FINAL

2014 INTERIM MEASURES FACILITY-WIDE GROUNDWATER MONITORING PLAN

Version 7

FORT WINGATE DEPOT ACTIVITY
McKinley County, New Mexico

13 January 2014

Contract No. W912PP-11-D-0024
Task Order No. 0007

Prepared for:

United States Army Corps of Engineers
Albuquerque District
4101 Jefferson Plaza NE
Albuquerque, New Mexico 87109-3435

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14. ABSTRACT

This Interim Facility-Wide Groundwater Monitoring Plan (GMP) for Fort Wingate Depot Activity (FWDA)describes the proposed groundwater monitoring to be conducted as part of the environmental restoration program at FWDA. This document has been prepared for submission to the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB), as required by Section V.A of Resource Conservation and Recovery Act (RCRA) Permit No. NM6213820974-1 (the Permit).

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BIA – NR = Bureau of Indian Affair – Navajo Representative
BIA – Zuni = Bureau of Indian Affair – Zuni
DOI/BLM = Department of Interior/Bureau of Land Management
DAIM-ODB = Department of the Army Installation Management- Operations Directorate Base Realignment and Closure Division
FWDA – BEC = Fort Wingate Depot Activity Base Realignment and Closure Environmental Coordinator
FWDA – EIMS = Fort Wingate Depot Activity Environmental Information Management System
HWB = Hazardous Waste Bureau
NN = Navajo Nation
NMED = New Mexico Environment Department
POZ = Pueblo of Zuni
SAIC = Science Applications International Corporation
USACE – SPA = U.S. Army Corps of Engineers – Albuquerque District
USACE – SWF = U.S. Army Corps of Engineers – Fort Worth District
USAEC = U.S. Army Environmental Command
USEPA 6 = U.S. Environmental Protection Agency

EXECUTIVE SUMMARY

This Interim Measures Facility-Wide Groundwater Monitoring Plan (GMP) for Fort Wingate Depot Activity (FWDA) describes the proposed groundwater monitoring to be conducted as part of the Environmental Restoration Program at FWDA. This document has been prepared for submission to the New Mexico Environment Department Hazardous Waste Bureau, as required by Section V.A of Resource Conservation and Recovery Act Permit No. NM 6213820974 (herein referred to as the Permit).

The current monitoring well network has been designed to evaluate the horizontal and vertical extent of chemical constituents in groundwater, and the transport of chemicals that originate from multiple sources. Not all wells need to be sampled for the same analytical suites because certain wells are located to monitor releases from specific Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs). The density of the well network is designed such that targeting select wells for specific chemical analyses, rather than all wells, provides sufficient data that meet the objectives of the monitoring program.

This GMP combines the original 2008 plan (approved) and subsequent revisions (annual), which are revised based on an analysis of historic groundwater monitoring data and a data quality objective (DQO) assessment. In accordance with Section V.A.4 of the Permit, the annual revision of this Interim Measures Facility-Wide GMP re-evaluates the constituent groups to be analyzed and the sampling frequencies at each target well using historical analytical data. To date, sampling frequency has been semi-annual. However, adjusting the sample frequency along with targeting select wells for specific sampling analysis are of central importance to maximizing the amount of relevant information (information required to effectively address the temporal and spatial objectives of monitoring program), while minimizing costs. Section 5.3.1 discusses this Interim Measures Facility-Wide GMP sampling rationale, including the specific chemical constituents to be analyzed and the proposed sampling frequency.

ES.1 PURPOSE

The purpose of this Interim Measures Facility-Wide GMP is to describe the groundwater monitoring program for the interim period before long-term monitoring can begin.

ES.2 PROPOSED INVESTIGATIONS

As described in this revision of the Interim Measures Facility-Wide GMP, the groundwater monitoring program will consist of the following data collection.

ES.2.1 Groundwater Elevation Surveys

Groundwater elevation data will be collected from all existing wells. As directed by New Mexico Environment Department Hazardous Waste Bureau, groundwater elevation data will be collected on a quarterly basis in January, April, July, and October.

ES.2.2 Groundwater Sampling

ES.2.2.1 Initial Groundwater Monitoring Program - 2008

The 2008 GMP initially identified semi-annual (April and October) sampling for the following analytical suites for characterization of groundwater at the Open Burning/Open Detonation (OB/OD) Unit and Parcel 3 SWMUs, and the Northern FWDA SWMUs and AOCs (Northern Area).

OB/OD Area (under temporary moratorium until ~2015)

- Explosives
- Nitrate/nitrite
- Perchlorate
- Target analyte list (TAL) metals (total and dissolved)
- White phosphorus
- Target compound list (TCL) volatile organic compounds (VOCs)
- TCL semi-volatile organic compound (SVOC)
- Dioxins and furans
- Cyanide
- Polychlorinated biphenyls
- Pesticides/herbicides

Northern FWDA Area

- Explosives
- Nitrate/nitrite
- Perchlorate

- TAL metals (total and dissolved)
- TCL VOCs
- TCL SVOCs
- Dioxins and furans
- Pesticides - wells in and around the Administration Area only
- Diesel range organics - wells monitoring releases from SWMU 45 only
- Gasoline range organics - wells monitoring releases from SWMU 45 only

The 2010 revision to the GMP eliminated cyanide, herbicides, polychlorinated biphenyls, and white phosphorus from the FWDA sampling roster. Based on the absence of detections, it was determined that continued monitoring for these constituents did not provide necessary and useful information. Additionally, a statistical analysis of dioxin/furan detections was submitted to NMED with the intention of eliminating these compounds from the FWDA sampling program. In August 2011, NMED agreed that dioxins and furans can be eliminated from the sampling requirements (NMED 2011). The 2012 revision proposed the following analytical suites and sampling frequencies for the project contaminants of interest (COIs).

Analyte Group	**OB/OD Unit***	**Northern Area Alluvium***	**Northern Area Bedrock***
Explosives	2x	2x	2x
Nitrate/Nitrite	2x	2x	2x
Perchlorate	2x	2x	2x
TAL Metals (total and dissolved)	2x	2x	2x
Mercury (total and dissolved)	2x	2x	2x
TCL VOC	2x	2x	2x
TCL SVOC	x/2	x/2	2x
Pesticides	x/5	x/5	x/5
Diesel Range Organics/ Gasoline Range Organics	N/A	2x	N/A

* Select wells only (see Section 5, Table 5-8)
2x = Analyses to be performed semi-annually
x/2 = Analyses to be performed every 2 years
x/5 = Analyses to be performed every 5 years
OB/OD = Open burn/open detonation
SVOC = Semi-volatile organic compound
TAL = Target analyte list
TCL = Target compound list
VOC = Volatile organic compound

ES.2.2.2 Revised Groundwater Monitoring Program – 2013 (Version 7)

Sampling activities in the OB/OD area will be under a temporary moratorium while munitions removal activities are conducted in the area. The moratorium is expected to be in effect throughout 2014 and into 2015. The area will not be considered safe and will be closed to all non-essential personal including sampling technicians until the clearance activities are accomplished. The OB/OD area will resume all groundwater monitoring activities on schedule once it is safe to resume. Notification of these activities was submitted in a letter dated June 10, 2013 from Mr. Mark Patterson, BRAC Environmental Coordinator, to Mr. John Kieling, Hazardous Waste Bureau Chief at the New Mexico Environment Department.

After review of the groundwater monitoring data there are some analytical suites that have not been detected for four consecutive sampling events for some monitoring wells. In accordance to the DQO process and sampling program rationale, these suites are recommended to be removed from the sampling program for the specific wells that have not had detections. Approval from the state will be obtained before implementing these recommendations.

This revision makes provisions for the East Landfill monitoring wells that will be abandoned when the landfill is removed (estimated winter 2013/spring 2014). The well abandonment activities are subject to NMED approval. If/once the wells are plugged and abandoned they will be removed from the sampling program. While the monitoring wells are existence though, they will continue to be sampled and the groundwater elevations measured.

Lastly, this revision updates the analytical perchlorate method from EPA Method 6850 to EPA Method 6860 based upon the recommendation of the laboratory and project chemist due to the method being capable of analyzing more perchlorate ions than 6850.

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FIGURES

TABLES

APPENDICES (provided on disc)

ACRONYNMS AND ABBREVIATIONS

°F	degrees Fahrenheit
AOC	Area of Concern
bgs	below ground surface
BRAC	Base Realignment and Closure
CLP	Contract Laboratory Program
COI	contaminant of interest
COR	Contracting Officer's Representative
CY	calendar year
DOI	Department of the Interior
DQO	data quality objective
EDMS	Environmental Data Management System
EPA	U.S. Environmental Protection Agency
FWDA	Fort Wingate Depot Activity
GMP	Groundwater Monitoring Plan
gpm	gallons per minute
ID	identification
IDW	investigation-derived waste
Innovar	Innovar Environmental, Inc.
MCL	maximum contaminant level
MDL	method detection limit
mg/L	milligram per liter
MS	matrix spike
MSD	matrix spike duplicate
NELAP	National Environmental Laboratory Accreditation Program
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
OB/OD	open burn/open detonation
PCB	polychlorinated biphenyl
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RDX	cyclotrimethylenetrinitramine
RFI	RCRA Facility Investigation
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
TAL	target analyte list
TCL	target compound list
TNT	trinitrotoluene
USACE	United States Army Corps of Engineers
USGS	U.S. Geologic Survey
UST	underground storage tank
VOC	volatile organic compound

ACRONYNMS AND ABBREVIATIONS (continued)

ZIST	Zone Isolation Sampling System
μg/L	micrograms per liter

1. INTRODUCTION

This Interim Measures Facility-Wide Groundwater Monitoring Plan (GMP) provides guidance for the groundwater monitoring activities to be conducted during calendar year (CY) 2014 at Fort Wingate Depot Activity (FWDA) in McKinley County, New Mexico. If no changes to the GMP are necessary then this guidance will also cover CY 2015. Innovar Environmental, Inc. (herein referred to as Innovar) and CB&I has prepared this GMP for the U.S. Army Corps of Engineers (USACE), Albuquerque District, in accordance with the Statement of Work dated March 2012 (Appendix A) under Contract No. W912PP-11-D-0024, Task Order No. 0007.

This is Version 7 of the Interim Measures Facility-Wide GMP, prepared in accordance with the Resource Conservation and Recovery Act (RCRA) Permit No. NM 6213820974 (the Permit) that became effective on 31 December 2005. Version 7 revises the 2012 GMP to reflect the current site conditions, a recent update in the perchlorate method from 6850 to 6860 which provides more ions for analysis and was recommended by the laboratory and project chemist, a temporary moratorium on sampling activities at the OB/OD area, the scheduled plugging and abandoning of the East Landfill monitoring wells, and recommendations of analytical suites to be removed from the sampling program for specific wells due to non-detect results for four consecutive sampling events. Revisions are based upon analyses of recent sampling data and historic groundwater monitoring data, assessment of data quality objectives (DQOs), utilization of information provided by the USACE, and previous groundwater investigations.

1.1 Background Information

The Secretary of the New Mexico Environment Department (NMED) issued Permit No. NM 6213820974 to the United States, Department of the Army, which is the owner and operator of FWDA. Section V of the Permit (NMED, 2005) requires an NMED-approved plan to provide guidance for interim groundwater monitoring activities for the entire facility prior to implementation of a long-term monitoring plan. Section VIII.B.1 of the Permit (NMED, 2005) requires consultation with the Navajo Nation and the Pueblo of Zuni during preparation of the Interim Measures Facility-Wide GMP and the required annual updates. Responses to comments for this version of the Interim Measures Facility-Wide GMP are presented in Appendix B. Version 7 of this GMP was submitted to the Navajo Nation and Zuni Pueblo as a draft on August 22, 2013. No comments were received within the 60 day review period.

The initial 2008 Interim Measures Facility-Wide GMP, prepared by TerranearPMC for the USACE, Fort Worth District, describes the proposed groundwater monitoring to be conducted as part of the Environmental Restoration Program at the FWDA. Section V.A.4 of the Permit (NMED, 2005) requires subsequent annual updates and revisions to the Interim Measures Facility-Wide GMP. Versions 3, 4, and 5 of the Interim Measures Facility-Wide GMP represent the updates for the CYs 2009, 2010, and 2011, respectively. The 2008 GMP is the only plan approved by NMED thus far; however, the subsequent plans are used as reference and guidance for the Version 7 revision.

1.2 Purpose and Objectives

The purpose of Version 7 of the Interim Measures Facility-Wide GMP is to perform a comprehensive assessment of the previous versions of the GMP and to provide recommendations for changes and enhancements. The fundamental objectives for the FWDA groundwater monitoring program are as follows:

- Evaluate compliance with the Permit groundwater cleanup levels, as identified in Section 7.1 of Attachment 7 to the Permit (NMED, 2005).
- Identify changes in ambient chemical conditions that affect fate and transport.
- Evaluate groundwater elevations to determine hydraulic gradients and groundwater flow paths.
- Monitor temporal changes and detect the movement of contaminants of interest (COIs) from one location to another.

COIs are chemicals that exceed or are likely to exceed the groundwater cleanup levels and are associated with known historical waste management activities. Meeting these objectives will support selection of appropriate corrective measures for the FWDA.

This Interim Facility-Wide GMP proposes the tasks below to fulfill the interim measures required by the Permit (NMED, 2005). Note: the OB/OD area wells will not be sampled while munitions removal activities are conducted (see Section 5.3.2).

- Collect quarterly groundwater elevation data from all existing and active monitoring wells.

- Collect groundwater samples from active monitoring wells using the methods described in Section 4.2 and submit groundwater samples for specific chemical analyses.

- Containerize and manage purge water as investigation-derived waste (IDW) following the procedures outlined in Section 4.5.

1.3 Work Plan Organization

This 2013 Interim Measures Facility-Wide GMP is organized as follows:

- ***Section 2***—Presents the available site history and general description of the FWDA facility and summarizes previous groundwater investigations.

- ***Section 3***—Presents the current site conditions and environmental setting of the FWDA.

- ***Section 4***—Details the procedures for groundwater sample collection, decontamination, quality assurance, and IDW characterization and disposal.

- ***Section 5***—Discusses the groundwater monitoring program objectives, data validation, data management, and reporting.

- ***Section 6***—Provides the projected sampling schedule for CY 2013/2014.

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2. SITE HISTORY AND BACKGROUND

2.1 General Description

The FWDA (Facility) currently occupies approximately 24 square miles (15,277 acres) of land in western New Mexico in McKinley County (Figure 2-1). The FWDA is located approximately 7 miles east of Gallup and about 130 miles west of Albuquerque. The main entrance to the FWDA is on U.S. Highway 66, west from Exit 33 off Interstate 40. The Facility is surrounded by federally owned and administered lands, including national forests, Zuni tribal lands, and Navajo tribal lands. North and west of the FWDA are Navajo trust and Native American allotted lands, to the east are lands that are administered by the Bureau of Indian Affairs, and to the south and southeast is the undeveloped Cibola National Forrest.

Originally founded in 1860 as a cavalry post, the U.S. Army established Fort Wingate as a munitions storage depot in 1918. The FWDA installation has had a number of missions since then, including ordinance storage, testing, and demilitarization, as well as missile defense testing.

The installation was closed in 1993 under the Defense Authorization Amendments and Base Realignment and Closure (BRAC) Act of 1988. In 2002, the Army reassigned many functions at FWDA to the BRAC Division, including: property disposal, caretaker duties, management of caretaker staff, and performance of environmental restoration and compliance activities. Facilities at FWDA include approximately 500 concrete bunkers located throughout the post, two former open burn/open detonation (OB/OD) areas, a workshop area, and various mission-support service structures located in the administration area.

At the present, approximately half of the FWDA is leased to the Missile Defense Agency and is used for operations related to missile testing. The remaining FWDA operations are focused on assessment and remediation of contamination resulting from past military activities. Efforts to remediate affected areas have concentrated on the removal of exploded and unexploded ordnance, in addition to characterizing soil across the installation and conducting semi-annually groundwater monitoring. The installation can be divided into several areas based upon location and historical land use. These major land-use areas include the following (Figure 2-2):

- ***The Administration Area***—Located in the northern portion of the installation and encompasses approximately 800 acres; consists of former office facilities, housing, equipment maintenance facilities, warehouse buildings, and utility support facilities.

- ***The Workshop Area***—Located south of the Administration Area and encompasses approximately 700 acres; consists of an industrial area containing former ammunition maintenance and renovation facilities, the former trinitrotoluene (TNT) washout facility, and the TNT Leaching Beds Area.

- ***The Magazine (Igloo) Area***—Located in the central portion of the installation and covers approximately 7,400 acres; consists of areas that encompass 10 Igloo Blocks (A through H, J, and K) that contain 732 earth-covered igloos and 241 earthen revetments previously used for munitions storage.

- ***The OB/OD Areas***—Located within the southwest and western portions of the installation; the OB/OD Area can be separated into two sub-areas based on period of operation:

  - *Closed OB/OD Area*—Inactive OB/OD unit that was used to treat military munitions and explosive-contaminated waste from 1948 to 1955; includes the Old Burning Ground, the Demolition Landfill Area, and the Old Demolition Area (PMC, 1999).

  - *Current OB/OD Area*—Inactive OB/OD unit where burning and detonation operations were performed after 1955 until installation closure in 1993 (PMC, 1999); contains the OB/OD Unit Hazardous Waste Management Unit identified in the Permit.

- ***Protection and Buffer Areas***—Located adjacent to the eastern, northern, and western boundaries of the installation and encompasses approximately 4,050 acres; consists of buffer zones surrounding the former magazine and demolition areas.

At present, FWDA has been undergoing final environmental restoration prior to property transfer/reuse. As part of the planned property transfer to the Department of Interior (DOI), the installation has been divided into reuse parcels with each site being addressed on a parcel-by-parcel basis, as specified by the Permit (NMED, 2005). Parcels transferred to-date are located near the southern and eastern boundaries of the installation and consist of Parcels 1, 15, and 17.

2.2 *Previous Groundwater Investigations*

Environmental restoration activities at the FWDA began in 1989 under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) guidelines, as part of the Installation Restoration Program. The one exception was the OB/OD Area, which proceeded under RCRA guidelines. During the period from 1980 through issuance of the Permit in December 2005, a number of environmental investigations were conducted by the Army and other parties (e.g., U.S. Environmental Protection Agency [EPA] and DOI) under CERCLA and RCRA guidance (BRAC, 2010).

Since that time, NMED has become the lead regulatory agency, and in 2002, NMED determined that the remediation pathway would be solely through a RCRA permit for post-closure care of the OB/OD Area with a RCRA corrective action module attached to address requirements for other sites/parcels. The Permit (NMED, 2005) was finalized in December 2005 and became effective 31 December 2005. The 2005 RCRA permit identified one Hazardous Waste Management Unit within the current OB/OD unit (Parcel 3), and a total of 93 solid waste management units (SWMUs) and areas of concern (AOCs).

Since the 1980s, a number of groundwater investigations have been completed at the FWDA. Generally, these investigations have been conducted with multiple phases to iteratively characterize groundwater at a single location over a period of time. Currently, 104 groundwater monitoring wells have been installed to characterize the nature and extent of contamination from activities associated with the OB/OD unit and various SWMUs and AOCs. While a majority of the wells is sampled, some are dry (5), buried (3), damaged (1), or plugged and abandoned (10), and therefore, are not currently being sampled (Table 2-1).

Groundwater investigation and characterization efforts have primarily focused on five areas:

- TNT Leaching Beds Area (SWMU 1 located within Parcel 21),
- Administration Area (multiple SWMUs and AOCs located in Parcels 6, 7, and 11),
- Eastern Landfill Area (SWMU 13 located within Parcel 18),
- Buildings 542 and 600 Area (SWMUs 11 and 4 located within Parcel 6),
- and the OB/OD Area (located within Parcel 3).

For discussion purposes related to groundwater sampling, these areas have been grouped within two major areas at the Facility: the OB/OD Area and the Northern Area. A map showing all existing monitoring well locations is included as Figures 2-3 through 2-5, well construction information for all wells to date is included in Table 2-1, and a Microsoft Excel® spreadsheet of all groundwater analytical results to-date is included in Appendix C.

2.2.1 Environmental Survey of FWDA - 1981

In 1981, an environmental survey of FWDA (ESE, 1981) was conducted to determine the potential presence and extent of contamination caused by activities related to munitions storage, munitions recycling, and treatment. The following describes the activities related to groundwater monitoring:

- Eleven monitoring wells (FW07, FW08, FW10, FW11, FW12, FW13, FW26, FW27, FW28, FW29, and FW35) were completed in the Northern Area during this assessment. However, groundwater was not encountered in the majority of the wells, thus most of these wells are considered dry and have been abandoned.

- One monitoring well (FW24), located near a north-south trending arroyo that drains into the OB/OD Area, was completed as part of the environmental survey of the OB/OD Area in 1981. Upon completion of the installation of FW24, the well had insufficient water for sampling and is considered dry and inactive.

- One background monitoring well, FW31, was completed east and south of any known potentially contaminated areas during the 1981 environmental survey. This well is near the former Pistol Range, over 10,000 feet southeast of the TNT Leaching Beds Area, and over 14,000 feet northeast of the OB/OD Area. This well is active and is currently being sampled on a semi-annual basis.

Unfortunately, most of the wells completed during the 1981 Environmental Survey have historically lacked sufficient water for interim semi-annual sampling as directed by the Permit.

2.2.2 Groundwater Investigations at Building 6 UST Area – 1993-1995

During January 1993, six underground storage tanks (USTs) were removed from Building 6 within the Administration Area (USACE, 1995a). During the removal, a fuel release was suspected, presumably from holes or cracks in the bottoms of several of the tanks or associated piping. This spill was discovered on 19 January and reported to the NMED, Petroleum Storage Tank Bureau (USACE, 1995a).

The USACE, Albuquerque District, conducted a site investigation for the Building 6 USTs. In 1993, 16 soil borings were advanced to an average depth of 60 feet below ground surface (bgs). Based on the laboratory and field results from the 16 soil borings, the vertical extent of the contamination appeared to be limited by a continuous clay layer occurring at approximately 40 feet bgs. The horizontal extent of the soil contamination appeared to be limited to within 250 feet downgradient of the former USTs. These results were submitted to the NMED in June 1993. After reviewing these results, the NMED requested in January 1994 that the investigation be expanded to better define the vertical and horizontal extent of the soil contamination and to determine if diesel products have significantly contaminated the shallow alluvial aquifer.

In October and November 1994, six soil borings were advanced to a depth of 60 feet bgs, and five monitoring wells were installed at three locations (MW-18S, MW-18D, MW-20, MW-22S, and MW-22D). Groundwater analytical data from MW-20, located south and west of the UST removal area, indicated benzene contamination of 110 micrograms per liter (µg/L), well above the state action level of 10 µg/L for benzene in groundwater. These monitoring wells were resampled in December 1994, and laboratory analysis indicated that the same well (MW-20) was still contaminated with benzene, but at a lower level of 59 µg/L. A soil gas survey was conducted in the UST area in March 1995 to better define the location of the benzene contamination in the vicinity of MW-20; however, benzene was not found in the soil at depths between 35 to 50 feet in that area. The monitoring wells were also resampled during the soil gas survey, and laboratory analytical data indicated that the benzene level in MW-20 had decreased to 4.4 µg/L (USACE, 1995b).

With the apparent steady decline in the benzene levels, the USACE, Albuquerque District, approached the NMED to suspend the investigation and any further requirements to install additional monitoring wells at this site. The NMED agreed that installation of additional monitoring wells was not needed at that time, however, a 2-year quarterly groundwater monitoring program was required to ensure that shallow groundwater quality has not been compromised (USACE, 1995b).

2.2.3 Remedial Investigation/Feasibility Study Report and RCRA Corrective Action Program Document - 1997

Environmental investigation activities at FWDA were implemented as part of base closure in the Fall of 1992 to determine the environmental impact (if any) from previously identified SWMUs and AOCs, and to identify areas requiring environmental restoration prior to property transfer to the DOI. Findings generated as a result of this effort were documented in the 1997 Remedial Investigation/Feasibility Study Report and RCRA Corrective Action Program Document (ERM PMC, 1997); a summary pertaining to the groundwater activities and findings are discussed below.

- Four groundwater monitoring wells (TMW01 through TMW04) were completed during 1996 to further characterize groundwater contamination near the TNT Leaching Beds Area in the Northern Area. Monitoring wells TMW01, TMW03, and TMW04 were completed between 60 and 75 feet bgs in the unconsolidated material overlying the mudstone/sandstone bedrock. Monitoring well TMW02 was completed to a depth of approximately 85 feet bgs into a sandstone water-bearing unit that underlies the TNT Leaching Beds Area.

- A single well (SMW01) was installed in 1996 to monitor potential impacts from the Sewage Treatment Plant also in the Northern Area. This well was completed in the unconsolidated alluvium overlying the mudstone/sandstone bedrock located in the most northern portion of the FWDA.

- A single well (FW38) was completed during November 1993 in an arroyo that drains the Current OB/OD Area. This well was completed to approximately 7.5 feet bgs in the unconsolidated alluvium overlying the mudstone/sandstone bedrock. This well is currently dry and is considered inactive.

During this phase of investigation, explosives and nitrate were the primary constituents detected in the monitoring wells completed near the TNT Leaching Beds Area. Nitrate, pesticides, and metals were the primary constituents detected in the samples collected from SMW01 near the FWDA sewage treatment plant. Explosives, nitrate/nitrite, and metals were the primary constituents detected in groundwater samples collected from FW38.

2.2.4 Minimum Site Assessment Report -1998

The purpose of the Minimum Site Assessment was to provide a summary of the actions taken by the USACE, Albuquerque District, to identify the horizontal and vertical extent of soil contamination and to determine if groundwater was impacted by potential fuel releases at the UST site adjacent to Building 45.

The Minimum Site Assessment was initiated in November 1996 with the completion of six soil borings (SB-1 through SB-6) and three shallow monitoring wells (MW01, MW02, and MW03) to determine the extent of hydrocarbon contamination. Analytical data from this assessment indicated that hydrocarbon contamination in the soil was limited to a small area. The area affected was restricted to a single soil boring at depths less than 40 feet bgs. Chemical characterization of underlying groundwater indicated minimal impact with a single detection of benzene at a low concentration at MW01.

2.2.5 RCRA Interim Status Closure Plan – OB/OD Area Phase 1B Report - 1999

Environmental characterization efforts in support of closure at the OB/OD Area were conducted during CYs 1996, 1997, 1998, and 1999. Overall, these efforts consisted of monitoring well installation and sampling, a seismic profile survey, groundwater elevation measurements, a well survey, geologic mapping, surface water sampling, and sediment sampling (PMC, 1999).

The objective of the 1996 investigation was to assess the presence and quality of shallow groundwater and to characterize the shallow hydrogeologic regime in the OB/OD Area. This investigation consisted of drilling and sampling of multiple soil borings; completion of shallow and intermediate depth monitoring wells; performance of down-hole video logging and slug tests on newly installed monitoring wells; and collection of groundwater, surface water, and sediment samples. Three groundwater monitoring wells (KMW09, KMW10, and KWM11) were installed in the Closed OB/OD Area and eleven groundwater monitoring wells (CMW02, CMW04, CMW06, CMW07, CMW10, CMW14, and CMW16 through CMW20) were installed in the Current OB/OD Area. Explosive constituents were detected in wells located in both OB/OD Areas; however, the areal extent could not be defined by the CY 1996 investigation and required further characterization efforts.

Subsurface characterization measures were conducted during CY 1997 to obtain additional data concerning the stratigraphy and structural setting of the OB/OD Area. This investigation consisted of a surface seismic survey, geologic mapping, and fracture trace analysis. From this and previous investigations, two groundwater systems within the OB/OD Areas were identified: the shallow, unconsolidated water-bearing zone and the deeper, bedrock water-bearing zone (PMC, 1999).

In 1998, two groundwater monitoring wells (KMW12 and KMW13) were installed within the Closed OB/OD Area, and four groundwater monitoring wells (CMW21, CMW22, CMW23, and CMW25) were installed north of monitoring well CMW16 located in the current OB/OD Area to identify the northern extent of impacted groundwater within the unconsolidated and bedrock water-bearing zones. In addition, CMW24, was installed northwest of CMW16 to determine if previously identified faults act as a groundwater flow barrier or conduit, and to determine the direction of groundwater flow in that area (PMC, 1999).

2.2.6 OB/OD Groundwater Monitoring – 1999 to 2005

Several quarterly sampling events have been completed in the OB/OD Areas since the issuance of the 1999 RCRA Interim Status Closure Plan - Phase 1B Report (PMC, 1999).

Quarterly groundwater monitoring events were conducted during CYs 2000 (PMC, 2001a), 2001 (PMC, 2002a), and 2002 (PMC, 2003), and an additional sampling event was completed in August 2005 (TerranearPMC, 2005). These quarterly events were documented in quarterly letter reports and an annual inclusive report for each year.

During the initial sampling investigation, a subset of nine wells (CMW02, CMW16, CMW18, CMW21, CMW22, CMW25, KMW09, KMW12, and KMW13) was sampled during the CY 2000 and the first half of the CY 2001. Monitoring well CMW23 was added midway through CY 2001, and a subset of 10 wells was sampled until CY 2005.

2.2.7 RCRA Facility Investigation Report of the TNT Leaching Beds Area - 2001

From 1998 to 2001, additional groundwater investigations were completed in the TNT Leaching Beds Area and the Administration Area (PMC, 2001b). Seven groundwater monitoring wells (TMW05 through TMW08, TMW10, TMW11, and TMW13) were installed to further characterize the hydrogeologic setting and potential environmental impacts caused by the former operations. As a result of these investigations, groundwater was found to be impacted by explosives, metals, nitrate, and nitrite, which appear to emanate from the TNT Leaching Beds Area. In addition, groundwater was also found to be impacted by pesticides and solvents, which appear to originate from the Administration Area.

2.2.8 Phase 1 RCRA Facility Investigation Report for Buildings 600 and 542 - 2002

In 2001, soil and groundwater were investigated to determine if previous detections of explosives in TMW11 were the result of activities at Buildings 600 and 542 (Ammunition Workshop) (PMC, 2002b).

Monitoring well TMW11, drilled in a location cross-gradient from the TNT Leaching Beds Area, was intended to provide groundwater chemical characterization data in an area thought to be unimpacted by historical operations. One explosive constituent, cyclotrimethylenetrinitramine (1,3,5-trinitro-1,3,5-triazinane or RDX), was detected at concentrations close to the laboratory method detection limit (MDL) during five of six sampling events conducted between October 1998 and January 2000. These detections of RDX initiated an investigation to identify other potential sources of explosives in the area.

A total of six monitoring wells (TMW14A through TMW19) were completed near Buildings 542 and 600 to determine the source of the contamination at TMW11. Monitoring well TMW15 was completed in the unconsolidated water-bearing zone, similar to TMW11. Monitoring wells TMW14A, TMW16, TMW17, TMW18, and TMW19 were completed in

the deeper, sandstone bedrock water-bearing zone. TMW14A was also installed as a potential background well.
Overall, only low concentrations of a single volatile organic compound (VOC), explosives, perchlorate, nitrate, nitrite, and a variety of metals were detected from samples collected during this investigation.

2.2.9 Groundwater Investigation Report of the Eastern Landfill - 2005

The Eastern Landfill is located approximately ½ mile northeast of the water towers and is reported to have been used for the disposal of garbage, trash, and debris from the Administration Area, and for the burning of other solid waste from activities at the FWDA. In 1968, the landfill was closed and covered with a layer of soil. During the Remedial Investigation (RI) phase, the Eastern Landfill was located using a geophysical survey, and soil sampling and a soil gas survey were conducted. The soil analytical results indicated that lead, mercury, and barium were present at levels slightly above background levels. Pesticides, VOCs and semi-volatile organic compounds (SVOCs) were not detected. The results of the soil gas survey indicated that low levels of methane were present; however, hydrogen sulfide gas was not detected. In October 1999, Safe Environment, Inc. removed surface debris in the area of the Eastern Landfill, which consisted of metal ammunitions lids, wire rope, I-beams, pipe, tires, wire fencing, concrete blocks, expended ammunition casings, scrap wood, and tree branches/trunks (TtNUS, 2005).

The primary objective of the 2005 groundwater investigation was to determine if contaminants have impacted the groundwater beneath the Eastern Landfill (TtNUS, 2005). During the investigation, four bedrock wells (EMW01 through EMW04) were completed to depths ranging from 100 to 120 feet bgs in 2004. Immediately after installation, only two of the four wells (EMW02 and EMW03) contained enough water for sampling (TtNUS, 2005). Several explosives, metals, pesticides, VOCs, SVOCs, nitrate, and nitrite were detected in these samples collected from the sampling event after well installation.

2.2.10 Administration and TNT Leaching Beds Areas Supplemental Groundwater Characterization Report - 2006

The purpose of the work described in this report was to gather additional information during 2002 and 2003 to address comments and discussions by members of the FWDA BRAC Cleanup Team regarding information presented in the 2001 Final RCRA Facility Investigation (RFI) for the TNT Leaching Beds Area (TerranearPMC, 2006).

These prior discussions indicated that the downgradient flow of groundwater from the TNT Leaching Beds Area to the north could possibly be split by the influence of a groundwater mound that has been shown to exist within the Administration Area. In this scenario, impacted groundwater could flow to the west-northwest and/or to the northeast around the Administration Area, thus the existing monitoring wells, TMW06 and TMW07, would not be properly placed to define the downgradient extent(s) of impacted groundwater. Therefore, additional monitoring wells were required to evaluate this scenario. In addition, the groundwater analytical data presented in the TNT Beds RFI Report indicated that the leading edge of impacted groundwater (as indicated principally by detected nitrite/nitrate concentrations) had reached the edge of the permeable sediments of the Rio Puerco Valley. Because groundwater from these sediments is used for domestic water supply in the immediate vicinity of the FWDA, additional efforts (monitoring wells and groundwater samples) were warranted to determine the current groundwater quality within the Rio Puerco sediments in the northern areas of the FWDA.

As a result, nine monitoring wells (TMW21 through TMW29) were installed and screened within the unconsolidated water-bearing zone. Upon completion of the new wells, a groundwater sampling event of all wells in the Northern Area of FWDA was conducted during October 2002 and April 2003. The results of this event were similar to those of the 2001 RFI Report of the TNT Leaching Beds Area and provided further information about the leading edges of impacted groundwater.

2.2.11 Parcel 11 RCRA Facility Investigation Report - 2011

In November and December of 2009, the U.S. Geological Survey (USGS) conducted a RFI in Parcel 11. Three monitoring wells were installed within Parcel 11 at SWMU 5 (TMW35, near Building 5), SWMU 6/AOC 47 (TMW34, west of Building 11), and SWMU 45 (USGS, 2011a). The SWMU 45 monitoring well (TMW33) was installed downgradient of former UST locations near Building 6 (USGS, 2011a). All three monitoring wells were constructed in the alluvium and in accordance with NMED guidance with the water table no less than 5 feet below the top of the screen.

Groundwater samples were collected in April 2010 during the scheduled semi-annual groundwater monitoring activities. No diesel fuel constituents were detected, but VOCs and nitrate were detected in samples with concentration above screening criteria. The screening level for nitrate is 10 milligrams per liter (mg/L). TMW34 and TMW35 samples contained nitrate at 177 mg/L and 84.5 mg/L, respectively (USGS, 2011a). Of the VOCs detected, 1,2-dichloroethane was detected in groundwater from TMW33 above the screening level of

5 μg/L. The groundwater sample collected from TMW33 had a 1,2-dichloroethane concentration of 30.7 μg/L (USGS, 2011a).

2.2.12 Parcel 22 RFI Report - 2011

In November and December of 2009, the USGS installed six monitoring wells as part of the RFI for Parcel 22 to investigate the suspected release of perchlorate originating from TPL, Inc. (a former tenant) operations related to demilitarization of munitions within SWMU 27 (USGS, 2011b). Five of the monitoring wells were completed within the sandstone water-bearing unit (TMW30, TMW31D, TMW32, TMW36, and TMW37), and one monitoring well was installed in alluvium (TMW31S). In addition, TMW31S and TMW31D were installed as dual-completion wells (two monitoring wells constructed in one borehole). TMW30 was a replacement monitoring well for TMW05 (dry since 2008), and TMW31S was installed as a replacement monitoring well for FW10, which is also dry.

Groundwater samples were collected in April 2010 during the scheduled semi-annual groundwater monitoring activities. Groundwater samples collected from monitoring wells TMW30, TMW31D, and TMW31S contained nitrate above the screening level of 10 mg/L with concentrations of 89.1 mg/L, 59.0 mg/L, and 35.0 mg/L, respectively (USGS, 2011b). Groundwater samples collected from monitoring wells TMW30, TMW31D, TMW31S, and TMW32 contained perchlorate concentrations exceeding the screening level of 6 micrograms per liter (μg/L) with concentrations of 1,900 μg/L, 1,420 μg/L, 465 μg/L, and 232 μg/L, respectively (USGS, 2011b).

2.2.13 Monitoring Well Installation and Abandonment Work Plan - 2011

The purpose of this work plan is to describe the work performed by the USGS on behalf of the USACE, Fort Worth District, as part of the Environmental Restoration Program at FWDA. The plan describes the installation of up to 18 groundwater monitoring wells and the abandonment of 10 groundwater monitoring wells. This work was performed to further delineate groundwater contaminant plumes, establish background concentration levels, monitor potential off-site migration, and remove from service several dry monitoring wells (USGS, 2011c).

Wells were installed at locations selected to address one of the following three objectives:

1) To monitor potential off-site migration of chemical constituents originating from former post activities

2) To determine background concentrations of major and trace metals

3) To add sufficient spatial data to further define the RDX, nitrate, and perchlorate groundwater plumes

Well Installation

- ***Sentinel Wells*** - Two alluvial sentinel monitoring wells (MW23 and MW24) were installed in June and July 2011 at the request of the NMED. These two wells are located in the northwest portion of the FWDA and were selected to monitor potential off-site migration of chemical constituents within the alluvial aquifer (USGS, 2011c).

- ***Background Wells*** - Three background monitoring wells (BGMW01, BGMW02, and BGMW03) were installed in February 2012 in the alluvial aquifer to determine the background concentrations of major and trace metals in the groundwater. The purpose of these wells is to determine the natural concentrations of constituents that reflect the naturally occurring water-rock interactions with the alluvial unit, as well as atmospheric inputs, clay mineralogy, pH, and water chemistry (USGS, 2011c).

- ***Perchlorate Plume Monitoring Wells* -** Alluvial monitoring wells (TMW39S, TMW40S, TMW41) were installed in July and September 2011 to aid in delineating the lateral extent of the perchlorate plume. Three bedrock monitoring wells (TMW38, TMW39D, and TMW40D) were also installed to define the lateral extent of the bedrock perchlorate plume (USGS, 2011c).

- ***RDX Plume Monitoring Wells*** - Three alluvial monitoring wells (TMW43, TMW44, and TMW45) were installed in the Northern Area in February 2012. Monitoring wells, TMW43 and TMW44, were installed to refine the concentration gradient in the center of the RDX plume and to allow for contaminant mass discharge estimates. These monitoring wells will also aid in defining the concentration gradient of nitrate in the alluvium, which comingles with the RDX plume. Monitoring well TMW45 was installed north of TMW23 to delineate the northern extent of the RDX plume (USGS, 2011c).

- ***Nitrate Plume Monitoring Wells*** - Two alluvial monitoring wells (TMW46 and TMW47) were installed in February 2012 to provide chemical data that will delineate the northwest and eastern boundaries of the alluvial nitrate plume. Additionally, because the nitrate alluvial plume comingles with the RDX plume and alluvial perchlorate plume, monitoring wells installed to characterize these plumes will also be used to further characterize the alluvial nitrate plume (USGS, 2011c).

Well Abandonment

Ten groundwater monitoring wells were plugged and abandoned in the summer of 2011 because these wells historically lacked sufficient groundwater volumes required for groundwater sampling. These 10 wells were all located in the Northern Area and were generally screened within the alluvium. The following list dictates which wells were plugged and abandoned:

Well ID	Northing[a]	Easting[a]	Casing Diameter (inches)	Well Depth (feet)
TMW05	1639949.83	2498884.78	2.0	37.40
FW07	1640839.18	2498075.06	4.0	30.50
FW08	1640572.50	2498132.47	4.0	51.00
FW10	1640848.95	2498936.89	4.0	51.50
FW11	1641334.02	2499124.16	4.0	28.00
FW12	1641609.82	2499038.13	4.0	29.00
FW13	1641688.39	2498830.01	4.0	30.50
FW27	1646461.42	2494395.93	4.0	32.00
FW28	1646584.14	2493050.57	4.0	33.00
FW29	1645804.02	2497681.98	4.0	32.00

[a] New Mexico State Plane – West.
ID = identification

2.2.14 Semi-Annual RCRA Groundwater Monitoring Reports and Updated Groundwater Monitoring Plans - Ongoing

In accordance with Section V.A of the Permit (NMED, 2005), the 2008 Interim Measures Facility-Wide GMP was prepared, approved by NMED, and implemented. Since 2008, groundwater sampling was conducted semi-annually (April and October), and semi-annual groundwater monitoring reports were prepared, providing the analytical data and water level maps for FWDA.

In addition, the Interim Measures Facility-Wide GMP is updated annually and is required to propose changes to the groundwater monitoring program annually. Section 5 provides the proposed changes to the 2013/2014 monitoring program.

3. SITE CONDITIONS

The general information below is a summary of the site conditions at the FWDA. More specific information including historic land use, natural and man-made features, ecological setting, fate and transport information, and detailed surface and subsurface characterization will be included in other documents (e.g., RFI Work Plans and Release Assessment Reports) prepared for the individual parcels as specified in the Permit.

3.1 Climate

Northwestern New Mexico is characterized by a semi-arid, continental climate with most precipitation occurring during the months of May through September as localized, heavy, and brief monsoon storms. The climate for the FWDA area varies with elevation but is generally mild during the summer with temperatures ranging between 65 and 95 degrees Fahrenheit (°F), and cold during the winter with average daily temperatures ranging between 30 and 35°F. The warmest month of the year is July with an average maximum temperature of 89°F, while the coldest month of the year is December with an average minimum temperature of 11°F. Daily temperature variations can be considerable during the summer months with an average temperature difference of approximately 35°F.

Mean annual rainfall for the area ranges between 10 and 16 inches, while the recorded average annual precipitation for the FWDA is approximately 11 inches. The wettest month of the year is August with an average rainfall of approximately 2 inches. Most of the precipitation occurs as rain or hail during violent summer thunderstorms; the remainder results from light winter snow accumulations with the slow release of spring snowmelt, which provides higher infiltration compared to the intense monsoon thunderstorms (Anderson *et al.*, 2003).

The area has generally sunny weather with average relative humidity varying from 50 to 15 percent during the wet season (summer monsoons) and the dry season, respectively. During spring, the area experiences very strong winds originating from the west and southwest with an average wind speed of approximately 12 miles per hour and maximum gust speeds approaching 65 miles per hour. These strong winds, high temperatures, and low relative humidities contribute to high evaporation rates at the FWDA.

3.2 Topography

Topographically, the FWDA can be divided into three areas: (1) the rugged north-south trending Nutria Monocline (commonly referred to as the Hogback) along the western and the southwestern boundaries of the installation; (2) the northern hill slopes of the Zuni Mountain Range in the southern portion of the installation; and (3) the alluvial plains marked by bedrock remnants in the northern portion of the installation. The elevation of FWDA ranges from approximately 8,200 feet above mean sea level in the south to 6,660 feet above mean sea level in the north.

This climate and topography supports a mixed ponderosa pine and fir forest at elevations above 7,500 feet, piñon and juniper vegetation at elevations from 7,500 to 6,800 feet, and shrubs and grasses at elevations below 6,800 feet.

3.3 Soil

The FWDA soil types range from a mixture of sand, silt, and clay. Alluvium most commonly found in arroyos is permeable sand and sandy loam clay mixtures that contain varying amounts of silt, gravel, and rock fragments; however, most soil across the Facility is composed of low-permeability sandy clay. Soil types at the FWDA are primarily alluvial materials with the exception of the Hogback along the western border and the northern hill slopes of the Zuni Mountain Range in the southern portion of the installation. The alluvial materials do not have distinct soil horizons as they are relatively shallow and undeveloped, excluding the arroyos, and the parent bedrock is either at or near the surface within more than a quarter of the installation.

High winds and water cause extensive soil erosion, especially where the vegetation cover is absent. The more permeable, sandy soil typically found in arroyos accounts for the majority of local surface-water infiltration. The thickness of the soil varies across the installation. In the OB/OD Area and at the eastern and southern perimeter of the Northern Area, the soil thickness is a thin veneer with parent bedrock at or near the surface. However, in the majority of the Northern Area, the flat alluvial plains are dominant with thick soil overlying deeper, steeply dipping bedrock. In the Administration Area alone, alluvium can be up to 70 feet thick and are even thicker near the Rio Puerco.

3.4 Geology

3.4.1 Regional Geology Tectonic Setting and Site-Specific Structure

The FWDA is located in an erosional basin within the Navajo section of the Colorado Plateau Physiographic Province and lies on the northwest apex of the Zuni Uplift. This basin is regionally bounded by the Gallup Sag to the west, the Acoma Sag and McCarty's Syncline to the east, and the Chaco Slope to the north. The Zuni Uplift is an elongated north-northwest trending structural uplift that is primarily a result of vertical upward displacement followed by deformation resulting from horizontal compressive stress associated with the Laramide Orogeny (Cretaceous). The uplift has exposed tilted Mesozoic sedimentary strata within the south-western portion of the installation, a majority of which are Triassic mudstones and sandstones.

Specifically, the dominant topographic structural feature located on the southwest margin of the Zuni Uplift is the Nutria Monocline or "Hogback." This steep structural feature is a monoclinal belt with dips ranging from 30 to 45 degrees near the Facility. Dips commonly exceed 60 degrees in the southern extension of the monocline, south of the Facility. The northern segment of the Nutria Monocline is exposed in the western portion of the FWDA, where westerly dipping Mesozoic strata is exposed to form a long, sharp-crested, north-to-south trending ridge. In areas of the installation east of the Hogback, the bedrock generally dips to the northwest.

3.4.2 Stratigraphy

In the northern portion of the installation, the surface is covered by either remnants of the Chinle Group (Triassic) or alluvial deposits (Quaternary). The majority of the alluvial deposits are mostly prevalent in the Northern Area in lowland areas between bedrock remnants. Alluvial deposits are also present along intermittent streams draining the Hogback and Zuni Mountains, which flow downgradient through the northern portion of the installation before joining the South Fork of the Puerco River. The alluvium ranges in grain size from clay to gravel, typical of braided stream deposits (Malcolm Pirnie, Inc., 2000). Because the alluvium was generally deposited by braided streams and arroyos, the texture and internal structure are characterized by lateral and vertical heterogeneity. Information obtained from records of previously installed wells indicates that the alluvial deposits are thickest near major drainages, such as the South Fork of the Rio Puerco, where alluvial deposits can be up to 150 feet thick. Near Fort Wingate High School (located east of the installation), the alluvial deposits are approximately 75 feet thick, whereas in the

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Administration Area, deposit thickness is variable with average thickness varying from 30 to 70 feet within a relatively small spatial area.

The majority of the FWDA is underlain by the Chinle Group (Triassic), which is predominantly non-marine, red-bed siliciclastics. The Chinle Group consists of the Shinarump, Bluewater Creek, Petrified Forest, and the Owl Rock Formations. The Petrified Forest Formation directly underlies the majority of the installation, and is subdivided into three members: the Blue Mesa, the Sonsela, and the Painted Desert Members. All three members of the Petrified Forest Formation outcrop in various locations across the installation. The Blue Mesa, Sonsela, and Painted Desert lithologies are green-gray smectitic mudstone, light-gray to yellowish-brown cross-bedded sandstone, and reddish-brown and grayish-red smectitic mudstone, respectively. At the eastern extent of the FWDA installation, the older Bluewater Creek and Shinarump Formations outcrop intermittently between Quarternary alluvium.

The Chinle Group is underlain by the older San Andres Limestone and Glorieta Sandstone, both Permian in age. The San Andres Limestone generally consists of fossiliferous limestone that intertongues the Glorieta Sandstone (Anderson *et al.*, 2003). These two formations do not outcrop within the boundaries of the Facility; however, the Glorieta Sandstone Formation does outcrop south of the installation where a thrust fault juxtaposes Permian strata against the Cretaceous Dakota Sandstone.. These two formations comprise the San Andres-Glorieta aquifer and is the principal source of drinking water in the area (Malcolm Pirnie, Inc., 2000). Figure 3-1 depicts the geology of the FWDA.

3.5 Surface Water

3.5.1 General Surface Water

Streams are ephemeral and fed by rain and snowmelt from the Zuni Mountain Range and the Nutria Monocline. All drainages in the FWDA area are intermittent with flow only occurring during and after heavy rainfall events (summer) or snowmelt (spring). These streams transport sediment to low-lying areas in the northern portion of the installation, thus creating thick and extensive alluvial deposits among remnants of Triassic strata of the Petrified Forest Formation. Main drainages at the FWDA generally follow the dominant topography, flowing from south to north and discharging into the South Fork of the Rio Puerco in the northern portion of the installation. Because of the nature of brief and heavy precipitation in this semi-arid region, the surface drainage is relatively shallow near headwaters. Downward erosion intensifies as the water moves downstream, thus resulting in a well-developed, steep-walled system of arroyos in Quaternary alluvium.

3.5.2 Site-Specific Surface Water

Three major drainage systems at the FWDA can be identified as follows: (1) eastern drainage system; (2) western drainage system; and (3) southwestern-corner drainage system. These drainage systems are divided by either bedrock ridges or bedrock remnants. Furthermore, in the northwest portion of the site, two artificial channels are present that were constructed during the 1940s to divert water away from Igloo Blocks A and B and the Administration Area (U.S. Department of Energy, 1990).

The eastern drainage system consists of washes that run in northwestern and northeastern directions off the slopes of the Zuni Mountains. Alluvial fans form in basins at the front of the slope, as well as between bedrock remnants. In the northeast section of the installation, the drainage flows around bedrock remnants before joining the South Fork of the Puerco River. The western drainage system (except for the southwest corner) consists primarily of two main drainages covering the western portion of the FWDA. Tributaries of the western drainage system pass the demolition area, cross the Hogback, and then join, flowing north depositing alluvium along the bedrock remnants (Herndon Solutions Group, 2011). The southwestern-corner drainage system flows southwest and joins the Bread Springs Wash on the western side of the Hogback. Because the southwestern drainage system is hydrogeologically isolated from the other parts of the site and installation activities have apparently not occurred in this area, the drainage system is of less environmental concern (U.S. Department of Energy, 1990).

3.6 Hydrogeology

Groundwater is present in several of the rock units underlying FWDA. Examination of these units and records of wells in the area indicates that the only formations at FWDA capable of yielding more than a few gallons per minute (gpm) are the Quatowam Alluvium (Quaternary) and the San Andres Limestone and Glorieta Sandstone (Permian). However, minor amounts of groundwater are present in bedrock underlying the shallow alluvial aquifer and are composed of Triassic-age Members of the Chinle Group: the Painted Desert Mudstone/Claystone, the Shinarump Conglomerate, and the Sonsella Sandstone. Water yields from the Shinarump and Sonsella Members generally yield 5 to 50 gpm, and the water quality is considered fair to poor. Water-bearing formations of Jurassic and Cretaceous ages capable of yielding 100 gpm or more are present 4 to 6 miles to the west of FWDA, but not within installation boundaries. The tilted bedrock underlying the majority of the FWDA installation dips gently to the northwest, which substantially influences the movement of groundwater. The groundwater flow gradient in the Northern Area is primarily to the south-

southwest in the alluvial system and to the west in the bedrock system. The groundwater flow gradient appears to be in a northerly direction in the OB/OD area.

3.6.1 Productive Aquifers

The Quaternary alluvial aquifer, which includes deposits in the Rio Puerco Valley along the northern edge of the installation, is composed of gravel, sand, silt, and clay derived from Triassic and Jurassic age strata that border the valley. This shallow aquifer is primarily recharged from surface runoff, although some deposits in the southern part of the installation are recharged by springs from underlying bedrock aquifers. Recharge of groundwater within the alluvium occurs mainly during the wet seasons of the year, specifically with the snowmelt in the spring.

The San Andres-Glorieta aquifer is the only groundwater source for FWDA installation and outcrops near the installation's southern boundary, dipping to the north. Snowmelt and precipitation furnish much of the recharge water to the aquifer. The downgradient flow of groundwater is in a northwesterly direction with the top of the San Andres-Glorieta aquifer approximately 1,100 feet bgs near the Administration Area. At this location, the aquifer is about 200 feet thick and under artesian pressure. Local variations in aquifer permeability can be large and unpredictable with hydraulic conductivity values ranging from 0.05 to 150 feet per day and yields that are highly variable from one location to another (USACE, 2011). In 1980, the region around Gallup, including FWDA, was declared an underground water basin by the State of New Mexico. This action prohibits any major new groundwater withdrawals without the approval of the State Engineer. The recharge basin for this aquifer covers approximately 1,439 square miles and includes the communities of Gallup, Fort Wingate, Camerco, Mariano Lake, Navajo Wingate Village, and Rehoboth (USACE, 2011).

3.6.2 OB/OD Area Hydrogeology

The general groundwater flow in the OB/OD Area is from south to north, following the general topographic gradient (Herndon Solutions Group, 2011). Groundwater in the OB/OD Area is mostly present in Triassic-age bedrock (Herndon Solutions Group, 2011) from the Chinle Group. According to data presented in monitoring well logs, the majority of monitoring wells in the OB/OD Area are constructed in undifferentiated Chinle units or the Sonsela Member of the Petrified Forest Formation. Because groundwater is generally not present in the alluvial deposits, groundwater can saturate the sediments that load arroyos generally only during and after substantial precipitation. Monitoring wells CMW20 and FW38 are constructed in arroyo sediment. FW38 is a dry well, and CMW20 only periodically contains sufficient groundwater to sample (Herndon Solutions Group, 2011).

3.6.3 Northern Area Hydrogeology

In the northern portion of the installation, the alluvium is thicker than in the OB/OD Area, thus has a higher storage capacity for groundwater. Saturated thickness within the alluvial aquifer (Quatowam Alluvium) varies greatly and tends to increase as it nears drainage channels and arroyos. The direction of general groundwater flow is from the north toward the south. However, directly beneath the Administration Area, groundwater flow from the north converges with groundwater flow from the southern edge of the Workshop Area. This convergence creates a local westerly groundwater flow direction (Herndon Solutions Group, 2011).

In addition, groundwater is also present in bedrock beneath the Workshop Area in discontinuous fine-grained, sandstone beds within the Painted Desert Member of the Petrified Forest Formation. Several monitoring wells are constructed with screens in these sandstones, and groundwater elevation measurements indicate that the downgradient is in a westerly direction (Herndon Solutions Group, 2011).

3.7 Cultural Resources

Traditional Cultural Properties and other cultural resources have been documented within FWDA boundaries. Existing groundwater monitoring wells and access routes are not located within identified archaeological sites. Because groundwater sampling activities are non-intrusive and confined to a small area immediately surrounding a given well, cultural resource monitoring will not be required during proposed sampling activities at existing wells.

Maps showing the locations of Traditional Cultural Properties relative to existing monitoring well locations will not be included in this Interim Measures Facility-Wide GMP, which will be a public document when final.

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4. SITE MONITORING AND SAMPLING METHODS

Field activities to be performed under this Interim Measures Facility-Wide GMP include groundwater elevation surveys and collection of groundwater samples from the monitoring wells at FWDA. The various types of purge methods required for sampling are identified in Table 4-1 and described in the following sections. Field equipment required for the following field activities is listed in Table 4-2. The Site Safety and Health Plan for this investigation is included in Appendix D.

4.1 Groundwater Elevation Survey

Groundwater elevation measurements in the existing wells listed in Table 4-1 will be measured quarterly over a two-day period (January, April, July, and October). When a groundwater elevation survey event coincides with a groundwater sampling event, water elevation data shall be collected prior to the start of sample collection.

Depth to groundwater shall be measured with an electronic water-level meter as follows:

- Slowly lower the probe of the water-level meter down into the well casing in order to minimize groundwater disturbance.

- Record measurement to the nearest 0.01 foot from the top-of-casing reference notch and document in field logbook.

- Remove water level probe from the well casing and decontaminate with Liquinox® and deionized water as described in Section 4.4. Use of any other type of detergent will be documented in the field logbooks and investigative reports.

4.2 Groundwater Sampling

Groundwater will be sampled from the monitoring wells listed in Table 4-1 in order of increasing chemical concentration (known or anticipated) and analyzed for the constituents of interest outlined in Section 5.3. Sample bottles will be filled in the following order:

Analytical Group	**Analytical Method**	**Container (Number, Size, and Type)**
TCL VOCs	8260C	(3) - 40 mL VOC glass vials
TCL SVOCs	8270D	(1) - 1-L am`ber bottle
TPH-GRO	8015B	(3) - 40 mL VOC glass vials

Analytical Group	Analytical Method	Container (Number, Size, and Type)
TPH-DRO	8015B	(1) - 1-L amber bottle
Explosives	8330B	(2) - 1-L amber bottles
Nitrate	300.0	(1) - 250-mL poly bottle
Nitrite	300.0	(1) - 500-mL poly bottle
Perchlorate	6860	(1) - 250-mL poly bottle
Pesticides	8081A	(2) - 1-L amber bottle
Total Metals and Mercury (unfiltered)	6010C/6020B/7470A	(1) - 1-L poly bottle
Dissolved Metals and Mercury (filtered)	6010C/6020B/7470A	(1) - 1-L poly bottle

L = liter
mL = milliliter
SVOC = semi-volatile organic compound
TCL = target compound list
TPH-DRO = total petroleum hydrocarbon - deisel range organics
TPH-GRO = total petroleum hydrocarbon - gasoline range organics
VOC = volatile organic compound

Sampling of the monitoring wells at FWDA involves a variety of purging and sampling methods. Use of a low-flow pump (described in Section 4.2.2) is the preferred method at FWDA and the NMED guidance document on low-flow sampling should be referenced when groundwater sampling is being conducted (NMED-HWB, 2001). However, due to low yield, some wells require one of the alternative methods described in Section 4.2.4. All water generated during purging activities, as well as the excess groundwater from sampling, will be collected in 5-gallon buckets or equivalent and managed as IDW following procedures described in Section 4.5.

Table 2-1 contains well construction data, including, top-of-casing and ground surface elevation data for calculation of well volumes. Monitoring wells that do not contain water are identified as dry.

4.2.1 Preliminary Site Activities

4.2.1.1 Initial Inspection

Upon arrival at each monitoring well, the wellhead and exposed casing will be inspected for evidence of tampering or other damage. Observations will be recorded in the field logbook, and the USACE Contracting Officer Representative (COR) will be notified of any vandalism or damage. Once initial inspection is complete, preventative measures will be employed at the site to reduce risk of contamination. Plastic sheeting or other materials such as absorbent pads will be placed around each wellhead to prevent contamination of sampling equipment and/or ground surface. A staging area will be designated for equipment decontamination to include cleaning solutions, brushes, 5-gallon buckets, and plastic sheeting or absorbent pad, as appropriate.

4.2.1.2 Measure Initial Water Level and Calculate Well Volume

Prior to purging and sampling, the depth to groundwater shall be measured from the top-of-casing reference notch and recorded to the nearest 0.01 foot by following the procedure described in Section 4.1. The well volume will be calculated using the measured groundwater level and casing dimensions in the following formula:

$$[\pi \times (\text{filter pack radius (inches)})^2 \times \text{height of filter pack (inches)}] +$$
$$[\pi \times (\text{well casing radius (inches)})^2 \times (\text{height of water in casing above annual seal) (inches)}] =$$
$$\text{well volume (inches}^3) \times 0.0043 = \text{well volume (gallons)}$$

Groundwater elevation and well volume calculations will be recorded in the field logbook and/or on the Low-Flow Sampling Data Form (Appendix E) as appropriate.

4.2.2 Low-Flow Pump Purging

Two types of dedicated, adjustable rate, low-flow pumps constructed of stainless steel and/or Teflon® and polyethylene are installed in select wells as listed in Table 4-1. Sampling methods for these pumps, identified as either traditional low-flow pumps or Zone Isolation Sampling System (ZIST) low-flow pumping systems, are described in the following sections. Refer to Table 4-2 for the list of required field equipment.

In a traditional low-flow pump, the pump intake is located approximately 2 feet from the bottom of the screened interval to ensure collection of formation water and to minimize mobilization of particulates present in the bottom of the well.

The ZIST pumping system is used in wells that cannot be purged by the traditional low-flow technique due to extremely low recharge rates. The system utilizes a low-flow pump and mechanical packers, which isolate the screened interval to ensure the sampling of formation water only. Below the mechanical packer assembly is a solid 1.5-inch diameter cylinder extending the length of the screened interval that reduces the volume of required purge water. Pumping rates at each well having a ZIST assembly will be determined prior to the sampling event to ensure that the pumping rate does not cause drawdown of the water column.

Because the low-flow pumps are dedicated (traditional and ZIST) and will remain in place between sampling events, approximately 1 liter of water (or more, depending on pump installation depth/length of discharge tubing and volume of water contained in tubing) will be purged to clear any stagnant water from the pump and discharge tubing.

4.2.2.1 Traditional Low-Flow Pump

Drawdown and final pump cycle setting information from previous sampling event(s) (Appendix C) will be checked for each well. The extraction rate of the previous sampling event(s) will be duplicated to the extent practical. The following steps will be performed for purging with traditional low-flow pumps.

1) Start pump at the lowest speed setting and slowly increase until discharge occurs.

2) Measure the water level again.

3) Adjust pump speed until there is little or no water level drawdown. Once water quality readings are stabilized (step nine), the established water level drawdown must not be more than 4 inches/0.33 feet.

4) Begin purging well to previously determine volume.

5) Monitor and record water level, purge volume, and purging rate approximately every 2 to 5 minutes during purging.

6) Make any necessary adjustments to pumping rates within the first 15 minutes of purging. Reduce pumping rates as needed to the minimum capabilities of the pump (for example, 30 to 400 milliliters per minute with at least 40 milliliters per pump cycle) to ensure stabilization of indicator parameters. Keep the water level above the well screen. If the static water level is above the well screen, avoid lowering the water level into the screen if possible.

7) Record all adjustments to pumping rate (both time and flow rate).

8) During well purging, monitor the following field parameters and record (approximately every 2 to 5 minutes) on the Low-Flow Sampling Data Form (Appendix E).

   - Turbidity
   - Temperature
   - Specific conductivity

- Hydrogen ion activity (pH)
- Dissolved oxygen
- Oxygen reduction potential

9) Purging is considered complete and sampling will begin when the field parameters have stabilized (or if stabilization has not occurred after 30 minutes of purging). Stabilization has occurred when three consecutive readings are within the following limits:

Parameter	Units	Stabilization Criteria
Temperature	°C	± 10%
pH	SU	± 0.5
Specific Conductivity	mS/cm	± 10%
Dissolved Oxygen	mg/L	10% (dissolved oxygen levels less than 1.0 mg/L fall within the margin of error limits)
Turbidity	NTU	± 10% for values greater than 1 NTU
Oxygen reduction potential	mV	± 10 mV
Water Level	feet	0 to 0.33 foot drawdown (or 4 inches)

°C = degrees Celsius
mg/L = milligram per liter
mS/cm = millisemen per centimeter
mV = millivolts
NTU = Nephelometric Turbidity Unit
SU = Standard Unit

All measurements, except turbidity, will be obtained using a transparent flow-through-cell that prevents air bubble entrapment in the cell. Field personnel will watch for particulate build-up within the cell, which may affect the transient field parameter values. This build-up may affect field parameter values measured within the cell, and may also cause an underestimation of turbidity values. If the cell needs to be cleaned during purging operations, pumping will continue, and the cell will be disconnected and rinsed with deionized water to remove sediment. The flow-through-cell will then be reconnected and monitoring activities will continue. Water should not be allowed to drain out of the flow-through-cell when the pump is turned off or cycling on/off. Field personnel will ensure that the monitoring probes remain submerged in water at all times with the exception of the time spent cleaning particulate build-up in the flow-through-cell.

4.2.2.2 ZIST Low-Flow Pump

Extraction rates from the initial pump setup are located on sample collection logs from previous sampling events and will be duplicated to the extent practical. The following steps will be performed for purging with ZIST low-flow pumps.

1) Start the pump at the predetermined extraction rate and allow to purge until discharge occurs.

2) Measure water level during the purging process to ensure that drawdown of the water column does not occur. If drawdown occurs, this will indicate that the mechanical packer system has failed and the ZIST will need to be removed, inspected, and repaired before continuing.

3) Begin purging well to previously determine volume.

4) Monitor and record water level and purging rate approximately every 2 to 5 minutes during purging.

5) During well purging, monitor the following field parameters as described in Section 4.2.2.1 and record (approximately every 2 to 5 minutes) on the Low-Flow Sampling Data Form (Appendix E).

4.2.3 Groundwater Sample Collection by Low-Flow Pump

Following stabilization of field parameters, groundwater samples will be collected according to the steps listed below. Sample collection will follow a constituent sampling order determined prior to initiating field activities with sample bottles for VOC and SVOC analyses filled first.

1) During sampling activities, maintain the pump at approximately the same flow rate during purging and stabilization of field parameters.

2) Monitor depth-to-water to ensure that the water level does not drop more than 0.33 feet from the established pumping level.

3) Disconnect the flow-through-cell.

4) Field personnel handling sample bottles will wear disposable latex or nitrile gloves.

5) Collect samples directly from the pump discharge tubing (not from the flow cell discharge tubing) by allowing the discharge to flow gently down the inside of the sample container in order to minimize turbulence.

6) The discharge tubing will remain filled with water during sampling to minimize possible changes in water chemistry caused by contact with the atmosphere. If the discharge tubing is not completely filled, a clamp or connector (Teflon® or stainless steel) will be added to constrict the sampling end of the tubing, or the flow rate will be increased slightly until the water completely fills the tubing. Small-diameter tubing for the groundwater discharge line will be used to help ensure discharge tubing remains filled with liquid when operating at very low pumping rates.

7) Fill sample containers in the predetermined order listed in Section 4.2, with containers for VOC and SVOC analyses filled first.

8) To collect groundwater samples for dissolved metals analysis, place a 0.45-micron filter on the pump discharge tube and allow 100 mL of sample water to flow through the filter as a pre-rinse. After pre-rinsing, fill a specified preserved sample container with the filtered groundwater.

9) For collecting the groundwater sample for perchlorate, use a pre-rinsed 0.40-micron filter to fill a sterile, non-preserved container. Run 100 mL of filtered sample water through a 0.20-micron filter as a pre-rinse for the 0.20-micron filter. After the pre-rinse, fill the perchlorate container with the twice-filtered sample water. This step may need to be repeated as necessary in order to fill the perchlorate sample container.

10) After filling each sample container, immediately seal, label, and place container into an iced cooler according to the sample management procedures discussed in Section 4.3.

11) Decontaminate the pump after completion of sampling at each monitoring well as described in Section 4.4.

12) Manage all liquid and solid IDW as described in Section 4.5.

4.2.4 Alternative Groundwater Purging and Sampling Procedures

Some wells at FWDA require alternative methods of purging and sampling due to extremely low yield/low water level. For these wells, purging and sampling are performed with one of the following: disposable bailers, a 12-volt-battery pump, or a dedicated Bennett pump. The methods and type of equipment required for purging and sampling are identified for each well in Table 4-1 and will be recorded on the individual sample log for each well.

These procedures emphasize the need to remove a sufficient volume of water from each well to ensure that the sampled groundwater is representative of the surrounding formation. Removal of a quantity of water equal to three times the calculated volume of standing water in the well (including the saturated annulus) will be completed wherever possible. See Section 4.2 for calculation of well volume.

Field parameters will be monitored at a time interval determined by the purge rate, and values will be recorded on the sample collection form (Appendix E). Stabilization of field parameters is used to indicate that conditions are suitable for sampling to begin. Purging is considered complete and sampling will occur under one of the three following scenarios:

- Before three well volumes have been evacuated, three consecutive readings of the field parameters are recorded within the limits listed in Section 4.2.2.1, thus indicating that stabilization has occurred. Discontinue purging and, if the recovery rate is rapid, allow the monitoring well to recover to its original volume prior to sample collection.

- After evacuation of three well volumes and if the field parameters have not stabilized, discontinue purging, collect samples, and provide a full explanation of attempts to achieve stabilization.

- The monitoring well is emptied before three well volumes can be evacuated due to very slow recovery. Ensure that a minimum of three field parameter readings have been collected. Obtain groundwater samples as soon as the monitoring well has recharged to sufficient volume, which typically occurs the following day. It may take several days to collect the full suite of parameters.

4.2.4.1 Disposable Bailers

The following steps describe purging and collecting groundwater samples with disposable bailers.

1) Securely attach nylon cord to the bailer, carefully lower the bailer into the monitoring well, and allow bailer to fill with groundwater.

2) Raise bailer out of the monitoring well and empty purge water into a 5-gallon bucket designated for IDW.

3) Repeat process until the calculated volume of groundwater has been purged from the monitoring well (3 times the well volume).

4) Discard the bailer used for purging and prepare a new bailer for sample collection.

5) Collect samples with the disposable bailer in the same manner as purging. Allow the groundwater discharge to flow gently from the bailer down the inside of the sample container via the sampling port at the bottom of the bailer to minimize turbulence.

6) Fill sample containers in the predetermined order listed in Section 4.2 with containers for VOC and SVOC analyses filled first.

7) To collect bailed groundwater samples for dissolved metals and/or perchlorates analysis, filter sample with a pre-rinsed 0.45-micron filter using the peristaltic pump and dedicated tubing into a specified preserved sample container (pre-rinsed with at least 100 mL of sample water).

8) After filling each sample container, immediately seal, label, and place container into an iced cooler according to the sample management procedures discussed in Section 4.3.

9) All disposable materials, including disposable bailers used for sampling and the collected purge water, will be managed as IDW as described in Section 4.5.

4.2.4.2 Grundfos Redi-Flo2 Pump

A Grundfos Redi-Flo2 submersible pump, or equivalent, will be used in monitoring wells where no dedicated pump is present and sufficient water is available to maintain a water level above the head capacity. The Grundfos pump will also be used to purge wells where sufficient water is available but recharge is poor (i.e. pump dry). Procedures for purging and collection groundwater samples with a Grundfos are as follows:

1) Attach clean unused polyethylene tubing to the top of the decontaminated Grundfos pump and secure the tubing with an appropriately sized hose clamp.

2) Lower the Grundfos pump into the well and take care not to agitate the water column. Attach nylon ties every 10 feet around the hose and lead line.

3) Very carefully touch the well bottom with the pump. Based on the well completion information, slowly raise the pump to just above the bottom of the screened interval.

4) Secure the tubing and lead line to the well head using nylon ties or equivalent, attach the discharge line to the flow through cell, and complete the circuit from the control box to the portable generator.

5) Energize the control box and begin the purge. Water will start to flow up the tubing at about 250HZ for a 65 foot well.

6) Establish a consistent flow rate of between 1 to 2 gallons per minute using a stop watch and a graduated cylinder. Discharge the calculated volume of purge water into 5-gallon bucket(s), as appropriate.

7) During well purging, monitor and record the transient field parameters as described in section 4.2.2.1 (once per well volume evacuated from well). Also document whether a static water-level can be achieved from well recharge, or if the purge will completely evacuate the well volume.

8) When purging is complete, remove the flow-through-cell to collect groundwater sample directly from the pump discharge tube. Allow the groundwater to flow gently from the discharge tube down the inside of the sample container to minimize turbulence.

   If the well has been purged dry, allow for recharge and collect samples via a disposable bailer (see section 4.2.4.1 for sample procedures).

9) Fill sample containers in the predetermined order listed in Section 4.2 with containers for VOC and SVOC analyses filled first.

10) To collect groundwater samples for dissolved metals analysis, place a 0.45-micron filter on the pump discharge tube and fill a specified preserved sample container

with the filtered groundwater. Allow for 100mL of groundwater to flow through the filter as a pre-rinse prior to sample collection.

11) For collecting the groundwater sample for perchlorate, use a pre-rinsed 0.40-micron filter to fill a sterile, non-preserved container. Run 100 mL of filtered sample water through a 0.20-micron filter as a pre-rinse for the 0.20-micron filter. After the pre-rinse, fill the perchlorate container with the twice-filtered sample water. This step may need to be repeated as necessary in order to fill the perchlorate sample container.

12) After filling each sample container, immediately seal, label, and place container into an iced cooler according to the sample management procedures discussed in Section 4.3.

13) Decontaminate the pump after completion of sampling at each monitoring well as described in Section 4.4.

14) Remove and dispose of the polyethylene tubing after completion of sampling/purging at each monitoring well. Manage all liquid and solid IDW as described in Section 4.5.

4.2.4.3 Bennett Sample Pump

Dedicated Bennett sample pumps are used in cases where the depth to water in a monitoring well is too deep to use disposable bailers. The Bennett pump system consists of a piston activated with pressurized nitrogen gas through a Teflon® tube, a second Teflon® tube that returns groundwater to the surface, and a third Teflon® tube for gas exhaust. Monitoring wells at FWDA equipped with Bennett pumps are identified in Table 4-1. The Bennett pump intake was placed approximately 2 feet from the bottom of the monitoring well. Procedures for using a Bennett pump to purge and collect groundwater samples are as follows:

1) Connect the air intake tubing from the dedicated pump to the the pressurized nitrogen cylinder. Connect the discharge tubing to the flow-through-cell.

2) Turn on gas flow from the nitrogen cylinder. Use initial pumping rate of approximately 4 gpm. For the last 15 to 20 feet of the water column, reduce pumping rate to approximately 1 gpm. Discharge the calculated volume of purge water into a 5-gallon bucket(s) or tank, as appropriate.

3) Monitor and record all adjustments to pumping rate.

4) During well purging, monitor and record the transient field parameters as described in Section 4.2.2.1 (approximately every 2 to 5 minutes).

5) When purging is complete, remove the flow-through-cell to collect samples from the discharge tubing. Allow the groundwater to flow gently from the discharge tube down the inside of the sample container to minimize turbulence.

6) Fill sample containers in the predetermined order listed in Section 4.2 with containers for VOC and SVOC analyses filled first.

7) To collect groundwater samples for dissolved metals analysis, place a 0.45-micron filter on the pump discharge tube and allow 100 mL of sample water to flow through the filter as a pre-rinse. After pre-rinsing, fill a specified preserved sample container with the filtered groundwater.

8) For collecting the groundwater sample for perchlorate, use a pre-rinsed 0.40-micron filter to fill a sterile, non-preserved container. Run 100 mL of filtered sample water through a 0.20-micron filter as a pre-rinse for the 0.20-micron filter. After the pre-rinse, fill the perchlorate container with the twice-filtered sample water. This step may need to be repeated as necessary in order to fill the perchlorate sample container.

9) After filling each sample container, immediately seal, label, and place container into an iced cooler according to the sample management procedures discussed in Section 4.3.

10) Manage all liquid and solid IDW as described in Section 4.5.

4.2.5 Post-Sampling Activities

Upon completion of groundwater sampling, the nondedicated sampling equipment will be removed from the well, and the final depth to groundwater will be measured from the top-of-casing reference notch and recorded to the nearest 0.01 foot. Reusable measurement and sampling equipment will be decontaminated prior to leaving the site, and all disposable materials and purge water collected during sampling activities will be removed from the site and treated as IDW following procedures outlined in Section 4.5. The monitoring well will be secured prior to leaving the site.

4.3 Sample Management Procedures

4.3.1 Sample Identification

Each sample will be assigned a unique sample identification (ID) number. Groundwater samples will be identified by the well number followed by the collection date (mmyyyy) (e.g., TMW07042011 for sample from TMW07 on 20 April 2011). Quality control (QC) samples such as field duplicate and quality assurance (QA) samples (described in Section 4.6) will have the same ID number as the parent sample and followed by DUP (i.e., duplicate), triplicate (TRP), matrix spike (MS), or matrix spike duplicate (MSD), as appropriate. Equipment rinsate blanks and trip blanks will carry the designation EQUXXX and TRIPXXX (XXX representing the sequence number of the sample), respectively.

4.3.2 Chain-of-Custody Documentation

Chain-of-custody documentation will be completed in the field to document sample collection, possession, and the chain of custody. Data on the forms will include the sample ID, tracking number, date sampled, time sampled, project name, project number, and signatures of those in possession of the sample. A sample is considered to be in a person's custody while either under physical custody or safely secured in a controlled access location. Sample custody can be transferred by signature relinquishment and acceptance. The shipping company waybills or bills of lading are considered part of the custody record between the time of collection and receipt at the analytical laboratory. Chain-of-custody records will accompany the sample until receipt at the analytical laboratory.

4.3.3 Packaging and Shipping

All samples will be packed and shipped by overnight air freight to the analytical laboratory by the end of the collection day. Unless otherwise indicated, samples will be treated as nonhazardous environmental samples, shipped in heavy-duty coolers, packed with materials such as bubble wrap, bubble bags, or foam blocks to prevent breakage, and preserved with ice in sealed plastic bags. Custody seals will be affixed to the non-hinged side of the lid of each cooler. The custody seals will be signed and dated by a sample team member. Each shipment will include the appropriate field QC samples. Corresponding chain-of-custody forms will be placed in waterproof bags and taped to the inside of the coolers lids. Sample shipments containing VOC samples will contain at least one trip blank.

4.4 Decontamination

Non-dedicated measurement and sampling equipment such as water-level tapes and submersible pumps will be decontaminated prior to and after each use. Equipment decontamination will follow the methods described below.

Sampling equipment dedicated for use at specific wells, i.e., Bennett sample pumps, will not require decontamination prior to use. Disposable sampling equipment that is used once and then disposed of will not require decontamination prior to use, provided that it is wrapped in the manufacturer's packaging or otherwise protected from inadvertent contamination prior to use.

4.4.1 Decontamination Materials

4.4.1.1 Specifications for Decontamination Solutions

Specifications for standard cleaning materials referred to in this section are as follows:

- A standard brand of phosphate-free laboratory detergent, such as Liquinox® obtained from a laboratory supply distributor, will be used for decontaminating reusable equipment. Use of any other type of detergent will be documented in the field logbooks and investigative reports.

- Deionized water will be used for rinsate and decontamination and may be purchased from local vendors

- Laboratory detergent and deionized water used to clean equipment will not be reused during field decontamination.

- Used decontamination liquids will be properly containerized and managed as IDW, as described in Section 4.5.

4.4.1.2 Containers for Decontamination Solutions

Improperly handled cleaning solutions may easily become contaminated. Storage and application containers must be constructed of the proper materials to ensure their integrity. The following are acceptable materials used for containing the specified cleaning solutions:

- Detergent solution is kept in clean plastic, metal, or glass containers until used; it is poured directly from the container during use.

Deionized water is kept in clean tanks, hand-held sprayers, or squeeze bottles.

4.4.1.3 Safety Procedures for Decontamination Operations

Some of the materials used to implement the cleaning procedures outlined in this section can be harmful if used improperly. Caution should be exercised by all field personnel and all applicable safety procedures should be followed. At a minimum, the following precautions will be observed in the field during decontamination operations:

- Safety glasses with splash shields or goggles and latex or nitrile gloves will be worn during all cleaning operations.

- No eating, smoking, drinking, chewing, or any hand-to-mouth contact shall be permitted during cleaning operations.

4.4.2 Decontamination Operations

A decontamination area will be established at Building 34. The basic steps for decontamination are as follows:

1) If necessary, remove particulate matter or debris using a brush or hand-held sprayer filled with deionized water.

2) Scrub the surfaces of the equipment using deionized water and Liquinox® solution and a second brush made of inert material.

3) Rinse the equipment thoroughly with deionized water.

4) Place the equipment on a clean surface and allow to air dry.

5) Containerize all decontamination liquids and manage as IDW, as described in Section 4.5.

After decontamination operations, equipment will be handled only by personnel wearing clean gloves to prevent re-contamination. The equipment will be moved away from the cleaning area to prevent re-contamination. If the equipment is not to be immediately re-used, it will be covered with plastic sheeting or wrapped in aluminum foil to prevent re-contamination. The area where the equipment is stored prior to re-use will be free of contaminants.

4.5 Waste Management Procedures

As required by federal and state law, liquid IDW samples from the 2008 and 2010 groundwater sampling events were submitted to an analytical laboratory to determine hazardous waste characteristics. Results from analytical testing showed that liquid IDW generated during these sampling events was non-hazardous. Therefore, purge water and decontamination water associated with the existing monitoring wells at the FWDA will be managed and disposed of by the procedures described below. These procedures apply only to the monitoring wells and sampling activities included in this Interim Measures Facility-Wide GMP.

Three types of groundwater IDW may be generated during the groundwater sampling events at FWDA: purge water and excess sample water from monitoring wells, decontamination liquids (non-hazardous soap and water), and solid waste (disposable sampling equipment and personal protective equipment).

Purge water, decontamination water, and other non-hazardous liquid IDW will be containerized at the sample site in clean buckets and/or tanks with a watertight lid. Depending upon the volumes generated, water from multiple wells may be consolidated into one or more containers. At the end of the sampling day, the filled IDW containers will be emptied into one of two low-density-polytheylene-lined evaporation tanks. The evaporation tanks are located at the former Building 542 in Parcel 6.

All solid waste such as disposable sampling equipment, personal protective equipment, and general refuse shall be placed in plastic trash bags. Small quantities of waste will be disposed of in trash containers (dumpsters) located in the Administration Area at FWDA; large quantities of waste material will be transported off site for disposal as municipal waste.

4.6 Quality Assurance Procedures

4.6.1 Field Equipment Calibration and Preventative Maintenance

Field instruments will be calibrated, operated, and maintained in accordance with the manufacturer's instructions. Daily, on-site field instrument calibrations will be performed before and during each day's use by trained technicians using certified standards. Instrument calibrations will be recorded in bound logbooks dedicated to calibration data and will include field instrument identification, date of calibration, standards used, and calibration results (as described in Section 4.6.3.1).

If an individual suspects an equipment malfunction, the meter will be removed from service and tagged so that it is not used inadvertently, and a substitute piece of equipment will be used. Additionally, equipment that fails calibration or becomes inoperable during use will be removed from service and tagged. Such equipment will be repaired and satisfactorily re-calibrated. The results of activities performed using equipment that has failed re-calibration will be evaluated. If the results are adversely affected, the outcome of the evaluation will be documented, and the USACE COR will be notified. Equipment that cannot be repaired will be replaced. Back-up equipment will be available in the field for use in case of a malfunction.

Preventative maintenance procedures for the field instruments will be carried out in accordance with procedures outlined by the manufacturer's equipment manuals. All records of inspection and maintenance will be dated and documented in the appropriate field logbook. Critical spare parts for field instruments will be included in the sampling kits to minimize downtime. In addition, back-up meters will be available, if needed. Spare parts will be purchased from accepted vendors. Daily inspections of field equipment will be conducted to ensure that equipment is functioning properly. If inspection results indicate that a piece of field equipment is deemed faulty or not useable, replacement equipment will be cleaned, calibrated if necessary, and used in place of the faulty equipment. The faulty equipment will then be shipped back to the vendor for repair.

4.6.2 Sample Collection Quality Assurance

Several types of field QC samples will be submitted to the analytical laboratory to assess the quality of the data resulting from the field sampling program. These samples will include field duplicate samples, trip blanks, equipment rinsate blanks, field blanks, and MS and MSD samples.

Field duplicate and QA split samples will be collected at a frequency of one per 10 environmental samples. Field equipment rinsate blanks are collected at a frequency of one per 20 environmental samples, or at least one per sampling event, on non-dedicated equipment.

Each shipment that contains samples of aqueous VOC analyses will contain a trip blank. The trip blank will be placed in a cooler containing VOC samples and will stay with the cooler until the cooler is returned to the analytical laboratory. Additional volume will be collected at specified sample locations so that one MS/MSD pair will be submitted to the laboratory for every 20 environmental samples.

4.6.3 Documentation Quality Assurance

Field documentation shall consist of one or more job- or area-specific field logbooks, field forms, sample chains of custody, and sample logs/labels. Photographic documentation is not required.

4.6.3.1 Logbooks

Site and field logbooks provide a daily handwritten record of all field activities. All logbooks will be permanently bound and have a hard cover. Logbooks will be ruled, or ruled and gridded, with sequentially numbered pages. All entries into field logbooks will be made with indelible ink. Field logbooks are detailed daily records that are kept in real time and are assigned to specific activities, positions, or areas within the site. Separate logbooks shall be used for each sampling and field team.

Documentation in field notebooks will include the following (as necessary):

- Location
- Date and time
- Names of field crew
- Names of subcontractors
- Weather conditions during field activity
- Sample type and sampling method
- Location of sample
- Sample ID number
- Sample description (such as color, odor, clarity)
- Amount of sample
- Field measurements
- Equipment specifications
- Depth to groundwater
- Decontamination and health and safety procedures
- Sampling notes (such as well condition, unexpected maintenance, work stoppage, etc.)

A separate logbook dedicated to calibration records will be maintained to include the following information:

- Calibration results

- Adverse trends in instrument calibration behavior
- Field instrument identification, date of calibration, and standards used

If entries in the field notebooks need to be corrected or changed, corrections will be made by crossing out mistakes with a single line, writing the corrections, and initialing and dating the entry. The use of correction fluid is not permitted. At the conclusion of each day in the field, the sampling team leader will review each page of the logbook for errors and omissions. The sampling team leader will then date and sign each reviewed page.

4.6.3.2 Field Data Record Forms

In addition to the field notebooks, various forms are used to document field efforts (Appendix E). These forms ensure that all required data and observations are recorded in a consistent manner. No blank spaces will be left; all non-applicable items will be marked “not applicable” (N/A). Forms that will be used include chain-of-custody forms and well sampling forms (Appendix E).

4.6.3.3 Final Evidence File Documentation

All evidential file documentation will be maintained under an internal project file system. The USACE COR will ensure that all project documentation and QA records are properly stored and retrievable.

5. MONITORING AND SAMPLING PROGRAM

5.1 Monitoring and Sampling Program

This section of the Interim Measures Facility-Wide GMP discusses the objectives for the groundwater monitoring program, the corresponding DQOs, the rationale for the groundwater monitoring program design, and a summary of the monitoring program for both the OB/OD Area and the Northern Area.

5.2 Data Quality Objectives

DQOs are qualitative and quantitative statements that clarify the project objectives, specify the most appropriate type of data for the project decisions, determine the most appropriate conditions from which to collect data, and specify tolerable limits on decision errors. DQOs are developed to satisfy the specific project objectives in accordance with applicable USACE specifications, NMED and EPA guidance; and are based on the end uses of data determined through a seven-step process as described in EPA QA/G-4 (EPA, 2006) discussed below. The DQO statements derived from the output of each step of the DQO process shall perform the following:

- Clarify the study objective
- Define the most appropriate type of data to collect
- Determine the most appropriate conditions from which to collect data
- Specify acceptance levels of decision errors that will be used as the basis for establishing the quantity and quality of data needed to support the decision.

DQOs are management tools used to develop a scientific and resource-effective sampling design. The DQOs assist in identifying the required type, quality, and quantity of data needed to support engineering and scientific evaluations, and withstand scientific and legal scrutiny. The DQO process must be initiated during project planning to produce investigations that result in data having a quantifiable degree of certainty.

5.2.1 Data Quality Objective Process

DQOs are based on the end uses of the data and are determined through a seven-step process as described in EPA QA/G-4 (EPA, 2006).

- **Step 1 - State the Problem**

  The purpose of this step is to clearly define the problem that requires new environmental data so the study focus will be clear and unambiguous.

- **Step 2 - Identify the Decision**

  This step involves the identification of the decision/objective that requires new environmental data. Key activities associated with this step include the following:

  - Identifying the key objective for the current phase or stage of the project
  - Identifying alternative actions that may be taken based on the findings of the field investigation
  - Identifying relationships between this objective and any other current or subsequent objectives

- **Step 3 - Identify Inputs to the Decision**

  The purpose of this step is to identify the information needed to support the objective and specify which inputs require new environmental measurements. Key activities associated with this step include the following:

  - Identifying the informational inputs needed to resolve the objective
  - Identifying sources for each informational input and listing those inputs that are obtained through environmental measurements
  - Defining the basis for establishing contaminant-specific action levels
  - Identifying potential sampling approaches and appropriate analytical methods

  The outputs that will result from this step include a list of informational inputs needed to make the specified decision and a list of environmental variables or characteristics that will be measured. The outputs from this step are actually the inputs that will be used to support the objective, sometimes referred to as the “decision.”

- **Step 4 - Define Boundaries of the Study**

  This step requires the definition of spatial and temporal aspects of environmental media that the data must represent to support the objective. Key activities associated with this step include the following:

  - Defining the geographic areas of the field investigation
  - Defining each environmental medium of concern
  - Dividing each medium into strata having relatively homogeneous characteristics
  - Defining the scale of decision making (this is the smallest area, volume, or time frame of the medium) in which the scoping team wishes to control decision errors
  - Determining the time frame to which the objective applies
  - Determining when to take samples
  - Identifying practical constraints that may hinder sample collection (reconsider previous steps as necessary)

- **Step 5 - Develop a Decision Rule**

  The purpose of this step is to integrate the output from the previous steps of the DQO process into a statement that defines the conditions that would cause the decision maker to choose among alternative actions. Key activities associated with this step include the following:

  - Specifying the parameter of interest (i.e., mean, medium, maximum, or proportion)
  - Specifying the action level for the decision

- **Step 6 - Specify Limits on Decision Errors**

  The purpose of this step is to specify the acceptable decision error limits based on a consideration of the consequences of making an incorrect decision. These limits will be used in the last step of the process.

- **Step 7 - Optimize the Design**

  The purpose of this step is to identify the most resource-effective sampling design that generates data that satisfy the DQOs specified in the preceding steps. To develop the optimal design for this study, it may be necessary to work through this step more than once after revisiting previous steps of the DQO process. Several of the steps in the DQO process can occur simultaneously; and in some situations, the process does not have to include all steps. For example, when enforcement or compliance monitoring programs are being developed to comply with existing regulations, many of the steps may have already been completed. As a general guideline, if a contaminant in a well has not been detected in 2 years (4 consecutive sampling events) it will be recommended that the contaminant will be removed from the sampling program for that well (pending NMED approval).

5.2.2 Interim Measures Facility-Wide Groundwater Monitoring Data Quality Objectives

The DQO process answers the questions of why this investigation is being conducted and what decisions are to be supported. In addition, the DQO process ensures that the data collected will have a quantifiable degree of certainty. In using the seven-step DQO process outlined in Section 5.2.1, the following DQOs for the sampling and analytical program for the Interim Measures Facility-Wide GMP were identified and summarized in the table below:

Objective	Discussion
State the Problem	Monitor constituents exceeding cleanup levels in groundwater during the period before long-term monitoring can begin.
Identify the Decision	1. Identify changes in ambient chemical conditions that affect fate and transport. 2. Evaluate groundwater elevations to determine hydraulic gradients and groundwater flow paths. 3. Monitor temporal changes and detect the movement of COIs from one location to another.
Identify Inputs to the Decision	1. Historical background and current site information 2. Operational history 3. Geologic, hydrologic, and soil data from published sources, previous investigations, and documented field observations 4. Chemical contaminant concentration data in groundwater, including: VOCs, SVOCs, explosives, TPH-GRO and DRO, TAL metals including mercury (dissolved and total), perchlorate, nitrate/nitrite, and pesticides 5. NMWQCC standards[a] 6. EPA MCLs[b] 7. EPA RSLs for tap water[c]

Objective	Discussion
Define the Study Boundaries	The boundaries of the monitoring area were selected based on review of the historical operational history and uses at the site. The monitoring areas are defined as follows: – Northern Area: consists of the Administration and Workshop Areas in the Northern region of FWDA. Wells located in the Northern Area are further divided into Alluvial wells and Bedrock wells – OB/OD Area: located within the southwest and western portions of the installation; the OB/OD Area can be separated into two sub-areas based on period of operation (Closed and Current OB/OD Area).
Develop a Decision Rule	1. If COIs in a given analytical suite are detected at frequencies >15% at concentrations above NMWQCC groundwater quality standards and EPA MCLs, it is recommended that the analytical suite be sampled in that particular well on a semi-annual basis. 2. If COIs in a given suite are detected at frequencies <15% at concentrations above the NMWQCC groundwater quality standards and EPA MCLs, such as SVOCs in the Northern Area, it is recommended that the analytical suite be sampled in that particular well every two years. 3. If COIs are detected at frequencies <1% at concentrations below NMWQCC groundwater quality standards and EPA MCLs, such as pesticides, it is recommended that the analytical suite be sampled in that particular well every five years
Specify Limits on Decision Errors	1. If sample analytical data show false positive indicators, that is, the presence of COIs in groundwater when truly none are present, this could result in additional investigation when none is required. QC procedures followed in the field and laboratory, as well as the data from QC sample analyses, will minimize the probability of making the decision for additional investigation based on false positive data. 2. A false negative decision error, that is, failing to detect and measure COIs present in groundwater samples, could result in a determination to reduce or eliminate COI analytical suites for the site or well when further investigation is warranted. The sampling plan design and QC procedures employed minimize the probability of making a false negative decision error. The investigation is designed to detect and measure COIs in the most likely exposure pathways.

Objective	Discussion
Optimize the Design	1. NMED and EPA-approved sampling methods will be used to provide definitive-level quantitative analytical data that will meet the applicable or relevant and appropriate requirements specified in the Permit (NMED, 2005). 2. Historical data will be used to re-evaluate the constituent groups to be analyzed and the sampling frequencies at each target well for both the OB/OD and Northern Areas in accordance with Section V.A.4 of the Permit (NMED, 2005). If a constituent group has not been detected at a well for four consecutive sampling events, it will be recommended for it to be removed from the sampling program.

[a] EPA, 2009, National Primary Drinking Water Standards Human Health Standards, EPA 816-F-09-0004, adopted by NMWQCC.
[b] EPA, 2011, U.S. Environmental Protection Agency Regions 3, 6, and 9 Regional Screening Levels for Chemical Contaminants at Superfund Sites, October. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm.
[c] EPA, 2012, U.S. Environmental Protection Agency Regional Screening Level Tapwater Supporting Table, http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm> (April).
> = Greater than
< = Less than
COI = Contaminant of interest
TPH-DRO = Total petroleum hydrocarbon as diesel range organics
EPA = U.S. Environmental Protection Agency
FWDA = Fort Wingate Depot Activity
TPH-GRO = Total petroleum hydrocarbon as gasoline range organics
MCL = Maximum contaminant level
NMED = New Mexico Environment Department
NMWQCC = New Mexico Water Quality Control Commission
OB/OD = Open Burn/Open Detonation
QC = Quality control
RSL = Regional screening level
SVOC = Semivolatile organic compound
TAL = Target Analyte List
VOC = Volatile organic compound

In addition, NMED- and EPA-approved sampling methods will be used to provide definitive-level quantitative analytical data that will meet the applicable or relevant and appropriate requirements specified in the Permit. Laboratories performing the sample analyses will follow the most recent version of the USACE EM 200-1-3 (USACE, 2001) and the most recent version of Department of Defense Quality Systems Manual (Appendix F). Laboratories performing sample analyses will hold current National Environmental Laboratory Accreditation Program (NELAP) accreditation for all appropriate fields of testing. Laboratories will also meet NMED and EPA standards, as required. Laboratories will submit self-declaration forms (including supporting documentation) as well as information related to NELAP accreditation to the USACE COR. Analytical results will be validated in accordance with the most current versions of EPA Contract Laboratory Program (CLP) National Functional Guidelines for Organic Data Review (EPA, 2008) and EPA CLP National Functional Guidelines for Inorganic Data Review (EPA, 2010) to ensure the data are of sufficient quality for the intended use.

5.3 Interim Groundwater Monitoring Analytical Program

FWDA is in an ongoing RCRA assessment and compliance monitoring phase (interim). Currently, sufficient data have been collected to identify COIs based on their magnitude and spatial distribution as well as their association with known waste management activities. These COIs include: explosives, nitrate/nitrite, perchlorate, petroleum hydrocarbons, and a limited list of VOCs and SVOCs. Compounds identified as COI require the most intensive monitoring level because their spatial distribution and transport in groundwater must be known to develop and evaluate appropriate corrective actions. Other detected chemicals require monitoring to better understand their presence in groundwater, but the monitoring program need not be as intensive. Targeting specific wells for sampling and analysis, and/or modifying the sampling for these analytical suites, can optimize the program design.

Attachment 7 of the Permit (NMED, 2005) provides cleanup levels applicable to the FWDA groundwater monitoring program. Groundwater chemical results are evaluated and compared to these cleanup levels (referred to as regulatory health standards). Therefore, the following documents and regulations are used to determine if the concentration of a particular hazardous constituent exceeds the Permit cleanup level (Appendix G).

- New Mexico Water Quality Control Commission (NMWQCC) standards of 20.6.2.4103.A and B New Mexico Administrative Code.

- EPA drinking water maximum contaminant level (MCL) under Title 40 Code of Federal Regulations Parts 141 and 142.

- If both a NMWQCC standard and an EPA MCL have been established for a contaminant, the lower of the two was used as a criterion.

- If no NMWQCC standard or EPA MCL has been established for a particular carcinogenic or noncarcinogenic hazardous constituent, the EPA regional screening level for tap water was used.

- Currently, there is no NMWQCC groundwater standard or MCL for perchlorate; however, perchlorate concentrations were compared to the value of 6 µg/L noted in the Permit.

The current monitoring well network has been designed to evaluate the horizontal and vertical extent of chemical constituents in groundwater, and the transport of chemicals that originate from multiple sources. Not all wells need to be sampled for the same analytical suites because certain wells are located to monitor releases from specific SWMUs, and the density of the well network is such that targeting select wells, rather than all wells, provides sufficient data that meet the objectives of the monitoring program.

In accordance with Section V.A.4 of the Permit (NMED, 2005), the annual revision of this Interim Measures Facility-Wide GMP re-evaluates the constituent groups to be analyzed and the sampling frequencies at each target well using historical analytical data. To date, sampling frequency has been semi-annual and has not been modified. However, adjusting the sample frequency along with targeting select wells for specific sampling analysis are of central importance to maximizing the amount of relevant information (information required to effectively address the temporal and spatial objectives of monitoring program), while minimizing costs. Section 5.3.1 discusses this Interim Measures Facility-Wide GMP sampling rationale, including the specific chemical constituents to be analyzed and the proposed sampling frequency.

5.3.1 Sampling Program Rationale

Table 5-1 provides summary statistics for detected chemical concentrations in groundwater at the OB/OD Area. In addition, Tables 5-2 and 5-3 list the summary statistics for detected chemical concentrations in groundwater for the alluvial and bedrock aquifers in the Northern Area, respectively. These tables do not include dissolved metals because approved groundwater background levels have not been established for FWDA. Therefore, specific identification of dissolved metals that may represent a COI cannot be determined at this time (anthropogenic vs. naturally occurring). However, dissolved and total metals and mercury (total and dissolved) will continue to be sampled semi-annually until this evaluation criterion has been completed.

Chemicals detected in groundwater can be subdivided into three categories based on criteria as defined in past monitoring plans. While maintaining consistency, the criteria and number of categories may be reevaluated and/or optimized as the data trends and analyses become more evident. In the meantime, the following categories will be used for the purpose of selecting the appropriate well network, analytical suites to monitor, and the sample frequency that meets the objectives of the monitoring program:

- Category 1: Chemicals that are frequently detected (greater than or equal to 15 percent) with concentrations exceeding the applicable groundwater standard (Table 5-4).

- Category 2: Chemicals that are infrequently detected (less than 15 percent) with concentrations exceeding the applicable groundwater standard (Table 5-5).

- Category 3: Chemicals that are infrequently detected (less than 1 percent) with concentrations below the applicable groundwater standard (Table 5-6).

If analytical suites or specific chemical compounds were not detected for 2 consecutive years in a specific well, then these analytical suites and/or compounds were considered as not being of interest, now or in the future (i.e., the data will have no effect on selection of future corrective actions). Consequently, these analytical suites and/or compounds were eliminated from the original chemical analysis roster presented in the initial Interim Measures Facility-Wide GMP (TerranearPMC, 2008). Based on this evaluation criterion only, this annual revision to the GMP eliminates specific suites from the sampling program for the individual wells listed in Table 5-11. This revision also upholds the previous elimination of the following analytical suites for all wells in both the OB/OD and Northern Areas: dioxins/furans, cyanide, herbicides, polychlorinated biphenyls (PCBs), and white phosphorus.

5.3.1.1 Category 1

Table 5-4 lists the Category 1 chemicals, the analytical suite, spatial occurrence, and the frequency of detection. Chemicals classified in Category 1 occur at concentrations exceeding the NMWQCC groundwater standards and/or the EPA MCLs (if present) at a frequency greater than or equal to 15 percent of the total samples collected. Category 1 chemicals identified for the GMP are as follows: RDX, bis(2-ethylhexyl)phthalate, carbon disulfide, toluene, nitrate, nitrite, total petroleum hydrocarbon (TPH) – diesel range organics (DRO), and perchlorate (Table 5-4). These Category 1 chemicals are recommended to be analyzed on a semi-annual basis.

All Category 1 chemicals are considered COIs that were previously released from various known sources at FWDA. Continued frequent groundwater monitoring of all VOCs at the OB/OD and Northern Areas may not provide useful data for future corrective action planning (i.e., long-term groundwater monitoring plan); however, because bis(2-ethylhexyl)phthalate, toluene, and carbon disulfide have frequency of detections greater than 15 percent and detections that exceed the applicable regulatory standard, sampling these chemicals semi-annually is recommended in areas that are applicable (Table 5-4).

Total petroleum hydrocarbons (DRO and GRO), which have been historically released from the USTs near Building 6 (SWMU 45) in the Northern Area, will continue to be analyzed on a semi-annual basis for the well network associated with SWMU 45.

Modifications to the perchlorate, nitrate/nitrite, and explosives are not proposed at this time and will continue to be monitored in select wells in the OB/OD Area and both aquifers in the Northern Area on a semi-annual basis.

5.3.1.2 Category 2

Table 5-5 lists the Category 2 chemicals, the analytical suite, spatial occurrence, and the frequency of detection. Chemicals classified in Category 2 occur at concentrations exceeding the NMWQCC groundwater standards and/or the EPA MCLs (if present) at a frequency of less than 15 percent of the total samples collected. Category 2 chemicals identified for the Interim Measures Facility-Wide GMP cluster into the following analytical suites: explosives, SVOCs, and VOCs (Table 5-5).

Because many SVOCs (except phenol in Northern Area bedrock wells) are grouped within Category 2, it is recommended that the full SVOC analytical suite be sampled every 2 years in select wells within the OB/OD and Northern Areas. Based on the sporadic occurrence of SVOCs, both spatially and temporally, and their relative immobility, changes in concentrations over time are expected to be relatively slow. Sampling every 2 years is adequate for the spatial and temporal characterization of SVOC chemicals if present in groundwater.

5.3.1.3 Category 3

Table 5-6 lists the Category 3 chemicals, the analytical suite, spatial occurrence, and the frequency of detection. Chemicals classified in Category 3 occur at concentrations *below* the NMWQCC groundwater standards and/or the EPA MCLs (if present) at a frequency of detection less than 1 percent of the total samples taken and will not require regulatory action.

Because these specific chemicals are below screening levels, it is suggested that this table be used to reduce the number of constituents in a given suite in the future long term monitoring plan (SVOCs, VOCs, and explosives). As previously stated, these chemicals have never exceeded regulatory standards and are detected rarely.

Some pesticide compounds are classified as Category 3 chemicals, thus pesticides should be sampled for every 5 years in select wells within the OB/OD and Northern Areas, as appropriate. Sampling every 5 years is expected to adequately characterize the spatial and temporal changes of pesticides if present in groundwater. Table 5-7 discusses the chemical properties of some Category 3 chemicals and their respective fate and transport characteristics.

5.3.2 OB/OD Area

In 2008, the Interim Measures Facility-Wide GMP proposed a broad chemical analysis roster because a comprehensive data set characterizing groundwater contamination did not exist at that time (i.e., identification of COIs was uncertain). In subsequent years, the chemical roster has been modified because specific compounds in several of these analytical suites, such as cyanide, herbicides, PCBs, white phosphorus, and dioxins/furans, had not been detected for 2 consecutive years.

NOTE: the OB/OD area has munitions removal activities scheduled until 2015. While these munitions clearance activities are underway, DOD safety protocols prevent non-essential personnel (i.e., sampling technicians) from accessing the site. The situation has been presented to the NMED during an April 3, 2013 conference call and written notification via a letter dated June 10, 2013. Therefore, sampling activities in the OB/OD area is under a temporary moratorium until the surface clearance activities are completed. This moratorium includes all groundwater sampling and measuring of groundwater elevations and is expected to be in effect until 2015.

The following paragraphs in this section will be applicable once sampling is allowed in the OB/OD area. After the completion of the munitions clearance, groundwater monitoring activities will resume and the following parameters will be collected.

The following roster combines the recommendations from Section 5.3.1 and lists the following analytical suites for select wells (Table 5-8) for the current general characterization of groundwater at the OB/OD Area:

- Explosives (semi-annually)

- Nitrite/nitrate (semi-annually)
- Perchlorate (semi-annually)
- TAL dissolved and total metals (semi-annually)
- Dissolved and total mercury (semi-annually)
- TCL VOCs (semi-annually)
- TCL SVOCs (every 2 years)
- Pesticides (every 5 years)

Groundwater samples will be collected from select wells in and around the OB/OD unit (closed and current). The targeted wells, sampling frequencies, and analytical suites are shown in Table 5-8. All remaining installed wells (plus any new wells if any are installed) will be sampled semi-annually for explosives, nitrate, nitrite, perchlorate, dissolved TAL metals and mercury, total TAL metals and mercury, TCL VOCs, TCL SVOCs, and pesticides for a minimum of four consecutive sampling events. If a parameter is not detected in a well after four consecutive sampling events, it will be recommended to be removed from the sampling schedule for that specific well. QA samples will be collected as summarized in Table 5-9. Additionally, quarterly water level data (site access permitting) and semi-annual water quality parameters (including dissolved oxygen, pH, specific conductance, turbidity, oxidation reduction potential, and temperature) will be collected and recorded as described in Sections 4.1 and 4.2.

5.3.3 Northern Area

In 2008, the Interim Measures Facility-Wide GMP proposed a broad chemical analysis roster because a comprehensive data set characterizing groundwater contamination did not exist at that time (i.e., identification of COIs was uncertain). In subsequent years, the chemical roster has been modified because specific compounds, such as herbicides, had not been detected for 2 consecutive years or in the case of dixons/furans statistical evaluation indicated the parameter was not a COI.

This annually updated roster combines the recommendations from Section 5.3.1 and lists the following analytical suites for select wells (Table 5-8) for the current general characterization of groundwater at the Northern Area:

- Explosives (semi-annually)
- Nitrite/nitrate (semi-annually)
- Perchlorate (semi-annually)
- TAL dissolved and total metals (semi-annually)

- Dissolved and total mercury (semi-annually)
- TCL VOCs (semi-annually)
- TCL SVOCs (semi-annually for bedrock, (semi-annually or every 2 years for alluvium)
- Pesticides (every 5 years)
- TPH-GRO and -DRO (associated with SWMU 45 only in alluvium)

Alluvial and bedrock groundwater samples will be collected from select wells in the Northern Area. The targeted wells, sampling frequencies, and analytical suites are shown in Table 5-8. QA samples will be collected as summarized in Table 5-10. All recently installed wells will be sampled semi-annually for explosives, nitrate, nitrite, perchlorate, dissolved TAL metals and mercury, total TAL metals and mercury, TCL VOCs, TCL SVOCs, pesticides, and TPH-GRO and TPH-DRO (wells associated with SWMU 45) for a minimum of four consecutive sampling events. If a parameter is not detected in a well after four consecutive sampling events, it will be recommended to be removed from the sampling schedule for that specific well. Additionally, quarterly water level data (site access permitting) and semi-annual water quality parameters (including dissolved oxygen, pH, specific conductance, turbidity, oxidation reduction potential, and temperature) will be collected and recorded as described in Sections 4.2 and 4.3.

NOTE: The monitoring wells associated with the East Landfill in Parcel 18 (EMW01, EMW02, EMW03, and EMW04) are scheduled to be plugged and abandoned once the landfill is removed; scheduled for sometime in 2013-2014 and subject to NMED approval. If the East Landfill monitoring wells are not plugged and abandoned as schedule, they will continue to be sampled and the groundwater elevations measured. If (or when) the wells are abandoned, they will be removed from the sampling program.

5.4 Data Validation

An independent data validation of the results of all chemical analyses analyzed by the accredited laboratory will be performed using the most recent version of the USACE EM 200-1-3 (USACE, 2001) and the *Department of Defense Quality Systems Manual for Environmental Laboratories* (U.S. Department of Defense, 2010) (Appendix F). Laboratories performing sample analyses will hold current NELAP accreditation for all appropriate fields of testing. Laboratories will also meet NMED and EPA standards, as required. Laboratories will submit self-declaration forms along with information related to NELAP accreditation to the USACE COR.

Analytical results will be validated in accordance with the most current versions of EPA CLP National Functional Guidelines for Organic Data Review (EPA, 2008) and EPA CLP National Functional Guideline for Inorganic Data Review (EPA, 2010) to ensure the data are of sufficient quality for the intended use. Data validation will consist of the following:

- Verification that the amount of data requested matches the amount of data received (i.e., completeness check)

- Verification of the procedures/methods used

- Verification that documentation/deliverables are complete

- Verification that hard copy and electronic versions of the data are identical

- Verification that the data seem reasonable based on analytical methodologies

- Evaluation and qualification of results based on sample receipt (sample temperature and preservation) and holding-time compliance

- Qualification of results based on method, field, and rinse blank results

- Evaluation and qualification of results based on MS/MSD analyses

- Evaluation and qualification of results based on surrogate recoveries

- Evaluation and qualification of results based on internal standard performance

- Verification that the analytical instrument was calibrated in accordance with required instrument and method criteria

- Evaluation and qualification of results based on initial and continuing instrument calibration verification check sample analyses, and initial and continuing instrument calibration blank results

- Evaluation and qualification of results based on laboratory control sample analyses

- Evaluation and qualification of results based on laboratory and field duplicate precision

- Verification that the instrument was properly tuned before sample analyses

- Verification that the analytical sequence included pertinent information required to track the analyses of all QA/QC and environmental samples

For new data, the USACE has specified a 100 percent Level 2a, Functional Guideline equivalent validation procedures, and a 10 percent Level 4 validation on all sample data generated for FWDA.

Standard EPA data qualifiers shall be used to indicate: (1) blank contamination, (2) sample-analytical anomalies associated with a constituent, (3) analytical results that fall between the MDL and the limit of quantitation, (4) data qualified because of an exceedance of method-specific holding times, high cooler temperatures, or other significant QA/QC data deficiencies, and (5) data results that exceed the upper calibration curve limit for that constituent and associated analytical instrument.

A Data Quality Summary Report, that will include a Data Validation Report, will be prepared that will discuss the performance of the laboratory with respect to the factors presented above. As much as possible, data will be presented in tabular form. In addition, the Data Validation Report will discuss the following:

- Actual MDLs and/or the limits of quantitation, as applicable;

- Adequacy of the detection limit for the intended purpose

- The possible influence(s) of matrix interferences, dilution factors, unusual shipping conditions, and any variance from the reference analytical methods

- Usability of the data with respect to the project objectives

- Attainment of DQO process–derived decision statements with respect to chemical data quality

An electronic data deliverable will be provided in a Microsoft® Access format compatible with USACE Albuquerque and FWDA Environmental Data Management System (EDMS) standards.

5.5 Environmental Data Management

Following review and approval, the data will be loaded into the FWDA EDMS database. As noted in Section 5.1.2, the groundwater sampling Statement of Work will contain the required information to ensure that data reporting and electronic data deliverables are compatible with the FWDA EDMS.

5.6 Data Evaluation

As described in Section 5.3, groundwater data generated during ground water monitoring will be evaluated with respect to cleanup levels described in Attachment 7 of the Permit (NMED, 2005).

5.7 Reporting

Analytical results will be submitted in a semi-annual report prepared in accordance with NMED guidance entitled *General Reporting Requirements for Routine Groundwater Monitoring at RCRA Sites* (2003; included in Appendix G). The report will be submitted to NMED not more than 60 days subsequent to the receipt of final validated laboratory reports.

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6. SCHEDULE

Groundwater elevation data will be collected on a quarterly basis in January, April, July, and October.

Groundwater samples from in and around the OB/OD Area and in the Northern Area of FWDA will be collected semi-annually in April and October.

The first sample collection under this Interim Measures Facility-Wide GMP took place in April 2008 and has continued each April and October according to the existing GMP.

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FIGURES

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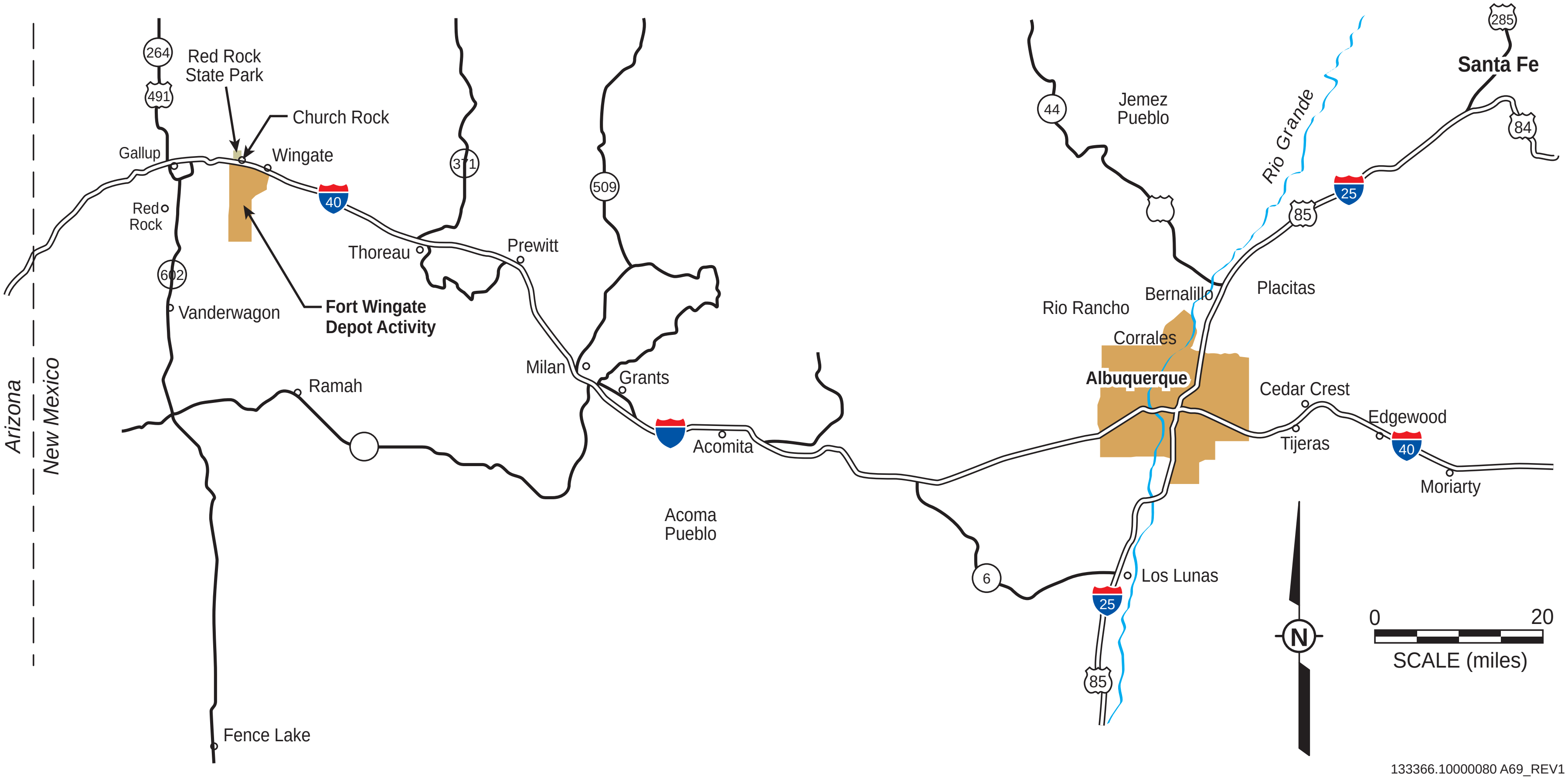

Figure 2-1
Site Location Map
Fort Wingate Depot Activity, New Mexico

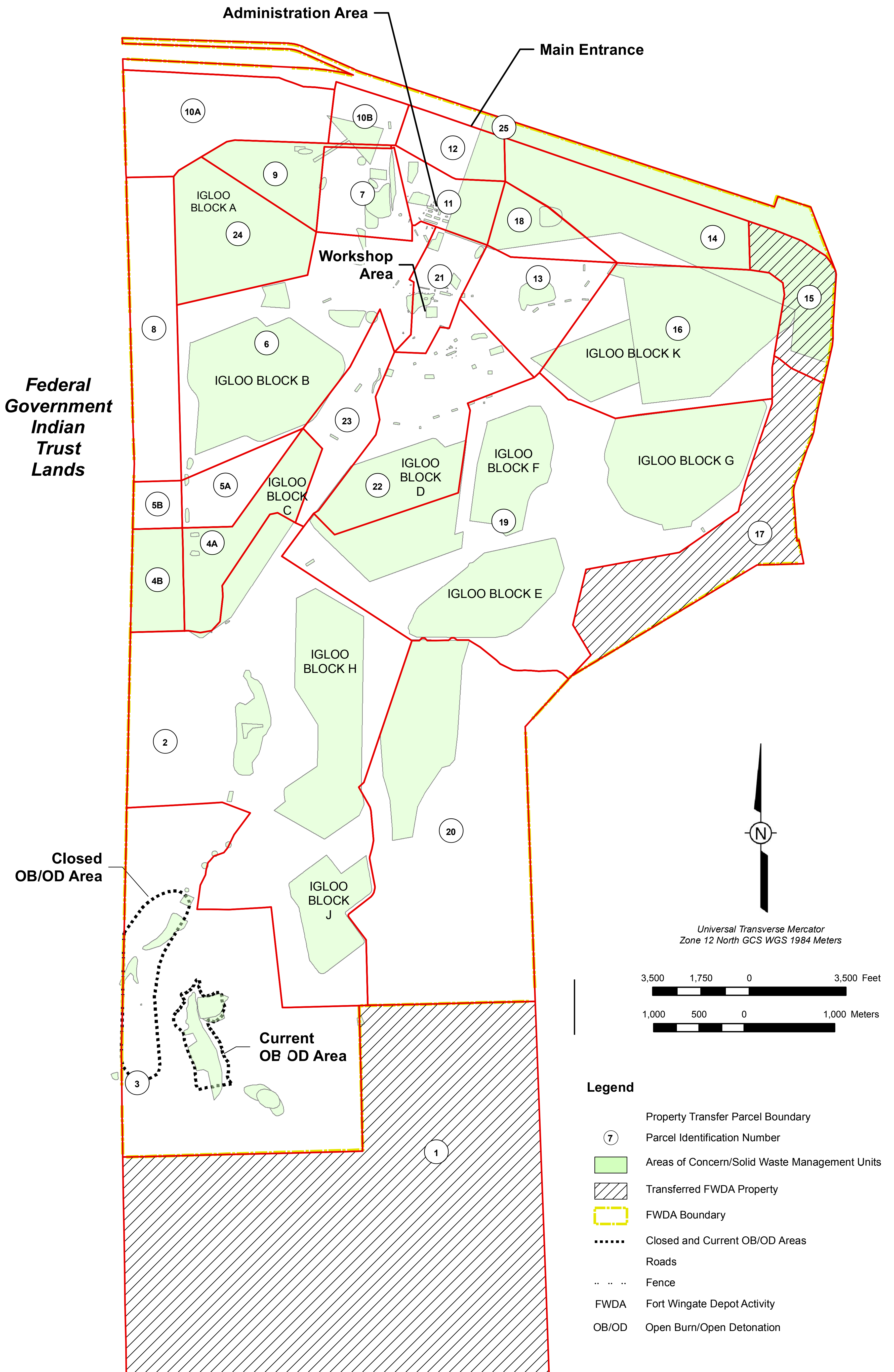

Figure 2-2
Historical Land Use and Reuse Parcel Boundaries

Interim Facility-Wide Groundwater Monitoring Plan
FWDA, New Mexico

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Figure 2-3
Facility-Wide
Groundwater Well Locations

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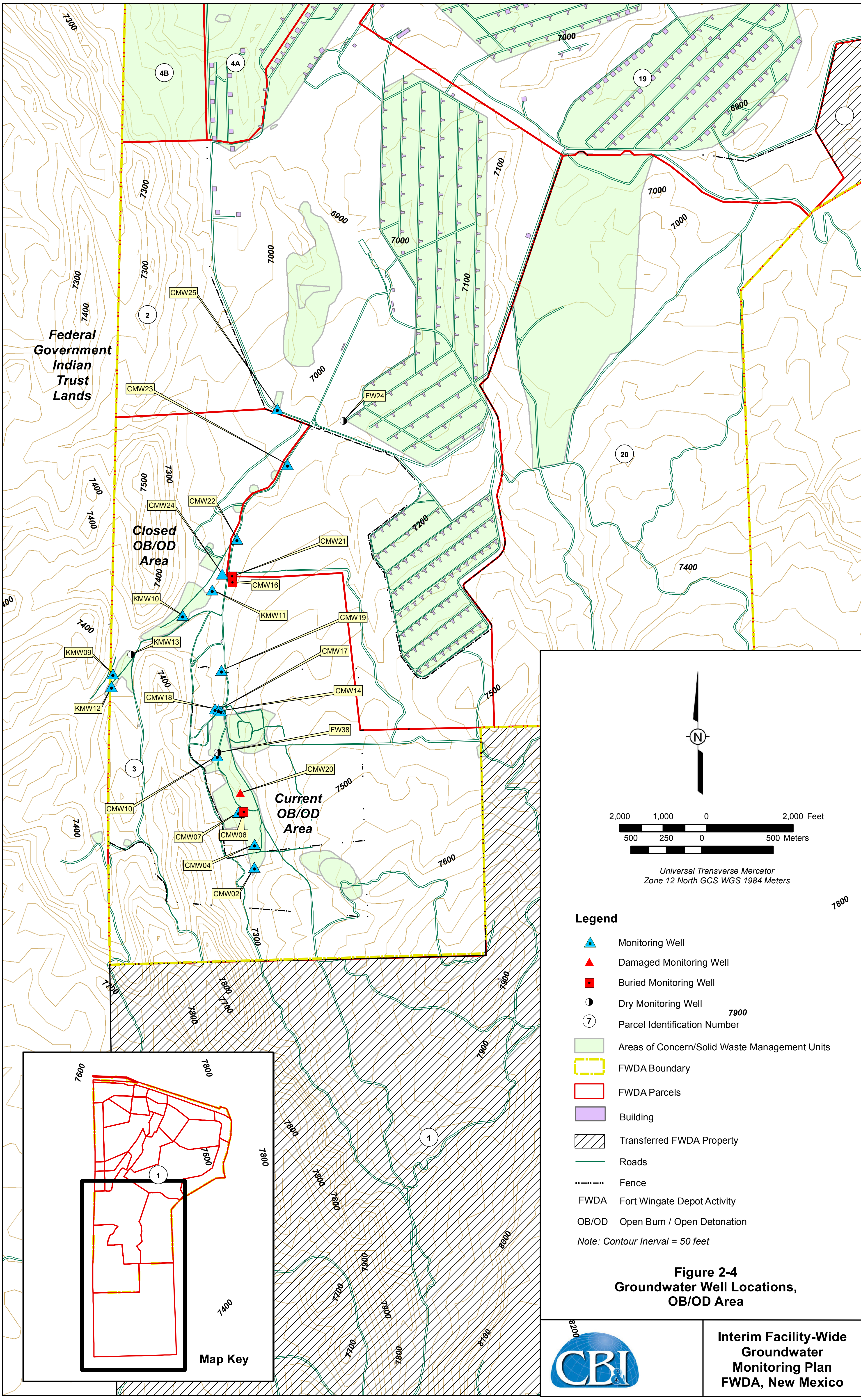

Figure 2-4
Groundwater Well Locations, OB/OD Area

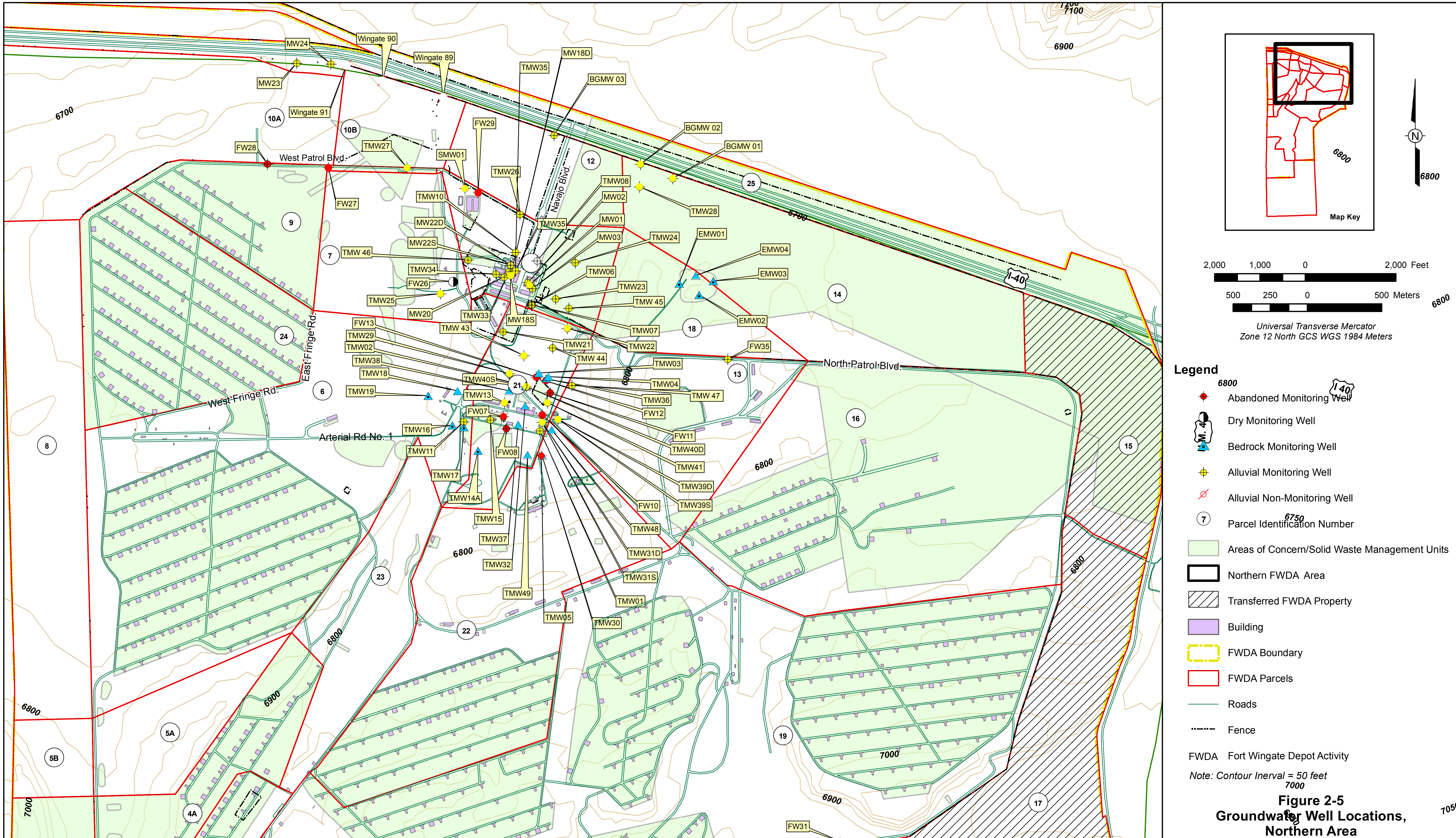

Figure 2-5
Groundwater Well Locations, Northern Area

Interim Facility-Wide Groundwater Monitoring Plan
FWDA, New Mexico

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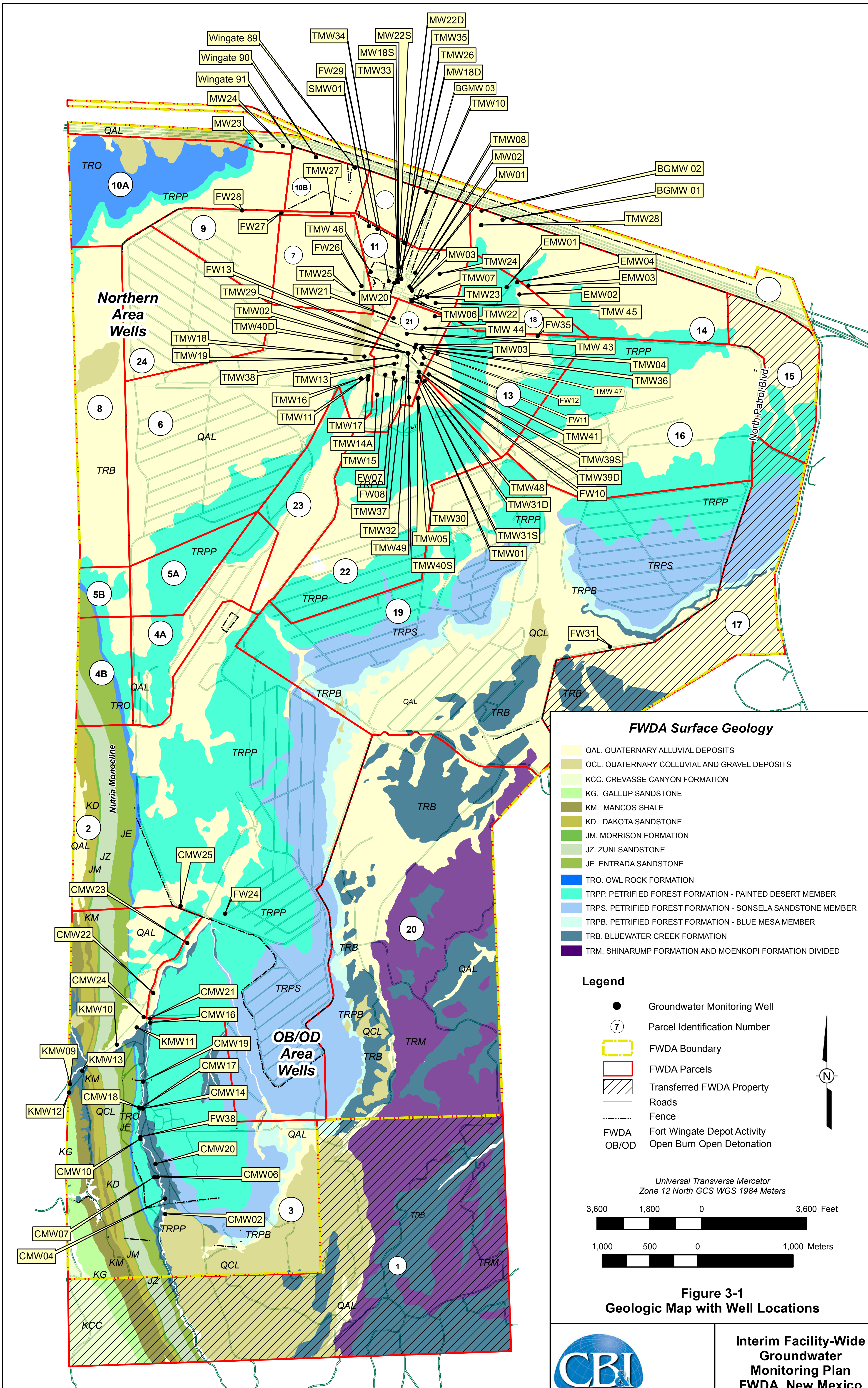

Figure 3-1
Geologic Map with Well Locations

TABLES

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Table 2-1
Groundwater Well Construction Details

Well ID	FWDA Parcel	Date Installed	Drilling Method	Northing[a]	Easting[a]	Ground Elevation (famsl)[b]	Measuring Point Elevation (famsl)[b]	Well Depth (ft bgs)	Boring Diameter (in)	Casing Diameter (in)	Casing Type	Screen Length (ft)	Screened Interval (ft bgs)	Screened Interval (famsl)	Status	Screened Formation	Description
OB/OD Area																	
CMW02	3	08/15/1996	HSA/AR	1612193.23	2489293.13	7256.32	7258.00	43.00	8.00	2.00	PVC/PVC screen	10.0	25.0 - 35.0	7230.39-7220.39	Active	Alluvium	Silty Clay
CMW04	3	08/15/1996	AR	1612755.29	2489317.38	7249.08	7251.15	136.60	8.00	2.00	PVC/PVC screen	20.0	115.0 - 135.0	7133.30-7113.30	Active	Alluvium	Silty Clay
CMW06	3	08/12/1996	HSA	1613477.48	2489087.84	7214.13	7216.05	18.60	4.00	2.00	PVC/PVC screen	10.0	8.3 - 18.3	7204.95-7194.95	Buried	Alluvium	Silty Clay/Silty Sand
CMW07	3	10/01/1996	HSA/AR	1613481.11	2488966.19	7233.04	7235.16	65.80	8.00	2.00	PVC/PVC screen	20.0	44.0 - 64.0	7188.90-7168.90	Active	Painted Desert Member	Sandstone
CMW10	3	09/30/1996	HSA/AR	1614801.68	2488525.71	7177.40	7179.31	70.85	8.00	2.00	PVC/PVC screen	20.0	50.5 - 70.5	7126.49-7106.49	Active	Painted Desert Member	Silty Claystone
CMW14	3	09/06/1996	HSA/AR	1615835.54	2488638.31	7151.34	7153.06	94.55	9.00	2.00	PVC/PVC screen	10.0	84.2 - 94.2	7066.82-7056.82	Active	Painted Desert Member	Silty Claystone
CMW16	3	08/17/1996	HSA/AR	1618788.98	2488995.95	7082.17	7084.23	31.80	8.00	2.00	PVC/PVC screen	10.0	20.0 - 30.0	7061.51-7051.51	Buried	Painted Desert Member	Sandstone
CMW17	3	08/21/1996	HSA/AR	1615860.63	2488582.47	7143.72	7145.18	53.00	8.00	2.00	PVC/PVC screen	20.0	32.0 - 52.0	7111.15-7091.15	Active	Painted Desert Member	Silty Claystone
CMW18	3	09/28/1996	HSA/AR	1615886.04	2488504.59	7156.24	7158.24	53.00	8.00	2.00	PVC/PVC screen	20.0	32.0 - 52.0	7124.48-7104.48	Active	Painted Desert Member	Silty Claystone
CMW19	3	10/05/1996	HSA/AR	1616766.18	2488680.46	7128.11	7129.85	52.80	8.00	2.00	PVC/PVC screen	15.0	33.5 - 48.5	7093.89-7078.89	Active	Painted Desert Member	Silty Claystone
CMW20	3	08/12/1998	HSA	1613921.71	2489020.26	7193.14	7194.68	5.80	4.00	2.00	PVC/PVC screen	3.0	2.5 - 5.5	7189.83-7186.83	Damaged	Painted Desert Member	Clayey Sandstone
CMW21	3	08/10/1998	HSA/AR	1618931.48	2488996.15	7192.70	7088.19	74.50	6.00	2.00	PVC/PVC screen	10.0	57.0-67.0	7025.72-7015.72	Buried	Sonsela Member	Silty Sandstone
CMW22	3	09/04/1998	HSA/AR	1619789.75	2489133.42	7080.50	7081.94	122.00	5.50	2.00	PVC/PVC screen	20.0	96.5-116.5	7029.68-7009.68	Active	Painted Desert Member	Sandstone/Siltstone
CMW23	3	07/31/1998	HSA/AR	1621477.51	2490357.19	7033.41	7035.58	112.00	5.50	2.00	PVC/PVC screen	20.0	84.0-104.0	6945.82-6925.82	Active	Sonsela Member	Sandstone
CMW24	3	09/15/1998	HSA/AR	1618994.34	2488773.81	7098.27	7099.68	262.00	6.30	2.00	PVC/PVC screen	30.0	230.0-260.0	6864.33-6834.33	Active	Sonsela Member	Sandstone
CMW25	3	09/28/1996	HSA/AR	1622764.90	2490166.62	7005.24	7007.52	97.00	8.75	2.00	PVC/PVC screen	25.0	71.0-96.0	6930.74-6905.74	Active	Painted Desert Member	Sandstone
FW24	3	11/14/1980	HSA	1622425.99	2491311.06	6997.49	6999.19	25.00	8.00	4.00	PVC/PVC screen	15.0	33.5-48.5	6984.56-6969.56	Dry	Alluvium	Clay
FW38	3	11/19/1993	HSA	1614875.40	2488533.75	7169.43	7172.02	7.50	3.00	2.00	PVC/PVC screen	ND	ND	ND	Dry	Alluvium	ND
KMW09	3	09/27/1996	HSA/AR	1616771.44	2486173.70	7186.02	7187.93	80.40	9.00	2.00	PVC/PVC screen	10.0	60.0 - 70.0	7125.48-7115.48	Active	Mancos Formation	Silty Claystone/Silty Sandstone
KMW10	3	08/06/1996	HSA/AR	1618066.89	2487827.76	7129.35	7131.38	168.45	8.00	2.00	PVC/PVC screen	10.0	158.0 - 168.0	6970.71-6960.71	Active	Unknown	Siltstone/Sandstone
KMW11	3	09/02/1998	HSA	1618649.14	2488515.19	7106.97	7108.78	63.00	9.00	2.00	PVC/PVC screen	20.0	35.0 - 55.0	7071.60-7051.60	Active	Painted Desert Member	Silty Claystone
KMW12	3	08/17/1998	HSA/AR	1616476.04	2486128.81	7191.70	7193.08	75.00	8.75	2.00	PVC/PVC screen	20.0	53.0-73.0	7134.74-7114.74	Active	Mancos Formation	Claystone
KMW13	3	11/13/1998	HSA/AR	1617203.45	2486607.14	7167.06	7168.46	52.50	8.75	2.00	PVC/PVC screen	20.0	32.0-52.0	7131.79-7111.79	Dry	Dakota Formation	Sandstone
Northern Area																	
BGMW01	14	02/06/2012	HSA	1645977.85	2501983.61	6690.28	6692.68	33.00	8.00	2.50	PVC/PVC screen	20.0	12.5-32.5	6677.78-6657.78	Active	Alluvium	Sandy Silt
BGMW02	14	02/09/2012	HSA	1646314.67	2501276.54	6689.20	6691.99	34.00	8.00	2.50	PVC/PVC screen	20.0	13.5-33.5	6675.70-6655.70	Active	Alluvium	Silt/Sand/Clay
BGMW03	12	02/05/2012	HSA	1647012.12	2499392.83	6677.79	6680.57	29.00	8.00	2.50	PVC/PVC screen	20.0	8.5-28.5	6669.29-6649.29	Active	Alluvium	Clay
EMW01	18	07/14/2004	HSA	1643655.61	2502045.53	6716.06	6718.38	120.70	7.80	2.00	PVC/PVC screen	15.0	105.0-120.0	6610.16-6595.16	Active	Painted Desert Member	Siltstone/Claystone
EMW02	18	07/19/2004	HSA/AR	1643391.22	2502476.99	6699.94	6702.49	120.00	6.00	2.00	PVC/PVC screen	15.0	93.0-108.0	6606.14-6591.14	Active	Painted Desert Member	Siltstone/Claystone
EMW03	18	07/21/2004	HSA/AR	1643687.88	2502800.30	6698.63	6701.09	100.00	6.00	2.00	PVC/PVC screen	15.0	78.0-93.0	6619.69-6604.69	Active	Painted Desert Member	Siltstone
EMW04	18	07/23/2004	HSA/AR	1643815.18	2502419.30	6705.68	6708.30	120.0	6.00	2.00	PVC/PVC screen	15.0	100.0-115.0	6604.84-6589.84	Active	Painted Desert Member	Claystone
FW07	21	11/22/1980	HSA	1640839.18	2498075.06	6713.00	6714.90	30.50	8.00	4.00	PVC/PVC screen	20.5	10.0-30.5	6700.03-6684.03	Abandoned	Alluvium	Silty Sand
FW08	21	11/21/1980	HSA/AR	1640572.50	2498132.47	6713.00	6714.90	51.00	8.00	4.00	PVC/PVC screen	40.0	9.0-49.0	6707.16-6667.16	Abandoned	Alluvium	Silty Sand/Sand/Clay
FW10	21	11/20/1980	HSA	1640848.95	2498936.89	6706.76	6708.38	51.50	10.00	4.00	PVC/PVC screen	40.0	9.0-49.0	6698.02-6658.02	Abandoned	Alluvium	Silty Sand/Silty Clay
FW11	21	11/21/1980	HSA	1641334.02	2499124.16	6701.20	6703.50	28.00	8.00	4.00	PVC/PVC screen	20.0	8.0-28.0	6692.78-6672.78	Abandoned	Alluvium	Clayey Sand
FW12	21	11/22/1980	HSA	1641609.82	2499038.13	6700.00	6702.00	29.00	8.00	4.00	PVC/PVC screen	20.0	9.0-29.0	6690.79-6670.79	Abandoned	Alluvium	Clayey Sand
FW13	21	11/22/1980	HSA	1641688.39	2498830.01	6701.20	6702.30	30.50	8.00	4.00	PVC/PVC screen	20.0	10.5-30.5	6689.99-6669.99	Abandoned	Alluvium	Clay
FW26	7	11/19/1980	HSA	1643853.34	2497067.39	6672.20	6674.40	31.00	8.00	4.00	PVC/PVC screen	20.0	11.0-31.0	6664.00-6644.00	Dry	Alluvium	Silt/Sand/Clay
FW27	9	11/17/1980	HSA	1646461.42	2494395.93	6657.75	6656.49	32.00	8.00	4.00	PVC/PVC screen	20.0	10.0-30.0	6645.39-6625.39	Abandoned	Alluvium	Silty Sand/Silty Clay/Clay
FW28	9	11/18/1980	HSA	1646584.14	2493050.57	6656.53	6657.50	33.00	8.00	4.00	PVC/PVC screen	23.0	10.0-33.0	6645.97-6622.97	Abandoned	Alluvium	Silt/Clay
FW29	11	11/16/1980	HSA	1645804.02	2497681.98	6669.17	6670.96	32.00	8.00	4.00	PVC/PVC screen	20.0	10.0-30.0	6659.69-6639.69	Abandoned	Alluvium	Gravel/Clay
FW31	19	11/19/1980	HSA	1631192.98	2505201.31	6830.72	6832.49	50.00	8.00	4.00	PVC/PVC screen	40.0	10.0-50.0	6815.71-6775.71	Active	Alluvium	Clay
FW35	13	11/15/1980	HSA	1641888.44	2503025.94	6709.17	6711.11	30.00	8.00	4.00	PVC/PVC screen	20.0	10.0-30.0	6699.26-6679.26	Active	Alluvium	Clay
MW01	11	11/22/1996	HSA	1643726.78	2498748.62	6686.03	6685.94	55.00	10.50	2.00	PVC/PVC screen	20.0	33.6-53.6	6651.99-6631.99	Active	Alluvium	Sand/Silty Clay
MW02	11	11/25/1996	HSA	1643783.35	2498712.23	6685.78	6685.22	48.00	10.50	2.00	PVC/PVC screen	10.0	37.0-47.0	6645.76-6635.76	Active	Alluvium	Clayey Sand/Clay
MW03	11	11/26/1996	HSA	1643644.43	2498801.96	6687.50	6689.53	53.00	10.50	2.00	PVC/PVC screen	10.0	43.0-53.0	6644.42-6634.42	Active	Alluvium	Silty Sand/Clay
MW18D	11	11/01/1994	HSA	1643947.99	2498331.32	6684.94	6686.32	59.90	8.00	2.00	PVC/PVC screen	10.0	47.0-57.0	6637.04-6627.04	Active	Alluvium	ND
MW18S	11	11/01/1994	HSA	1643948.08	2498331.62	6684.67	6686.61	39.04	8.00	2.00	PVC/PVC screen	10.0	27.0-37.0	6658.17-6648.17	Dry	Alluvium	ND
MW20	11	11/01/1994	HSA	1643922.12	2498193.80	6685.34	6687.67	59.40	8.00	2.00	PVC/PVC screen	10.0	47.0-57.0	6638.79-6628.79	Active	Alluvium	ND

Table 2-1 (continued)
Groundwater Well Construction Details

Well ID	FWDA Parcel	Date Installed	Drilling Method	Northing[a]	Easting[a]	Ground Elevation (famsl)[b]	Measuring Point Elevation (famsl)[b]	Well Depth (ft bgs)	Boring Diameter (in)	Casing Diameter (in)	Casing Type	Screen Length (ft)	Screened Interval (ft bgs)	Screened Interval (famsl)[b]	Status	Screened Formation	Description
Northern Area (continued)																	
MW22D	11	11/01/1994	HSA	1644178.39	2498343.15	6682.69	6684.55	58.62	8.00	2.00	PVC/PVC screen	10.0	47.0-57.0	6636.55-6626.55	Active	Alluvium	ND
MW22S	11	11/01/1994	HSA	1644178.59	2498343.06	6682.69	6684.69	43.54	8.00	2.00	PVC/PVC screen	10.0	31.0-41.0	6651.57-6641.57	Active	Alluvium	ND
MW23	25	06/30/2011	HSA	1648792.02	2493767.75	6652.46	6654.50	134.0	8.00	2.50	PVC/PVC screen	70.0	63.5-133.5	6588.96-6518.96	Active	Alluvium	Sand/Clay
MW24	25	07/02/2011	HSA	1648746.52	2494518.24	6655.09	6657.08	66.50	8.00	2.50	PVC/PVC screen	50.0	16.0-66.0	6638.09-6588.09	Active	Alluvium	Sand/Clay
SMW01	11	07/29/1996	HSA	1645908.54	2497392.99	6668.41	6669.94	50.21	8.00	2.00	PVC/PVC screen	20.0	29.9 - 49.9	6637.86-6617.86	Active	Alluvium	Silty Sand/Sandy Clay
TMW01	21	07/31/1996	HSA	1640504.34	2498872.04	6709.79	6711.84	60.00	8.00	2.00	PVC/PVC screen	15.0	44.0 - 59.0	6666.18-6651.18	Active	Alluvium	Clay with Sand Layer
TMW02	21	07/31/1996	HSA	1641503.03	2498583.97	6703.34	6705.35	85.00	8.00	2.00	PVC/PVC screen	14.0	67.9 - 81.9	6636.06-6622.06	Active	Painted Desert Member	Sandstone
TMW03	21	07/25/1996	HSA	1641773.65	2498883.04	6700.37	6702.43	70.10	8.00	2.00	PVC/PVC screen	20.0	49.8 - 69.8	6650.86-6630.86	Active	Alluvium	Silty Clay/Clayey Sand
TMW04	21	07/26/1996	HSA	1641690.11	2499095.25	6699.00	6700.86	70.50	8.00	2.00	PVC/PVC screen	20.0	50.0 - 70.0	6649.08-6629.08	Active	Alluvium	Upper Sand/Lower Clay
TMW05	22	07/23/1998	HSA/AR	1639949.83	2498884.78	6712.64	6714.67	37.40	5.50	2.00	PVC/PVC screen	10.0	25.0-35.0	6687.69-6677.69	Abandoned	Painted Desert Member	Sandstone/Siltstone
TMW06	11	08/27/1998	HSA	1643285.82	2498783.81	6689.08	6690.63	57.00	8.80	2.00	PVC/PVC screen	10.0	45.0-55.0	6643.85-6633.85	Active	Alluvium	Sandy Silt
TMW07	11	07/24/1998	HSA/AR	1643289.14	2498772.33	6689.08	6690.47	76.00	5.50	2.00	PVC/PVC screen	10.0	65.0-75.0	6633.74-6623.74	Active	Alluvium	Sandy Silt
TMW08	11	08/29/1998	HSA	1644255.04	2498930.01	6678.55	6680.31	62.00	8.80	2.00	PVC/PVC screen	30.0	30.0-60.0	6648.43-6618.43	Active	Alluvium	Silty Sand/Clay
TMW10	11	08/20/1998	HSA	1644455.63	2498459.83	6677.74	6680.04	65.00	8.80	2.00	PVC/PVC screen	30.0	28.0-58.0	6648.86-6618.86	Active	Alluvium	Silty Sand/Clay
TMW11	6	09/09/1998	HSA	1640758.33	2497201.28	6716.16	6718.28	82.00	8.75	2.00	PVC/PVC screen	25.0	55.0-80.0	6661.24-6636.24	Active	Alluvium	Silty Gravel/Sand
TMW13	21	08/11/1998	HSA	1641150.12	2498112.40	6705.42	6707.49	72.50	8.80	2.00	PVC/PVC screen	10.0	60.7-70.7	6644.35-6634.35	Active	Alluvium	Sandy Clay/Silt
TMW14A	21	01/25/2001	AR	1640105.58	2497489.30	6721.08	6723.54	110.00	6.00	2.00	PVC/PVC screen	15.0	94.25-109.25	6627.34-6612.34	Active	Painted Desert Member	Sandstone
TMW15	21	12/09/2001	AR	1640779.84	2497787.12	6710.80	6713.89	82.00	6.00	2.00	PVC/PVC screen	15.0	56.0-71.0	6652.88-6637.88	Active	Alluvium	Silty Gravel/Sand
TMW16	6	12/05/2001	AR	1640687.46	2496941.08	6711.65	6714.15	142.00	6.00	2.00	PVC/PVC screen	15.0	123.0-138.0	6587.59-6572.95	Active	Painted Desert Member	Sandstone
TMW17	6	12/13/2001	AR	1640639.74	2497193.66	6717.40	6719.89	152.00	6.00	2.00	PVC/PVC screen	15.0	112.0-127.0	6605.49-6590.49	Active	Painted Desert Member	Sandstone
TMW18	6	12/14/2001	AR	1641437.52	2497083.23	6710.14	6713.49	220.00	6.00	2.00	PVC/PVC screen	10.0	150.0-160.0	6563.66-6553.66	Active	Painted Desert Member	Sandstone
TMW19	6	12/03/2001	AR	1641357.45	2496433.25	6697.57	6700.52	187.00	6.00	2.00	PVC/PVC screen	15.0	169.0-184.0	6528.57-6513.57	Active	Painted Desert Member	Sandstone
TMW21	21	08/09/2002	HSA	1642714.59	2498128.03	6692.75	6695.14	72.00	8.00	2.00	PVC/PVC screen	10.0	48.0-58.0	6644.76-6634.76	Active	Alluvium	Sand/Silt/Clay
TMW22	21	08/08/2002	HSA	1642741.03	2499552.37	6689.80	6691.74	77.00	8.00	2.00	PVC/PVC screen	10.0	52.0-62.0	6637.13-6627.13	Active	Alluvium	Sand/Silt/Clay
TMW23	11	08/06/2002	HSA	1643402.27	2499309.65	6685.37	6687.66	72.00	8.00	2.00	PVC/PVC screen	10.0	46.0-56.0	6638.81-6628.81	Active	Alluvium	Clay/Sand
TMW24	11	08/03/2003	HSA	1644192.07	2499766.39	6678.52	6680.42	75.00	8.00	2.00	PVC/PVC screen	10.0	44.0-54.0	6633.30-6623.30	Active	Alluvium	Silty Sand/Silt/Sand
TMW25	7	08/01/2002	HSA	1643599.42	2496775.99	6671.09	6672.88	74.00	8.00	2.00	PVC/PVC screen	10.0	42.5-52.5	6627.72-6617.72	Active	Alluvium	Silty Sand/Clay
TMW26	11	07/30/2002	HSA	1645294.52	2498581.83	6674.88	6677.71	64.80	8.00	2.00	PVC/PVC screen	10.0	45.0-55.0	6629.97-6619.97	Active	Alluvium	Silt/Sand/Clay
TMW27	9	07/26/2002	HSA	1646400.43	2496126.29	6665.45	6668.13	102.20	8.00	2.00	PVC/PVC screen	10.0	60.0-70.0	6605.37-6595.37	Active	Alluvium	Sandy Clay/Silt
TMW28	14	07/24/2002	HSA	1645827.16	2501250.48	6686.77	6689.17	72.50	8.00	2.00	PVC/PVC screen	10.0	37.0-47.0	6649.79-6639.79	Active	Alluvium	Silty Sand/Sand/Clay
TMW29	21	08/19/2002	HSA	1641786.37	2498235.92	6700.31	6702.88	69.00	8.00	2.00	PVC/PVC screen	10.0	49.0-59.0	6652.32-6642.32	Active	Alluvium	Sand/Sandy Clay
TMW30	21	11/15/2009	HSA/AR	1639957.87	2498898.99	6712.35	6714.59	51.50	6.00	2.00	PVC/PVC screen	10.0	35.0-45.0	6677.31-6667.31	Active	Painted Desert Member	Sandstone
TMW31D	21	11/16/2009	HSA/AR	1640689.53	2498931.95	6708.53	6710.44	111.50	6.00	2.00	PVC/PVC screen	30.0	77.0 - 107.0	6631.98-6601.98	Active	Painted Desert Member	Sandstone
TMW31S	21	11/17/2009	HSA/AR	1640689.53	2498931.95	6708.53	6710.20	61.00	6.00	2.00	PVC/PVC screen	10.0	50.0-60.0	6658.98-6648.98	Active	Alluvium	Silty Sand/Sand/Clay
TMW32	21	11/18/2009	HSA	1641059.71	2498559.18	6707.09	6709.31	139.10	6.00	2.00	PVC/PVC screen	20.0	117.0-137.0	6590.89-6570.89	Active	Painted Desert Member	Sandstone
TMW33	11	11/19/2009	HSA	1644035.48	2498303.75	6684.09	6686.60	60.40	6.00	2.00	PVC/PVC screen	20.0	37.0-57.0	6646.78-6626.78	Active	Alluvium	Silty Sand/Sand/Clay
TMW34	11	11/20/2009	HSA	1643993.95	2498014.09	6684.32	6687.29	57.25	6.00	2.00	PVC/PVC screen	20.0	37.0-57.0	6650.32-6630.32	Active	Alluvium	Silty Sand/Sand/Clay
TMW35	11	11/21/2009	HSA/AR	1644050.75	2498442.31	6684.14	6686.52	55.00	6.00	2.00	PVC/PVC screen	20.0	35.0-55.0	6649.26-6629.26	Active	Alluvium	Silty Sand/Sand/Clay
TMW36	21	11/22/2009	HSA/AR	1641645.74	2499049.17	6697.33	6699.04	157.00	6.00	2.00	PVC/PVC screen	20.0	132.0-152.0	6567.32-6547.32	Active	Painted Desert Member	Sandstone
TMW37	21	11/23/2009	HSA/AR	1640648.14	2498397.74	6710.51	6713.09	111.00	6.00	2.00	PVC/PVC screen	20.0	88.0-108.0	6622.88-6602.88	Active	Painted Desert Member	Sandstone
TMW38	21	09/03/2011	HSA	1641400.80	2498219.52	6704.41	6706.79	159.50	8.00	2.50	PVC/PVC screen	40.0	118.9-158.9	6585.41-6545.41	Active	Sandstone	Sandstone
TMW39S	13	07/05/2011	HSA	1640745.21	2499279.83	6706.53	6708.61	53.00	8.00	2.50	PVC/PVC screen	20.0	32.5-52.5	6674.03-6654.03	Active	Alluvium	Clay
TMW39D	13	09/07/2011	HSA	1640745.21	2499279.83	6706.53	6708.61	100.50	8.00	2.50	PVC/PVC screen	30.0	70.0-100.0	6636.53-6606.53	Active	Sandstone	Sandstone
TMW40S	21	09/20/2011	HSA	1641487.06	2498603.50	6703.81	6706.40	60.50	8.00	2.50	PVC/PVC screen	10.0	50.0-60.0	6653.81-6643.81	Active	Alluvium	Sitl/Sand/Clay
TMW40D	21	09/20/2011	HSA	1641487.06	2498603.50	6703.81	6706.15	155.50	8.00	2.50	PVC/PVC screen	20.0	135.0-155.0	6568.81-6548.81	Active	Sandstone	Sandstone
TMW41	21	07/01/2011	HSA	1641113.86	2499058.48	6703.48	6705.21	66.00	8.00	2.50	PVC/PVC screen	10.0	55.5-65.5	6647.48-6637.48	Active	Alluvium	Clay with Gravel
TMW43	21	02/03/2012	HSA	1642171.46	2498570.92	6695.63	6698.63	78.5	8.00	2.50	PVC/PVC screen	20.0	58.0-78.0	6637.8-6617.8	Active	Alluvium	Sand with Gravel
TMW44	21	02/04/2012	HSA	1642323.41	2499212.51	6694.81	6697.31	64.0	8.00	2.50	PVC/PVC screen	20.0	43.5-63.5	6651.5-6631.5	Active	Alluvium	Silty Clay/Sand
TMW45	11	02/08/2012	HSA	1643187.53	2499597.72	6686.50	6689.00	59.0	8.00	2.50	PVC/PVC screen	20.0	38.5-58.5	6648.2-6628.2	Active	Alluvium	Sand/Clay

Table 2-1 (concluded)
Groundwater Well Construction Details

Well ID	FWDA Parcel	Date Installed	Drilling Method	Northing[a]	Easting[a]	Ground Elevation (famsl)[b]	Measuring Point Elevation (famsl)[b]	Well Depth (ft bgs)	Boring Diameter (in)	Casing Diameter (in)	Casing Type	Screen Length (ft)	Screened Interval (ft bgs)	Screened Interval (famsl)	Status	Screened Formation	Description
Northern Area (concluded)																	
TMW46	11	02/05/2012	HSA	1644326.04	2497404.70	6678.69	6680.98	59.0	8.00	2.50	PVC/PVC screen	20.0	38.5-58.5	6640.19-6620.19	Active	Alluvium	Sandy Clay with Gravel
TMW47	13	02/01/2012	HSA	1641475.95	2499610.93	6699.32	6701.88	103.0	8.00	2.50	PVC/PVC screen	20.0	82.5-102.5	6616.82-6596.82	Active	Alluvium	Clay/Silt
TMW48	13	09/15/2011	HSA	1640515.53	2499131.31	6707.8	6709.8	91.5	8.00	2.50	PVC/PVC screen	20.0	71.0-91.0	6636.80-6616.80	Active	Alluvium	Sand
TMW49	21	09/09/2011	HSA	1639979.77	2498578.38	6712.2	6714.7	60.0	8.00	2.50	PVC/PVC screen	20.0	40.0-60.0	6672.20-6652.20	Active	Alluvium	Sand
Wingate 89[c]	10B	01/01/1963	ND	1647927.73	2496972.14	6663.2	6663.7	ND	ND	8.00	PVC/PVC screen	ND	ND	ND	Active	Alluvium	ND
Wingate 90[c]	10B	01/02/1963	ND	1648335.14	2495646.34	6655.3	6656.5	102.0	ND	8.00	PVC/PVC screen	ND	ND	ND	Active	Alluvium	ND
Wingate 91[c]	10B	01/03/1963	ND	1648705.22	2494863.70	6658.8	6659.7	ND	ND	8.00	PVC/PVC screen	ND	ND	ND	Active	Alluvium	ND

[a] Horizontal Coordinate System: NM NAD83 State Plane Central
[b] Vertical Coordinate System: NAVD88
[c] Indicates the well is used for water level measurements; not sampled
AR = Air Rotary
FWDA = Fort Wingate Depot Activity
famsl = Feet above mean sea level
ft = Feet
bgs = Below ground surface
HSA = Hollow Stem Auger
ID = Identification
in = Inches
NA = Not applicable
NAD83 = North American Datum of 1983
NAVD88 = North American Vertical Datum of 1988
ND = No data available
NM = New Mexico
PVC = Polyvinyl Chloride

Table 4-1
Groundwater Purge Method

Well ID	Casing Diameter (in)	Well Depth (ft bgs)	Screened Interval (ft bgs)	Screen Length (in)	Dedicated Pump?	Low Flow?	Purge Method
OB/OD Area (REMOVED from Sampling Plan until 2015 due to surface clearance conducted by URS)							
CMW02	2.00	43.0	25.0-35.0	10.0	Yes	Yes	ZIST Low Flow
CMW04	2.00	136.6	115.0-135.0	20.0	Yes	Yes	ZIST Low Flow
CMW06	2.00	18.6	8.3-18.3	10.0	Buried		
CMW07	2.00	65.8	44.0-64.0	20.0	Yes	Yes	Trad. Low Flow
CMW10	2.00	70.9	50.5-70.5	20.0	No	No	Hand Bail
CMW14	2.00	94.6	84.2-94.2	10.0	Yes	Yes	ZIST Low Flow
CMW16	2.00	31.8	20.0-30.0	10.0	Buried		
CMW17	2.00	53.0	32.0-52.0	20.0	No	No	Grundfos Pump
CMW18	2.00	53.0	32.0-52.0	20.0	Yes	Yes	Trad. Low Flow
CMW19	2.00	52.8	33.5-48.5	15.0	Yes	Yes	ZIST Low Flow
CMW20	2.00	5.8	2.5-5.5	3.0	Damaged		
CMW21	2.00	74.5	57.0-67.0	10.0	Buried		
CMW22	2.00	122.0	96.5-116.5	20.0	No	No	Hand Bail
CMW23	2.00	112.0	84.0-104.0	20.0	No	No	Hand Bail
CMW24	2.00	262.0	230.0-260.0	30.0	Yes	Yes	ZIST Low Flow
CMW25	2.00	97.0	71.0-96.0	25.0	Yes	Yes	Trad. Low Flow
FW24	4.00	25.0	33.5-48.5	15.0	Dry		
FW38	2.00	7.5	ND	ND	Dry		
KMW09	2.00	80.4	60.0-70.0	10.0	Yes	Yes	ZIST Low Flow
KMW10	2.00	168.5	158.0-168.0	10.0	No	No	Hand Bail
KMW11	2.00	63.0	35.0-55.0	20.0	Yes	Yes	Trad. Low Flow
KMW12	2.00	75.0	53.0-73.0	20.0	Yes	No	Bennett Pump
KMW13	2.00	52.5	32.0-52.0	20.0	Dry		
Northern Area							
BGMW01	2.50	33.0	12.5-32.5	20.0	Yes	Yes	Trad. Low Flow
BGMW02	2.50	34.0	13.5-33.5	20.0	Yes	Yes	Trad. Low Flow
BGMW03	2.50	29.0	8.5-28.5	20.0	Yes	Yes	Grundfos Pump
EMW01	2.00	120.7	105.0-120.0	15.0	Yes	No	Pumped Dry
EMW02	2.00	120.0	93.0-108.0	15.0	Yes	No	Pumped Dry
EMW03	2.00	100.0	78.0-93.0	15.0	Yes	No	Pumped Dry

Table 4-1 (continued)
Groundwater Purge Method

Well ID	Casing Diameter (in)	Well Depth (ft bgs)	Screened Interval (ft bgs)	Screen Length (in)	Dedicated Pump?	Low Flow?	Purge Method
Northern Area (continued)							
EMW04	2.00	120.0	100.0-115.0	15.0	Yes	No	Bennett Pump
FW26	4.00	31.0	11.0-31.0	20.0	Dry		
FW31	4.00	50.0	10.0-50.0	40.0	No	No	Grundfos Pump
FW35	4.00	30.0	10.0-30.0	20.0	No	No	Grundfos Pump
MW01	2.00	55.0	33.6-53.6	20.0	No	No	Hand Bail
MW02	2.00	48.0	37.0-47.0	10.0	No	No	Hand Bail
MW03	2.00	53.0	43.0-53.0	10.0	Yes	Yes	Trad. Low Flow
MW18D	2.00	59.9	47.0-57.0	10.0	Yes	Yes	Trad. Low Flow
MW18S	2.00	39.0	27.0-37.0	10.0	Dry		
MW20	2.00	59.4	47.0-57.0	10.0	Yes	Yes	Trad. Low Flow
MW22D	2.00	58.6	47.0-57.0	10.0	Yes	Yes	Trad. Low Flow
MW22S	2.00	43.5	31.0-41.0	10.0	No	No	Hand Bail
MW23	2.50	134.0	63.5-133.5	70.0	Yes	No	Bailer
MW24	2.50	66.5	16.0-66.0	50.0	Yes	No	Trad. Low Flow
SMW01	2.00	50.2	29.9-49.9	20.0	Yes	Yes	Trad. Low Flow
TMW01	2.00	60.0	44.0-59.0	15.0	Yes	Yes	Trad. Low Flow
TMW02	2.00	85.0	67.9-81.9	14.0	Yes	Yes	Trad. Low Flow
TMW03	2.00	70.1	49.8-69.8	20.0	Yes	Yes	Trad. Low Flow
TMW04	2.00	70.5	50.0-70.0	20.0	Yes	Yes	Trad. Low Flow
TMW06	2.00	57.0	45.0-55.0	10.0	Yes	Yes	Trad. Low Flow
TMW07	2.00	76.0	65.0-75.0	10.0	No	No	Hand Bail
TMW08	2.00	62.0	30.0-60.0	30.0	Yes	Yes	Trad. Low Flow
TMW10	2.00	65.0	28.0-58.0	30.0	Yes	Yes	Trad. Low Flow
TMW11	2.00	82.0	55.0-80.0	25.0	Yes	Yes	Trad. Low Flow
TMW13	2.00	72.5	60.7-70.7	10.0	Yes	Yes	Trad. Low Flow
TMW14A	2.00	110.0	94.25-109.25	15.0	Yes	Yes	ZIST Low Flow
TMW15	2.00	82.0	56.0-71.0	15.0	Yes	Yes	Trad. Low Flow
TMW16	2.00	142.0	123.0-138.0	15.0	Yes	No	Bennett Pump
TMW17	2.00	152.0	112.0-127.0	15.0	Yes	Yes	ZIST Low Flow
TMW18	2.00	220.0	150.0-160.0	10.0	Yes	No	Bennett Pump

Table 4-1 (continued)
Groundwater Purge Method

Well ID	Casing Diameter (in)	Well Depth (ft bgs)	Screened Interval (ft bgs)	Screen Length (in)	Dedicated Pump?	Low Flow?	Purge Method
Northern Area (continued)							
TMW19	2.00	187.0	169.0-184.0	15.0	Yes	No	Bennett Pump
TMW21	2.00	72.0	48.0-58.0	10.0	Yes	Yes	Trad. Low Flow
TMW22	2.00	77.0	52.0-62.0	10.0	No	No	Hand Bail
TMW23	2.00	72.0	46.0-56.0	10.0	No	No	Hand Bail
TMW24	2.00	75.0	44.0-54.0	10.0	Yes	Yes	Trad. Low Flow
TMW25	2.00	74.0	42.5-52.5	10.0	Yes	Yes	Trad. Low Flow
TMW26	2.00	64.8	45.0-55.0	10.0	Yes	Yes	Trad. Low Flow
TMW27	2.00	102.2	60.0-70.0	10.0	Yes	Yes	Trad. Low Flow
TMW28	2.00	72.5	37.0-47.0	10.0	Yes	Yes	Trad. Low Flow
TMW29	2.00	69.0	49.0-59.0	10.0	No	No	Hand Bail
TMW30	2.00	51.5	35.0-45.0	10.0	No	No	Grundfos Pump
TMW31D	2.00	111.5	77.0-107.0	30.0	Yes	Yes	Trad. Low Flow
TMW31S	2.00	61.0	50.0-60.0	10.0	No	No	Grundfos Pump
TMW32	2.00	139.1	117.0-137.0	20.0	Yes	Yes	Trad. Low Flow
TMW33	4.00	60.4	37.0-57.0	20.0	No	No	Grundfos Pump
TMW34	2.00	57.25	37.0-57.0	20.0	Yes	Yes	Trad. Low Flow
TMW35	2.00	55.0	35.0-55.0	20.0	Yes	Yes	Trad. Low Flow
TMW36	2.00	157.0	132.0-152.0	20.0	Yes	No	Bennett Pump
TMW37	2.00	111.0	88.0-108.0	20.0	Yes	No	Bennett Pump
TMW38	2.50	159.5	118.9-158.9	40.0	Yes	Yes	Trad. Low Flow
TMW39S	2.50	53.0	32.5-52.5	20.0	No	No	Hand Bail
TMW39D	2.50	100.5	70.0-100.0	30.0	Yes	Yes	Trad. Low Flow
TMW40S	2.50	60.5	50.0-60.0	10.0	No	No	Hand Bail
TMW40D	2.50	155.5	135.0-155.0	20.0	Yes	Yes	Trad. Low Flow
TMW41	2.50	66.0	55.5-65.5	10.0	No	No	Hand Bail
TMW43	2.50	78.5	58.0-78.0	20.0	Yes	Yes	Trad. Low Flow
TMW44	2.50	64.0	43.5-63.5	20.0	No	No	Hand Bail
TMW45	2.50	59.0	38.5-58.5	20.0	No	No	Hand Bail
TMW46	2.50	59.0	38.5-58.5	20.0	No	No	Hand Bail
TMW47	2.50	103.0	82.5-102.5	20.0	Yes	Yes	Trad. Low Flow

Table 4-1 (concluded)
Groundwater Purge Method

Well ID	Casing Diameter (in)	Well Depth (ft bgs)	Screened Interval (ft bgs)	Screen Length (in)	Dedicated Pump?	Low Flow?	Purge Method
Northern Area (concluded)							
TMW48	2.50	91.5	71.0-91.0	20.0	Yes	Yes	Trad. Low Flow
TMW49	2.50	60.0	40.0-60.0	20.0	Yes	Yes	Trad. Low Flow

ft bgs = Feet below ground surface
ID = Identification
in = Inches
ND = No data
OB/OD = Open burn/open detonation
Trad. = Traditional
ZIST = Zone Isolation System Technology

Table 4-2
Field Equipment List

Equipment and Materials	Elevation Survey	Traditional Low-Flow	ZIST Low-Flow	Hand Bail	Grundfos Pump	Bennett Sample Pump
Electronic water level meter, capable of measuring to 0.01 feet accuracy	X	X	X	X	X	X
Power source (generator, portable rechargeable battery, etc.)*		X	X		X	
Nitrogen Tanks		X	X			X
Reusable pump (e.g. Grundfos)					X	
Power Inverter		X	X			
Control Box		X	X		X	
Indicator field parameter monitoring instruments		X	X	X	X	X
Flow measurement supplies (e.g., graduated cylinder and stopwatch)		X	X	X	X	X
Teflon tubing		X	X		X	X
Nitrogen Tank Airline Hose		X	X			X
Teflon or polyethylene bailers				X		
Teflon clamp or connector		X	X	X	X	X
Nylon cord				X		
5-Gallon buckets		X	X	X	X	X
Large capacity Tank(s)						X
Decontamination supplies including non-phosphate detergent, distilled water, brushes, and buckets	X	X	X	X	X	X
Plastic sheeting or absorbent pads	X	X	X	X	X	X
Disposable latex or nitrile gloves	X	X	X	X	X	X
Safety glasses	X	X	X	X	X	X
Trash bags	X	X	X	X	X	X
Sample bottles		X	X	X	X	X
Sample labels		X	X	X	X	X
Shipping supplies including heavy duty cooler(s), zip-lock bags, packing tape, bubble pack, shipping forms		X	X	X	X	X
Logbook and groundwater sampling forms	X	X	X	X	X	X
Well construction data, location map, field data from last sampling event	X	X	X	X	X	X
Well keys	X	X	X	X	X	X

*If a gasoline generator is used, it will be located downwind and at least 15 feet from the well so that the exhaust fumes do not contaminate the samples
ZIST = Zone Isolation Sampling Technology

Table 5-1
Summary of Detected Analytes in Groundwater for OB/OD[a]

Analyte	Sample Analysis						Regulatory Standard			
	Total Samples	No. Detects	Frequency of Detection	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	Arithmetic Mean (µg/L)	NMW QCC[b] (µg/L)	EPA MCL[c] (µg/L)	EPA HHMS SL[d] (µg/L)	Max. Detect Conc. > Min. Screening Level?
Explosives										
Dinitrobenzene, 1,3-	144	10	6.9 %	0.30	12	6.17	NE	NE	1.50	YES
Dinitrotoluene, 2,4-	138	3	2.1%	0.0856	0.58	0.35	NE	NE	30.0	NO
Dinitrotoluene, 2-Amino-4,6	144	20	13.9%	0.064	3.89	1.73	NE	NE	30.0	NO
Dinitrotoluene, 4-Amino-2,6	144	18	12.5%	0.15	6.13	2.37	NE	NE	30.0	NO
Hexahydro-1,3,5-trinitro-1,3,5-triazine	145	29	20%	0.093	250	46.9	NE	NE	0.61	YES
Methyl-2,4,6-trinitrophenylnitramine	30	2	6.7%	0.52	14	7.26	NE	NE	NE	NO
Nitrobenzene	144	4	2.8%	0.098	2.7	1.03	NE	NE	0.12	YES
Nitrotoluene, 2-	144	2	1.4%	0.205	0.72	0.46	NE	NE	0.31	YES
Nitrotoluene, 3-	144	1	0.69%	0.94	0.94	0.94	NE	NE	1.3	NO
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	144	19	13.2%	0.20	28	15.17	NE	NE	780	NO
Tetryl	105	3	2.9%	0.47	1.1	0.84	NE	NE	61.0	NO
Trinitrobenzene, 1,3,5-	145	1	0.69%	1.8	1.8	1.8	NE	NE	460	NO
Trinitrotoluene, 2,4,6-	144	8	5.6%	0.17	2.5	0.72	NE	NE	2.20	YES
Perchlorate (µg/L)										
Perchlorate	136	72	53%	0.025	13	2.16	NE	15.0	11.0	NO
Pesticides (µg/L)										
DDD, 4,4'-	85	1	1.2%	0.0096	0.0096	0.0096	NE	NE	0.027	NO
Chlordane, alpha-	85	1	1.2%	0.025	0.025	0.025	NE	2.00	0.19	NO
Delta-BHC	85	3	3.5%	0.014	0.050	0.036	NE	NE	NE	NO
Endrin Ketone	85	1	1.2%	0.26	0.26	0.26	NE	NE	NE	NO
Heptachlor	85	2	2.4%	0.0085	0.038	0.023	NE	0.40	0.0018	NO
Methoxychlor	85	1	1.2%	0.011	0.011	0.011	NE	40.0	27.0	NO

Table 5-1
Summary of Detected Analytes in Groundwater for OB/OD[a]

Analyte	Sample Analysis						Regulatory Standard			
	Total Samples	No. Detects	Frequency of Detection	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	Arithmetic Mean (µg/L)	NMW QCC[b] (µg/L)	EPA MCL[c] (µg/L)	EPA HHMS SL[d] (µg/L)	Max. Detect Conc. > Min. Screening Level?
Semivolatile Organic Compounds										
Acetophenone	91	2	2.2%	1.15	2.2	1.68	NE	NE	1,500	NO
Benzoic Acid	6	1	16.7%	14	14	14	NE	NE	58,000	NO
Benzaldehyde	92	1	1.1%	0.55	0.55	0.55	NE	NE	1,500	NO
Bis(2-ethylhexyl)phthalate	101	20	19.8%	0.28	8.5	1.91	NE	6.00	4.80	YES
Caprolactam	82	6	7.3%	3.2	140	28.8	NE	NE	7,700	NO
Dibutyl phthalate	96	7	7.3%	0.24	2.66	1.47	NE	NE	670	NO
Diethyl phthalate	102	1	0.98%	0.36	0.36	0.36	NE	NE	11,000	NO
Di-n-butyl phthalate	6	1	16.7%	1.7	1.7	1.7	NE	NE	NE	NO
Di-n-octyl phthalate	102	1	0.98%	0.25	0.25	0.25	NE	NE	NE	NO
Dinitrophenol, 2,4-	103	1	0.98%	19	19	19	NE	NE	30	NO
Dinitrotoluene, 2,4-	102	2	2%	0.32	0.38	0.35	NE	NE	30.0	NO
Nitroso-di-N-propylamine, N-	102	1	0.98%	0.33	0.33	0.33	NE	NE	0.0093	YES
Nitrosodiphenylamine, N-	102	5	4.9%	0.44	1.2	0.70	NE	NE	14.0	NO
Phenol	103	5	4.9%	0.20	3.14	2.0	NE	NE	4,500	NO
Volatile Organic Compounds										
Acetone	177	20	11.3%	1.4	28	9.92	NE	NE	12,000	NO
Benzene	178	13	7.3%	0.11	1.6	0.82	10.0	5.00	0.39	NO
Bromomethane	178	5	2.8%	0.088	0.2	0.15	NE	NE	7.00	NO
Butanone, 2-	178	4	2.2%	1.1	3.2	2.1	NE	NE	4900	NO
Carbon disulfide	179	47	26.3%	0.12	940	41.6	NE	NE	720	NO
Chlorobenzene	178	3	1.7	0.10	0.13	0.11	NE	100	72	NO
Chloroform	178	2	1.1%	0.071	0.16	0.12	100	80.0	0.19	NO
Chloromethane	178	21	11.8%	0.082	3.1	1.02	NE	NE	190	NO
Dichloroethane, 1,2-	178	2	1.1%	0.051	0.057	0.054	10.0	5.00	0.15	NO
Dichloroethene, cis-1,2-	178	1	0.56%	0.68	0.68	0.68	NE	70	28	NO
Dicholorethene, trans-1,2-	178	1	0.56%	0.20	0.20	0.20	NE	100	86	NO
Dioxane, 1,4-	89	6	6.7%	16	32	24.7	NE	NE	0.67	YES

Table 5-1
Summary of Detected Analytes in Groundwater for OB/OD[a]

Analyte	Sample Analysis						Regulatory Standard			
	Total Samples	No. Detects	Frequency of Detection	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	Arithmetic Mean (µg/L)	NMWQCC[b] (µg/L)	EPA MCL[c] (µg/L)	EPA HHMSSL[d] (µg/L)	Max. Detect Conc. > Min. Screening Level?
Hexanone, 2-	178	3	1.7%	0.19	0.67	0.43	NE	NE	34.0	NO
Methyl acetate	161	1	0.62%	0.88	0.88	0.88	NE	NE	16,000	NO
Methylene chloride	178	2	1.1%	0.10	0.2	0.15	100	5.00	5.00	NO
Methyl isobutyl ketone	113	3	2.7%	0.21	3.2	1.36	NE	NE	1,000	NO
Tetrachloroethene	178	14	7.9%	0.21	3.1	1.69	20.0	5.00	9.9	NO
Toluene	178	9	5.1%	0.21	18	3.07	750	1,000	860	NO
Anions										
Cyanide	58	1	1.7%	0.010	0.010	0.010	200	200	1.40	NO
Nitrate	150	94	62.7%	0.9	27,100	3,180	10,000	10,000	25,000	YES
Nitrite	137	25	18.2%	2.7	880	170	NE	1,000	1600	NO
Nitrate as N	15	12	80%	240	9,000	2,180	10,000	10,000	10,000	NO
Nitrite as N	15	1	6.7%	54	54	54	NE	1,000	1,000	NO

Note: If both a NMWQCC standard and an EPA MCL have been established for a contaminant, the more conservative value will be compared against. If no NMWQCC standard or EPA MCL have been established, the EPA HHMSSL will be compared against.
[a] Table summarizes groundwater data collected at FWDA from April 2008 through October 2012.
[b] New Mexico Water Quality Control Commission (NMWQCC), 2001. 20.6.2.7(ww) New Mexico Administrative Code (NMAC), Definitions – toxic pollutant.
[c] U.S. Environmental Protection Agency (EPA), 2012. Regions 3, 6, and 9 Regional Screening Levels for Chemical Contaminants at Superfund Sites, updated November.
[d] U.S. Environmental Protection Agency (EPA), 2012. Regional Screening Level Tapwater Supporting Table, updated November.
[e] For perchlorate, a value of 6 µg/L is used per the FWDA RCRA Permit
> = Greater than
EPA = Environmental Protection Agency
FWDA = Fort Wingate Depot Activity
HHMSSL = Human Health Medium-Specific Screening Level
MCL = Maximum Contaminant Level
µg/L = Microgram per liter
NE = Not established
NMED = New Mexico Environment Department
NMWQCC = New Mexico Water Quality Control Commission
No. = Number
OB/OD = Open Burn/Open Detonation
RCRA = Resource Conservation and Recovery Act

Table 5-2
Summary of Detected Analytes in Alluvial Groundwater for Northern Area[a]

Analyte	Sample Analysis						Regulatory Standard			
	Total Samples	No. Detects	Frequency of Detection	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	Arithmetic Mean	NMWQCC[b] (µg/L)	EPA MCL[c] (µg/L)	EPA HHMSSL[d] (µg/L)	Max. Detect Conc. > Min. Screening Level?
Explosives										
Dinitrobenzene, 1,3	331	16	4.83%	0.036	40.0	3.00	NE	NE	1.5	YES
Dinitrotoluene, 2,4	329	10	3.04%	0.091	1.1	0.401	NE	NE	0.20	YES
Dinitrotoluene, 2,6	331	1	0.3%	0.24	0.24	0.24	NE	NE	15.0	NO
Dinitrotoluene, 2-Amino-4,6	331	26	7.9%	0.048	3.43	1.61	NE	NE	30.0	NO
Dinitrotoluene, 4-Amino-2,6	331	32	9.7%	0.043	4.23	1.76	NE	NE	30.0	NO
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	332	50	15.06%	0.090	927.0	91.84	NE	NE	0.61	YES
Nitrobenzene	331	13	3.93%	0.25	7.4	2.23	NE	NE	0.12	YES
Nitrotoluene, m-	331	3	0.91%	0.69	1.4	1.10	NE	NE	1.3	YES
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	331	21	6.34%	0.23	126.0	17.19	NE	NE	780.0	NO
Tetryl (Trinitrophenylmethylnitramine)	256	6	2.34%	0.76	5.5	1.88	NE	NE	61.0	NO
Trinitrobenzene, 1,3,5	332	21	6.32%	0.059	10.70	3.06	NE	NE	460.0	NO
Trinitrotoluene, 2,4,6	331	12	3.63%	0.097	0.57	0.25	NE	NE	2.2	NO
Perchlorate										
Perchlorate	312	118	37.82%	0.017	2800.0	303.03	6.0[e]	15	11	YES
Pesticides										
Aldrin	156	1	0.64%	0.0064	0.0064	0.0064	NE	NE	0.004	NO
Delta-BHC	156	4	2.56%	0.01	0.051	0.027	NE	NE	13000.0	NO
gamma-Chlordane	156	1	0.64%	0.0041	0.0041	0.0041	NE	2.0	0.19	NO
Heptachlor	156	2	1.28%	0.0068	0.028	0.017	NE	0.40	0.0018	NO
Methoxychlor	157	3	1.91%	0.0037	0.04	0.024	NE	40.0	27.0	NO
Semi-volatile Organic Compounds										
2-Nitroaniline	263	3	1.14%	0.30	0.33	0.32	NE	NE	150	NO
Acetophenone	223	6	2.69%	0.212	0.432	2.72	NE	NE	1,500	NO
Benz[a]anthracene	243	1	0.41%	0.66	0.66	0.66	NE	NE	0.029	YES
Bis(2-ethylhexyl)phthalate	264	50	18.94%	0.066	15.20	2.49	NE	6.0	4.8	YES
Dinitrophenol, 2,4	260	12	4.62%	9.6	74	34.78	NE	NE	30.0	NO
Dinitrotoluene, 2,4	263	8	3.04%	0.28	1.8	0.94	NE	NE	0.20	YES
Dinitrotoluene, 2,6	263	2	0.76%	0.29	1.7	0.995	NE	NE	15.0	NO
Caprolactam	195	4	2.05%	7.0	46.0	19.23	NE	NE	7,700	NO
Chloroaniline, p	263	1	0.38%	3.30	3.30	3.30	NE	NE	0.32	YES
Chrysene	263	1	0.38%	0.80	0.80	0.80	NE	NE	2.9	NO
Cresol, o	180	2	1.11%	0.368	3.01	1.70	NE	NE	720.0	NO
Cresol, p	18	1	5.56%	19.0	19.0	19.0	NE	NE	1,400	NO
Dibutyl Phthalate	244	15	6.15%	0.21	2.42	0.60	NE	NE	670.0	NO
Diethyl Phthalate	259	10	3.86%	0.026	0.76	0.43	NE	NE	11,000	NO
Dimethyl phthalate	234	3	1.28%	0.23	0.27	0.24	NE	NE	15,000	NO
Dinitrophenol, 2,4	260	12	4.62%	9.6	74.0	34.78	NE	NE	30.0	YES
Di-n-octyl phthalate	264	1	0.38%	0.82	0.82	0.82	NE	NE	15,000	NO

Table 5-2 (continued)
Summary of Detected Analytes in Alluvial Groundwater for Northern Area[a]

Analyte	Sample Analysis						Regulatory Standard			
	Total Samples	No. Detects	Frequency of Detection	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	Arithmetic Mean	NMWQCC[b] (µg/L)	EPA MCL[c] (µg/L)	EPA HHMSSL[d] (µg/L)	Max. Detect Conc. > Min. Screening Level?
Semi-volatile Organic Compounds										
Fluoranthene	263	1	0.38%	0.41	0.41	0.41	NE	NE	630.0	NO
M,P-Cresol	246	4	1.63%	0.34	11.0	4.16	NE	NE	1,100	NO
Nitroso-di-N-propylamine, N-	263	2	0.76%	0.31	12.0	6.15	NE	NE	0.0093	YES
Phenol	260	12	4.62%	0.21	38.0	5.31	5.0	NE	4,500	YES
Volatile Organic Compounds										
2-Hexanone	377	3	0.80%	0.14	1.20	0.52	NE	NE	34.0	NO
Acetone	377	20	5.3%	0.17	160.0	14.64	NE	NE	12000	NO
Benzene	377	2	0.53%	0.32	0.71	0.52	10.0	5.0	0.39	NO
Bromodichloromethane	377	2	0.53%	0.12	0.29	0.21	NE	80.0	0.12	NO
Bromoform	377	2	0.53%	0.16	0.33	0.25	NE	80.0	7.9	NO
Bromomethane	377	4	1.06%	0.15	1.2	0.75	NE	NE	7.0	NO
Carbon Disulfide	377	54	14.32%	0.10	650.0	20.55	NE	NE	720	NO
Chloroform	377	7	1.86%	0.071	0.48	0.14	100.0	80.0	0.19	NO
Chloromethane	377	16	4.24%	0.081	2.2	0.34	NE	NE	190.0	NO
Dibromochloromethane	377	2	0.53%	0.07	0.20	0.14	NE	80.0	0.15	NO
Dichloroethane, 1,1	377	9	2.39%	0.12	0.83	0.46	NE	NE	2.4	NO
Dichloroethane, 1,2	377	53	14.06%	0.14	128.48	20.15	10.0	5.0	0.15	YES
Dichloroethylene, 1,1	377	1	0.27%	0.085	0.085	0.085	5.0	7.0	260	NO
Dioxane, 1,4	188	14	7.45%	9.10	620.0	94.49	NE	NE	0.67	YES
Ethylbenzene	377	2	0.53%	0.08	0.31	0.20	750.0	700.0	1.3	NO
Methyl Ethyl Ketone (2-Butanone)	377	4	1.06%	2.5	4.9	3.33	NE	NE	4,900	NO
Methyl tert-Butyl Ether (MTBE)	377	6	1.59%	0.16	0.49	0.29	NE	NE	12.0	NO
Methylcyclohexane	315	1	0.32%	0.32	0.32	0.32	NE	NE	NE	NO
Methylene Chloride	377	4	1.06%	0.093	0.10	0.098	NE	5.0	9.9	NO
Toluene	377	28	7.42%	0.20	490.0	49.77	750.0	1,000	860	NO
Trichloroethane, 1,1,1	377	8	2.12%	1.40	4.3	3.54	NE	200.0	7,500	NO
Trichloroethylene	377	1	0.27%	1.30	1.30	1.30	NE	5.0	0.44	NO
Vinyl Chloride	377	2	0.53%	0.42	3.8	2.11	1.0	2.0	0.015	YES
Xylene, m,p	377	2	0.53%	0.25	1.1	0.675	620	10,000	190	NO
Petroleum Hydrocarbons										
TPH-DRO	89	15	16.85%	44	490	121.25	400[f]	NE	NE	YES
TPH-GRO	80	4	5.00%	12	110	38.5	NE	NE	NE	NO

Table 5-2 (concluded)
Summary of Detected Analytes in Alluvial Groundwater for Northern Area[a]

Analyte	Sample Analysis						Regulatory Standard			
	Total Samples	No. Detects	Frequency of Detection	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	Arithmetic Mean	NMWQCC[b] (µg/L)	EPA MCL[c] (µg/L)	EPA HHMSSL[d] (µg/L)	Max. Detect Conc. > Min. Screening Level?
Anions										
Nitrate	359	303	84.4%	2.3	165,000.0	14,708	10,000	10,000	25,000	YES
Nitrite	326	67	20.55%	4.7	7,000.0	776.2	NE	1,000	1,600	YES

Note: If both a NMWQCC standard and an EPA MCL have been established for a contaminant, the more conservative value will be compared against. If no NMWQCC standard or EPA MCL have been established, the EPA HHMSSL will be compared against.
[a] Table summarizes groundwater data collected at FWDA from April 2008 through November 2012
[b] New Mexico Water Quality Control Commission (NMWQCC), Human Health Standards
[c] EPA, 2011, Regional Screening Level Summary Table, November 2011
[d] EPA, 2012, Regional Screening Level Tapwater Supporting Table
[e] For perchlorate, a value of 6 µg/L is used per the FWDA RCRA Permit
[f] NMED, 2012, Table 6-2 of the NMED Risk Assessment Guidance for Site Investigations and Remediation, Diesel #2/Crankcase Oil value
> = Greater than
EPA = Environmental Protection Agency
FWDA = Fort Wingate Depot Activity.
HHMSSL = Human Health Medium-Specific Screening Level
MCL = Maximum Contaminant Level
µg/L = Microgram per liter
NE = Not established
NMED = New Mexico Environment Department
NMWQCC = New Mexico Water Quality Control Commission
No. = Number
RCRA = Resource Conservation and Recovery Act
TPH = Total Petroleum Hydrocarbon
TPH-DRO = Total Petroleum Hydrocarbon Diesel Range Organic
TPH-GRO = Total Petroleum Hydrocarbon Gasoline Range Organic

Table 5-3
Summary of Detected Analytes in Bedrock Groundwater for Northern Area[a]

Analyte	Sample Analysis						Regulatory Standard			
	Total Samples	No. Detects	Frequency of Detection	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	Arithmetic Mean (µg/L)	NMWQCC[b] (µg/L)	EPA MCL[c] (µg/L)	EPA HHMSSL[d] (µg/L)	Max. Detect Conc. > Min. Screening Level?
Explosives (µg/L)										
Dinitrobenzene, 1,3	130	10	7.7%	0.10	1.9	0.68	NE	NE	1.50	YES
Dinitrotoluene, 2,4-	129	1	0.78%	0.45	0.45	0.45	NE	NE	0.20	YES
Dinitrotoluene, 2-Amino-4,6	130	3	2.3%	0.048	0.54	0.24	NE	NE	30.0	NO
Dinitrotoluene, 4-Amino-2,6	129	5	3.9%	0.03	0.70	0.27	NE	NE	30.0	NO
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	130	5	3.8%	0.11	2.0	0.56	NE	NE	0.61	YES
Methyl-2,4,6-trinitrophenylnitramine	45	1	2.2%	0.23	0.23	0.23	NE	NE	NE	NO
Nitrobenzene	130	4	3.1%	0.089	1.6	0.81	NE	NE	0.12	YES
Nitrotoluene, o-	130	1	0.77%	0.18	0.18	0.18	NE	NE	0.27	NO
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	130	4	3.1%	0.23	1.7	0.63	NE	NE	780	NO
Trinitrobenzene, 1,3,5-	130	5	3.8%	0.059	0.51	0.25	NE	NE	460	NO
Trinitrotoluene, 2,4,6-	130	2	1.5%	0.18	0.32	0.25	NE	NE	2.20	NO
Perchlorate (µg/L)										
Perchlorate	108	46	42.6%	0.017	5,010	760.8	6.0[e]	15.0	11.0	YES
Pesticides										
Delta-BHC	75	2	2.7%	0.0064	0.016	0.011	NE	NE	53.0	NO
Endrin aldehyde	75	1	1.3%	0.016	0.016	0.016	NE	NE	1.70	NO
Heptachlor	75	1	1.3%	0.0038	0.0038	0.0038	NE	0.40	0.002	NO
Semi-volatile Organic Compounds (µg/L)										
Acetophenone	98	11	11.2%	0.18	49	10.7	NE	NE	1,500	NO
Benzoic Acid	20	1	5.0%	11	11	11	NE	NE	58,000	NO
Bis(2-chloroisopropyl)ether	63	1	1.6%	9.3	9.3	9.3	NE	NE	NE	NO
Bis(2-ethylhexyl)phthalate	130	37	28.5%	0.27	50	4.12	NE	NE	4.80	YES
Caprolactam	81	8	9.9%	0.64	430	115.8	NE	NE	7,700	NO
Chloroaniline, p-	130	1	0.77%	4.3	4.3	4.3	NE	NE	0.32	YES
Chloronaphthalene, beta-	130	1	0.77%	0.63	0.63	0.63	NE	NE	550	NO
Cresol, m,p-	122	6	4.9%	0.34	9.6	3.31	NE	NE	1,100	NO
Cresol, o-	67	6	9.0%	0.368	3.1	1.86	NE	NE	720	NO
Dibutyl Phthalate	110	11	10.0%	0.26	3.62	1.24	NE	NE	670	NO
Diethyl Phthalate	129	6	4.7%	0.27	0.41	0.31	NE	NE	11,000	NO
Dimethyl Phthalate	115	2	1.7%	0.22	0.25	0.24	NE	NE	NE	NO
Dimethylphenol, 2,4-	107	1	0.93%	13.2	13.2	13.2	NE	NE	270	NO
Dinitrotoluene, 2,6-	130	2	1.5%	0.39	1.7	1.05	NE	NE	15.0	NO
Isophrone	130	1	0.77%	1.20	1.20	1.20	NE	NE	67.0	NO
Nitrosodiphenlyamine, N-	130	1	0.77%	2.0	2.0	2.0	NE	NE	10.0	NO
Nitroso-di-N-propylamine, N-	130	1	0.77%	1.1	1.1	1.1	NE	NE	0.0093	YES
Phenol	129	19	14.7%	0.29	180	21.7	5.0	NE	4,500	YES
Volatile Organic Compounds (µg/L)										
Acetone	145	14	9.7%	1.8	75	12.31	NE	NE	12,000	NO
Benzene	145	3	2.1%	0.16	0.29	0.23	10.0	5.00	0.39	NO
Bromodichloromethane	145	1	0.69%	0.20	0.20	0.20	NE	80.0	0.12	NO
Bromoform	145	1	0.69%	0.22	0.22	0.22	NE	80.0	7.90	NO
Bromomethane	145	3	2.1%	0.20	2.3	1.43	NE	NE	7.00	NO
Butanone, 2-	145	4	2.8%	1.8	11	5.7	NE	NE	4,900	NO
Carbon Disulfide	145	32	22.1%	0.18	42	9.42	NE	NE	720	NO
Chloroform	145	4	2.8%	0.083	1.2	0.75	100	80.0	0.19	NO

Table 5-3 (concluded)
Summary of Detected Analytes in Bedrock Groundwater for Northern Area[a]

Analyte	Sample Analysis						Regulatory Standard			
	Total Samples	No. Detects	Frequency of Detection	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	Arithmetic Mean (µg/L)	NMWQCC[b] (µg/L)	EPA MCL[c] (µg/L)	EPA HHMSSL[d] (µg/L)	Max. Detect Conc. > Min. Screening Level?
Volatile Organic Compounds (µg/L)										
Chloromethane	145	17	11.7%	0.1	4.6	1.83	NE	NE	190	NO
Dibromochloromethane	145	1	0.69%	0.18	0.18	0.18	NE	80.0	0.15	NO
Dichloroethene, trans-1,2-	145	1	0.69%	0.24	0.24	0.24	NE	100	86	NO
Dioxane, 1,4-	54	2	3.7%	27	100	63.5	NE	NE	0.67	YES
Ethyl chloride	74	3	4.1%	0.096	0.34	0.20	NE	NE	21,000	NO
Ethylbenzene	145	6	4.1%	0.088	0.30	0.21	750	700	1.30	NO
Hexanone, 2-	145	2	1.4%	0.99	3.4	2.2	NE	NE	34.0	NO
Methyl isobutyl ketone	74	8	10.8%	0.30	2.3	1.23	NE	NE	1,000	NO
Methylcyclohexane	109	1	0.92%	0.25	0.25	0.25	NE	NE	53.0	NO
Methylene chloride	145	3	2.1%	0.10	0.20	0.13	100	5.00	9.9	NO
Napthalene	152	1	0.66%	0.70	0.70	0.70	30.0	NE	NE	NO
Styrene	145	1	0.69%	0.82	0.82	0.82	NE	100.0	1100	NO
Tetrachloroethylene	145	1	0.69%	0.38	0.38	0.38	20.0	5.00	5.00	NO
Toluene	145	38	26.2%	0.39	1,180	192.4	750	1,000	860	YES
Trichloroethylene	145	2	1.4%	0.11	0.19	0.15	100	5.00	0.44	NO
Xylenes, total	145	3	2.1%	0.17	1.3	0.57	620	10,000	190	NO
Petroleum Hydrocarbons (µg/L)										
TPH-DRO	21	4	19.0%	0.044	117	29.3	200[f]	NE	NE	NO
Anions (µg/L)										
Nitrate	117	66	56.41%	4.4	110,000	17,254	10,000	10,000	25,000	YES
Nitrite	111	19	17.12%	17.6	1490	297	NE	1,000	1,600	YES
Nitrate as N	17	8	47.1%	48	99,000	19,470	10,000	10,000	NE	YES
Nitrite as N	16	2	12.5%	54	340	197	NE	10,000	NE	NO

Note: If both a NMWQCC standard and an EPA MCL have been established for a contaminant, the more conservative value will be compared against. If no NMWQCC standard or EPA MCL have been established, the EPA HHMSSL will be compared against.
[a] Table summarizes groundwater data collected at FWDA from April 2008 through October 2012.
[b] New Mexico Water Quality Control Commission (NMWQCC), 2001. 20.6.2.7(ww) New Mexico Administrative Code (NMAC), Definitions – toxic pollutant.
[c] U.S. Environmental Protection Agency (EPA), 2012. Regions 3, 6, and 9 Regional Screening Levels for Chemical Contaminants at Superfund Sites, updated November.
[d] U.S. Environmental Protection Agency (EPA), 2012. Regional Screening Level Tapwater Supporting Table, updated November.
[e] For perchlorate, a value of 6 µg/L is used per the FWDA RCRA Permit.
[f] New Mexico Environment Department (NMED), 2012. Table 6-2. TPH Screening Guidelines for Potable Groundwater (GW-1), Risk Assessment Guidance for Site Investigations and Remediation, Volume I, Tier 1: Soil Screening Guidance Technical Background Document, Hazardous Waste Bureau and the Ground Water Quality Bureau – Voluntary Remediation Program, February 2012. Values provided are for unknown oil.
> = Greater than
EPA = Environmental Protection Agency
FWDA = Fort Wingate Depot Activity
HHMSSL = Human Health Medium-Specific Screening Level
MCL = Maximum Contaminant Level
µg/L = Microgram per liter
NE = Not established
NMED = New Mexico Environment Department
NMWQCC = New Mexico Water Quality Control Commission
No. = Number
RCRA = Resource Conservation and Recovery Act
TPH-DRO = Total Petroleum Hydrocarbon Diesel Range Organic

Table 5-4
Category 1 COIs

Analyte	Occurrence (> 15% Detection and Exceeds Minimum Screening Level)			100% Detection Frequency	Analytical Suite
	OB/OD	Northern Alluvial	Northern Bedrock		
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	X	X		TMW03, TMW23	Explosive
Bis(2-ethylhexyl)phthalate	X	X	X	FW08, TMW19, TMW41, TMW48, TMW49	VOC
Carbon disulfide	X			CMW24	VOC
Toluene			X	None	VOC
Nitrate	X	X	X	CMW02, CMW10, CMW18, KMW10, KMW11, TMW02, TMW05, TMW30, TMW31D, TMW32, TMW39D, TMW40D, FW01, FW05, FW06, FW08, FW10, FW35, MW01, MW03, MW20, MW22D, MW22S, TMW01, TMW04, TMW06, TMW08, TMW11, TMW13, TMW15, TMW21, TMW22, TMW23, TMW25, TMW29, TMW31S, TMW34, TMW35, TMW39D, TMW39S, TMW40S, TMW41, TMW48, TMW49	Anion
Nitrite		X	X	TMW03, TMW40S, TMW48, TMW32, TMW40D	Anion
Perchlorate	X	X	X	KMW10, TMW01, TMW31S, TMW39D, TMW39S, TMW40S, TMW41, TMW48, TMW49, TWM30, TMW31D, TMW32, TMW39D, TMW40D	Perchlorate
TPH-DRO		X		None	TPH

> = Greater than
% = Percent
COI = Constituent of interest
DRO = Diesel Range Organics
OB/OD = Open Burn/Open Detonation
SVOC = Semi-volatile organic compound
TPH = Total petroleum hydrocarbons
VOC = Volatile organic compound

Table 5-5
Category 2 COIs

Analyte	Occurrence (< 15%) Detection and Exceeds Minimum Screening Level			Analytical Suite
	OB/OD	Northern Alluvial	Northern Bedrock	
Dinitrobenzene, 1,3-	X	X	X	Explosive
Dinitrophenol, 2,4-		X		Explosive
Dinitrotoluene, 2,4-		X	X	Explosive
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)			X	Explosive
Nitrobenzene	X	X	X	Explosive
Nitrotoluene, 2-	X	X		Explosive
Trinitrotoluene, 2,4,6-	X			Explosive
Benz[a]anthracene		X		SVOC
Chloroaniline, p-		X	X	SVOC
Nitroso-di-N-propylamine, N-	X	X	X	SVOC
Phenol		X	X	SVOC
Dichloroethane, 1,2-		X		VOC
Dioxane, 1,4-	X	X	X	VOC
Vinyl Chloride		X		VOC

< = Less than
% = Percent
COI = Constituent of interest
OB/OD = Open Burn/Open Detonation
SVOC = Semi-volatile organic compound
TPH-DRO = Total petroleum hydrocarbon diesel range organic
VOC = Volatile organic compound

Table 5-6
Category 3 COIs

Analyte	Infrequent Occurrence (< 1%) with Concentrations Below Minimum Screening Level			Analytical Suite
	OB/OD	Northern Alluvial	Northern Bedrock	
Dinitrotoluene, 2,6-		X		Explosive
Nitrotoluene, 3-	X		X	Explosive
Trinitrobenzene, 1,3,5--	X			Explosive
Chloronaphthalene, beta-			X	SVOC
Chrysene		X		SVOC
Diethyl phthalate	X			SVOC
Di-n-ocyl phthalate	X	X		SVOC
Dinitrophenol, 2,4-	X		X	SVOC
Fluoranthene		X		SVOC
Isophorone			X	SVOC
Benzene		X		VOC
Bromodichloromethane		X	X	VOC
Bromoform		X	X	VOC
Dibromochloromethane		X	X	VOC
Dichloroethylene, 1,1-		X		VOC
Dichloroethylene, cis-1,2-	X			VOC
Dichloroethylene, trans-1,2-	X		X	VOC
Ethylbenzene		X		VOC
Hexanone, 2-		X		VOC
Methyl acetate	X			VOC
Methylcyclohexane		X	X	VOC
Naphthalene			X	VOC
Styrene			X	VOC
Tetrachloroethylene			X	VOC
Trichloroethylene		X		VOC
Xylene, m,p-		X		VOC
Aldrin		X		Pesticide
Gamma-Chlordane		X		Pesticide

< = Less than
% = Percent
COI = Constituent of interest
OB/OD = Open Burn/Open Detonation
SVOC = Semi-volatile organic compound
VOC = Volatile organic compound

Table 5-7
Interpretation of Category 3 Chemical Properties Effecting Fate and Transport

Chemical Property	Property Value Range	Characteristic Qualifier	Characteristic
Solubility @ 25° C (mg/L)	<10	Low	Mobility in groundwater is limited.
	10 to 1000	Medium	
	>1,000	High	Tends to leach to groundwater if Kd is low.
Vapor Pressure @ 25° C (mm Hg)	<1E-06	Low	Will not evaporate from soil.
	1E-06 to 1E-02	Medium	
	>1E-02	High	Tends to volatilize in soil and not leach to groundwater.
Kow	<500	Low	Bioaccumulation is limited.
	500 to 1000	Medium	
	>1,000	High	Tends to bioaccumulate.
Koc	<1,000	Low	Can leach to groundwater.
	1000 to 10000	Medium	
	>10,000	High	Tends to adsorb to soil if organic carbon is present.

Chemical	Nitrotoluene, 3-	Trinitrobenzene, 1,3,5-	Diethyl phthalate	Di-n-octyl phthalate	Dinitro-phenol, 2,4-	Bromodichloro-methane	Bromoform	Dichloroethylene, cis-1,2-	Dichloroethylene, trans-1,2-	Dibromo-chloromethane	Hexanone, 2-	Methyl acetate	Methyl-cyclohexane
Properties													
Solubility (mg/L)	498 (at 30°C)	278 (15°C)	896	3	6,000	4500	3100	3,500	6,260	5250	35,000	52,000	16
Vapor Pressure (mm Hg)	0.25	6.44x10-6	0.00165	0.00014	0.00039 (at 30°C)	60	5.6	273	337.5	80	3.8	80	46
Kow	263	15	195	1.15X10+8	34	76	220	72	2.09	120	24	5	725
Koc	510	104	69	2x10+6	18	62	180	250	59	83	135	30	2000
Interpretation													
Sorbs to Soil?	No	No	No	Yes	No	No	No	No	No	No	No	No	Yes
Bioaccumulates?	No	Negligible	No	Yes	Negligible	Negligible	Negligible	No	No	Negligible	Negligible	Negligible	Negligible
Biodegradable?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Leaches to Groundwater?	Medium	Medium	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Medium
Volatile?	Yes	Medium	Medium	Medium	Medium	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Persistent?	No	No	No	No	No	No	No	No	No	No	No	No	No

K_d = distribution coefficient
Koc = Organic carbon sorption coefficient.
Kow = Octanol-Water partition coefficient.
mg/L = Milligrams per liter.
mm Hg = Millimeters of mercury.
NA = Not available.

Table 5-8
Groundwater Sampling Frequency

Well ID	GW Level Measurements	Analytical Suite and EPA Method Number[a]										Purge Method
		Explosives (8330B)	TCL VOCs (8260C)	TCL SVOCs (8270D)	Pesticides (8081A)	Total TAL Metals/Mercury (6020B/7470)	Dissolved TAL Metals/Mercury (6020B/7470)	Nitrate/Nitrite (9056)	Perchlorate (6860)	TPH-DRO (8015B)	TPH-GRO (8015B)	
OB/OD Area Wells, REMOVED FROM SAMPLING PLAN UNTIL 2015 DUE TO SURFACE CLEARANCE CONDUCTED BY URS												
CMW02	Quarterly		2x		x/5	2x	2x	2x	2x			ZIST Low Flow
CMW04	Quarterly	2x	2x			2x	2x					ZIST Low Flow
CMW06	**Buried - Not Sampled**											
CMW07	Quarterly		2x			2x	2x					Trad. Low Flow
CMW10	Quarterly		2x	x/2		2x	2x	2x	2x			Hand Bail
CMW14	Quarterly	2x	2x	x/2		2x	2x	2x	2x			ZIST Low Flow
CMW16	**Buried - Not Sampled**											
CMW17	Quarterly	2x	2x			2x	2x	2x	2x			Grundfos Pump
CMW18	Quarterly	2x	2x	x/2		2x	2x	2x	2x			Trad. Low Flow
CMW19	Quarterly	2x	2x	x/2		2x	2x	2x				ZIST Low Flow
CMW20	**Damaged – Not Sampled**											
CMW21	**Buried - Not Sampled**											
CMW22	Quarterly		2x			2x	2x	2x				Hand Bail
CMW23	Quarterly	2x	2x			2x	2x	2x	2x			Hand Bail
CMW24	Quarterly	2x	2x	x/2	x/5	2x	2x					ZIST Low Flow
CMW25	Quarterly		2x		x/5	2x	2x	2x				Trad. Low Flow
FW24	**Dry - Not Sampled**											
FW38	**Dry - Not Sampled**											
KMW09	Quarterly	2x	2x			2x	2x	2x	2x			ZIST Low Flow
KMW10	Quarterly		2x	x/2		2x	2x	2x	2x			Hand Bail
KMW11	Quarterly	2x	2x			2x	2x	2x	2x			Trad. Low Flow
KMW12	Quarterly		2x			2x	2x	2x				Bennett Pump
KMW13	**Dry - Not Sampled**											
Northern Area Alluvial Wells												
BGMW01*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Trad. Low Flow
BGMW02*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Trad. Low Flow
BGMW03*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Trad. Low Flow
FW26	**Dry - Not Sampled**											
FW31	Quarterly	2x		x/2		2x	2x	2x				Grundfos Pump
FW35	Quarterly	2x		x/2		2x	2x	2x				Grundfos Pump
MW01	Quarterly	2x	2x		x/5	2x	2x	2x	2x	2x	2x	Hand Bail
MW02	Quarterly	2x	2x			2x	2x	2x	2x	2x	2x	Hand Bail
MW03	Quarterly	2x	2x			2x	2x	2x	2x	2x	2x	Trad. Low Flow
MW18D	Quarterly	2x	2x			2x	2x	2x	2x	2x	2x	Trad. Low Flow
MW18S	**Dry - Not Sampled**											

Table 5-8 (continued)
Groundwater Sampling Frequency

Well ID	GW Level Measurements	Analytical Suite and EPA Method Number[a]										Purge Method
		Explosives (8330B)	TCL VOCs (8260C)	TCL SVOCs (8270D)	Pesticides (8081A)	Total TAL Metals/Mercury (6020B/7470)	Dissolved TAL Metals/Mercury (6020B/7470)	Nitrate/Nitrite (9056)	Perchlorate (6860)	TPH-DRO (8015B)	TPH-GRO (8015B)	
Northern Area Alluvial Wells (continued)												
MW20	Quarterly		2x	x/2		2x	2x	2x	2x	2x	2x	Trad. Low Flow
MW22D	Quarterly		2x		x/5	2x	2x	2x	2x	2x	2x	Hand Bail
MW22S	Quarterly	2x	2x	x/2	x/5	2x	2x	2x	2x	2x	2x	Trad. Low Flow
MW23*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Bennett Pump
MW24*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Bennett Pump
SMW01	Quarterly	2x		x/2		2x	2x					Trad. Low Flow
TMW01	Quarterly					2x	2x					Trad. Low Flow
TMW03	Quarterly	2x		x/2		2x	2x	2x	2x			Trad. Low Flow
TMW04	Quarterly	2x		x/2		2x	2x	2x	2x			Trad. Low Flow
TMW06	Quarterly	2x	2x			2x	2x	2x				Trad. Low Flow
TMW07	Quarterly	2x	2x	x/2		2x	2x	2x				Hand Bail
TMW08	Quarterly		2x			2x	2x	2x		2x	2x	Trad. Low Flow
TMW10	Quarterly					2x	2x	2x				Trad. Low Flow
TMW11	Quarterly	2x				2x	2x	2x	2x			Trad. Low Flow
TMW13	Quarterly					2x	2x	2x	2x			Trad. Low Flow
TMW15	Quarterly		2x	x/2		2x	2x	2x	2x			Trad. Low Flow
TMW21	Quarterly	2x	2x			2x	2x	2x				Trad. Low Flow
TMW22	Quarterly	2x		x/2		2x	2x	2x	2x			Hand Bail
TMW23	Quarterly	2x	2x			2x	2x	2x	2x			Hand Bail
TMW24	Quarterly		2x			2x	2x	2x				Trad. Low Flow
TMW25	Quarterly					2x	2x	2x				Trad. Low Flow
TMW26	Quarterly	2x	2x			2x	2x					Trad. Low Flow
TMW27	Quarterly		2x			2x	2x		2x			Trad. Low Flow
TMW28	Quarterly		2x			2x	2x					Trad. Low Flow
TMW29	Quarterly		2x			2x	2x	2x	2x			Hand Bail
TMW31S	Quarterly	2x	2x	x/2		2x	2x	2x	2x			Grundfos Pump
TMW33	Quarterly		2x	x/2		2x	2x	2x		2x	2x	Grundfos Pump
TMW34	Quarterly		2x			2x	2x	2x	2x	2x	2x	Trad. Low Flow
TMW35	Quarterly		2x	x/2		2x	2x	2x	2x	2x	2x	Trad. Low Flow
TMW39S*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Hand Bail
TWM40S*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Hand Bail
TMW41*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Hand Bail
TMW43*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Trad. Low Flow
TMW44*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Hand Bail
TMW45*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Hand Bail
TMW46*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Hand Bail
TMW47*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Trad. Low Flow
TMW48*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Trad. Low Flow
TMW49*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Trad. Low Flow

Table 5-8 (concluded)
Groundwater Sampling Frequency

Well ID	GW Level Measurements	Analytical Suite and EPA Method Number[a]										Purge Method
		Explosives (8330B)	TCL VOCs (8260C)	TCL SVOCs (8270D)	Pesticides (8081A)	Total TAL Metals/Mercury (6020B/7470)	Dissolved TAL Metals/Mercury (6020B/7470)	Nitrate/Nitrite (9056)	Perchlorate (6860)	TPH-DRO (8015B)	TPH-GRO (8015B)	
Northern Area Bedrock Wells												
EMW01	Quarterly	2x	2x	x/2	x/5	2x	2x		2x			Pumped Dry
EMW02	Quarterly			x/2	x/5	2x	2x	2x				Pumped Dry
EMW03	Quarterly	2x	2x	x/2	x/5	2x	2x	2x				Pumped Dry
EMW04	Quarterly		2x	x/2		2x	2x	2x				Bennett Pump
TMW02	Quarterly	2x				2x	2x	2x	2x			Trad. Low Flow
TMW14A	Quarterly	2x	2x	2x		2x	2x	2x	2x			ZIST Low Flow
TMW16	Quarterly	2x	2x	2x		2x	2x		2x			Bennett Pump
TMW17	Quarterly		2x			2x	2x	2x	2x			ZIST Low Flow
TMW18	Quarterly	2x	2x	2x		2x	2x		2x			Bennett Pump
TMW19	Quarterly	2x	2x	2x		2x	2x					Bennet Pump
TMW30	Quarterly	2x	2x	2x	x/5	2x	2x	2x	2x			Grundfos Pump
TMW31D	Quarterly	2x	2x	2x	x/5	2x	2x	2x	2x			Grundfos Pump
TMW32	Quarterly	2x	2x	2x	x/5	2x	2x	2x	2x			Trad. Low Flow
TMW36	Quarterly	2x	2x	2x	x/5	2x	2x	2x	2x			Bennett Pump
TMW37	Quarterly	2x	2x	2x	x/5	2x	2x	2x	2x			Bennett Pump
TMW38*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Trad. Low Flow
TMW39D*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Trad. Low Flow
TMW40D*	Quarterly	2x	2x	2x	2x	2x	2x	2x	2x			Trad. Low Flow
Wingate 89	Quarterly											N/A
Wingate 90	Quarterly											N/A
Wingate 91	Quarterly											N/A

* Wells have been recently installed (2011 – 2012)
[a] *Test Methods for Evaluating Solid Waste*, Second Edition, Office of Solid Waste Manual SW-846
Note: Semi-annual sample collection under the Interim Groundwater Monitoring Plan began in April 2008 and has continued each April and October
Indicates that the specific well has never had a detection for any analyte in the applicable analytical suite
EPA = Environmental Protection Agency
2x = Semi-annually
x/2 = Every two years
x/5 = Every five years
FWDA = Fort Wingate Depot Activity
GW = Groundwater
ID = Identification
OB/OD = Open Burn/Open Detonation
Quarterly = Samples/water levels collected in January, April, July, and October
Semi-annually = Samples collected in April and October
SVOC = Semi-volatile Organic Compound
TAL = Target Analyte List
TCL = Target Compound List
TPH-DRO = Total Petroleum Hydrocarbon - Diesel Range Organics
TPH-GRO = Total Petroleum Hydrocarbon - Gasoline Range Organics
VOC = Volatile Organic Compound

Table 5-9
Analytical Requirements and Sample Summary for OB/OD Area Wells
REMOVED FROM SAMPLING PLAN UNTIL 2015 DUE TO SURFACE CLEARANCE CONDUCTED BY URS

Matrix	Analytical Group	Analytical Method[a]	Container (Number, Size, and Type)	Preservation Requirements	Analytical Holding Time	Number of Samples	Number of Field Duplicates[b]	Number of Field Triplicate (Split) Samples[b]	Number of MS/MSD Samples[c]	Number of Field Blank Samples
Water	TCL VOCs	8260C	(3) - 40 mL VOC glass vials	Cool to ≤4°C; pH <2 with HCl	14 days to analysis	16	2	2	1	TBD
Water	TCL SVOCs	8270D	(1) - 1 L Amber bottle	Cool to ≤4°C	7 days extraction/40 days analysis	6	1	1	1	TBD
Water	Explosives	8330B	(2) - 1 L Amber bottles	Cool to ≤4°C	7 days to extraction; 40 days from extraction to analysis	9	1	1	1	TBD
Water	Nitrite	9056	(1) - 500 mL Poly bottle	Cool to ≤4°C	28 days to analysis	13	2	2	1	TBD
Water	Perchlorate	6860	(1) - 250 mL Poly bottle	Cool to ≤4°C	28 days	9	1	1	1	TBD
Water	Pesticides	8081A	(1) - 1 L Amber bottle	Cool to ≤4°C	7 days to extraction; 40 days from extraction to analysis	3	1	1	1	TBD
Water	Nitrate	9056	(1) - 250 mL Poly bottle	Cool to ≤4°C; H2SO4 to pH <2	48 hours to analysis	13	2	2	1	TBD
Water	Total Mercury/TAL Metals	7470/6010C or 6020B	(1) - 1 L Poly bottle	Cool to ≤4°C; HNO3 to pH <2	6 months for TAL metals; 28 days for Mercury	16	2	2	1	TBD
Water	Dissolved Mercury/ TAL Metals	7470/6010C or 6020B	(1) - 1 L Poly bottle	Cool to ≤4°C; HNO3 to pH <2	6 months for TAL metals; 28 days for Mercury	16	2	2	1	TBD
					Total Number of Samples	**101**	**14**	**14**	**9**	**TBD**

[a] *Test Methods for Evaluating Solid Waste*, Second Edition, Office of Solid Waste Manual SW-846
[b] One per ten samples
[c] One per twenty samples
[d] One per cooler with volatile samples
Note: Number of samples is based on proposed sample frequency
< = Less than
°C = Degree Celsius
H_2SO_4 = Sulfuric acid
HCl = Hydrochloric acid
HNO_3 = Nitric acid
L = Liter
mL = Milliliter
SVOC = Semi-volatile organic compound
TAL = Target Analyte List
TBD = To be decided based per sampling event
TCL = Target Compound List
VOC = Volatile organic compound

Table 5-10
Analytical Requirements and Sample Summary for Northern Area Wells

Matrix	Analytical Group	Analytical Method[a]	Container (Number, Size, and Type)	Preservation Requirements	Analytical Holding Time	Number of Samples	Number of Field Duplicates[b]	Number of Field Triplicate (Split) Samples[b]	Number of MS/MSD Samples[c]	Number of Field Blank Samples
Water	TCL VOCs	8260C	(3) - 40 mL VOC glass vials	Cool to ≤4°C; HCl to pH <2	14 days to analysis	53	5	5	3	TBD
Water	TPH-GRO	8015B	(3) - 40 mL VOC glass vials	Cool to ≤4°C; HCl to pH <2	14 days to analysis	11	2	2	1	TBD
Water	TCL SVOCs	8270D	(1) - 1 L Amber bottle	Cool to ≤4°C	7 days extraction/40 days analysis	44	5	5	3	TBD
Water	Explosives	8330B	(2) - 1 L Amber bottles	Cool to ≤4°C	7 days to extraction; 40 days from extraction to analysis	48	5	5	3	TBD
Water	TPH-DRO	8015B	(1) - 1 L Amber bottle	Cool to ≤4°C	7 days to extraction; 40 days from extraction to analysis	11	2	2	1	TBD
Water	Nitrite	9056	(1) - 500 mL poly bottle	Cool to ≤4°C	28 days to analysis	57	6	6	3	TBD
Water	Perchlorate	6860	(1) - 250 mL poly bottle	Cool to ≤4°C	28 days	47	5	5	3	TBD
Water	Pesticides	8081A	(1) - 1 L Amber bottle	Cool to ≤4°C	7 days to extraction; 40 days from extraction to analysis	29	3	3	2	TBD
Water	Nitrate	9056	(1) - 250 mL poly bottle	Cool to ≤4°C; H2SO4 to pH <2	48 hours to analysis	57	6	6	3	TBD
Water	Total Mercury/TAL Metals	7470/6010C or 6020B	(1) - 1 L Poly bottle	Cool to ≤4°C; HNO3 to pH <2	6 months for TAL metals; 28 days for Mercury	66	7	7	4	TBD
Water	Dissolved Mercury/ TAL Metals	7470/6010C or 6020B	(1) - 1 L Poly bottle	Cool to ≤4°C; HNO3 to pH <2	6 months for TAL metals; 28 days for Mercury	66	7	7	4	TBD
					Total Number of Samples	**489**	**53**	**53**	**30**	**TBD**

[a] *Test Methods for Evaluating Solid Waste*, Second Edition, Office of Solid Waste Manual SW-846
[b] One per ten samples
[c] One per twenty samples
Note: Number of samples is based on proposed sample frequency
< = Less than
°C = Degree Celsius
H_2SO_4 = Sulfuric acid.
HCl = Hydrochloric acid
HNO_3 = Nitric acid
L = Liter
mL = Milliliter
SVOC = Semi-volatile organic compound
TAL = Target Analyte List
TBD = To be decided based per sampling event
TCL = Target Compound List
TPH- DRO = Total petroleum hydrocarbon diesel range organic
TPH- GRO = Total petroleum hydrocarbon gasoline range organic
VOC = Volatile organic compound

Table 5-11 Summary of Consecutive Non-detected Analytical Suites

OBOD Wells											
Well	**Spring 2008**	**Fall 2008**	**Spring 2009**	**Fall 2009**	**Spring 2010**	**Fall 2010**	**Spring 2011**	**Fall 2011**	**Spring 2012**	**Fall 2012**	**4 Recent Consecutive ND**
Anions											
CMW24	x	x	ND	x	ND	ND	ND	ND	ND		Y
Perchlorates											
CMW07	ND	ND	ND		ND	ND	ND	ND	ND		Y
CMW19	x	x	ND	ND	ND	ND	ND	ND	ND		Y
KMW09		ND	ND	ND	x	ND	ND	ND	ND		Y
Metals											
CMW10	ND		ND	ND	ND	ND	ND	ND	ND	ND	Y
CMW14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
CMW24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
Pesticides											
CMW02	x	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
CMW19	x	ND	ND	ND	ND		ND	ND	ND	ND	Y
CMW25	ND	x	ND	ND	ND	ND	ND	ND	ND	ND	Y
VOCs											
CMW02	ND	ND		ND		ND	ND	ND	ND	ND	Y
CMW17	ND	x		x		x	ND	ND	ND	ND	Y
SVOCs											
CMW18	ND	ND	ND	ND	ND	x	ND	ND	ND	ND	Y
Northern Alluvium Wells											
Anions											
SMW01	x	x	ND	x	ND	ND	ND	ND	ND		Y
TMW26	ND	ND	ND	x	ND	ND	ND	ND	ND		Y
TMW33				Installed	ND	ND	ND		ND		Y
Perchlorates											
SMW01	ND	ND	ND		ND		ND	ND			Y
TMW08	ND	ND	ND		ND	ND	ND	ND			Y
TMW10	ND	ND		ND	ND	ND	ND	ND			Y
TMW21	x	ND	ND		ND	ND	ND	ND			Y
TMW24	ND	ND	ND	ND	ND	ND	ND	ND			Y
TMW26	ND	ND			ND	ND	ND	ND			Y

Table 5-11 Summary of Consecutive Non-detected Analytical Suites

Well	Spring 2008	Fall 2008	Spring 2009	Fall 2009	Spring 2010	Fall 2010	Spring 2011	Fall 2011	Spring 2012	Fall 2012	4 Recent Consecutive ND
Metals											
MW18D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
MW22S	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW03	ND	x	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW07	ND	ND	x	ND	ND	ND	ND	ND	ND	ND	Y
TMW08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW22	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW26	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW27	ND	ND	ND	x	ND	ND	ND	ND	ND	ND	Y
TMW31S					ND	ND	ND	ND	ND	ND	Y
TMW33					ND	ND	ND	ND	ND	ND	Y
TPH-DRO											
MW01					x	ND	ND	ND	ND		Y
MW02					x	ND	ND	ND	ND		Y
MW03					x	ND	ND	ND	ND		Y
MW18D	x	ND	ND		ND	ND	ND	ND	ND		Y
MW20		ND	ND		ND	ND	ND	ND	ND		Y
MW22D	ND	ND	ND	ND	ND	ND	ND	ND	ND		Y
TMW33					ND	ND	ND	ND	ND		Y
TMW34					ND	ND	ND	ND	ND		Y
TMW35					ND	ND	ND	ND	ND		Y
TPH_GRO											
MW01					ND	ND	ND	ND	ND		Y
MW02					ND	ND	ND	ND	ND		Y
MW03					ND	ND	ND	ND	ND		Y
MW18D	ND	ND	ND	x	ND	ND	ND	ND	ND		Y
MW20	ND	ND	ND	x	ND	ND	ND	ND	ND		Y
MW22D	x	ND	ND	ND	ND	ND	ND	ND	ND		Y
MW22S		ND	ND	ND	ND	ND	ND	ND	ND		Y
TW33					ND	ND	ND	ND	ND		Y
TW34					ND	ND	ND	ND	ND		Y
TW35					ND	ND	ND	ND	ND		Y

Table 5-11 Summary of Consecutive Non-detected Analytical Suites

Well	Spring 2008	Fall 2008	Spring 2009	Fall 2009	Spring 2010	Fall 2010	Spring 2011	Fall 2011	Spring 2012	Fall 2012	4 Recent Consecutive ND
Pesticides											
MW02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
MW20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TW08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TW24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW31S					ND	ND	ND	ND	ND	ND	Y
TMW35					ND	ND	ND	ND	ND		Y
VOCs											
FW35	ND	x		ND		ND	ND	ND	ND	ND	Y
MW02	x	x		x		ND	ND	ND	ND	ND	Y
MW03	x	x		ND		ND	ND	ND	ND	ND	Y
SMW01	s	ND		ND		ND	ND	ND	ND	ND	Y
TMW03	x	ND		ND		ND	ND	ND	ND	ND	Y
TMW04	ND	ND		ND	ND	ND	ND	ND	ND	ND	Y
TMW07	ND	s		ND		ND	ND	ND	ND	ND	Y
TMW08	x	x		ND		ND	ND	ND	ND	ND	Y
TMW10	ND	ND		ND		ND	ND	ND	ND	ND	Y
TMW11	x	x		ND		ND	ND	ND	ND	ND	Y
TMW13	ND	x		x		ND	ND	ND	ND	ND	Y
TMW22	x	ND		ND		ND	ND	ND	ND	ND	Y
TMW25	x	x		ND		ND	ND	ND	ND	ND	Y
TMW26	ND	x		ND		ND	ND	ND	ND	ND	Y
TMW28	x	x		ND		ND	ND	ND	ND	ND	Y
Explosives											
MW02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
MW20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW25	ND	ND	ND		ND	ND	ND	ND	ND	ND	Y
Northern Bedrock Wells											
Anions											
TMW18	x	x	ND	x	ND	ND	ND	ND	ND		Y
Perchlorates											
TMW16	ND		ND	ND	ND	ND	ND	ND	ND		Y
TMW17	ND	ND	ND			ND	ND	ND	ND		Y

Table 5-11 Summary of Consecutive Non-detected Analytical Suites

Well	Spring 2008	Fall 2008	Spring 2009	Fall 2009	Spring 2010	Fall 2010	Spring 2011	Fall 2011	Spring 2012	Fall 2012	4 Recent Consecutive ND
TMW18	ND	ND	ND			ND	ND	ND	ND		Y
TMW36					ND	ND	ND	ND	ND		Y
TMW37					ND	ND	ND	ND	ND		Y
Metals											
EMW01	x	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
EMW02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
EMW03	ND	ND	x	ND	ND	ND	ND	ND	ND	ND	Y
EMW04			x	ND	x	ND	ND	ND	ND	ND	Y
TMW02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW16	ND	ND	ND		x	ND	ND	ND	ND	ND	Y
TMW18	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW19	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW32					ND	ND	ND	ND	ND	ND	Y
TMW37					ND	ND	ND	ND	ND	ND	Y
Pesticides											
EMW01	x	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
EMW02	ND	x	ND	ND	ND	ND	ND	ND	ND	ND	Y
EMW03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Y
TMW32					ND	ND	ND	ND	ND	ND	Y
VOCs											
EMW01	x	x		x		ND	ND	ND	ND	ND	Y
EMW02	ND	x		ND		ND	ND	ND	ND	ND	Y
EMW03	x	ND		x		x	ND	ND	ND	ND	Y
TMW02	ND	ND		ND		ND	ND	ND	ND	ND	Y
TMW32						x	ND	ND	ND	ND	Y
Explosives											
TMW19	ND	ND	ND	ND	ND	ND	ND	ND	ND		Y
TMW37						ND	ND	ND	ND		Y

ND	Non-detect
x	Detected
	Either not shown or left blank
(shaded)	Four consecutive Non-detects