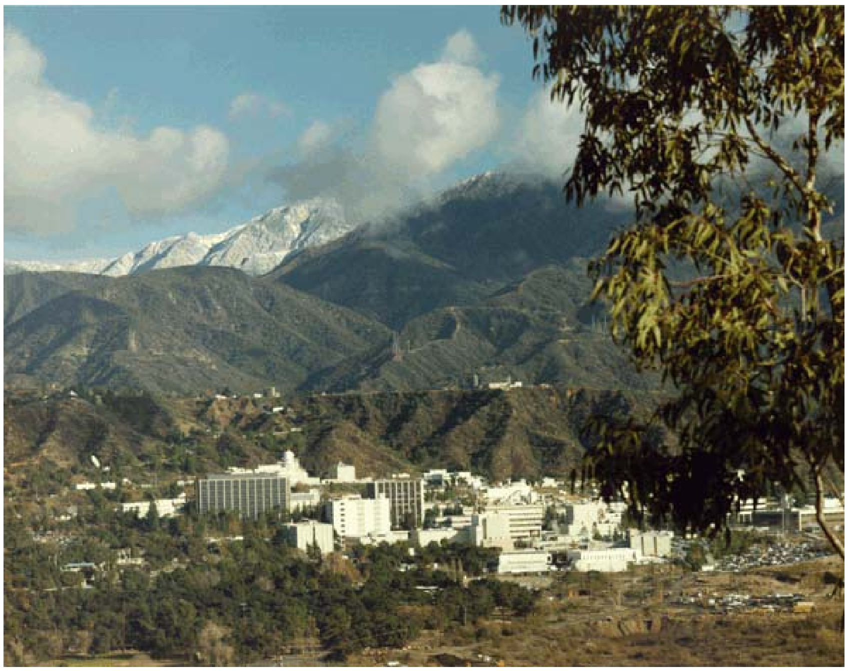
NAS7.10361
NASA-JPL
SSIC No. 9661

DRAFT

Operable Unit 3 Remedial Investigation Addendum Monitoring Well 25 Construction Report

Contract Number N47408-01-D-8207
Task Order No. 0048



PREPARED FOR:

National Aeronautics and Space Administration
Management Office, Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, California 91109

March 2005

CONTENTS

FIGURES

TABLES

APPENDICES

ACRONYMS AND ABBREVIATIONS

asml	above mean sea level
BESST	Best Environmental Subsurface Sampling Technologies
bgs	below ground surface
Cal-EPA	California Environmental Protection Agency
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DEH	Department of Environmental Health
DHS	Department of Health Services
DO	dissolved oxygen
DOT	Department of Transportation
DTSC	Department of Toxic Substances Control
DVD	digital video disc
DWR	Department of Water Resources
FFA	Federal Facility Agreement
FS	Feasibility Study
IDW	investigation-derived waste
JPL	Jet Propulsion Laboratory
LCS/LCSD	laboratory control spike/laboratory control spike duplicate
MCL	maximum contaminant level
MOA	Memorandum of Agreement
MP	multi-port
MS/MSD	matrix spike/matrix spike duplicate
MW	monitoring well
NAD	North American Datum
NASA	National Aeronautics and Space Administration
NAVFAC	Naval Facilities Engineering Command
NDMA	*n*-nitrosodimethylamine
NFESC	Naval Facilities Engineering Service Center
NPL	National Priorities List
O.D.	outside diameter
ORP	oxidation-reduction potential
OU-3	Operable Unit 3

PWP	Pasadena Water and Power
PSP	Pasadena Sampling Plan
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
RBMB	Raymond Basin Management Board
RI	Remedial Investigation
RPD	relative percent difference
RSD	relative standard deviation
RWQCB	Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SVOC	semivolatile organic compound
1,2,3-TCP	1,2,3-trichloropropane
TDS	total dissolved solids
TPH	total petroleum hydrocarbons
USCS	Unified Soil Classification System
U.S. EPA	United States Environmental Protection Agency
VHS	Video Home System
VOC	volatile organic compound
WDC	Water Development Corporation
%D	percent differences
%R	percent recovery

1.0 INTRODUCTION

This Construction Report for Remedial Investigation (RI) Addendum Monitoring Well (MW)-25 was prepared for the National Aeronautics and Space Administration (NASA) as part of the ongoing activities associated with the *Operable Unit 3 (OU-3) RI Addendum Work Plan* (NASA, 2004). RI Addendum activities include an additional investigation within OU-3, off-facility groundwater to (1) evaluate the downgradient (southern) extent of chemicals that originate from the Jet Propulsion Laboratory (JPL) facility, and (2) determine if the occurrence of perchlorate in the Sunset Reservoir area is associated with migration from the JPL facility. NASA-JPL, which is located in Pasadena, CA (Figure 1-1), is on the National Priorities List (NPL) and subject to the provision of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA).

NASA is the lead federal agency for selecting, implementing, and funding remedial activities at the JPL; and Naval Facilities Engineering Command (NAVFAC) is providing technical services, including contracting, under a Memorandum of Agreement (MOA). In accordance with the Federal Facility Agreement (FFA), the United States Environmental Protection Agency (U.S. EPA), California Environmental Protection Agency (Cal-EPA), California Department of Toxic Substances Control (DTSC), and the Regional Water Quality Control Board (RWQCB) Los Angeles Region provide oversight and technical assistance. In addition, NASA is working in conjunction with the City of Pasadena, the California Department of Health Services (DHS), and the Raymond Basin Management Board (RBMB) to implement the activities associated with the additional investigation.

This Construction Report is divided into five sections and provides details regarding the installation of groundwater monitoring well 25 (MW-25). This section discusses the objectives of the well installation and provides a brief discussion on the background of the NASA-JPL CERCLA project. Section 2.0 summarizes multi-port (MP) well installation. Section 3.0 discusses the sample analytical results from groundwater samples collected during the well installation process. Section 4.0 is a summary of the well installation process and Section 5.0 provides a listing of references.

1.1 Background

Beginning in the early 1990s, an RI for on-facility (OU-1) and off-facility (OU-3) groundwater at JPL was conducted to identify the nature and extent of chemicals in groundwater. During the RI, 13 additional wells (including shallow and deep MP wells) were added to the existing 11 wells in the JPL monitoring network (Figure 1-1).

The groundwater monitoring program at NASA JPL was initiated in 1996 and, prior to installation of MW-25, consisted of a network of 24 monitoring wells that are monitored on either a quarterly or annual basis (except MW-2). Sixteen wells are located on-facility and eight wells are located off-facility (Figure 1-1). Of the 24 wells, 11 are relatively shallow conventional wells with a single screened interval. The other 13 wells, including all of the off-facility

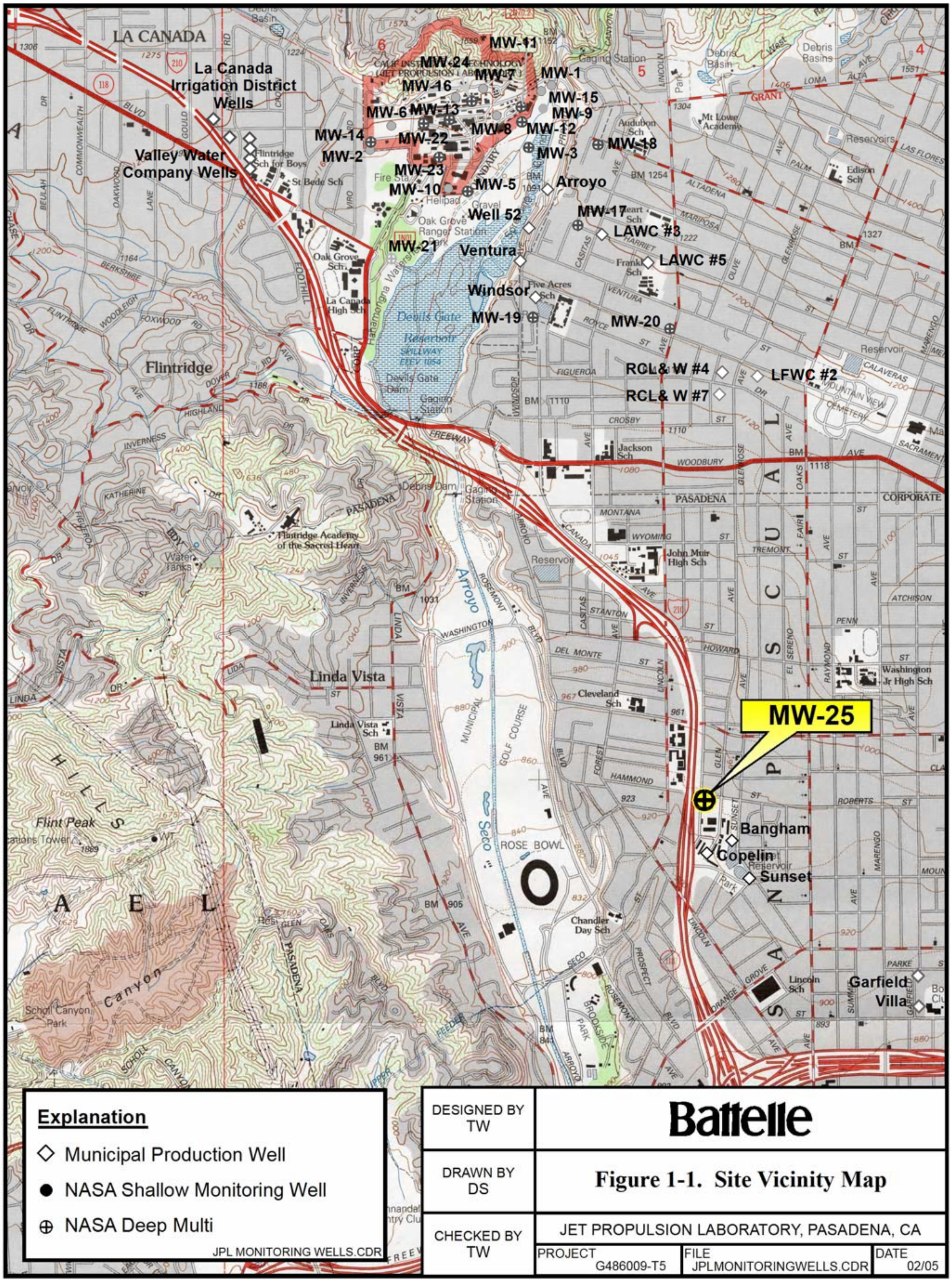


Figure 1-1. Site Vicinity Map

monitoring wells, are relatively deep, multi-port wells that contain five screened intervals each and a Westbay® multi-port casing system that allows for simultaneous or independent monitoring of different aquifer zones.

1.2 Objectives

The objective of this report is to document the installation of a new MP groundwater monitoring well located southeast of the JPL facility (see Figure 1-1) Groundwater samples collected from this well, in conjunction with sample data collected from the existing JPL groundwater monitoring wells, will be used to achieve the objectives of the RI Addendum. This report describes the activities associated with the installation of one additional deep MP monitoring well (MW-25) and collection of initial monitoring data from this well.

2.0 SUMMARY OF MULTI-PORT GROUNDWATER MONITORING WELL MW-25 INSTALLATION

A MP well was selected due to the depth of the aquifer in the area of interest and the presence of stratification within the aquifer. Selection of the monitoring well location was based on groundwater analytical data from existing wells and groundwater flow patterns in the OU-3 (NASA, 2004).

The well location was determined in coordination with the City of Pasadena. To facilitate ease of access and minimize impact to private property and public right-of-way, the well was sited on City of Pasadena property. The well is located in the northwest corner of the Pasadena Water and Power (PWP) City Yards Maintenance Complex near the intersection of Hammond Street and the Foothill Freeway (see Figure 2-1).

2.1 Well Permit Requirements

No state or local permits were required for MW-25 under CERCLA § 121(e)(1) and 40 Code of Federal Regulations (CFR) § 300.400(e). However, MW-25 did meet the substantive permitting requirements associated with monitoring well installation. This included requirements associated with the Los Angeles County Department of Environmental Health (DEH), City of Pasadena Building and Health Departments, RWQCB Los Angeles Region, and the California Department of Water Resources (DWR) Southern District. A copy of the well permit package submitted to the City of Pasadena Health Department is included in Appendix A.

2.2 Coordination with the City of Pasadena

MW-25 is located on City of Pasadena property. The well location was selected in coordination with City of Pasadena PWP personnel. In general, coordination activities associated with the City of Pasadena for this project included the following:

- Completion of appropriate City of Pasadena Department of Health well construction permitting requirements (including public notification requirements) (Appendix A).
- Utility map review and underground utility locating and clearances.
- Selection of locations for placement of construction equipment and support facilities including a temporary storage area for supplies and investigation-derived waste (IDW) at the well site.
- Coordination of drilling, well construction, waste disposal, and surveying schedules.

NASA and the City of Pasadena have executed a legal agreement that allows NASA to conduct CERCLA actions on certain properties owned by the City of Pasadena. This Use Agreement and Right-of-Entry for Environmental Actions requires that the scope and location of specific actions be documented by NASA and approved by the City of Pasadena as part of a Pasadena Sampling Plan (PSP). The RI Addendum Work Plan (NASA, 2004) fulfilled the PSP requirement of the legal agreement and was given the subtitle of PSP-2004-1.

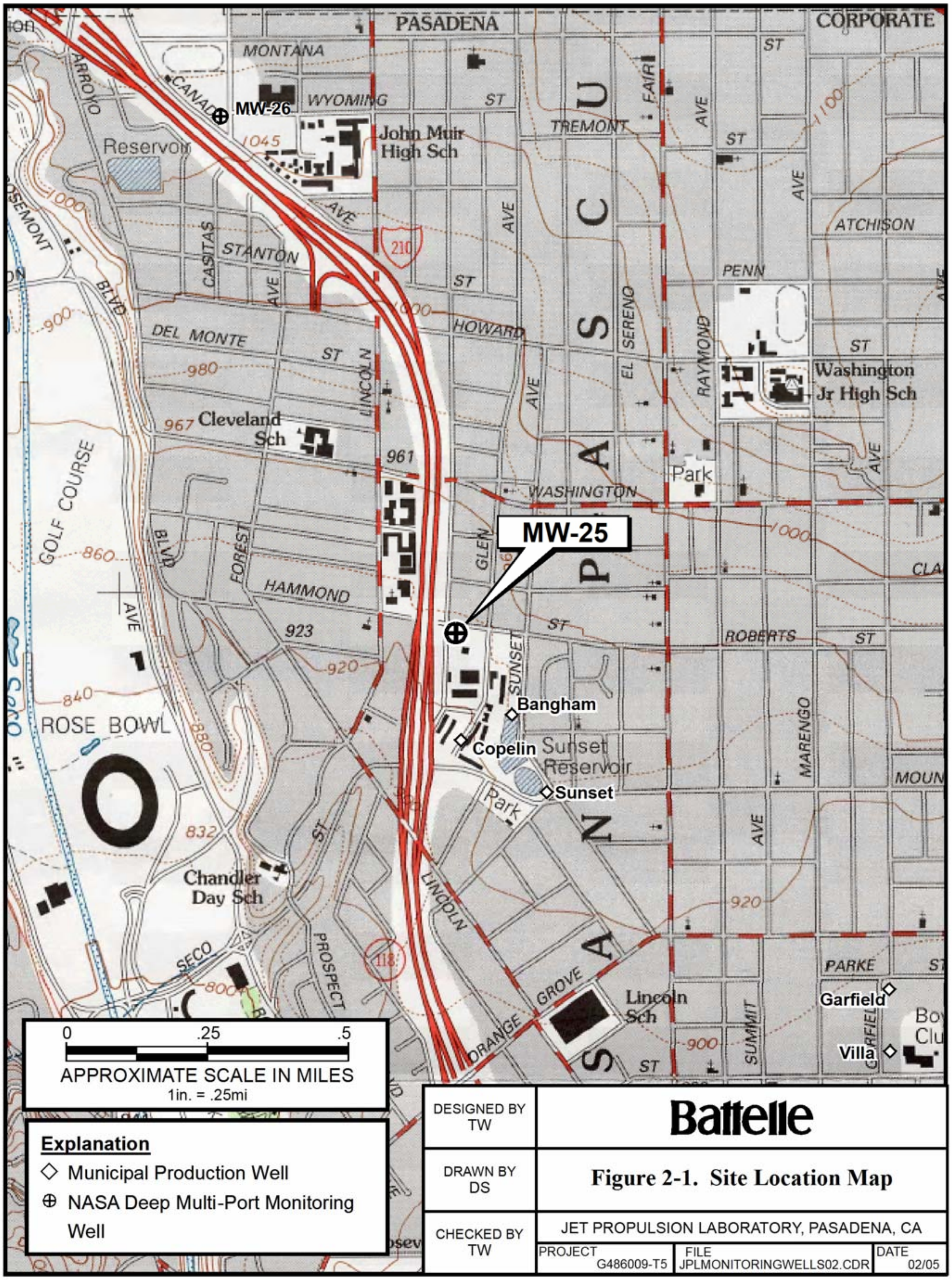


Figure 2-1. Site Location Map

2.3 Well Construction

This section describes the activities that were performed as part of well construction. Construction activities include drilling, geophysical logging, well casing installation, initial well development, MP well installation, and MP well development. These activities are similar in scope to those performed as part of NASA's regulator-approved *Final Work Plan for Performing a Remedial Investigation/Feasibility Study (RI/FS) at NASA JPL* (Ebasco, 1993a). MW-25 was constructed in accordance with the requirements of the California DWR, Water Well Standards, Bulletin 74-90, and Supplement to Bulletin 74-81.

2.3.1 Drilling

MW-25 was drilled to approximately 815 feet below ground surface (bgs) using a 12.25-inch outside diameter (O.D.) mud-rotary drilling bit. Approximately 20 ft of conductor casing was set at the surface of the borehole to maintain the near-surface integrity. The conductor casing was removed after the well was constructed and backfill materials were in place. During the drilling and well construction, the drill cuttings were separated from the drilling mud using a mud shaker.

The bentonite drilling mud was monitored for weight, viscosity, and sand content with a mud scale, marsh funnel and cup, and a sand content kit, respectively. The mud weight was kept below approximately 70 pounds/cubic foot, the viscosity between 40 and 60 seconds, and the sand content at less than 4 percent. The mud properties were controlled by the driller, Water Development Corporation (WDC), to maintain the borehole stability, fluid loss, and equipment integrity. The separated mud was recycled into the drilling process and the cuttings were stored in roll-off bins until the appropriate method of disposal was determined. Drilling mud monitoring results are included on the boring log provided as Appendix B. Additional details regarding IDW storage and disposal are provided in Section 2.6.

All drilling equipment and materials including drilling bits and pipes, drilling mud components, and backfill equipment were either new or cleaned in the field using a high pressure steam cleaner. Water used during drilling and well construction activities came from a nearby City of Pasadena fire hydrant. Prior to use, a water sample was collected from the fire hydrant and analyzed for volatile organic compounds (VOCs) and perchlorate using U.S. EPA-approved methods. Analytical results from the fire hydrant sample are included in the laboratory reports provided in Appendix C.

The drilling method described above is a standard method for the installation of environmental groundwater monitoring wells. Cross contamination between aquifer layers was minimized during the drilling process because the drilling mud in the borehole has a higher viscosity than the groundwater in the aquifer. The difference in viscosity between these media limits groundwater flow within the borehole during the drilling and well installation activities. During the well construction and development, to the extent possible, the drilling mud was removed from the well to allow the groundwater to flow into the well filter pack and casing for future sampling.

Detailed descriptions of the mud rotary process and field documentation procedure are provided in the *Final Work Plan for Performing a Remedial Investigation/Feasibility Study (RI/FS) at NASA JPL* (Ebasco, 1993a).

2.3.2 Geophysical Logging

The total depth of MW-25 was determined by the on-site geologist based on the depth that crystalline bedrock was encountered. Based on an interpretation of the geophysical logs from MW-25, bedrock was encountered at approximately 760 ft bgs; however, during the drilling process, the borehole was advanced to approximately 815 ft bgs to ensure the presence of crystalline bedrock rather than a boulder or large cobbles which were commonly encountered during the drilling process.

Upon completion of the drilling and prior to the well installation, the borehole was logged using geophysical methods to assist the field geologist with the identification of; "sand-rich" layers for the placement of well screens; borehole lithologies; water-bearing intervals; and stratigraphic correlation with existing JPL monitoring wells. Geophysical methods employed included:

- **Gamma Log**. This method records the amount of natural gamma radiation emitted by the rocks surrounding the borehole. Clay-and shale-bearing zones often emit relatively high gamma radiation because they include weathering products that include uranium and thorium.
- **Caliper Log**. This method records borehole diameter. Changes in the borehole diameter are related to well construction, such as casing or drill-bit size, and to fracturing or caving along the borehole wall. Borehole diameter is useful in interpreting the other geophysical logs because it can affect the log response of the other methods.
- **Single-Point Resistance Log.** This method records the electrical resistance from points within the borehole to an electrical ground at the surface. Typically, resistance increases with increasing grain size and decreases with increasing borehole diameter, fracture density, and dissolved-solids concentrations of the water.
- **Spontaneous-Potential Log.** This method records potentials or voltages developed between the borehole fluid and the surrounding rock and fluids. Spontaneous-potential logs can be used in the determination of lithology and water quality.

Based on the results of the geophysical logs, the depth to shallow groundwater was estimated to be approximately 340 ft bgs. However, the actual depth to groundwater measured inside of the well casing following well development was approximately 278 ft bgs. In general, the lithologies encountered during the drilling process consisted of fine to coarse grained sands and gravels with various percentages of silts. Additionally, cobble and boulder sized material was observed at various levels throughout the drilling interval. These interpretations are based on visual observations of the drill cuttings, observations of the drilling equipment, and geophysical logging results. Boring lithologic descriptions are provided on the boring log in Appendix B. The downhole geophysical logs are provided in Appendix D.

2.3.3 Well Casing Installation

The well design was based primarily on the downhole geophysical survey. The design of other deep MP monitoring wells located in the vicinity (e.g., MW-19 and MW-20) was also taken into consideration. The outer well casing consists of sections of 4-inch-diameter low carbon steel blank casing and five 10-ft-long, 4-inch-diameter stainless steel wire-wrap screens with 0.010-inch slots welded together. In order to accurately define the well construction, each section of screen and blank casing was measured before being lowered into the boring. The sections of screen and blank casing were brand new and packaged either in factory-provided cardboard boxes or shrink-wrap. The five screen depths were selected based on conditions observed during the drilling of the well, as well as conditions observed during the downhole geophysical survey. All bentonite seals and sand packs were tremied into place. The sand packs consist of No. 2 silica sand. A grout pump was used to circulate the drilling fluid (e.g. mud and water) out of the hole and to pump backfill materials into the boring. The backfill materials included sand, a bentonite sealing mixture consisting of sand and bentonite, and high density, polymer-free grout. A concrete encased traffic box was installed at the well surface, after the grout seal had time to adequately set, to protect the wellhead from damage and to prevent surface water from entering the well casing. Well screen elevations are summarized in Table 2-1 and well construction details are provided in Appendix B.

Table 2-1. Summary of Well Elevation and Location Survey Data

Well Feature		Elevation (ft amsl)	Northing	Easting
Top of Casing		934.52	1,882,639.53	6,514,027.89
Zone 1	Top	579.52		
	Bottom	569.52		
Zone 2	Top	514.52		
	Bottom	504.52		
Zone 3	Top	434.52		
	Bottom	424.52		
Zone 4	Top	304.52		
	Bottom	294.52		
Zone 5	Top	224.52		
	Bottom	214.52		
Bottom of Casing		194.52		

asml = above mean seal level

2.3.4 Initial Well Development

Initial well development procedures began within 24 hours after the installation of the 4-inch casing. Time was important at this stage of the well construction because a large majority of the drilling mud had been removed from the borehole during well construction and therefore, the five screened intervals were not isolated from one another to prevent mixing of water from each zone. The development procedures were conducted in order to remove residual drilling mud and fine sediments from around the well screen and to stabilize the filter pack at each screened zone. Additionally, well development was performed to create hydraulic communication between the aquifer and the new well. All development activities were recorded in a bound field logbook.

Development was initiated by bailing the residual drilling mud from the well casing. During this process, approximately 1,155 gallons of drilling mud mixed with water was removed from the well. Each screened zone was then surged for a half hour using a rubber-disc swab tool. The well was then bailed to remove the remaining sediments that had accumulated in the bottom of the well. Approximately 50 gallons of additional sediment-laden water was removed from the well.

Following swabbing and bailing operations, each screened zone was individually developed using an isolated air-lift system to pump and surge the well. During this process, compressed air was injected into the well to help lift the water to the surface. Periodically, the pumping was discontinued to allow the water to drop back into the well creating a surging effect in the zone being developed. The screened zone being pumped was isolated from the other screened zones in the well using rubber K-packers. The progress of the air-assisted development of each screened zone was measured by visually monitoring the sand content of the water produced. Air-assisted pumping was discontinued at each zone when, based on visual observations, the sand content of the purge water had diminished and a submersible pump could be used without being damaged by the sand in the water. Approximately 50 gallons was pumped from Screen 1 (355-365 ft bgs), 581 gallons from Screen 2 (420-430 ft bgs), 2,520 gallons from Screen 3 (500-510 ft bgs), 1,680 gallons from Screen 4 (630-640 ft bgs), and 5,280 gallons from Screen 5 (710-720 ft bgs). [Table 2-2].

At the completion of the air-lift operations, the well was purged using a submersible pump. Prior to purging, the sampling interval was isolated from the rest of the well by placing a K-packer above and below the screen of the target interval. The pump was lowered to the first well screen and pumping was initiated. Occasionally, pumping was discontinued, and the pump was raised and lowered to surge the screened zone. During the purging process, physical and chemical parameters including pH, turbidity, dissolved oxygen (DO), salinity, total dissolved solids (TDS), and oxidation-reduction potential (ORP) were monitored and recorded. Each zone was purged until the chemical and physical parameters, with the exception of turbidity, varied by approximately 10% or less over three consecutive readings. When development of the screened zone was completed, the pump was lowered to the next screened zone and the process was repeated. Approximately 3,960 gallons was pumped from Screen 1, 8,622 gallons from Screen 2, 7,753 gallons from Screen 3, 6,437 gallons from Screen 4, and 6,911 gallons from Screen 5. Development logs summarizing the parameter reading and purge volumes recorded during the development and purging processes are included in Appendix E.

Following well development and prior to the initial groundwater sampling activities, Pacific Surveys performed a downhole video survey to assess the effectiveness of the development procedures. During the video survey, a waterproof camera was lowered down the well and the images were observed on a video monitor and simultaneously captured on a Video Home System (VHS) tape and digital video disc (DVD). Based on the results of the video survey, well development was considered adequate and no additional development was required. However, additional development occurred during the groundwater sample purging activities (Section 2.4.1). Still images of each of the five screened zones were captured during the survey. The DVD of the video log performed on MW 25, as well as the still images of each screened zone, are included in Appendix F.

All development discharge water was stored in 21,000-gallon Baker® Tanks until the appropriate method of disposal was determined. Additional details regarding IDW storage and disposal is provided in Section 2.6.

2.3.5 Westbay® Multi-Port System Installation

After the initial well development, the MP casing system was installed within the 4-inch steel casing. The MP system is a multi-level groundwater monitoring system capable of providing isolated access to each of the five discrete, screened intervals within MW-25.

The MP casing system consists of various components including 1.5-inch-diameter schedule 80 polyvinyl chloride (PVC) blank casing, PVC couplings used to connect various casing components, PVC measurement-port couplings that allow access to the aquifer for pressure measurements and water sampling, PVC pumping-port couplings that allow access to the aquifer for well purging and hydraulic conductivity testing, and nitrile rubber inflatable packers that seal the annulus between the measurement and pumping ports at each screened interval.

As part of the MP system, valved ports are located in the 4-inch steel casing opposite the well screens and isolated within the well casing by inflatable packers. The packers are located within the well casing, above and below the screened interval. From the surface, a Westbay® trained technician lowers a probe into the MP casing, locates the desired port using magnetic sensors, docks the probe at the measurement-port, and takes a pressure reading or collects a groundwater sample.

The MP system was provided and installed by certified technical representatives of Westbay® Instruments, Inc., of Vancouver, Canada. Each MP casing component arrived on-site cleaned by the manufacturer with a nonphosphate detergent solution and packed in plastic bags for transport. Before the MP system was installed in MW-25, the components were organized at the surface and partly assembled in accordance with a casing installation log. The casing installation log was used to accurately place the packers and measurement ports at the desired depths.

Table 2-2. Summary of Well Development Parameters Prior to Multi-Port Casing Installation

	Final Characteristics of Purge Water									Total Volume Purged (gals.)
Screen/Task	**pH**	**Conductivity (µmhos)**	**Turbidity (NTU)**	**Dissolved Oxygen**	**Temperature (°C)**	**Salinity**	**Total Dissolved Solids**	**Oxygen Reduction Potential**	**Pump Rate (gpm)**	
Screen #1 (Top) (355-365 ft. bgs)										
Air Lift in 4-inch casing	Not enough water above screen for adequate air lift.									50
Submersible pump in 4-inch casing	7.35	1.13	59.3	12.87	21.5	0.1	0.49	153	9.0	3,960
Screen #2 (420-430 ft. bgs)										
Air Lift in 4-inch casing	--	--	--	--	--	--	--	--	1.8	581
Submersible pump in 4-inch casing	7.64	0.745	3.37	10.91	21.2	0.0	0.7	146	9.0	8,622
Screen #3 (500-510 ft. bgs)										
Air Lift in 4-inch casing	--	--	--	--	--	--	--	--	6.0	
Submersible pump in 4-inch casing	7.62	1.10	11.05	9.74	21.3	0.0	0.48	208	9.0	7,753
Screen #4 (630-640 ft. bgs)										
Air Lift in 4-inch casing	--	--	--	--	--	--	--	--	8.0	
Submersible pump in 4-inch casing	7.50	0.750	7.39	8.77	21.8	0.1	0.48	238	7.7	6,437
Screen #5 (Bottom) (710-720 ft. bgs)										
Air Lift in 4-inch casing	--	--	--	--	--	--	--	--	11.0	
Submersible pump in 4-inch casing	7.48	0.740	180	8.18	20.8	0.0	0.47	90	6.0	6,911

-- = Readings not recorded

The MP casing string was assembled by lowering the casing segments into the 4-inch steel casing by hand and attaching each successive segment to the adjacent coupling one at a time. Each coupling was pressure tested before it was run into the hole to verify the integrity of the system during installation. Each coupling was pressure tested using a probe with two small packers that was lowered into the casing so that the packers were located on each side of the coupling. The small packers were inflated and water was then injected under pressure into the casing opposite the coupling. If the coupling did not leak, it was lowered into the well. Once the MP casing had been placed in the well, the nitrile rubber packers between screen intervals were inflated with water, one at a time, beginning with the lowest packer, using a downhole tool designed for this purpose. After installation, several additional quality assurance/quality control (QA/QC) checks were performed. These checks included an initial pressure profile to confirm the operation of the measurement ports and observation of head differences across the packers to confirm that the packers had properly sealed the annulus. Additional details regarding the equipment and procedures used during MP casing installation and procedures for the required QA/QC checks are further described in the *Final Work Plan for Performing a Remedial Investigation/Feasibility Study at NASA JPL* (Ebasco, 1993a). MP casing installation logs are provided in Appendix B.

2.3.6 Westbay® Multi-Port System Development

Following the installation of the MP casing system, a second development of the screened zones was performed. This well development was intended to remove stagnant water and residual suspended materials from the well casing remaining from the initial well development.

The depth of the well and the relatively small diameter of the Westbay® MP casing system do not allow for standard well development techniques. Therefore, a specialized pump was required to purge the deep MP screens. The screen zones surrounding the MP casing sample ports were developed using a Barcad pump from Best Environmental Subsurface Sampling Technologies (BESST), Inc. of San Rafael, California. The Barcad pump is small enough in diameter to fit into the MP casing and can operate at depths up to 3,000 ft bgs. The pump is a gas displacement pump that utilizes hydraulic pressure differential to capture the water in the aquifer and pump it to the surface. Appendix G contains a depiction of the Barcad Pump operation.

During this development process, the pump was lowered to each screened interval, the MP purging-port coupling was opened to expose the MP screen, and the pump was activated. At each zone, approximately 3 casing volumes were purged. In general, approximately 30 gallons was purged from each zone during the MP well development. Following purging at each zone, the Westbay® purging-port was closed and the MP development was considered complete. After development of all five MP zones was completed, the well construction and development activities were considered complete. Following the completion of the MP development, a second round of depth discrete groundwater samples were collected from each screened zones. Additional details regarding the second round of groundwater sampling is provided in Section 2.4.

All development discharge water was stored in 21,000-gallon Baker® tanks until the appropriate method of disposal was determined. Additional details regarding IDW storage and disposal are provided in Section 2.6.

2.4 Groundwater Sampling Activities

Samples were collected for analysis from MW-25 prior to and following the installation of the Westbay® MP casing. The first sampling event was conducted during November 2004 and the second sampling event was conducted during December 2004. The following sections describe these sampling activities.

2.4.1 Groundwater Sampling Prior to MP System Installation

Following the installation and initial well development, each of the screened intervals was purged and sampled. These sample analytical results were used as baseline data for comparison with subsequent analytical data collected following the MP casing installation (i.e., purge and sample versus no purge sampling).

Before groundwater samples were collected, each screened interval was purged. The sampling interval was isolated from the rest of the well by placing a rubber K-packer above and below the screen zone of the target interval. The purge/sample pump was located between the packers and was connected to the packers such that they are one continuous piece of equipment. The packer/pump unit was connected to the surface using 2-inch galvanized steel discharge pipe. At the surface, the discharge pipe was configured to direct purge water to the designated storage containers. Additionally, the pipeline was fitted with a sampling port which could be opened or closed to allow a slipstream of the purge water to be directed to the monitoring and sampling equipment. During groundwater purging, a Horiba Model U-22 multi-probe water-monitoring chamber (flow-through cell) containing probes from various field instruments was connected to the sampling port and was used to monitor groundwater parameters. Groundwater turbidity measurements were collected from the discharge line of the pump using an Oakton Turbidity meter.

During the purging process, physical and chemical parameters including pH, turbidity, DO, salinity, TDS, and ORP were monitored and recorded. Each zone was purged until the chemical and physical parameters varied by approximately 10% or less over three consecutive readings. When development of the screened zone was completed, the pump was lowered to the next screened zone and the process was repeated. Approximately 1,015 gallons was pumped from Screen 1, 1,925 gallons from Screen 2, 1,540 gallons from Screen 3, 2,100 gallons from Screen 4, and 315 gallons from Screen 5. Upon groundwater parameters stabilization, the screened interval was considered ready to sample and a sample was collected. Groundwater sampling purge logs are provided in Appendix E.

Once collected, groundwater samples were placed on ice, and shipped via overnight courier to Alpha Analytical Laboratory, a California-certified laboratory in Sparks, Nevada. The groundwater purged during these sampling activities was contained in 21,000-gallon Baker®

tanks for later disposal. Additional details regarding IDW management can be found in Section 2.5.

2.4.2 Multi-Port Well Sampling

Sampling of MP systems requires specialized sampling equipment manufactured by Westbay®. This unique equipment includes a pressure profiling/sampling probe with a surface control unit. Field personnel using the Westbay® equipment are trained by Westbay® to ensure proper use. Copies of the detailed operations manuals for the pressure profiling/sampling probe are included in the *Final Field Sampling and Analysis Plan for Performing a Remedial Investigation at Operable Unit 3* (Ebasco, 1994).

The Westbay® Sampling probe and sample-collection bottles were decontaminated prior to sampling each screened interval in MW-25 according to the following procedure:

1. Each 250-ml stainless-steel sample-collection bottle is washed in a solution of non-phosphate detergent (e.g., Liquinox®).
2. Each bottle is rinsed with distilled water.
3. The interior surfaces of the Westbay® sampling probe, and the hoses and valves associated with Westbay® sampling bottles, were decontaminated by forcing several volumes of Liquinox® and distilled water through them. A final rinse with distilled water was carried out. Each of these decontamination procedures is completed using clean plastic spray bottles used only for this purpose.
4. All parts were rinsed by forcing several volumes of distilled water through them using a clean plastic squeeze bottle used only for this purpose.

Purging before sampling is not required in the deep MP monitoring wells because the groundwater sample is collected directly from the aquifer, thus ensuring that the groundwater sample has not been exposed to the atmosphere. Samples were collected using the Westbay® equipment, brought to the surface, and transferred to the appropriate sample containers. Groundwater samples were then placed on ice, and shipped via overnight courier to Alpha Analytical Laboratory, a California-certified laboratory in Sparks, Nevada.

2.5 Soil Sampling Activities

During drilling, soil samples were collected from the mud shaker screen for lithologic logging purposes and then disposed of with the soil cuttings. Soil samples collected from the mud shaker screen were logged using the Unified Soil Classification System (USCS).

In accordance with the *OU-3 Remedial Investigation Addendum Work Plan* (NASA, 2004), depth-discrete soil sampling was attempted during the drilling process to collect unsaturated and saturated soil samples. Soil samples were planned to be analyzed for several physical parameters, including bulk density, effective porosity, horizontal and vertical hydraulic conductivity, and fraction organic carbon. Additionally, the soil samples were planned to be used for column tests in an effort to determine site-specific sorption coefficient for perchlorate. The attempted sampling efforts involved removing the downhole drilling equipment from the borehole and lowering the soil sampling equipment to the bottom of the borehole for sample collection. Split-spoon samples were attempted at 200, 295, 490 and 635 ft bgs utilizing a California-modified split-spoon sampler equipped with a 300-lb slide hammer. The slide hammer was raised and dropped for 100 blow counts at each of the respective depths. At each interval, the sampling attempts yielded little or no recovery due to the density and coarse-grained nature of the material. Therefore, no useable samples were collected for the purposes listed above. However, the limited sample material that was collected at 295 and 490 ft bgs was evaluated in the field and was described on the lithologic log. Additional details regarding the attempted soil sampling can be found on the lithologic boring log provided in Appendix B.

2.6 Investigation Derived Waste Sampling and Disposal

The primary wastes generated during the installation, development, and sampling of MW-25 included drill cuttings mixed with drilling mud, well development water, monitoring well purge water, and decontamination rinse water.

Seven Department of Transportation (DOT)-approved, 20-cubic-yard capacity roll-off bins were used to temporarily store the soil cuttings and drilling mud mixture. Grab samples of this waste were collected from each roll-off bin and placed in 8-ounce wide-mouth glass jars, capped and labeled. Once collected, IDW soil samples were placed on ice, and shipped via overnight courier to Alpha Analytical Laboratory, a California-certified laboratory in Sparks, Nevada. The samples were analyzed for VOCs and semivolatile organic compounds (SVOCs), Title 26 metals, plus strontium, cyanide, hexavalent chromium, perchlorate, and total petroleum hydrocarbons (TPH) to determine disposal options for the soil cuttings pursuant to EPA's guidance on the management of IDW (EPA, 1991 and 1992).

Water generated during the well development and sampling of the monitoring well was temporarily stored in three 21,000-gallon Baker® tanks. Grab samples of the water were collected from each Baker® tank and were placed in appropriate sampling containers, capped, labeled. Once collected, IDW water samples were placed on ice, and shipped via overnight courier to Alpha Analytical Laboratory, a California-certified laboratory in Sparks, Nevada. The samples were analyzed for VOCs and SVOCs, Title 26 metals, plus strontium, cyanide, hexavalent chromium, perchlorate, and total petroleum hydrocarbons to determine disposal options for the soil cuttings pursuant to EPA's guidance on the management of investigation-derived wastes (EPA, 1991 and 1992).

Based on the laboratory results, the solid and liquid IDW was classified as nonhazardous waste in accordance with the Code of Federal Regulations (40 CFR 261.31 to 261.33 and 261.21 to 261.24) and 22 California Code of Regulations (CCR). The nonhazardous waste manifests were signed by a NASA authorized representative. EFR Environmental of Lakeside, California, a licensed transporter, transported the waste off-site.

Soil cuttings generated during the installation of monitoring well MW-25 were disposed at the Waste Management facility in Azusa, California. The drilling fluids generated during the installation of monitoring well MW-25 were disposed at the McKittrick waste facility in McKittrick, California. Development and sampling purge water generated during the installation and initial sampling of monitoring well MW-25 was disposed of at the U.S. Filter facility in Los Angeles, California.

A summary of the analytical results for IDW samples and waste manifests for the IDW are provided in Appendix C. Complete laboratory analytical reports for IDW samples are included in Appendix C. Additional details regarding waste handling, analysis, and disposal can be found in the *Final Work Plan for Performing a Remedial Investigation/Feasibility Study (RI/FS) at NASA JPL* (Ebasco, 1993a).

2.7 Well Location Survey

Following the installation of the Westbay® system in MW-25, a local subcontractor, Western States Surveying, Inc., surveyed the well location according to the North American Datum (NAD) 83 coordinate system. The results of this survey were used to create the site map provided as Figure 2-2 and the original survey map is included as Appendix H.

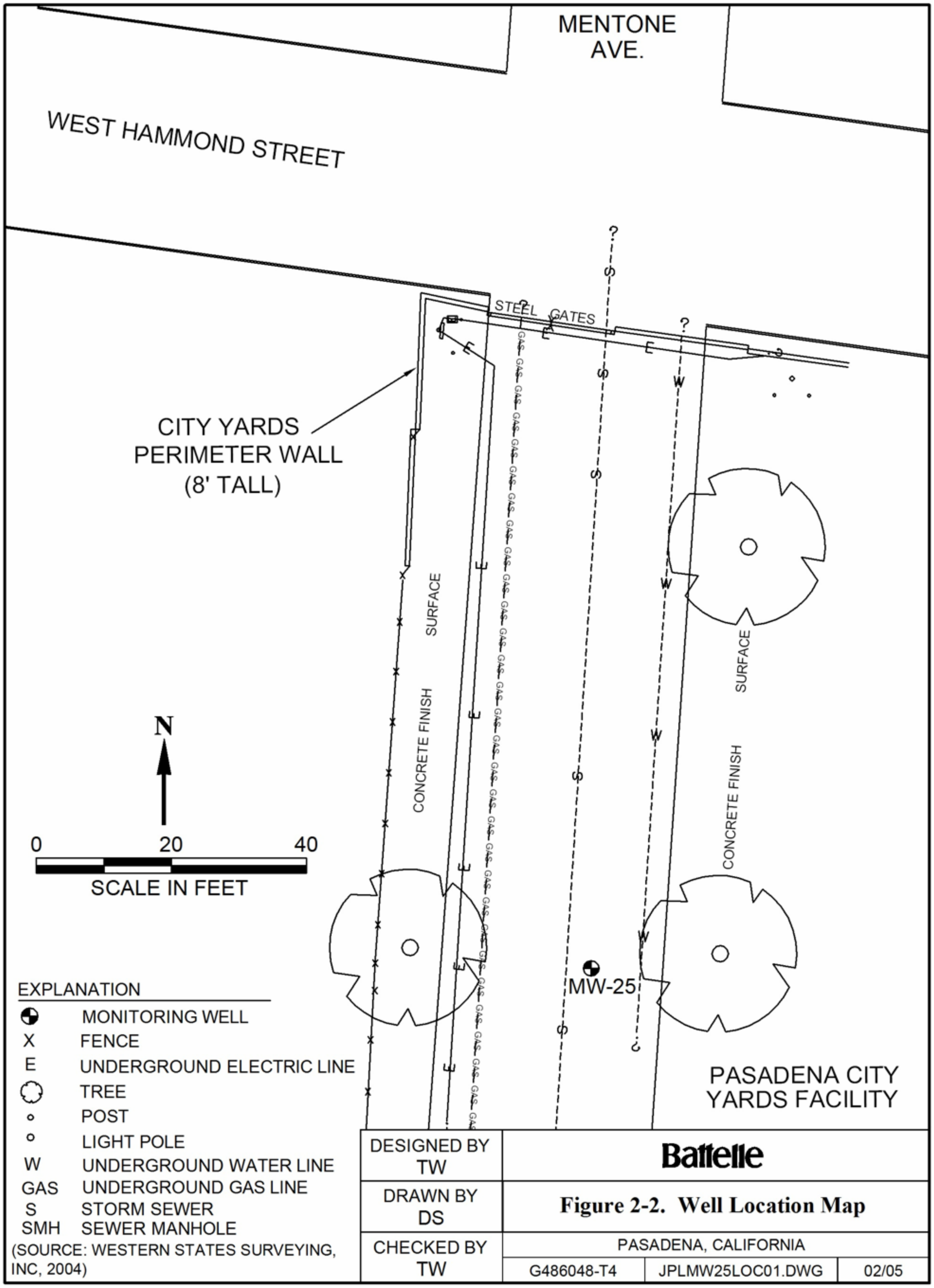


Figure 2-2. Well Location Map

3.0 SAMPLE ANALYTICAL RESULTS

This section describes the groundwater sample analytical testing methods, the analytical results, and the QA/QC program implemented during initial groundwater sampling conducted as part of the MW-25 well construction.

It is important to note that during construction and development of MP wells, a temporary mixing or homogenization effect on the local groundwater occurs. The homogenization of the groundwater near the well affects initial sampling data. The Westbay® technical staff suggests that initial groundwater sampling data be corroborated with longer term data before any significant decisions are made. For this reason, analytical results presented in this section should be considered qualitative. Data collected during the quarterly groundwater monitoring events will be used quantitatively in the RI Addendum Report.

3.1 Analytical Methods

During November 2004, MW-25 was sampled from each screened interval prior to the installation of the MP equipment and within one week following the well casing development. Additionally, during December 2004, a second round of samples was collected from each screened interval following the installation and development of the MP System equipment. During these initial monitoring events, groundwater samples were collected and analyzed for VOCs, perchlorate, metals, hexavalent chromium, anions, 1,2,3-trichloropropane (1,2,3-TCP), 1,4-dioxane, *n*-nitrosodimethylamine (NDMA), TDS, and alkalinity by EPA Methods 524.2, 314.0, 200.8, 7196A, 300.0, California DHS Method for 1,2,3-TCP, 8260B, 8270C, 160.1, and 310.1, respectively.

Groundwater samples collected from MW-25 and IDW samples for this task order were analyzed by Alpha Analytical of Sparks, Nevada, a California-certified laboratory. Additionally, Alpha Analytical is an analytical laboratory that has successfully completed the Navy evaluation process through the Naval Facilities Engineering Service Center (NFESC). Groundwater sample results are discussed in the following sections.

3.2 Results

This section includes a summary of the chemical data pertaining to the sampling of MW-25 during November and December 2004. Complete analytical reports for these sampling events are included in Appendix C. A summary of the chemical constituents that were detected during the November and December MW-25 sampling events can be found in the analytical results table in Appendix C.

During the November and December 2004 sampling events, VOCs were not detected in the groundwater samples collected from the five screened zones, with the exception of low levels of chloroform, which was detected in all five zones during the November 2004 event and in Zone 3 during the December 2004 event.

Perchlorate was detected at a concentration of 13 µg/L in all five screened zones during the November 2004 sampling event. The consistency of these results indicates that mixing and homogenization of the groundwater in the vicinity of the new well had occurred due to the well drilling and development activities. During the December 2004 event, perchlorate was detected at concentrations of 8.1, 12, 8.7, and 8.1 µg/L in Screens 1 through 4, respectively. Perchlorate was not detected above the analytical reporting limit of 2.0 µg/L in Screen 5 during the December 2004 sampling event.

Several metals were detected in groundwater samples from MW-25 in November and December 2004. Metals detected included: sodium, magnesium, potassium, calcium, and total chromium. The total chromium detection (Screen 5) during November 2004 of 70 mg/L is above the California maximum contaminant level (MCL) of 0.05 mg/L. However, the December 2004 detection of total chromium of 0.02 mg/L in the same zone is below the California MCL.

Concentrations of all other analytes were below the reporting limits in each zone. A summary of analytical results and complete laboratory analytical reports are provided in Appendix C. Additional details regarding groundwater conditions at the MW-25 location will be provided in the RI Addendum report and subsequent NASA-JPL quarterly groundwater monitoring reports.

3.3 Quality Assurance/Quality Control

A comprehensive QA/QC plan for groundwater monitoring has been established and is described in detail in the Sampling and Analysis Plan, which is provided as Appendix A of the *OU-3 RI Addendum Work Plan* (NASA, 2004). QA can be described as an integrated system of activities in the quality planning, assessment, and improvement to provide the project with a measurable assurance that the established standards of quality are met. QC checks, including both field and laboratory, are the specific operational techniques and activities used to fulfill the QA requirements. Proper sample acquisition and handling procedures are necessary to ensure the integrity of the analytical results.

3.3.1 Field Quality Assurance/Quality Control

The field QA/QC program for samples collected from JPL monitoring wells includes the collection of duplicate samples, equipment blanks, field blanks, and trip blanks. However, during the November and December 2004 sampling events, trip blanks were the only QA/QC samples collected. As a result, the groundwater sample analytical results for the November and December sampling events should only be used for qualitative purposes. These sample results were used as part of a qualitative evaluation of the aquifer recovery and not for any decision-making processes associated with the RI Addendum (see Section 3.0 for a discussion on initial well sampling). The field QA/QC program will be in effect during all future groundwater monitoring activities at MW-25.

Trip blanks, prepared by the laboratory, consisted of laboratory reagent water placed in 40-mL glass vials transported with the sample bottles to and from the field. One trip blank was submitted with each shipment of groundwater samples from the field to the laboratory. Trip blanks were used to identify any cross contamination of groundwater samples during transport and are analyzed if VOCs are detected in any of the groundwater samples. No VOCs were detected during this round of sampling (with the exception of chloroform); therefore the trip blank was not analyzed.

Complete laboratory analytical reports are provided in Appendix C. The comprehensive QA/QC plan for groundwater monitoring is described in detail in the Sampling and Analysis Plan (SAP), which is provided as Appendix A in the *OU-3 RI Addendum Work Plan* (NASA, 2004).

3.3.2 Data QC Review

A QC review of the analytical data for samples collected from well MW-25 in November and December 2004 was performed. Key data quality parameters were reviewed and evaluated. In this case, the quantitative criteria for assessing data quality were precision, accuracy and completeness.

Precision quantifies the repeatability of a given measurement. Precision was determined by calculating the relative percent difference (RPD) between matrix spike/matrix spike duplicate (MS/MSD) pairs in the analytical laboratory. Data from repetitive analysis of calibration standards were also generated to assess the laboratory's analytical precision in terms of percent difference (%D) and relative standard deviation (RSD) of instrument response factors calculated for each analyte. Results of initial and continuing calibrations were reviewed to assess system variability in terms of RPD, %D and RSD. All samples fell within the precision acceptability limits required by the SAP (NASA, 2004).

Laboratory accuracy refers to the percentage of a known amount of analyte recovered from a given matrix. Accuracy was determined quantitatively by calculating the percent recovery (%R) from MS/MSD and for organic analytes, with surrogate compounds. Laboratory accuracy was also assessed from %R results generated from the periodic analysis of calibration check standards and laboratory control spikes/laboratory control spike duplicates (LCS/LCSD). All spiked samples fell within the percent recovery ranges required by the SAP (NASA, 2004).

Completeness refers to the percentage of valid data received from actual testing done in the laboratory. Completeness for all compounds exceeded the target of 90%.

3.3.3 Data Verification

The analytical data for samples collected from well MW-25 in November and December 2004 along with associated laboratory QC data were reviewed by Battelle. Data were reviewed for conformance to the SAP (NASA, 2004) and generally accepted standards of data quality. The QC data generated by the analytical laboratory were specific to the analytical method and included LCS/LCSD, MS/MSD, surrogate spikes (if applicable), and method blanks. The results of the data verification indicated that the data met all analytical criteria.

4.0 SUMMARY

MW-25 was drilled and constructed at the PWP City Yards Maintenance Complex as part of NASA's JPL CERCLA program (NASA, 2004). MW-25 is located in the northwest corner of the City Yards facility and is hydraulically downgradient from the JPL facility. This well adds to the current NASA-JPL groundwater monitoring well network. MW-25 is the fourteenth deep MP well containing five screened intervals and a Westbay® MP casing system.

MW-25 was drilled to the crystalline bedrock using mud-rotary drilling technique. In general the lithologies encountered while drilling MW-25 consisted of silty and gravelly sands with occasional layers of cobbles and boulders. These lithologies appear to be relatively consistent with the lithologies observed in the nearest NASA monitoring wells, MW-19 and MW-20.

Initial groundwater samples were collected prior to the installation of the MP casing system and following installation of the MP casing system. Temporary mixing or homogenization of groundwater surrounding MW-25 occurred due to the well drilling and development activities. Therefore, these initial data were considered qualitatively. As expected, perchlorate was detected at concentrations above the analytical detection limit. No statement can yet be made as to the source of the perchlorate detected in MW-25.

5.0 SELECTED REFERENCES

Ebasco Environmental Corp. 1993a. *Final Work Plan for Performing a Remedial Investigation/Feasibility (RI/FS) at NASA JPL.* Prepared for the National Aeronautics and Space Administration Jet Propulsion Laboratory. December.

Ebasco Environmental Corp. 1993b. *Quality Assurance Program for Performing a Remedial Investigation for the NASA-Jet Propulsion Laboratory.* December.

Ebasco Environmental Corp. 1994. *Final Field Sampling and Analysis Plan for Performing a Remedial Investigation at Operable Unit 3: Off-Site Groundwater, NASA-Jet Propulsion Laboratory.*

EPA, see United States Environmental Protection Agency.

National Aeronautics and Space Administration. 2004. *Operable Unit 3 Remedial Investigation (RI) Addendum Work Plan (Pasadena Sampling Plan [PSP]-2004-1).* Prepared for the National Aeronautics and Space Administration Jet Propulsion Laboratory. November.

NASA, see National Aeronautics and Space Administration.

United States Environmental Protection Agency. 1991. *Management of Investigation Derived Wastes During Site Inspections.* U.S. EPA Office of Research and Development. EPA/540/G-91/009. May 1991.

United States Environmental Protection Agency. 1992. *Guide to Management of Investigation-Derived Wastes*. U.S. EPA Office of Solid Waste and Emergency Response. Publication 9345.3-03FS. April 1992.