- 1/8 Filter Pack (Gravel)
- Bentonite Grout
- 12/20 Sand Bentonite Mix
- Bentonite Seal
- Slough

Elevation (ft amsl) / Depth (ft bgs)



Borehole/Well Casing Descriptions
All depths are below ground surface

Stick-Up = 0.97 ft. ags at installation.
Surface Casing Stick-Up = 2 ft. ags at installation

The well was completed as an Extraction well below grade in a cement vault.

20" OD Carbon Steel Surface Casing Depth = 100.0 ft.

Annular Materials Descriptions
All depths are below ground surface

Top of Cement Grout (Portland II) = 3 ft.
Top of 8/20 Sand/Bentonite Mix = 8 ft.

Alluvium formation from surface is Santa Fe Group to 520.0 ft.

17 1/2" (reamed 26") borehole cemented to 117 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-5** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4, SW 1/4, SW 1/4, Sec 32, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **554429.994 N, 1516493.434 E**
Elevation (Brass Cap): **4516.707 ft.**
Elevation (Top of Casing): **4520.808 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **940 ft.**
Borehole Diameter: **17 1/2" 0-100 ft.; reamed 26"; 17 1/2" 100-940 ft.**
Depth to Bedrock (bgs): **590 ft. (Latite)**
Depth to Groundwater: **451.30 ft. (measured 5/11/00)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **7/12 - 7/25/01**
Date(s) Well Installed: **11/30 - 12/5/99**
Date(s) Well Developed: **2/1-5/00 bailing; 4/20 - 5/11/00 pumping**
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **817 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **7.85" ID; 9.05" OD**
Screened Zone (bgs): **418.0-797.0 ft.**
Comments: **Field Reps. cont'd: John Pearson, Murry Stepro, Ron Weaver**
bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

- Surface Casing — **19.5" OD Carbon Steel**
- Completion Casing — **7.85" ID; 9.05" OD CertainTeed PVC**
- Well Screen — **7.85" ID; 9.05" OD 0.085"-Slot**
- Steel Centralizer
- Steel End Cap
- Water Table

Annular Materials Explanation

- Neat Cement
- Bentonite Grout
- Bentonite Seal
- 1/8 Filter Pack (Gravel)
- 12/20 Sand Bentonite Mix
- Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4260 / 260 4250 / 270 4240 / 280 4230 / 290 4220 / 300 4210 / 310 4200 / 320 4190 / 330 4180 / 340 4170 / 350 4160 / 360 4150 / 370 4140 / 380 4130 / 390 4120 / 400 4110 / 410 4100 / 420 4090 / 430 4080 / 440 4070 / 450 4060 / 460 4050 / 470 4040 / 480 4030 / 490 4020 / 500	Steel cage centralizer bolted together around casing coupling at 418.0 ft. Top of 7.85" minimum ID; 9.05" OD CertainTeed SDR 17 0.085"-Slot PVC Screen = 418.0 ft. Water Table Depth = 451.3 ft. (measured during development 5/11/01) Steel cage centralizer bolted together around casing coupling 497.8 ft.	Top of 1/8 Gravel/Bentonite Mix = 250 ft. Top of Upper Bentonite Seal = 375 ft. Top of 1/8 Gravel = 400 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-5** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4, SW 1/4, SW 1/4, Sec 32, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **554429.994 N, 1516493.434 E**
Elevation (Brass Cap): **4516.707 ft.**
Elevation (Top of Casing): **4520.808 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **940 ft.**
Borehole Diameter: **17 1/2" 0-100 ft.; reamed 26"; 17 1/2" 100-940 ft.**
Depth to Bedrock (bgs): **590 ft. (Latite)**
Depth to Groundwater: **451.30 ft. (measured 5/11/00)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **7/12 - 7/25/01**
Date(s) Well Installed: **11/30 - 12/5/99**
Date(s) Well Developed: **2/1-5/00 bailing; 4/20 - 5/11/00 pumping**
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **817 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **7.85" ID; 9.05" OD**
Screened Zone (bgs): **418.0-797.0 ft.**
Comments: **Field Reps. cont'd: John Pearson, Murry Stepro, Ron Weaver**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

- Surface Casing — **19.5" OD Carbon Steel**
- Completion Casing — **7.85" ID; 9.05" OD** **CertainTeed PVC**
- Well Screen — **7.85" ID; 9.05" OD** **0.085"-Slot**
- Steel Centralizer
- Steel End Cap
- Water Table

Annular Materials Explanation

- Neat Cement
- Bentonite Grout
- Bentonite Seal
- 1/8 Filter Pack (Gravel)
- 12/20 Sand Bentonite Mix
- Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4010 / 510 4000 / 520 3990 / 530 3980 / 540 3970 / 550 3960 / 560 3950 / 570 3940 / 580 3930 / 590 3920 / 600 3910 / 610 3900 / 620 3890 / 630 3880 / 640 3870 / 650 3860 / 660 3850 / 670 3840 / 680 3830 / 690 3820 / 700 3810 / 710 3800 / 720 3790 / 730 3780 / 740 3770 / 750	Steel cage centralizer bolted together around casing coupling 597.5 ft. Steel cage centralizer bolted together around casing coupling 696.3 ft.	Volcanic-Rich Alluvium Depth = 520 ft. Volcanic Latite Bedrock Depth = 590 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-5** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4, SW 1/4, SW 1/4, Sec 32, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **554429.994 N, 1516493.434 E**
Elevation (Brass Cap): **4516.707 ft.**
Elevation (Top of Casing): **4520.808 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **940 ft.**
Borehole Diameter: **17 1/2" 0-100 ft.; reamed 26"; 17 1/2" 100-940 ft.**
Depth to Bedrock (bgs): **590 ft. (Latite)**
Depth to Groundwater: **451.30 ft. (measured 5/11/00)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **7/12 - 7/25/01**
Date(s) Well Installed: **11/30 - 12/5/99**
Date(s) Well Developed: **2/1-5/00 bailing; 4/20 - 5/11/00 pumping**
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **817 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **7.85" ID; 9.05" OD**
Screened Zone (bgs): **418.0-797.0 ft.**
Comments: **Field Reps. cont'd: John Pearson, Murry Stepro, Ron Weaver**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

- Surface Casing — **19.5" OD Carbon Steel**
- Completion Casing — **7.85" ID; 9.05" OD CertainTeed PVC**
- Well Screen — **7.85" ID; 9.05" OD 0.085"-Slot**
- Steel Centralizer
- Steel End Cap
- Water Table

Annular Materials Explanation

- Neat Cement
- Bentonite Grout
- Bentonite Seal
- 1/8 Filter Pack (Gravel)
- 12/20 Sand Bentonite Mix
- Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
3760 / 760 3750 / 770 3740 / 780 3730 / 790 3720 / 800 3710 / 810 3700 / 820 3690 / 830 3680 / 840 3670 / 850 3660 / 860 3650 / 870 3640 / 880 3630 / 890 3620 / 900 3610 / 910 3600 / 920 3590 / 930 3580 / 940	Bottom of 7.85" minimum ID; 9.05" OD CertainTeed SDR 17 0.085"-Slot PVC Screen = 797.0 ft. Steel cage centralizer bolted together around casing coupling 796.0 ft. Sump consists of 20' blank riser and end cap 7.85" minimum ID; 9.05" OD CertainTeed SDR 17 PVC Casing TD = 817.0 ft.	Volcanic Rhyolitic Tuff Bedrock Depth = 790 ft. Mixed Volcanic Latite and Rhyolitic Tuff Bedrock Depth = 820 ft. Top of Lower Bentonite Seal = 824 ft. Top of Slough = 932 ft. 17 1/2" Borehole TD = 940 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-7** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4, SW 1/4, SW 1/4, Sec 32, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553603.619 N, 1514082.197 E**
Elevation (Brass Cap): **4478.5 ft.**
Elevation (Top of Casing): **4479.5 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **D. Gaddy**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **720 ft.**
Borehole Diameter: **17 1/2" 0-117 ft.; reamed 26"; 17 1/2" 117-720 ft.**
Depth to Bedrock (bgs): **Not Reached**
Depth to Groundwater: **412.11 ft. (measured 8/27/01)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **7/12 - 7/25/01**
Date(s) Well Installed: **7/25 - 7/29/01**
Date(s) Well Developed: **7/29/01 jetted; 8/27/01 pumping**
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **697.6 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **9.31" ID; 10.75" OD**
Screened Zone (bgs): **398.0-677.6 ft.**
Comments: **Field Reps. cont'd: John Pearson, Murry Stepro, Ron Weaver**
bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
9.31" ID; 10.75" OD
CertainTeed PVC

Well Screen
9.31" ID; 10.75" OD
0.085"-Slot

Steel Centralizer

Steel End Cap

Water Table

Annular Materials Explanation

Neat Cement

Bentonite Grout

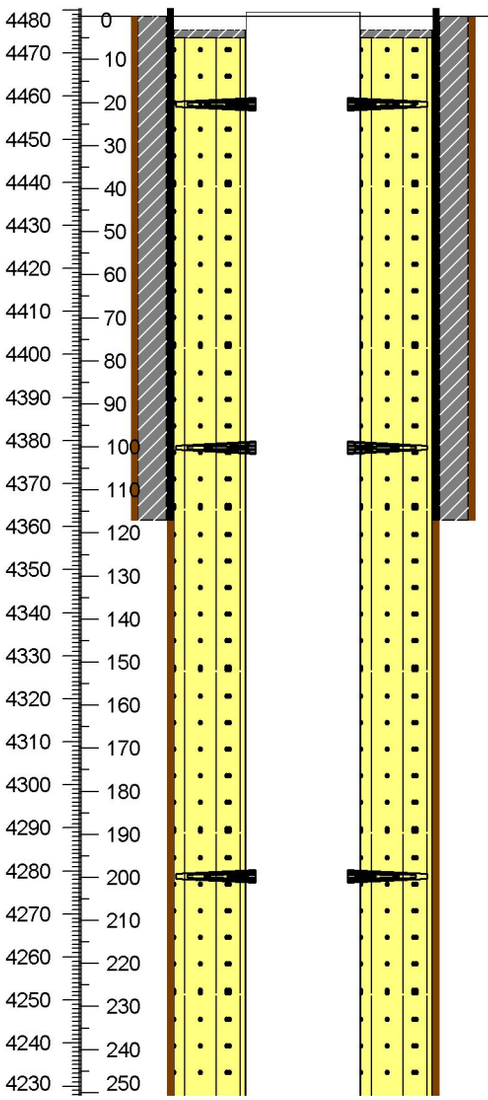
Bentonite Seal

4/8 Filter Pack Sand

12/20 Sand Bentonite Mix

Slough

Elevation (ft amsl) / Depth (ft bgs)



Borehole/Well Casing Descriptions
All depths are below ground surface

Stick-Up = 1.0 ft. ags at installation.
Surface Casing Stick-Up = 2 ft. ags at installation

Steel cage centralizer bolted together around casing coupling at 18.9 ft.

The well was completed as an Extraction well below grade in a cement vault.

NOTE: Number and locations of centralizers were not recorded at installation. Centralizers assumed to have been installed per the well design.

Steel cage centralizer bolted together around casing coupling at 98.6 ft.

20" OD Carbon Steel Surface Casing Depth = 100.0 ft.

Steel cage centralizer bolted together around casing coupling at 198.3 ft.

Annular Materials Descriptions
All depths are below ground surface

Top of Cement Grout (Portland II) = 3 ft.
Top of 4/8 Sand/Bentonite Mix = 5 ft.

Alluvium formation from surface is Santa Fe Group to 480.0 ft.

17 1/2" (reamed 26") borehole cemented to 117 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-7** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4, SW 1/4, SW 1/4, Sec 32, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553603.619 N, 1514082.197 E**
Elevation (Brass Cap): **4478.5 ft.**
Elevation (Top of Casing): **4479.5 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **D. Gaddy**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **720 ft.**
Borehole Diameter: **17 1/2" 0-117 ft.; reamed 26"; 17 1/2" 117-720 ft.**
Depth to Bedrock (bgs): **Not Reached**
Depth to Groundwater: **412.11 ft. (measured 8/27/01)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **7/12 - 7/25/01**
Date(s) Well Installed: **7/25 - 7/29/01**
Date(s) Well Developed: **7/29/01 jetted; 8/27/01 pumping**
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **697.6 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **9.31" ID; 10.75" OD**
Screened Zone (bgs): **398.0-677.6 ft.**
Comments: **Field Reps. cont'd: John Pearson, Murry Stepro, Ron Weaver**
bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
14" OD Carbon Steel

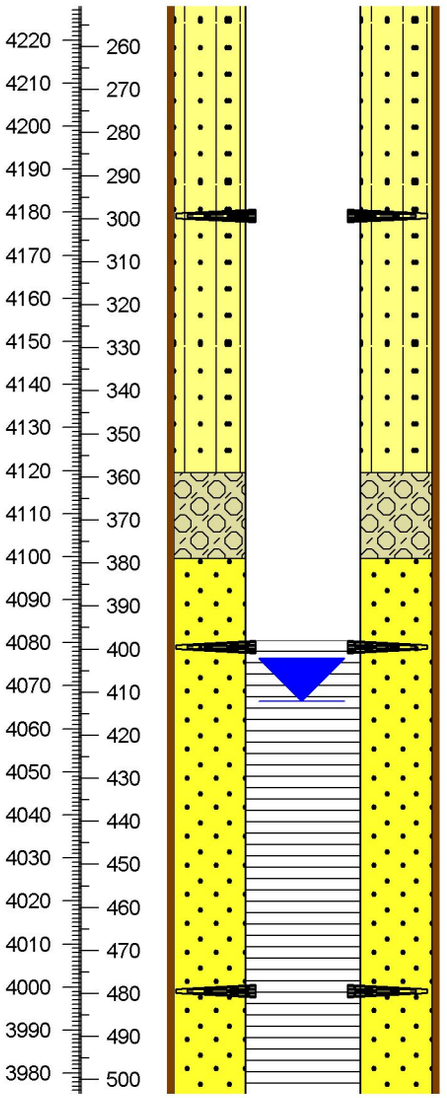
Completion Casing
9.31" ID; 10.75" OD
CertainTeed PVC

Well Screen
9.31" ID; 10.75" OD
0.085"-Slot

Steel Centralizer
Steel End Cap
Water Table

Annular Materials Explanation

Neat Cement
Bentonite Grout
Bentonite Seal
4/8 Filter Pack Sand
12/20 Sand Bentonite Mix
Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
	Steel cage centralizer bolted together around casing coupling at 297.9 ft. Steel cage centralizer bolted together around casing coupling 398.0 ft. Water Table Depth = 412.11 ft. (measured during development 8/27/01) Top of Screen = 398.0 ft. (9.31" minimum ID/ 10.75" OD CertainTeed SDR 17 0.085" - Slot PVC) Steel cage centralizer bolted together around casing coupling 477.9 ft.	Top of Upper Bentonite Seal = 359 ft. Top of 4/8 Sand = 379 ft. Volcanic-Rich Alluvium Depth = 480 ft.

WELL COMPLETION DIAGRAM
EXTRACTION WELL

Location ID: **PFE-7** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4, SW 1/4, SW 1/4, Sec 32, T20S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **553603.619 N, 1514082.197 E**
Elevation (Brass Cap): **4478.5 ft.**
Elevation (Top of Casing): **4479.5 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **D. Gaddy**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **720 ft.**
Borehole Diameter: **17 1/2" 0-117 ft.; reamed 26"; 17 1/2" 117-720 ft.**
Depth to Bedrock (bgs): **Not Reached**
Depth to Groundwater: **412.11 ft. (measured 8/27/01)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **7/12 - 7/25/01**
Date(s) Well Installed: **7/25 - 7/29/01**
Date(s) Well Developed: **7/29/01 jetted; 8/27/01 pumping**
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **697.6 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **9.31" ID; 10.75" OD**
Screened Zone (bgs): **398.0-677.6 ft.**
Comments: **Field Reps. cont'd: John Pearson, Murry Stepro, Ron Weaver**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

- Surface Casing: **14" OD Carbon Steel**
- Completion Casing: **9.31" ID; 10.75" OD CertainTeed PVC**
- Well Screen: **9.31" ID; 10.75" OD 0.085"-Slot**
- Steel Centralizer
- Steel End Cap
- Water Table

Annular Materials Explanation

- Neat Cement
- Bentonite Grout
- Bentonite Seal
- 4/8 Filter Pack Sand
- 12/20 Sand Bentonite Mix
- Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
3970 / 510 3960 / 520 3950 / 530 3940 / 540 3930 / 550 3920 / 560 3910 / 570 3900 / 580 3890 / 590 3880 / 600 3870 / 610 3860 / 620 3850 / 630 3840 / 640 3830 / 650 3820 / 660 3810 / 670 3800 / 680 3790 / 690 3780 / 700 3770 / 710 3760 / 720	Steel cage centralizer bolted together around casing coupling 577.6 ft. Bottom of Screen = 677.6 ft. (9.31" minimum ID/ 10.75" OD CertainTeed SDR 17 0.085" - Slot PVC) Steel cage centralizer bolted together around casing coupling 676.5 ft. Sump consists of 20' blank riser and end cap Casing TD = 697.6 ft.; 9.31" minimum ID; 10.75" OD CertainTeed SDR 17 PVC	Top of Lower Bentonite Seal = 712 ft. 17 1/2" Borehole TD = 720 ft.

WELL COMPLETION DIAGRAM
INJECTION WELL

Location ID: **PFI-2** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 NW 1/4 SE 1/4 Sec 5, T21S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **548733.344 N, 1515813.04 E**
Elevation (Brass Cap): **4481.143 ft.**
Elevation (Top of Casing): **4482.143 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **1020 ft.**
Borehole Diameter: **17 1/2" 0-115 ft.; reamed 26"; 17 1/2" 115-1,020 ft.**
Depth to Bedrock (bgs): **Not Reached**
Depth to Groundwater: **436.64 ft. (date not recorded)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **5/28 - 6/14/00**
Date(s) Well Installed: **6/20 - 6/24/00**
Date(s) Well Developed: **9/5 - 9/6/00 pumping**
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **996.62 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **7.85" ID; 9.05" OD**
Screened Zone (bgs): **418.13-976.67 ft.**
Comments: **Field Reps. cont'd: John Pearson, Murry Stepro, Ron Weaver**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

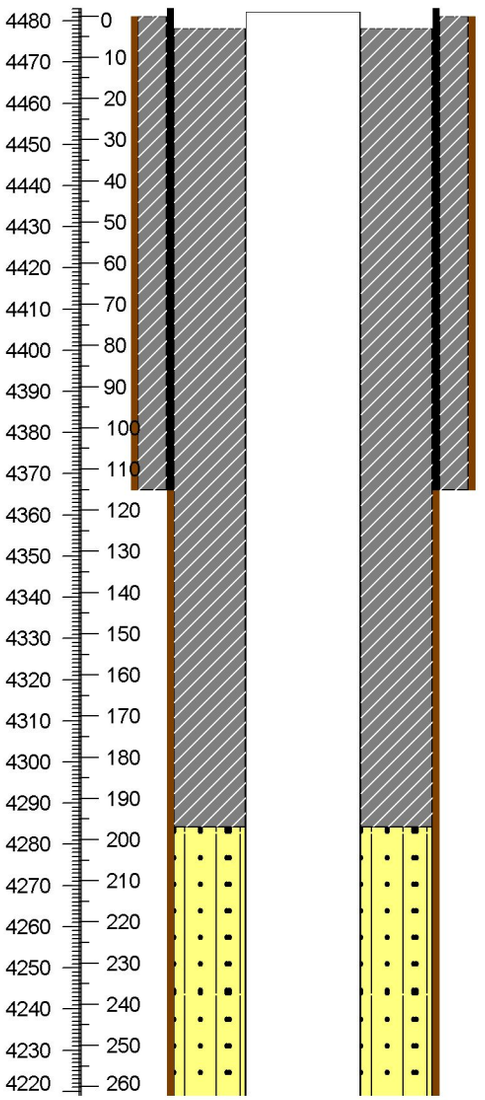
Casing Explanation

- Surface Casing: **20" OD Carbon Steel**
- Completion Casing: **7.85" ID; 9.05" OD CertainTeed PVC**
- Well Screen: **7.85" ID; 9.05" OD 0.085"-Slot**
- Steel Centralizer
- Steel End Cap
- Water Table

Annular Materials Explanation

- Neat Cement
- Bentonite Grout
- Bentonite Seal
- 4/8 Filter Pack Sand
- 8/12 Sand Bentonite Mix
- Slough

Elevation (ft amsl) / Depth (ft bgs)



Borehole/Well Casing Descriptions
All depths are below ground surface

Stick-Up = 1.0 ft. ags at installation.
Surface Casing Stick-Up = 2 ft. ags at installation

The well was completed as an Injection well below grade in a cement vault.

20" OD Carbon Steel Surface Casing Depth = 115.0 ft.

Annular Materials Descriptions
All depths are below ground surface

Top of Cement Grout (Portland II) = 3 ft.

Alluvium formation from surface is Santa Fe Group to 570.0 ft.

17 1/2" (reamed 26") borehole cemented to 115 ft.

Top of 8/12 Sand/Bentonite Mix = 197 ft.

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
7.85" ID; 9.05" OD
CertainTeed PVC

Well Screen
7.85" ID; 9.05" OD
0.085"-Slot

Bolted Steel Centralizer

PVC End Cap

Water Table

Annular Materials Exlplanation

Neat Cement

Bentonite Grout

12/20 Sand Bentonite Mix

10/20 Filter Pack Sand

Slough

Depth **Feet/Meters**	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4210 270 4200 280 4190 290 4180 300 4170 310 4160 320 4150 330 4140 340 4130 350 4120 360 4110 370 4100 380 4090 390 4080 400 4070 410 4060 420 4050 430 4040 440 4030 450 4020 460 4010 470 4000 480 3990 490 3980 500 3970 510 3960 520 3950 530 3940 540 3930 550 3920 560 3910 570 3900 580 3890 590 3880 600 3870 610 3860 620 3850 630 3840 640 3830 650	Steel cage centralizer bolted together around casing coupling at 418.13 ft. Top of Screen = 418.13 ft. (7.85" minimum ID; 9.05" OD CertainTeed SDR 17 0.085"-Slot PVC) Water Table Depth = 436.64 ft. (measured post development date unknown) Steel cage centralizer bolted together around casing coupling 517.9 ft. Steel cage centralizer bolted together around casing coupling 617.6 ft.	Top of Upper Bentonite Seal = 376 ft. Top of 4/8 Sand = 396 ft. Volcanic-Rich Alluvium Depth = 570 ft.

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
7.85" ID; 9.05" OD
CertainTeed PVC

Well Screen
7.85" ID; 9.05" OD
0.085"-Slot

Bolted Steel Centralizer

PVC End Cap

Water Table

Annular Materials Exlplanation

Neat Cement

Bentonite Grout

12/20 Sand Bentonite Mix

10/20 Filter Pack Sand

Slough

Depth **Feet/Meters**	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
3820 660 3810 670 3800 680 3790 690 3780 700 3770 710 3760 720 3750 730 3740 740 3730 750 3720 760 3710 770 3700 780 3690 790 3680 800 3670 810 3660 820 3650 830 3640 840 3630 850 3620 860 3610 870 3600 880 3590 890 3580 900 3570 910 3560 920 3550 930 3540 940 3530 950 3520 960 3510 970 3500 980 3490 990 3480 1000 3470 1010 3460 1020	Steel cage centralizer bolted together around casing coupling 737.4 ft. Steel cage centralizer bolted together around casing coupling 857.0 ft. Steel cage centralizer bolted together around casing coupling 976.67 ft. Bottom of Screen = 976.67 ft. (7.85" minimum ID; 9.05" OD CertainTeed SDR 17 0.085"-Slot PVC) Sump consists of 20' blank riser and end cap Casing TD = 996.58 ft.; 9.31" minimum ID; 10.75" OD CertainTeed SDR 17 PVC	Top of Lower Bentonite Seal = 997 ft. Top of Slough = 1008 ft. 17 1/2" Borehole TD = 1020 ft.

WELL COMPLETION DIAGRAM

INJECTION WELL

Location ID: **PFI-3** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NW 1/4 SE 1/4 SE 1/4 Sec 5, T21S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **548211.69 N, 1516334.495 E**
Elevation (Brass Cap): **4498.865 ft.**
Elevation (Top of Casing): **4499.865 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **1020 ft.**
Borehole Diameter: **17 1/2" 0-115 ft.; reamed 26"; 17 1/2" 115-1,020 ft.**
Depth to Bedrock (bgs): **Not Reached**
Depth to Groundwater: **446.74 ft. (date not recorded)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **5/2 - 5/16/00**
Date(s) Well Installed: **5/24 - 5/27/00**
Date(s) Well Developed: **9/8 - 9/9/00 pumping**
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **996.89 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **7.85" ID; 9.05" OD**
Screened Zone (bgs): **417.95 - 976.89 ft.**
Comments: **Field Reps. cont'd: John Pearson, Murry Stepro**

bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
20" OD Carbon Steel

Completion Casing
7.85" ID; 9.05" OD
CertainTeed PVC

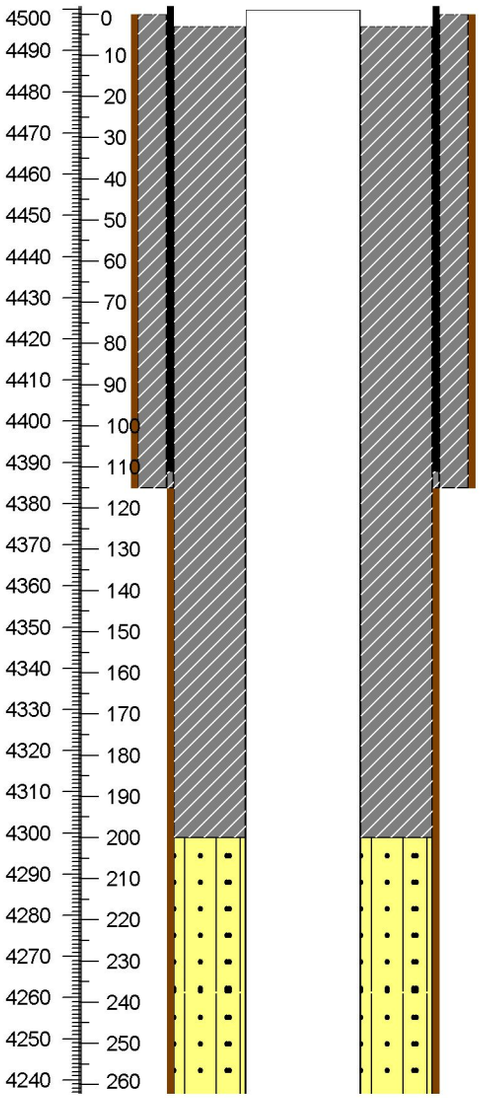
Well Screen
7.85" ID; 9.05" OD
0.085"-Slot

Steel Centralizer
Steel End Cap
Water Table

Annular Materials Explanation

Neat Cement
Bentonite Grout
Bentonite Seal
4/8 Filter Pack Sand
8/12 Sand Bentonite Mix
Slough

Elevation (ft amsl) / Depth (ft bgs)



Borehole/Well Casing Descriptions
All depths are below ground surface

Stick-Up = 1.0 ft. ags at installation.
Surface Casing Stick-Up = 2 ft. ags at installation

The well was completed as an Injection well below grade in a cement vault.

20" OD Carbon Steel Surface Casing Depth = 111.5 ft.

NOTE: Number and locations of centralizers were not recorded at installation. Centralizers assumed to have been installed per the well design.

Annular Materials Descriptions
All depths are below ground surface

Top of Cement Grout (Portland II) = 3 ft.

Alluvium formation from surface is Santa Fe Group to 560.0 ft.

17 1/2" (reamed 26") borehole cemented to 115 ft.

Top of 8/12 Sand/Bentonite Mix = 200 ft.

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
7.85" ID; 9.05" OD
CertainTeed PVC

Well Screen
7.85" ID; 9.05" OD
0.085"-Slot

Bolted Steel Centralizer

PVC End Cap

Water Table

Annular Materials Exlplanation

Neat Cement

Bentonite Grout

12/20 Sand Bentonite Mix

10/20 Filter Pack Sand

Slough

Depth **Feet/Meters**	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4230 270 4220 280 4210 290 4200 300 4190 310 4180 320 4170 330 4160 340 4150 350 4140 360 4130 370 4120 380 4110 390 4100 400 4090 410 4080 420 4070 430 4060 440 4050 450 4040 460 4030 470 4020 480 4010 490 4000 500 3990 510 3980 520 3970 530 3960 540 3950 550 3940 560 3930 570 3920 580 3910 590 3900 600 3890 610 3880 620 3870 630 3860 640 3850 650 3840	Top of Screen = 417.95 ft. (7.85" minimum ID; 9.05" OD CertainTeed SDR 17 0.085"-Slot PVC) Water Table Depth = 446.74 ft. (measured post development date unknown) Steel cage centralizer bolted together around casing coupling 497.8 ft. Steel cage centralizer bolted together around casing coupling 597.6 ft.	Top of Upper Bentonite Seal = 378 ft. Top of 4/8 Sand = 398 ft. Volcanic-Rich Alluvium Depth = 560 ft.

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
7.85" ID; 9.05" OD
CertainTeed PVC

Well Screen
7.85" ID; 9.05" OD
0.085"-Slot

Bolted Steel Centralizer

PVC End Cap

Water Table

Annular Materials Exlplanation

Neat Cement

Bentonite Grout

12/20 Sand Bentonite Mix

10/20 Filter Pack Sand

Slough

Depth **Feet/Meters**	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
3830 660 3820 670 3810 680 3800 690 3790 700 3780 710 3770 720 3760 730 3750 740 3740 750 3730 760 3720 770 3710 780 3700 790 3690 800 3680 810 3670 820 3660 830 3650 840 3640 850 3630 860 3620 870 3610 880 3600 890 3590 900 3580 910 3570 920 3560 930 3550 940 3540 950 3530 960 3520 970 3510 980 3500 990 3490 1000 3480 1010 1020	Steel cage centralizer bolted together around casing coupling 697.4 ft. Steel cage centralizer bolted together around casing coupling 797.2 ft. Steel cage centralizer bolted together around casing coupling 897.2 ft. Bottom of Screen = 976.67 ft. (7.85" minimum ID; 9.05" OD CertainTeed SDR 17 0.085"-Slot PVC) Steel cage centralizer bolted together around casing coupling at 976.6 ft. Sump consists of 20' blank riser and end cap Casing TD = 996.58 ft.; 9.31" minimum ID; 10.75" OD CertainTeed SDR 17 PVC	Top of Slough = 1016 ft. 17 1/2" Borehole TD = 1020 ft.

WELL COMPLETION DIAGRAM

INJECTION WELL

Location ID: **PFI-4** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4, SE 1/4, SE 1/4, Sec 5, T21S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **547790.168 N, 1516934.722 E**
Elevation (Brass Cap): **4516.74 ft.**
Elevation (Top of Casing): **4517.74 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **911 ft.**
Borehole Diameter: **17 1/2" 0-115 ft.; reamed 26"; 17 1/2" 115-911 ft.**
Depth to Bedrock (bgs): **890 ft (Rhyolite)**
Depth to Groundwater: **457.86 ft. (date not recorded)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **5/2 - 5/16/00**
Date(s) Well Installed: **7/19 - 7/21/00**
Date(s) Well Developed: **9/9 - 9/10/00 pumping**
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **897.68 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **7.85" ID; 9.05" OD**
Screened Zone (bgs): **397.88-877.75 ft.**
Comments: **Field Reps. cont'd: John Pearson, Murry Stepro, Ron Weaver**
bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

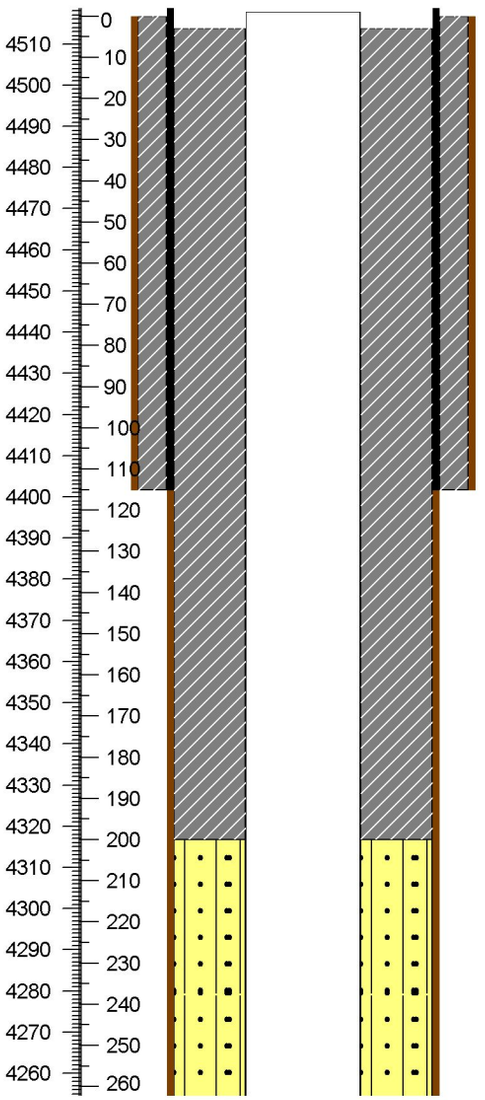
Casing Explanation

- Surface Casing: **20" OD Carbon Steel**
- Completion Casing: **7.85" ID; 9.05" OD CertainTeed PVC**
- Well Screen: **7.85" ID; 9.05" OD 0.085"-Slot**
- Steel Centralizer
- Steel End Cap
- Water Table

Annular Materials Explanation

- Neat Cement
- 4/8 Filter Pack Sand
- Bentonite Grout
- 8/12 Sand Bentonite Mix
- Bentonite Seal
- Slough

Elevation (ft amsl) / Depth (ft bgs)



Borehole/Well Casing Descriptions
All depths are below ground surface

Stick-Up = 1.0 ft. ags at installation.
Surface Casing Stick-Up = 2 ft. ags at installation

The well was completed as an Injection well below grade in a cement vault.

20" OD Carbon Steel Surface Casing Depth = 115 ft.

Annular Materials Descriptions
All depths are below ground surface

Top of Cement Grout (Portland II) = 3 ft.

Alluvium formation from surface is Santa Fe Group to 566.0 ft.

17 1/2" (reamed 26") borehole cemented to 115 ft.

Top of 8/12 Sand/Bentonite Mix = 200 ft.

Casing Explanation

Surface Casing
14" OD Carbon Steel

Completion Casing
7.85" ID; 9.05" OD
CertainTeed PVC

Well Screen
7.85" ID; 9.05" OD
0.085"-Slot

Bolted Steel Centralizer

PVC End Cap

Water Table

Annular Materials Exlplanation

Neat Cement

Bentonite Grout

12/20 Sand Bentonite Mix

10/20 Filter Pack Sand

Slough

Depth **Feet/Meters**	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
4250 270 4240 280 4230 290 4220 300 4210 310 4200 320 4190 330 4180 340 4170 350 4160 360 4150 370 4140 380 4130 390 4120 400 4110 410 4100 420 4090 430 4080 440 4070 450 4060 460 4050 470 4040 480 4030 490 4020 500 4010 510 4000 520 3990 530 3980 540 3970 550 3960 560 3950 570 3940 580 3930 590 3920 600 3910 610 3900 620 3890 630 3880 640 3870 650 3860	Steel cage centralizer bolted together around casing coupling at 397.88 ft. Top of Screen = 397.88 ft. (7.85" minimum ID; 9.05" OD CertainTeed SDR 17 0.085"-Slot PVC) Water Table Depth = 457.86 ft. (measured post development date unknown) Steel cage centralizer bolted together around casing coupling 497.7 ft. Steel cage centralizer bolted together around casing coupling 597.6 ft.	Top of Upper Bentonite Seal = 354 ft. Top of 4/8 Sand = 378 ft. Volcanic-Rich Alluvium Depth = 566 ft.

WELL COMPLETION DIAGRAM
INJECTION WELL

Location ID: **PFI-4** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4, SE 1/4, SE 1/4, Sec 5, T21S, R3E**
NM State Plane Coordinates (NAD 83)(ft): **547790.168 N, 1516934.722 E**
Elevation (Brass Cap): **4516.74 ft.**
Elevation (Top of Casing): **4517.74 ft.**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Method of Drilling: **Mud Rotary**
Total Depth of Borehole (bgs): **911 ft.**
Borehole Diameter: **17 1/2" 0-115 ft.; reamed 26"; 17 1/2" 115-911 ft.**
Depth to Bedrock (bgs): **890 ft (Rhyolite)**
Depth to Groundwater: **457.86 ft. (date not recorded)**
Diameter and Type Surface Casing: **19.5" ID; 20" OD**

Dates Borehole Drilled: **5/2 - 5/16/00**
Date(s) Well Installed: **7/19 - 7/21/00**
Date(s) Well Developed: **9/9 - 9/10/00 pumping**
Field Representative(s): **Marry Canavan, Geoff Giles, Lela Hunnicutt-Mack...**
Total Depth Well Casing (bgs): **897.68 ft.**
Type of Casing: **CertainTeed PVC**
Diameter Well Casing: **7.85" ID; 9.05" OD**
Screened Zone (bgs): **397.88-877.75 ft.**
Comments: **Field Reps. cont'd: John Pearson, Murry Stepro, Ron Weaver**
bgs = below ground surface TOC=Top of Casing
ags= above ground surface
ID = Inner Diameter OD= Outer Diameter

Casing Explanation

Surface Casing
20" OD Carbon Steel

Completion Casing
7.85" ID; 9.05" OD
CertainTeed PVC

Well Screen
7.85" ID; 9.05" OD
0.085"-Slot

Steel Centralizer

Steel End Cap

Water Table

Annular Materials Explanation

Neat Cement

Bentonite Grout

Bentonite Seal

4/8 Filter Pack Sand

8/12 Sand Bentonite Mix

Slough

Elevation (ft amsl) / Depth (ft bgs)	**Borehole/Well Casing Descriptions** All depths are below ground surface	**Annular Materials Descriptions** All depths are below ground surface
3850 660 3840 670 3830 680 3820 690 3810 700 3800 710 3790 720 3780 730 3770 740 3760 750 3750 760 3740 770 3730 780 3720 790 3710 800 3700 810 3690 820 3680 830 3670 840 3660 850 3650 860 3640 870 3630 880 3620 890 3610 900 910	Steel cage centralizer bolted together around casing coupling 697.88 ft. Steel cage centralizer bolted together around casing coupling 797.7 ft. Bottom of Screen = 976.67 ft. (7.85" minimum ID; 9.05" OD CertainTeed SDR 17 0.085"-Slot PVC) Steel cage centralizer bolted together around casing coupling 897.2 ft. Sump consists of 20' blank riser and end cap Casing TD = 996.58 ft.; 9.31" minimum ID; 10.75" OD CertainTeed SDR 17 PVC	Volcanic bedrock (Rhyolite) depth = 890 ft. Top of Slough = 907 ft. 17 1/2" Borehole TD = 911 ft.

Appendix B
PFTS Instrumentation and Control System Features

The control system has the ability to:

- Startup the treatment system in either “auto” or “manual” mode
- Operate the system with any combination of four or more extraction wells online, one or both air strippers in operation, a combination of ten or more UV lamps operating, and any combination of injection wells online
- Shut down an injection well if it detects out-of-tolerance conditions
- Shut down an extraction well if it detects out-of-tolerance conditions
- Shut down the entire system if it detects out-of-tolerance conditions
- Initiate an operator notification if a system shutdown has occurred or if an alarm condition could lead to a system shutdown
- Log system alarms and data to workstation for troubleshooting, historical trending, and preventive maintenance analyses
- Allow system shutdown by an Emergency Stop button
- Allow the operator to initiate a controlled shutdown of the treatment system

The following components are installed as part of the instrumentation and control (I&C) system:

Extraction Wells

- Flow control valves
- Flow meters with automatic Highway Addressable Remote Transducer (HART) flow totalization
- Water-level pressure transducers
- Wellhead pressure transducers
- PLCs
- Power monitors
- Fiber optic cable connection to network
- Motor control centers and submonitors
- Well pumps and motor protectors
- Associated control wiring, hand switches, lights, etc.

Building 650- PFTS facility

- Scale cleaning system control panel
- Scale control system control panel
- Building 650 PLC control panel
- Air stripper #1 PLC control panel and motor controls

- Air stripper #2 PLC control panel and motor controls
- UV reactor PLC control panel and power supply cabinet
- Various Building 650 electrical sensors; sump float switches, compressed air pressure switch
- Cartridge filter pressure switch, pressure transducers, and an automatic cartridge switching system
- Flow meters at air strippers and UV reactor inlets
- Leak detection system control panel
- Leak detection sensors
- Automatic pressure relief valve
- Alarm autodialer
- Building 650 power monitor
- Control stationserver, backup PC, and printer
- Wiring and communication links between the control stationserver, all PLCs, treatment equipment, leak detection system
- Secure building entry monitoring system
- Associated control wiring, hand switches, indicator lights, etc.

Building 651- Injection Manifold Building

- Building 651 PLC control panel
- PFI well flow meters with automatic HART flow totalization
- Fiber optic cable connection to network

Injection Wells

- Flow meters (backwash flow only) with automatic HART flow totalization
- Injection downhole control valves
- Injection line remote operated valves
- Backwash line remote operated valves
- Water-level transducers
- Well head pressure transducers
- PLCs
- Power monitors
- Fiber optic cable connections to network
- Well pumps and motor controls
- Vault float switches (to shunt trip)
- Associated control wiring, hand switches, lights, etc.

Appendix C
PFTS Alarm Conditions

Amber alarm conditions:

- Effluent block valve fails to open
- Effluent block valve fails to close
- Recycle block valve fails to open
- Recycle block valve fails to close
- Spent cleaning solution tank level HI
- Spent cleaning solution tank level HI-HI
- Air stripper flow fails HI or LO
- Air stripper discharge pressure fails HI
- UV inlet pressure fails HI
- UV air pressure fails LO
- UV wiper fault
- UV lamp contactor fault
- UV lamp GFI fault
- UV lamp HI-temp fault
- UV lamp amps fail HI or LO
- UV lamp volts fail LO

Red alarm conditions:

- PFE-X pump failure (two or more extraction wells inoperable)
- Sump level HI (Building 650)
- Pipeline leak detected
- Filter skid pressure HI-HI
- Air stripper fails (commanded on but not operating)
- Air stripper water flow fails HI-HI or LO-LO
- Air stripper water level fails HI or LO
- Air stripper air pressure fails HI or LO
- Air stripper air filter pressure HI
- Moisture detected in UV lamp enclosure
- UV water flow fails LO

- UV water level fails LO
- UV water temp fails HI
- UV not enough lamps on
- UV wiper fault if longer than 24 hours
- UV irradiance LO-LO
- UV inlet pressure HI-HI
- UV lamp enclosure door open
- UV power cabinet temperature fails HI
- UV power cabinet door open
- Building 650 compressed air pressure LO
- PFI flow to grade detected
- PFI backwash flow LO
- PFI backwash valve Fail to Open or Close
- PFI injection valve Fail to Open or Close
- PFI injection valve pressure HI or LO
- PFI GN2 pressure LO
- PFI float switch shunt tripped
- PFI pump Fail to Start or Stop
- PFI well level HI
- PFI well head pressure HI or LO
- PLC communication failure
- HMI emergency stop
- Emergency stop button depressed (outside main entrance to Building 650).
- UV console emergency stop button depressed.

Appendix D
MPITS Instrumentation and Control System Features

The MPITS HMI displays information and has the ability to:

- Connect to the network for communication with the PLC
- Start the process input pacing constant for chemical addition
- Place the control of the extraction wells in manual or auto and monitor well level, wellhead pressure, flow, and status, and alarms
- Monitor surge tank level
- Place air stripper filters in manual or auto mode and monitor inlet and outlet pressures and filter status
- Start the air stripper and monitor air flow, sump level
- Place UV filters in manual or auto mode and monitor inlet and outlet pressures and filter status
- Monitor the UV process variables, system status, critical information, and alarms
- Cycle the discharge and recirculation valves, and monitor status

The MPITS PLC has the ability to:

- Connects to the network for communication with the HMI
- Provide the logic control to start the process within operating parameters, alarm, and output signal to chemical feed pump
- Provide the logic to control the extraction wells and receive information on level, well head pressure, flow, status, and alarm
- Receive information from the surge tank level sensors and alarm and provide information to control the extraction well pumps
- Provide the logic to control the air stripper filter auto change over, receive inlet and outlet pressure information, and alarm
- Provide the logic to start the air stripper, receive information from pressure switches, air flow meters, level transducer and motor status
- Provide the logic to control the UV filter auto change over, receive inlet and outlet pressure information, and alarm
- Provide the logic to shut down the MPITS process when major and critical alarms have been received and alarm
- Provide the logic to place the effluent valves in either discharge or recirculation position.
- Send signals to the Auto Dialer

The following components are installed as part of the instrumentation and control (I&C) system:

Extraction Well Enclosures

- Flow meters with automatic HART flow totalization
- Well head pressure transducers
- Water level transducers
- Leak detection system
- Shunt trip
- Combination starter with auxiliary contacts.

Building 655- MPITS facility

- Network hub
- Transient voltage surge suppressor
- Shunt trip circuit
- Autodialer
- Influent flow meter
- Chemical metering pump
- Surge tank level transducer, high level switch, and low-level switch
- Air stripper inlet and outlet pressure transducer, inlet valve position indicator, and flow
- Air stripper air inlet flow transducer, air sump high- and low-pressure switch, sump level transducer
- UV air filter inlet and outlet pressure transducers and inlet valve position indicator
- UV system
    - Flow meter
    - Transmittance analyzer
    - Reactor water level sensor
    - Reactor water temperature sensor
    - Reactor irradiance sensor
    - Power monitor
    - PLC
    - HMI
    - Power distribution center

Infiltration Basin

- Flow meter with automatic HART flow totalization
- Altitude control valve

Appendix E
MPITS Alarm Conditions

The list of treatment alarms that force the UV system to increase UV intensity to 100% are identified as "Major" alarms and provided below.

- UV Transmittance Low
- System UV Transmittance Meter Faulted (Optiview)
- System UV Transmittance Analog Signal Fault
- Water Temperature Low
- Water Temperature High
- System Inlet Water Temperature Analog Signal Fault
- Train UV Dose Low
- Train Power Level Low
- Train UV Log Reduction Low Train UV
- Train Water Flow Low
- Train Water Flow High
- Train Water Flow Meter Analog Signal Fault
- Reactor Communication Control Board Communications Lost Fault Present
- Reactor Low UV Intensity
- Reactor Multiple Lamp Failure (NOT Broken Lamp)
- UV Log Reduction Low

The list of "Critical" treatment shutdown alarms (UV and process) includes:

- Air Stripper Air Pressure Low
- UV Pump1 Failed To Stop
- UV Pump2 Failed To Stop
- UV Broken Lamp
- Train Water Level
- Reactor Multiple Lamp Failure
- Reactor Wiper Fault
- Reactor Communication Control Board Communications Lost Fault Present
- UV Log Reduction Low Critical Alarm
- UV System Critical Alarm

- UV Train Critical Alarm
- System PLC Faulted Major Fault Detected
- System input/output Module Fault Present

The List of critical safety related shutdowns includes:

- B655 Sump High-High Level
- Control Room Emergency Stop Button
- East Exterior Door Emergency Stop Button
- Fire Flow Alarm
- B655 Power Loss, Power Imbalance, and Loss of phase