EBASCO SERVICES INCORPORATED

EBASCO

3000 W. MacArthur Blvd., Santa Ana, CA 92704-6993, (714) 662-4000

NAS7.000240
NASA - JPL
SSIC No. 9661

April 11, 1988
NASA/88-039
No response required

Mr. Michael Green
NASA Headquarters
300 7th Street, SW
Washington, D.C. 20546

SUBJECT: NASA CONTRACT NO. NASW-4301
PRELIMINARY ASSESSMENT/SITE INSPECTION
JET PROPULSION LABORATORY

Dear Mr. Green:

We have enclosed the Preliminary Assessment/Site Inspection report prepared for the Jet Propulsion Laboratory (JPL). The report incorporates the comments of both NASA Headquarters and JPL staff.

As indicated by the HRS score (38.3), this facility should have a high priority for additional contamination assessment work. Specifically, we would recommend prompt investigations of the six seepage pits where chemical wastes were disposed of in the 1940's and 1950's, and which may have caused contamination of the municipal water supply wells. We would also recommend investigations of the alleged chemical spills near Building 187 and continued study of the contaminated municipal wells. These studies should be coordinated with the on-going Corps of Engineers (Former Sites Program) study.

Specifically, we would recommend the following hydrogeologic studies:

- Soil borings and groundwater monitoring wells should be implemented near each of the six alleged disposal pits and at Building 187 (former spill location). In order to determine more precise locations of the pits, further interviews with JPL employees should also be conducted.

- Deeper definition of the contamination near the city water supply wells. Because the volatile organic constituents of concern are more dense than water, they tend to accumulate in the lowest part of the aquifer. Samples taken to date have been collected from a depth of 366 feet (cased depth of well), whereas the aquifer probably extends to 600 feet.

- The seepage pits and the municipal wells should be sampled for all EPA priority pollutants because of the disposal of unknown chemicals in the seepage pits.

06/01/2015
Item 27

We wish to extend our thanks to Ms. Mary Drazek and the other JPL staff, who were very helpful in identifying past and present waste disposal practices. If you have any specific questions or concerns, please contact Mr. Gary Cronk at (714) 662-4050 or Mr. Stephen Turner at (703) 558-7512.

Sincerely,

Thomas H. Magness III
Manager of Environmental Projects

THM/ST/wpc
Attachments

cc: M. Drazek, JPL

3214E

SUMMARY

1. Introduction

Ebasco Services, Inc. representatives visited the NASA-Jet Propulsion Laboratory (JPL) in Pasadena, CA on February 22-24, 1988. The purpose of this visit was to perform a Preliminary Assessment and Site Inspection (PA/SI) as mandated by the EPA. Ebasco was represented by Mr. Gary Cronk and Ms. Michelle Leonard. The NASA-JPL representative was Ms. Mary Drazek. This summary report presents the findings of the Preliminary Assessment.

The NASA-JPL facility is located northeast of the 210 Foothill Freeway in Pasadena, California. The site is comprised of 176 acres, and is situated on the south-facing slope of a foothill ridge of the San Gabriel Mountains adjacent to the Arroyo Seco wash. The site is situated on an alluvial fan and is characterized by highly permeable soils.

The site was developed by the Army between 1945 and 1957, and remained under Army control until it was taken over by NASA in 1958. The California Institute of Technology (Cal Tech) operates the lab for NASA. The lab functions as NASA's primary center for unmanned interplanetary exploration in conjunction with the NASA mission of space exploration and aeronautical research and development. Over 100 different types of chemicals are used at the facility in conducting research in spacecraft propulsion and design, and in alternative energy sources and pollution control.

2. Concerns

Several areas of environmental concern were identified by Mary Drazek and other JPL staff. The following is a brief discussion of these areas:

a. Seepage Pit #1 near Building #103 (see Map Location #1). The site was located outside of the JPL fence in the Arroyo Seco dry wash, at the southeast corner of the lab. This site was approximately 15 feet wide by 15 feet deep, and was used primarily for disposal of municipal solid wastes. However, according to JPL personnel, chemical wastes were also disposed, including solvents, freon, mercury, solid rocket fuel propellants, cooling tower chemicals, and sulfuric acid. None of the wastes were disposed in containers except for the mercury which was in small flasks. No sampling near this pit has been conducted to verify contamination.

b. Seepage Pit #2 near Arroyo Parking Lot (see Map Location #2). This site was located below the Southern California Edison substation, approximately 50 yards from the end of the main storm drain that empties into the Arroyo Seco wash. This pit was approximately 30 feet wide and 15 feet deep. The pit is believed to be under the existing parking lot. Wastes disposed at this pit were similar to those at Pit #1. The site was also used for burning debris, and for disposal of fluorescent lights and waste magnesium. No sampling of this pit has been conducted.

c. Seepage Pit #3 near Building #117 (see Map Location #3). This disposal pit was located just northwest of two current day bunkers #140 and #141, used for storing propellants. The pit was approximately 30 feet deep, and was used primarily for the disposal of propellants and mixed solvents. No sampling of this pit has been conducted. Seepage pits #1, #2, and #3 received chemical wastes over the period 1954-1958 according to JPL personnel.

d. Seepage Pit #4 near Building 303 and former building 59 (see Map). This pit was used exclusively for disposal of chemistry lab wastes. This pit location was investigated down to a depth of 11 feet in 1984 by R.C. Slade.(1) Lead concentrations (200 ppm) were found above normal levels. No other contaminants were found.

e. Seepage Pit #5 near Building 302 and former building 65 (see Map). This pit was also used exclusively for disposal of chemistry lab wastes. R.C. Slade also investigated this pit and didn't find any contaminants above normal levels down to 11 feet.

f. Seepage Pit #6 near Building 97 (see Map). This was the former site of a chemistry lab that used this pit for disposal of lab wastes. R.C. Slade investigated this pit to 11 feet and no contaminants above normal levels were found. Disposal in Pits #4, #5, and #6 occurred during the approximate period of 1941-1960.

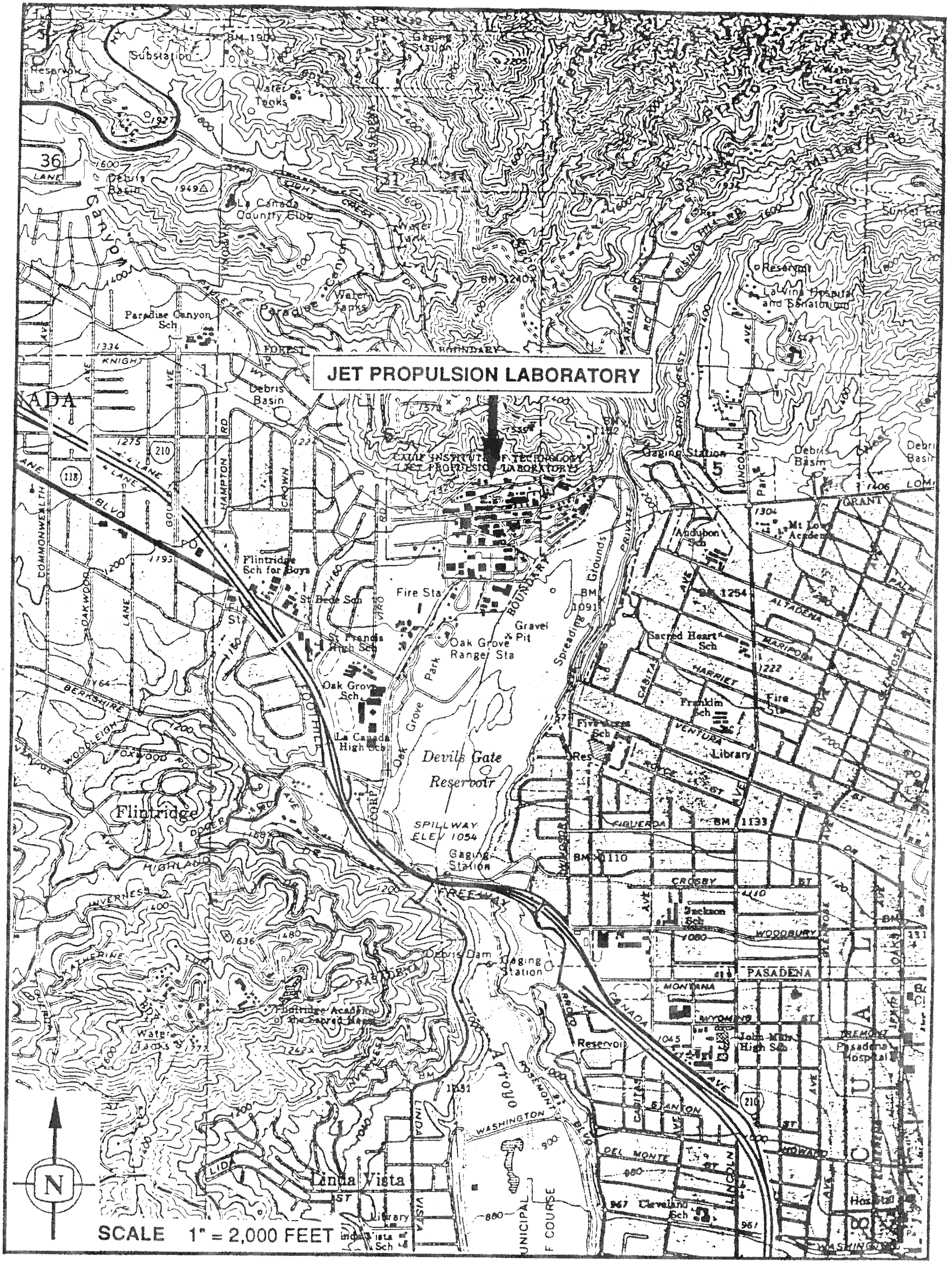
g. Past Spills Near Chemical Storage Building (Building 187). According to JPL personnel, waste solvents were historically dumped onto the soils near this storage building. No sampling has ever been conducted to confirm any contamination.

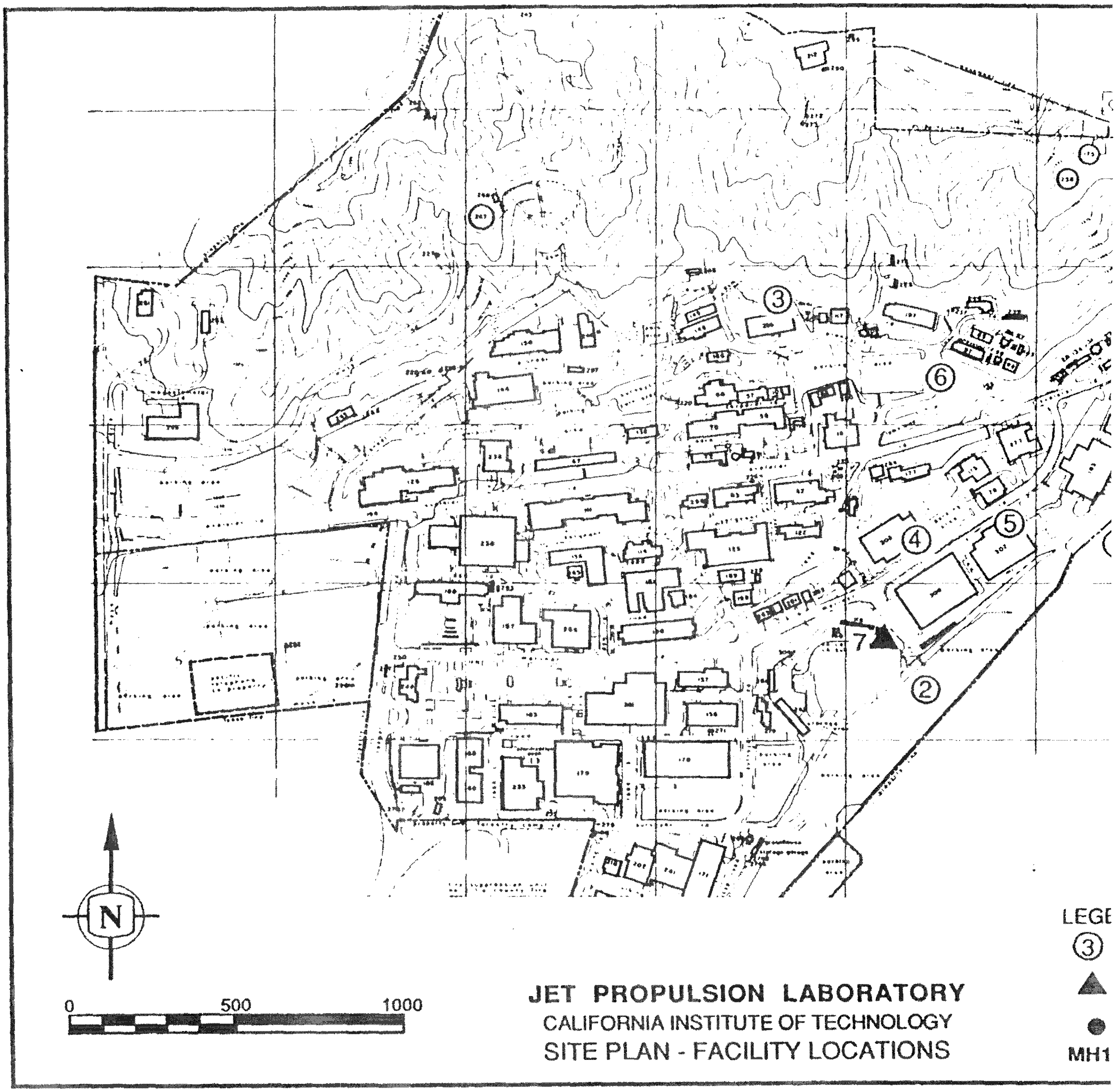
h. Municipal Water Wells. Testing in 1980 of three City of Pasadena wells, 1,000 feet downgradient of the JPL site, indicated concentrations of TCE, PCE, and CCl_4 above drinking water standards. The wells, which provide drinking water to San Gabriel Valley residents, were removed from service. A hydrogeologic study was conducted by R.C. Slade,(1) who drilled a monitoring well about half the distance (500 ft.) from JPL. This well showed contaminant levels of 7.5 ug/l for TCE and 2.4 ug/l for CCl_4. He concluded that past JPL (and U.S. Army) activities probably contributed to the groundwater contamination. In another study conducted for the City by James M. Montgomery, several treatment alternatives were evaluated which led to the installation of a pilot treatment plant at one of the contaminated wells.(2) However, the studies conducted to date have not determined the full extent or degree of contamination, nor do they identify the specific source areas of contamination.

The U.S. Army Corps of Engineers (Los Angeles District) is currently conducting a remedial investigation of the site, including the placement of monitoring wells in Arroyo Seco and west of the JPL facility.

3. Recommendations

Due to the nature of past JPL waste disposal activities and the current contamination of downgradient municipal water supply wells, a Site Inspection of JPL should be conducted.


JET PROPULSION LABORATORY
CALIF INSTITUTE OF TECHNOLOGY (JET PROPULSION LABORATORY)
Devils Gate Reservoir
SPILLWAY ELEV 1054
Gaging Station
Oak Grove Park
Oak Grove Ranger Sta
Gravel Pit
Spreading Grounds
Fire Sta
Flintridge Sch for Boys
St Bede Sch
St Francis High Sch
Oak Grove Sch
La Canada High Sch
La Canada Country Club
Paradise Canyon Sch
Debris Basin
Flintridge
Flintridge Academy of the Sacred Heart
Debris Dam
Linda Vista
Library
Linda Vista Sch
Arroyo
Municipal Golf Course
Reservoir
John Muir High Sch
Pasadena Hospital
Jackson Sch
Cleveland Sch
Franklin Sch
Sacred Heart Sch
Audubon Sch
Five Acres Sch
La Vina Hospital and Sanatorium
Mt Lowe Academy
FOOTHILL BLVD
FREEWAY
210
118
36
SCALE 1" = 2,000 FEET
N



JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
SITE PLAN - FACILITY LOCATIONS

Reference Documents

1. Preliminary Hydrogeologic Assessment of Soils and Groundwater Monitoring at JPL; Richard C. Slade, September 1984. (Attachment).

2. Treatability/Feasibility Study for Groundwater Contaminated with Volatile Organic Chemicals in the Monk Hill Subarea of the Raymond Basin; James M. Montgomery, Consulting Engineers, Inc., November 1986. (Attachment).

3. Environmental Resources Document, JPL, December, 1980.

4. AB 1803 Water Analysis Plan for the Raymond Basin; Raymond Basin Management Board, May 1985.

5. Watermaster Service in Raymond Basin, July 1, 1984-June 30, 1985; California Department of Water Resources, Southern District, September 1985.

6. Memorandum from Mary Wang, JPL Environmental Coordinator, to William Rains, regarding review of Treatability feasibility Study, December 1986.

7. Letter from Karl A. Johnson, General Manager, City of Pasadena, to Lt. General Charles H. Terhune, Deputy Director, JPL, suggesting JPL and City work cooperatively on program to investigate presence of chemicals in City's wells.

8. Report on TCE Investigation, April 1980 (w/Addendums) - Los Angeles RWQCB.

9. Jet Propulsion Laboratory Asbestos Survey. Final Report: Building Plan Booklet, Associated Safety Consultants, January 1985.

10. Hazardous Materials Inventory. JPL, Occupational Safety and Environmental Health Office.

11. California Division of Mines and Geology, Open File Report 86-4 LA - Geology of North Half of Pasadena quad.
    a. Geology of the North Half of the Pasadena Quad., L.A. County.
    b. Geologic sections of the North Half of the Pasadena Quad.
    c. Structural Contour Map of the Top of Crystalline Basement Rocks, North Half of Pasadena Quad.

Personnel Interviewed

1. Mary Drazek, JPL Environmental Coordinator (1½ years service with JPL), Meetings 2/21 - 2/23 -- Discussed overall program, concerns, approach to PA/SI, contacts.

2. Bruce Fisher, JPL Energy Resources Coordinator, Interview 2/22 -- Discussed underground tank program, asbestos removal, AQMD permits, and county sanitation sewer analyses.

3. Bill Fehlings, JPL Facilities Maintenance and Operation Section (JPL Employee since 1954). Interview 2/21 -- Discussed past waste disposal practices.

4. Roscoe Edwards, JPL Facilities Maintenance and Operation Section, Interview 2/23 -- Discussed waste disposal practices, aerial photograph (circa 1951).

5. Al Klascius, JPL Safety Office (JPL Employee since 1958). Interview 2/22 -- Discussed beryllium shop and subcommittee, sewer installation.

6. Richard MacGillivray, JPL Facilities Maintenance and Operation Section (JPL Employee since 1959). Interview 2/23 — Discussed waste disposal practices.

7. Lane Prior, Former (Retired) JPL Safety Officer. Interview with M. Drazek, JPL Environmental Contact, information transferred to Ebasco Services. Discussed past disposal practices.

8. Tom Underbrink, Civil Engineer, City of Pasadena Water and Power Department. Discussed population served by groundwater; referred to Health Department for past response activities at JPL.

9. Tom Reardon, City of Pasadena Environmental Health Department. Discussed agency responsibilities for response activities.

10. Laura Dahl, Planner, City of Pasadena. Discussed land use and population densities in vicinity of JPL.

11. Bill Campbell, Director, City of La Canada, Flintridge Community Development Department. Discussed land use, and population densities in vicinity of JPL.

EPA

POTENTIAL HAZARDOUS WASTE SITE
PRELIMINARY ASSESSMENT
PART 1 - SITE INFORMATION AND ASSESSMENT

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
CA	9800013030

II. SITE NAME AND LOCATION

01 SITE NAME (Legal, common, or descriptive name of site)	02 STREET, ROUTE NO., OR SPECIFIC LOCATION IDENTIFIER
NASA - Jet Propulsion Laboratory	4800 Oak Grove Dr.

03 CITY	04 STATE	05 ZIP CODE	06 COUNTY	07 COUNTY CODE	08 CONG DIST
Pasadena	CA	91109	Los Angeles	037	25

09 COORDINATES LATITUDE 34°12' 00.N LONGITUDE 118°10' 30.W

10 DIRECTIONS TO SITE (Starting from nearest public road)

Off Highway 210 take Bershire Exit East, then Northwest on Oak Grove approximately 1 mile

III. RESPONSIBLE PARTIES

01 OWNER (If known)	02 STREET (Business, mailing, residential)
NASA	4800 Oak Grove Drive

03 CITY	04 STATE	05 ZIP CODE	06 TELEPHONE NUMBER
Pasadena	CA	91109	(818) 354-4710

07 OPERATOR (If known and different from owner)	08 STREET (Business, mailing, residential)
JPL/California Institute of Technology	4800 Oak Grove Drive

09 CITY	10 STATE	11 ZIP CODE	12 TELEPHONE NUMBER
Pasadena	CA	91109	(818) 354-4710

13 TYPE OF OWNERSHIP (Check one)

☐ A. PRIVATE ☒ B. FEDERAL: NASA (Agency name) ☐ C. STATE ☐ D. COUNTY ☐ E. MUNICIPAL

☐ F. OTHER: ______ (Specify) ☐ G. UNKNOWN

14 OWNER/OPERATOR NOTIFICATION ON FILE (Check all that apply)

☒ A. RCRA 3001 DATE RECEIVED: Fall / 80 (MONTH DAY YEAR) ☐ B. UNCONTROLLED WASTE SITE (CERCLA 103 c) DATE RECEIVED: __/__/__ (MONTH DAY YEAR) ☐ C. NONE

IV. CHARACTERIZATION OF POTENTIAL HAZARD

01 ON SITE INSPECTION

☐ YES DATE __/__/__ (MONTH DAY YEAR)
☐ NO

BY (Check all that apply) ☐ A. EPA ☐ B. EPA CONTRACTOR ☐ C. STATE ☐ D. OTHER CONTRACTOR ☐ E. LOCAL HEALTH OFFICIAL ☐ F. OTHER: ______ (Specify)

CONTRACTOR NAME(S): ______

02 SITE STATUS (Check one)

☒ A. ACTIVE ☐ B. INACTIVE ☐ C. UNKNOWN

03 YEARS OF OPERATION

1941 (BEGINNING YEAR) | Present (ENDING YEAR) ☐ UNKNOWN

Army 1941-58
NASA 1958-Present

04 DESCRIPTION OF SUBSTANCES POSSIBLY PRESENT, KNOWN, OR ALLEGED

Three seepage Pits formerly used (1954-1958) for disposal of solvents, freon, mercury, solid rocket propellants, sulfuric acid, cooling tower chemicals. Three Seepage Pits formerly used (1941-1960) for disposal of chemistry lab wastes.

05 DESCRIPTION OF POTENTIAL HAZARD TO ENVIRONMENT AND/OR POPULATION

Former Seepage Pits are located in wash, creating a potential for surface and groundwater contamination. On-site pits present potential for soil and groundwater contamination. Downgradient drinking water supply has elevated levels of TCE, PCE, and CCl_4

V. PRIORITY ASSESSMENT

01 PRIORITY FOR INSPECTION (Check one. If high or medium is checked, complete Part 2 - Waste Information and Part 3 - Description of Hazardous Conditions and Incidents)

☒ A. HIGH (Inspection required promptly) ☐ B. MEDIUM (Inspection required) ☐ C. LOW (Inspect on time available basis) ☐ D. NONE (No further action needed, complete current disposition form)

VI. INFORMATION AVAILABLE FROM

01 CONTACT	02 OF (Agency/Organization)	03 TELEPHONE NUMBER
Mary Drazek	NASA - JPL	(818) 354-4710

04 PERSON RESPONSIBLE FOR ASSESSMENT	05 AGENCY	06 ORGANIZATION	07 TELEPHONE NUMBER	08 DATE
M. Leonard/G. Cronk		Ebasco	(714) 662-4050	2/22/88 (MONTH DAY YEAR)

POTENTIAL HAZARDOUS WASTE SITE
PRELIMINARY ASSESSMENT
PART 2 - WASTE INFORMATION

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
CA	9800013030

II. WASTE STATES, QUANTITIES, AND CHARACTERISTICS

01 PHYSICAL STATES *(Check all that apply)*

[✓ A. SOLID]
B. POWDER, FINES
[✓ C. SLUDGE]
D. OTHER ______ (Specify)
E. SLURRY
[✓ F. LIQUID]
G. GAS

02 WASTE QUANTITY AT SITE *(Measures of waste quantities must be independent)*

TONS ______
CUBIC YARDS ______
NO. OF DRUMS 15-20/3 months

03 WASTE CHARACTERISTICS *(Check all that apply)*

[✓ A. TOXIC]
[✓ B. CORROSIVE]
[✓ C. RADIOACTIVE]
D. PERSISTENT
E. SOLUBLE
F. INFECTIOUS
[✓ G. FLAMMABLE]
[✓ H. IGNITABLE]
I. HIGHLY VOLATILE
[✓ J. EXPLOSIVE]
[✓ K. REACTIVE]
[✓ L. INCOMPATIBLE]
M. NOT APPLICABLE

III. WASTE TYPE

CATEGORY	SUBSTANCE NAME	01 GROSS AMOUNT	02 UNIT OF MEASURE	03 COMMENTS
SLU	SLUDGE	unknown	Drums	Paints
OLW	OILY WASTE	3,000	Gal	Waste Oil/4-5 months
SOL	SOLVENTS	10-15	Drums	Mixed Solvents/3 months
PSD	PESTICIDES			
OCC	OTHER ORGANIC CHEMICALS	Unknown	Drums	PCBs
IOC	INORGANIC CHEMICALS			
ACD	ACIDS	Unknown		Sulfuric, acetic, hydrochloric
BAS	BASES	Unknown		Sodium Hydroxide, Lead
MES	HEAVY METALS	1.2	Tons	Mercury, batteries (recycled)

IV. HAZARDOUS SUBSTANCES *(See Appendix for most frequently cited CAS Numbers)*

01 CATEGORY	02 SUBSTANCE NAME	03 CAS NUMBER	04 STORAGE DISPOSAL METHOD	05 CONCENTRATION	06 MEASURE OF CONCENTRATION
MES	Beryllium	7440-41-7	Drums/contract Haul		
MES	Mercury	7439-97-6	Drums/contract Haul		
IOC	Asbestos	1332-21-4	Drums/contract Haul		
SOL	Benzene	71-43-2	Lab Packs/contract Haul		
SOL	Toluene	108-88-3	Lab Packs/contract Haul		
OCC	PCB oils	1336-36-3	Drums/contract Haul		
OCC	Freon	999	Drums/contract Haul		
SOL	Methylene Chloride	999	Drums/contract Haul		
MES	Lead	301-04-2	Recycle batteries	200 (soil)	PPM
SOL	Trichloroethane	25323-89-1	Drums/contract Haul		
SOL	Trichlorotrifluoroethane	999	Drums/contract Haul		
ACD	Sulfuric Acid	7664-93-9	Drums/contract Haul		
ACD	Acetic Acid	64-19-7	Drums/contract Haul		
BAS	Sodium Hydroxide	1310-73-2	Drums/contract Haul		
ACD	Hydrochloric Acid	7647-01-0	Drums/contract Haul		
	* See note below				

V. FEEDSTOCKS *(See Appendix for CAS Numbers)*

CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER	CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER
FDS	Mercury	7439-97-6	FDS	Acetone	67-64-1
FDS	Toluene	108-88-3	FDS	Acetic Acid	64-19-7
FDS	Sulfuric Acid	7664-93-9	FDS	Hydrochloric Acid	7647-01-0
FDS	Sodium Hydroxide	1310-73-2	FDS		

VI. SOURCES OF INFORMATION *(Cite specific references, e.g., state files, sample analysis, reports)*

° Hazardous Waste Manifests
° Mary Drazek, JPL Environmental contact

Note: Over 100 hazardous substances stored at a time, in quantities of less than than a gallon of liquid or a kilogram of solids

EPA

POTENTIAL HAZARDOUS WASTE SITE
PRELIMINARY ASSESSMENT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
CA	9800013030

II. HAZARDOUS CONDITIONS AND INCIDENTS

01 ☒ A. GROUNDWATER CONTAMINATION
02 ☒ OBSERVED (DATE since 1980) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED ______
04 NARRATIVE DESCRIPTION

VOC contamination of three (3) Municipal wells 1000 ft. downgradient from JPL. Sampling at monitoring well between JPL and municipal wells showed concentration of VOCs at 7.5 ug/l for TCE and 2.4 ug/l for CCl_4.

01 ☐ B. SURFACE WATER CONTAMINATION
02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☒ ALLEGED
03 POPULATION POTENTIALLY AFFECTED ______
04 NARRATIVE DESCRIPTION

. Seepage pit located in Arroyo (1954-58) probably contaminated surface water.
. Periodic chemical spills drain directly to Arroyo Seco

01 ☐ C. CONTAMINATION OF AIR
02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED ______
04 NARRATIVE DESCRIPTION

None Alleged or Observed

01 ☐ D. FIRE/EXPLOSIVE CONDITIONS
02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED ______
04 NARRATIVE DESCRIPTION

None Alleged or Observed

01 ☐ E. DIRECT CONTACT
02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED ______
04 NARRATIVE DESCRIPTION

None Alleged or Observed

01 ☒ F. CONTAMINATION OF SOIL
02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☒ ALLEGED
03 AREA POTENTIALLY AFFECTED ______ (Acres)
04 NARRATIVE DESCRIPTION

Potential for soil contamination at six seepage pits from dumping of freon, mercury, solvents and other chemicals (See facility map).

01 ☒ G. DRINKING WATER CONTAMINATION
02 ☒ OBSERVED (DATE 1980) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED ______
04 NARRATIVE DESCRIPTION

Municipal wells downgradient of JPL have been detected with TCE, PCE, CC14 contamination. Specific source has not been determined. Wells have been shut down periodically between 1983 and 1986.

01 ☐ H. WORKER EXPOSURE/INJURY
02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☐ ALLEGED
03 WORKERS POTENTIALLY AFFECTED ______
04 NARRATIVE DESCRIPTION

None Alleged or Observed

01 ☐ I. POPULATION EXPOSURE/INJURY
02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED ______
04 NARRATIVE DESCRIPTION

None Alleged or Observed

EPA

POTENTIAL HAZARDOUS WASTE SITE
PRELIMINARY ASSESSMENT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION
01 STATE CA
02 SITE NUMBER 9800013030

II. HAZARDOUS CONDITIONS AND INCIDENTS (Continued)

01 ☐ J. DAMAGE TO FLORA 02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

None Alleged or Observed

01 ☐ K. DAMAGE TO FAUNA 02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION (include name(s) of species)

None Alleged or Observed

01 ☐ L. CONTAMINATION OF FOOD CHAIN 02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

None Alleged or Observed

01 ☒ M. UNSTABLE CONTAINMENT OF WASTES (Spills runoff standing liquids leaking drums) 02 ☐ OBSERVED (DATE ______) ☒ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: 0
04 NARRATIVE DESCRIPTION

No spill containment provisions at hazardous waste storage area.

01 ☒ N. DAMAGE TO OFFSITE PROPERTY 02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☒ ALLEGED
04 NARRATIVE DESCRIPTION

JPL may have contributed to contamination of Municipal water supply wells.

01 ☒ O. CONTAMINATION OF SEWERS, STORM DRAINS, WWTPs 02 ☐ OBSERVED (DATE ______) ☒ POTENTIAL ☒ ALLEGED
04 NARRATIVE DESCRIPTION

- Alleged dumping of chemicals into storm drains and sewers.

01 ☐ P. ILLEGAL/UNAUTHORIZED DUMPING 02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☒ ALLEGED
04 NARRATIVE DESCRIPTION

None alleged or Observed

05 DESCRIPTION OF ANY OTHER KNOWN, POTENTIAL, OR ALLEGED HAZARDS

III. TOTAL POPULATION POTENTIALLY AFFECTED: ______

IV. COMMENTS

Locations of seepage Pits are based on JPL employees recollections; areas have been changed considerably since 1958 with new buildings, removal of old structures, re-alignment of roads, and grading. Further sampling, data research, and interviewing is necessary.

V. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

- Interviews with JPL personnel.
- Treat ability/feasibility study for groundwater contaminated w/VOCs - J. M. Montgomery
- Preliminary Hydrogeologic Assessment of soils & groundwater monitoring - R.C.Slade

SITE INSPECTION REPORT
FOR
NASA-JET PROPULSION LABORATORY

4800 Oak Grove Drive
Pasadena, CA 91109
Site Number CA9800013030

SUMMARY

1. Introduction

Ebasco Services, Inc. representatives visited the NASA-Jet Propulsion Laboratory (JPL) in Pasadena, CA on February 22-24, 1988. The purpose of this visit was to perform a Preliminary Assessment and Site Inspection (PA/SI) as mandated by the EPA. Ebasco was represented by Mr. Gary Cronk and Ms. Michelle Leonard. The NASA-JPL representative was Ms. Mary Drazek. This summary report presents the findings of the Site Inspection and the Hazard Ranking System (HRS) scoring.

2. Concerns

Potential areas of concern were evaluated through interviews with former and present JPL employees, a literature review, and investigations of seepage pit locations. The following sites were evaluated in the SI and the HRS scoring:

a. Seepage Pit #1 near Building #103 (see Map Location #1). The site was located outside of the JPL fence in the Arroyo Seco dry wash, at the southeast corner of the lab. This site was approximately 15 feet wide by 15 feet deep, and was used primarily for disposal of municipal solid wastes. However, according to JPL personnel, chemical wastes were also disposed, including solvents, freon, mercury, solid rocket fuel propellants, cooling tower chemicals, and sulfuric acid. None of the wastes were disposed in containers except for the mercury which was in small flasks. No sampling near this pit has been conducted to verify contamination.

b. Seepage Pit #2 near Arroyo Parking Lot (see Map Location #2). This site was located below the Southern California Edison substation, approximately 50 yards from the end of the main storm drain that empties into the Arroyo Seco wash. This pit was approximately 30 feet wide and 15 feet deep. The pit is believed to be under the existing parking lot. Wastes disposed at this pit were similar to those at Pit #1. The site was also used for burning debris, and for disposal of fluorescent lights and waste magnesium. No sampling of this pit has been conducted.

c. Seepage Pit #3 near Building #117 (see Map Location #3). This disposal pit was located just northwest of two current day bunkers #140 and #141, used for storing propellants. The pit was approximately 30 feet deep, and was used primarily for the disposal of propellants and mixed solvents. No sampling of this pit has been conducted. Seepage pits #1, #2, and #3 received chemical wastes over the period 1954-1958 according to JPL personnel.

d. Seepage Pit #4 near Building 303 and former building 59 (see Map). This pit was used exclusively for disposal of chemistry lab wastes. This pit location was investigated down to a depth of 11 feet in 1984 by R.C. Slade.(1) Lead concentrations (200 ppm) were found above normal levels. No other contaminants were found.

e. Seepage Pit #5 near Building 302 and former building 65 (see Map). This pit was also used exclusively for disposal of chemistry lab wastes. R.C. Slade also investigated this pit and didn't find any contaminants down to the 11 foot level.

f. Seepage Pit #6 near Building 97 (see Map). This was the former site of a chemistry lab that used this pit for disposal of lab wastes. R.C. Slade investigated this pit to 11 feet and no contaminants above normal levels were found. Disposal in Pits #4, #5, and #6 occurred during the approximate period of 1941-1960.

g. Past Spills Near Chemical Storage Building (Building 187). According to JPL personnel, waste solvents were historically dumped onto the soils near this storage building. No sampling has ever been conducted to confirm any contamination.

h. Municipal Water Wells. Testing in 1980 of three City of Pasadena wells, only 1,000 feet downgradient of the JPL site, indicated concentrations of TCE, PCE, and CCl_4 above drinking water standards. The wells, which provide drinking water to San Gabriel Valley residents, were removed from service. A hydrogeologic study was conducted by R.C. Slade, who drilled a monitoring well about half the distance (500 ft.) from JPL. This well showed contaminant levels of 7.5 ug/l for TCE and 2.4 ug/l for CCl_4. He concluded that past JPL (and U.S. Army) activities probably contributed to the groundwater contamination.(1) In another study conducted for the City by James M. Montgomery, several treatment alternatives were evaluated which led to the installation of a pilot treatment plant at one of the contaminated wells.(2) However, the studies conducted to date have not determined the full extent or degree of contamination, nor do they identify the specific source areas of contamination.

The U.S. Army Corps of Engineers (Los Angeles District) is currently conducting a remedial investigation of the site, including the placement of monitoring wells in Arroy Seco and to the west of the JPL facility.

3. Data Gaps

The following information was not available or was estimated during completion of the SI form:

- Hazardous substances, Part 2, IV (incomplete list)
- Description of wells, Part 5, III-09 (not readily available)
- Permeability of unsaturated zone, Part 5, VI-01 (estimated)
- Permeability of bedrock, Part 5, VI-02 (estimated)
- Depth of contaminated soil zone, Part 5, VI-04 (unknown)
- Site slope and terrain average slope, Part 5, VI-08 (unknown)
- Distance to agricultural land, Part 5, VI-13 (unknown)

4. Hazard Ranking System Score

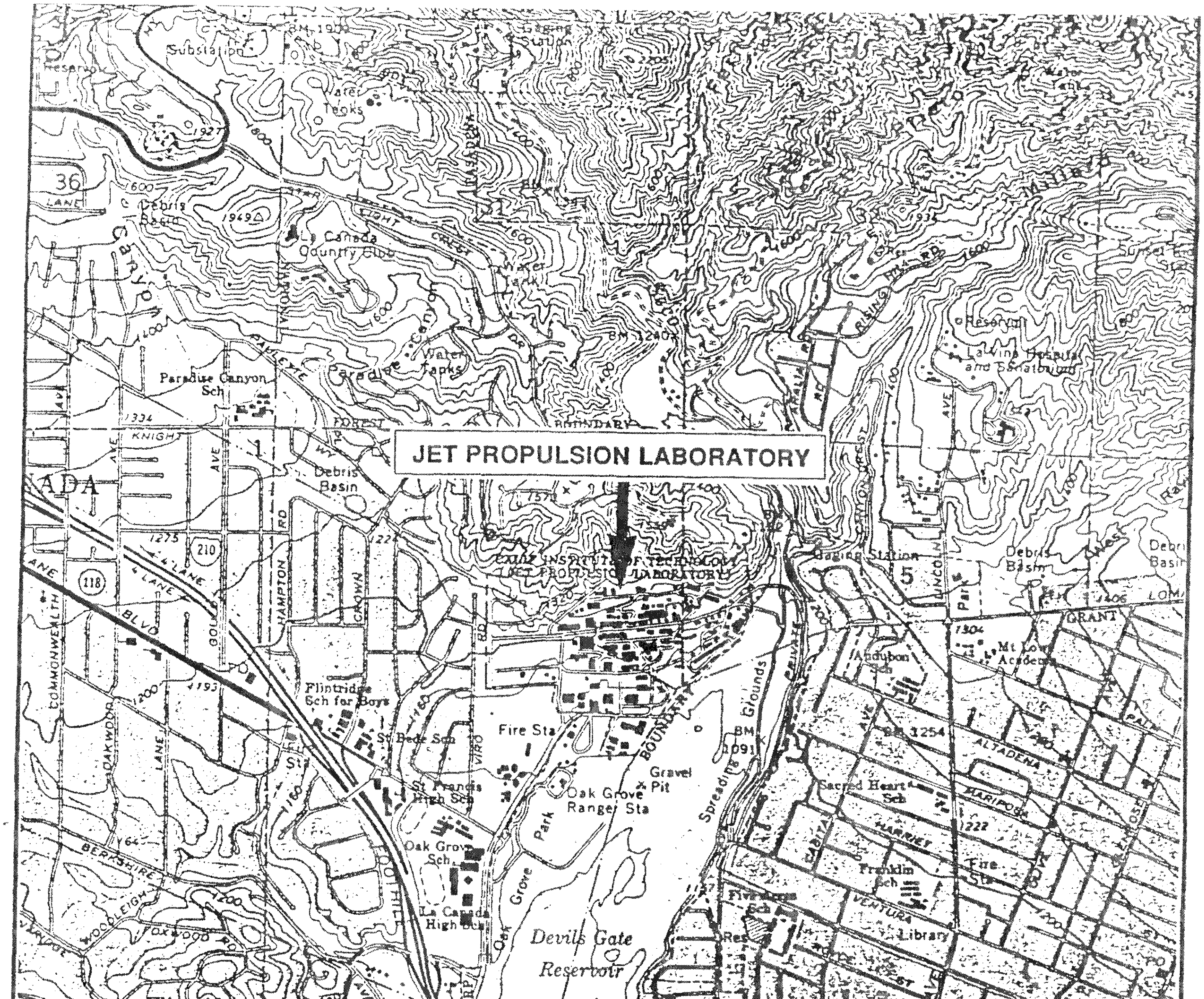
Following completion of the SI investigation a Hazard Ranking System (HRS) score was computed for JPL. The overall migration route score (S_m) and the individual migration scores are summarized below:

S_m (weighted-overall score) = 38.3
S_{gw} (groundwater migration route) = 65.9
S_{sw} (surface water migration route) = 7.4
S_a (air migration route) = 0

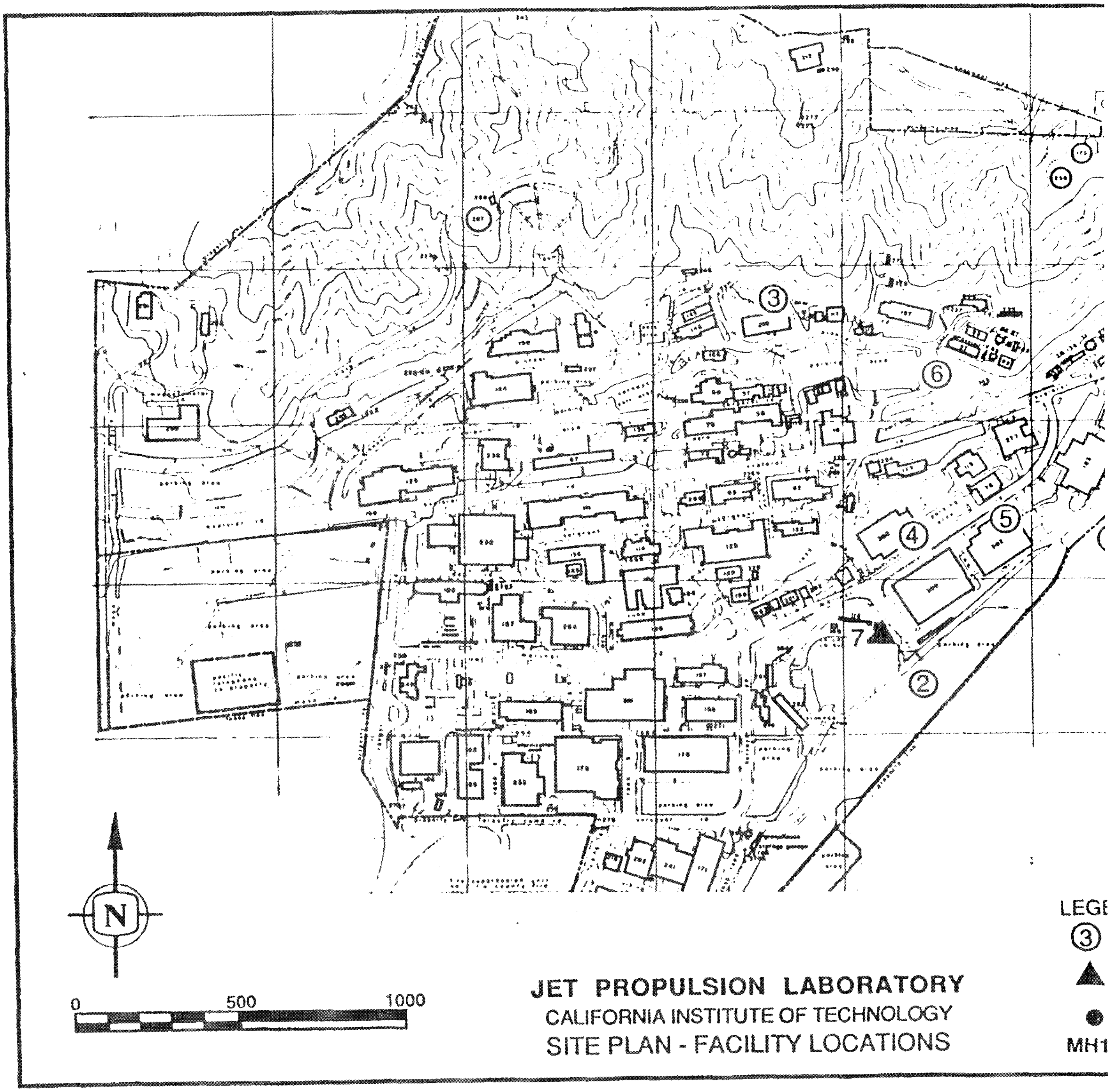
The overall score of 38.3 is well above the 28.5 level to be considered for the National Priorities List (NPL). Thus, the relative environmental and public health hazard at JPL must be considered high. JPL was ranked very high for the groundwater migration route (S_{gw} = 65.9), since a municipal water supply has already been affected. It should be noted that this score assumed a conservative value for hazardous waste quantity disposed, using a range 41-250 drums (2,000-12,500 gallons). It is unknown how much hazardous waste may have actually been dumped into the seepage pits.

5. Recommendations

JPL should receive a high priority for further hydrogeologic studies due to the severity of the on-site contamination sources. The high HRS score of 38.3 is reflective of the high public health risk due to the contamination of the City of Pasadena's water wells. Additional studies should focus on the 6 seepage pits, the chemical spill site near Building 187, and continued monitoring of the municipal wells. The Army Corps of Engineers is currently conducting a remedial investigation surrounding the JPL Site, and efforts should be made to coordinate future work with the Corps of Engineers.



JET PROPULSION LABORATORY
California Institute of Technology Jet Propulsion Laboratory
Devils Gate Reservoir
Spillway Elev 1054
Oak Grove Park
Oak Grove Ranger Sta
Gravel Pit
Spreading Grounds
Flintridge
La Canada Country Club
Paradise Canyon Sch
Flintridge Sch for Boys
St Bede Sch
St Francis High Sch
Oak Grove Sch
La Canada High Sch
Fire Sta
Foothill Freeway
Gaging Station
Debris Basin
Debris Dam
Flintridge Academy of the Sacred Heart
Linda Vista
Municipal Golf Course
Audubon Sch
Sacred Heart Sch
Franklin Sch
Library
Jackson Sch
John Muir High Sch
Pasadena Hospital
Cleveland Sch
Altadena
Pasadena
N
SCALE 1" = 2,000 FEET



JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
SITE PLAN - FACILITY LOCATIONS

Reference Documents

1. Preliminary Hydrogeologic Assessment of Soils and Groundwater Monitoring at JPL; Richard C. Slade, September 1984. (Attachment).

2. Treatability/Feasibility Study for Groundwater Contaminated with Volatile Organic Chemicals in the Monk Hill Subarea of the Raymond Basin; James M. Montgomery, Consulting Engineers, Inc., November 1986. (Attachment).

3. Environmental Resources Document, JPL, December, 1980.

4. AB 1803 Water Analysis Plan for the Raymond Basin; Raymond Basin Management Board, May 1985.

5. Watermaster Service in Raymond Basin, July 1, 1984-June 30, 1985; California Department of Water Resources, Southern District, September 1985.

6. Memorandum from Mary Wang, JPL Environmental Coordinator, to William Rains, Safety Office, regarding review of Treatability feasibility Study, December 1986.

7. Letter from Karl A. Johnson, General Manager, City of Pasadena, to Lt. General Charles H. Terhune, Deputy Director, JPL, suggesting JPL and City work cooperatively on program to investigate presence of chemicals in City's wells.

8. Report on TCE Investigation, April 1980 (w/Addendums) - Los Angeles RWQCB.

9. Jet Propulsion Laboratory Asbestos Survey. Final Report: Building Plan Booklet, Associated Safety Consultants, January 1985.

10. Hazardous Materials Inventory. JPL, Occupational Safety and Environmental Health Office.

11. California Division of Mines and Geology, Open File Report 86-4 LA - Geology of North Half of Pasadena Quad.
    a. Geology of the North Half of the Pasadena Quad., L.A. County.
    b. Geologic sections of the North Half of the Pasadena Quad.
    c. Structural Contour Map of the Top of Crystalline Basement Rocks, North Half of Pasadena Quad.

<u>Personnel Interviewed</u>

1. Mary Drazek, JPL Environmental Coordinator (1½ years service with JPL), Meetings 2/21 - 2/23 -- Discussed overall program, concerns, approach to PA/SI, contacts.

2. Bruce Fisher, JPL Energy Resources Coordinator, Interview 2/22 -- Discussed underground tank program, asbestos removal, AQMD permits, and county sanitation sewer analyses.

3. Bill Fehlings, JPL Facilities Maintenance and Operation Section, (JPL Employee since 1954). Interview 2/21 -- Discussed past waste disposal practices.

4. Roscoe Edwards, JPL Facilities Maintenance and Operation Section, Interview 2/23 -- Discussed waste disposal practices, aerial photograph (circa 1951).

5. Al Klascius, JPL Safety Office (JPL Employee since 1958). Interview 2/22 -- Discussed beryllium shop and subcommittee, sewer installation.

6. Richard MacGillivray, JPL Facilities Maintenance and Operation Section (JPL Employee since 1959). Interview 2/23 — Discussed waste disposal practices.

7. Lane Prior, Former (Retired) JPL Safety Officer. Interview with M. Drazek, JPL Environmental Contact, information transferred to Ebasco Services. Discussed past disposal practices.

8. Tom Underbrink, Civil Engineer, City of Pasadena Water and Power Department. Discussed population served by groundwater; referred to Health Department for past response activities at JPL.

9. Tom Reardon, City of Pasadena Environmental Health Department. Discussed agency responsibilities for response activities.

10. Laura Dahl, Planner, City of Pasadena. Discussed land use and population densities in vicinity of JPL.

11. Bill Campbell, Director, City of La Canada, Flintridge Community Development Department. Discussed land use, and population densities in vicinity of JPL.

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 1 - SITE LOCATION AND INSPECTION INFORMATION

I. IDENTIFICATION

01 STATE: CA
02 SITE NUMBER: 9800013030

II. SITE NAME AND LOCATION

01 SITE NAME *(Legal, common, or descriptive name of site)*: NASA - Jet Propulsion Laboratory

02 STREET, ROUTE NO., OR SPECIFIC LOCATION IDENTIFIER: 4800 Oak Grove Drive

03 CITY: Pasadena

04 STATE: CA

05 ZIP CODE: 91109

06 COUNTY: Los Angeles

07 COUNTY CODE: 037

08 CONG DIST: 25

09 COORDINATES
LATITUDE: 34° 12' 0 0.N
LONGITUDE: 1 18 1 0 3 0.W

10 TYPE OF OWNERSHIP *(Check one)*
☐ A. PRIVATE ☒ B. FEDERAL NASA ☐ C. STATE ☐ D. COUNTY ☐ E. MUNICIPAL
☐ F. OTHER ☐ G. UNKNOWN

III. INSPECTION INFORMATION

01 DATE OF INSPECTION: 2 / 22/ 88 (MONTH DAY YEAR)

02 SITE STATUS
☒ ACTIVE
☐ INACTIVE

03 YEARS OF OPERATION: Approx. 1941 (BEGINNING YEAR) | Present (ENDING YEAR) ___ UNKNOWN

04 AGENCY PERFORMING INSPECTION *(Check all that apply)*
☐ A. EPA ☐ B. EPA CONTRACTOR ________ *(Name of firm)* ☐ C. MUNICIPAL ☐ D. MUNICIPAL CONTRACTOR ________ *(Name of firm)*
☐ E. STATE ☐ F. STATE CONTRACTOR ________ *(Name of firm)* ☒ G. OTHER Ebasco Services *(Specify)*

05 CHIEF INSPECTOR	06 TITLE	07 ORGANIZATION	08 TELEPHONE NO
Mr. Gary Cronk	Hydrologist	Ebasco	(714) 662-4050

09 OTHER INSPECTORS	10 TITLE	11 ORGANIZATION	12 TELEPHONE NO
Ms. Michelle Leonard	Environmental Scientist	Ebasco	(714) 662-4050
			( )
			( )
			( )
			( )

13 SITE REPRESENTATIVES INTERVIEWED	14 TITLE	15 ADDRESS	16 TELEPHONE NO
Mary Drazek	Environmental Coordinator	JPL-Safety & Environmental Health 4800 Oak Grove Dr.Pasadena	(818) 354-4710
Bruce Fischer	Energy Resources Administrator	JPL-Facilities Maintenance and operation Section 4800 Oak Grove Dr.,Pasadena	(818) 354-2539
William Fehlings	Supervisor, Plumbers	JPL-Facilities Section 4800 Oak Grove Dr.,Pasadena	(818) 354-3522
Richard MacGillivray	Permit and Maintenance Records	JPL-Facilities Maintenance and Operations Section	(818) 354-3522
Alfonse Klascius	Industrial Hygienist	JPL - Safety Office	(818) 354-4710
			( )

17 ACCESS GAINED BY *(Check one)*
☒ PERMISSION
☐ WARRANT

18 TIME OF INSPECTION: 0800-1600 Hrs. Feb.22-24, 1988

19 WEATHER CONDITIONS: Clear, Warm

IV. INFORMATION AVAILABLE FROM

01 CONTACT: Mary Drazek

02 OF *(Agency/Organization)*: NASA - JPL, Environmental Coordinator

03 TELEPHONE NO: (818) 354-4710

04 PERSON RESPONSIBLE FOR SITE INSPECTION FORM: G. Cronk/M.P. Leonard

05 AGENCY:

06 ORGANIZATION: Ebasco Services

07 TELEPHONE NO.: 714/ 662-4050

08 DATE: 03 /17/88 (MONTH DAY YEAR)

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 2 - WASTE INFORMATION

I. IDENTIFICATION

01 STATE: CA
02 SITE NUMBER: 9800013030

II. WASTE STATES, QUANTITIES, AND CHARACTERISTICS

01 PHYSICAL STATES (Check all that apply)

[✓ A SOLID]
B POWDER, FINES
[✓ C SLUDGE]
D OTHER ______ (Specify)
E SLURRY
[✓ F LIQUID]
G GAS

02 WASTE QUANTITY AT SITE (Measures of waste quantities must be independent)

TONS ______
CUBIC YARDS ______
NO. OF DRUMS 15-20/3 months

03 WASTE CHARACTERISTICS (Check all that apply)

[✓ TOXIC]
[✓ CORROSIVE]
[✓ RADIOACTIVE]
[✓ PERSISTENT]
[✓ SOLUBLE]
F INFECTIOUS
[✓ FLAMMABLE]
[✓ IGNITABLE]
[✓ HIGHLY VOLATILE]
[✓ EXPLOSIVE]
[✓ REACTIVE]
[✓ INCOMPATIBLE]
M NOT APPLICABLE

III. WASTE TYPE

CATEGORY	SUBSTANCE NAME	01 GROSS AMOUNT	02 UNIT OF MEASURE	03 COMMENTS
SLU	SLUDGE	Unknown		Paint sludge
OLW	OILY WASTE	3,000	Gallons	Waste oil/4-5 Months
SOL	SOLVENTS	10-15	Drums	Mixed solvents/3 months
PSD	PESTICIDES			
OCC	OTHER ORGANIC CHEMICALS	Unknown	Drums	PCBs
IOC	INORGANIC CHEMICALS			
ACD	ACIDS	Unknown		Sulfuric, acetic, hydrochloric
BAS	BASES	Unknown		Sodium hydroxide, lead
MES	HEAVY METALS	1.2	Tons	Mercury;Batteries (Recycled)

IV. HAZARDOUS SUBSTANCES (See Appendix for most frequently cited CAS Numbers)

01 CATEGORY	02 SUBSTANCE NAME	03 CAS NUMBER	04 STORAGE/DISPOSAL METHOD	05 CONCENTRATION	06 MEASURE OF CONCENTRATION
MES	Beryllium	7440-41-7	Drum/contract Haul		
MES	Mercury	7439-97-6	Drum/Contract Haul		
IOC	Asbestos	1332-21-4	Drum/Contract Haul		
SOL	Methylene chloride	999	Drum/Contract Haul		
SOL	Benzene	71-43-2	Drum/Contract Haul		
SOL	Toluene	108-88-3	Drum/Contract Haul		
OCC	PCB Oils	1336-36-3	Drum/Contract Haul		
MES	Lead	301-04-2	Recycle Batteries	200 (Soil)	PPM
SOL	Trichloroethane	25323-89-1	Drum/Contract Haul		
SOL	Trichlorotrifluoroethane	999	Drum/Contract Haul		
ACD	Sulfuric Acid	7664-93-9	Drum/Contract Haul		
ACD	Acetic Acid	64-19-7	Drum/Contract Haul		
BAS	Sodium Hydroxide	1310-73-2	Drum/Contract Haul		
ACD	Hydrochloric Acid	7647-01-0	Drum/Contract Haul		
	* See Note Below				

V. FEEDSTOCKS (See Appendix for CAS Numbers)

CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER	CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER
FDS	Mercury	7439-97-6	FDS	Acetone	67-64-1
FDS	Toluene	108-88-3	FDS	Acetic Acid	64-19-7
FDS	Sulfuric Acid	7664-93-9	FDS	Hydrochloric Acid	7647-01-0
FDS	Sodium Hydroxide	1310-73-2	FDS		

VI. SOURCES OF INFORMATION (Cite specific references, e.g. state files, sample analysis, reports)

- Mary Drazek, JPL Environmental Contact
- Current JPL Disposal Practices List
- JPL Waste Data Sheet, Manifests
- R. C. Slade Report
- Note: Over 100 hazardous substances stored at a time, in quantities of less than one gallon of liquids or a kilogram of solids.

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION

01 STATE CA
02 SITE NUMBER 9800013030

II. HAZARDOUS CONDITIONS AND INCIDENTS

01 ☒ A GROUNDWATER CONTAMINATION — 02 ☒ OBSERVED (DATE Since 1980) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED ______ — 04 NARRATIVE DESCRIPTION

VOC contamination of 3 municipal wells 1000 feet down gradient from JPL, first observed in 1980. Samples from monitoring well between site and municipal wells showed concentrations os 7.5 ppb of TCE and 2.4 ppb of CCl_4.

01 ☒ B SURFACE WATER CONTAMINATION — 02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☒ ALLEGED
03 POPULATION POTENTIALLY AFFECTED ______ — 04 NARRATIVE DESCRIPTION

. Seepage pit located in Arroyo (1954-1958) probably contaminated surface water.
. Historic chemical spills drained directly into Arroyo Seco.

01 ☐ C CONTAMINATION OF AIR — 02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED ______ — 04 NARRATIVE DESCRIPTION

None alleged or observed

01 ☐ D FIRE/EXPLOSIVE CONDITIONS — 02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED ______ — 04 NARRATIVE DESCRIPTION

None alleged or observed

01 ☐ E. DIRECT CONTACT — 02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED ______ — 04 NARRATIVE DESCRIPTION

None alleged or observed

01 ☒ F CONTAMINATION OF SOIL — 02 ☐ OBSERVED (DATE ______) ☒ POTENTIAL ☐ ALLEGED
03 AREA POTENTIALLY AFFECTED: 0.5 (Acres) — 04 NARRATIVE DESCRIPTION

Alleged dumping of freon, mercury, solvents and other chemicals in 6 disposal pits occurred on-site between 1941 and 1960, potential for soil contamination (see facility map).

01 ☒ G DRINKING WATER CONTAMINATION — 02 ☒ OBSERVED (DATE 1980) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED ______ — 04 NARRATIVE DESCRIPTION

Municipal wells downgradient of JPL have been detected with TCE, PCE, CCl4 contamination. Specific source has not been determined. Wells have been shut down periodically between 1983 and 1986.

01 ☐ H WORKER EXPOSURE/INJURY — 02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☐ ALLEGED
03 WORKERS POTENTIALLY AFFECTED ______ — 04 NARRATIVE DESCRIPTION

None alleged or observed.

01 ☐ I. POPULATION EXPOSURE/INJURY — 02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED ______ — 04 NARRATIVE DESCRIPTION

None alleged or observed.

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
CA	9800013030

II. HAZARDOUS CONDITIONS AND INCIDENTS (Continued)

01 ☐ J DAMAGE TO FLORA — 02 ☐ OBSERVED (DATE ________) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

None alleged or observed

01 ☐ K DAMAGE TO FAUNA — 02 ☐ OBSERVED (DATE ________) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION (Include name(s) of species)

None alleged or observed

01 ☐ L CONTAMINATION OF FOOD CHAIN — 02 ☐ OBSERVED (DATE ________) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

None alleged or observed

01 ☒ M UNSTABLE CONTAINMENT OF WASTES (Spills Runoff Standing liquids Leaking drums) — 02 ☐ OBSERVED (DATE ________) ☒ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED ________ 04 NARRATIVE DESCRIPTION

No spill containment provisions at hazardous waste storage area .

01 ☐X N DAMAGE TO OFFSITE PROPERTY — 02 ☐ OBSERVED (DATE ________) ☐ POTENTIAL ☒ ALLEGED
04 NARRATIVE DESCRIPTION

JPL may have contributed to contamination of Municipal Water Supply Wells.

01 ☐X O CONTAMINATION OF SEWERS, STORM DRAINS, WWTPs — 02 ☐ OBSERVED (DATE ________) ☒ POTENTIAL ☒ ALLEGED
04 NARRATIVE DESCRIPTION

. Alleged dumping of chemicals into storm drains and sewers.

01 ☒ P ILLEGAL/UNAUTHORIZED DUMPING — 02 ☐ OBSERVED (DATE ________) ☐ POTENTIAL ☒ ALLEGED
04 NARRATIVE DESCRIPTION

None alleged or observed

05 DESCRIPTION OF ANY OTHER KNOWN, POTENTIAL, OR ALLEGED HAZARDS

III. TOTAL POPULATION POTENTIALLY AFFECTED: ________

IV. COMMENTS

Soil samples are from 2 of 6 former seepage/disposal pits on site. Further sampling from other pits is necessary.
No monitoring of groundwater has been conducted on site.

V. SOURCES OF INFORMATION (Cite specific references, e.g. state files, sample analysis, reports)

1. R.C. Slade: Preliminary Hydrogeologic Assessment of Soils and Groundwater Monitoring at JPL.; 1984.
2. J.M. Montgomery: Appdx E, Hydrogeologic Investigation Report, 1986.
3. Interviews with JPL Staff

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION
PART 4 - PERMIT AND DESCRIPTIVE INFORMATION

I. IDENTIFICATION

01 STATE CA
02 SITE NUMBER 9800013030

II. PERMIT INFORMATION

01 TYPE OF PERMIT ISSUED (Check all that apply)	02 PERMIT NUMBER	03 DATE ISSUED	04 EXPIRATION DATE	05 COMMENTS
☐ A. NPDES				
☐ B. UIC				
☒ C. AIR	SCAQMD 11887-AE			Emissions and serveral othe permits
☐ D. RCRA				
☐ E. RCRA INTERIM STATUS				
☐ F. SPCC PLAN				
☐ G. STATE (Specify)				
☒ H. LOCAL (Specify) LA County Public Works		Unknown		Underground tanks/Interim Stat
☒ I. OTHER (Specify) LA County Sanitation Dist.	1710061	Unknown		Wastewater permit
☐ J. NONE				

III. SITE DESCRIPTION

01 STORAGE/DISPOSAL (Check all that apply)	02 AMOUNT	03 UNIT OF MEASURE
☐ A. SURFACE IMPOUNDMENT		
☐ B. PILES		
☒ C. DRUMS, ABOVE GROUND	15-20	Drums
☐ D. TANK, ABOVE GROUND		
☐ E. TANK, BELOW GROUND		
☐ F. LANDFILL		
☐ G. LANDFARM		
☒ H. OPEN DUMP	Unknown	
☐ I. OTHER (Specify)		

04 TREATMENT (Check all that apply)

- ☒ A. INCENERATION (Past Years)
- ☐ B. UNDERGROUND INJECTION
- ☐ C. CHEMICAL/PHYSICAL
- ☐ D. BIOLOGICAL
- ☐ E. WASTE OIL PROCESSING
- ☐ F. SOLVENT RECOVERY
- ☐ G. OTHER RECYCLING/RECOVERY
- ☐ H. OTHER ____ (Specify)

05 OTHER

☒ A. BUILDINGS ON SITE

06 AREA OF SITE

176 (Acres)

07 COMMENTS

Open disposal pits were used between 1941 and 1960 for dumping of municipal solid wastes and solid and liquid hazardous wastes. Pits were located both on JPL property, and off property in Arroyo Seco Wash. Pits were approximately 15 feet wide by 15 feet deep, largest pit was 30 feet across by 15 feet deep. Two of the seepage pits were allegedly "Lined" with brick.

IV. CONTAINMENT

01 CONTAINMENT OF WASTES (Check one)

☐ A. ADEQUATE, SECURE ☐ B. MODERATE ☐ C. INADEQUATE, POOR ☒ D. INSECURE, UNSOUND, DANGEROUS

02 DESCRIPTION OF DRUMS, DIKING, LINERS, BARRIERS, ETC.

The historic dumping practices (until early 1960's) were insecure due to the hazardous nature of the substances disposed, proximity to sources of drinking water, and absence of protective measures to contain or prevent migration of substances. Present day storage of chemical drums and drummed wastes are not in bermed or protected areas.

V. ACCESSIBILITY

01 WASTE EASILY ACCESSIBLE ☐ YES ☒ NO

02 COMMENTS

Historic sites are beneath existing parking lots, paved areas, or in the Arroyo Seco Wash. Present day drums are sealed to prevent access.

VI. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

- JPL Environmental Resources Document; 1980.
- JPL Staff Interviews.

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 5 - WATER, DEMOGRAPHIC, AND ENVIRONMENTAL DATA

I. IDENTIFICATION
01 STATE: CA
02 SITE NUMBER: 9800013030

VI. ENVIRONMENTAL INFORMATION

01 PERMEABILITY OF UNSATURATED ZONE (Check one)
☐ A. $10^{-6} - 10^{-8}$ cm/sec ☐ B. $10^{-4} - 10^{-6}$ cm/sec ☒ C. $10^{-4} - 10^{-3}$ cm/sec ☐ D. GREATER THAN 10^{-3} cm/sec
estimated
silty-sand-gravel

02 PERMEABILITY OF BEDROCK (Check one)
estimated
☐ A. IMPERMEABLE (Less than 10^{-6} cm/sec) ☒ B. RELATIVELY IMPERMEABLE ($10^{-4} - 10^{-6}$ cm/sec) ☐ C. RELATIVELY PERMEABLE ($10^{-2} - 10^{-4}$ cm/sec) ☐ D. VERY PERMEABLE (Greater than 10^{-2} cm/sec)

03 DEPTH TO BEDROCK: 600+ (ft)
04 DEPTH OF CONTAMINATED SOIL ZONE: Unknown (ft)
05 SOIL pH: 7.8

06 NET PRECIPITATION: 20 (in)
07 ONE YEAR 24 HOUR RAINFALL: 2 (in)
08 SLOPE
SITE SLOPE: Unknown %
DIRECTION OF SITE SLOPE: SSE
TERRAIN AVERAGE SLOPE: Unknown %

09 FLOOD POTENTIAL
SITE IS IN 500+ YEAR FLOODPLAIN

10 ☐ SITE IS ON BARRIER ISLAND, COASTAL HIGH HAZARD AREA, RIVERINE FLOODWAY

11 DISTANCE TO WETLANDS (5 acre minimum)
ESTUARINE A. 22 (mi)
OTHER B. N/A (mi)

12 DISTANCE TO CRITICAL HABITAT (of endangered species)
Possible existence in Arroyo Seco 0.2 (mi)
ENDANGERED SPECIES: Nevin's Barberry (Plant)

13 LAND USE IN VICINITY
DISTANCE TO:
COMMERCIAL/INDUSTRIAL A. 0.04 (mi)
RESIDENTIAL AREAS, NATIONAL/STATE PARKS, FORESTS, OR WILDLIFE RESERVES B. 0.04 (mi)
AGRICULTURAL LANDS
PRIME AG LAND C. 0.04 (mi)
AG LAND D. Unknown (mi)

14 DESCRIPTION OF SITE IN RELATION TO SURROUNDING TOPOGRAPHY

The site is situated on a hillside at the base of the San Gabriel Mountains. The site is situated between the Angeles National Forest on the North and the Devil's Gate Dam/Reservoir on the South. To the East lies the Arroyo Seco Canyon, an intermittent stream, and to the Southwest are the San Rafael Hills. The rugged topography of the site and its surroundings seperates the lab from the adjoining residential neighborhoods and other land uses in the vicinity.

VII. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

- USGS topographic Quad. Pasadena, CA
- City of Pasadena Planning Dept. census tract information - L. Dahl, Planner
- City of La Canada-Flintridge, community development - B. Campbell, Director
- JPL Environmental Resources Document
- Montgomery - Appndx. E Hydrogeologic Investigation Report, 1986.

- Slade - Preliminary Hydrogeologic Assessment, 1984.

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 6 - SAMPLE AND FIELD INFORMATION

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER
CA	9800013030

II. SAMPLES TAKEN

SAMPLE TYPE	01 NUMBER OF SAMPLES TAKEN	02 SAMPLES SENT TO	03 ESTIMATED DATE RESULTS AVAILABLE
GROUNDWATER	9	Montgomery Laboratories, Pasadena	1984
SURFACE WATER			
WASTE			
AIR			
RUNOFF			
SPILL			
SOIL	8	Montgomery Laboratories, Pasadena	1984
VEGETATION			
OTHER			

III. FIELD MEASUREMENTS TAKEN

01 TYPE	02 COMMENTS
Soils - Fluoride, pH, Chromium, Metals	All testing was done at off-site lab. One test pit sampled natural, uncontaminated, in-place soils, remaining test pits (7) sampled soils in areas of suspected seepage pits. (1)
Soils - Volatile Organics	Carbon tet, trichloroethane, tetra chloroethane, 1-1-1 trichloroethane
Soils - Emission Spectroscopy	- On two tests with positive results for metals (1)
Water-Heavy metals Fluoride & Cyanide	All testing was done at off-site lab, for silver, arsenic, beryllium, cadmium, chromium, copper, mercury, nickel, lead, and antimony, selenium, thallium, zinc (1)
Water-Volatile organics	Carbon tet, tetra chloroethane, 1-1-1 trichloroethane, Hexane, trichloroethane (1)

IV. PHOTOGRAPHS AND MAPS

01 TYPE ☐ GROUND ☒ AERIAL

02 IN CUSTODY OF Army Corps of Engineers-LA District
(Name of organization or individual)

03 MAPS ☒ YES ☐ NO

04 LOCATION OF MAPS JPL; Ebasco Services, Santa Ana

V. OTHER FIELD DATA COLLECTED (Provide narrative description)

Dispersion coefficient of 10 ft. ^{2}/day and velocities between o.07 and 0.14 ft/day were determined. (2)

VI. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

1. R. C. Slade, Preliminary hydrogeologic Assessment of Soils and groundwater monitoring at JPL, 1984.
2. J. M. Montgomery, Appndx. E, Hydrogeologic Investigation Report, 1986.

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 7 - OWNER INFORMATION

I. IDENTIFICATION
01 STATE CA
02 SITE NUMBER 9800013030

II. CURRENT OWNER(S)

01 NAME National Aeronautics and Space Administration
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.) 4800 Oak Grove
04 SIC CODE
05 CITY Pasadena
06 STATE CA
07 ZIP CODE 91109

01 NAME
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

01 NAME
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

01 NAME
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

PARENT COMPANY (If applicable)

08 NAME N/A
09 D+B NUMBER
10 STREET ADDRESS (P.O. Box, RFD #, etc.)
11 SIC CODE
12 CITY
13 STATE
14 ZIP CODE

08 NAME
09 D+B NUMBER
10 STREET ADDRESS (P.O. Box, RFD #, etc.)
11 SIC CODE
12 CITY
13 STATE
14 ZIP CODE

08 NAME
09 D+B NUMBER
10 STREET ADDRESS (P.O. Box, RFD #, etc.)
11 SIC CODE
12 CITY
13 STATE
14 ZIP CODE

08 NAME
09 D+B NUMBER
10 STREET ADDRESS (P.O. Box, RFD #, etc.)
11 SIC CODE
12 CITY
13 STATE
14 ZIP CODE

III. PREVIOUS OWNER(S) (List most recent first)

01 NAME U.S. Department of the Army
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY Washington, D.C.
06 STATE
07 ZIP CODE

01 NAME
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

01 NAME
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

IV. REALTY OWNER(S) (If applicable, list most recent first)

01 NAME
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

01 NAME
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

01 NAME
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

V. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

- JPL Staff

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 8 - OPERATOR INFORMATION

I. IDENTIFICATION

01 STATE: CA
02 SITE NUMBER: 9800013030

II. CURRENT OPERATOR *(Provide if different from owner)*

01 NAME: Jet Propulsion Lab/ California Institute of Technology
02 D+B NUMBER:
03 STREET ADDRESS *(P O Box, RFD #, etc.)*: 4800 Oak Grove
04 SIC CODE:
05 CITY: Pasadena
06 STATE: CA
07 ZIP CODE: 91109
08 YEARS OF OPERATION: 1941-Present
09 NAME OF OWNER: NASA

OPERATOR'S PARENT COMPANY *(If applicable)*

10 NAME:
11 D+B NUMBER:
12 STREET ADDRESS *(P O Box, RFD #, etc.)*:
13 SIC CODE:
14 CITY:
15 STATE:
16 ZIP CODE:

III. PREVIOUS OPERATOR(S) *(List most recent first; provide only if different from owner)*

01 NAME: N/A
02 D+B NUMBER:
03 STREET ADDRESS *(P O Box, RFD #, etc.)*:
04 SIC CODE:
05 CITY:
06 STATE:
07 ZIP CODE:
08 YEARS OF OPERATION:
09 NAME OF OWNER DURING THIS PERIOD:

01 NAME:
02 D+B NUMBER:
03 STREET ADDRESS *(P O Box, RFD #, etc.)*:
04 SIC CODE:
05 CITY:
06 STATE:
07 ZIP CODE:
08 YEARS OF OPERATION:
09 NAME OF OWNER DURING THIS PERIOD:

01 NAME:
02 D+B NUMBER:
03 STREET ADDRESS *(P O Box, RFD #, etc.)*:
04 SIC CODE:
05 CITY:
06 STATE:
07 ZIP CODE:
08 YEARS OF OPERATION:
09 NAME OF OWNER DURING THIS PERIOD:

PREVIOUS OPERATORS' PARENT COMPANIES *(If applicable)*

10 NAME:
11 D+B NUMBER:
12 STREET ADDRESS *(P O Box, RFD #, etc.)*:
13 SIC CODE:
14 CITY:
15 STATE:
16 ZIP CODE:

10 NAME:
11 D+B NUMBER:
12 STREET ADDRESS *(P O Box, RFD #, etc.)*:
13 SIC CODE:
14 CITY:
15 STATE:
16 ZIP CODE:

10 NAME:
11 D+B NUMBER:
12 STREET ADDRESS *(P O Box, RFD #, etc.)*:
13 SIC CODE:
14 CITY:
15 STATE:
16 ZIP CODE:

IV. SOURCES OF INFORMATION *(Cite specific references, e.g., state files, sample analysis, reports)*

JPL Staff Interviews

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 9 - GENERATOR/TRANSPORTER INFORMATION

I. IDENTIFICATION
01 STATE: CA
02 SITE NUMBER: 9800013030

II. ON-SITE GENERATOR

01 NAME: NASA - JPL
02 D+B NUMBER:
03 STREET ADDRESS (P.O. Box, RFD #, etc.): 4800 Oak Grove
04 SIC CODE:
05 CITY: Pasadena
06 STATE: CA
07 ZIP CODE: 91109

III. OFF-SITE GENERATOR(S)

01 NAME: None
02 D+B NUMBER:
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

01 NAME
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

01 NAME
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

01 NAME
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

IV. TRANSPORTER(S)

01 NAME: None
02 D+B NUMBER:
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

01 NAME
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

01 NAME
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

01 NAME
02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)
04 SIC CODE
05 CITY
06 STATE
07 ZIP CODE

V. SOURCES OF INFORMATION (Cite specific references, e.g. state files, sample analysis, reports)

- JPL Staff Interviews

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 10 - PAST RESPONSE ACTIVITIES

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
CA	9800013030

II. PAST RESPONSE ACTIVITIES

01 ☐ A. WATER SUPPLY CLOSED 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ B. TEMPORARY WATER SUPPLY PROVIDED 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ C. PERMANENT WATER SUPPLY PROVIDED 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ D. SPILLED MATERIAL REMOVED 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ E. CONTAMINATED SOIL REMOVED 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ F. WASTE REPACKAGED 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ G. WASTE DISPOSED ELSEWHERE 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ H. ON SITE BURIAL 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ I. IN SITU CHEMICAL TREATMENT 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ J. IN SITU BIOLOGICAL TREATMENT 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ K. IN SITU PHYSICAL TREATMENT 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ L. ENCAPSULATION 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ M. EMERGENCY WASTE TREATMENT 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ N. CUTOFF WALLS 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ O. EMERGENCY DIKING/SURFACE WATER DIVERSION 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ P. CUTOFF TRENCHES/SUMP 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

01 ☐ Q. SUBSURFACE CUTOFF WALL 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION
N/A

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 10 - PAST RESPONSE ACTIVITIES

I. IDENTIFICATION

01 STATE: CA

02 SITE NUMBER: 9800013030

II PAST RESPONSE ACTIVITIES *(Continued)*

01 ☐ R. BARRIER WALLS CONSTRUCTED 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION

N/A

01 ☐ S. CAPPING/COVERING 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION

N/A

01 ☐ T. BULK TANKAGE REPAIRED 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION

N/A

01 ☐ U. GROUT CURTAIN CONSTRUCTED 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION

N/A

01 ☐ V. BOTTOM SEALED 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION

N/A

01 ☐ W. GAS CONTROL 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION

N/A

01 ☐ X. FIRE CONTROL 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION

N/A

01 ☐ Y. LEACHATE TREATMENT 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION

N/A

01 ☐ Z. AREA EVACUATED 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION

N/A

01 ☐ 1. ACCESS TO SITE RESTRICTED 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION

N/A

01 ☐ 2. POPULATION RELOCATED 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION

N/A

01 ☐ 3. OTHER REMEDIAL ACTIVITIES 02 DATE ______ 03 AGENCY ______
04 DESCRIPTION

III. SOURCES OF INFORMATION *(Cite specific references, e.g., state files, sample analysis, reports)*

JPL Staff Interviews

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 11 - ENFORCEMENT INFORMATION

I. IDENTIFICATION

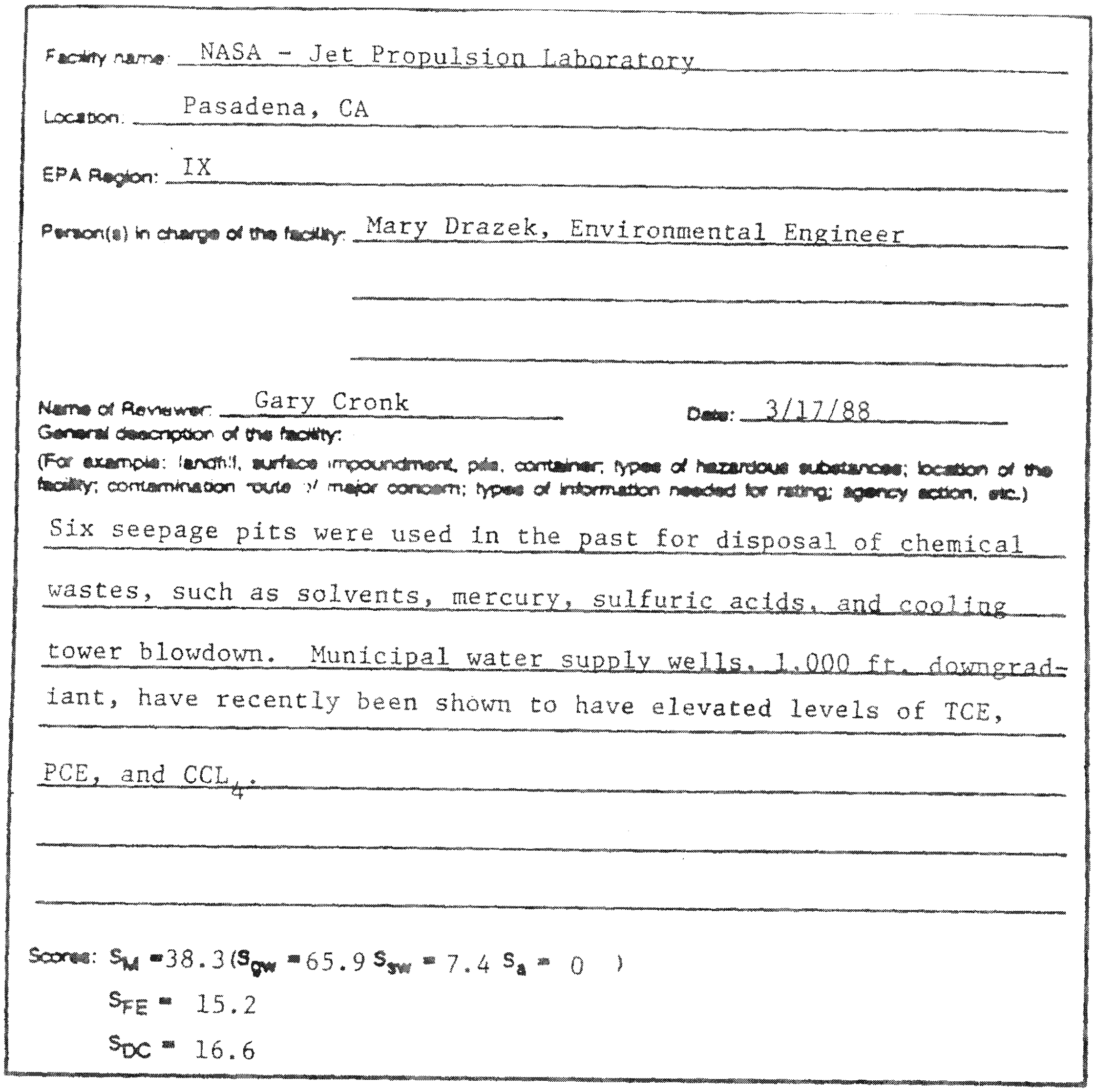
01 STATE	02 SITE NUMBER
CA	9800013030

II. ENFORCEMENT INFORMATION

01 PAST REGULATORY/ENFORCEMENT ACTION ☐ YES ☒ NO

02 DESCRIPTION OF FEDERAL, STATE, LOCAL REGULATORY/ENFORCEMENT ACTION

III. SOURCES OF INFORMATION *(Cite specific references, e.g., state files, sample analysis, reports)*



Facility name: NASA - Jet Propulsion Laboratory

Location: Pasadena, CA

EPA Region: IX

Person(s) in charge of the facility: Mary Drazek, Environmental Engineer

Name of Reviewer: Gary Cronk

Date: 3/17/88

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

Six seepage pits were used in the past for disposal of chemical wastes, such as solvents, mercury, sulfuric acids, and cooling tower blowdown. Municipal water supply wells, 1,000 ft. downgradiant, have recently been shown to have elevated levels of TCE, PCE, and CCL_4.

Scores: $S_M = 38.3$ ($S_{gw} = 65.9$ $S_{sw} = 7.4$ $S_a = 0$)

$S_{FE} = 15.2$

$S_{DC} = 16.6$

FIGURE 1
HRS COVER SHEET

Ground Water Route Work Sheet					
Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 [✓ 45]	1	45	45	3.1
If observed release is given a score of 45, proceed to line 4. If observed release is given a score of 0, proceed to line 2.					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Toxicity/Persistence	0 3 6 9 12 15 [✓ 18]	1	18	18	
Hazardous Waste Quantity	0 1 [✓ 2] 3 4 5 6 7 8	1	2	8	
	Total Waste Characteristics Score		20	26	
5 Targets					3.5
Ground Water Use	0 1 [✓ 2] 3	3	2	9	
Distance to Nearest Well/Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 [✓ 40]	1	40	40	
	Total Targets Score		42	49	
6 If line 1 is 45, multiply 1 x 4 x 5 If line 1 is 0, multiply 2 x 3 x 4 x 5	45x20x42		37,800	57,330	
7 Divide line 6 by 57,330 and multiply by 100	S_{gw} = 65.9				

FIGURE 2
GROUND WATER ROUTE WORK SHEET

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	(Section)
$\boxed{1}$ Observed Release	[✓ 0] 45	1	0	45	4.1

If observed release is given a value of 45, proceed to line $\boxed{4}$.
If observed release is given a value of 0, proceed to line $\boxed{2}$.

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	(Section)
$\boxed{2}$ Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 [✓ 3]		3	3	
1-yr. 24-hr. Rainfall	0 1 [✓ 2] 3	1	2	3	
Distance to Nearest Surface Water	0 1 2 [✓ 3]	2	6	6	
Physical State	0 1 2 [✓ 3]	1	3	3	
Total Route Characteristics Score			14	15	
$\boxed{3}$ Containment	0 1 2 [✓ 3]	1	3	3	4.3
$\boxed{4}$ Waste Characteristics					4.4
Toxicity/Persistence	0 3 6 9 12 15 [✓ 18]	1	18	18	
Hazardous Waste Quantity	0 [✓ 1] 2 3 4 5 6 7 8	1	1	8	
Total Waste Characteristics Score			19	26	
$\boxed{5}$ Targets					4.5
Surface Water Use	0 1 [✓ 2] 3	3	6	9	
Distance to a Sensitive Environment	[✓ 0] 1 2 3	2	0	6	
Population Served/Distance to Water Intake Downstream	[✓ 0] 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
Total Targets Score			6	55	
$\boxed{6}$ If line $\boxed{1}$ is 45, multiply $\boxed{1}$ x $\boxed{4}$ x $\boxed{5}$ If line $\boxed{1}$ is 0, multiply $\boxed{2}$ x $\boxed{3}$ x $\boxed{4}$ x $\boxed{5}$			4,788	64,350	

$\boxed{7}$ Divide line $\boxed{6}$ by 64,350 and multiply by 100 S_{sw} = 7.4

FIGURE 7
SURFACE WATER ROUTE WORK SHEET

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
$\boxed{1}$ Observed Release	[✓ 0] 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If line $\boxed{1}$ is 0, then S_a = 0. Enter on line $\boxed{5}$. If line $\boxed{1}$ is 45, then proceed to line $\boxed{2}$.					
$\boxed{2}$ Waste Characteristics					5.2
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
	Total Waste Characteristics Score			20	
$\boxed{3}$ Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
$\boxed{4}$ Multiply $\boxed{1}$ x $\boxed{2}$ x $\boxed{3}$				35,100	
$\boxed{5}$ Divide line $\boxed{4}$ by 35,100 and multiply by 100		S_a =	0		

FIGURE 9
AIR ROUTE WORK SHEET

	S	S^2
Groundwater Route Score (S_{gw})	65.9	4,342.8
Surface Water Route Score (S_{sw})	7.4	54.8
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		4,397.6
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		66.3
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} \,/\, 1.73 = S_M =$		38.3

FIGURE 10
WORKSHEET FOR COMPUTING S_M

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Containment	[✓ 1] 3	1	1	3.	7.1
2 Waste Characteristics					7.2
Direct Evidence	[✓ 0] 3	1		3	
Ignitability	0 1 2 [✓ 3]	1		3	
Reactivity	0 1 2 [✓ 3]	1		3	
Incompatibility	0 1 [✓ 2] 3	1		3	
Hazardous Waste Quantity	0 1 [✓ 2] 3 4 5 6 7 8	1		8	
	Total Waste Characteristics Score		10	20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 [✓ 5]	1		5	
Distance to Nearest Building	0 1 2 [✓ 3]	1		3	
Distance to Sensitive Environment	0 1 2 [✓ 3]	1		3	
Land Use	0 1 2 [✓ 3]	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 [✓ 5]	1		5	
Buildings Within 2-Mile Radius	0 1 2 [✓ 3] 4 5	1		5	
	Total Targets Score		22	24	
4 Multiply 1 x 2 x 3			220	1,440	
5 Divide line 4 by 1,440 and multiply by 100			S_{FE} = 15.2		

FIGURE 11
FIRE AND EXPLOSION WORK SHEET

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Incident	[✓ 0] 45	1	0	45	8.1
If line 1 is 45, proceed to line 4 If line 1 is 0, proceed to line 2					
2 Accessibility	[✓ 0] 1 2 3	1	0	3	8.2
3 Containment	0 [✓ 15]	1	15	15	8.3
4 Waste Characteristics Toxicity	0 1 2 [✓ 3]	5	15	15	8.4
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 [✓ 4] 5	4	16	20	
Distance to a Critical Habitat	[✓ 0] 1 2 3	4		12	
Total Targets Score			16	32	
6 If line 1 is 45, multiply 1 x 4 x 5 If line 1 is 0, multiply 2 x 3 x 4 x 5			3600	21,600	
7 Divide line 6 by 21,600 and multiply by 100			S_{DC} = 16.6		

FIGURE 12
DIRECT CONTACT WORK SHEET

National Aeronautics and Space Administration

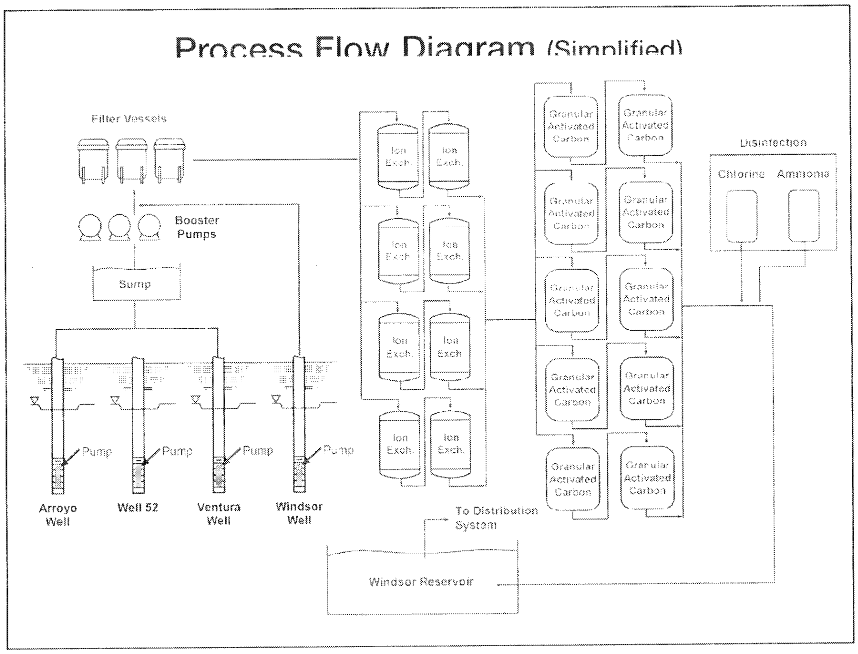
The Monk Hill Groundwater Treatment System

This fact sheet describes construction activities associated with a new groundwater treatment plant being built and funded by NASA in Pasadena, how community input has helped shape the facility's appearance and what measures are being taken to reduce possible disturbances during construction.

NASA and Pasadena Water and Power (PWP) are set to begin construction of a new groundwater treatment plant in Pasadena. This plant is part of an overall cleanup effort NASA is taking to remove chemicals from areas beneath and adjacent to the Jet Propulsion Laboratory (JPL). [See sidebar to the right.] NASA and the City of Pasadena considered the potential impacts from this project and identified mitigation measures that would be taken to protect public health and the environment. These measures along with those to reduce disturbances during construction and operation of the plant were folded into the project requirements. At the same time, NASA and PWP met with neighbors and community members to solicit public input for the facility's appearance and landscaping. Over the next year and a half, construction activities will be taking place at the City-owned Windsor Reservoir site and near four closed municipal water production wells. Once construction is complete, PWP will operate the plant. [See description of How Treatment Works.] Treating groundwater at this location will remove chemicals in groundwater and restore water quality in part of the aquifer underlying Altadena and Pasadena, thus enabling PWP to resume using four wells for supplying clean drinking water to customers.

How Treatment Works

Extracted groundwater first passes through a three vessel inlet water filter system to remove any sediment, then into the ion exchange tanks. The ion exchange system is made up of four pairs of steel tanks containing 12,000 to 16,000 pounds of tiny plastic beads called resin. As water flows through the tanks, perchlorate in the water attaches to the resin. Next, the Liquid-Phase Granular Activated Carbon (carbon filter) system, made up of five pairs of steel tanks containing about 40,000 pounds of charcoal-like carbon particles, removes Volatile Organic Compounds (VOCs). Routinely, the carbon particles and resin are changed out and are disposed of at licensed facilities. Finally, the clean water is disinfected, preventing the growth of bacteria in water for distribution. During operation of the treatment plant, the clean water is to be stored in the Windsor Reservoir before being distributed to PWP customers.


Process Flow Diagram (Simplified)

CONTINUED ON REVERSE SIDE

NASA received regulatory approval on the Monk Hil Treatment System's final design, construction, and operation and maintenance plan (OU3 Remedial Design/Remedial Action Workplan). Expected to come online in late 2010, this will be the third of three NASA-funded treatment plants operating as part of NASA's Comprehensive Environmental Restoratio and Liability Act (CERCLA) Groundwater Cleanup Program at the Jet Propulsion Laboratory (JPL). The new Pasadena facility will be operating along with existing treatment plants at the source area located on site at JPL and at two wells at the Lincoln Avenue Water Company to remove groundwater chemicals from beneath and in areas adjacent to JPL.

06/01/2015
Item 27

Treatment Plant Construction

Construction of the new treatment plant is set to begin this Spring and will last roughly twelve months. Inside the fence, some of the first activity involves earthmoving – building access roads for maintenance vehicles and site grading on the property to lower the profile of the facility by three feet as viewed from the street. Activities also include constructing a water disinfection building, installing pipelines, making electrical improvements and building a concrete pad on which the treatment tanks will be placed. These tanks and other treatment plant structures will be painted a neutral tone to blend with the existing views. Landscaping, which began last November (also when "green-screen fencing" was installed), will continue outside the fence as curb-and-gutter and sidewalk work is completed. A new turn lane into the south gate will improve safety and appearances along Windsor Avenue. Watering the work area during earthmoving activities will be done to reduce dust. Typical construction equipment such as back hoes, excavators, bull-dozers and dump trucks will be operated during approved work hours in accordance with the City's noise ordinance. Cars owned by the work crew (typically 12 to 20 people), will be parked inside the fence.

Flowering shrubs planted last November are in bloom along Windsor Avenue.

Construction at the Wells

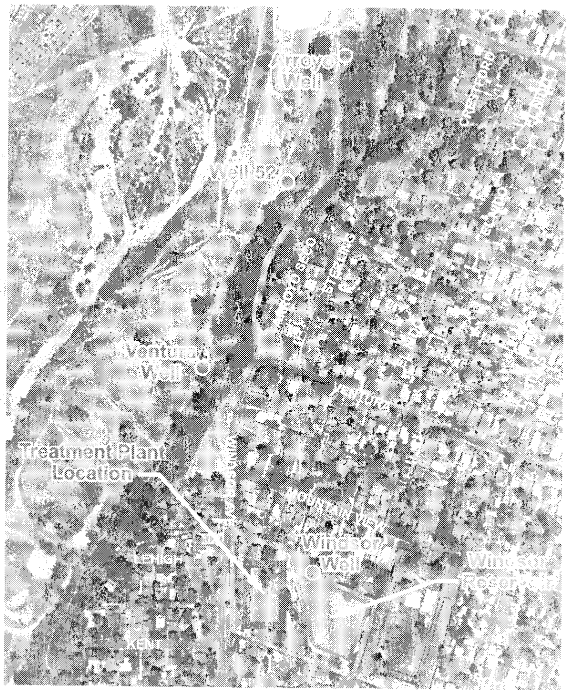
Construction at four City-owned production wells will run concurrently with construction of the treatment plant at Windsor Reservoir and will last three to four months. The wells (Arroyo, Ventura, Well 52 and Windsor Wells) have been closed due to the presence of perchlorate. Construction activities at the wells consist of installing pipes and new electrical components and pumps. New high-efficiency booster pumps will be installed near Ventura Well. These pumps are needed to push the extracted groundwater through the entire treatment system and on to the Windsor Reservoir.

Well Rehabilitation

Well rehabilitation will begin in the fall of 2009 after construction activities at each of the wells have been completed, and is expected to take nine to ten months. Rehabilitation includes well cleaning, relining when necessary, and water pump testing. These tests extract large volumes of groundwater that will be treated at the new plant and distributed to the Arroyo spreading basins. During work at the Ventura Well and Well 52, work crews (typically three to four people) will stage equipment either inside the fence when possible, or in a way that leaves at least four feet of unobstructed pavement for pedestrian, equestrian and bicycle access along Karl Johnson Parkway (the JPL access road along the east side of the spreading basins).

Start Up Testing

Start up testing will be conducted when rehabilitation has been completed at all four wells (anticipated in summer 2010). This testing will ensure that the entire system operates as it should and that the groundwater is cleaned to appropriate state and federal drinking water standards. Water flowing through the system during testing will be discharged to the Arroyo spreading basins, in compliance with Regional Water Quality Control Board surface water discharge requirements. PWP is required to obtain a permit from the State Department of Public Health prior to distributing the clean water to customers.



Four wells in Pasadena from which groundwater will be pumpled to the new Monk Hill Groundwater Treatment Plant.

ADDITIONAL INFORMATION

▶**About NASA's Groundwater Cleanup Program at JPL is available at Information Repositorie located in area libraries and on the JPL wate cleanup Web site at http://jplwater.nasa.gov.**

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▶**About construction and operation of the Monk Hill Groundwater Treatment Plant**

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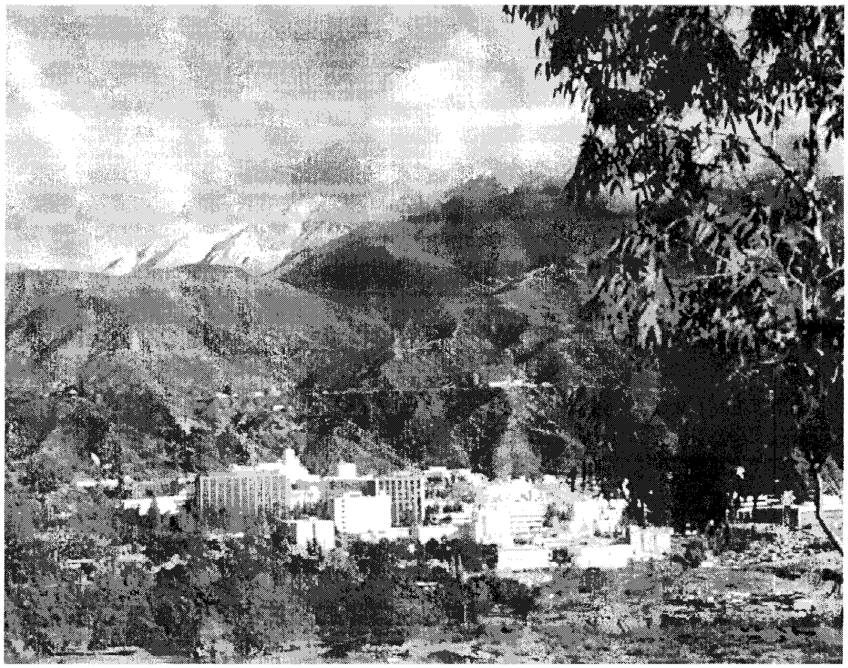
FINAL

OPERABLE UNIT 3
REMEDIAL INVESTIGATION (RI) ADDENDUM WORK PLAN
(PASADENA SAMPLING PLAN [PSP]-2004-1)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JET PROPULSION LABORATORY
PASADENA, CALIFORNIA

EPA ID# CA9800013030



PREPARED FOR:

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November 2004

06/01/2015
Item 27

FINAL

OPERABLE UNIT 3
REMEDIAL INVESTIGATION (RI) ADDENDUM WORK PLAN
(PASADENA SAMPLING PLAN [PSP]-2004-1)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JET PROPULSION LABORATORY
PASADENA, CALIFORNIA

EPA ID# CA9800013030

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Abbreviations and Acronyms

3-D	three-dimensional
bgs	below ground surface
Cal-EPA	California Environmental Protection Agency
CCl_4	carbon tetrachloride
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFEST	Coupled Flow Energy and Solute Transport model
CFR	Code of Federal Regulations
DEH	(Los Angeles County) Department of Environmental Health
DHS	(California) Department of Health Services
DO	dissolved oxygen
DTSC	(California) Department of Toxic Substances Control
DWR	(California) Department of Water Resources
EM	electromagnetic imaging
FWEC	Foster Wheeler Environmental Corporation
FFA	Federal Facility Agreement
GPR	ground-penetrating radar
GSC	General Sciences Corporation
IDW	investigation-derived waste
JPL	Jet Propulsion Laboratory
K_d	distribution coefficient
LAWC	Lincoln Avenue Water Company
LCID	La Cañada Irrigation District
LCS	laboratory control sample
MCL	maximum contaminant level
MDL	method detection limit
MOA	Memorandum of Agreement
MS/MSD	matrix spike/matrix spike duplicate
MWD	Metropolitan Water District (of Southern California)
N/A	not analyzed
NA	not available
NASA	National Aeronautics and Space Administration
NAVFAC	Naval Facilities Engineering Command
ND	not detected
NDMA	*n*-nitrosodimethylamine
NPL	National Priorities List

O.D.	outside diameter
ORP	oxidation-reduction potential
OU	Operable Unit
PCE	tetrachloroethene
PVC	polyvinyl chloride
PUSD	Pasadena Unified School District
PWP	Pasadena Water and Power
QA/QC	quality assurance/quality control
RBMB	Raymond Basin Management Board
RCLWA	Rubio Canyon Land and Water Association
RI	Remedial Investigation
RWQCB	Regional Water Quality Control Board, Los Angeles Region
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SESOIL	Seasonal Soil Compartment model
SHSP	Site Health and Safety Plan
SVOC	semivolatile organic compound
TBD	to be determined
TCE	trichloroethene
TDS	total dissolved solids
TNRCC	Texas Natural Resources Conservation Council
TPH	total petroleum hydrocarbons
USA	Underground Services Alert
U.S. EPA	United States Environmental Protection Agency
USCS	Unified Soil Classification System
USGS	United States Geological Survey
VOC	volatile organic compound
VWC	Valley Water Company

1.0 INTRODUCTION

This Work Plan was prepared for the National Aeronautics and Space Administration (NASA). An additional investigation is proposed within Operable Unit 3 (OU-3), off-facility groundwater, to better determine the extent of chemicals in groundwater that originate from the Jet Propulsion Laboratory (JPL) facility. This document and the additional investigation described herein will serve as an addendum to the *Remedial Investigation (RI) for OU-1 and OU-3* (Foster Wheeler Environmental Corporation [FWEC], 1999). NASA-JPL, which is located in Pasadena, CA (Figure 1-1), is on the United States Environmental Protection Agency (U.S. EPA) 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 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). This Work Plan fulfills the PSP requirement of the legal agreement and has been given the subtitle of PSP-2004-1. Ongoing efforts described in any previous PSP remain in effect and are not superceded by this PSP.

NASA is the lead federal agency for selecting, implementing, and funding remedial activities at 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 U.S. EPA, California Environmental Protection Agency (Cal-EPA) 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 OU-3 investigation.

This Work Plan is divided into five sections. This section discusses the objectives of the additional investigation and summarizes previous investigations. Section 2.0 summarizes background information on site conditions. Section 3.0 provides an evaluation of available data and identifies current uncertainties. Section 4.0 discusses the proposed methods by which the additional investigation will be implemented. Section 5.0 provides a listing of references.

1.1 Objective

The objectives of the additional investigation are (1) to evaluate the downgradient (southern) extent of chemicals that originate from the JPL facility, and (2) to determine if the occurrence of perchlorate in the Sunset Reservoir area is associated with migration from the JPL facility. This report outlines the strategy by which the additional investigation will be implemented. In addition, this report will serve to document the results of the evaluation of existing data in selected municipal production wells within the Raymond Basin.

1.2 Previous Investigations

Several documents and data sets associated with previous investigations were evaluated and utilized during preparation of this work plan. Some of these investigations were conducted as part of the NASA

JPL CERCLA program and some were sponsored by drinking water purveyors in the Raymond Basin. These investigations are briefly summarized in the following sections.

1.2.1 First Technical Assessment of the Devil's Gate Multi-Use Project. Phase 1 (CH2M-Hill, 1990) and Phase 2 (CH2M-Hill, 1992) of the *First Technical Assessment of the Devil's Gate Multi-Use Project* were designed to assess how much water could be stored in the Raymond Basin and the associated potential impacts on groundwater quality. These documents were not prepared as part of the NASA-JPL CERCLA Program. The primary objective of the assessment was to develop and evaluate a conjunctive use alternative that could be implemented within the basin to meet increasing potable water demands. As part of this assessment, general groundwater quality of the Raymond Basin was provided for the period July 1979 through June 1988 and represented by five parameters: total dissolved solids (TDS), nitrate, trichloroethene (TCE), tetrachloroethene (PCE), and carbon tetrachloride (CCl_4).

A three-dimensional (3-D) groundwater flow model of the Raymond Basin was developed during Phase 2 of the assessment to assist in the conjunctive use alternative evaluation. The Coupled Flow Energy and Solute Transport (CFEST) model was selected to simulate groundwater flow in the basin and potential groundwater migration pathways. Particle tracking from near the Arroyo Seco spreading grounds was performed for the period July 1989 through June 2023 to provide an estimate of the migration of nitrate and volatile organic compounds (VOCs). The results of the simulations projected a southerly groundwater flow path from the Arroyo Seco spreading basins and the unsewered areas in the La Cañada-Flintridge areas toward the City of Pasadena production wells located near the Sunset Reservoir. The City of Pasadena has referenced these modeling results as evidence that the perchlorate concentrations near the Sunset Reservoir are associated with a release from JPL. However, this preliminary modeling exercise only evaluated flow paths and did not consider sorption, dispersion, biodegradation of chemicals, nor did it evaluate fate and transport of chemicals originating from the JPL facility.

1.2.2 Remedial Investigation. The RI for on-facility (OU-1) and off-facility (OU-3) groundwater at JPL was conducted as part of the CERCLA program to identify the nature and extent of chemicals in groundwater (FWEC, 1999). The RI assessed the fate and transport of chemicals in the groundwater beneath and adjacent to the JPL facility and provided a baseline risk assessment to evaluate exposure to chemicals in groundwater to human health and the environment. During the RI, 13 additional wells (including shallow wells and deep multi-port wells) were added to 10 existing wells in the JPL monitoring network (Figure 1-2). Samples were collected from the 23 wells and analyzed for an extensive list of chemicals, including: VOCs, semivolatile organic compounds (SVOCs), Title 26 metals, chromium, lead, arsenic, hexavalent chromium, total petroleum hydrocarbons (TPH), perchlorate, and water chemistry parameters (i.e., TDS, anions, and cations). Additionally, groundwater levels were recorded in shallow and deep wells during the RI and hydraulic conductivities of the aquifer were estimated using slug/bail and rising head tests in individual wells.

Data collected during the RI indicated the pumping of the City of Pasadena and other municipal production wells appears to be an effective barrier to extensive downgradient chemical migration (FWEC, 1999). Conservative fate and transport simulations were subsequently conducted using the transport model SOLUTE to estimate potential migration of CCl_4, TCE, and perchlorate from monitoring well MW-17 if the City of Pasadena and other nearby production wells were not in operation. Results indicated that the production wells would need to be off-line for more than 20 years for migration of these chemicals at existing levels to be detected above action levels (ALs) in downgradient monitoring well MW-20. This finding contradicts some recent monitoring data, which has shown detections of perchlorate in MW-20 (Screen 4) that appear to originate from the JPL facility. Therefore, additional modeling and investigation are warranted.

1.2.3 Raymond Basin Database. The RBMB compiled a database containing information relating to the municipal production wells in the Raymond Basin (Geoscience, Inc., 2003). The database was not prepared as part of the NASA-JPL CERCLA Program. The Raymond Basin Database contains historical information on the following: production well construction details, groundwater chemical concentrations, groundwater quality data, well-specific production and injection volumes, spreading volumes, and groundwater-level elevations. These data were used extensively in the evaluation presented in Section 3.0 of this work plan.

1.2.4 NASA-JPL Groundwater Monitoring Program. The groundwater monitoring program at NASA JPL was initiated in 1996 and currently consists of a network of 23 monitoring wells, each of which is monitored on either a quarterly or annual basis. 18 wells are located on-facility and 5 wells are located off-facility (Figure 1-2). Of the 23 wells, ten are relatively shallow conventional wells with a single screened interval spanning the groundwater table. All of the shallow wells are located on the JPL facility. The other 13 wells, including all of the off-facility 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. Data from the NASA-JPL Groundwater Monitoring Program were used extensively in the evaluation presented in Section 3.0.

1.2.5 JPL Groundwater Modeling Report. A 3-D finite element groundwater model of the Monk Hill Subarea was developed using FEFLOW (Diersch, 2002) as part of the NASA-JPL CERCLA Program. The groundwater model encompasses a 4,560-acre area and consists of four elemental layers that are bounded by five nodal slices. The extent of the model domain and the calibrated material properties for each of the four layers is discussed in detail in the *JPL Groundwater Modeling Report* (NASA, 2003). Particle tracking was used to confirm the appropriateness of the simulation results with regard to the flow directions and gradients in the JPL facility area. In addition, the report serves to document the results of a multiple well pumping test that was designed to estimate aquifer parameters within the Monk Hill Subarea. This groundwater model provides enhanced understanding of groundwater flow near the JPL facility and was used as part of the evaluation presented in Section 3.0.

The study area for the additional investigation described in this Work Plan includes the on-facility (OU-1) and off-facility (OU-3) groundwater that contains chemicals related to historical activities conducted at JPL. The term "on-facility" refers to locations within the JPL facility boundaries, and the term "off-facility" refers to locations outside JPL facility boundaries.

2.1 Municipal Extraction and Injection Wells

Several municipal production wells are located in the vicinity of the JPL facility and are of interest in the additional investigation. Municipal production wells owned by the City of Pasadena, Lincoln Avenue Water Company (LAWC), Rubio Canyon Land and Water Association (RCLWA), and Las Flores Water Company are located hydraulically downgradient of JPL, and municipal production wells operated by La Cañada Irrigation District (LCID) and Valley Water Company (VWC) are located hydraulically upgradient of JPL (Figure 2-1) (NASA, 2003). Table 2-1 provides a listing of the individual production wells along with information regarding dates of operation, well construction, and extraction volumes. Two City of Pasadena production wells (Bangham and Garfield) and two VWC production wells (VWC-2 and VWC-3) are constructed to serve as extraction and injection wells. Table 2-2 provides a summary of the dates of operation and historical injection volumes for these wells. Table 2-2 indicates that the two VWC wells injected over 5,600 acre-ft of water since 1992, and the Bangham and Garfield wells combined have injected nearly 2,200 acre-ft of water since 1992. During this time period, the four VWC wells have extracted nearly 12,000 acre-ft and the Bangham and Garfield wells have extracted over 15,000 acre-ft. Although the extracted volume significantly exceeds the injected volume, the injections primarily occurred during periods when the surrounding extraction wells were not in operation for several months prior to and after injection.

In the early 1980s, analyses of groundwater from the City of Pasadena water supply wells located in the Arroyo Seco, near JPL, revealed the presence of VOCs. VOCs also were detected in two LAWC water supply wells during this timeframe. To ensure the delivery of safe drinking water to its customers, the City of Pasadena installed a VOC treatment facility for its drinking water wells in the Arroyo Seco in 1990 (FWEC, 1999). By 1992, the LAWC also had installed a VOC treatment facility to ensure the delivery of safe drinking water to its customers. Agreements were made with the City of Pasadena and LAWC for NASA to pay for construction and operation of the VOC treatment systems. During the summer of 2004, NASA funded installation and operation of a perchlorate treatment system for LAWC. NASA is currently working with the City of Pasadena to install a perchlorate treatment system associated with the four production wells in the Monk Hill Subarea.

2.2 Historical Chemical Usage at JPL

Testing of aeronautical equipment at the JPL facility commenced in 1936. To meet its mission objectives, JPL used various chemicals and materials including a variety of solvents, solid and liquid propellants, cooling-tower chemicals, and analytical laboratory chemicals. Many buildings at JPL used seepage pits/cesspools during the 1940s and 1950s to dispose of liquid and solid materials via infiltration into surrounding soil. Some of these seepage pits may have received chlorinated solvents, solid fuel residue containing perchlorate, and other chemicals that currently are found in the groundwater. A sewer system was installed during the mid-1950s, and use of the seepage pits for waste disposal was discontinued between 1956 and 1961 as buildings were demolished or connected to the sanitary sewer line (Table 2-3) (Develle, 2003). The seepage pits were backfilled between 1961 and 1963 (Ebasco, 1990). In addition, an on-facility incinerator and a furnace were constructed in the mid-1950s and 1960s, respectively, for use in burning propellants (NASA, 1998). Therefore, it is believed that the VOCs and perchlorate observed in groundwater today are associated with releases that occurred in the 1940s and 1950s. Figure 2-2 presents a chronology of early activities at the site. Today, all chemical wastes are either recycled or sent off-facility for treatment and disposal at regulated facilities.

2.3 Hydrogeology

The Raymond Basin, where the JPL facility is located, is bordered on the north by the San Gabriel Mountains, on the west by the San Rafael Hills, and on the south and east by the Raymond Fault. The Raymond Basin is further divided into three subareas based on differences in groundwater elevations and flow directions: the Pasadena Subarea, the Santa Anita Subarea, and the Monk Hill Subarea. JPL is located in the Monk Hill Subarea, which provides an important source of potable groundwater for many communities in the area including Pasadena, La Cañada-Flintridge, and Altadena.

The aquifer in the Monk Hill Subarea and the Pasadena Subarea is generally considered to be an unconfined, or water table, aquifer. However, vertical hydraulic head differences with depth are observed between screens in deep JPL multi-port monitoring wells located near active production wells. This indicates that the aquifer does not exhibit truly unconfined conditions, due to the presence of relatively thin, silt-rich layers located throughout the alluvial aquifer that inhibit vertical flow of groundwater. The aquifer can be divided into four groundwater aquifer zones above the crystalline basement complex, based to a large extent on how these silt-rich intervals influence the hydraulic heads in the aquifer during pumping periods at the nearby municipal wells. The primary aquifer zones were identified based on geologic formation maps published by the California Division of Mines and Geology and the United States Geological Survey (USGS). The four aquifer zones in the study area include the upper and lower sections of the Older Fanglomerate Series (Aquifer Zones 1 and 2, respectively), the Pacoima Formation (Aquifer Zone 3), and the Saugus Formation (Aquifer Zone 4). A conceptual model of the aquifer zones and associated silt-rich intervals is shown in Figure 2-3. It should be noted that the amount of available information for delineating aquifer zones significantly decreases with distance from the JPL facility and Arroyo Seco area (where the JPL monitoring wells are located).

In the Raymond Basin, groundwater generally flows southerly from areas of recharge at the base of the San Gabriel Mountains to areas of discharge along the Raymond Fault. A confluence of groundwater flow regimes occurs within the Monk Hill Subarea where JPL is located. At the western end of the Monk Hill Subarea (west of JPL) the groundwater flow is predominantly to the southeast; and at the eastern end of the Monk Hill Subarea (east of JPL) the groundwater flow is predominantly to the south.

The groundwater flow direction and magnitude (hydraulic gradient) beneath the study area are dynamic. In general, natural groundwater flow is across the facility to the southeast. However, the aquifer is affected by various natural and anthropogenic influences that include: (1) pumping from nearby municipal production wells, (2) groundwater recharge from Arroyo Seco spreading basins, (3) seasonal and regional groundwater recharge from precipitation (primarily at the mouth of the Arroyo Seco), and (4) regional groundwater flow. The extraction of water from municipal production wells (see Figure 1-2) has the most significant effect on the natural groundwater flow.

The groundwater surface has been measured in the JPL monitoring wells at depths ranging from approximately 22 ft (groundwater mound near the mouth of the Arroyo Seco) to 270 ft below ground surface (bgs). This wide range of depths to groundwater can primarily be contributed to the relatively steep topography present at the JPL facility and local groundwater mounding. It also can be accounted for by seasonal groundwater recharge from nearby spreading grounds and the extraction of groundwater from nearby municipal production wells. Based on monitoring data collected since 1996, groundwater elevations have fluctuated up to 75 ft each year beneath JPL, primarily as a result of these influences.

Figures 2-4 and 2-5 show generalized groundwater elevation contour maps for January 1998 and January 2002 that were constructed using groundwater elevation data from JPL monitoring wells and selected municipal production wells within the Monk Hill Subarea. Groundwater elevation data from the uppermost screen in the JPL multi-port wells were used during construction of the maps. These dates were chosen because they coincide with comprehensive groundwater monitoring events at NASA JPL, during which groundwater chemistry parameters were collected. These maps indicate a southeast flow direction to the west of JPL and a southwest flow direction near the mouth of the Arroyo Seco. Groundwater flow to the south of JPL is heavily influenced by operation of the municipal pumping wells and recharge at the Arroyo Seco.

2.4 Groundwater Chemistry

During the RI (FWEC, 1999), groundwater samples collected from JPL monitoring wells and from municipal production wells were analyzed for major anions (including chloride, sulfate, nitrate, and alkalinity), major cations (including calcium, magnesium, sodium, potassium, and iron), and TDS. The results of these analyses were used to evaluate the general chemistry of groundwater. Data were compiled in Stiff diagrams for a visual categorization of each water sample. A review of these diagrams suggest that the majority of groundwater at JPL can be divided into three general types:

Type 1: Calcium-bicarbonate groundwater. Groundwater with calcium as the dominant cation and bicarbonate as the dominant anion. Type 1 water appears to originate as rainwater runoff from the San Gabriel Mountains and enters the study area through the Arroyo Seco and the spreading grounds.

Type 2: Sodium-bicarbonate groundwater. Groundwater with sodium as the dominant cation and bicarbonate as the dominant anion. Type 2 water is typically found in deeper portions of the aquifer.

Type 3: Calcium-bicarbonate/chloride/sulfate groundwater. Groundwater with calcium as the dominant cation and bicarbonate the dominant anion, but with relatively elevated chloride and sulfate concentrations. This water type consistently has higher levels of TDS than the other two general types.

In addition to the general water types listed above, the analytical data suggest that mixing, or blending of water types, creates "intermediate" water types.

The most common water type at JPL, Type 1 water (calcium-bicarbonate), was detected primarily in monitoring and production wells in and near the mouth of the Arroyo Seco. It appears that Type 1 water may originate as rainwater runoff from the San Gabriel Mountains and enter the study area via the Arroyo Seco and spreading grounds. Type 2 water (sodium bicarbonate) is typically is found in deeper portions of the aquifer. Type 2 water, although found deep in the aquifer, is similar to water Type 1 in that both have relatively low TDS levels. A significant difference between these water types is that sodium is the predominant cation found in Type 2 water, whereas calcium is the predominant cation in Type 1 water. Type 3 water (calcium-bicarbonate/chloride/sulfate) is most prevalent in wells located upgradient and to the west of the JPL facility and is indicative of a mixture of Type 1 water and Colorado River water imported by the Metropolitan Water District of Southern California (MWD) (FWEC, 1999). Some Type 3 water also is found downgradient to the south of JPL. This water type differs from Types 1 and 2 by having elevated levels of chloride, sulfate, and TDS. A piper diagram showing the distribution of the three water types is presented in Figure 2-6. Figures 2-7 and 2-8 graphically present groundwater quality at JPL in January 1998 and January 2001, respectively.

Perchlorate detections have been reported in municipal production wells located throughout the Raymond Basin, including the wells owned by the City of Pasadena, LAWC, RCWLA, Las Flores Water Company, VWC, and LCID. In addition, perchlorate detections in furthest downgradient JPL monitoring well, MW-20, indicate the leading edge of the chemical plume originating at JPL is not currently delineated. NASA is pursuing treatment of VOCs and perchlorate in four City of Pasadena wells (Arroyo, Well 52, Ventura, and Windsor) and the two LAWC wells (LAWC 3 and LAWC 5). In the early 1990s, agreements were made with the City of Pasadena and LAWC for NASA to pay for implementation of VOC treatment systems. Recently, NASA modified the agreement with LAWC to include perchlorate treatment and a similar modification is being pursued for the four City of Pasadena wells. An initial evaluation of available data was performed to better determine the extent of chemicals originating from the JPL facility and to identify uncertainties that need to be addressed as part of the additional investigation (described in Section 4.0 of this work plan).

3.1 Methods of Analysis

Several different methods were used to evaluate the occurrence of VOCs and perchlorate in municipal production wells, including groundwater chemical concentrations, groundwater quality parameters, vadose zone and groundwater modeling, and other methods. A brief explanation of each is provided in the following sections.

3.1.1 Groundwater Chemical Concentrations. Chemical concentrations reported in groundwater collected from JPL monitoring wells and municipal production wells were evaluated to determine trends and the spatial distribution of VOCs and perchlorate.

The VOCs chosen for evaluation include PCE, TCE, and CCl_4 (each of these VOCs have been primarily used as degreasing agents). CCl_4 appears to have a unique association to JPL in the Monk Hill Subarea, with consistent detections in on-facility monitoring wells (maximum concentration of 208 μg/L in MW-7 in April 2002) and consistent nondetections in upgradient production wells. Historical records indicate CCl_4 was used during early activities at the JPL facility, but was reportedly phased out by the end of the 1950s (NASA, 1998). Therefore, CCl_4 is considered a good tracer for chemicals originating from JPL.

TCE also has been linked to historical activities at JPL; however, it has also been detected in upgradient wells. Low levels of PCE have been detected in wells located on the JPL facility; although higher levels observed in upgradient and downgradient production wells appear to be associated with sources other than JPL, such as dry cleaning sites and unsewered areas in La Cañada-Flintridge (FWEC, 1999). Because these three VOCs have similar characteristics associated with fate and transport in groundwater (e.g., retardation factors), higher levels of PCE and/or TCE and the absence of CCl_4 in downgradient municipal production wells generally indicate a VOC source other than JPL (FWEC, 1999).

Perchlorate detections throughout the Raymond Basin have necessitated the additional investigation described in this Work Plan. Compared to the fate and transport characteristics of VOCs, perchlorate has a lower retardation factor, which may result in faster migration in groundwater. Perchlorate usage has been linked to the JPL facility, where testing of perchlorate as a component of solid rocket propellant began around 1942 (NASA, 1969). Concentrations of perchlorate as high as 13,300 μg/L (MW-7 in October/November 2002) have been detected in samples from wells located on the JPL facility. While no other study has been conducted to determine sources of perchlorate in the Raymond Basin, MWD water imported from the Colorado River has been linked with perchlorate detections in the upgradient VWC wells (FWEC, 1999). Colorado River water has higher chloride, sulfate, and TDS concentrations (i.e., Type 3 water quality, see Section 2.4) than local water sources (i.e., Types 1 and 2). Therefore, perchlorate concentrations detected in samples with influences of Type 3 groundwater quality may be associated with a source other than JPL.

3.1.2 Groundwater Quality. Similar to chemical concentrations, water quality data in groundwater samples collected from JPL monitoring wells and municipal production wells were evaluated to determine trends and the spatial distribution. Each set of data was assigned a water-quality type consistent with the criteria discussed in Section 2.4. These data were used to make evaluations of the source of water for the respective sample. Type 1 and 2 groundwater originate locally and are found below the JPL facility, whereas Type 3 groundwater is not associated with sources originating from JPL.

3.1.3 Vadose Zone and Groundwater Modeling. As part of this work plan a vadose zone model was developed to predict migration time for select JPL chemicals of interest through approximately 200 ft of unsaturated soil to the groundwater table (i.e., simulating travel from a seepage pit to the groundwater). The Seasonal Soil Compartment (SESOIL) model (General Sciences Corporation [GSC], 1998) was used to make the predictions, taking into account site-specific input parameters. The model incorporated sorption to allow for the differentiation of chemicals through the use of a chemical-specific retardation factor that is based on the distribution coefficient (K_d). The SESOIL vadose zone model predicted a minimum travel time through the vadose zone of 7.5 years using conservative estimates of site-specific and chemical-specific (i.e., perchlorate) input parameters. By incorporating less conservative estimates of sorption in the model for perchlorate (Battelle, in press; Texas Natural Resources Conservation Council [TNRCC], 2002; Batista, et al., 2003), the estimated travel time could increase by a factor of 2 or more (i.e., $\geq$ 15 years).

The JPL groundwater flow model (NASA, 2003), which was constructed using FEFLOW (Diersch, 2002), was designed to simulate groundwater flow in the Monk Hill Subarea. The model was used to conduct particle tracking simulations that illustrate flow paths and provide estimates of advective travel times from potential chemical release sites to downgradient locations. Additionally, the boundaries of the JPL groundwater flow model were expanded to create a basin-scale groundwater flow model that encompassed the Monk Hill Subarea and a large portion of the Pasadena Subarea, including the wells near the Sunset Reservoir. Results from the groundwater flow model developed and implemented as part of the *Phase 2 First Technical Assessment, Devil's Gate Multi-Use Project* (CH2M-Hill, 1992) also were evaluated during the analysis. Results from the vadose zone and groundwater flow models were combined to estimate chemical travel times from a release near the ground surface (e.g., seepage pit) to a downgradient receptor in groundwater. Groundwater modeling results are provided in Sections 3.2 through 3.4.

3.1.4 Additional Methods. Additional methods of analysis include evaluation of groundwater-level elevation data, groundwater flux in the basin, and historical data review, whereby federal, state, and local databases were searched in a comprehensive Environmental Data Resources (EDR) Area Study Report to identify other potential sources within the study area (see Attachment A).

3.2 Sunset Reservoir Wells

The City of Pasadena wells located near the Sunset Reservoir include the Sunset, Bangham, Copelin, Garfield, and Villa (Figure 2-1). Table 3-1 provides a summary of VOC and perchlorate concentrations that have been detected in the Sunset Reservoir wells and in the most southerly JPL monitoring wells (MW-19 and MW-20). The data were compiled using information from the Raymond Basin (Geoscience, 2003), the JPL CERCLA Program (NASA, 2003), and DHS (DHS, 2004). Figure 3-1 shows the concentrations of perchlorate that have been detected in the Sunset Reservoir wells.

In general, the data evaluated for the Sunset Reservoir wells are inconclusive regarding the source of perchlorate. As such, Section 4.0 describes installation of additional monitoring wells to better understand the extent of perchlorate that originated from JPL.

Chemical Concentrations and Water Quality. PCE and TCE concentrations detected in the Sunset, Bangham, and Copelin wells are not consistent with a source originating from JPL because the concentrations are significantly higher than those detected in NASA's furthest downgradient monitoring wells MW-19 and MW-20. The absence of CCl_4 in the Sunset Reservoir wells and in NASA's furthest downgradient monitoring wells MW-19 and MW-20, with the exception of an isolated detection in August/September 1996 (0.5 μg/L in MW-19), further support that VOCs from JPL have not migrated to the Sunset Reservoir wells. However, due to its chemical properties, perchlorate could migrate faster than VOCs.

Since 1997, perchlorate has consistently been detected in the Sunset Reservoir wells, with maximum concentrations of 12.8, 9.0, 17.4, 27.7, and 7.2 μg/L in the Sunset, Bangham, Copelin, Garfield, and Villa wells, respectively (see Table 3-1 and Figure 3-1). Figures 3-2 through 3-4 show water quality trends in Sunset Reservoir wells, and indicate increasing chloride, sulfate, and TDS values since the early 1960s. Classification of the water quality in these wells indicates a shift from a Type 1 (local source) to a Type 3 water (not associated with JPL). Given this water quality data, it is not possible to determine the source of perchlorate in the Sunset Reservoir wells.

Sporadic detections have been observed in samples collected from MW-20 (Screen 4) since 1998 associated with deeper portions of the aquifer and Type 1 or 2 water quality (consistent with a source originating from JPL). Specifically, samples collected from MW-20 (Screen 4) contained perchlorate concentrations of 20 μg/L, 30 μg/L, 58.5 μg/L, and 124 μg/L in October/November 1998, April/May 2002, October/November 2002, and April/May 2003. All other samples from Screen 4 have shown non-detect concentrations of perchlorate. Nevertheless, the presence of perchlorate in MW-20 (Screen 4) indicates that the leading edge of NASA's plume has traveled beyond this monitoring location and the extent of the plume is not fully known in this area and it is not possible to say whether or not it may have impacted the Sunset wells. As such, NASA is proposing additional wells (see Section 4.0) to help delineate the leading edge of the perchlorate plume.

Samples collected in Screen 1 of MW-20 (located approximately 2 miles north of the Sunset Reservoir) have shown low levels of perchlorate since 1997; however, these samples were collected from locations in the uppermost hydrostratigraphic layer and were associated with Type 3 water, indicating a source other than JPL. In MW-19 (Figure 2-1), perchlorate has not been detected above 8 μg/L. Figure 3-5 shows historical perchlorate concentrations in JPL monitoring wells MW-19 and MW-20.

Figures 3-6 through 3-11 show a vertical cross section (A-A') extending from the JPL facility to the downgradient Sunset Reservoir municipal production wells. These figures include concentrations of PCE, CCl_4, and perchlorate and indicate water type in monitoring wells and production wells for years 1997 through 2002.

It should be noted that MWD water has been injected into two Sunset Reservoir wells (approximately 2,200 acre ft in Bangham and Garfield wells between 1992 and 1996); however, the quantities injected (see Table 2-2) do not appear to be large enough to account for the magnitude and duration of observed perchlorate concentrations.

Vadose Zone and Groundwater Modeling. The SESOIL vadose zone model predicted a minimum travel time through the vadose zone of 7.5 years using conservative estimates (i.e., most rapid transport) of site-specific and chemical-specific input parameters. The basin-scale groundwater model constructed using FEFLOW was used to simulate flow in the Raymond Basin from the JPL facility to the Sunset Reservoir wells. This model indicates the advective travel times (i.e., most conservative) for a particle originating on the JPL Facility near MW-7 and captured at the Sunset Reservoir wells is between 40 and 96 years, with an average travel time of 70 years. Using these travel times, the estimated release period ranges between 1899 and 1955 (i.e., 2002 minus [40 to 96 years] minus 7.5 [vadose zone travel time]), with the average starting prior to prior to 1924. As indicated earlier, the JPL facility did not start testing perchlorate as a solid rocket propellant until after 1942. It should be noted that simulations performed using the groundwater flow model assume steady state conditions; therefore, recent modifications in production well operation may result in slightly different travel time estimates.

While particle tracking can be used to estimate groundwater flow paths and conservative travel times, it does not necessarily indicate that enough perchlorate mass traveled to the Sunset Reservoir wells to result in the observed concentrations. As indicated in previous reports (FWEC, 1999; NASA, 2003), the production wells in the Monk Hill Subarea have been in operation since the early 1900s and provide effective hydraulic containment of the groundwater originating from the JPL facility. Therefore, the vadose zone and groundwater modeling efforts provide additional uncertainty regarding the source of perchlorate in the Sunset Reservoir.

Other Potential Sources. Although none of the potential sources of chemicals in groundwater identified in the EDR Study were associated with perchlorate, it should be noted that the study area only encompassed the area downgradient of the JPL facility. As stated above, the RI indicates that injection of Colorado River water (which has been shown to contain perchlorate) in upgradient production wells has been shown to influence groundwater quality in the Basin (FWEC, 1999). Other potential sources include system leakage at/near the Sunset Reservoir, which receives water from MWD, or other underdetermined sources.

3.3 RCLWA and Las Flores Water Company Wells

RCLWA 7, RCLWA 4, and Las Flores 2 wells (Figure 2-1) are located in the Monk Hill Subarea, downgradient and approximately 1,200 feet southeast of JPL monitoring well MW-20. A summary of PCE, TCE, CCl_4, and perchlorate concentration data for the RCLWA, Las Flores, and LAWC (provided for comparison) wells is presented in Table 3-2. Figure 3-12 shows the concentrations of perchlorate that have been detected in the RCLWA and Las Flores Water Company wells.

CCl_4 has not been detected at all and TCE has not been detected at concentrations above maximum contaminant levels (MCLs) in the RCLWA and Las Flores wells. PCE was detected above its MCL only in the Las Flores 2 well (the only well associated with a mixture of Type 3 water), at a maximum concentration 17.2 μg/L. PCE first exceeded its MCL in the Las Flores 2 well in May of 1998 and has continued to exceed the MCL through the most recent data set, with detections consistently near or above 10 μg/L. The absence of CCl_4 indicates that VOCs from the source area at JPL have not migrated to the RCLWA or Las Flores Water Company wells. For comparison, CCl_4 and TCE have been detected in the LAWC 3 and LAWC 5 wells at concentrations above their MCLs. During the summer of 2004, NASA funded installation and operation of a perchlorate treatment system for LAWC.

Perchlorate has been detected above at or above 6 μg/L in the RCLWA 4 and Las Flores 2 wells. Perchlorate has not been detected in the RCLWA 7 well. A summary of groundwater quality information for the RCLWA and Las Flores Water Company wells is presented in Table 3-3. Groundwater from the

RCLWA 4 well has an average TDS of 371 mg/L and is consistently classified as Type 1 water, which originates locally. Groundwater from the RCLWA 7 well has an average TDS of 276 mg/L and varies between Type 1 and Type 2, which originate locally. Groundwater from the Las Flores 2 well has an average TDS of 396 mg/L and exhibits a combination of Type 1 and Type 3 water, indicating that groundwater extracted from the well is a mixture of local and non-local sources.

Isolated perchlorate concentrations (as high as 124 μg/L in Screen 4) in JPL monitoring well MW-20 have been detected in the lower two screened intervals, characterized by Type 2 groundwater. Perchlorate concentrations in MW-20 in the upper-most screen have been detected as high as 7.8 μg/L and were associated with Type 3 or 1/3 waters. Because the RCLWA and Las Flores wells are screened across multiple aquifer zones, the contributions of perchlorate from different zones, represented by the different screened intervals in MW-20, is uncertain. Figure 3-5 shows the historical concentrations of perchlorate in MW-20.

Due to the low levels of perchlorate in the RCLWA and Las Flores Water Company wells, these purveyors have not needed to treat for perchlorate (although Las Flores Water Company does have a DHS approved blending plan for perchlorate). Therefore, installation of an additional monitoring well east of these production wells does not appear to be appropriate at this time due to the proximity of MW-20 and the southerly groundwater flow conditions in the area. The data will continue to be evaluated closely for increasing perchlorate concentrations, presence of VOCs (particularly CCl_4), and groundwater quality.

Figures 3-13 through 3-18 are vertical cross-sections along a transect (B-B') extending from the JPL facility to the RCLWA and Las Flores Water Company wells. Figures 3-19 through 3-24 are cross-sections along transect (C-C') extending from LCID and VWC wells to the RCLWA and Las Flores Water Company wells. Each of these cross sections shows CCl_4, PCE, and perchlorate concentrations in addition to water quality and groundwater level information.

3.4 VWC/LCID Wells

Six municipal production wells are located upgradient of the JPL Facility, including wells VWC 1 through VWC 4, LCID 1, and LCID 6 (Figure 2-1). In addition to their extraction capability, production wells VWC-2 and VWC-3 were constructed to function as injection wells and inject MWD water. A summary of PCE, TCE, CCl_4, and perchlorate concentration data for these wells is presented in Table 3-4, which also includes information from two JPL monitoring wells (MW-14 and MW-6) that are located between the NASA facility and the production wells, and JPL monitoring well MW-7, which is located in the suspected JPL source area. A summary of groundwater quality information for these wells is presented in Table 3-5.

Elevated PCE and TCE in the VWC production wells and the absence of CCl_4 (with the exception of an isolated detection of 0.6 μg/L in production well VWC 4), indicate a VOC source other than JPL. PCE detections have been attributed to unsewered areas in La Cañada-Flintridge, where PCE was evidentially used as a septic system cleaner, and several dry cleaner sites. Figures 3-25 through 3-30 show CCl_4, PCE, and perchlorate concentrations and water quality data along a transect (D-D') from the NASA facility to the upgradient production wells VWC wells to the downgradient production wells for years 1997 through 2002.

Perchlorate concentrations in the VWC wells have been attributed to injection of MWD Colorado River water (FWEC, 1999). Groundwater samples from the VWC wells (two of which have historically injected Colorado River water) have an average TDS of over 600 mg/L and are consistently classified as Type 1/3 or Type 3, indicating that it does not originate locally. Groundwater from the LCID wells, which are upgradient of the VWC wells, has an average TDS of under 420 mg/L and varies between Type 1 and Type 1/3, which indicates that it is primarily rainwater runoff with minor contributions from Colorado River water. Figures 2-7 and 2-8 show water quality distribution throughout the northern portion of the Monk Hill Subarea, including the NASA facility, for January 1998 and January 2001, respectively. These figures illustrate the transition from Type 1 to Type 3 waters between the NASA facility and the VWC and LCID production wells.

Groundwater elevation data (Figures 2-4 and 2-5) and groundwater flow modeling also support a chemical source other than JPL in the VWC and LCID wells. The simulations indicate that groundwater flows to the southeast in accordance with the regional flow in the Monk Hill Subarea and that particles released in the vicinity of the suspected source area at JPL would not migrate to the VWC and LCID wells. Additionally, the width of the Monk Hill Subarea narrows and the base of the alluvial aquifer (i.e., top of bedrock) increases in elevation toward the northwest, as indicated in Figures 3-25 through 3-30. These two characteristics inhibit the ability of the groundwater to flow from the JPL Facility toward the VWC wells due to the reduction in aquifer storage capacity and further support a southeasterly flow direction.

3.5 Summary and Conclusions

Table 3-6 summarizes the results from the data evaluation as they relate to the Sunset Reservoir, RCLWA, Las Flores, VWC, and LCID wells. The data indicate the following:

- The VOCs and perchlorate in the VWC and LCID wells do not appear to originate from the JPL Facility. This conclusion is supported by elevated levels of PCE and TCE and the absence of CCl_4, groundwater-level elevation data, water quality data showing significant Type 3 characteristics, and groundwater modeling.
- The VOCs in the Las Flores Water Company well do not appear to originate from the JPL Facility due to elevated PCE and the absence of CCl_4. The origin of perchlorate concentrations in the Las Flores Water Company well is uncertain. Although there is Type 3 water characteristics present (indicating a source other than JPL), samples collected from the deeper screens of MW-20 (located 1,200 feet upgradient) have shown elevated perchlorate concentrations that appear to originate from JPL.
- The VOCs in the RCLWA wells do not appear to originate from the JPL Facility due to the absence of CCl_4. However, the perchlorate detections in RCLWA 4 appear to originate from the JPL facility due to the presence of Type 1 water quality characteristics and the proximity to MW-20, which has perchlorate concentrations in samples from deeper screens that appear to originate at JPL.
- The VOCs in the Sunset Reservoir wells do not appear to originate from the JPL Facility due to elevated PCE and TCE, and the absence of CCl_4. However, the origin of perchlorate concentrations in the Sunset Reservoir wells is uncertain. The presence of Type 3 water characteristics and the results of groundwater modeling indicate a source other than JPL. However, the leading edge of perchlorate plume is not delineated (i.e., samples collected from the deeper screens of the furthest downgradient monitoring well, MW-20, have shown elevated perchlorate concentrations that appear to originate from JPL) and the Sunset Reservoir wells are hydraulically downgradient of the JPL Facility. Even though these wells are hydraulically downgradient of JPL, it is not clear whether the source is JPL due to travel time estimates and hydraulic containment by production wells in the Monk Hill Subarea. Additional investigation is warranted.

3.6 Recommendations

Due to the uncertainty associated with the origin of perchlorate in the Las Flores Water Company well and the Sunset Reservoir wells, NASA recommends the following:

- Continued monitoring of the RCLWA and Las Flores Water Company wells. Installation of an additional monitoring well east of these production wells does not appear to be appropriate at this time due to the proximity of MW-20 and the southerly groundwater flow conditions in the area. The data should be evaluated closely for increasing perchlorate concentrations, presence of VOCs (particularly CCl_4), and groundwater quality.
- Installation of additional multi-port monitoring wells south of MW-20 and near the Sunset Reservoir wells. These wells are recommended to help define the leading edge of the perchlorate plume and to help understand the relationship between water quality and perchlorate concentrations near the Sunset Reservoir.
- Collection of soil samples to better define aquifer characteristics, including bulk density, effective porosity, hydraulic conductivity, and fraction organic carbon. Column tests on soil samples are recommended to determine site-specific sorption coefficient (K_ds) for perchlorate. Estimation of these parameters will provide a better understanding of site-specific and chemical-specific characteristics that can be incorporated into groundwater modeling simulations. A work plan is provided as Appendix C.

4.0 ADDITIONAL INVESTIGATION

Additional investigation is proposed to delineate the leading edge of the perchlorate plume originating from the JPL Facility and to improve the understanding of the relationship between water quality and perchlorate concentrations near the Sunset Reservoir. The additional investigation includes installation of two multi-port monitoring wells and collection of monitoring data from these wells.

Multi-port wells are recommended due to the thickness of the aquifer in the area of interest and the presence of stratification within the aquifer. Well locations were selected in coordination with the City of Pasadena. To the extent possible, well locations were sited within City of Pasadena property to facilitate ease of access and minimize impact to private property and public right-of-way (e.g., streets, etc). Upon installation and development of the proposed wells, an initial round of groundwater monitoring will be conducted to provide a baseline understanding of hydrogeologic conditions in the vicinity of these wells. Monitoring data will consist of chemical concentrations, water quality parameters, and groundwater-level elevations. Data from the multi-port screens will be used to develop a vertical profile of the groundwater conditions. Groundwater monitoring and data collection will be conducted in accordance with the Sampling and Analysis Plan (SAP) provided in Appendix A. Following the initial sampling event, subsequent sampling events will be conducted as part of the existing JPL groundwater monitoring program conducted by NASA. All field activities at the site will be conducted according to the procedures outlined in the Site Health and Safety Plan (SHSP) (Appendix B).

In addition, an attempt will be made to collect one saturated and one unsaturated soil sample from each location for analysis of several physical parameters, including bulk density, effective porosity, horizontal and vertical hydraulic conductivity, and fraction organic carbon. In addition, collection of samples for column tests will be performed in an effort to determine site-specific sorption coefficient (K_ds) for perchlorate. The sample collection efforts are described in this Work Plan; however, a separate Work Plan has been prepared to discuss the column tests to determine perchlorate sorption coefficient (Appendix C).

4.1 Schedule

A proposed schedule for installation of the additional monitoring wells is presented in Table 4-1, and includes a timeframe for logistic coordination and field work. The proposed start date and subsequent milestones will be contingent upon modification of the *Use Agreement and Right-of-Entry for Environmental Actions* between the City of Pasadena and NASA.

4.2 Logistics Coordination

To ensure the successful planning, installation, construction, and monitoring of the proposed multi-port wells, this project will require coordination with all parties to the FFA, including NASA, U.S. EPA, DTSC, and the RWQCB Los Angeles Region, as well as the City of Pasadena and the RBMB. NASA has already initiated coordination with the City of Pasadena associated with well location and property access. A brief description of specific coordination activities associated with the City of Pasadena and the RBMB is provided below.

4.2.1 City of Pasadena. Proposed well locations are within City of Pasadena property and were selected in coordination with City of Pasadena Pasadena Water and Power (PWP) personnel. Therefore, close coordination of well installation and sampling activities will be required between NASA and the City of Pasadena. Use of portions of some City of Pasadena roads will potentially be disrupted, but the traffic can likely be accommodated through usual traffic control methods. In general, coordination activities associated with the City of Pasadena for this project will include the following:

- Finalization of the *Use Agreement and Right-of-Entry for Environmental Actions* between the City of Pasadena and NASA for access to well sites for project personnel, equipment, and vehicles during field related activities.
- Completion of appropriate City of Pasadena Department of Public Works and Department of Planning boring and construction approvals (including public notification requirements and traffic control plans).
- 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 each proposed well site.
- Coordination of drilling, well construction, waste disposal, surveying, and groundwater sampling field schedules.

Prior to and during monitoring well installation on City-owned land, NASA will comply with all of the requirements in the *Use Agreement and Right-of-Entry for Environmental Actions*. NASA will submit to PWP a firm schedule of commitment two weeks prior to commencing with the well construction to coordinate with PWP inspections and planning.

4.2.2 RBMB. The RBMB oversees implementation of the adjudication provisions of the Raymond Basin Judgment. NASA will obtain written authorization from the Raymond Basin Watermaster for constructing and operating the proposed monitoring wells. Because well construction and development require groundwater extraction, the RBMB will be notified of estimated and actual extracted groundwater quantities before and after well construction.

4.3 Well Locations

Selection of the proposed additional monitoring well locations was based on groundwater analytical data from existing wells, known groundwater flow patterns in the OU-3 area, and available property. Two proposed monitoring well locations have been identified, each of which is located on property owned by the City of Pasadena. The first proposed location is downgradient of JPL monitoring well MW-20 (NASA's furthest downgradient monitoring well) on Montana Street (see Figure 4-1). The well is located between NASA's two most downgradient monitoring wells and the Sunset Reservoir wells. An alternate location is proposed on Pasadena Unified School District (PUSD) property, just south of the Montana Street location (see Figure 4-1). The exact location of the proposed monitoring well has yet to be finalized, and will be based upon the results of meetings with the drillers, a subsurface utility survey, and discussions with the City of Pasadena and PUSD. Data collected from this well will serve primarily to evaluate the downgradient extent of chemical that originate from the JPL facility. The well will be completed with depth-discrete monitoring points (see Section 4.4), so that vertical profiling of the aquifer can be performed to correlate depth with water quality and chemical concentrations.

The second proposed location is slightly upgradient of the City of Pasadena Sunset Reservoir area Bangham and Copelin wells (see Figure 2-3), in the northwest corner of the City's Yards complex, which encompasses both the Sunset Reservoir and three production wells, and near the intersection of Hammond Street and the Foothill Freeway (Figure 4-1). This monitoring well will be located north of the Sunset Reservoir and south of the first proposed location. The Sunset Reservoir wells are currently inactive, but the proposed location is approximately 1,000 ft upgradient of the closest well. Data collected from this well will serve primarily to better understand the occurrence of perchlorate in the vicinity of the Sunset Reservoir area. The well will be completed with depth-discrete monitoring points (see Section 4.4), so that vertical profiling of the aquifer can be performed to correlate depth with water quality and chemical concentrations.

Additional locations in OU-3 may be necessary depending on the groundwater sampling results from the two proposed wells. If the monitoring results necessitate additional locations, a letter report will be submitted as an addendum to this document. The letter report will document the rationale behind additional monitoring wells and the proposed location of these wells.

4.4 Well Construction

The following sections describe the well installation activities that will be performed as part of this additional investigation. These activities include permitting, geophysical surveying, deep multi-port well installation, and IDW treatment and disposal. Additional assessment activities are similar in scope to those performed as part of NASA's regulator approved *Work Plan for Performing a Remedial Investigation/Feasibility Study at NASA JPL* (Ebasco, 1993).

4.4.1 Well Permit Requirements. The proposed monitoring wells are located within the OU-3. As a CERCLA site, the activities conducted as part of this additional assessment are only subject to substantive requirements and not procedural or administrative requirements such as permits. Under CERCLA § 121(e)(1) and 40 Code of Federal Regulations (CFR) § 300.400(e), no Federal, State, or local permit is required for this additional RI, provided that the action is selected and carried out in compliance with CERCLA. This applies to all permits, including environmental and building permits.

Although permits are not required, NASA will comply with the substantive permitting requirements associated with monitoring well installation. This includes permitting requirements associated with the Los Angeles County Department of Environmental Health (DEH), City of Pasadena Building Department, RWQCB Los Angeles region, and the California Department of Water Resources (DWR) Southern District. NASA will coordinate with each agency on installation of additional monitoring wells.

4.4.2 Pre-Drilling Activities. Prior to beginning drilling, all available utility maps will be reviewed. To the extent possible, well locations will be strategically sited in the vicinity of the proposed location to avoid existing utilities. In addition, prior to performing any subsurface activities, the well locations will be scanned for underground utilities using geophysical methods. The utility-locating contractor will employ several methods, including ground-penetrating radar (GPR), magnetometer, magnetic gradiometer, and/or electromagnetic imaging (EM). As required by California State law, Underground Services Alert (USA) will be notified of the planned drilling activities. USA is a communication center that provides notice to utility owners that may potentially have underground utilities within the proposed well sites. USA requires notification a minimum of 48 hours prior to conducting any underground excavation. Following map review, geophysical utility locating, and USA clearance, the surface of the ground will be clearly marked where underground utilities are discovered. Drilling locations will be selected to avoid impact to existing utilities. Prior to the initiation of drilling activities, the drilling contractor will attempt to hand auger a pilot hole to a depth of approximately 5 ft bgs at each proposed well location to ensure that no underground utilities or obstructions are present.

4.4.3 Deep Multi-Port Well Installation. Similar to the existing JPL multi-port monitoring wells, the proposed monitoring wells have been designed to include five depth discrete monitoring points within one well casing, and will be equipped with the Westbay Instruments Ltd. Multi-port casing monitoring system. Both new wells will be drilled to the top of the crystalline bedrock. Based on boring logs from nearby wells (e.g., Sunset Well and MW-20), it is anticipated that the proposed wells will extend to depths of approximately 700 to 1,000 ft. This design may be amended in the field if site-specific conditions warrant a modified construction.

The remainder of this section includes a brief description of the drilling method, well construction details, well development procedures, and the multi-port casing system installation procedures. A detailed description of these procedures can be found in NASA's regulator approved *Work Plan for Performing a Remedial Investigation/Feasibility Study at NASA JPL* (Ebasco, 1993).

4.4.3.1 ***Drilling Method.*** Each groundwater monitoring well will be drilled to the required depth below ground surface using a 12.25-inch outside diameter (O.D.) mud-rotary drilling bit. Approximately 20 ft of steel conductor casing will be set at the surface of each borehole to maintain the near surface integrity. The conductor casing will be removed after the well is constructed and all backfill materials have been placed. During drilling and well construction, drill cuttings will be separated from the drilling mud using a mud shaker. The separated mud is recycled into the drilling process and the cuttings are stored in a roll-off bin. Additional details regarding containerization and disposal of IDW are provided in Section 4.4.3.6.

All drilling equipment and materials including drilling bits and pipes, drilling mud, and backfill materials will be either new or cleaned in the field using a high pressure steam cleaner. Clean, imported water or water supplied from a nearby clean water source (e.g., water spigot) will be used during drilling and well construction activities. Prior to use, a water sample will be collected from each water source. The water sample will be analyzed for perchlorate and VOCs using U.S. EPA-approved methods.

During drilling, soil samples will be collected for lithologic logging purposes and then disposed of with the soil cuttings. Soil samples will be logged using the Unified Soil Classification System (USCS). Soil boring logs will be incorporated into a bound field notebook. The field notebook will be used to document all sampling activities. These notebooks will be maintained as permanent records. A minimum of one saturated and one unsaturated soil sample will be collected from each monitoring well for use in determining selected physical parameters, such as hydraulic conductivity, porosity, and bulk density. In order to collect these samples, the downhole drilling equipment will be tripped so that soil sampling equipment can be inserted down the well for sample collection. A modified split-spoon sampler attached to a 300-pound hammer will be used to collect undisturbed soil samples that will be used for analysis of physical parameters and in column studies for determining chemical-specific transport parameters. The drilling method described above is a standard method for installation of environmental monitoring wells. Cross-contamination between aquifer layers will be minimized because the drilling mud is of a different viscosity thereby restricting groundwater flow within the borehole during the drilling and well installation activities. Additionally, during well construction and development, to the extent possible, the drilling mud will eventually be completely removed from the well.

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

4.4.3.2 ***Well Construction.*** The total depth of each well will be determined by the on-site geologist based on the depth that crystalline bedrock is encountered. Based on the lithology defined by similar wells in the area, it is assumed that the wells will be advanced to approximately 700 to 1000 ft.

Well construction will satisfy the requirements of the California DWR, Water Well Standards, Bulletin 74-90, Supplement to Bulletin 74-81. The initial well design will be based on the design of other deep multi-port wells located in the vicinity (e.g., MW-19 and MW-20). The outer well casing will consist 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. Each section of screen and blank casing will be measured and steam cleaned before being lowered into the boring. The proposed screen depths will initially be chosen based on lithologic information from existing production and monitoring wells and existing groundwater level data. However, field changes to the proposed screen depths may occur as a result of information collected from lithologic logging during drilling and geophysical logging (see Section 4.4.3.3). All bentonite seals and sand packs will be tremied into place. The sand packs will consist of No. 2 silica sand. A grout pump will be used to circulate drilling fluid out of the hole and to pump backfill materials into the boring. The backfill materials will include sand, a bentonite sealing mixture consisting of sand and bentonite, and Volclay grout or equivalent. A locking monument cover or a traffic box will be installed at the well after the grout has set. Concrete will be used to secure the monument cover or traffic box in place. Well design may be modified in the field based on site-specific conditions.

Additional details regarding well construction can be found in NASA's regulator approved *Work Plan for Performing a Remedial Investigation/Feasibility Study at NASA JPL* (Ebasco, 1993).

4.4.3.3 Geophysical Logging. Upon completion of the drilling, the wells will be logged in the open borehole using geophysical methods to assist the identification of well screen depths, borehole lithologies, water-bearing intervals, and stratigraphic correlation with existing JPL monitoring wells. During the geophysical logging, the sides of the open borehole will be held in place by the viscosity of the drill mud, which will remain in place throughout the process. To accurately interpret results from the logging, the properties of the drilling mud will be subtracted out during analysis of the data. Proposed geophysical methods include natural gamma radiation, electrical resistivity (R/SP), guard resistivity, and caliper surveying.

4.4.3.4 Multi-Port Casing System Installation. The multi-port casing will be provided and installed by certified technical representatives of Westbay Instruments, Inc. The multi-port casing will arrive on-site, pre-cleaned in factory packaging and will be installed by hand within the previously installed well casing. The multi-port equipment consists of 1.5- inch-diameter schedule 80 polyvinyl chloride (PVC) blank casing, PVC couplings used to connect various casing components, PVC measurement-port couplings, PVC pumping-port couplings, and nitrile rubber inflatable packers. The measurement ports are installed to allow access to the aquifer for well purging and hydraulic conductivity testing. The pumping-ports are installed to allow access to the aquifer for pressure measurements and water sampling and the packers are used to seal the annulus between the measurement and pumping ports at each screened interval.

During well construction and casing installation, cross contamination will be minimized through the placement of a bentonite seal between each screened interval. Each screened interval will be developed independently. Once the development is complete, the outer casing will be purged free of water.

Additional details regarding the multi-port casing system installation, testing, and well development can be found in NASA's regulator approved Work *Plan for Performing a Remedial Investigation/Feasibility Study at NASA JPL* (Ebasco, 1993).

4.4.3.5 Well Development Procedures. Each monitoring well will be developed within 24 hours after being installed. Well development will include an initial period of surging followed by over-pumping. Development will be considered complete when the pH, conductivity, temperature, and turbidity measurements reach stability (when two successive measurements collected 3 minutes apart are within approximately 10% of each other). Following development the interior of the steel well casing will be video logged to evaluate the efficacy of the initial development. Based on the results of the video log additional development may be conducted. Field notes collected during well development will be recorded on a well development log. Well development activities will be conducted in accordance with NASA's regulator approved *Work Plan for Performing a Remedial Investigation/Feasibility Study at NASA JPL* (Ebasco, 1993).

4.4.3.6 ***IDW Generation, Treatment, and Disposal.*** The primary wastes generated from implementing this additional assessment Work Plan include drill cuttings/mud, well development water, monitoring well purge water, and decontamination rinse water. The amount of waste generated will vary based on actual field operations. Waste samples will be analyzed for the medium-specific parameters presented on Table 4-2. If possible, development water will be stored in approved containers at each site until IDW disposal activities can be coordinated. Otherwise, IDW will be moved onto the JPL site and stored until appropriate disposal is arranged. Based on the laboratory results, the waste will be classified as hazardous or nonhazardous waste in accordance with the Code of Federal Regulations (40 CFR 261.31 to 261.33 and 261.21 to 261.24) and the California Code of Regulations (22 CCR). Battelle will prepare all required waste profiles and manifests for the waste. An appropriate U.S. EPA-certified waste disposal facility will be selected and a licensed transporter will haul the waste off-site for disposal. All waste transported off-site will be accompanied by the appropriate hazardous or nonhazardous waste manifest, signed by a NASA authorized representative. The disposal of waste will be in accordance with federal, state, and local laws, regulations, and instructions.

4.5 Monitoring Frequency and Analyses

Following the installation and development of the steel well casing, each of the screened intervals will be isolated using K-packers then purged and sampled. These sample analytical results will be used as baseline data for comparison with subsequent analytical data collected following the multi-port casing installation (i.e., purge and sample versus no purge sampling). Additionally, to evaluate flow conditions in the well prior to the installation of the multi-port casing system, a spinner log will be run under static conditions.

Following the installation of the multi-port casing system, the newly installed monitoring wells will be initially sampled from each interval following the development of the multi-port casing system (Westbay). Following the initial well sampling, these wells will be added to the JPL monitoring program, and monitoring will occur on a quarterly schedule. During the initial monitoring events, groundwater samples will be collected and analyzed for VOCs (including 1,2,3-trichloropropane), SVOCs, perchlorate, water quality parameters, *n*-nitrosodimethylamine (NDMA), and 1,4-dioxane. The method detection limits (MDLs) for these analytes are listed in Appendix A. The analysis frequency for selected parameters (i.e., SVOCs and water quality parameters) may be reduced after the initial year of monitoring if warranted by the historical results. Groundwater samples will be transported under chain-of-custody to a California approved analytical laboratory.

A comprehensive quality assurance/quality control (QA/QC) plan for groundwater monitoring has been established and is described in detail in the SAP (Appendix A). QA can be described as an integrated system of activities in the area of 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. All procedures will be followed in both the field and the laboratory. The types and quantities of field QC samples will be collected as follows: field duplicates (10%), equipment rinsate (1 per day), trip blank (1 per cooler), and field blank (1 per day). Laboratory QC, including laboratory blank samples, matrix spike/matrix spike duplicate (MS/MSD) samples, and laboratory control samples (LCSs), will be collected at a frequency of 5% of the total number of samples.

4.6 Reporting

The results of the multi-port monitoring well installation portion of the OU-3 additional investigation will be submitted in a technical memorandum following well completion and initial monitoring within 60 days after completion of the investigation. Results from subsequent monitoring will be included in deliverables associated with the JPL quarterly monitoring program. NASA will report sampling results to PWP in accordance with the *Use Agreement and Right-of-Entry for Environmental Actions*.

5.0 REFERENCES

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FWEC, see Foster Wheeler Environmental Corporation.

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GSC, see General Sciences Corporation.

NASA, see National Aeronautics and Space Administration.

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Jet Propulsion Laboratory (NASA)

On this page

- Description and History
- Contaminants and Risks
- Who is Involved
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- Cleanup Results to Date
- Potentially Responsible Parties
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- Community Involvement

- Public Information Repositories
- Additional Links
- Contacts
- Progress Profile (EPA Headquarters)

EPA #: CA9800013030

State: California(CA)

County: Los Angeles

City: Pasadena

Congressional District: 27

Other Names:

Map this site in Cleanups in My Community

Description and History

NASA JPL Federal Facility Agreement

NASA JPL Information Repository

NASA JPL CERCLA Program Website

NPL Listing History

NPL Status: Final
Proposed Date: 02/07/92
Final Date: 10/14/92
Deleted Date:

The Jet Propulsion Laboratory (JPL) is a 176-acre site in Pasadena, California. The area is primarily residential with some light commercial operations. The site is bordered by the San Gabriel Mountains on the north, an equestrian club and the local Fire Station on the south, a residential neighborhood on the west, and the Arroyo Seco Dry Wash on the east. The Army developed and operated JPL between 1945 and 1957. In 1958, jurisdiction was transferred to the National Aeronautics and Space Administration (NASA). The California Institute of Technology conducts research and development at JPL under a NASA contract in the areas of aeronautics, space technology, and space transportation. JPL's primary activities include the exploration of the earth and solar system by automated spacecraft and the design and operation of the Global Deep Space Tracking Network.

Sources of contamination at the site include approximately 35 seepage pits where liquid and solid wastes were reportedly disposed of, a settling chamber in the JPL storm drain system, contaminated soil excavated from part of that system, and an area where waste solvents were dumped into three separate holes. Hazardous substances located at JPL include waste solvents, solid rocket fuel propellants, cooling tower chemicals, sulfuric acid, freon, mercury, and chemical laboratory wastes. In 1990, JPL detected significantly elevated levels of contaminants in the groundwater underneath and down-gradient of the site. Due to volatile organic compound (VOC) contamination in the groundwater, four municipal wells were shut down between 1989 and 1990 and two Lincoln Avenue Water Company wells were shut down in 1987. NASA installed treatment systems, and municipal wells began operating again in October of 1990. The Lincoln Avenue Water Company also has installed a treatment system on its wells, which are again operational. Approximately 120,840 people live within 4 miles of the site; an estimated 68,000 people obtain drinking water from municipal wells within 4 miles of the site. The Pasadena wells were shut down again in 2001 because of perchlorate (a component of solid rocket fuel) contamination. The perchlorate plume reached the Lincoln Avenue wells at levels above the State of California standards in 2004 and NASA paid for the installation of an ion-exchange/carbon filter treatment system. In March 2011, NASA completed the construction of the Monk Hill Treatment System for Pasadena Water and Power to address the perchlorate contamination in the Pasadena wells. Treated groundwater from both the Lincoln Avenue Treatment Plant and the Monk Hill Treatment System complies with all State of California Drinking Water standards and are delivered to the respective drinking water conveying systems.

The EPA and NASA have negotiated a Federal Facilities Agreement that requires NASA to conduct the cleanup efforts at the site.

Contaminants and Risks

Contaminated Media

- Groundwater
- Soil and Sludges

The groundwater contamination from the JPL has traveled off site and has affected several drinking water wells, including four municipal drinking wells belonging to the City of Pasadena and two drinking water wells belonging to the Lincoln Avenue Water Company. The contaminants are primarily VOCs (including trichloroethylene and carbon tetrachloride) and perchlorate, which is a component of solid rocket fuel. The water from the contaminated wells are treated to State and Federal drinking water standards prior to delivery to customers.

Who is Involved

This site is being addressed through Federal, State, and local actions.

Investigation and Cleanup Activities

This site is being addressed in four stages: initial actions and three long-term remedial phases focusing on the on-site groundwater, source control, and off-site contamination.

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Initial Actions

Initial Actions: In 1987, two Lincoln Avenue Water Company wells were affected by groundwater contamination from the JPL and were shut down. A treatment system for VOCs has since been installed and the wells are now operational. Between 1989 and 1990, four wells in the City of Pasadena also were impacted; a treatment system for VOCs has since been installed on these wells. Four wells owned by the City of Pasadena are still out of service because of perchlorate contamination, but NASA has begun installing a treatment system. Three additional wells owned by the City of Pasadena are located several miles downgradient. NASA installed a monitoring well in late 2004 and plans to install another well in 2005 to investigate whether this is part of the JPL plume. NASA paid for the installation of an ion-exchange/carbon filter treatment system in 2004 for the two Lincoln Avenue wells that had levels of perchlorate contamination above the State of California drinking water standard.

Site Studies

On-Site Groundwater: During an investigation of the on-site groundwater, NASA installed several wells to sample the nature and extent of contamination at the site. The results of the investigation are being used to design a system of extraction wells to control and remediate the plume.

Site Studies

Source Control: During the summer of 1993, NASA began investigating sources of contamination at the site. These studies were primarily focused on the seepage pits and three other disposal points. NASA collected soil samples from numerous deep soil bearings and subsurface gas samples to determine which seepage pits are sources of contamination. NASA also investigated the extent of soil contamination. The surface soil was found to not contain contaminants at a level high enough to pose a threat to human health or the environment, so no further action is necessary for surface soils.

Site Studies

Off-Site Contamination: NASA has installed several groundwater wells to determine the nature and extent of contamination off site.

Cleanup Complete

Source Control (OU 2): A Final Record of Decision (ROD) was signed in 2002 that specified that VOCs will be removed from the subsurface soils using Soil Vapor Extraction (SVE). The SVE system was installed in 2003 and is designed to remove sufficient contamination so that the underlying groundwater aquifer is no longer at risk of receiving new contaminants that could raise the concentrations in the groundwater above Safe Drinking Water Act regulatory levels. In March 2007, NASA finalized the Remedial Action Report for this site.

Remedy Selected

On-Site Groundwater (OU 1): A pilot study was conducted in the winter of 2002/2003 to test the viability of using in-situ bioremediation to reduce the concentration of perchlorate in the on-site source area. The test showed that a bio-reactor was successful in destroying perchlorate to below detectable levels. In February 2007 an Interim Record of Decision was signed by all parties of the FFA, selecting the bio-reactor technology in an expanded groundwater extraction system on the NASA JPL property.

Remedy Selected

Off-Site Groundwater (OU 3): NASA has tested several treatment systems to remove perchlorate from drinking water and selected Ion-Exchange as the most appropriate method to install at the City of Pasadena wells. An Interim Record of Decision for OU 3 was signed by the FFA parties selecting Ion-Exchange as the best alternative to treat perchlorate from drinking water.

Cleanup Ongoing

On-Site (OU 1): A four well pump and treat system was installed in 2004 in portion of the aquifer with the highest levels of VOCs and perchlorate. The system uses carbon filters to remove VOCs and a fluidized bed bio-reactor to destroy perchlorate. The system is operational in 2005 and expanded under the OU 1 Record of Decision signed in February 2007.

Cleanup Ongoing

Off-Site (OU 3): An ion-exchange and carbon filtration system was installed on the two Lincoln Avenue wells in 2004 to remove VOCs and perchlorate from drinking water. In March 2009 NASA started construction of a second groundwater treatment system (the Monk Hill Treatment System) which will remove VOCS and perchlorate from four of City of Pasadena's drinking water wells. NASA completed the construction of the Monk Hill System in 2011. Pasadena Water and Power (PWP) start delivering drinking water to customers from the Monk hill Treatment System in March 2011. Both treatment systems also provide hydrologic control to help slow migration of the plume further downgradient. The Interim Record of Decision for OU 3 signed in June 2007 will continue to fund treatment of the groundwater.

Site Studies

NASA installed monitoring wells in 2004 and 2005 in the Sunset Reservoir area of Pasadena, which is several miles downgradient from the JPL source area. The City of Pasadena has shut down four wells in this area because of high perchlorate levels. In 2013, with the support and participation of the California Department of Toxic Substance Control and Los Angeles Regional Water Quality Control Board, EPA technical support staff conducted an independent comprehensive evaluation of available site data. The evaluation concluded that existing data does not suggest that NASA contributed to the perchlorate contamination in the Sunset Area. NASA will continue to monitor the situation and if the data suggests otherwise, EPA will re-evaluate this finding.

Cleanup Results to Date

The treatment systems installed on the Lincoln Avenue and Pasadena drinking water wells have reduced potential risks to human health and the environment while further investigations of site contamination are being completed at the Jet Propulsion Laboratory (NASA) site.

Five Year Review

NASA completed the first five-year review in January 2012 of the groundwater cleanup remedies undertaken at the NASA JPL CERCLA Site to determine if they continue to be protective. These remedies include three groundwater extraction and above-ground treatment systems to remove volatile organic compounds (VOCs) and perchlorate from the groundwater. The Five Year Review Report concluded that the interim remedies at both OU-1 and OU-3 evaluated in this Five-Year Review Report are protective of human health and the environment in the short term. Potential exposure pathways that could result

in unacceptable risk (i.e., ingestion and contact with chemicals in groundwater) are being controlled through groundwater extraction and treatment by the Monk Hill Treatment System (MHTS) and Lincoln Avenue Water Company (LAWC) treatment system. Both systems have routine monitoring programs in place to ensure chemicals are effectively removed. Treated water from both the MHTS and the LAWC system is in compliance with all water quality requirements specified by Federal and state regulations, with concentrations below Federal and California MCLs. In order for the remedy to be protective in the long term, final remedies for OU-1 and OU-3 must be incorporated into a final decision document and implemented. It is anticipated that a Final ROD for groundwater will be issued prior to the next Five-Year Review and will include any active

remedial actions and institutional controls necessary to provide long-term protection of human health and the environment. EPA concurred with NASA's Five Year Review on February 17, 2012.

Potentially Responsible Parties

Potentially responsible parties (PRPs) refers to companies that are potentially responsible for generating, transporting, or disposing of the hazardous waste found at the site.

NASA is the PRP. For more information, click here for the NASA JPL CERCLA Program Website.

Documents and Reports

Legal Documents

12/30/92 Federal Facility Agreement

Records of Decision

09/19/02 OU 2 Record of Decision and Remedial Action Plan

02/08/07 OU 1 Source Area Groundwater Interim Record of Decision

06/28/07 OU 3 Off Facility Groundwater Interim Record of Decision

Technical Documents

02/17/12 First Five Year Review Report, National Aeronautics and Space Administration Jet Propulsion Laboratory, Pasadena, California

Community Involvement

Public Meetings:

Public Information Repositories

The public information repositories for the site are at the following locations.

Pasadena Central Library
285 East Walnut Street
Pasadena, CA 91101
626 744-4052

Altadena Public Library
600 East Mariposa Avenue
Altadena, CA 91001
626-798-0833

La Canada Flintridge Public Library
4545 Oakwood Avenue
La Canada Flintridge, CA 91011

Additional Links

Administrative Records are the responsibility of NASA JPL and are available online at http://www.jplwater.nasa.gov/?id=inforepository

Record of Decisons are available in the NASA JPL Administrative Records.

Contacts

EPA Site Manager

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EPA Community Involvement Coordinator

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EPA Public Information Center

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r9.info@epa.gov

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Mr. Jeff Brooks
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wjeffers@dtsc.ca.gov

Brownfields and Environmental Remediation Program Office
Department of Toxic Substances Control
9211 Oakdale Avenue
Chatsworth, CA 91311
California Regional Water Quality Control Board
Los Angeles Region
320 West 4th St., Suite 200
Los Angeles, California 90013

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NASA Project Manager

Ms. Merrilee Fellows
NASA Manager for Community Involvement
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mfellows@nasa.gov
NASA Management Office
4800 Oak Grove Drive
Pasadena, CA 91109

Community Contact

Other Contacts

After Hours (Emergency Response)

US EPA
(800) 424-8802

818-790-3330
JPL Library
(JPL employees
only)
Building 111, Room
112
818-354-4200

The most complete collection of documents is the official EPA site file, maintained at the following location:

Superfund Records
Center
Mail Stop SFD-7C
95 Hawthorne
Street, Room 403
San Francisco, CA
94105
(415) 820-4700

Enter main lobby of 75 Hawthorne street go to 4th floor of South Wing Annex

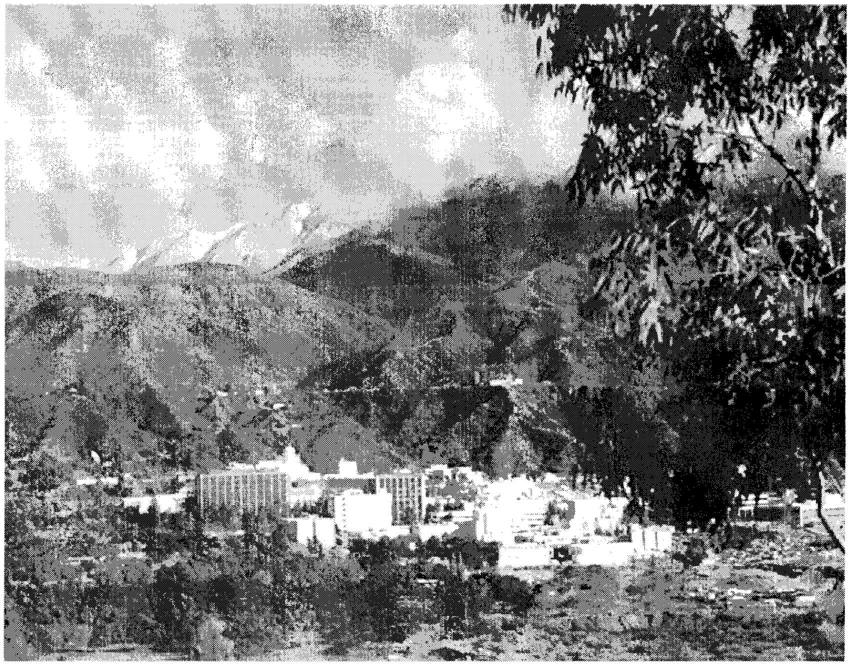
NAS7.010345
NASA - JPL
SSIC No. 9661

FINAL

OPERABLE UNIT 3
REMEDIAL INVESTIGATION (RI) ADDENDUM WORK PLAN
(PASADENA SAMPLING PLAN [PSP]-2004-1)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JET PROPULSION LABORATORY
PASADENA, CALIFORNIA

EPA ID# CA9800013030



PREPARED FOR:

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

November 2004

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FINAL

OPERABLE UNIT 3
REMEDIAL INVESTIGATION (RI) ADDENDUM WORK PLAN
(PASADENA SAMPLING PLAN [PSP]-2004-1)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JET PROPULSION LABORATORY
PASADENA, CALIFORNIA

EPA ID# CA9800013030

Prepared for:

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Prepared by:

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Columbus, Ohio 43201

November 2004

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Figures

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Appendices

Attachments

Abbreviations and Acronyms

3-D	three-dimensional
bgs	below ground surface
Cal-EPA	California Environmental Protection Agency
CCl_4	carbon tetrachloride
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFEST	Coupled Flow Energy and Solute Transport model
CFR	Code of Federal Regulations
DEH	(Los Angeles County) Department of Environmental Health
DHS	(California) Department of Health Services
DO	dissolved oxygen
DTSC	(California) Department of Toxic Substances Control
DWR	(California) Department of Water Resources
EM	electromagnetic imaging
FWEC	Foster Wheeler Environmental Corporation
FFA	Federal Facility Agreement
GPR	ground-penetrating radar
GSC	General Sciences Corporation
IDW	investigation-derived waste
JPL	Jet Propulsion Laboratory
K_d	distribution coefficient
LAWC	Lincoln Avenue Water Company
LCID	La Cañada Irrigation District
LCS	laboratory control sample
MCL	maximum contaminant level
MDL	method detection limit
MOA	Memorandum of Agreement
MS/MSD	matrix spike/matrix spike duplicate
MWD	Metropolitan Water District (of Southern California)
N/A	not analyzed
NA	not available
NASA	National Aeronautics and Space Administration
NAVFAC	Naval Facilities Engineering Command
ND	not detected
NDMA	*n*-nitrosodimethylamine
NPL	National Priorities List

O.D.	outside diameter
ORP	oxidation-reduction potential
OU	Operable Unit
PCE	tetrachloroethene
PVC	polyvinyl chloride
PUSD	Pasadena Unified School District
PWP	Pasadena Water and Power
QA/QC	quality assurance/quality control
RBMB	Raymond Basin Management Board
RCLWA	Rubio Canyon Land and Water Association
RI	Remedial Investigation
RWQCB	Regional Water Quality Control Board, Los Angeles Region
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SESOIL	Seasonal Soil Compartment model
SHSP	Site Health and Safety Plan
SVOC	semivolatile organic compound
TBD	to be determined
TCE	trichloroethene
TDS	total dissolved solids
TNRCC	Texas Natural Resources Conservation Council
TPH	total petroleum hydrocarbons
USA	Underground Services Alert
U.S. EPA	United States Environmental Protection Agency
USCS	Unified Soil Classification System
USGS	United States Geological Survey
VOC	volatile organic compound
VWC	Valley Water Company

1.0 INTRODUCTION

This Work Plan was prepared for the National Aeronautics and Space Administration (NASA). An additional investigation is proposed within Operable Unit 3 (OU-3), off-facility groundwater, to better determine the extent of chemicals in groundwater that originate from the Jet Propulsion Laboratory (JPL) facility. This document and the additional investigation described herein will serve as an addendum to the *Remedial Investigation (RI) for OU-1 and OU-3* (Foster Wheeler Environmental Corporation [FWEC], 1999). NASA-JPL, which is located in Pasadena, CA (Figure 1-1), is on the United States Environmental Protection Agency (U.S. EPA) 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 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). This Work Plan fulfills the PSP requirement of the legal agreement and has been given the subtitle of PSP-2004-1. Ongoing efforts described in any previous PSP remain in effect and are not superceded by this PSP.

NASA is the lead federal agency for selecting, implementing, and funding remedial activities at 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 U.S. EPA, California Environmental Protection Agency (Cal-EPA) 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 OU-3 investigation.

This Work Plan is divided into five sections. This section discusses the objectives of the additional investigation and summarizes previous investigations. Section 2.0 summarizes background information on site conditions. Section 3.0 provides an evaluation of available data and identifies current uncertainties. Section 4.0 discusses the proposed methods by which the additional investigation will be implemented. Section 5.0 provides a listing of references.

1.1 Objective

The objectives of the additional investigation are (1) to evaluate the downgradient (southern) extent of chemicals that originate from the JPL facility, and (2) to determine if the occurrence of perchlorate in the Sunset Reservoir area is associated with migration from the JPL facility. This report outlines the strategy by which the additional investigation will be implemented. In addition, this report will serve to document the results of the evaluation of existing data in selected municipal production wells within the Raymond Basin.

1.2 Previous Investigations

Several documents and data sets associated with previous investigations were evaluated and utilized during preparation of this work plan. Some of these investigations were conducted as part of the NASA

JPL CERCLA program and some were sponsored by drinking water purveyors in the Raymond Basin. These investigations are briefly summarized in the following sections.

1.2.1 First Technical Assessment of the Devil's Gate Multi-Use Project. Phase 1 (CH2M-Hill, 1990) and Phase 2 (CH2M-Hill, 1992) of the *First Technical Assessment of the Devil's Gate Multi-Use Project* were designed to assess how much water could be stored in the Raymond Basin and the associated potential impacts on groundwater quality. These documents were not prepared as part of the NASA-JPL CERCLA Program. The primary objective of the assessment was to develop and evaluate a conjunctive use alternative that could be implemented within the basin to meet increasing potable water demands. As part of this assessment, general groundwater quality of the Raymond Basin was provided for the period July 1979 through June 1988 and represented by five parameters: total dissolved solids (TDS), nitrate, trichloroethene (TCE), tetrachloroethene (PCE), and carbon tetrachloride (CCl_4).

A three-dimensional (3-D) groundwater flow model of the Raymond Basin was developed during Phase 2 of the assessment to assist in the conjunctive use alternative evaluation. The Coupled Flow Energy and Solute Transport (CFEST) model was selected to simulate groundwater flow in the basin and potential groundwater migration pathways. Particle tracking from near the Arroyo Seco spreading grounds was performed for the period July 1989 through June 2023 to provide an estimate of the migration of nitrate and volatile organic compounds (VOCs). The results of the simulations projected a southerly groundwater flow path from the Arroyo Seco spreading basins and the unsewered areas in the La Cañada-Flintridge areas toward the City of Pasadena production wells located near the Sunset Reservoir. The City of Pasadena has referenced these modeling results as evidence that the perchlorate concentrations near the Sunset Reservoir are associated with a release from JPL. However, this preliminary modeling exercise only evaluated flow paths and did not consider sorption, dispersion, biodegradation of chemicals, nor did it evaluate fate and transport of chemicals originating from the JPL facility.

1.2.2 Remedial Investigation. The RI for on-facility (OU-1) and off-facility (OU-3) groundwater at JPL was conducted as part of the CERCLA program to identify the nature and extent of chemicals in groundwater (FWEC, 1999). The RI assessed the fate and transport of chemicals in the groundwater beneath and adjacent to the JPL facility and provided a baseline risk assessment to evaluate exposure to chemicals in groundwater to human health and the environment. During the RI, 13 additional wells (including shallow wells and deep multi-port wells) were added to 10 existing wells in the JPL monitoring network (Figure 1-2). Samples were collected from the 23 wells and analyzed for an extensive list of chemicals, including: VOCs, semivolatile organic compounds (SVOCs), Title 26 metals, chromium, lead, arsenic, hexavalent chromium, total petroleum hydrocarbons (TPH), perchlorate, and water chemistry parameters (i.e., TDS, anions, and cations). Additionally, groundwater levels were recorded in shallow and deep wells during the RI and hydraulic conductivities of the aquifer were estimated using slug/bail and rising head tests in individual wells.

Data collected during the RI indicated the pumping of the City of Pasadena and other municipal production wells appears to be an effective barrier to extensive downgradient chemical migration (FWEC, 1999). Conservative fate and transport simulations were subsequently conducted using the transport model SOLUTE to estimate potential migration of CCl_4, TCE, and perchlorate from monitoring well MW-17 if the City of Pasadena and other nearby production wells were not in operation. Results indicated that the production wells would need to be off-line for more than 20 years for migration of these chemicals at existing levels to be detected above action levels (ALs) in downgradient monitoring well MW-20. This finding contradicts some recent monitoring data, which has shown detections of perchlorate in MW-20 (Screen 4) that appear to originate from the JPL facility. Therefore, additional modeling and investigation are warranted.

1.2.3 Raymond Basin Database. The RBMB compiled a database containing information relating to the municipal production wells in the Raymond Basin (Geoscience, Inc., 2003). The database was not prepared as part of the NASA-JPL CERCLA Program. The Raymond Basin Database contains historical information on the following: production well construction details, groundwater chemical concentrations, groundwater quality data, well-specific production and injection volumes, spreading volumes, and groundwater-level elevations. These data were used extensively in the evaluation presented in Section 3.0 of this work plan.

1.2.4 NASA-JPL Groundwater Monitoring Program. The groundwater monitoring program at NASA JPL was initiated in 1996 and currently consists of a network of 23 monitoring wells, each of which is monitored on either a quarterly or annual basis. 18 wells are located on-facility and 5 wells are located off-facility (Figure 1-2). Of the 23 wells, ten are relatively shallow conventional wells with a single screened interval spanning the groundwater table. All of the shallow wells are located on the JPL facility. The other 13 wells, including all of the off-facility 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. Data from the NASA-JPL Groundwater Monitoring Program were used extensively in the evaluation presented in Section 3.0.

1.2.5 JPL Groundwater Modeling Report. A 3-D finite element groundwater model of the Monk Hill Subarea was developed using FEFLOW (Diersch, 2002) as part of the NASA-JPL: CERCLA Program. The groundwater model encompasses a 4,560-acre area and consists of four elemental layers that are bounded by five nodal slices. The extent of the model domain and the calibrated material properties for each of the four layers is discussed in detail in the *JPL Groundwater Modeling Report* (NASA, 2003). Particle tracking was used to confirm the appropriateness of the simulation results with regard to the flow directions and gradients in the JPL facility area. In addition, the report serves to document the results of a multiple well pumping test that was designed to estimate aquifer parameters within the Monk Hill Subarea. This groundwater model provides enhanced understanding of groundwater flow near the JPL facility and was used as part of the evaluation presented in Section 3.0.

2.0 BACKGROUND

The study area for the additional investigation described in this Work Plan includes the on-facility (OU-1) and off-facility (OU-3) groundwater that contains chemicals related to historical activities conducted at JPL. The term "on-facility" refers to locations within the JPL facility boundaries, and the term "off-facility" refers to locations outside JPL facility boundaries.

2.1 Municipal Extraction and Injection Wells

Several municipal production wells are located in the vicinity of the JPL facility and are of interest in the additional investigation. Municipal production wells owned by the City of Pasadena, Lincoln Avenue Water Company (LAWC), Rubio Canyon Land and Water Association (RCLWA), and Las Flores Water Company are located hydraulically downgradient of JPL, and municipal production wells operated by La Cañada Irrigation District (LCID) and Valley Water Company (VWC) are located hydraulically upgradient of JPL (Figure 2-1) (NASA, 2003). Table 2-1 provides a listing of the individual production wells along with information regarding dates of operation, well construction, and extraction volumes. Two City of Pasadena production wells (Bangham and Garfield) and two VWC production wells (VWC-2 and VWC-3) are constructed to serve as extraction and injection wells. Table 2-2 provides a summary of the dates of operation and historical injection volumes for these wells. Table 2-2 indicates that the two VWC wells injected over 5,600 acre-ft of water since 1992, and the Bangham and Garfield wells combined have injected nearly 2,200 acre-ft of water since 1992. During this time period, the four VWC wells have extracted nearly 12,000 acre-ft and the Bangham and Garfield wells have extracted over 15,000 acre-ft. Although the extracted volume significantly exceeds the injected volume, the injections primarily occurred during periods when the surrounding extraction wells were not in operation for several months prior to and after injection.

In the early 1980s, analyses of groundwater from the City of Pasadena water supply wells located in the Arroyo Seco, near JPL, revealed the presence of VOCs. VOCs also were detected in two LAWC water supply wells during this timeframe. To ensure the delivery of safe drinking water to its customers, the City of Pasadena installed a VOC treatment facility for its drinking water wells in the Arroyo Seco in 1990 (FWEC, 1999). By 1992, the LAWC also had installed a VOC treatment facility to ensure the delivery of safe drinking water to its customers. Agreements were made with the City of Pasadena and LAWC for NASA to pay for construction and operation of the VOC treatment systems. During the summer of 2004, NASA funded installation and operation of a perchlorate treatment system for LAWC. NASA is currently working with the City of Pasadena to install a perchlorate treatment system associated with the four production wells in the Monk Hill Subarea.

2.2 Historical Chemical Usage at JPL

Testing of aeronautical equipment at the JPL facility commenced in 1936. To meet its mission objectives, JPL used various chemicals and materials including a variety of solvents, solid and liquid propellants, cooling-tower chemicals, and analytical laboratory chemicals. Many buildings at JPL used seepage pits/cesspools during the 1940s and 1950s to dispose of liquid and solid materials via infiltration into surrounding soil. Some of these seepage pits may have received chlorinated solvents, solid fuel residue containing perchlorate, and other chemicals that currently are found in the groundwater. A sewer system was installed during the mid-1950s, and use of the seepage pits for waste disposal was discontinued between 1956 and 1961 as buildings were demolished or connected to the sanitary sewer line (Table 2-3) (Develle, 2003). The seepage pits were backfilled between 1961 and 1963 (Ebasco, 1990). In addition, an on-facility incinerator and a furnace were constructed in the mid-1950s and 1960s, respectively, for use in burning propellants (NASA, 1998). Therefore, it is believed that the VOCs and perchlorate observed in groundwater today are associated with releases that occurred in the 1940s and 1950s. Figure 2-2 presents a chronology of early activities at the site. Today, all chemical wastes are either recycled or sent off-facility for treatment and disposal at regulated facilities.

2.3 Hydrogeology

The Raymond Basin, where the JPL facility is located, is bordered on the north by the San Gabriel Mountains, on the west by the San Rafael Hills, and on the south and east by the Raymond Fault. The Raymond Basin is further divided into three subareas based on differences in groundwater elevations and flow directions: the Pasadena Subarea, the Santa Anita Subarea, and the Monk Hill Subarea. JPL is located in the Monk Hill Subarea, which provides an important source of potable groundwater for many communities in the area including Pasadena, La Cañada-Flintridge, and Altadena.

The aquifer in the Monk Hill Subarea and the Pasadena Subarea is generally considered to be an unconfined, or water table, aquifer. However, vertical hydraulic head differences with depth are observed between screens in deep JPL multi-port monitoring wells located near active production wells. This indicates that the aquifer does not exhibit truly unconfined conditions, due to the presence of relatively thin, silt-rich layers located throughout the alluvial aquifer that inhibit vertical flow of groundwater. The aquifer can be divided into four groundwater aquifer zones above the crystalline basement complex, based to a large extent on how these silt-rich intervals influence the hydraulic heads in the aquifer during pumping periods at the nearby municipal wells. The primary aquifer zones were identified based on geologic formation maps published by the California Division of Mines and Geology and the United States Geological Survey (USGS). The four aquifer zones in the study area include the upper and lower sections of the Older Fanglomerate Series (Aquifer Zones 1 and 2, respectively), the Pacoima Formation (Aquifer Zone 3), and the Saugus Formation (Aquifer Zone 4). A conceptual model of the aquifer zones and associated silt-rich intervals is shown in Figure 2-3. It should be noted that the amount of available information for delineating aquifer zones significantly decreases with distance from the JPL facility and Arroyo Seco area (where the JPL monitoring wells are located).

In the Raymond Basin, groundwater generally flows southerly from areas of recharge at the base of the San Gabriel Mountains to areas of discharge along the Raymond Fault. A confluence of groundwater flow regimes occurs within the Monk Hill Subarea where JPL is located. At the western end of the Monk Hill Subarea (west of JPL) the groundwater flow is predominantly to the southeast; and at the eastern end of the Monk Hill Subarea (east of JPL) the groundwater flow is predominantly to the south.

The groundwater flow direction and magnitude (hydraulic gradient) beneath the study area are dynamic. In general, natural groundwater flow is across the facility to the southeast. However, the aquifer is affected by various natural and anthropogenic influences that include: (1) pumping from nearby municipal production wells, (2) groundwater recharge from Arroyo Seco spreading basins, (3) seasonal and regional groundwater recharge from precipitation (primarily at the mouth of the Arroyo Seco), and (4) regional groundwater flow. The extraction of water from municipal production wells (see Figure 1-2) has the most significant effect on the natural groundwater flow.

The groundwater surface has been measured in the JPL monitoring wells at depths ranging from approximately 22 ft (groundwater mound near the mouth of the Arroyo Seco) to 270 ft below ground surface (bgs). This wide range of depths to groundwater can primarily be contributed to the relatively steep topography present at the JPL facility and local groundwater mounding. It also can be accounted for by seasonal groundwater recharge from nearby spreading grounds and the extraction of groundwater from nearby municipal production wells. Based on monitoring data collected since 1996, groundwater elevations have fluctuated up to 75 ft each year beneath JPL, primarily as a result of these influences.

Figures 2-4 and 2-5 show generalized groundwater elevation contour maps for January 1998 and January 2002 that were constructed using groundwater elevation data from JPL monitoring wells and selected municipal production wells within the Monk Hill Subarea. Groundwater elevation data from the uppermost screen in the JPL multi-port wells were used during construction of the maps. These dates were chosen because they coincide with comprehensive groundwater monitoring events at NASA JPL, during which groundwater chemistry parameters were collected. These maps indicate a southeast flow direction to the west of JPL and a southwest flow direction near the mouth of the Arroyo Seco. Groundwater flow to the south of JPL is heavily influenced by operation of the municipal pumping wells and recharge at the Arroyo Seco.

2.4 Groundwater Chemistry

During the RI (FWEC, 1999), groundwater samples collected from JPL monitoring wells and from municipal production wells were analyzed for major anions (including chloride, sulfate, nitrate, and alkalinity), major cations (including calcium, magnesium, sodium, potassium, and iron), and TDS. The results of these analyses were used to evaluate the general chemistry of groundwater. Data were compiled in Stiff diagrams for a visual categorization of each water sample. A review of these diagrams suggest that the majority of groundwater at JPL can be divided into three general types:

Type 1: Calcium-bicarbonate groundwater. Groundwater with calcium as the dominant cation and bicarbonate as the dominant anion. Type 1 water appears to originate as rainwater runoff from the San Gabriel Mountains and enters the study area through the Arroyo Seco and the spreading grounds.

Type 2: Sodium-bicarbonate groundwater. Groundwater with sodium as the dominant cation and bicarbonate as the dominant anion. Type 2 water is typically found in deeper portions of the aquifer.

Type 3: Calcium-bicarbonate/chloride/sulfate groundwater. Groundwater with calcium as the dominant cation and bicarbonate the dominant anion, but with relatively elevated chloride and sulfate concentrations. This water type consistently has higher levels of TDS than the other two general types.

In addition to the general water types listed above, the analytical data suggest that mixing, or blending of water types, creates "intermediate" water types.

The most common water type at JPL, Type 1 water (calcium-bicarbonate), was detected primarily in monitoring and production wells in and near the mouth of the Arroyo Seco. It appears that Type 1 water may originate as rainwater runoff from the San Gabriel Mountains and enter the study area via the Arroyo Seco and spreading grounds. Type 2 water (sodium bicarbonate) is typically is found in deeper portions of the aquifer. Type 2 water, although found deep in the aquifer, is similar to water Type 1 in that both have relatively low TDS levels. A significant difference between these water types is that sodium is the predominant cation found in Type 2 water, whereas calcium is the predominant cation in Type 1 water. Type 3 water (calcium-bicarbonate/chloride/sulfate) is most prevalent in wells located upgradient and to the west of the JPL facility and is indicative of a mixture of Type 1 water and Colorado River water imported by the Metropolitan Water District of Southern California (MWD) (FWEC, 1999). Some Type 3 water also is found downgradient to the south of JPL. This water type differs from Types 1 and 2 by having elevated levels of chloride, sulfate, and TDS. A piper diagram showing the distribution of the three water types is presented in Figure 2-6. Figures 2-7 and 2-8 graphically present groundwater quality at JPL in January 1998 and January 2001, respectively.

Perchlorate detections have been reported in municipal production wells located throughout the Raymond Basin, including the wells owned by the City of Pasadena, LAWC, RCWLA, Las Flores Water Company, VWC, and LCID. In addition, perchlorate detections in furthest downgradient JPL monitoring well, MW-20, indicate the leading edge of the chemical plume originating at JPL is not currently delineated. NASA is pursuing treatment of VOCs and perchlorate in four City of Pasadena wells (Arroyo, Well 52, Ventura, and Windsor) and the two LAWC wells (LAWC 3 and LAWC 5). In the early 1990s, agreements were made with the City of Pasadena and LAWC for NASA to pay for implementation of VOC treatment systems. Recently, NASA modified the agreement with LAWC to include perchlorate treatment and a similar modification is being pursued for the four City of Pasadena wells. An initial evaluation of available data was performed to better determine the extent of chemicals originating from the JPL facility and to identify uncertainties that need to be addressed as part of the additional investigation (described in Section 4.0 of this work plan).

3.1 Methods of Analysis

Several different methods were used to evaluate the occurrence of VOCs and perchlorate in municipal production wells, including groundwater chemical concentrations, groundwater quality parameters, vadose zone and groundwater modeling, and other methods. A brief explanation of each is provided in the following sections.

3.1.1 Groundwater Chemical Concentrations. Chemical concentrations reported in groundwater collected from JPL monitoring wells and municipal production wells were evaluated to determine trends and the spatial distribution of VOCs and perchlorate.

The VOCs chosen for evaluation include PCE, TCE, and CCl_4 (each of these VOCs have been primarily used as degreasing agents). CCl_4 appears to have a unique association to JPL in the Monk Hill Subarea, with consistent detections in on-facility monitoring wells (maximum concentration of 208 μg/L in MW-7 in April 2002) and consistent nondetections in upgradient production wells. Historical records indicate CCl_4 was used during early activities at the JPL facility, but was reportedly phased out by the end of the 1950s (NASA, 1998). Therefore, CCl_4 is considered a good tracer for chemicals originating from JPL.

TCE also has been linked to historical activities at JPL; however, it has also been detected in upgradient wells. Low levels of PCE have been detected in wells located on the JPL facility; although higher levels observed in upgradient and downgradient production wells appear to be associated with sources other than JPL, such as dry cleaning sites and unsewered areas in La Cañada-Flintridge (FWEC, 1999). Because these three VOCs have similar characteristics associated with fate and transport in groundwater (e.g., retardation factors), higher levels of PCE and/or TCE and the absence of CCl_4 in downgradient municipal production wells generally indicate a VOC source other than JPL (FWEC, 1999).

Perchlorate detections throughout the Raymond Basin have necessitated the additional investigation described in this Work Plan. Compared to the fate and transport characteristics of VOCs, perchlorate has a lower retardation factor, which may result in faster migration in groundwater. Perchlorate usage has been linked to the JPL facility, where testing of perchlorate as a component of solid rocket propellant began around 1942 (NASA, 1969). Concentrations of perchlorate as high as 13,300 μg/L (MW-7 in October/November 2002) have been detected in samples from wells located on the JPL facility. While no other study has been conducted to determine sources of perchlorate in the Raymond Basin, MWD water imported from the Colorado River has been linked with perchlorate detections in the upgradient VWC wells (FWEC, 1999). Colorado River water has higher chloride, sulfate, and TDS concentrations (i.e., Type 3 water quality, see Section 2.4) than local water sources (i.e., Types 1 and 2). Therefore, perchlorate concentrations detected in samples with influences of Type 3 groundwater quality may be associated with a source other than JPL.

3.1.2 Groundwater Quality. Similar to chemical concentrations, water quality data in groundwater samples collected from JPL monitoring wells and municipal production wells were evaluated to determine trends and the spatial distribution. Each set of data was assigned a water-quality type consistent with the criteria discussed in Section 2.4. These data were used to make evaluations of the source of water for the respective sample. Type 1 and 2 groundwater originate locally and are found below the JPL facility, whereas Type 3 groundwater is not associated with sources originating from JPL.

3.1.3 Vadose Zone and Groundwater Modeling. As part of this work plan a vadose zone model was developed to predict migration time for select JPL chemicals of interest through approximately 200 ft of unsaturated soil to the groundwater table (i.e., simulating travel from a seepage pit to the groundwater). The Seasonal Soil Compartment (SESOIL) model (General Sciences Corporation [GSC], 1998) was used to make the predictions, taking into account site-specific input parameters. The model incorporated sorption to allow for the differentiation of chemicals through the use of a chemical-specific retardation factor that is based on the distribution coefficient (K_d). The SESOIL vadose zone model predicted a minimum travel time through the vadose zone of 7.5 years using conservative estimates of site-specific and chemical-specific (i.e., perchlorate) input parameters. By incorporating less conservative estimates of sorption in the model for perchlorate (Battelle, in press; Texas Natural Resources Conservation Council [TNRCC], 2002; Batista, et al., 2003), the estimated travel time could increase by a factor of 2 or more (i.e., ≥ 15 years).

The JPL groundwater flow model (NASA, 2003), which was constructed using FEFLOW (Diersch, 2002), was designed to simulate groundwater flow in the Monk Hill Subarea. The model was used to conduct particle tracking simulations that illustrate flow paths and provide estimates of advective travel times from potential chemical release sites to downgradient locations. Additionally, the boundaries of the JPL groundwater flow model were expanded to create a basin-scale groundwater flow model that encompassed the Monk Hill Subarea and a large portion of the Pasadena Subarea, including the wells near the Sunset Reservoir. Results from the groundwater flow model developed and implemented as part of the *Phase 2 First Technical Assessment, Devil's Gate Multi-Use Project* (CH2M-Hill, 1992) also were evaluated during the analysis. Results from the vadose zone and groundwater flow models were combined to estimate chemical travel times from a release near the ground surface (e.g., seepage pit) to a downgradient receptor in groundwater. Groundwater modeling results are provided in Sections 3.2 through 3.4.

3.1.4 Additional Methods. Additional methods of analysis include evaluation of groundwater-level elevation data, groundwater flux in the basin, and historical data review, whereby federal, state, and local databases were searched in a comprehensive Environmental Data Resources (EDR) Area Study Report to identify other potential sources within the study area (see Attachment A).

3.2 Sunset Reservoir Wells

The City of Pasadena wells located near the Sunset Reservoir include the Sunset, Bangham, Copelin, Garfield, and Villa (Figure 2-1). Table 3-1 provides a summary of VOC and perchlorate concentrations that have been detected in the Sunset Reservoir wells and in the most southerly JPL monitoring wells (MW-19 and MW-20). The data were compiled using information from the Raymond Basin (Geoscience, 2003), the JPL CERCLA Program (NASA, 2003), and DHS (DHS, 2004). Figure 3-1 shows the concentrations of perchlorate that have been detected in the Sunset Reservoir wells.

In general, the data evaluated for the Sunset Reservoir wells are inconclusive regarding the source of perchlorate. As such, Section 4.0 describes installation of additional monitoring wells to better understand the extent of perchlorate that originated from JPL.

Chemical Concentrations and Water Quality. PCE and TCE concentrations detected in the Sunset, Bangham, and Copelin wells are not consistent with a source originating from JPL because the concentrations are significantly higher than those detected in NASA's furthest downgradient monitoring wells MW-19 and MW-20. The absence of CCl_4 in the Sunset Reservoir wells and in NASA's furthest downgradient monitoring wells MW-19 and MW-20, with the exception of an isolated detection in August/September 1996 (0.5 µg/L in MW-19), further support that VOCs from JPL have not migrated to the Sunset Reservoir wells. However, due to its chemical properties, perchlorate could migrate faster than VOCs.

Since 1997, perchlorate has consistently been detected in the Sunset Reservoir wells, with maximum concentrations of 12.8, 9.0, 17.4, 27.7, and 7.2 µg/L in the Sunset, Bangham, Copelin, Garfield, and Villa wells, respectively (see Table 3-1 and Figure 3-1). Figures 3-2 through 3-4 show water quality trends in Sunset Reservoir wells, and indicate increasing chloride, sulfate, and TDS values since the early 1960s. Classification of the water quality in these wells indicates a shift from a Type 1 (local source) to a Type 3 water (not associated with JPL). Given this water quality data, it is not possible to determine the source of perchlorate in the Sunset Reservoir wells.

Sporadic detections have been observed in samples collected from MW-20 (Screen 4) since 1998 associated with deeper portions of the aquifer and Type 1 or 2 water quality (consistent with a source originating from JPL). Specifically, samples collected from MW-20 (Screen 4) contained perchlorate concentrations of 20 µg/L, 30 µg/L, 58.5 µg/L, and 124 µg/L in October/November 1998, April/May 2002, October/November 2002, and April/May 2003. All other samples from Screen 4 have shown non-detect concentrations of perchlorate. Nevertheless, the presence of perchlorate in MW-20 (Screen 4) indicates that the leading edge of NASA's plume has traveled beyond this monitoring location and the extent of the plume is not fully known in this area and it is not possible to say whether or not it may have impacted the Sunset wells. As such, NASA is proposing additional wells (see Section 4.0) to help delineate the leading edge of the perchlorate plume.

Samples collected in Screen 1 of MW-20 (located approximately 2 miles north of the Sunset Reservoir) have shown low levels of perchlorate since 1997; however, these samples were collected from locations in the uppermost hydrostratigraphic layer and were associated with Type 3 water, indicating a source other than JPL. In MW-19 (Figure 2-1), perchlorate has not been detected above 8 µg/L. Figure 3-5 shows historical perchlorate concentrations in JPL monitoring wells MW-19 and MW-20.

Figures 3-6 through 3-11 show a vertical cross section (A-A') extending from the JPL facility to the downgradient Sunset Reservoir municipal production wells. These figures include concentrations of PCE, CCl_4, and perchlorate and indicate water type in monitoring wells and production wells for years 1997 through 2002.

It should be noted that MWD water has been injected into two Sunset Reservoir wells (approximately 2,200 acre ft in Bangham and Garfield wells between 1992 and 1996); however, the quantities injected (see Table 2-2) do not appear to be large enough to account for the magnitude and duration of observed perchlorate concentrations.

Vadose Zone and Groundwater Modeling. The SESOIL vadose zone model predicted a minimum travel time through the vadose zone of 7.5 years using conservative estimates (i.e., most rapid transport) of site-specific and chemical-specific input parameters. The basin-scale groundwater model constructed using FEFLOW was used to simulate flow in the Raymond Basin from the JPL facility to the Sunset Reservoir wells. This model indicates the advective travel times (i.e., most conservative) for a particle originating on the JPL Facility near MW-7 and captured at the Sunset Reservoir wells is between 40 and 96 years, with an average travel time of 70 years. Using these travel times, the estimated release period ranges between 1899 and 1955 (i.e., 2002 minus [40 to 96 years] minus 7.5 [vadose zone travel time]), with the average starting prior to prior to 1924. As indicated earlier, the JPL facility did not start testing perchlorate as a solid rocket propellant until after 1942. It should be noted that simulations performed using the groundwater flow model assume steady state conditions; therefore, recent modifications in production well operation may result in slightly different travel time estimates.

While particle tracking can be used to estimate groundwater flow paths and conservative travel times, it does not necessarily indicate that enough perchlorate mass traveled to the Sunset Reservoir wells to result in the observed concentrations. As indicated in previous reports (FWEC, 1999; NASA, 2003), the production wells in the Monk Hill Subarea have been in operation since the early 1900s and provide effective hydraulic containment of the groundwater originating from the JPL facility. Therefore, the vadose zone and groundwater modeling efforts provide additional uncertainty regarding the source of perchlorate in the Sunset Reservoir.

Other Potential Sources. Although none of the potential sources of chemicals in groundwater identified in the EDR Study were associated with perchlorate, it should be noted that the study area only encompassed the area downgradient of the JPL facility. As stated above, the RI indicates that injection of Colorado River water (which has been shown to contain perchlorate) in upgradient production wells has been shown to influence groundwater quality in the Basin (FWEC, 1999). Other potential sources include system leakage at/near the Sunset Reservoir, which receives water from MWD, or other underdetermined sources.

3.3 RCLWA and Las Flores Water Company Wells

RCLWA 7, RCLWA 4, and Las Flores 2 wells (Figure 2-1) are located in the Monk Hill Subarea, downgradient and approximately 1,200 feet southeast of JPL monitoring well MW-20. A summary of PCE, TCE, CCl_4, and perchlorate concentration data for the RCLWA, Las Flores, and LAWC (provided for comparison) wells is presented in Table 3-2. Figure 3-12 shows the concentrations of perchlorate that have been detected in the RCLWA and Las Flores Water Company wells.

CCl_4 has not been detected at all and TCE has not been detected at concentrations above maximum contaminant levels (MCLs) in the RCLWA and Las Flores wells. PCE was detected above its MCL only in the Las Flores 2 well (the only well associated with a mixture of Type 3 water), at a maximum concentration 17.2 μg/L. PCE first exceeded its MCL in the Las Flores 2 well in May of 1998 and has continued to exceed the MCL through the most recent data set, with detections consistently near or above 10 μg/L. The absence of CCl_4 indicates that VOCs from the source area at JPL have not migrated to the RCLWA or Las Flores Water Company wells. For comparison, CCl_4 and TCE have been detected in the LAWC 3 and LAWC 5 wells at concentrations above their MCLs. During the summer of 2004, NASA funded installation and operation of a perchlorate treatment system for LAWC.

Perchlorate has been detected above at or above 6 μg/L in the RCLWA 4 and Las Flores 2 wells. Perchlorate has not been detected in the RCLWA 7 well. A summary of groundwater quality information for the RCLWA and Las Flores Water Company wells is presented in Table 3-3. Groundwater from the

RCLWA 4 well has an average TDS of 371 mg/L and is consistently classified as Type 1 water, which originates locally. Groundwater from the RCLWA 7 well has an average TDS of 276 mg/L and varies between Type 1 and Type 2, which originate locally. Groundwater from the Las Flores 2 well has an average TDS of 396 mg/L and exhibits a combination of Type 1 and Type 3 water, indicating that groundwater extracted from the well is a mixture of local and non-local sources.

Isolated perchlorate concentrations (as high as 124 μg/L in Screen 4) in JPL monitoring well MW-20 have been detected in the lower two screened intervals, characterized by Type 2 groundwater. Perchlorate concentrations in MW-20 in the upper-most screen have been detected as high as 7.8 μg/L and were associated with Type 3 or 1/3 waters. Because the RCLWA and Las Flores wells are screened across multiple aquifer zones, the contributions of perchlorate from different zones, represented by the different screened intervals in MW-20, is uncertain. Figure 3-5 shows the historical concentrations of perchlorate in MW-20.

Due to the low levels of perchlorate in the RCLWA and Las Flores Water Company wells, these purveyors have not needed to treat for perchlorate (although Las Flores Water Company does have a DHS approved blending plan for perchlorate). Therefore, installation of an additional monitoring well east of these production wells does not appear to be appropriate at this time due to the proximity of MW-20 and the southerly groundwater flow conditions in the area. The data will continue to be evaluated closely for increasing perchlorate concentrations, presence of VOCs (particularly CCl_4), and groundwater quality.

Figures 3-13 through 3-18 are vertical cross-sections along a transect (B-B′) extending from the JPL facility to the RCLWA and Las Flores Water Company wells. Figures 3-19 through 3-24 are cross-sections along transect (C-C′) extending from LCID and VWC wells to the RCLWA and Las Flores Water Company wells. Each of these cross sections shows CCl_4, PCE, and perchlorate concentrations in addition to water quality and groundwater level information.

3.4 VWC/LCID Wells

Six municipal production wells are located upgradient of the JPL Facility, including wells VWC 1 through VWC 4, LCID 1, and LCID 6 (Figure 2-1). In addition to their extraction capability, production wells VWC-2 and VWC-3 were constructed to function as injection wells and inject MWD water. A summary of PCE, TCE, CCl_4, and perchlorate concentration data for these wells is presented in Table 3-4, which also includes information from two JPL monitoring wells (MW-14 and MW-6) that are located between the NASA facility and the production wells, and JPL monitoring well MW-7, which is located in the suspected JPL source area. A summary of groundwater quality information for these wells is presented in Table 3-5.

Elevated PCE and TCE in the VWC production wells and the absence of CCl_4 (with the exception of an isolated detection of 0.6 μg/L in production well VWC 4), indicate a VOC source other than JPL. PCE detections have been attributed to unsewered areas in La Cañada-Flintridge, where PCE was evidentially used as a septic system cleaner, and several dry cleaner sites. Figures 3-25 through 3-30 show CCl_4, PCE, and perchlorate concentrations and water quality data along a transect (D-D′) from the NASA facility to the upgradient production wells VWC wells to the downgradient production wells for years 1997 through 2002.

Perchlorate concentrations in the VWC wells have been attributed to injection of MWD Colorado River water (FWEC, 1999). Groundwater samples from the VWC wells (two of which have historically injected Colorado River water) have an average TDS of over 600 mg/L and are consistently classified as Type 1/3 or Type 3, indicating that it does not originate locally. Groundwater from the LCID wells, which are upgradient of the VWC wells, has an average TDS of under 420 mg/L and varies between Type 1 and Type 1/3, which indicates that it is primarily rainwater runoff with minor contributions from Colorado River water. Figures 2-7 and 2-8 show water quality distribution throughout the northern portion of the Monk Hill Subarea, including the NASA facility, for January 1998 and January 2001, respectively. These figures illustrate the transition from Type 1 to Type 3 waters between the NASA facility and the VWC and LCID production wells.

Groundwater elevation data (Figures 2-4 and 2-5) and groundwater flow modeling also support a chemical source other than JPL in the VWC and LCID wells. The simulations indicate that groundwater flows to the southeast in accordance with the regional flow in the Monk Hill Subarea and that particles released in the vicinity of the suspected source area at JPL would not migrate to the VWC and LCID wells. Additionally, the width of the Monk Hill Subarea narrows and the base of the alluvial aquifer (i.e., top of bedrock) increases in elevation toward the northwest, as indicated in Figures 3-25 through 3-30. These two characteristics inhibit the ability of the groundwater to flow from the JPL Facility toward the VWC wells due to the reduction in aquifer storage capacity and further support a southeasterly flow direction.

3.5 Summary and Conclusions

Table 3-6 summarizes the results from the data evaluation as they relate to the Sunset Reservoir, RCLWA, Las Flores, VWC, and LCID wells. The data indicate the following:

- The VOCs and perchlorate in the VWC and LCID wells do not appear to originate from the JPL Facility. This conclusion is supported by elevated levels of PCE and TCE and the absence of CCl_4, groundwater-level elevation data, water quality data showing significant Type 3 characteristics, and groundwater modeling.
- The VOCs in the Las Flores Water Company well do not appear to originate from the JPL Facility due to elevated PCE and the absence of CCl_4. The origin of perchlorate concentrations in the Las Flores Water Company well is uncertain. Although there is Type 3 water characteristics present (indicating a source other than JPL), samples collected from the deeper screens of MW-20 (located 1,200 feet upgradient) have shown elevated perchlorate concentrations that appear to originate from JPL.
- The VOCs in the RCLWA wells do not appear to originate from the JPL Facility due to the absence of CCl_4. However, the perchlorate detections in RCLWA 4 appear to originate from the JPL facility due to the presence of Type 1 water quality characteristics and the proximity to MW-20, which has perchlorate concentrations in samples from deeper screens that appear to originate at JPL.
- The VOCs in the Sunset Reservoir wells do not appear to originate from the JPL Facility due to elevated PCE and TCE, and the absence of CCl_4. However, the origin of perchlorate concentrations in the Sunset Reservoir wells is uncertain. The presence of Type 3 water characteristics and the results of groundwater modeling indicate a source other than JPL. However, the leading edge of perchlorate plume is not delineated (i.e., samples collected from the deeper screens of the furthest downgradient monitoring well, MW-20, have shown elevated perchlorate concentrations that appear to originate from JPL) and the Sunset Reservoir wells are hydraulically downgradient of the JPL Facility. Even though these wells are hydraulically downgradient of JPL, it is not clear whether the source is JPL due to travel time estimates and hydraulic containment by production wells in the Monk Hill Subarea. Additional investigation is warranted.

3.6 Recommendations

Due to the uncertainty associated with the origin of perchlorate in the Las Flores Water Company well and the Sunset Reservoir wells, NASA recommends the following:

- Continued monitoring of the RCLWA and Las Flores Water Company wells. Installation of an additional monitoring well east of these production wells does not appear to be appropriate at this time due to the proximity of MW-20 and the southerly groundwater flow conditions in the area. The data should be evaluated closely for increasing perchlorate concentrations, presence of VOCs (particularly CCl_4), and groundwater quality.
- Installation of additional multi-port monitoring wells south of MW-20 and near the Sunset Reservoir wells. These wells are recommended to help define the leading edge of the perchlorate plume and to help understand the relationship between water quality and perchlorate concentrations near the Sunset Reservoir.
- Collection of soil samples to better define aquifer characteristics, including bulk density, effective porosity, hydraulic conductivity, and fraction organic carbon. Column tests on soil samples are recommended to determine site-specific sorption coefficient (K_ds) for perchlorate. Estimation of these parameters will provide a better understanding of site-specific and chemical-specific characteristics that can be incorporated into groundwater modeling simulations. A work plan is provided as Appendix C.

Additional investigation is proposed to delineate the leading edge of the perchlorate plume originating from the JPL Facility and to improve the understanding of the relationship between water quality and perchlorate concentrations near the Sunset Reservoir. The additional investigation includes installation of two multi-port monitoring wells and collection of monitoring data from these wells.

Multi-port wells are recommended due to the thickness of the aquifer in the area of interest and the presence of stratification within the aquifer. Well locations were selected in coordination with the City of Pasadena. To the extent possible, well locations were sited within City of Pasadena property to facilitate ease of access and minimize impact to private property and public right-of-way (e.g., streets, etc). Upon installation and development of the proposed wells, an initial round of groundwater monitoring will be conducted to provide a baseline understanding of hydrogeologic conditions in the vicinity of these wells. Monitoring data will consist of chemical concentrations, water quality parameters, and groundwater-level elevations. Data from the multi-port screens will be used to develop a vertical profile of the groundwater conditions. Groundwater monitoring and data collection will be conducted in accordance with the Sampling and Analysis Plan (SAP) provided in Appendix A. Following the initial sampling event, subsequent sampling events will be conducted as part of the existing JPL groundwater monitoring program conducted by NASA. All field activities at the site will be conducted according to the procedures outlined in the Site Health and Safety Plan (SHSP) (Appendix B).

In addition, an attempt will be made to collect one saturated and one unsaturated soil sample from each location for analysis of several physical parameters, including bulk density, effective porosity, horizontal and vertical hydraulic conductivity, and fraction organic carbon. In addition, collection of samples for column tests will be performed in an effort to determine site-specific sorption coefficient (K_ds) for perchlorate. The sample collection efforts are described in this Work Plan; however, a separate Work Plan has been prepared to discuss the column tests to determine perchlorate sorption coefficient (Appendix C).

4.1 Schedule

A proposed schedule for installation of the additional monitoring wells is presented in Table 4-1, and includes a timeframe for logistic coordination and field work. The proposed start date and subsequent milestones will be contingent upon modification of the *Use Agreement and Right-of-Entry for Environmental Actions* between the City of Pasadena and NASA.

4.2 Logistics Coordination

To ensure the successful planning, installation, construction, and monitoring of the proposed multi-port wells, this project will require coordination with all parties to the FFA, including NASA, U.S. EPA, DTSC, and the RWQCB Los Angeles Region, as well as the City of Pasadena and the RBMB. NASA has already initiated coordination with the City of Pasadena associated with well location and property access. A brief description of specific coordination activities associated with the City of Pasadena and the RBMB is provided below.

4.2.1 City of Pasadena. Proposed well locations are within City of Pasadena property and were selected in coordination with City of Pasadena Pasadena Water and Power (PWP) personnel. Therefore, close coordination of well installation and sampling activities will be required between NASA and the City of Pasadena. Use of portions of some City of Pasadena roads will potentially be disrupted, but the traffic can likely be accommodated through usual traffic control methods. In general, coordination activities associated with the City of Pasadena for this project will include the following:

- Finalization of the *Use Agreement and Right-of-Entry for Environmental Actions* between the City of Pasadena and NASA for access to well sites for project personnel, equipment, and vehicles during field related activities.
- Completion of appropriate City of Pasadena Department of Public Works and Department of Planning boring and construction approvals (including public notification requirements and traffic control plans).
- 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 each proposed well site.
- Coordination of drilling, well construction, waste disposal, surveying, and groundwater sampling field schedules.

Prior to and during monitoring well installation on City-owned land, NASA will comply with all of the requirements in the *Use Agreement and Right-of-Entry for Environmental Actions*. NASA will submit to PWP a firm schedule of commitment two weeks prior to commencing with the well construction to coordinate with PWP inspections and planning.

4.2.2 **RBMB.** The RBMB oversees implementation of the adjudication provisions of the Raymond Basin Judgment. NASA will obtain written authorization from the Raymond Basin Watermaster for constructing and operating the proposed monitoring wells. Because well construction and development require groundwater extraction, the RBMB will be notified of estimated and actual extracted groundwater quantities before and after well construction.

4.3 Well Locations

Selection of the proposed additional monitoring well locations was based on groundwater analytical data from existing wells, known groundwater flow patterns in the OU-3 area, and available property. Two proposed monitoring well locations have been identified, each of which is located on property owned by the City of Pasadena. The first proposed location is downgradient of JPL monitoring well MW-20 (NASA's furthest downgradient monitoring well) on Montana Street (see Figure 4-1). The well is located between NASA's two most downgradient monitoring wells and the Sunset Reservoir wells. An alternate location is proposed on Pasadena Unified School District (PUSD) property, just south of the Montana Street location (see Figure 4-1). The exact location of the proposed monitoring well has yet to be finalized, and will be based upon the results of meetings with the drillers, a subsurface utility survey, and discussions with the City of Pasadena and PUSD. Data collected from this well will serve primarily to evaluate the downgradient extent of chemical that originate from the JPL facility. The well will be completed with depth-discrete monitoring points (see Section 4.4), so that vertical profiling of the aquifer can be performed to correlate depth with water quality and chemical concentrations.

The second proposed location is slightly upgradient of the City of Pasadena Sunset Reservoir area Bangham and Copelin wells (see Figure 2-3), in the northwest corner of the City's Yards complex, which encompasses both the Sunset Reservoir and three production wells, and near the intersection of Hammond Street and the Foothill Freeway (Figure 4-1). This monitoring well will be located north of the Sunset Reservoir and south of the first proposed location. The Sunset Reservoir wells are currently inactive, but the proposed location is approximately 1,000 ft upgradient of the closest well. Data collected from this well will serve primarily to better understand the occurrence of perchlorate in the vicinity of the Sunset Reservoir area. The well will be completed with depth-discrete monitoring points (see Section 4.4), so that vertical profiling of the aquifer can be performed to correlate depth with water quality and chemical concentrations.

Additional locations in OU-3 may be necessary depending on the groundwater sampling results from the two proposed wells. If the monitoring results necessitate additional locations, a letter report will be submitted as an addendum to this document. The letter report will document the rationale behind additional monitoring wells and the proposed location of these wells.

4.4 Well Construction

The following sections describe the well installation activities that will be performed as part of this additional investigation. These activities include permitting, geophysical surveying, deep multi-port well installation, and IDW treatment and disposal. Additional assessment activities are similar in scope to those performed as part of NASA's regulator approved *Work Plan for Performing a Remedial Investigation/Feasibility Study at NASA JPL* (Ebasco, 1993).

4.4.1 Well Permit Requirements. The proposed monitoring wells are located within the OU-3. As a CERCLA site, the activities conducted as part of this additional assessment are only subject to substantive requirements and not procedural or administrative requirements such as permits. Under CERCLA § 121(e)(1) and 40 Code of Federal Regulations (CFR) § 300.400(e), no Federal, State, or local permit is required for this additional RI, provided that the action is selected and carried out in compliance with CERCLA. This applies to all permits, including environmental and building permits.

Although permits are not required, NASA will comply with the substantive permitting requirements associated with monitoring well installation. This includes permitting requirements associated with the Los Angeles County Department of Environmental Health (DEH), City of Pasadena Building Department, RWQCB Los Angeles region, and the California Department of Water Resources (DWR) Southern District. NASA will coordinate with each agency on installation of additional monitoring wells.

4.4.2 Pre-Drilling Activities. Prior to beginning drilling, all available utility maps will be reviewed. To the extent possible, well locations will be strategically sited in the vicinity of the proposed location to avoid existing utilities. In addition, prior to performing any subsurface activities, the well locations will be scanned for underground utilities using geophysical methods. The utility-locating contractor will employ several methods, including ground-penetrating radar (GPR), magnetometer, magnetic gradiometer, and/or electromagnetic imaging (EM). As required by California State law, Underground Services Alert (USA) will be notified of the planned drilling activities. USA is a communication center that provides notice to utility owners that may potentially have underground utilities within the proposed well sites. USA requires notification a minimum of 48 hours prior to conducting any underground excavation. Following map review, geophysical utility locating, and USA clearance, the surface of the ground will be clearly marked where underground utilities are discovered. Drilling locations will be selected to avoid impact to existing utilities. Prior to the initiation of drilling activities, the drilling contractor will attempt to hand auger a pilot hole to a depth of approximately 5 ft bgs at each proposed well location to ensure that no underground utilities or obstructions are present.

4.4.3 Deep Multi-Port Well Installation. Similar to the existing JPL multi-port monitoring wells, the proposed monitoring wells have been designed to include five depth discrete monitoring points within one well casing, and will be equipped with the Westbay Instruments Ltd. Multi-port casing monitoring system. Both new wells will be drilled to the top of the crystalline bedrock. Based on boring logs from nearby wells (e.g., Sunset Well and MW-20), it is anticipated that the proposed wells will extend to depths of approximately 700 to 1,000 ft. This design may be amended in the field if site-specific conditions warrant a modified construction.

The remainder of this section includes a brief description of the drilling method, well construction details, well development procedures, and the multi-port casing system installation procedures. A detailed description of these procedures can be found in NASA's regulator approved *Work Plan for Performing a Remedial Investigation/Feasibility Study at NASA JPL* (Ebasco, 1993).

4.4.3.1 ***Drilling Method.*** Each groundwater monitoring well will be drilled to the required depth below ground surface using a 12.25-inch outside diameter (O.D.) mud-rotary drilling bit. Approximately 20 ft of steel conductor casing will be set at the surface of each borehole to maintain the near surface integrity. The conductor casing will be removed after the well is constructed and all backfill materials have been placed. During drilling and well construction, drill cuttings will be separated from the drilling mud using a mud shaker. The separated mud is recycled into the drilling process and the cuttings are stored in a roll-off bin. Additional details regarding containerization and disposal of IDW are provided in Section 4.4.3.6.

All drilling equipment and materials including drilling bits and pipes, drilling mud, and backfill materials will be either new or cleaned in the field using a high pressure steam cleaner. Clean, imported water or water supplied from a nearby clean water source (e.g., water spigot) will be used during drilling and well construction activities. Prior to use, a water sample will be collected from each water source. The water sample will be analyzed for perchlorate and VOCs using U.S. EPA-approved methods.

During drilling, soil samples will be collected for lithologic logging purposes and then disposed of with the soil cuttings. Soil samples will be logged using the Unified Soil Classification System (USCS). Soil boring logs will be incorporated into a bound field notebook. The field notebook will be used to document all sampling activities. These notebooks will be maintained as permanent records. A minimum of one saturated and one unsaturated soil sample will be collected from each monitoring well for use in determining selected physical parameters, such as hydraulic conductivity, porosity, and bulk density. In order to collect these samples, the downhole drilling equipment will be tripped so that soil sampling equipment can be inserted down the well for sample collection. A modified split-spoon sampler attached to a 300-pound hammer will be used to collect undisturbed soil samples that will be used for analysis of physical parameters and in column studies for determining chemical-specific transport parameters. The drilling method described above is a standard method for installation of environmental monitoring wells. Cross-contamination between aquifer layers will be minimized because the drilling mud is of a different viscosity thereby restricting groundwater flow within the borehole during the drilling and well installation activities. Additionally, during well construction and development, to the extent possible, the drilling mud will eventually be completely removed from the well.

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

4.4.3.2 ***Well Construction.*** The total depth of each well will be determined by the on-site geologist based on the depth that crystalline bedrock is encountered. Based on the lithology defined by similar wells in the area, it is assumed that the wells will be advanced to approximately 700 to 1000 ft.

Well construction will satisfy the requirements of the California DWR, Water Well Standards, Bulletin 74-90, Supplement to Bulletin 74-81. The initial well design will be based on the design of other deep multi-port wells located in the vicinity (e.g., MW-19 and MW-20). The outer well casing will consist 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. Each section of screen and blank casing will be measured and steam cleaned before being lowered into the boring. The proposed screen depths will initially be chosen based on lithologic information from existing production and monitoring wells and existing groundwater level data. However, field changes to the proposed screen depths may occur as a result of information collected from lithologic logging during drilling and geophysical logging (see Section 4.4.3.3). All bentonite seals and sand packs will be tremied into place. The sand packs will consist of No. 2 silica sand. A grout pump will be used to circulate drilling fluid out of the hole and to pump backfill materials into the boring. The backfill materials will include sand, a bentonite sealing mixture consisting of sand and bentonite, and Volclay grout or equivalent. A locking monument cover or a traffic box will be installed at the well after the grout has set. Concrete will be used to secure the monument cover or traffic box in place. Well design may be modified in the field based on site-specific conditions.

Additional details regarding well construction can be found in NASA's regulator approved *Work Plan for Performing a Remedial Investigation/Feasibility Study at NASA JPL* (Ebasco, 1993).

4.4.3.3 ***Geophysical Logging.*** Upon completion of the drilling, the wells will be logged in the open borehole using geophysical methods to assist the identification of well screen depths, borehole lithologies, water-bearing intervals, and stratigraphic correlation with existing JPL monitoring wells. During the geophysical logging, the sides of the open borehole will be held in place by the viscosity of the drill mud, which will remain in place throughout the process. To accurately interpret results from the logging, the properties of the drilling mud will be subtracted out during analysis of the data. Proposed geophysical methods include natural gamma radiation, electrical resistivity (R/SP), guard resistivity, and caliper surveying.

4.4.3.4 ***Multi-Port Casing System Installation.*** The multi-port casing will be provided and installed by certified technical representatives of Westbay Instruments, Inc. The multi-port casing will arrive on-site, pre-cleaned in factory packaging and will be installed by hand within the previously installed well casing. The multi-port equipment consists of 1.5- inch-diameter schedule 80 polyvinyl chloride (PVC) blank casing, PVC couplings used to connect various casing components, PVC measurement-port couplings, PVC pumping-port couplings, and nitrile rubber inflatable packers. The measurement ports are installed to allow access to the aquifer for well purging and hydraulic conductivity testing. The pumping-ports are installed to allow access to the aquifer for pressure measurements and water sampling and the packers are used to seal the annulus between the measurement and pumping ports at each screened interval.

During well construction and casing installation, cross contamination will be minimized through the placement of a bentonite seal between each screened interval. Each screened interval will be developed independently. Once the development is complete, the outer casing will be purged free of water.

Additional details regarding the multi-port casing system installation, testing, and well development can be found in NASA's regulator approved Work *Plan for Performing a Remedial Investigation/Feasibility Study at NASA JPL* (Ebasco, 1993).

4.4.3.5 ***Well Development Procedures.*** Each monitoring well will be developed within 24 hours after being installed. Well development will include an initial period of surging followed by over-pumping. Development will be considered complete when the pH, conductivity, temperature, and turbidity measurements reach stability (when two successive measurements collected 3 minutes apart are within approximately 10% of each other). Following development the interior of the steel well casing will be video logged to evaluate the efficacy of the initial development. Based on the results of the video log additional development may be conducted. Field notes collected during well development will be recorded on a well development log. Well development activities will be conducted in accordance with NASA's regulator approved *Work Plan for Performing a Remedial Investigation/Feasibility Study at NASA JPL* (Ebasco, 1993).

4.4.3.6 IDW Generation, Treatment, and Disposal. The primary wastes generated from implementing this additional assessment Work Plan include drill cuttings/mud, well development water, monitoring well purge water, and decontamination rinse water. The amount of waste generated will vary based on actual field operations. Waste samples will be analyzed for the medium-specific parameters presented on Table 4-2. If possible, development water will be stored in approved containers at each site until IDW disposal activities can be coordinated. Otherwise, IDW will be moved onto the JPL site and stored until appropriate disposal is arranged. Based on the laboratory results, the waste will be classified as hazardous or nonhazardous waste in accordance with the Code of Federal Regulations (40 CFR 261.31 to 261.33 and 261.21 to 261.24) and the California Code of Regulations (22 CCR). Battelle will prepare all required waste profiles and manifests for the waste. An appropriate U.S. EPA-certified waste disposal facility will be selected and a licensed transporter will haul the waste off-site for disposal. All waste transported off-site will be accompanied by the appropriate hazardous or nonhazardous waste manifest, signed by a NASA authorized representative. The disposal of waste will be in accordance with federal, state, and local laws, regulations, and instructions.

4.5 Monitoring Frequency and Analyses

Following the installation and development of the steel well casing, each of the screened intervals will be isolated using K-packers then purged and sampled. These sample analytical results will be used as baseline data for comparison with subsequent analytical data collected following the multi-port casing installation (i.e., purge and sample versus no purge sampling). Additionally, to evaluate flow conditions in the well prior to the installation of the multi-port casing system, a spinner log will be run under static conditions.

Following the installation of the multi-port casing system, the newly installed monitoring wells will be initially sampled from each interval following the development of the multi-port casing system (Westbay). Following the initial well sampling, these wells will be added to the JPL monitoring program, and monitoring will occur on a quarterly schedule. During the initial monitoring events, groundwater samples will be collected and analyzed for VOCs (including 1,2,3-trichloropropane), SVOCs, perchlorate, water quality parameters, *n*-nitrosodimethylamine (NDMA), and 1,4-dioxane. The method detection limits (MDLs) for these analytes are listed in Appendix A. The analysis frequency for selected parameters (i.e., SVOCs and water quality parameters) may be reduced after the initial year of monitoring if warranted by the historical results. Groundwater samples will be transported under chain-of-custody to a California approved analytical laboratory.

A comprehensive quality assurance/quality control (QA/QC) plan for groundwater monitoring has been established and is described in detail in the SAP (Appendix A). QA can be described as an integrated system of activities in the area of 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. All procedures will be followed in both the field and the laboratory. The types and quantities of field QC samples will be collected as follows: field duplicates (10%), equipment rinsate (1 per day), trip blank (1 per cooler), and field blank (1 per day). Laboratory QC, including laboratory blank samples, matrix spike/matrix spike duplicate (MS/MSD) samples, and laboratory control samples (LCSs), will be collected at a frequency of 5% of the total number of samples.

4.6 Reporting

The results of the multi-port monitoring well installation portion of the OU-3 additional investigation will be submitted in a technical memorandum following well completion and initial monitoring within 60 days after completion of the investigation. Results from subsequent monitoring will be included in deliverables associated with the JPL quarterly monitoring program. NASA will report sampling results to PWP in accordance with the *Use Agreement and Right-of-Entry for Environmental Actions*.

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Technical Memorandum

Third Quarter 2014 Groundwater Monitoring Summary
National Aeronautics and Space Administration
Jet Propulsion Laboratory, Pasadena, California

Final

October 2014

This technical memorandum summarizes the results of the third quarter 2014 groundwater sampling event completed as part of the groundwater monitoring program at the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL). The third quarter 2014 groundwater sampling event was conducted from July 25 through August 8, 2014.

INTRODUCTION

During the third quarter 2014 sampling event, groundwater samples were collected from 23 JPL monitoring wells (MWs), both on and off facility, and analyzed for volatile organic compounds (VOCs), total chromium, hexavalent chromium [Cr(VI)], and perchlorate. Figure 1 shows the locations of the groundwater monitoring wells.

Groundwater samples were shipped to BC Laboratories, Inc., in Bakersfield, CA for chemical analysis. BC Laboratories, Inc. is certified by the State Water Resources Control Board (CalEPA). Sample collection procedures and sample analyses were conducted in accordance with the approved *Work Plan for Performing a Remedial Investigation/Feasibility Study*.[1] No reported data were rejected for noncompliance with method requirements during the course of validation and no reported data were deemed unusable.

Table 1 summarizes analytical results for VOCs and perchlorate and Table 2 summarizes analytical results for metals during the most recent five quarters. Table 3 summarizes VOC and perchlorate concentrations in production wells located near the JPL facility during the most recent five quarters. No tentatively identified compounds (TICs) were detected in the samples collected during the third quarter of 2014.

Figures summarizing the results from the third quarter 2014 sampling event are included in this technical memorandum. Figure 2 shows the lateral extent of carbon tetrachloride concentrations in groundwater and Figure 3 provides a cross section detailing the horizontal and vertical extent of carbon tetrachloride. Figure 4 shows the lateral extent of perchlorate concentrations in groundwater, and Figure 5 provides a cross section detailing the horizontal and vertical extent of perchlorate in groundwater. Figure 6 shows the lateral extent of tetrachloroethene (PCE) concentrations in groundwater. Figure 7 shows the lateral extent of trichloroethene (TCE) concentrations in groundwater. Figure 8 shows groundwater elevation contours and groundwater flow directions.

The groundwater monitoring wells have been grouped into four categories:

- On facility source area wells (MW-7, MW-13, MW-16, and MW-24);
- Other on facility wells (MW-6, MW-8, MW-11, MW-22, and MW-23);
- Perimeter off facility wells (MW-1, MW-3, MW-4, MW-5, MW-9, MW-10, MW-12, MW-14, and MW-15 [MW-1 and MW-9 were not sampled during the third quarter 2014]); and
- Off facility wells (MW-17, MW-18, MW-19, MW-20, MW-21, MW-25, and MW-26).

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[1] Ebasco. 1993. *Work Plan for Performing a Remedial Investigation/Feasibility Study*. National Aeronautics and Space Administration Jet Propulsion Laboratory, Pasadena, California. December.

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Well MW-2 has not been sampled during the groundwater monitoring program since it was replaced with well MW-14.

On Facility Source Area Wells

On facility source area wells consist of wells that have historically contained the highest concentration of site-related chemicals. This group of wells is located within the JPL facility (on facility) and consists of monitoring wells MW-7, MW-13, MW-16, and MW-24. (Note: grab samples were collected with a disposable bailer at MW-7, MW-13, and MW-16 due to insufficient water available to use the dedicated pumps to purge the wells.)

The source area treatment system has been operating since 2005 and addresses groundwater beneath the JPL facility that has historically contained the highest concentrations of perchlorate and VOCs (i.e., the source area). Operation of the source area treatment system appears to have resulted in a significant reduction of chemicals of interest in wells MW-7, MW-16, and MW-24, which are located within the treatment zone. Additional details regarding chemical concentrations in these wells are presented below.

Perchlorate Analytical Results

- During the third quarter 2014 sampling event, concentrations of perchlorate in excess of the state maximum contaminant level (MCL) (6.0 micrograms per liter [µg/L]) were reported in samples collected from wells MW-13 (160 µg/L) and MW-24 (Screen 2 [6.0 µg/L]). No other perchlorate detections occurred in the on-facility source area wells during the third quarter 2014.
- Perchlorate concentrations decreased from their respective last sampling event to the third quarter 2014 in MW-7 (5.3 µg/L to non-detect with a reporting limit of 4.0 µg/L), MW-13 (200 µg/L to 160 µg/L) and MW-24 (Screens 1 [45.0 µg/L to non-detect] and 2 [8.5 µg/L to 6.0 µg/L]).
- Perchlorate concentrations in MW-7, MW-16 and MW-24 (Screens 1 and 3) were non-detect during the third quarter 2014, with a reporting limit of 4.0 µg/L.

VOC Analytical Results

- Carbon tetrachloride was not detected in any of the on facility source area wells during the third quarter 2014 with a reporting limit of 0.5 µg/L.
- During the third quarter 2014, TCE was detected below the state and federal MCL of 5.0 µg/L at an estimated concentration in MW-13 (0.2J µg/L [estimated values indicated with "J"]).
- During the third quarter 2014, PCE was detected below the state and federal MCL of 5.0 µg/L in MW-13 (1.7 µg/L) and MW-24 (Screens 2 [0.2J µg/L] and 3 [0.1J µg/L]).

Other Notable Analytical Results

- During the third quarter 2014, Cr(VI)[2] was detected below the state MCL of 10.0 µg/L in MW-16 (2.0 µg/L) and MW-24 (Screen 2 [2.0 µg/L]).

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[2] On July 1, 2014, the State Water Resources Control Board (CalEPA) adopted an MCL for Cr(VI) of 10.0 µg/L. See http://www.waterboards.ca.gov/drinking water/certlic/drinkingwater/Chromium6.shtml.

- During the third quarter 2014, total chromium was detected above the state MCL of 50.0 µg/L in wells MW-7 (9,100 µg/L), MW-13 (51,000 µg/L) and MW-16 (2,900 µg/L). Total chromium was also detected below the state MCL of 50.0 µg/L in MW-24 (Screens 1 [6.1 µg/L] and 2 [1.7J µg/L]). The total chromium detections in MW-7 (9,100), MW-13 (51,000 µg/L) and MW-16 (2,900 µg/L) are abnormally high and correlate with the sample collection method in which grab samples were collected with a disposable bailer due to insufficient water for purging (associated with the drought in California). This collection method yielded results that are not representative of aquifer conditions. It is recommended for future sampling events that metals analysis is not performed on the shallow standpipe wells when there is insufficient water for purging.

OTHER ON FACILITY WELLS

This well group consists of monitoring wells MW-6, MW-8, MW-11, MW-22, and MW-23. These wells are located on the JPL facility but outside the source area.

PERCHLORATE ANALYTICAL RESULTS

- During the third quarter 2014, perchlorate was detected in MW-6 (3.8J µg/L), MW-8 (180 µg/L), MW-22 (Screens 1 [3.2J µg/L] and 3 [2.7J µg/L]) and MW-23 (Screens 1 [3.8J µg/L], 2 [4.4 µg/L] and 3 [3.9J µg/L]); however, only the detection of 180 µg/L in MW-8 is above the state MCL of 6.0 µg/L.
- Perchlorate concentrations increased from their respective last sampling date to the third quarter 2014 in MW-6 (2.7J µg/L to 3.8J µg/L), MW-8 (47.0 µg/L to 180 µg/L), MW-22 (Screen 1 [3.0J µg/L to 3.2J µg/L]) and MW-23 (Screens 1 [2.6J µg/L to 3.8J µg/L] and 3 [3.0J µg/L to 3.9J µg/L]).
- Perchlorate concentrations decreased slightly from their respective last sampling event to the third quarter 2014 in MW-22 (Screens 2 [2.9J µg/L to non-detect] and 3 [2.8J µg/L to 2.7J µg/L]) and MW-23 (Screen 2 [4.7 µg/L to 4.4 µg/L]).
- During the third quarter 2014, perchlorate was not detected in MW-11 (Screens 1 through 4) and MW-22 (Screen 2) with a reporting limit of 4.0 µg/L.

VOC ANALYTICAL RESULTS

- During the third quarter 2014, carbon tetrachloride was detected below the state MCL (0.5 µg/L) in MW-8 (0.2J µg/L). No other carbon tetrachloride detections occurred in the other on facility wells during the third quarter 2014.
- During the third quarter 2014, TCE was detected below the state and federal MCL of 5.0 µg/L in MW-6 (3.9 µg/L), MW-8 (0.4J µg/L), MW-11 (Screen 3 [0.1J µg/L]), MW-22 (Screens 1 [2.2 µg/L] and 2 [0.1J µg/L]) and MW-23 (Screens 1 [3.8 µg/L] and 2 [1.4 µg/L]).
- During the third quarter 2014, PCE was detected below the state and federal MCL for PCE (5.0 µg/L) in MW-6 (1.2 µg/L), MW-22 (Screens 1 [0.6 µg/L] and 2 [0.1J µg/L]) and MW-23 (Screens 1 [0.5 µg/L] and 2 [0.5 µg/L]).

OTHER NOTABLE ANALYTICAL RESULTS

- During the third quarter 2014, Cr(VI)[2] was detected below the state MCL of 10.0 µg/L in MW-8 (3.0 µg/L), MW-22 (Screens 2 [2.0J µg/L] and 3 [2.0 µg/L]) and MW-23 (Screens 1 through 4 [1.0J µg/L, 1.0J µg/L, 3.0 µg/L and 3.0 µg/L, respectively]).

- During the third quarter 2014, total chromium was detected below the state and federal MCL (50.0 µg/L) in MW-6 (26.0 µg/L), MW-8 (18.0 µg/L), MW-22 (Screens 2 [1.0J µg/L] and 3 [1.4J µg/L]) and MW-23 (Screens 1 through 4 [1.2J µg/L, 1.3J µg/L, 3.2 µg/L and 2.8J µg/L, respectively]).

PERIMETER OFF FACILITY WELLS

The perimeter off facility wells are located near the JPL fence line along the perimeter of the property. This group of wells consists of MW-1, MW-3, MW-4, MW-5, MW-9, MW-10, MW-12, MW-14, and MW-15 (consistent with approved sampling frequencies, MW-1 and MW-9 are not sampled during third quarter events). It should be noted that during the third quarter MW-12 [Screen 1] was dry and no sample was collected. This well screen was dry due to declining water levels associated with the drought in California.

PERCHLORATE ANALYTICAL RESULTS

- During the third quarter 2014 sampling event, concentrations of perchlorate in excess of the state MCL (6.0 µg/L) were reported in samples collected from wells MW-3 (Screen 2 [31.0 µg/L]), MW-4 (Screen 2 [28.0 µg/L]) and MW-5 (9.4 µg/L).
- Perchlorate was detected below the state MCL of 6.0 µg/L in MW-3 (Screens 3 [1.3J µg/L] and 4 [1.1J µg/L]), MW-4 (Screen 3 [1.5J µg/L]), MW-10 (3.7J µg/L), MW-12 (Screens 2 through 5 [2.3J µg/L, 3.3J µg/L, 2.9J µg/L and 2.0J µg/L, respectively]) and MW-14 (Screens 1 through 4 [2.9J µg/L, 3.8J µg/L, 4.9 µg/L and 4.5 µg/L, respectively]).
- Perchlorate concentrations increased from their respective last sampling date to the third quarter 2014 in MW-3 (Screens 2 [25.0 µg/L to 31.0 µg/L]) and 3 [non-detect to 1.3J µg/L]), MW-5 (non-detect to 9.4 µg/L), MW-12 (Screens 3 through 5 [3.0J µg/L to 3.3J µg/L, non-detect to 2.9J µg/L and non-detect to 2.0J µg/L, respectively]) and MW-14 (Screen 4 [4.1 µg/L to 4.5 µg/L]).
- Perchlorate concentrations decreased from their last sampling event to the third quarter 2014 in MW-3 (Screen 4 [1.3J µg/L to 1.1 µg/L]), MW-4 (Screens 2 [64.0 µg/L to 28.0 µg/L] and 3 [2.6J µg/L to 1.5J µg/L]), MW-10 (4.2 µg/L to 3.7J µg/L),MW-12 (Screen 2 [3.9J µg/L to 2.3J µg/L]) and MW-14 (Screens 1 through 3 ([3.8J µg/L to 2.9J µg/L, 4.1 µg/L to 3.8J µg/L] and [5.9 µg/L to 4.9 µg/L, respectively]).
- The perchlorate detection of 31.0 µg/L in MW-3 (Screen 2) in the third quarter of 2014 is the second detection above the state MCL (6.0 µg/L) since the second quarter 2011. Perchlorate has been non-detect in MW-3 (Screen 2) since the second quarter 2011 with five exceptions: 3.0 µg/L, 1.3 µg/L, 3.9J µg/L, 25.0 µg/L and 31 µg/L (third quarter 2011, second quarter 2012, first quarter 2014, second quarter 2014, third quarter 2014 respectively). MW-3 is within the capture zone of the Monk Hill Treatment System (MHTS).
- The perchlorate concentration of 28.0 µg/L in MW-4 (Screen 2) continues to decline from the high detection of 250 µg/L (third quarter 2013). The perchlorate detection is consistent with recent detections in this well screen. Since the first quarter 2011, concentrations have exceeded the state MCL (6.0 µg/L). MW-4 is within the capture zone of the MHTS.
- Perchlorate concentrations in MW-12 (Screen 2) were detected below the state MCL (6.0 µg/L) from the first quarter 2008 through the third quarter 2010. Since the fourth quarter 2010, the detections have been above the state MCL (6.0 µg/L) with eight exceptions: 5.7 µg/L, 5.4 µg/L, 5.3 µg/L, non-detect, 5.6 µg/L, 4.2 µg/L, 3.9J µg/L and 2.3J µg/L (first and second quarters of 2011, fourth quarter 2011, first and fourth quarters of 2013, first, second and third quarters of 2014, respectively). MW-12 is within the capture zone of the MHTS.

- Perchlorate was not detected in MW-4 (Screen 1), MW-12 (Screen 1) and MW-14 (Screen 5) with a reporting limit of 4.0 μg/L.

VOC ANALYTICAL RESULTS

- During the third quarter 2014, carbon tetrachloride was detected above the state MCL (0.5 μg/L) in MW-12 (Screens 3 [0.6 μg/L] and 4 [0.7 μg/L]) and at a concentration below the state MCL in MW-12 (Screen 5 [0.4J μg/L]). No other carbon tetrachloride detections occurred in the perimeter off facility wells during the third quarter 2014.
- During the third quarter 2014, TCE was detected in wells MW-4 (Screen 2 [2.0 μg/L]), MW-5 (2.7 μg/L), MW-10 (8.1 μg/L), MW-12 (Screens 4 [0.3J μg/L] and 5 [0.2J μg/L]) and MW-14 (Screens 1 through 4 [2.6 μg/L, 4.1 μg/L, 2.7 μg/L and 0.4J μg/L, respectively]); however, only the detection of 8.1 μg/L in MW-10 was above the state and federal MCL (5.0 μg/L). No other TCE detections occurred in the perimeter off facility wells during the third quarter 2014.
- During the third quarter 2014, PCE was detected below the state and federal MCL (5.0 μg/L) in wells MW-3 (Screens 3 [0.2J μg/L] and 4 [0.2J μg/L), MW-4 (Screen 2 [1.1 μg/L]), MW-5 (0.5J μg/L), MW-10 (0.8 μg/L) and MW-14 (Screens 1 through 4 [0.4J μg/L, 0.6 μg/L, 0.9 μg/L and 0.4J μg/L, respectively]). No other PCE detections occurred in the perimeter off facility wells during the third quarter 2014.

OTHER NOTABLE ANALYTICAL RESULTS

- During the third quarter 2014, Cr(VI)[2] was detected below the state MCL of 10.0 μg/L in MW-10 (1.0J μg/L) and MW-14 (Screen 1 [1.0J μg/L]). No other Cr(VI)[2] detections occurred in the perimeter off facility wells during the third quarter 2014.
- During the third quarter 2014, total chromium was detected below the state MCL of 50.0 μg/L in MW-3 (Screens 3 and 4 [4.5 μg/L and 6.9 μg/L, respectively]), MW-5 (7.8 μg/L), MW-10 (5.7 μg/L) and MW-14 (Screens 1 [0.5J μg/L] and 3 [0.9J μg/L]).

OFF FACILITY WELLS

The off facility wells consist of monitoring wells MW-17, MW-18, MW-19, MW-20, MW-21, MW-25, and MW-26. These wells are located near and downgradient of the two off facility treatment systems: MHTS and Lincoln Avenue Water Company (LAWC) treatment system. Daily operation of the MHTS began in February 2011. Operation of the LAWC system began in July 2004.

Note: During the third quarter MW-20 [Screen1] and MW-21 [Screen 1] were dry and no sample was collected. In addition, MW-18 [Screen 1], which is only sampled during the second and fourth quarters, but is measured for water levels, was also dry. These well screens were dry due to declining water levels associated with the drought in California.

PERCHLORATE ANALYTICAL RESULTS

- During the third quarter 2014 sampling event, concentrations of perchlorate in excess of the state MCL (6.0 μg/L) were reported in samples collected from wells MW-17 (Screens 3 and 4 [6.4 μg/L and 18.0 μg/L, respectively]), MW-18 (Screens 3 [27.0 μg/L] and 4 [16.0 μg/L]) and MW-25 (Screens 1 through 4 [11.0 μg/L, 15.0 μg/L, 12.0 μg/L and 11.0 μg/L, respectively]).
- Perchlorate was detected below the state MCL of 6.0 μg/L in MW-19 (Screens 2 through 5 [5.7 μg/L, 4.4 μg/L, 3.4J μg/L and 2.3J μg/L, respectively]), MW-20 (Screen 2 [3.5J μg/L]), MW-21

(Screens 2 through 5 [2.3J µg/L, 1.8J µg/L, 2.7J µg/L and 2.2J µg/L, respectively]) and MW-26 (Screens 1 [1.9J µg/L] and 2 [3.1J µg/L]).

- Perchlorate concentrations increased slightly from their respective last sampling date to the third quarter 2014 in MW-17 (Screen 4 [17.0 µg/L to 18.0 µg/L]), MW-19 (Screens 3 [2.9J µg/L to 4.4 µg/L] and 4 [3.3J µg/L to 3.4J µg/L]), MW-21 (Screens 4 [2.2J µg/L to 2.7J µg/L] and 5 [non-detect to 2.2J µg/L]), MW-25 (Screens 2 [14.0 µg/L to 15.0 µg/L], 3 [11.0 µg/L to 12.0 µg/L] and 4 [8.5 µg/L to 11.0 µg/L]) and MW-26 (Screen 2 [2.3J µg/L to 3.1J µg/L]).
- The perchlorate concentrations decreased slightly from their respective last sampling event to the third quarter 2014 in MW-17 (Screen 3 [7.6 µg/L to 6.4 µg/L]), MW-18 (Screen 3 [36.0 µg/L to 27.0 µg/L), MW-19 (Screens 2 [6.3 µg/L to 5.7 µg/L] and 5 [3.1J µg/L to 2.3J µg/L]), MW-20 (Screen 2 [4.0 µg/L to 3.5J µg/L]), MW-21 (Screens 2 [2.8J µg/L to 2.3J µg/L] and 3 [4.0 µg/L to 1.8J µg/L]) and MW-26 (Screen 1 [2.5J µg/L to 1.9J µg/L]).
- The perchlorate concentration of 18.0 µg/L in MW-17 (Screen 4) is the sixth detection above the state MCL (6.0 µg/L) since the first quarter 2013. From the third quarter 2002 to the first quarter 2013, the perchlorate concentrations in MW-17 (Screen 4) had been either non-detect or below the state MCL (6.0 µg/L) with only one detection that exceeded the state MCL (second quarter 2003 [6.5 µg/L]). MW-17 is located within the capture zone of the LAWC treatment system.
- Concentrations of perchlorate were not detected in MW-17 (Screen 2), MW-18 (Screens 2 and 5), MW-19 (Screen 1), MW-20 (Screens 3 through 5) and MW-25 (Screen 5) with a reporting limit of 4.0 µg/L.

VOC ANALYTICAL RESULTS

- During the third quarter 2014, carbon tetrachloride was detected above the state MCL (0.5 µg/L) in MW-17 (Screen 4 [0.9 µg/L]) and MW-18 (Screens 3 [9.6 µg/L] and 4 [4.2 µg/L]) and at a concentration below the state MCL in MW-17 (Screen 3 [0.2J µg/L]). No other carbon tetrachloride detections occurred in the off facility wells during the third quarter 2014. The detection of 0.9 µg/L in MW-17 (Screen 4) is the fifth detection above the state MCL (0.5 µg/L) in this well screen interval since it was first analyzed for carbon tetrachloride in 1996. Since the first quarter 2005, the carbon tetrachloride concentrations in MW-18 (Screen 3) have exceeded the state MCL (0.5 µg/L). Carbon tetrachloride detections in MW-18 (Screen 4) have exceeded the state MCL (0.5 µg/L) since the third quarter 1996 with one exception (non-detect [fourth quarter 2010]). MW-17 and MW-18 are located in the capture zone of the LAWC treatment system.
- During the third quarter 2014, TCE was detected in MW-17 (Screens 3 and 4), MW-18 (Screens 3 and 4), MW-19 (Screens 2 through 5), MW-20 (Screens 2 and 3), MW-21 (Screens 2 through 4), MW-25 (Screens 1 and 2) and MW-26 (Screens 1 and 2); however, no detections exceeded the state and federal MCL (5.0 µg/L).
- During the third quarter 2014, PCE was detected in MW-17 (Screens 3 and 4), MW-18 (Screens 3 and 4), MW-19 (Screens 2 through 5), MW-20 (Screens 2 and 3), MW-21 (Screens 2 through 5), MW-25 (Screen 3) and MW-26 (Screens 1 and 2); however, no detections exceeded the state and federal MCL (5.0 µg/L).

OTHER NOTABLE ANALYTICAL RESULTS

- During the third quarter 2014, Cr(VI)[2] was detected below the state MCL of 10.0 µg/L in MW-17 (Screens 3 [1.0J µg/L] and 4 [2.0 µg/L]), MW-18 (Screens 3 [2.0J µg/L] and 4 [2.0J µg/L]) and MW-25 (Screens 2 through 4 [2.0 µg/L, 3.0 µg/L and 1.0J µg/L, respectively]).

- During the third quarter 2014, total chromium was detected below the state MCL of 50.0 µg/L in MW-17 (Screen 4 [2.8J µg/L]), MW-18 (Screen 3 [1.9J µg/L] and 4 [2.4J µg/L]), MW-21 (Screen 4 [1.9J µg/L]), MW-25 (Screens 2 through 4 [3.0 µg/L, 3.5 µg/L and 1.4J µg/L, respectively]) and MW-26 (Screen 2 [2.0J µg/L]).

ALL WELL CATEGORIES (OTHER RESULTS)

- Comparing the second quarter 2014 to the third quarter 2014, groundwater elevations decreased by an average of approximately 10.07 ft.
- The uppermost sampling ports (i.e., Screen 1) in MW-12, MW-20, and MW-21 were dry and could not be sampled during the third quarter. In addition, MW-18 (Screen 1), which is only sampled during the second and fourth quarters, but is measured for water levels, was also dry. This is the third consecutive quarter in 2014 in which MW-18 (Screen 1) was dry and the first quarter for MW-12 (Screen 1), MW-20 (Screen 1), and MW-21 (Screen 1).
- Monitoring wells MW-7, MW-13, and MW-16 could not be purged with the dedicated submersible pumps due to the low water table. Therefore, grab samples were collected at each monitoring location with disposable bailers. This is the third consecutive quarter in 2014 in which grab samples were collected at MW-16 and this first quarter for MW-7 and MW-13.
- Groundwater elevations recorded in the JPL monitoring wells have been steadily declining since the first and second quarters of 2011. Current elevations are approaching or have exceeded historic lows last recorded in 1996 and 1997. Groundwater elevations will be closely monitored as California faces one of the most severe droughts on record.
- Groundwater level measurements collected during the third quarter 2014 indicate that groundwater gradients and flow directions are generally consistent with previous observations (see Figure 8).

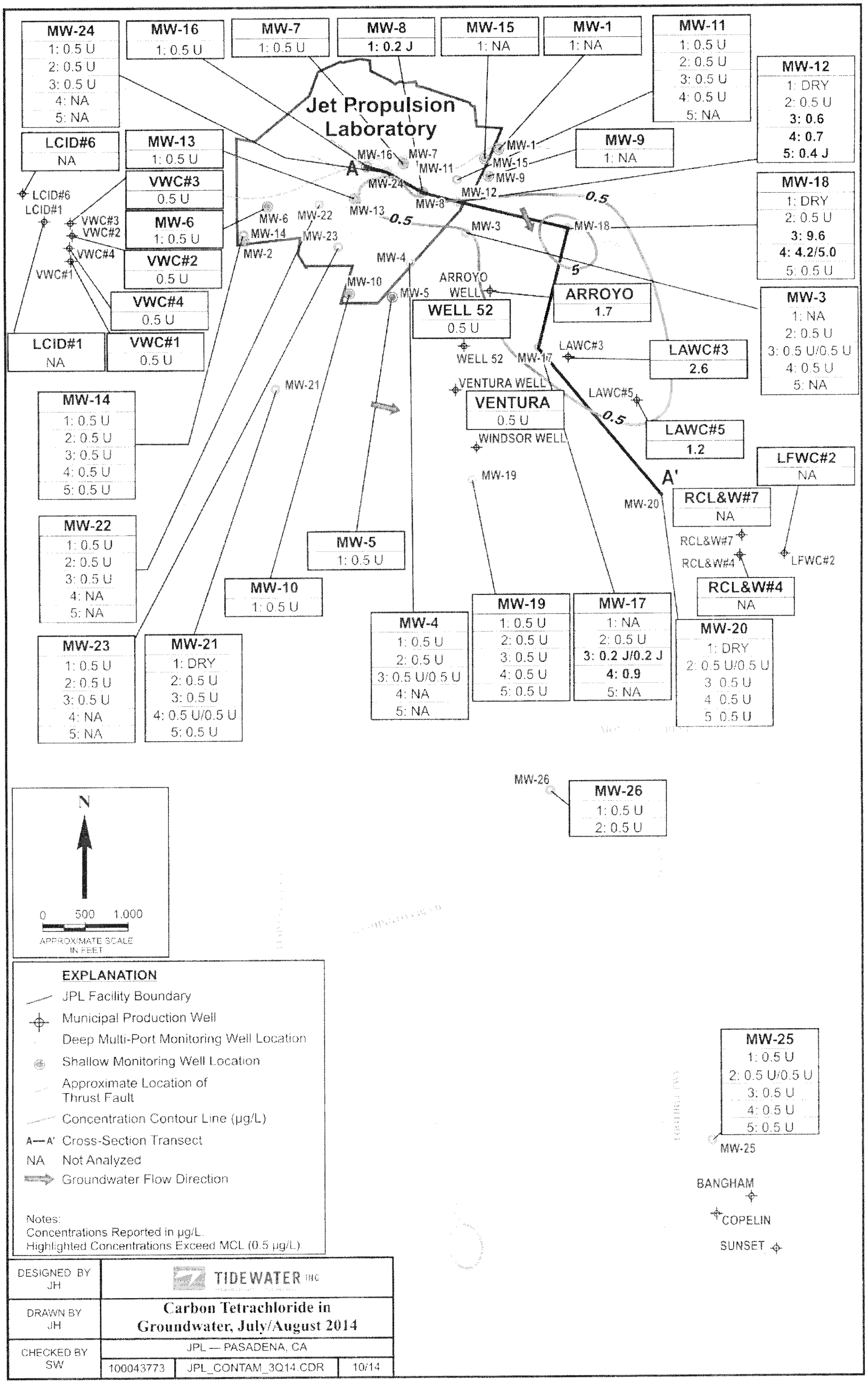
ATTACHMENTS

Attachments to this technical memorandum include the following:

- Attachment 1: Quality Assurance/Quality Control Summary
- Attachment 2: Data Validation Reports (Summary Sheets)
- Attachment 3: Laboratory Analytical Reports (Summary Sheets)
- Attachment 4: Field Logs
- Attachment 5: Water Level Measurements
- Attachment 6: Time-Series Concentration Plots
- Attachment 7: Tables 1A, 2A, and 3A (Historical Perchlorate, VOCs, and Metals from 1996 to present)

FIGURES

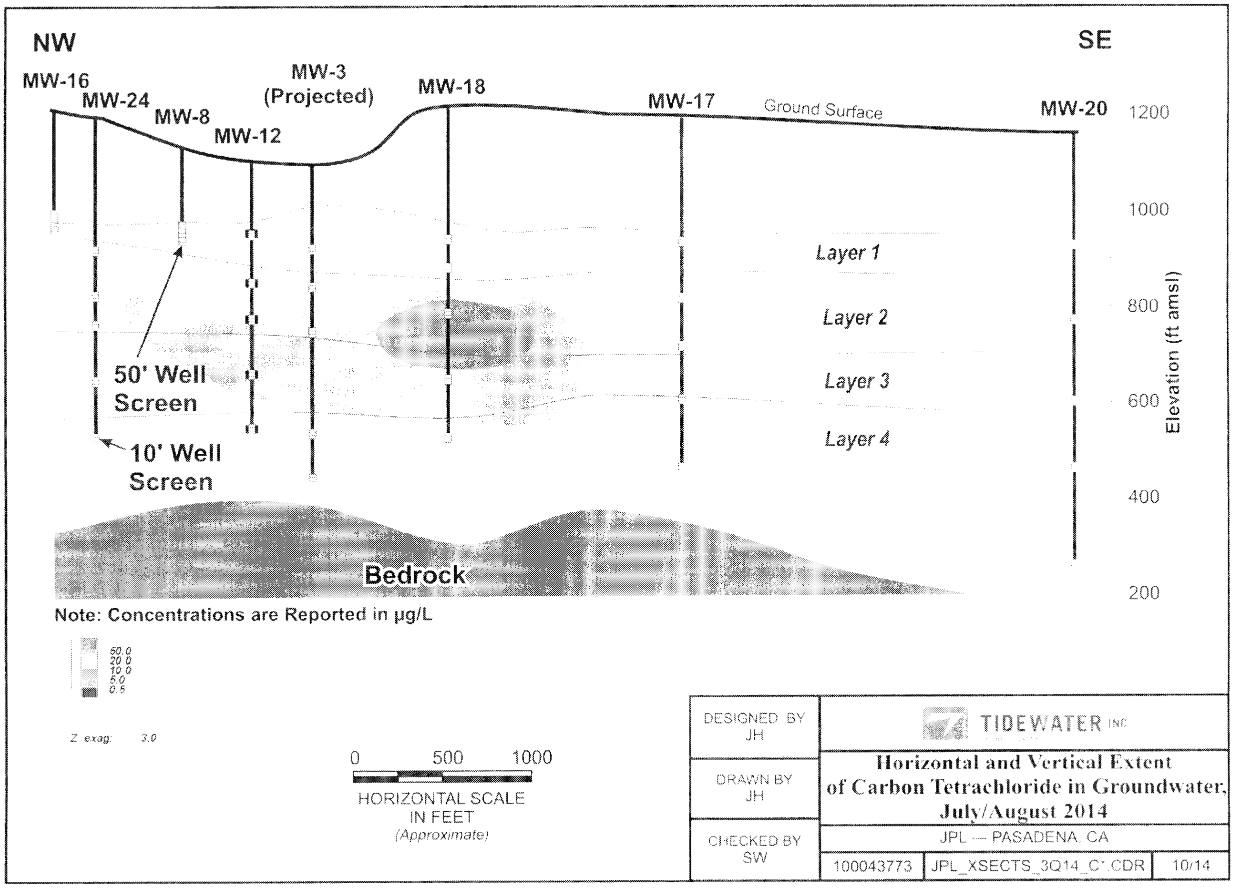
MW-1
MW-7
MW-15
MW-16
MW-11
MW-24
MW-9
MW-22
MW-12
MW-6
MW-13
MW-8
MW-18
MW-14
MW-3
MW-23
MW-2
MW-4
MW-10
ARROYO WELL
MW-5
WELL 52
MW-17
LAWC#3
MW-21
VENTURA WELL
LAWC#5
WINDSOR WELL
MW-19
MW-20
LCID#6
LCID#1
VWC#3
VWC#2
VWC#4
VWC#1
RCL8
RCL8
MW-26
N



Notes:
Concentrations Reported in µg/L.
Highlighted Concentrations Exceed MCL (0.5 µg/L).

DESIGNED BY JH	TIDEWATER INC
DRAWN BY JH	**Carbon Tetrachloride in Groundwater, July/August 2014**
CHECKED BY SW	JPL — PASADENA, CA 100043773 JPL_CONTAM_3Q14.CDR 10/14

Figure 2.

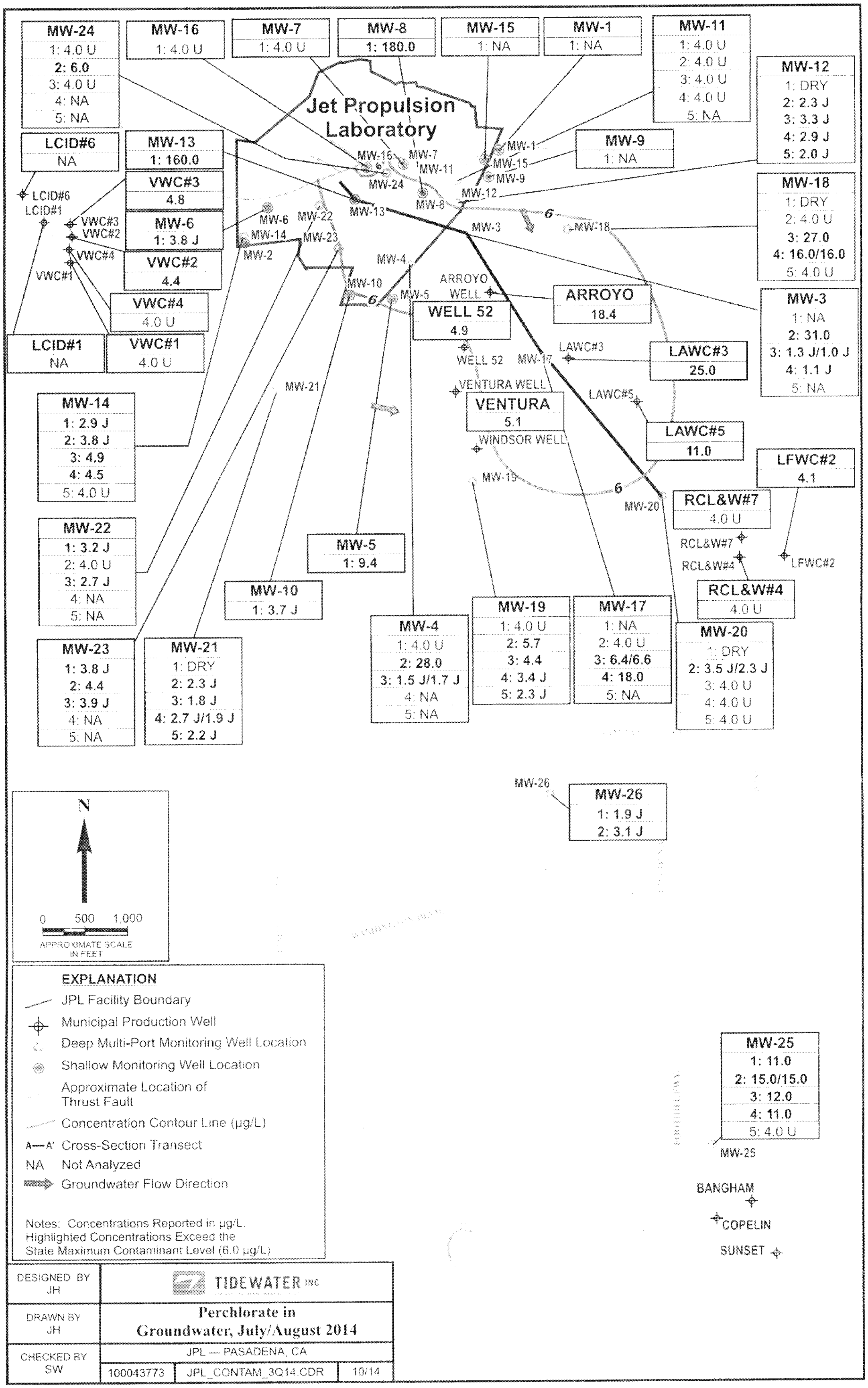


Horizontal and Vertical Extent of Carbon Tetrachloride in Groundwater, July/August 2014

JPL — PASADENA, CA

100043773 | JPL_XSECTS_3Q14_C'.CDR | 10/14

Figure 3.



DESIGNED BY JH	TIDEWATER INC
DRAWN BY JH	Perchlorate in Groundwater, July/August 2014
CHECKED BY SW	JPL — PASADENA, CA 100043773 JPL_CONTAM_3Q14.CDR 10/14

Figure 4.

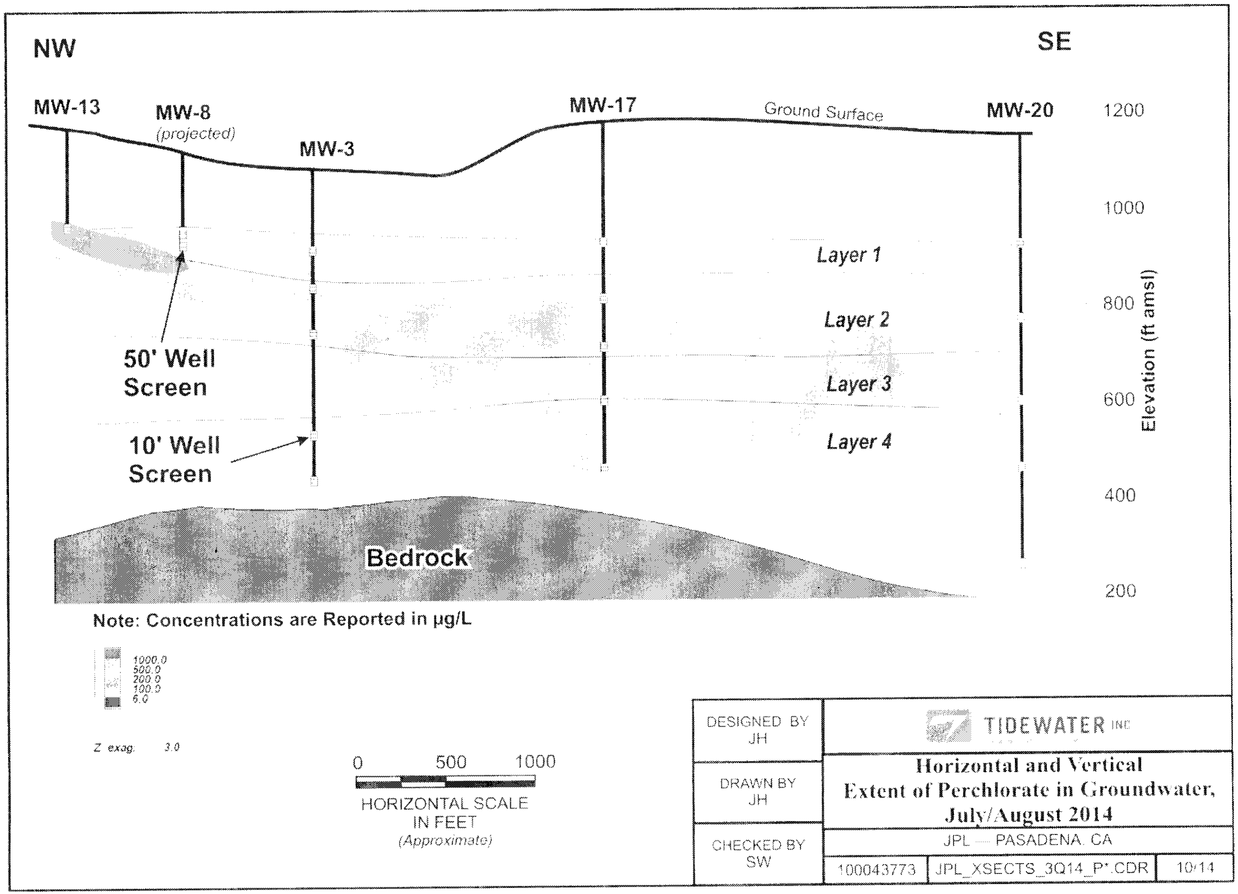
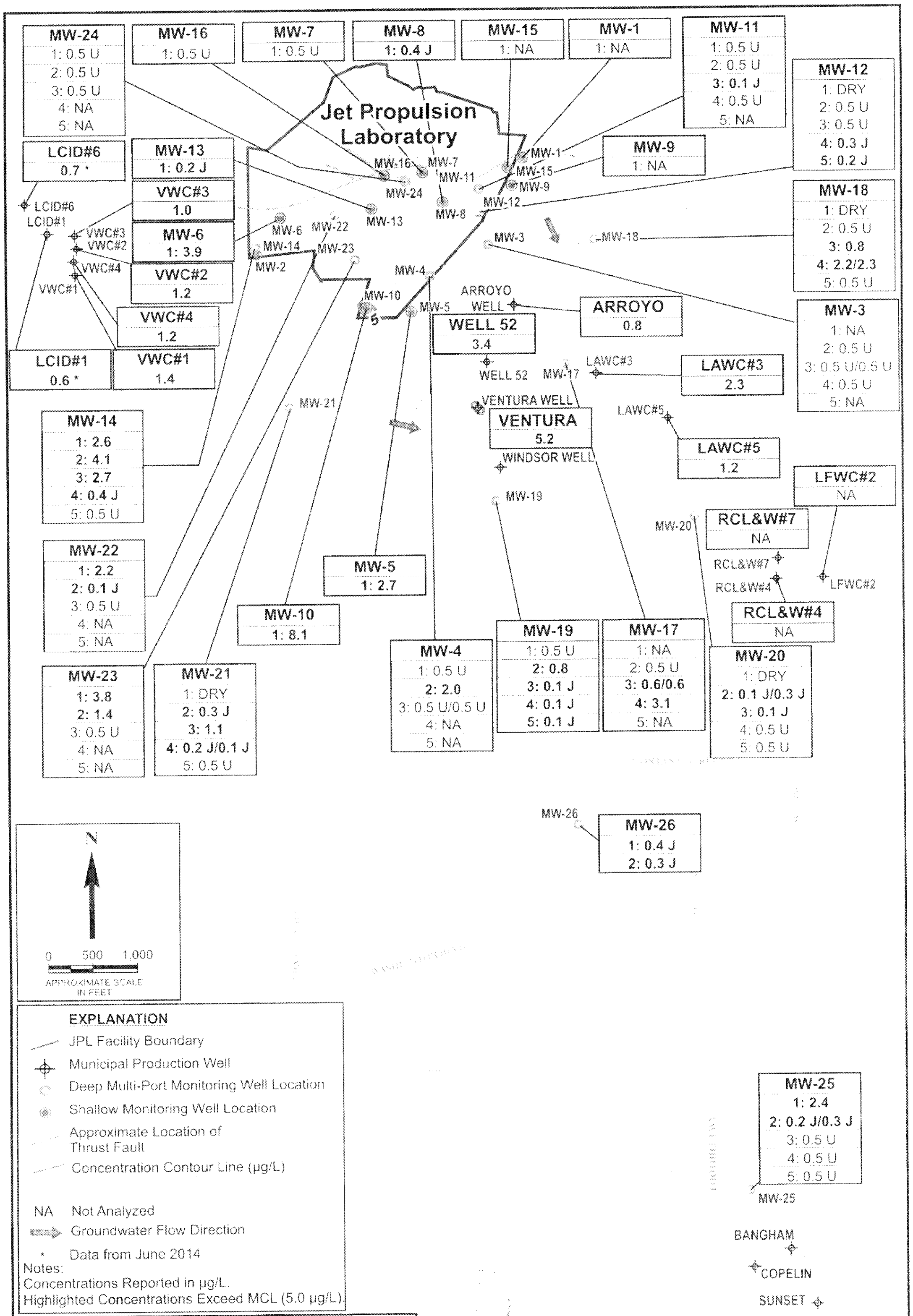

NW
SE
MW-13
MW-8
(projected)
MW-3
MW-17
Ground Surface
MW-20
1200
1000
800
600
400
200
Elevation (ft amsl)
Layer 1
Layer 2
Layer 3
Layer 4
50' Well Screen
10' Well Screen
Bedrock
Note: Concentrations are Reported in µg/L
1000.0
500.0
200.0
100.0
6.0
Z exag. 3.0
0
500
1000
HORIZONTAL SCALE IN FEET
(Approximate)
DESIGNED BY
JH
DRAWN BY
JH
CHECKED BY
SW
TIDEWATER INC
Horizontal and Vertical Extent of Perchlorate in Groundwater, July/August 2014
JPL — PASADENA, CA
100043773
JPL_XSECTS_3Q14_P*.CDR
10/14

Figure 5.



DESIGNED BY JH	TIDEWATER INC
DRAWN BY JH	**Trichloroethene (TCE) in Groundwater, July/August 2014**
CHECKED BY SW	JPL — PASADENA, CA 100043773 JPL_CONTAM_3Q14.CDR 10/14

Figure 7.

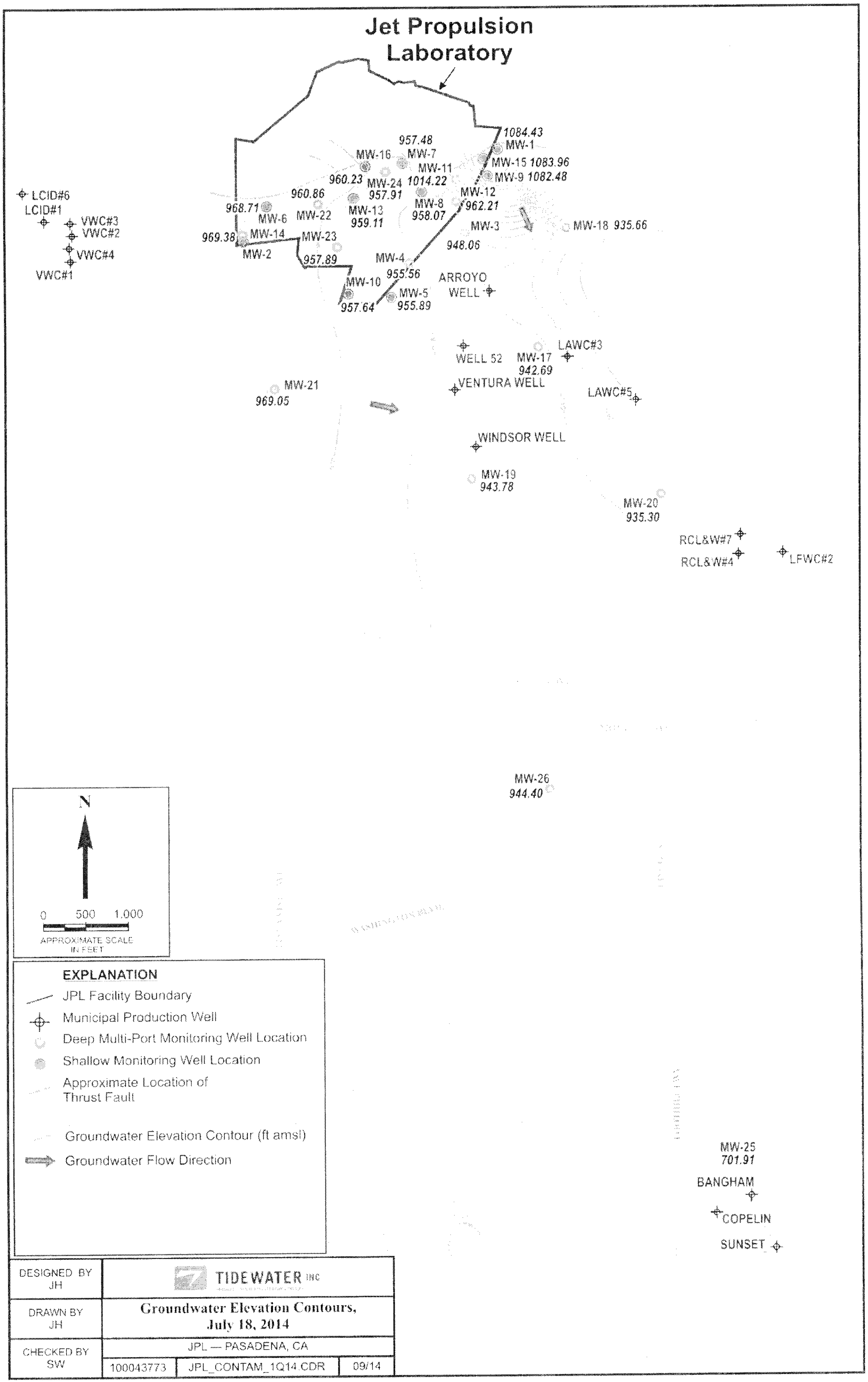

Jet Propulsion Laboratory
1084.43
MW-1
MW-15 1083.96
MW-9 1082.48
957.48
MW-16
MW-7
MW-11
960.23
MW-24
1014.22
MW-12
960.86
957.91
MW-8
962.21
968.71
MW-6
MW-22
MW-13
958.07
959.11
MW-3
MW-18 935.66
969.38
MW-14
MW-23
948.06
MW-2
957.89
MW-4
955.56
ARROYO WELL
MW-10
MW-5
957.64
955.89
LCID#6
LCID#1
VWC#3
VWC#2
VWC#4
VWC#1
WELL 52
MW-17
942.69
LAWC#3
MW-21
969.05
VENTURA WELL
LAWC#5
WINDSOR WELL
MW-19
943.78
MW-20
935.30
RCL&W#7
RCL&W#4
LFWC#2
MW-26
944.40
MW-25
701.91
BANGHAM
COPELIN
SUNSET
N
0 500 1,000
APPROXIMATE SCALE IN FEET
EXPLANATION
JPL Facility Boundary
Municipal Production Well
Deep Multi-Port Monitoring Well Location
Shallow Monitoring Well Location
Approximate Location of Thrust Fault
Groundwater Elevation Contour (ft amsl)
Groundwater Flow Direction
DESIGNED BY JH
DRAWN BY JH
CHECKED BY SW
TIDEWATER INC
Groundwater Elevation Contours, July 18, 2014
JPL — PASADENA, CA
100043773
JPL_CONTAM_1Q14.CDR
09/14

Figure 8.

TABLES

TABLE 1
SUMMARY OF VOLATILE ORGANIC COMPOUNDS AND PERCHLORATE DETECTED DURING THE LAST FIVE SAMPLING EVENTS OF THE LONG-TERM QUARTERLY GROUNDWATER SAMPLING PROGRAM

(All concentrations reported in µg/L)

(Shaded values exceed State or Federal MCLs or action levels)

Sample Location	Sampling Event	Sample Number	Carbon tetrachloride	TCE	PCE	1,1-DCA	1,2-DCA	1,1-DCE	Freon 113	Chloroform	Perchlorate	Other Volatile Organic Compounds and 1,4-Dioxane, NDMA, NDPA, 1,2,3-TCP	
MW-1	Oct/Nov 2013	MW-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-1	Apr/May 2014	MW-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-1	Apr/May 2014	DUP-6-2Q14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-3 Screen 1	Oct/Nov 2013	MW-3-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-3 Screen 1	Apr/May 2014	MW-3-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-3 Screen 2	Jul 2013	MW-3-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-3 Screen 2	Jul 2013	DUPP-5-3Q13	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-3 Screen 2	Oct/Nov 2013	MW-3-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-3 Screen 2	Jan/Feb 2014	MW-3-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	3.9 J		
MW-3 Screen 2	Apr/May 2014	MW-3-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 J	25.0	Bromodichloromethane	0.2 J
MW-3 Screen 2	Jul/Aug 2014	MW-3-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.0	31.0	Bromodichloromethane	0.4 J
MW-3 Screen 3	Jul 2013	MW-3-3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-3 Screen 3	Oct/Nov 2013	MW-3-3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-3 Screen 3	Jan/Feb 2014	MW-3-3	0.5 U	0.5 U	0.5 U	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-3 Screen 3	Jan/Feb 2014	DUPE-3-1Q14	0.5 U	0.5 U	0.2 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-3 Screen 3	Apr/May 2014	MW-3-3	0.5 U	0.5 U	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-3 Screen 3	Jul/Aug 2014	MW-3-3	0.5 U	0.5 U	0.2 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	1.3 J		
MW-3 Screen 3	Jul/Aug 2014	DUP-5-3Q14	0.5 U	0.5 U	0.2 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	1.0 J		
MW-3 Screen 4	Jul 2013	MW-3-4	0.5 U	0.5 U	0.2 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-3 Screen 4	Oct/Nov 2013	MW-3-4	0.5 U	0.5 U	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	1.0 J		
MW-3 Screen 4	Jan/Feb 2014	MW-3-4	0.5 U	0.5 U	0.1 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-3 Screen 4	Apr/May 2014	MW-3-4	0.5 U	0.5 U	0.2 J	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	1.3 J		
MW-3 Screen 4	Jul/Aug 2014	MW-3-4	0.5 U	0.5 U	0.2 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	1.1 J		
MW-3 Screen 5	Oct/Nov 2013	MW-3-5	0.5 U	0.5 U	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-3 Screen 5	Apr/May 2014	MW-3-5	0.5 U	0.5 U	0.2 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-4 Screen 1	Jul 2013	MW-4-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-4 Screen 1	Oct/Nov 2013	MW-4-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-4 Screen 1	Jan/Feb 2014	MW-4-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-4 Screen 1	Apr/May 2014	MW-4-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-4 Screen 1	Jul/Aug 2014	MW-4-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-4 Screen 2	Jul 2013	MW-4-2	0.2 J	1.1	1.7	0.5 J	0.5 U	0.2 J	0.5 U	3.8	250.0	Bromodichloromethane Dibromochloromethane	2.2 1.1
MW-4 Screen 2	Oct/Nov 2013	MW-4-2	0.5 U	0.6	0.5 J	0.2 J	0.5 U	0.5 U	0.5 U	1.7	210.0	Bromodichloromethane Dibromochloromethane	1.2 0.6
MW-4 Screen 2	Jan/Feb 2014	MW-4-2	0.5 U	1.0	0.7	0.3 J	0.5 U	0.5 U	0.5 U	1.2	100.0	Bromodichloromethane Dibromochloromethane	0.7 0.4 J
MW-4 Screen 2	Apr/May 2014	MW-4-2	0.5 U	0.8	0.5 J	0.2 J	0.5 U	0.5 U	0.5 U	0.7	64.0	Bromodichloromethane Dibromochloromethane	0.4 J 0.2 J
MW-4 Screen 2	Jul/Aug 2014	MW-4-2	0.5 U	2.0	1.1	0.3 J	0.5 U	0.5 U	0.5 U	0.9	28.0	Bromodichloromethane	0.3 J
MW-4 Screen 3	Jul 2013	MW-4-3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-4 Screen 3	Oct/Nov 2013	MW-4-3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.2 J		
MW-4 Screen 3	Jan/Feb 2014	MW-4-3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.4 J		
MW-4 Screen 3	Jan/Feb 2014	DUP-1-1Q14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.7 J		

Sample Location	Sampling Event	Sample Number	Carbon tetrachloride	TCE	PCE	1,1-DCA	1,2-DCA	1,1-DCE	Freon 113	Chloroform	Perchlorate	Other Volatile Organic Compounds and 1,4-Dioxane, NDMA, NDPA, 1,2,3-TCP	
MW-4 Screen 3	Apr/May 2014	MW-4-3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**2.6 J**		
MW-4 Screen 3	Jul/Aug 2014	MW-4-3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**1.5 J**		
MW-4 Screen 3	Jul/Aug 2014	DUP-7-3Q14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**1.7 J**		
MW-4 Screen 4	Oct/Nov 2013	MW-4-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-4 Screen 4	Apr/May 2014	MW-4-4	0.5 U	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**2.0 J**		
MW-4 Screen 5	Oct/Nov 2013	MW-4-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.1 J
MW-4 Screen 5	Apr/May 2014	MW-4-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**2.0 J**	Styrene	0.1 J
MW-5	Jul 2013	MW-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-5	Oct/Nov 2013	MW-5	0.5 U	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	**1.5 J**		
MW-5	Jan/Feb 2014	MW-5	0.5 U	3.6	0.4 J	0.5 U	0.5 U	0.5 U	0.5 U	1.0	**10.0**		
MW-5	Jan/Feb 2014	DUPL-6-1Q14	0.5 U	3.2	0.4 J	0.5 U	0.5 U	0.5 U	0.5 U	0.8	**9.7**		
MW-5	Apr/May 2014	MW-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-5	Jul/Aug 2014	MW-5	0.5 U	2.7	0.5 J	0.5 U	0.5 U	0.5 U	0.5 U	0.8	**9.4**		
MW-6	Jul 2013	MW-6	0.5 U	4.4	1.3	0.3 J	0.5 U	0.3 J	0.5 U	0.8	**3.5 J**	trans-1,2-Dichloroethene	0.2 J
MW-6	Oct/Nov 2013	MW-6	0.5 U	4.3	1.3	0.3 J	0.5 U	0.3 J	0.5 U	0.8	**3.3 J**	trans-1,2-Dichloroethene	0.3 J
MW-6	Jan/Feb 2014	MW-6	0.5 U	4.2	1.1	0.3 J	0.5 U	0.2 J	0.5 U	0.8	**2.9 J**	cis-1,2-Dichloroethene	0.1 J
MW-6	Apr/May 2014	MW-6	0.5 U	4.2	1.1	0.2 J	0.5 U	0.5 U	0.5 U	0.7	**2.7 J**	cis-1,2-Dichloroethene	0.1 J
MW-6	Jul/Aug 2014	MW-6	0.5 U	3.9	1.2	0.2 J	0.5 U	0.2 J	0.5 U	0.7	**3.8 J**	cis-1,2-Dichloroethene trans-1,2-Dichloroethene	0.1 J 0.2 J
MW-7	Jul 2013	MW-7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5.4	**4.0**	Bromodichloromethane	0.9
MW-7	Oct/Nov 2013	MW-7	0.5 U	0.5 U	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	8.7	**6.1**	Bromodichloromethane Dibromochloromethane	1.9 0.7
MW-7	Jan/Feb 2014	MW-7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	11.0	**2.4 J**	Bromodichloromethane	0.4 J
MW-7	Jan/Feb 2014	DUPL-5-1Q14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	11.0	**2.0 J**	Bromodichloromethane	0.4 J
MW-7	Apr/May 2014	MW-7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5.7	**5.3**	Bromodichloromethane	0.4 J
MW-7	Apr/May 2014	DUP-8-2Q14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5.9	**5.2**	Bromodichloromethane	0.4 J
MW-7	Jul/Aug 2014	MW-7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.7	4.0 U		
MW-8	Jul 2013	MW-8	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Trichlorofluoromethane	0.7
MW-8	Oct/Nov 2013	MW-8	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.1	**71.0**	Bromodichloromethane Dibromochloromethane Trichlorofluoromethane	0.9 0.5 0.2 J
MW-8	Oct/Nov 2013	DUPL-5-4Q13	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.2	**71.0**	Bromodichloromethane Dibromochloromethane Trichlorofluoromethane	0.9 0.6 0.3 J
MW-8	Jan/Feb 2014	MW-8	0.5 U	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	6.1	**93.0**	Bromodichloromethane Dibromochloromethane Trichlorofluoromethane	2.6 0.6 0.2 J
MW-8	Jan/Feb 2014	DUPL-7-1Q14	0.5 U	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	6.3	**94.0**	Bromodichloromethane Dibromochloromethane Trichlorofluoromethane	2.7 0.6 0.1 J
MW-8	Apr/May 2014	MW-8	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	**47.0**	Trichlorofluoromethane	0.2 J
MW-8	Jul/Aug 2014	MW-8	0.2 J	0.4 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5.1	**180.0**	Bromodichloromethane	0.7
MW-9	Apr/May 2014	MW-9	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-9	Apr/May 2014	DUP-5-2Q14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-10	Jul 2013	MW-10	0.5 U	9.8	1.0	0.2 J	0.5 U	0.5 U	0.5 U	1.2	**9.0**	cis-1,2-Dichloroethene trans-1,2-Dichloroethene	0.1 J 0.3 J
MW-10	Oct/Nov 2013	MW-10	0.5 U	8.0	0.9	0.2 J	0.5 U	0.5 U	0.5 U	0.9	**6.4**	cis-1,2-Dichloroethene trans-1,2-Dichloroethene	0.2 J 0.2 J
MW-10	Oct/Nov 2013	DUPL-4-4Q13	0.5 U	8.1	0.9	0.2 J	0.5 U	0.5 U	0.5 U	0.9	**6.4**	cis-1,2-Dichloroethene trans-1,2-Dichloroethene	0.2 J 0.3 J

Sample Location	Sampling Event	Sample Number	Carbon tetrachloride	TCE	PCE	1,1-DCA	1,2-DCA	1,1-DCE	Freon 113	Chloroform	Perchlorate	Other Volatile Organic Compounds and 1,4-Dioxane, NDMA, NDPA, 1,2,3-TCP	
MW-10	Jan/Feb 2014	MW-10	0.5 U	**6.6**	**0.8**	**0.2 J**	0.5 U	0.5 U	0.5 U	**0.7**	**3.4 J**	cis-1,2-Dichloroethene	0.2 J
MW-10	Apr/May 2014	MW-10	0.5 U	**6.6**	**0.8**	**0.2 J**	0.5 U	0.5 U	0.5 U	**0.7**	**4.2**	cis-1,2-Dichloroethene trans-1,2-Dichloroethene	0.2 J 0.2 J
MW-10	Jul/Aug 2014	MW-10	0.5 U	**8.1**	**0.8**	**0.2 J**	0.5 U	0.5 U	0.5 U	**0.8**	**3.7 J**	cis-1,2-Dichloroethene trans-1,2-Dichloroethene	0.3 J 0.5 J
MW-11 Screen 1	Jul 2013	MW-11-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-11 Screen 1	Oct/Nov 2013	MW-11-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.1 J
MW-11 Screen 1	Jan/Feb 2014	MW-11-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.1 J
MW-11 Screen 1	Apr/May 2014	MW-11-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-11 Screen 1	Jul/Aug 2014	MW-11-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-11 Screen 2	Jul 2013	MW-11-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-11 Screen 2	Jul 2013	DUPE-6-3Q13	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-11 Screen 2	Oct/Nov 2013	MW-11-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-11 Screen 2	Jan/Feb 2014	MW-11-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-11 Screen 2	Apr/May 2014	MW-11-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-11 Screen 2	Jul/Aug 2014	MW-11-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-11 Screen 3	Jul 2013	MW-11-3	0.5 U	**0.1 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.2 J**	4.0 U	Styrene	0.1 J
MW-11 Screen 3	Oct/Nov 2013	MW-11-3	0.5 U	**0.1 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.1 J
MW-11 Screen 3	Jan/Feb 2014	MW-11-3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.1 J**	4.0 U	Styrene	0.2 J
MW-11 Screen 3	Apr/May 2014	MW-11-3	0.5 U	**0.1 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.1 J
MW-11 Screen 3	Jul/Aug 2014	MW-11-3	0.5 U	**0.1 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Methyl-tert-butyl ether (MTBE) Styrene	0.3 J 0.3 J
MW-11 Screen 4	Jul 2013	MW-11-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.2 J
MW-11 Screen 4	Oct/Nov 2013	MW-11-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.2 J
MW-11 Screen 4	Jan/Feb 2014	MW-11-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.2 J
MW-11 Screen 4	Apr/May 2014	MW-11-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Carbon disulfide Styrene	0.1 J 0.2 J
MW-11 Screen 4	Jul/Aug 2014	MW-11-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.1 J
MW-11 Screen 5	Oct/Nov 2013	MW-11-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.2 J
MW-11 Screen 5	Apr/May 2014	MW-11-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.1 J
MW-12 Screen 1	Jul 2013	MW-12-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-12 Screen 1	Oct/Nov 2013	MW-12-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Trichlorofluoromethane	0.2 J
MW-12 Screen 1	Jan/Feb 2014	MW-12-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Trichlorofluoromethane	0.3 J
MW-12 Screen 1	Apr/May 2014	MW-12-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Trichlorofluoromethane	0.2 J
MW-12 Screen 1	Apr/May 2014	DUP-4-2Q14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Trichlorofluoromethane	0.2 J
MW-12 Screen 2	Jul 2013	MW-12-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**7.2**	Styrene	0.1 J
MW-12 Screen 2	Oct/Nov 2013	MW-12-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**5.6**		
MW-12 Screen 2	Jan/Feb 2014	MW-12-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**4.2**		
MW-12 Screen 2	Apr/May 2014	MW-12-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**3.9 J**		
MW-12 Screen 2	Jul/Aug 2014	MW-12-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**2.3 J**		
MW-12 Screen 3	Jul 2013	MW-12-3	0.5 U	**0.2 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**2.0**	4.0 U	Styrene	0.1 J
MW-12 Screen 3	Oct/Nov 2013	MW-12-3	**0.4 J**	**0.1 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5**	**4.5**		
MW-12 Screen 3	Jan/Feb 2014	MW-12-3	**0.5 J**	**0.1 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.7**	**1.6 J**	Styrene	0.1 J
MW-12 Screen 3	Apr/May 2014	MW-12-3	**0.6**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5**	**3.0 J**		
MW-12 Screen 3	Jul/Aug 2014	MW-12-3	**0.6**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5**	**3.3 J**		
MW-12 Screen 4	Jul 2013	MW-12-4	**0.8**	**0.3 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.8**	**3.2 J**		
MW-12 Screen 4	Oct/Nov 2013	MW-12-4	**0.5**	**0.2 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.6**	**3.3 J**		
MW-12 Screen 4	Jan/Feb 2014	MW-12-4	**0.9**	**0.4 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.7**	**3.5 J**	Styrene	0.1 J
MW-12 Screen 4	Apr/May 2014	MW-12-4	**0.5 J**	**0.2 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.6**	4.0 U		
MW-12 Screen 4	Jul/Aug 2014	MW-12-4	**0.7**	**0.3 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.7**	**2.9 J**		

Sample Location	Sampling Event	Sample Number	Carbon tetrachloride	TCE	PCE	1,1-DCA	1,2-DCA	1,1-DCE	Freon 113	Chloroform	Perchlorate	Other Volatile Organic Compounds and 1,4-Dioxane, NDMA, NDPA, 1,2,3-TCP	
MW-12 Screen 5	Jul 2013	MW-12-5	0.4 J	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.4 J	2.1 J		
MW-12 Screen 5	Oct/Nov 2013	MW-12-5	0.3 J	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	3.3 J		
MW-12 Screen 5	Jan/Feb 2014	MW-12-5	0.5 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	2.5 J	Styrene	0.1 J
MW-12 Screen 5	Apr/May 2014	MW-12-5	0.3 J	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	4.0 U		
MW-12 Screen 5	Jul/Aug 2014	MW-12-5	0.4 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.4 J	2.0 J	Styrene	0.1 J
MW-13	Jul 2013	MW-13	0.6	0.2 J	0.9	0.2 J	0.5 U	0.5 J	0.5 U	7.3	1200.0	Bromodichloromethane	0.2 J
MW-13	Oct/Nov 2013	MW-13	0.5 U	0.2 J	1.6	0.4 J	0.5 U	0.2 J	0.5 U	2.5	520.0		
MW-13	Jan/Feb 2014	MW-13	0.5 U	0.3 J	2.3	0.6	0.5 U	0.5 U	0.5 U	0.7	33.0	Methyl-tert-butyl ether (MTBE)	0.1 J
MW-13	Jan/Feb 2014	DUPE-4-1Q14	0.5 U	0.3 J	2.3	0.5	0.5 U	0.5 U	0.5 U	0.7	36.0	Methyl-tert-butyl ether (MTBE)	0.1 J
MW-13	Apr/May 2014	MW-13	0.5 U	0.3 J	2.1	0.3 J	0.5 U	0.5 U	0.5 U	1.0	200.0		
MW-13	Jul/Aug 2014	MW-13	0.5 U	0.2 J	1.7	0.4 J	0.5 U	0.5 U	0.5 U	1.4	160.0	Methyl-tert-butyl ether (MTBE)	0.1 J
MW-14 Screen 1	Jul 2013	MW-14-1	0.5 U	2.1	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	0.6	3.1 J	Methyl-tert-butyl ether (MTBE)	0.5 J
MW-14 Screen 1	Oct/Nov 2013	MW-14-1	0.5 U	1.6	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5	4.0	cis-1,2-Dichloroethene Methyl-tert-butyl ether (MTBE)	0.1 J 0.4 J
MW-14 Screen 1	Oct/Nov 2013	DUPE-2-4Q13	0.5 U	1.3	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.4 J	3.7 J	Methyl-tert-butyl ether (MTBE)	0.4 J
MW-14 Screen 1	Jan/Feb 2014	MW-14-1	0.5 U	3.4	0.4 J	0.1 J	0.5 U	0.5 U	0.5 U	0.8	3.4 J	cis-1,2-Dichloroethene Methyl-tert-butyl ether (MTBE)	0.2 J 0.3 J
MW-14 Screen 1	Apr/May 2014	MW-14-1	0.5 U	2.2	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	0.6	3.8 J	Methyl-tert-butyl ether (MTBE)	0.2 J
MW-14 Screen 1	Jul/Aug 2014	MW-14-1	0.5 U	2.6	0.4 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5	2.9 J	cis-1,2-Dichloroethene	0.1 J
MW-14 Screen 2	Jul 2013	MW-14-2	0.5 U	5.4	0.5 J	0.2 J	0.5 U	0.5 U	0.5 U	0.6	1.3 J	cis-1,2-Dichloroethene trans 1,2-Dichloroethene	0.2 J 0.3 J
MW-14 Screen 2	Jul 2013	DUPE-2-3Q13	0.5 U	6.1	0.5 J	0.2 J	0.5 U	0.5 U	0.5 U	0.6	3.2 J	cis-1,2-Dichloroethene trans 1,2-Dichloroethene	0.3 J 0.3 J
MW-14 Screen 2	Oct/Nov 2013	MW-14-2	0.5 U	4.0	0.3 J	0.1 J	0.5 U	0.5 U	0.5 U	0.5 J	4.0 U	cis-1,2-Dichloroethene trans 1,2-Dichloroethene	0.3 J 0.2 J
MW-14 Screen 2	Jan/Feb 2014	MW-14-2	0.5 U	3.7	0.4 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5	3.4 J	cis-1,2-Dichloroethene	0.3 J
MW-14 Screen 2	Apr/May 2014	MW-14-2	0.5 U	8.5	1.0	0.3 J	0.5 U	0.5 U	0.5 U	0.9	4.1	cis-1,2-Dichloroethene trans 1,2-Dichloroethene	0.4 J 0.3 J
MW-14 Screen 2	Apr/May 2014	DUP-1-2Q14	0.5 U	7.7	0.9	0.3 J	0.5 U	0.5 U	0.5 U	0.9	3.8 J	cis-1,2-Dichloroethene trans 1,2-Dichloroethene	0.3 J 0.2 J
MW-14 Screen 2	Jul/Aug 2014	MW-14-2	0.5 U	4.1	0.6	0.2 J	0.5 U	0.5 U	0.5 U	0.7	3.8 J	cis-1,2-Dichloroethene	0.2 J
MW-14 Screen 3	Jul 2013	MW-14-3	0.5 U	2.4	0.7	0.3 J	0.5 U	0.5 U	0.5 U	0.6	5.3	cis-1,2-Dichloroethene	0.2 J
MW-14 Screen 3	Oct/Nov 2013	MW-14-3	0.5 U	2.0	0.5 J	0.3 J	0.5 U	0.5 U	0.5 U	0.5	5.7	cis-1,2-Dichloroethene	0.2 J
MW-14 Screen 3	Jan/Feb 2014	MW-14-3	0.5 U	2.0	0.5	0.3 J	0.5 U	0.5 U	0.5 U	0.6	4.7	cis-1,2-Dichloroethene	0.2 J
MW-14 Screen 3	Apr/May 2014	MW-14-3	0.5 U	1.6	0.5	0.3 J	0.5 U	0.5 U	0.5 U	0.5	5.9	cis-1,2-Dichloroethene	0.1 J
MW-14 Screen 3	Jul/Aug 2014	MW-14-3	0.5 U	2.7	0.9	0.5 J	0.5 U	0.5 U	0.5 U	0.8	4.9	cis-1,2-Dichloroethene	0.2 J
MW-14 Screen 4	Jul 2013	MW-14-4	0.5 U	0.2 J	0.3 J	0.1 J	0.5 U	0.5 U	0.5 U	0.2 J	3.7 J	cis-1,2-Dichloroethene	0.1 J
MW-14 Screen 4	Oct/Nov 2013	MW-14-4	0.5 U	0.2 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	5.3	cis-1,2-Dichloroethene	0.1 J
MW-14 Screen 4	Jan/Feb 2014	MW-14-4	0.5 U	0.4 J	0.4 J	0.2 J	0.5 U	0.5 U	0.5 U	0.3 J	4.0	cis-1,2-Dichloroethene	0.2 J
MW-14 Screen 4	Apr/May 2014	MW-14-4	0.5 U	0.4 J	0.4 J	0.2 J	0.5 U	0.5 U	0.5 U	0.3 J	4.1	cis-1,2-Dichloroethene	0.2 J
MW-14 Screen 4	Jul/Aug 2014	MW-14-4	0.5 U	0.4 J	0.4 J	0.2 J	0.5 U	0.5 U	0.5 U	0.2 J	4.5	cis-1,2-Dichloroethene	0.2 J
MW-14 Screen 5	Jul 2013	MW-14-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	4.0 U		
MW-14 Screen 5	Oct/Nov 2013	MW-14-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-14 Screen 5	Jan/Feb 2014	MW-14-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	4.0 U		
MW-14 Screen 5	Apr/May 2014	MW-14-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	4.0 U		
MW-14 Screen 5	Jul/Aug 2014	MW-14-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.4 J	4.0 U		
MW-15	Oct/Nov 2013	MW-15	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-15	Oct/Nov 2013	DUPE-6-4Q13	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-15	Apr/May 2014	MW-15	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-15	Apr/May 2014	DUP-7-2Q14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		

Sample Location	Sampling Event	Sample Number	Carbon tetrachloride	TCE	PCE	1,1-DCA	1,2-DCA	1,1-DCE	Freon 113	Chloroform	Perchlorate	Other Volatile Organic Compounds and 1,4-Dioxane, NDMA, NDPA, 1,2,3-TCP	
MW-16	Jul 2013	MW-16	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	7.9	2.0 J	Bromodichloromethane	12.0
												Bromoform	4.9
												Dibromochloromethane	11.0
MW-16	Oct/Nov 2013	MW-16	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	6.0	4.0 U	Bromodichloromethane	7.3
												Bromoform	2.2
												Dibromochloromethane	6.4
MW-16	Oct/Nov 2013	DUPE-7-4Q13	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	6.6	4.0 U	Bromodichloromethane	8.1
												Bromoform	2.0
												Dibromochloromethane	6.7
MW-16	Jan/Feb 2014	MW-16	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	9.3	2.3 J	Bromodichloromethane	9.8
												Bromoform	6.8
												Dibromochloromethane	9.0
MW-16	Apr/May 2014	MW-16	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0	4.0 U	Bromodichloromethane	6.7
												Bromoform	6.1
												Dibromochloromethane	8.4
MW-16	Jul/Aug 2014	MW-16	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Dibromochloromethane	0.2 J
MW-17 Screen 1	Oct/Nov 2013	MW-17-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-17 Screen 1	Apr/May 2014	MW-17-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-17 Screen 2	Jul 2013	MW-17-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-17 Screen 2	Oct/Nov 2013	MW-17-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-17 Screen 2	Jan/Feb 2014	MW-17-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.1 J
MW-17 Screen 2	Apr/May 2014	MW-17-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-17 Screen 2	Jul/Aug 2014	MW-17-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-17 Screen 3	Jul 2013	MW-17-3	0.3 J	0.2 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	7.6		
MW-17 Screen 3	Oct/Nov 2013	MW-17-3	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	7.1		
MW-17 Screen 3	Jan/Feb 2014	MW-17-3	0.5 U	0.2 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	7.4		
MW-17 Screen 3	Apr/May 2014	MW-17-3	0.5 U	0.2 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	7.6		
MW-17 Screen 3	Jul/Aug 2014	MW-17-3	0.2 J	0.6	0.5	0.2 J	0.5 U	0.5 U	0.5 U	0.4 J	6.4		
MW-17 Screen 3	Jul/Aug 2014	DUP-2-3Q14	0.2 J	0.6	0.5	0.2 J	0.5 U	0.5 U	0.5 U	0.4 J	6.6		
MW-17 Screen 4	Jul 2013	MW-17-4	0.5 U	1.0	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	1.8 J	Styrene	0.1 J
MW-17 Screen 4	Oct/Nov 2013	MW-17-4	0.6	2.0	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	0.6	15.0		
MW-17 Screen 4	Jan/Feb 2014	MW-17-4	0.8	3.1	0.4 J	0.5 U	0.5 U	0.5 U	0.5 U	0.8	18.0		
MW-17 Screen 4	Apr/May 2014	MW-17-4	0.8	2.4	0.4 J	0.5 U	0.5 U	0.5 U	0.5 U	0.6	17.0		
MW-17 Screen 4	Jul/Aug 2014	MW-17-4	0.9	3.1	0.5	0.5 U	0.5 U	0.5 U	0.5 U	0.8	18.0		
MW-17 Screen 5	Oct/Nov 2013	MW-17-5	0.4 J	2.0	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	0.7	9.9		
MW-17 Screen 5	Apr/May 2014	MW-17-5	1.0	3.3	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.9	15.0		
MW-18 Screen 2	Jul 2013	MW-18-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-18 Screen 2	Oct/Nov 2013	MW-18-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-18 Screen 2	Jan/Feb 2014	MW-18-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-18 Screen 2	Apr/May 2014	MW-18-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-18 Screen 2	Jul/Aug 2014	MW-18-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-18 Screen 3	Jul 2013	MW-18-3	10.0	0.7	0.2 J	0.5 U	0.5 U	0.5 U	0.3 J	1.5	44.0		
MW-18 Screen 3	Oct/Nov 2013	MW-18-3	16.0	1.6	0.3 J	0.5 U	0.5 U	0.5 U	0.3 J	2.2	44.0		
MW-18 Screen 3	Jan/Feb 2014	MW-18-3	5.2	0.5 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.2	35.0		
MW-18 Screen 3	Apr/May 2014	MW-18-3	6.4	0.5	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	1.3	32.0		
MW-18 Screen 3	Apr/May 2014	DUPE-1-2Q14	7.2	0.6	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	1.3	36.0		
MW-18 Screen 3	Jul/Aug 2014	MW-18-3	9.6	0.8	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	1.7	27.0		
MW-18 Screen 4	Jul 2013	MW-18-4	2.1	0.9	1.0	0.5 U	0.5 U	0.5 U	0.5 U	0.7	13.0		
MW-18 Screen 4	Jul 2013	DUPE-3-3Q13	1.5	0.6	0.7	0.5 U	0.5 U	0.5 U	0.5 U	0.6	13.0		
MW-18 Screen 4	Oct/Nov 2013	MW-18-4	1.9	0.9	0.8	0.5 U	0.5 U	0.5 U	0.5 U	0.7	15.0		

Sample Location	Sampling Event	Sample Number	Carbon tetrachloride	TCE	PCE	1,1-DCA	1,2-DCA	1,1-DCE	Freon 113	Chloroform	Perchlorate	Other Volatile Organic Compounds and 1,4-Dioxane, NDMA, NDPA, 1,2,3-TCP	
MW-18 Screen 4	Jan/Feb 2014	MW-18-4	**1.8**	1.0	0.9	0.5 U	0.5 U	0.5 U	0.5 U	0.7	**15.0**		
MW-18 Screen 4	Apr/May 2014	MW-18-4	**1.4**	0.8	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.6	**16.0**		
MW-18 Screen 4	Jul/Aug 2014	MW-18-4	**4.2**	2.2	2.2	0.5 U	0.5 U	0.5 U	0.5 U	1.2	**16.0**		
MW-18 Screen 4	Jul/Aug 2014	DUP-3-3Q14	**5.0**	2.3	2.5	0.5 U	0.5 U	0.5 U	0.5 U	1.2	**16.0**		
MW-18 Screen 5	Jul 2013	MW-18-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.1 J
MW-18 Screen 5	Oct/Nov 2013	MW-18-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.1 J
MW-18 Screen 5	Jan/Feb 2014	MW-18-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-18 Screen 5	Apr/May 2014	MW-18-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-18 Screen 5	Jul/Aug 2014	MW-18-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-19 Screen 1	Jul 2013	MW-19-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-19 Screen 1	Oct/Nov 2013	MW-19-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-19 Screen 1	Jan/Feb 2014	MW-19-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-19 Screen 1	Apr/May 2014	MW-19-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-19 Screen 1	Jul/Aug 2014	MW-19-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-19 Screen 2	Jul 2013	MW-19-2	0.5 U	0.9	1.2	0.3 J	0.5 U	0.5 U	0.5 U	0.9	**6.1**	Bromodichloromethane cis-1,2-Dichloroethene	0.4 J 0.3 J
MW-19 Screen 2	Oct/Nov 2013	MW-19-2	0.5 U	0.5 J	0.7	0.2 J	0.5 U	0.5 U	0.5 U	0.6	**6.1**	Bromodichloromethane cis-1,2-Dichloroethene	0.2 J 0.2 J
MW-19 Screen 2	Jan/Feb 2014	MW-19-2	0.5 U	0.8	1.3	0.3 J	0.5 U	0.5 U	0.5 U	0.9	**5.9**	Bromodichloromethane cis-1,2-Dichloroethene	0.4 J 0.3 J
MW-19 Screen 2	Apr/May 2014	MW-19-2	0.5 U	0.4 J	0.7	0.2 J	0.5 U	0.5 U	0.5 U	0.7	**6.3**	Bromodichloromethane cis-1,2-Dichloroethene Dibromochloromethane	0.3 J 0.2 J 0.2 J
MW-19 Screen 2	Jul/Aug 2014	MW-19-2	0.5 U	0.8	1.3	0.2 J	0.5 U	0.5 U	0.5 U	1.0	**5.7**	Bromodichloromethane cis-1,2-Dichloroethene Dibromochloromethane	0.4 J 0.3 J 0.2 J
MW-19 Screen 3	Jul 2013	MW-19-3	0.5 U	0.5 U	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	**3.8 J**		
MW-19 Screen 3	Oct/Nov 2013	MW-19-3	0.5 U	0.5 U	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	**3.4 J**		
MW-19 Screen 3	Jan/Feb 2014	MW-19-3	0.5 U	0.5 U	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.4 J	**2.4 J**		
MW-19 Screen 3	Apr/May 2014	MW-19-3	0.5 U	0.5 U	0.4 J	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	**2.9 J**		
MW-19 Screen 3	Jul/Aug 2014	MW-19-3	0.5 U	0.1 J	0.7	0.5 U	0.5 U	0.5 U	0.5 U	0.4 J	**4.4**		
MW-19 Screen 4	Jul 2013	MW-19-4	0.5 U	0.1 J	0.5	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	**3.2 J**		
MW-19 Screen 4	Oct/Nov 2013	MW-19-4	0.5 U	0.1 J	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	**2.9 J**		
MW-19 Screen 4	Jan/Feb 2014	MW-19-4	0.5 U	0.1 J	0.7	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	**3.4 J**		
MW-19 Screen 4	Apr/May 2014	MW-19-4	0.5 U	0.1 J	0.5 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	**3.3 J**		
MW-19 Screen 4	Jul/Aug 2014	MW-19-4	0.5 U	0.1 J	0.5	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	**3.4 J**		
MW-19 Screen 5	Jul 2013	MW-19-5	0.5 U	0.2 J	1.0	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	**3.1 J**	Styrene	0.1 J
MW-19 Screen 5	Jul 2013	DUP-1-3Q13	0.5 U	0.1 J	0.9	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	**3.0 J**		
MW-19 Screen 5	Oct/Nov 2013	MW-19-5	0.5 U	0.1 J	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	**3.8 J**		
MW-19 Screen 5	Jan/Feb 2014	MW-19-5	0.5 U	0.1 J	1.0	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	**2.8 J**		
MW-19 Screen 5	Apr/May 2014	MW-19-5	0.5 U	0.1 J	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	**3.1 J**		
MW-19 Screen 5	Jul/Aug 2014	MW-19-5	0.5 U	0.1 J	0.7	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	**2.3 J**		
MW-20 Screen 1	Jul 2013	MW-20-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	1.2 J	Methyl-tert-butyl ether (MTBE)	0.2 J
MW-20 Screen 1	Oct/Nov 2013	MW-20-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	4.0 U	Carbon disulfide	0.4 J
MW-20 Screen 1	Jan/Feb 2014	MW-20-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	4.0 U		
MW-20 Screen 1	Jan/Feb 2014	DUPE-3-1Q14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	4.0 U		
MW-20 Screen 1	Apr/May 2014	MW-20-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-20 Screen 2	Jul 2013	MW-20-2	0.5 U	0.8	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	1.9 J		
MW-20 Screen 2	Oct/Nov 2013	MW-20-2	0.5 U	0.5 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	2.3 J		
MW-20 Screen 2	Jan/Feb 2014	MW-20-2	0.5 U	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	1.6 J	Styrene	0.1 J

Sample Location	Sampling Event	Sample Number	Carbon tetrachloride	TCE	PCE	1,1-DCA	1,2-DCA	1,1-DCE	Freon 113	Chloroform	Perchlorate	Other Volatile Organic Compounds and 1,4-Dioxane, NDMA, NDPA, 1,2,3-TCP	
MW-20 Screen 2	Apr/May 2014	MW-20-2	0.5 U	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	4.0		
MW-20 Screen 2	Jul/Aug 2014	MW-20-2	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	3.5 J		
MW-20 Screen 2	Jul/Aug 2014	DUP-1-3Q14	0.5 U	0.3 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 J	2.3 J		
MW-20 Screen 3	Jul 2013	MW-20-3	0.5 U	0.2 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Acrylonitrile Ethylbenzene Styrene Toluene	2.9 J 0.2 J 0.4 J 0.1 J
MW-20 Screen 3	Oct/Nov 2013	MW-20-3	0.5 U	0.2 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Acrylonitrile Carbon disulfide Ethylbenzene Styrene Toluene	2.6 J 0.6 J 0.1 J 0.4 J 0.1 J
MW-20 Screen 3	Jan/Feb 2014	MW-20-3	0.5 U	0.1 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Acrylonitrile Ethylbenzene Styrene Toluene	2.6 J 0.2 J 0.4 J 0.1 J
MW-20 Screen 3	Apr/May 2014	MW-20-3	0.5 U	0.1 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Carbon disulfide Ethylbenzene Styrene	0.6 J 0.1 J 0.1 J
MW-20 Screen 3	Jul/Aug 2014	MW-20-3	0.5 U	0.1 J	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Acrylonitrile Ethylbenzene Styrene	2.0 J 0.2 J 0.3 J
MW-20 Screen 4	Jul 2013	MW-20-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-20 Screen 4	Oct/Nov 2013	MW-20-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Carbon disulfide	0.5 J
MW-20 Screen 4	Oct/Nov 2013	DUPE-1-4Q13	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Carbon disulfide	0.6 J
MW-20 Screen 4	Jan/Feb 2014	MW-20-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.1 J
MW-20 Screen 4	Apr/May 2014	MW-20-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Carbon disulfide	0.5 J
MW-20 Screen 4	Jul/Aug 2014	MW-20-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Acetone	5.5 J
MW-20 Screen 5	Jul 2013	MW-20-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.2 J
MW-20 Screen 5	Oct/Nov 2013	MW-20-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Carbon disulfide Styrene	0.8 J 0.3 J
MW-20 Screen 5	Jan/Feb 2014	MW-20-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.2 J
MW-20 Screen 5	Apr/May 2014	MW-20-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.2 J
MW-20 Screen 5	Jul/Aug 2014	MW-20-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Carbon disulfide Styrene	0.4 J 0.2 J
MW-21 Screen 1	Jul 2013	MW-21-1	0.5 U	0.2 J	0.9	0.5 U	0.5 U	0.5 U	0.5 U	2.1	3.1 J		
MW-21 Screen 1	Oct/Nov 2013	MW-21-1	0.5 U	0.9	0.4 J	0.5 U	0.5 U	0.5 U	0.5 U	1.4	9.3		
MW-21 Screen 1	Jan/Feb 2014	MW-21-1	0.5 U	1.2	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	1.1	11.0		
MW-21 Screen 1	Apr/May 2014	MW-21-1	0.5 U	1.1	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	1.0	12.0		
MW-21 Screen 2	Jul 2013	MW-21-2	0.5 U	0.4 J	2.3	0.5 U	0.5 U	0.5 U	0.5 U	0.6	2.7 J	cis-1,2-Dichloroethene Methyl-tert-butyl ether (MTBE)	0.2 J 0.2 J
MW-21 Screen 2	Oct/Nov 2013	MW-21-2	0.5 U	0.3 J	1.6	0.5 U	0.5 U	0.5 U	0.5 U	0.6	3.5 J	cis-1,2-Dichloroethene Methyl-tert-butyl ether (MTBE)	0.2 J 0.2 J
MW-21 Screen 2	Jan/Feb 2014	MW-21-2	0.5 U	0.3 J	1.6	0.5 U	0.5 U	0.5 U	0.5 U	0.4 J	2.9 J	cis-1,2-Dichloroethene Methyl-tert-butyl ether (MTBE)	0.2 J 0.2 J
MW-21 Screen 2	Apr/May 2014	MW-21-2	0.5 U	0.3 J	1.5	0.5 U	0.5 U	0.5 U	0.5 U	0.4 J	2.6 J	Methyl-tert-butyl ether (MTBE)	0.2 J
MW-21 Screen 2	Jul/Aug 2014	MW-21-2	0.5 U	0.3 J	1.8	0.5 U	0.5 U	0.5 U	0.5 U	0.5 J	2.3 J	Methyl-tert-butyl ether (MTBE)	0.2 J
MW-21 Screen 3	Jul 2013	MW-21-3	0.5 U	1.9	12.0	0.3 J	0.5 U	0.5 U	0.5 U	3.1	2.9 J	cis-1,2-Dichloroethene Methyl-tert-butyl ether (MTBE)	1.4 0.3 J

Sample Location	Sampling Event	Sample Number	Carbon tetrachloride	TCE	PCE	1,1-DCA	1,2-DCA	1,1-DCE	Freon 113	Chloroform	Perchlorate	Other Volatile Organic Compounds and 1,4-Dioxane, NDMA, NDPA, 1,2,3-TCP	
MW-21 Screen 3	Oct/Nov 2013	MW-21-3	0.5 U	0.9	3.6	0.2 J	0.5 U	0.5 U	0.5 U	1.4	3.5 J	cis-1,2-Dichloroethene Methyl-tert-butyl ether (MTBE)	0.7 0.3 J
MW-21 Screen 3	Jan/Feb 2014	MW-21-3	0.5 U	0.9	3.7	0.2 J	0.5 U	0.5 U	0.5 U	1.3	2.7 J	cis-1,2-Dichloroethene Methyl-tert-butyl ether (MTBE)	0.6 0.3 J
MW-21 Screen 3	Apr/May 2014	MW-21-3	0.5 U	1.1	3.1	0.2 J	0.5 U	0.5 U	0.5 U	1.0	4.0	cis-1,2-Dichloroethene Methyl-tert-butyl ether (MTBE)	0.4 J 0.2 J
MW-21 Screen 3	Jul/Aug 2014	MW-21-3	0.5 U	1.1	2.7	0.2 J	0.5 U	0.5 U	0.5 U	0.9	1.8 J	cis-1,2-Dichloroethene Methyl-tert-butyl ether (MTBE)	0.4 J 0.2 J
MW-21 Screen 4	Jul 2013	MW-21-4	0.5 U	0.2 J	1.1	0.5 U	0.5 U	0.5 U	0.5 U	9.2	2.0 J	cis-1,2-Dichloroethene	0.2 J
MW-21 Screen 4	Jul 2013	DUP-7-2013	0.5 U	0.1 J	1.1	0.5 U	0.5 U	0.5 U	0.5 U	9.9	2.2 J	cis-1,2-Dichloroethene	0.2 J
MW-21 Screen 4	Oct/Nov 2013	MW-21-4	0.5 U	0.1 J	0.8	0.5 U	0.5 U	0.5 U	0.5 U	8.8	2.1 J	cis-1,2-Dichloroethene	0.2 J
MW-21 Screen 4	Jan/Feb 2014	MW-21-4	0.5 U	0.1 J	0.6	0.5 U	0.5 U	0.5 U	0.5 U	5.3	2.1 J	cis-1,2-Dichloroethene	0.1 J
MW-21 Screen 4	Apr/May 2014	MW-21-4	0.5 U	0.1 J	0.8	0.5 U	0.5 U	0.5 U	0.5 U	7.6	2.2 J	cis-1,2-Dichloroethene	0.1 J
MW-21 Screen 4	Jul/Aug 2014	MW-21-4	0.5 U	0.2 J	1.2	0.5 U	0.5 U	0.5 U	0.5 U	9.5	2.7 J	cis-1,2-Dichloroethene	0.1 J
MW-21 Screen 4	Jul/Aug 2014	DUP-6-2014	0.5 U	0.1 J	0.9	0.5 U	0.5 U	0.5 U	0.5 U	7.5	1.9 J	cis-1,2-Dichloroethene	0.1 J
MW-21 Screen 5	Jul 2013	MW-21-5	0.5 U	0.1 J	0.9	0.5 U	0.5 U	0.5 U	0.5 U	6.0	2.1 J	cis-1,2-Dichloroethene	0.1 J
MW-21 Screen 5	Oct/Nov 2013	MW-21-5	0.5 U	0.1 J	0.6	0.5 U	0.5 U	0.5 U	0.5 U	5.8	3.0 J		
MW-21 Screen 5	Jan/Feb 2014	MW-21-5	0.5 U	0.1 J	1.2	0.1 J	0.5 U	0.5 U	0.5 U	7.9	1.7 J	cis-1,2-Dichloroethene	0.2 J
MW-21 Screen 5	Apr/May 2014	MW-21-5	0.5 U	0.5 U	0.6	0.5 U	0.5 U	0.5 U	0.5 U	6.4	4.0 U		
MW-21 Screen 5	Jul/Aug 2014	MW-21-5	0.5 U	0.5 U	0.9	0.5 U	0.5 U	0.5 U	0.5 U	7.0	2.2 J		
MW-22 Screen 1	Jul 2013	MW-22-1	0.5 U	1.5	0.6	0.1 J	0.5 U	0.5 U	0.5 U	0.5 J	3.0 J		
MW-22 Screen 1	Oct/Nov 2013	MW-22-1	0.5 U	1.0	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.4 J	3.7 J		
MW-22 Screen 1	Jan/Feb 2014	MW-22-1	0.5 U	2.0	0.6	0.1 J	0.5 U	0.5 U	0.5 U	0.5	3.3 J		
MW-22 Screen 1	Apr/May 2014	MW-22-1	0.5 U	1.4	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.4 J	3.0 J		
MW-22 Screen 1	Jul/Aug 2014	MW-22-1	0.5 U	2.2	0.6	0.1 J	0.5 U	0.5 U	0.5 U	0.5	3.2 J		
MW-22 Screen 2	Jul 2013	MW-22-2	0.5 U	0.2 J	0.2 J	0.1 J	0.5 U	0.5 U	0.5 U	0.2 J	4.0 U		
MW-22 Screen 2	Oct/Nov 2013	MW-22-2	0.5 U	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	3.5 J		
MW-22 Screen 2	Jan/Feb 2014	MW-22-2	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	2.5 J		
MW-22 Screen 2	Apr/May 2014	MW-22-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.9 J		
MW-22 Screen 2	Jul/Aug 2014	MW-22-2	0.5 U	0.1 J	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	4.0 U		
MW-22 Screen 3	Jul 2013	MW-22-3	0.5 U	0.1 J	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	3.6 J		
MW-22 Screen 3	Oct/Nov 2013	MW-22-3	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.6 J		
MW-22 Screen 3	Jan/Feb 2014	MW-22-3	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.6 J		
MW-22 Screen 3	Apr/May 2014	MW-22-3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.8 J		
MW-22 Screen 3	Jul/Aug 2014	MW-22-3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.7 J		
MW-22 Screen 4	Oct/Nov 2013	MW-22-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-22 Screen 4	Apr/May 2014	MW-22-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-22 Screen 5	Oct/Nov 2013	MW-22-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Carbon disulfide	0.7 J
MW-22 Screen 5	Apr/May 2014	MW-22-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-23 Screen 1	Jul 2013	MW-23-1	0.5 U	2.7	0.4 J	0.5 U	0.5 U	0.5 U	0.5 U	0.4 J	3.2 J		
MW-23 Screen 1	Oct/Nov 2013	MW-23-1	0.5 U	2.3	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	0.4 J	4.7		
MW-23 Screen 1	Jan/Feb 2014	MW-23-1	0.5 U	3.5	0.5 J	0.1 J	0.5 U	0.5 U	0.5 U	0.5	3.7 J		
MW-23 Screen 1	Apr/May 2014	MW-23-1	0.5 U	2.1	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.4 J	2.6 J		
MW-23 Screen 1	Jul/Aug 2014	MW-23-1	0.5 U	3.8	0.5	0.1 J	0.5 U	0.5 U	0.5 U	0.6	3.8 J	cis-1,2-Dichloroethene trans-1,2-Dichloroethene	0.1 J 0.2 J
MW-23 Screen 2	Jul 2013	MW-23-2	0.5 U	1.1	0.5	0.2 J	0.5 U	0.5 U	0.5 U	0.6	4.0		
MW-23 Screen 2	Oct/Nov 2013	MW-23-2	0.5 U	0.8	0.3 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 J	4.1		
MW-23 Screen 2	Jan/Feb 2014	MW-23-2	0.5 U	1.1	0.4 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5	4.6		
MW-23 Screen 2	Apr/May 2014	MW-23-2	0.5 U	1.1	0.4 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5	4.7		
MW-23 Screen 2	Jul/Aug 2014	MW-23-2	0.5 U	1.4	0.5	0.2 J	0.5 U	0.5 U	0.5 U	0.6	4.4		
MW-23 Screen 3	Jul 2013	MW-23-3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.6 J		

Sample Location	Sampling Event	Sample Number	Carbon tetrachloride	TCE	PCE	1,1-DCA	1,2-DCA	1,1-DCE	Freon 113	Chloroform	Perchlorate	Other Volatile Organic Compounds and 1,4-Dioxane, NDMA, NDPA, 1,2,3-TCP	
MW-23 Screen 3	Oct/Nov 2013	MW-23-3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**3.1 J**		
MW-23 Screen 3	Jan/Feb 2014	MW-23-3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**2.8 J**		
MW-23 Screen 3	Apr/May 2014	MW-23-3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**3.0 J**		
MW-23 Screen 3	Jul/Aug 2014	MW-23-3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**3.9 J**		
MW-23 Screen 4	Oct/Nov 2013	MW-23-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-23 Screen 4	Apr/May 2014	MW-23-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-23 Screen 5	Oct/Nov 2013	MW-23-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Carbon disulfide Ethylbenzene Styrene	0.5 J 0.1 J 0.4 J
MW-23 Screen 5	Apr/May 2014	MW-23-5	0.5 U	1.0 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Ethylbenzene Styrene	0.1 J 0.3 J
MW-24 Screen 1	Jul 2013	MW-24-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**3.8**	4.0 U	Bromodichloromethane	0.2 J
MW-24 Screen 1	Oct/Nov 2013	MW-24-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**5.0 J**	**2.3 J**	Bromodichloromethane	0.2 J
MW-24 Screen 1	Jan/Feb 2014	MW-24-1	**0.7**	0.5 U	**1.2**	0.5 U	0.5 U	0.5 U	**0.2 J**	**7.6**	**160.0**	Bromodichloromethane	1.0
MW-24 Screen 1	Apr/May 2014	MW-24-1	0.5 U	0.5 U	**0.2 J**	0.5 U	0.5 U	0.5 U	0.5 U	**5.9**	**45.0**		
MW-24 Screen 1	Jul/Aug 2014	MW-24-1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**3.0**	4.0 U		
MW-24 Screen 2	Jul 2013	MW-24-2	**0.3 J**	**0.1 J**	**0.2 J**	**0.2 J**	0.5 U	0.5 U	0.5 U	**0.6**	**10.0**	Bromodichloromethane	0.4 J
MW-24 Screen 2	Oct/Nov 2013	MW-24-2	**0.4 J**	**0.2 J**	**0.3 J**	**0.3 J**	0.5 U	0.5 U	0.5 U	**1.1**	**9.7**	Bromodichloromethane	0.8
MW-24 Screen 2	Jan/Feb 2014	MW-24-2	0.5 U	0.5 U	**0.1 J**	**0.1 J**	0.5 U	0.5 U	0.5 U	**0.7**	**8.0**	Bromodichloromethane	0.7
MW-24 Screen 2	Apr/May 2014	MW-24-2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.7**	**8.5**	Bromodichloromethane	0.9
MW-24 Screen 2	Apr/May 2014	DUP-2-2014	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.7**	**8.1**	Bromodichloromethane Chloromethane	0.8 0.5
MW-24 Screen 2	Jul/Aug 2014	MW-24-2	0.5 U	0.5 U	**0.2 J**	**0.2 J**	0.5 U	0.5 U	0.5 U	**1.1**	**6.0**	Bromodichloromethane	1.0
MW-24 Screen 3	Jul 2013	MW-24-3	0.5 U	0.5 U	**0.2 J**	**0.2 J**	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.1 J
MW-24 Screen 3	Oct/Nov 2013	MW-24-3	0.5 U	0.5 U	0.5 U	**0.1 J**	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Carbon disulfide	0.4 J
MW-24 Screen 3	Jan/Feb 2014	MW-24-3	0.5 U	0.5 U	**0.1 J**	**0.1 J**	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-24 Screen 3	Apr/May 2014	MW-24-3	0.5 U	0.5 U	0.5 U	**0.1 J**	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-24 Screen 3	Jul/Aug 2014	MW-24-3	0.5 U	0.5 U	**0.1 J**	**0.2 J**	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-24 Screen 4	Oct/Nov 2013	MW-24-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Ethylbenzene Styrene	0.2 J 0.2 J
MW-24 Screen 4	Apr/May 2014	MW-24-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Styrene	0.1 J
MW-24 Screen 5	Oct/Nov 2013	MW-24-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-24 Screen 5	Apr/May 2014	MW-24-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-25 Screen 1	Jul 2013	MW-25-1	0.5 U	**2.4**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.8**	**11.0**	Methyl-tert-butyl ether (MTBE)	0.3 J
MW-25 Screen 1	Oct/Nov 2013	MW-25-1	0.5 U	**2.5**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.6**	**11.0**	Methyl-tert-butyl ether (MTBE)	0.3 J
MW-25 Screen 1	Jan/Feb 2014	MW-25-1	0.5 U	**1.9**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.4 J**	**11.0**	Methyl-tert-butyl ether (MTBE)	0.3 J
MW-25 Screen 1	Apr/May 2014	MW-25-1	0.5 U	**2.5**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.6**	**11.0**	Methyl-tert-butyl ether (MTBE)	0.2 J
MW-25 Screen 1	Jul/Aug 2014	MW-25-1	0.5 U	**2.4**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.7**	**11.0**	Methyl-tert-butyl ether (MTBE)	0.3 J
MW-25 Screen 2	Jul 2013	MW-25-2	0.5 U	**0.3 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.2 J**	**16.0**		
MW-25 Screen 2	Oct/Nov 2013	MW-25-2	0.5 U	**0.2 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.1 J**	**15.0**		
MW-25 Screen 2	Oct/Nov 2013	DUP-1-4Q13	0.5 U	**0.2 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.2 J**	**16.0**		
MW-25 Screen 2	Jan/Feb 2014	MW-25-2	0.5 U	**0.2 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**15.0**		
MW-25 Screen 2	Apr/May 2014	MW-25-2	0.5 U	**0.3 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.1 J**	**14.0**		
MW-25 Screen 2	Jul/Aug 2014	MW-25-2	0.5 U	**0.2 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**15.0**		
MW-25 Screen 2	Jul/Aug 2014	DUP-4-3Q14	0.5 U	**0.3 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.2 J**	**15.0**		
MW-25 Screen 3	Jul 2013	MW-25-3	0.5 U	0.5 U	**0.2 J**	0.5 U	0.5 U	0.5 U	0.5 U	**0.6**	**11.0**		
MW-25 Screen 3	Jul 2013	DUPE-4-3Q13	0.5 U	0.5 U	**0.2 J**	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 J**	**11.0**		
MW-25 Screen 3	Oct/Nov 2013	MW-25-3	0.5 U	0.5 U	**0.2 J**	0.5 U	0.5 U	0.5 U	0.5 U	**0.9**	**13.0**		
MW-25 Screen 3	Jan/Feb 2014	MW-25-3	0.5 U	0.5 U	**0.4 J**	0.5 U	0.5 U	0.5 U	0.5 U	**0.9**	**12.0**		
MW-25 Screen 3	Apr/May 2014	MW-25-3	0.5 U	**0.1 J**	**0.9**	0.5 U	0.5 U	0.5 U	0.5 U	**1.2**	**11.0**		

Sample Location	Sampling Event	Sample Number	Carbon tetrachloride	TCE	PCE	1,1-DCA	1,2-DCA	1,1-DCE	Freon 113	Chloroform	Perchlorate	Other Volatile Organic Compounds and 1,4-Dioxane, NDMA, NDPA, 1,2,3-TCP	
MW-25 Screen 3	Jul/Aug 2014	MW-25-3	0.5 U	0.5 U	0.5 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5	12.0		
MW-25 Screen 4	Jul 2013	MW-25-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	9.3		
MW-25 Screen 4	Oct/Nov 2013	MW-25-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	10.0	Carbon disulfide	0.5 J
MW-25 Screen 4	Jan/Feb 2014	MW-25-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	10.0		
MW-25 Screen 4	Apr/May 2014	MW-25-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	8.5		
MW-25 Screen 4	Jul/Aug 2014	MW-25-4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	11.0		
MW-25 Screen 5	Jul 2013	MW-25-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-25 Screen 5	Oct/Nov 2013	MW-25-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Carbon disulfide	0.7 J
MW-25 Screen 5	Jan/Feb 2014	MW-25-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Carbon disulfide	0.5 J
MW-25 Screen 5	Apr/May 2014	MW-25-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U	Carbon disulfide	0.5 J
MW-25 Screen 5	Jul/Aug 2014	MW-25-5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.0 U		
MW-26 Screen 1	Jul 2013	MW-26-1	0.5 U	0.6	1.2	0.1 J	0.5 U	0.5 U	0.5 U	0.4 J	4.0 U	cis-1,2-Dichloroethene	0.1 J
MW-26 Screen 1	Oct/Nov 2013	MW-26-1	0.5 U	0.4 J	0.4 J	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	4.5		
MW-26 Screen 1	Oct/Nov 2013	DUPE-3-4Q13	0.5 U	0.4 J	0.5 J	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	4.2		
MW-26 Screen 1	Jan/Feb 2014	MW-26-1	0.5 U	0.4 J	0.4 J	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	2.5 J		
MW-26 Screen 1	Apr/May 2014	MW-26-1	0.5 U	0.4 J	0.5	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	2.5 J		
MW-26 Screen 1	Jul/Aug 2014	MW-26-1	0.5 U	0.4 J	0.7	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	1.9 J		
MW-26 Screen 2	Jul 2013	MW-26-2	0.5 U	0.5 U	0.4 J	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	1.4 J		
MW-26 Screen 2	Oct/Nov 2013	MW-26-2	0.5 U	0.3 J	2.0	0.5 U	0.5 U	0.5 U	0.5 U	1.1	3.3 J	Bromodichloromethane cis-1,2-Dichloroethene	0.2 J 0.3 J
MW-26 Screen 2	Jan/Feb 2014	MW-26-2	0.5 U	0.3 J	2.0	0.5 U	0.5 U	0.5 U	0.5 U	1.2	2.6 J	Bromodichloromethane cis-1,2-Dichloroethene	0.2 J 0.3 J
MW-26 Screen 2	Apr/May 2014	MW-26-2	0.5 U	0.3 J	2.2	0.5 U	0.5 U	0.5 U	0.5 U	1.3	2.3 J	Bromodichloromethane cis-1,2-Dichloroethene	0.2 J 0.1 J
MW-26 Screen 2	Jul/Aug 2014	MW-26-2	0.5 U	0.3 J	2.0	0.5 U	0.5 U	0.5 U	0.5 U	1.3	3.1 J	Bromodichloromethane cis-1,2-Dichloroethene	0.2 J 0.2 J
California Maximum Contaminant Level (MCL)			0.5	5	5	5	0.5	6	1,200	TTHM	6.0		
EPA Region IX Maximum Contaminant Level			5	5	5	NE	5	7	NE	TTHM	NE		

Notes

DUPE	Field Duplicate
NA	Not analyzed
NE	Not established
TTHM	Chloroform is regulated under the state and federal MCL of 80 µg/L for Total Trihalomethanes (TTHMs); the MCL applies to the sum of all four trihalomethanes (Bromodichloromethane, Bromoform, Dibromochloromethane and Chloroform) as an annual average
J	Analyte concentration is an estimated value
U	Analyte was analyzed for, but not detected at or above the stated limit

TABLE 2
SUMMARY OF METALS DETECTED
DURING THE LAST FIVE SAMPLING EVENTS OF THE LONG-TERM QUARTERLY GROUNDWATER SAMPLING PROGRAM

(All concentrations reported in µg/L; except for Hexavalent Chromium, which is reported in mg/L.)

(Shaded values exceed State or Federal MCLs or action levels.)

Sample Location	Sampling Event	Sample Number	Arsenic (µg/L)	Lead (µg/L)	Chromium, Total (µg/L)	Chromium, Hexavalent (mg/L)
MW-1	Oct/Nov 2013	MW-1	NA	NA	3.0 U	0.002 U
MW-1	Apr/May 2014	MW-1	2.0 U	1.000 U	**0.5 J**	0.002 U
MW-1	Apr/May 2014	DUP-6-2Q14	**0.8 J**	1.000 U	**1.1 J**	0.002 U
MW-3 Screen 1	Oct/Nov 2013	MW-3-1	NA	NA	3.0 U	0.002 U
MW-3 Screen 1	Apr/May 2014	MW-3-1	2.0 U	1.000 U	3.0 U	0.002 U
MW-3 Screen 2	Jul 2013	MW-3-2	NA	NA	**0.6 J**	0.002 U
MW-3 Screen 2	Jul 2013	DUPE-5-3Q13	NA	NA	3.0 U	0.002 U
MW-3 Screen 2	Oct/Nov 2013	MW-3-2	NA	NA	**0.7 J**	0.002 U
MW-3 Screen 2	Jan/Feb 2014	MW-3-2	NA	NA	3.0 U	0.002 U
MW-3 Screen 2	Apr/May 2014	MW-3-2	2.0 U	1.000 U	3.0 U	**0.001 J**
MW-3 Screen 2	Jul/Aug 2014	MW-3-2	NA	NA	0.8 U	0.001 U
MW-3 Screen 3	Jul 2013	MW-3-3	NA	NA	**2.4 J**	0.002 U
MW-3 Screen 3	Oct/Nov 2013	MW-3-3	NA	NA	**1.8 J**	**0.002 J**
MW-3 Screen 3	Jan/Feb 2014	MW-3-3	NA	NA	**1.4 J**	0.002 U
MW-3 Screen 3	Jan/Feb 2014	DUPE-3-1Q14	NA	NA	**6.3**	0.002 U
MW-3 Screen 3	Apr/May 2014	MW-3-3	**3.2**	1.000 U	3.4 U	**0.001 J**
MW-3 Screen 3	Jul/Aug 2014	MW-3-3	NA	NA	3.0 U	0.001 U
MW-3 Screen 3	Jul/Aug 2014	DUP-5-3Q14	NA	NA	**4.5**	0.001 U
MW-3 Screen 4	Jul 2013	MW-3-4	NA	NA	**22.0**	0.002 U
MW-3 Screen 4	Oct/Nov 2013	MW-3-4	NA	NA	**3.1**	0.002 U
MW-3 Screen 4	Jan/Feb 2014	MW-3-4	NA	NA	**6.2**	**0.001 J**
MW-3 Screen 4	Apr/May 2014	MW-3-4	**14.0**	1.000 U	**15.0**	**0.001 J**
MW-3 Screen 4	Jul/Aug 2014	MW-3-4	NA	NA	**6.9**	0.001 U
MW-3 Screen 5	Oct/Nov 2013	MW-3-5	NA	NA	**7.3**	**0.001 J**
MW-3 Screen 5	Apr/May 2014	MW-3-5	**7.7**	1.000 U	**11.0**	**0.001 J**
MW-4 Screen 1	Jul 2013	MW-4-1	NA	NA	**0.6 J**	0.002 U
MW-4 Screen 1	Oct/Nov 2013	MW-4-1	NA	NA	3.0 U	0.002 U
MW-4 Screen 1	Jan/Feb 2014	MW-4-1	NA	NA	3.0 U	0.002 U
MW-4 Screen 1	Apr/May 2014	MW-4-1	2.0 U	1.000 U	3.0 U	0.002 U
MW-4 Screen 1	Jul/Aug 2014	MW-4-1	NA	NA	3.0 UJ	0.002 U
MW-4 Screen 2	Jul 2013	MW-4-2	NA	NA	**3.2**	**0.002 J**
MW-4 Screen 2	Oct/Nov 2013	MW-4-2	NA	NA	**12.0**	0.002 U
MW-4 Screen 2	Jan/Feb 2014	MW-4-2	NA	NA	**2.4 J**	**0.001 J**
MW-4 Screen 2	Apr/May 2014	MW-4-2	**1.2 J**	1.000 U	**16.0**	**0.001 J**
MW-4 Screen 2	Jul/Aug 2014	MW-4-2	NA	NA	2.8 U	0.002 U

Sample Location	Sampling Event	Sample Number	Arsenic (µg/L)	Lead (µg/L)	Chromium, Total (µg/L)	Chromium, Hexavalent (mg/L)
MW-4 Screen 3	Jul 2013	MW-4-3	NA	NA	**1.0 J**	0.002 U
MW-4 Screen 3	Oct/Nov 2013	MW-4-3	NA	NA	**1.9 J**	0.002 U
MW-4 Screen 3	Jan/Feb 2014	MW-4-3	NA	NA	**1.0 J**	**0.001 J**
MW-4 Screen 3	Jan/Feb 2014	DUP-1-1Q14	NA	NA	**1.1 J**	**0.001 J**
MW-4 Screen 3	Apr/May 2014	MW-4-3	**1.4 J**	1.000 U	2.3 U	0.002 U
MW-4 Screen 3	Jul/Aug 2014	MW-4-3	NA	NA	2.5 U	0.002 U
MW-4 Screen 3	Jul/Aug 2014	DUP-7-3Q14	NA	NA	3.1 U	0.002 U
MW-4 Screen 4	Oct/Nov 2013	MW-4-4	NA	NA	**1.1 J**	0.002 U
MW-4 Screen 4	Apr/May 2014	MW-4-4	2.0 U	1.000 U	2.0 U	0.001 U
MW-4 Screen 5	Oct/Nov 2013	MW-4-5	NA	NA	3.0 U	0.002 U
MW-4 Screen 5	Apr/May 2014	MW-4-5	2.0 U	1.000 U	3.0 U	0.001 U
MW-5	Jul 2013	MW-5	NA	NA	0.8 U	0.002 U
MW-5	Oct/Nov 2013	MW-5	NA	NA	3.0 U	0.002 U
MW-5	Jan/Feb 2014	MW-5	NA	NA	**0.7 J**	0.002 U
MW-5	Jan/Feb 2014	DUPE-6-1Q14	NA	NA	**0.7 J**	0.002 U
MW-5	Apr/May 2014	MW-5	2.0 U	1.000 U	**0.8 J**	0.002 U
MW-5	Jul/Aug 2014	MW-5	NA	NA	**7.8**	0.002 U
MW-6	Jul 2013	MW-6	NA	NA	2.9 U	0.002 U
MW-6	Oct/Nov 2013	MW-6	NA	NA	**39.0**	0.001 U
MW-6	Jan/Feb 2014	MW-6	NA	NA	**8.1**	0.002 U
MW-6	Apr/May 2014	MW-6	2.0 U	1.000 U	**190.0**	**0.002 J**
MW-6	Jul/Aug 2014	MW-6	NA	NA	**26.0**	0.002 U
MW-7	Jul 2013	MW-7	NA	NA	**17.0**	**0.004**
MW-7	Oct/Nov 2013	MW-7	NA	NA	**16.0**	**0.004**
MW-7	Jan/Feb 2014	MW-7	NA	NA	**49.0**	**0.002**
MW-7	Jan/Feb 2014	DUPE-5-1Q14	NA	NA	**42.0**	**0.001 J**
MW-7	Apr/May 2014	MW-7	2.0 U	**0.100 J**	**15.0**	**0.007**
MW-7	Apr/May 2014	DUP-8-2Q14	2.0 U	1.000 U	**16.0**	**0.007**
MW-7	Jul/Aug 2014	MW-7	NA	NA	**9100.0**	0.002 U
MW-8	Jul 2013	MW-8	NA	NA	1.5 U	0.002 U
MW-8	Oct/Nov 2013	MW-8	NA	NA	**2.4 J**	**0.001 J**
MW-8	Oct/Nov 2013	DUPE-5-4Q13	NA	NA	**2.1 J**	**0.001 J**
MW-8	Jan/Feb 2014	MW-8	NA	NA	**3.0**	**0.001 J**
MW-8	Jan/Feb 2014	DUPE-7-1Q14	NA	NA	**3.4**	**0.001 J**
MW-8	Apr/May 2014	MW-8	2.0 U	1.000 U	**1.7 J**	**0.001 J**
MW-8	Jul/Aug 2014	MW-8	NA	NA	**18.0**	**0.003**
MW-9	Apr/May 2014	MW-9	2.0 U	1.000 U	3.0 U	0.002 U
MW-9	Apr/May 2014	DUP-5-2Q14	2.0 U	1.000 U	**0.6 J**	0.002 U
MW-10	Jul 2013	MW-10	NA	NA	3.3 U	**0.002 J**
MW-10	Oct/Nov 2013	MW-10	NA	NA	**2.9 J**	0.001 U
MW-10	Oct/Nov 2013	DUPE-8-4Q13	NA	NA	**3.4**	0.001 U
MW-10	Jan/Feb 2014	MW-10	NA	NA	7.9 U	0.002 U

Sample Location	Sampling Event	Sample Number	Arsenic (µg/L)	Lead (µg/L)	Chromium, Total (µg/L)	Chromium, Hexavalent (mg/L)
MW-10	Apr/May 2014	MW-10	2.0 U	1.000 U	**2.4 J**	**0.001 J**
MW-10	Jul/Aug 2014	MW-10	NA	NA	**5.7**	**0.001 J**
MW-11 Screen 1	Jul 2013	MW-11-1	NA	NA	**3.6**	0.002 U
MW-11 Screen 1	Oct/Nov 2013	MW-11-1	NA	NA	3.0 U	0.002 U
MW-11 Screen 1	Jan/Feb 2014	MW-11-1	NA	NA	3.0 U	0.002 U
MW-11 Screen 1	Apr/May 2014	MW-11-1	2.0 U	1.000 U	3.0 U	0.001 U
MW-11 Screen 1	Jul/Aug 2014	MW-11-1	NA	NA	3.0 U	0.002 U
MW-11 Screen 2	Jul 2013	MW-11-2	NA	NA	3.0 U	0.002 U
MW-11 Screen 2	Jul 2013	DUPE-6-3Q13	NA	NA	3.0 U	0.002 U
MW-11 Screen 2	Oct/Nov 2013	MW-11-2	NA	NA	3.0 U	0.002 U
MW-11 Screen 2	Jan/Feb 2014	MW-11-2	NA	NA	3.0 U	0.002 U
MW-11 Screen 2	Apr/May 2014	MW-11-2	**0.7 J**	1.000 U	**0.9 J**	0.001 U
MW-11 Screen 2	Jul/Aug 2014	MW-11-2	NA	NA	3.0 U	0.002 U
MW-11 Screen 3	Jul 2013	MW-11-3	NA	NA	**0.5 J**	0.002 U
MW-11 Screen 3	Oct/Nov 2013	MW-11-3	NA	NA	3.0 U	0.002 U
MW-11 Screen 3	Jan/Feb 2014	MW-11-3	NA	NA	3.0 U	0.002 U
MW-11 Screen 3	Apr/May 2014	MW-11-3	**1.9 J**	1.000 U	1.0 U	0.001 U
MW-11 Screen 3	Jul/Aug 2014	MW-11-3	NA	NA	3.0 U	0.002 U
MW-11 Screen 4	Oct/Nov 2013	MW-11-4	NA	NA	3.0 U	0.002 U
MW-11 Screen 4	Apr/May 2014	MW-11-4	2.0 U	1.000 U	0.9 U	0.001 U
MW-11 Screen 5	Oct/Nov 2013	MW-11-5	NA	NA	3.0 U	0.002 U
MW-11 Screen 5	Apr/May 2014	MW-11-5	**5.8**	**1.200**	4.0	0.001 U
MW-12 Screen 1	Jul 2013	MW-12-1	NA	NA	**1.0 J**	0.002 U
MW-12 Screen 1	Oct/Nov 2013	MW-12-1	NA	NA	**1.9 J**	**0.001 J**
MW-12 Screen 1	Jan/Feb 2014	MW-12-1	NA	NA	3.0 U	0.002 U
MW-12 Screen 1	Apr/May 2014	MW-12-1	2.0 U	1.000 U	**1.1 J**	0.002 U
MW-12 Screen 1	Apr/May 2014	DUP-4-2Q14	2.0 U	1.000 U	**1.1 J**	0.002 U
MW-12 Screen 2	Jul 2013	MW-12-2	NA	NA	**1.6 J**	0.002 U
MW-12 Screen 2	Oct/Nov 2013	MW-12-2	NA	NA	**1.0 J**	0.002 U
MW-12 Screen 2	Jan/Feb 2014	MW-12-2	NA	NA	**1.0 J**	0.002 U
MW-12 Screen 2	Apr/May 2014	MW-12-2	2.0 U	1.000 U	**1.0 J**	0.002 U
MW-12 Screen 2	Jul/Aug 2014	MW-12-2	NA	NA	2.6 U	0.002 U
MW-12 Screen 3	Jul 2013	MW-12-3	NA	NA	3.0 U	0.002 U
MW-12 Screen 3	Oct/Nov 2013	MW-12-3	NA	NA	3.0 U	0.002 U
MW-12 Screen 3	Jan/Feb 2014	MW-12-3	NA	NA	3.0 U	0.002 U
MW-12 Screen 3	Apr/May 2014	MW-12-3	**0.8 J**	1.000 U	3.0 U	0.002 U
MW-12 Screen 3	Jul/Aug 2014	MW-12-3	NA	NA	1.1 U	0.002 U
MW-12 Screen 4	Oct/Nov 2013	MW-12-4	NA	NA	**0.9 J**	**0.001 J**
MW-12 Screen 4	Apr/May 2014	MW-12-4	**2.3**	1.000 U	3.0 U	0.002 U
MW-12 Screen 5	Oct/Nov 2013	MW-12-5	NA	NA	**1.5 J**	**0.002 J**
MW-12 Screen 5	Apr/May 2014	MW-12-5	**1.9 J**	1.000 U	**1.8 J**	**0.001 J**
MW-13	Jul 2013	MW-13	NA	NA	**140.0**	**0.004**

Sample Location	Sampling Event	Sample Number	Arsenic (µg/L)	Lead (µg/L)	Chromium, Total (µg/L)	Chromium, Hexavalent (mg/L)
MW-13	Oct/Nov 2013	MW-13	NA	NA	**67.0**	**0.002 J**
MW-13	Jan/Feb 2014	MW-13	NA	NA	**150.0**	0.002 U
MW-13	Jan/Feb 2014	DUPE-4-1Q14	NA	NA	**150.0**	0.002 U
MW-13	Apr/May 2014	MW-13	2.0 U	1.000 U	**220.0**	0.002 U
MW-13	Jul/Aug 2014	MW-13	NA	NA	**51000.0**	0.002 U
MW-14 Screen 1	Jul 2013	MW-14-1	NA	NA	**1.3 J**	0.002 U
MW-14 Screen 1	Oct/Nov 2013	MW-14-1	NA	NA	**0.8 J**	0.002 U
MW-14 Screen 1	Oct/Nov 2013	DUPE-2-4Q13	NA	NA	**1.0 J**	0.002 U
MW-14 Screen 1	Jan/Feb 2014	MW-14-1	NA	NA	3.0 U	**0.001 J**
MW-14 Screen 1	Apr/May 2014	MW-14-1	2.0 U	1.000 U	0.7 U	0.002 U
MW-14 Screen 1	Jul/Aug 2014	MW-14-1	NA	NA	**0.5 J**	**0.001 J**
MW-14 Screen 2	Jul 2013	MW-14-2	NA	NA	**1.3 J**	0.002 U
MW-14 Screen 2	Jul 2013	DUPE-2-3Q13	NA	NA	**1.3 J**	0.002 U
MW-14 Screen 2	Oct/Nov 2013	MW-14-2	NA	NA	3.0 U	0.002 U
MW-14 Screen 2	Jan/Feb 2014	MW-14-2	NA	NA	3.0 U	0.002 U
MW-14 Screen 2	Apr/May 2014	MW-14-2	2.0 U	1.000 U	2.2 U	0.002 U
MW-14 Screen 2	Apr/May 2014	DUP-1-2Q14	2.0 U	1.000 U	3.0 U	0.002 U
MW-14 Screen 2	Jul/Aug 2014	MW-14-2	NA	NA	3.0 U	0.002 U
MW-14 Screen 3	Jul 2013	MW-14-3	NA	NA	**1.1 J**	0.002 U
MW-14 Screen 3	Oct/Nov 2013	MW-14-3	NA	NA	3.0 U	0.002 U
MW-14 Screen 3	Jan/Feb 2014	MW-14-3	NA	NA	**0.8 J**	**0.001 J**
MW-14 Screen 3	Apr/May 2014	MW-14-3	2.0 U	1.000 U	3.0 U	0.001 U
MW-14 Screen 3	Jul/Aug 2014	MW-14-3	NA	NA	**0.9 J**	0.002 U
MW-14 Screen 4	Oct/Nov 2013	MW-14-4	NA	NA	3.0 U	**0.002 J**
MW-14 Screen 4	Apr/May 2014	MW-14-4	2.0 U	1.000 U	2.1 U	0.003 U
MW-14 Screen 5	Oct/Nov 2013	MW-14-5	NA	NA	3.0 U	0.002 U
MW-14 Screen 5	Apr/May 2014	MW-14-5	**1.0 J**	0.660 U	3.0 U	0.001 U
MW-15	Jul 2013	MW-15	NA	NA	4.2	0.002 U
MW-15	Oct/Nov 2013	MW-15	NA	NA	3.0 U	0.002 U
MW-15	Oct/Nov 2013	DUPE-6-4Q13	NA	NA	3.0 U	0.002 U
MW-15	Jan/Feb 2014	MW-15	NA	NA	3.0 U	0.002 U
MW-15	Apr/May 2014	MW-15	**1.0 J**	1.000 U	1.0 J	0.002 U
MW-15	Apr/May 2014	DUP-7-2Q14	**1.0 J**	1.000 U	1.4 J	0.002 U
MW-15	Jul/Aug 2014	MW-15	NA	NA	2.7 U	0.002 U
MW-16	Jul 2013	MW-16	NA	NA	**15.0**	**0.014**
MW-16	Oct/Nov 2013	MW-16	NA	NA	**260.0**	**0.014**
MW-16	Oct/Nov 2013	DUPE-7-4Q13	NA	NA	**180.0**	**0.014**
MW-16	Jan/Feb 2014	MW-16	NA	NA	**410.0**	**0.015**
MW-16	Apr/May 2014	MW-16	**11.0**	**3.200**	**690.0**	**0.007**
MW-16	Jul/Aug 2014	MW-16	NA	NA	**2900.0**	**0.002**
MW-17 Screen 1	Oct/Nov 2013	MW-17-1	NA	NA	3.0 U	0.002 U
MW-17 Screen 1	Apr/May 2014	MW-17-1	2.0 U	1.000 U	3.0 U	0.002 U

Sample Location	Sampling Event	Sample Number	Arsenic (µg/L)	Lead (µg/L)	Chromium, Total (µg/L)	Chromium, Hexavalent (mg/L)
MW-17 Screen 2	Jul 2013	MW-17-2	NA	NA	**0.7 J**	0.002 U
MW-17 Screen 2	Oct/Nov 2013	MW-17-2	NA	NA	3.0 U	0.002 U
MW-17 Screen 2	Jan/Feb 2014	MW-17-2	NA	NA	3.0 U	0.002 U
MW-17 Screen 2	Apr/May 2014	MW-17-2	2.0 U	1.000 U	3.0 U	0.002 U
MW-17 Screen 2	Jul/Aug 2014	MW-17-2	NA	NA	3.0 U	0.002 U
MW-17 Screen 3	Jul 2013	MW-17-3	NA	NA	**0.9 J**	0.002 U
MW-17 Screen 3	Oct/Nov 2013	MW-17-3	NA	NA	3.0 U	0.002 U
MW-17 Screen 3	Jan/Feb 2014	MW-17-3	NA	NA	3.0 U	0.002 U
MW-17 Screen 3	Apr/May 2014	MW-17-3	**1.0 J**	1.000 U	**1.2 J**	**0.002 J**
MW-17 Screen 3	Jul/Aug 2014	MW-17-3	NA	NA	3.0 U	**0.001 J**
MW-17 Screen 3	Jul/Aug 2014	DUP-2-3Q14	NA	NA	3.0 U	0.002 U
MW-17 Screen 4	Jul 2013	MW-17-4	NA	NA	**0.6 J**	0.002 U
MW-17 Screen 4	Oct/Nov 2013	MW-17-4	NA	NA	**2.0 J**	**0.002 J**
MW-17 Screen 4	Jan/Feb 2014	MW-17-4	NA	NA	**4.0**	**0.003**
MW-17 Screen 4	Apr/May 2014	MW-17-4	**1.9 J**	1.000 U	**2.5 J**	**0.002**
MW-17 Screen 4	Jul/Aug 2014	MW-17-4	NA	NA	**2.8 J**	**0.002**
MW-17 Screen 5	Oct/Nov 2013	MW-17-5	NA	NA	3.0 U	0.002 U
MW-17 Screen 5	Apr/May 2014	MW-17-5	**3.3**	**0.250 J**	**1.5 J**	0.002 U
MW-18 Screen 2	Jul 2013	MW-18-2	NA	NA	**0.6 J**	0.002 U
MW-18 Screen 2	Oct/Nov 2013	MW-18-2	NA	NA	3.0 U	0.002 U
MW-18 Screen 2	Jan/Feb 2014	MW-18-2	NA	NA	3.0 U	0.002 U
MW-18 Screen 2	Apr/May 2014	MW-18-2	2.0 U	1.000 U	3.0 U	0.002 U
MW-18 Screen 2	Jul/Aug 2014	MW-18-2	NA	NA	3.0 U	0.002 U
MW-18 Screen 3	Jul 2013	MW-18-3	NA	NA	**2.8 J**	**0.001 J**
MW-18 Screen 3	Oct/Nov 2013	MW-18-3	NA	NA	**2.9 J**	**0.001 J**
MW-18 Screen 3	Jan/Feb 2014	MW-18-3	NA	NA	**1.8 J**	**0.002 J**
MW-18 Screen 3	Apr/May 2014	MW-18-3	**1.0 J**	1.000 U	2.6 U	**0.002**
MW-18 Screen 3	Apr/May 2014	DUP-3-2Q14	2.0 U	1.000 U	2.7 U	**0.002**
MW-18 Screen 3	Jul/Aug 2014	MW-18-3	NA	NA	**1.9 J**	**0.002 J**
MW-18 Screen 4	Jul 2013	MW-18-4	NA	NA	**2.5 J**	0.002 U
MW-18 Screen 4	Jul 2013	DUPE-3-3Q13	NA	NA	**2.1 J**	0.002 U
MW-18 Screen 4	Oct/Nov 2013	MW-18-4	NA	NA	**3.5**	**0.001 J**
MW-18 Screen 4	Jan/Feb 2014	MW-18-4	NA	NA	**2.8 J**	**0.002**
MW-18 Screen 4	Apr/May 2014	MW-18-4	**1.5 J**	1.000 U	**3.4**	**0.002**
MW-18 Screen 4	Jul/Aug 2014	MW-18-4	NA	NA	**2.4 J**	**0.002 J**
MW-18 Screen 4	Jul/Aug 2014	DUP-3-3Q14	NA	NA	**2.4 J**	**0.002 J**
MW-18 Screen 5	Oct/Nov 2013	MW-18-5	NA	NA	3.0 U	0.002 U
MW-18 Screen 5	Apr/May 2014	MW-18-5	**1.0 J**	1.000 U	0.7 U	0.002 U
MW-19 Screen 1	Oct/Nov 2013	MW-19-1	NA	NA	**2.3 J**	0.002 U
MW-19 Screen 1	Apr/May 2014	MW-19-1	2.0 U	1.000 U	0.6 U	0.002 U
MW-19 Screen 2	Oct/Nov 2013	MW-19-2	NA	NA	**2.1 J**	0.002 U
MW-19 Screen 2	Apr/May 2014	MW-19-2	2.0 U	1.000 U	2.9 U	**0.001 J**

Sample Location	Sampling Event	Sample Number	Arsenic (µg/L)	Lead (µg/L)	Chromium, Total (µg/L)	Chromium, Hexavalent (mg/L)
MW-19 Screen 3	Oct/Nov 2013	MW-19-3	NA	NA	**2.6 J**	0.002 U
MW-19 Screen 3	Apr/May 2014	MW-19-3	**1.0 J**	1.000 U	3.0 U	**0.002 J**
MW-19 Screen 4	Oct/Nov 2013	MW-19-4	NA	NA	**2.5 J**	**0.002 J**
MW-19 Screen 4	Apr/May 2014	MW-19-4	**1.3 J**	1.000 U	**2.6 J**	**0.001 J**
MW-19 Screen 5	Oct/Nov 2013	MW-19-5	NA	NA	**1.1 J**	0.002 U
MW-19 Screen 5	Apr/May 2014	MW-19-5	**1.5 J**	1.000 U	**1.4 J**	0.002 U
MW-20 Screen 1	Jul 2013	MW-20-1	NA	NA	**1.1 J**	0.002 U
MW-20 Screen 1	Oct/Nov 2013	MW-20-1	NA	NA	3.0 U	0.002 U
MW-20 Screen 1	Jan/Feb 2014	MW-20-1	NA	NA	3.0 U	0.002 U
MW-20 Screen 1	Jan/Feb 2014	DUPE-2-1Q14	NA	NA	3.0 U	0.002 U
MW-20 Screen 1	Apr/May 2014	MW-20-1	2.0 U	1.000 U	0.8 U	0.002 U
MW-20 Screen 2	Jul 2013	MW-20-2	NA	NA	3.0 U	0.002 U
MW-20 Screen 2	Oct/Nov 2013	MW-20-2	NA	NA	3.0 U	0.002 U
MW-20 Screen 2	Jan/Feb 2014	MW-20-2	NA	NA	3.0 U	0.002 U
MW-20 Screen 2	Apr/May 2014	MW-20-2	2.0 U	1.000 U	2.2 U	**0.001 J**
MW-20 Screen 2	Jul/Aug 2014	MW-20-2	NA	NA	3.0 U	0.004 UJ
MW-20 Screen 2	Jul/Aug 2014	DUP-1-3Q14	NA	NA	3.0 U	0.004 UJ
MW-20 Screen 3	Jul 2013	MW-20-3	NA	NA	**0.9 J**	0.002 U
MW-20 Screen 3	Oct/Nov 2013	MW-20-3	NA	NA	3.0 U	0.002 U
MW-20 Screen 3	Jan/Feb 2014	MW-20-3	NA	NA	3.0 U	0.002 U
MW-20 Screen 3	Apr/May 2014	MW-20-3	2.0 U	1.000 U	0.9 U	0.002 U
MW-20 Screen 3	Jul/Aug 2014	MW-20-3	NA	NA	3.0 U	0.004 UJ
MW-20 Screen 4	Jul 2013	MW-20-4	NA	NA	**0.9 J**	0.002 U
MW-20 Screen 4	Oct/Nov 2013	MW-20-4	NA	NA	3.0 U	0.002 U
MW-20 Screen 4	Oct/Nov 2013	DUPE-1-4Q13	NA	NA	3.0 U	0.002 U
MW-20 Screen 4	Jan/Feb 2014	MW-20-4	NA	NA	3.0 U	0.002 U
MW-20 Screen 4	Apr/May 2014	MW-20-4	**1.1 J**	1.000 U	0.5 U	0.010 U
MW-20 Screen 4	Jul/Aug 2014	MW-20-4	NA	NA	3.0 U	0.004 UJ
MW-20 Screen 5	Jul 2013	MW-20-5	NA	NA	**1.5 J**	0.002 U
MW-20 Screen 5	Oct/Nov 2013	MW-20-5	NA	NA	3.0 U	0.002 U
MW-20 Screen 5	Jan/Feb 2014	MW-20-5	NA	NA	3.0 U	**0.001 J**
MW-20 Screen 5	Apr/May 2014	MW-20-5	2.0 U	1.000 U	0.7 U	0.002 U
MW-20 Screen 5	Jul/Aug 2014	MW-20-5	NA	NA	3.0 U	0.004 UJ
MW-21 Screen 1	Jul 2013	MW-21-1	NA	NA	1.4 U	**0.001 J**
MW-21 Screen 1	Oct/Nov 2013	MW-21-1	NA	NA	3.9 U	0.002 U
MW-21 Screen 1	Jan/Feb 2014	MW-21-1	NA	NA	**1.8 J**	**0.002**
MW-21 Screen 1	Apr/May 2014	MW-21-1	2.0 U	1.000 U	**1.6 J**	0.002 U
MW-21 Screen 2	Jul 2013	MW-21-2	NA	NA	1.2 U	0.002 U
MW-21 Screen 2	Oct/Nov 2013	MW-21-2	NA	NA	1.3 U	0.002 U
MW-21 Screen 2	Jan/Feb 2014	MW-21-2	NA	NA	3.0 U	**0.001 J**
MW-21 Screen 2	Apr/May 2014	MW-21-2	2.0 U	1.000 U	3.0 U	0.002 U
MW-21 Screen 2	Jul/Aug 2014	MW-21-2	NA	NA	0.9 U	0.001 U

Sample Location	Sampling Event	Sample Number	Arsenic (µg/L)	Lead (µg/L)	Chromium, Total (µg/L)	Chromium, Hexavalent (mg/L)
MW-21 Screen 3	Jul 2013	MW-21-3	NA	NA	1.0 U	0.002 U
MW-21 Screen 3	Oct/Nov 2013	MW-21-3	NA	NA	2.0 U	0.002 U
MW-21 Screen 3	Jan/Feb 2014	MW-21-3	NA	NA	**0.6 J**	**0.001 J**
MW-21 Screen 3	Apr/May 2014	MW-21-3	2.0 U	1.000 U	3.0 U	0.002 U
MW-21 Screen 3	Jul/Aug 2014	MW-21-3	NA	NA	1.3 U	0.001 U
MW-21 Screen 4	Jul 2013	MW-21-4	NA	NA	**1.6 J**	0.002 U
MW-21 Screen 4	Jul 2013	DUPE-7-3Q13	NA	NA	**1.6 J**	0.002 U
MW-21 Screen 4	Oct/Nov 2013	MW-21-4	NA	NA	1.9 U	0.002 U
MW-21 Screen 4	Jan/Feb 2014	MW-21-4	NA	NA	**0.9 J**	**0.001 J**
MW-21 Screen 4	Apr/May 2014	MW-21-4	2.0 U	1.000 U	**1.2 J**	0.002 U
MW-21 Screen 4	Jul/Aug 2014	MW-21-4	NA	NA	**1.9 J**	0.002 U
MW-21 Screen 4	Jul/Aug 2014	DUP-6-3Q14	NA	NA	1.7 U	0.002 U
MW-21 Screen 5	Jul 2013	MW-21-5	NA	NA	**1.7 J**	**0.001 J**
MW-21 Screen 5	Oct/Nov 2013	MW-21-5	NA	NA	2.3 U	**0.001 J**
MW-21 Screen 5	Jan/Feb 2014	MW-21-5	NA	NA	1.1 U	**0.002 J**
MW-21 Screen 5	Apr/May 2014	MW-21-5	2.0 U	1.000 U	**1.2 J**	0.002 U
MW-21 Screen 5	Jul/Aug 2014	MW-21-5	NA	NA	2.0 U	0.002 U
MW-22 Screen 1	Jul 2013	MW-22-1	NA	NA	**0.9 J**	0.002 U
MW-22 Screen 1	Oct/Nov 2013	MW-22-1	NA	NA	1.0 U	0.002 U
MW-22 Screen 1	Jan/Feb 2014	MW-22-1	NA	NA	**2.7 J**	0.002 U
MW-22 Screen 1	Apr/May 2014	MW-22-1	2.0 U	1.000 U	0.7 U	0.002 U
MW-22 Screen 1	Jul/Aug 2014	MW-22-1	NA	NA	3.0 U	0.002 U
MW-22 Screen 2	Jul 2013	MW-22-2	NA	NA	**1.9 J**	**0.001 J**
MW-22 Screen 2	Oct/Nov 2013	MW-22-2	NA	NA	2.4 U	**0.001 J**
MW-22 Screen 2	Jan/Feb 2014	MW-22-2	NA	NA	**1.4 J**	0.002 U
MW-22 Screen 2	Apr/May 2014	MW-22-2	1.2 U	1.000 U	1.7 U	0.002 U
MW-22 Screen 2	Jul/Aug 2014	MW-22-2	NA	NA	**1.0 J**	**0.002 J**
MW-22 Screen 3	Jul 2013	MW-22-3	NA	NA	**2.7 J**	**0.002 J**
MW-22 Screen 3	Oct/Nov 2013	MW-22-3	NA	NA	3.2 U	**0.002**
MW-22 Screen 3	Jan/Feb 2014	MW-22-3	NA	NA	**1.4 J**	0.003 U
MW-22 Screen 3	Apr/May 2014	MW-22-3	1.2 U	1.000 U	2.5 U	0.003 U
MW-22 Screen 3	Jul/Aug 2014	MW-22-3	NA	NA	**1.4 J**	**0.002**
MW-22 Screen 4	Oct/Nov 2013	MW-22-4	NA	NA	2.0 U	**0.002 J**
MW-22 Screen 4	Apr/May 2014	MW-22-4	1.1 U	1.000 U	1.9 U	0.002 U
MW-22 Screen 5	Oct/Nov 2013	MW-22-5	NA	NA	3.0 U	0.002 U
MW-22 Screen 5	Apr/May 2014	MW-22-5	0.7 U	1.000 U	3.0 U	0.002 U
MW-23 Screen 1	Jul 2013	MW-23-1	NA	NA	**7.0**	0.002 U
MW-23 Screen 1	Oct/Nov 2013	MW-23-1	NA	NA	**2.0 J**	0.002 U
MW-23 Screen 1	Jan/Feb 2014	MW-23-1	NA	NA	**1.6 J**	0.002 U
MW-23 Screen 1	Apr/May 2014	MW-23-1	2.0 U	1.000 U	1.0 U	0.001 U
MW-23 Screen 1	Jul/Aug 2014	MW-23-1	NA	NA	**1.2 J**	**0.001 J**
MW-23 Screen 2	Jul 2013	MW-23-2	NA	NA	**1.4 J**	**0.001 J**

Sample Location	Sampling Event	Sample Number	Arsenic (µg/L)	Lead (µg/L)	Chromium, Total (µg/L)	Chromium, Hexavalent (mg/L)
MW-23 Screen 2	Oct/Nov 2013	MW-23-2	NA	NA	**0.9 J**	**0.001 J**
MW-23 Screen 2	Jan/Feb 2014	MW-23-2	NA	NA	**1.2 J**	0.002 U
MW-23 Screen 2	Apr/May 2014	MW-23-2	2.0 U	1.000 U	0.6 U	0.002 U
MW-23 Screen 2	Jul/Aug 2014	MW-23-2	NA	NA	**1.3 J**	**0.001 J**
MW-23 Screen 3	Jul 2013	MW-23-3	NA	NA	**3.1**	**0.003**
MW-23 Screen 3	Oct/Nov 2013	MW-23-3	NA	NA	**2.7 J**	**0.003**
MW-23 Screen 3	Jan/Feb 2014	MW-23-3	NA	NA	**3.1**	0.003 U
MW-23 Screen 3	Apr/May 2014	MW-23-3	**1.0 J**	1.000 U	3.1 U	0.004 U
MW-23 Screen 3	Jul/Aug 2014	MW-23-3	NA	NA	**3.2**	**0.003**
MW-23 Screen 4	Jul 2013	MW-23-4	NA	NA	**3.3**	**0.002 J**
MW-23 Screen 4	Oct/Nov 2013	MW-23-4	NA	NA	**2.3 J**	**0.003**
MW-23 Screen 4	Jan/Feb 2014	MW-23-4	NA	NA	**2.6 J**	**0.003**
MW-23 Screen 4	Apr/May 2014	MW-23-4	**1.3 J**	1.000 U	3.1 U	0.004 U
MW-23 Screen 4	Jul/Aug 2014	MW-23-4	NA	NA	**2.8 J**	**0.003**
MW-23 Screen 5	Oct/Nov 2013	MW-23-5	NA	NA	3.0 U	0.002 U
MW-23 Screen 5	Apr/May 2014	MW-23-5	2.0 U	1.000 U	0.6 U	0.001 U
MW-24 Screen 1	Jul 2013	MW-24-1	NA	NA	**13.0**	**0.007**
MW-24 Screen 1	Oct/Nov 2013	MW-24-1	NA	NA	**9.9**	**0.006**
MW-24 Screen 1	Jan/Feb 2014	MW-24-1	NA	NA	**16.0**	0.002 U
MW-24 Screen 1	Apr/May 2014	MW-24-1	2.0 U	1.000 U	**16.0**	**0.006**
MW-24 Screen 1	Jul/Aug 2014	MW-24-1	NA	NA	**6.1**	0.002 U
MW-24 Screen 2	Jul 2013	MW-24-2	NA	NA	**2.4 J**	**0.001 J**
MW-24 Screen 2	Oct/Nov 2013	MW-24-2	NA	NA	2.3 U	**0.002 J**
MW-24 Screen 2	Jan/Feb 2014	MW-24-2	NA	NA	**2.6 J**	**0.002**
MW-24 Screen 2	Apr/May 2014	MW-24-2	**2.2**	1.000 U	**2.0 J**	**0.003**
MW-24 Screen 2	Apr/May 2014	DUP-2-2Q14	**2.5**	1.000 U	**2.4 J**	**0.003**
MW-24 Screen 2	Jul/Aug 2014	MW-24-2	NA	NA	**1.7 J**	**0.002**
MW-24 Screen 3	Jul 2013	MW-24-3	NA	NA	3.0 U	0.002 U
MW-24 Screen 3	Oct/Nov 2013	MW-24-3	NA	NA	3.0 U	0.002 U
MW-24 Screen 3	Jan/Feb 2014	MW-24-3	NA	NA	3.0 U	0.002 U
MW-24 Screen 3	Apr/May 2014	MW-24-3	2.2 U	1.000 U	3.0 U	0.001 U
MW-24 Screen 3	Jul/Aug 2014	MW-24-3	NA	NA	3.0 U	0.002 U
MW-24 Screen 4	Jul 2013	MW-24-4	NA	NA	**0.6 J**	0.002 U
MW-24 Screen 4	Oct/Nov 2013	MW-24-4	NA	NA	3.0 U	0.002 U
MW-24 Screen 4	Jan/Feb 2014	MW-24-4	NA	NA	3.0 U	0.002 U
MW-24 Screen 4	Apr/May 2014	MW-24-4	1.3 U	1.000 U	0.6 U	0.002 U
MW-24 Screen 4	Jul/Aug 2014	MW-24-4	NA	NA	3.0 U	0.002 U
MW-24 Screen 5	Oct/Nov 2013	MW-24-5	NA	NA	3.1 U	**0.001 J**
MW-24 Screen 5	Apr/May 2014	MW-24-5	2.4 U	1.000 U	2.5 U	0.003 U
MW-25 Screen 1	Jul 2013	MW-25-1	NA	NA	**1.7 J**	0.002 U
MW-25 Screen 1	Oct/Nov 2013	MW-25-1	NA	NA	2.3 U	0.002 U
MW-25 Screen 1	Jan/Feb 2014	MW-25-1	NA	NA	2.0 U	0.002 U

Sample Location	Sampling Event	Sample Number	Arsenic (µg/L)	Lead (µg/L)	Chromium, Total (µg/L)	Chromium, Hexavalent (mg/L)
MW-25 Screen 1	Apr/May 2014	MW-25-1	2.0 U	1.000 U	**1.5 J**	0.002 U
MW-25 Screen 1	Jul/Aug 2014	MW-25-1	NA	NA	1.5 U	0.002 U
MW-25 Screen 2	Jul 2013	MW-25-2	NA	NA	**2.9 J**	**0.002 J**
MW-25 Screen 2	Oct/Nov 2013	MW-25-2	NA	NA	**2.5 J**	**0.001 J**
MW-25 Screen 2	Oct/Nov 2013	DUPE-4-4Q13	NA	NA	3.7 U	**0.001 J**
MW-25 Screen 2	Jan/Feb 2014	MW-25-2	NA	NA	**4.0**	**0.002 J**
MW-25 Screen 2	Apr/May 2014	MW-25-2	**0.8 J**	1.000 U	2.8 U	**0.002 J**
MW-25 Screen 2	Jul/Aug 2014	MW-25-2	NA	NA	**3.0**	**0.002**
MW-25 Screen 2	Jul/Aug 2014	DUP-4-3Q14	NA	NA	**2.7 J**	**0.002**
MW-25 Screen 3	Jul 2013	MW-25-3	NA	NA	**3.3**	**0.003**
MW-25 Screen 3	Jul 2013	DUPE-4-3Q13	NA	NA	**3.1**	**0.003**
MW-25 Screen 3	Oct/Nov 2013	MW-25-3	NA	NA	**2.4 J**	**0.002**
MW-25 Screen 3	Jan/Feb 2014	MW-25-3	NA	NA	**1.8 J**	**0.003**
MW-25 Screen 3	Apr/May 2014	MW-25-3	**1.0 J**	1.000 U	2.7 U	**0.003**
MW-25 Screen 3	Jul/Aug 2014	MW-25-3	NA	NA	**3.5**	**0.003**
MW-25 Screen 4	Jul 2013	MW-25-4	NA	NA	**1.5 J**	0.002 U
MW-25 Screen 4	Oct/Nov 2013	MW-25-4	NA	NA	**1.1 J**	0.002 U
MW-25 Screen 4	Jan/Feb 2014	MW-25-4	NA	NA	**0.9 J**	**0.001 J**
MW-25 Screen 4	Apr/May 2014	MW-25-4	**0.8 J**	1.000 U	1.4 U	**0.001 J**
MW-25 Screen 4	Jul/Aug 2014	MW-25-4	NA	NA	**1.4 J**	**0.001 J**
MW-25 Screen 5	Jul 2013	MW-25-5	NA	NA	3.0 U	0.002 U
MW-25 Screen 5	Oct/Nov 2013	MW-25-5	NA	NA	3.0 U	0.002 U
MW-25 Screen 5	Jan/Feb 2014	MW-25-5	NA	NA	3.0 U	0.002 U
MW-25 Screen 5	Apr/May 2014	MW-25-5	**1.7 J**	1.000 U	3.0 U	0.002 U
MW-25 Screen 5	Jul/Aug 2014	MW-25-5	NA	NA	3.0 U	0.002 U
MW-26 Screen 1	Jul 2013	MW-26-1	NA	NA	3.0 U	0.002 U
MW-26 Screen 1	Oct/Nov 2013	MW-26-1	NA	NA	3.0 U	0.002 U
MW-26 Screen 1	Oct/Nov 2013	DUPE-3-4Q13	NA	NA	**7.2**	0.002 U
MW-26 Screen 1	Jan/Feb 2014	MW-26-1	NA	NA	3.0 U	0.002 U
MW-26 Screen 1	Apr/May 2014	MW-26-1	2.0 U	1.000 U	3.0 U	0.002 U
MW-26 Screen 1	Jul/Aug 2014	MW-26-1	NA	NA	3.0 U	0.002 U
MW-26 Screen 2	Jul 2013	MW-26-2	NA	NA	**2.6 J**	0.002 U
MW-26 Screen 2	Oct/Nov 2013	MW-26-2	NA	NA	**2.1 J**	0.002 U

Sample Location	Sampling Event	Sample Number	Arsenic (µg/L)	Lead (µg/L)	Chromium, Total (µg/L)	Chromium, Hexavalent (mg/L)
MW-26 Screen 2	Jan/Feb 2014	MW-26-2	NA	NA	3.0 U	0.001 U
MW-26 Screen 2	Apr/May 2014	MW-26-2	**2.3**	1.000 U	**5.0**	0.002 U
MW-26 Screen 2	Jul/Aug 2014	MW-26-2	NA	NA	**2.0 J**	0.002 U
California Maximum Contaminant Level (MCL)			10	15 *	50	0.01 **
EPA Region IX Maximum Contaminant Level			50	15 *	100	NE

Notes

DUPE	Field Duplicate
NA	Not analyzed
NE	Not established
UNK	PQL value unknown
*	Interim Action Level - California Department of Health Services
**	As of January 6, 2004, hexavalent chromium is regulated under the 50-µg/L MCL for total chromium.
	DHS will be adopting an MCL that is specific for hexavalent chromium (DHS, 2004).
	As of December 31, 2010, a draft PHG of 0.02 µg/L has been established by Cal/EPA (e.g., Health and Safety Code requirement to establish the MCL); however, the CDPH (formerly DHS) has not established an MCL.
	On August 23, 2013, the California Department of Public Health (CDPH) proposed to establish a specific MCL for Cr(VI) at a concentration of 0.010 milligram per liter (10.0 µg/L equivalent).
	On July 1, 2014 the State Water Resources Control Board (CalEPA) adopted an MCL for Cr(VI) of 10.0 µg/L.
J	Analyte concentration is an estimated value
U	Analyte was analyzed for but not detected at or above the stated limit
UJ	Analyte was analyzed for but not detected; analyte concentration is an estimated value

TABLE 3
SUMMARY OF VOLATILE ORGANIC COMPOUNDS AND PERCHLORATE REPORTED IN MUNICIPAL PRODUCTION WELLS NEAR JPL DURING LAST FIVE SAMPLING EVENTS OF THE LONG-TERM QUARTERLY GROUNDWATER SAMPLING PROGRAM

(All concentrations reported in µg/L.)

(Shaded values exceed State or Federal MCLs or action levels.)

Purveyor	Well Name	Sample Date	Perchlorate	Carbon Tetrachloride	PCE	TCE
LINCOLN AVENUE WATER CO.	WELL 03	7/30/13	17.0	NA	NA	NA
		8/06/13	17.0	1.1	0.5 U	1.2
		8/13/13	18.0	NA	NA	NA
		8/20/13	17.0	NA	NA	NA
		8/26/13	NA	1.3	0.5 U	1.5
		8/27/13	17.0	NA	NA	NA
		9/03/13	17.0	1.4	0.5 U	1.6
		9/10/13	19.0	NA	NA	NA
		9/17/13	19.0	NA	NA	NA
		9/24/13	19.0	NA	NA	NA
		11/05/13	25.0	1.8	0.5 U	1.8
		11/12/13	24.0	NA	NA	NA
		11/19/13	22.0	NA	NA	NA
		12/03/13	26.0	2.0	0.5 U	1.9
		12/10/13	27.0	NA	NA	NA
		12/17/13	29.0	NA	NA	NA
		12/23/13	27.0	NA	NA	NA
		2/11/14	13.0	NA	NA	NA
		2/18/14	28.0	NA	NA	NA
		2/25/14	27.0	NA	NA	NA
		3/04/14	30.0	2.0	0.5 U	1.9
		3/14/14	29.0	NA	NA	NA
		3/18/14	27.0	NA	NA	NA
		3/25/14	27.0	NA	NA	NA
		4/01/14	26.0	2.5	0.6	2.6
		4/08/14	25.0	NA	NA	NA
		4/15/14	25.0	NA	NA	NA
		4/22/14	25.0	NA	NA	NA
		4/29/14	24.0	NA	NA	NA
		5/20/14	22.0	NA	NA	NA
		5/27/14	22.0	NA	NA	NA
		6/03/14	23.0	2.1	0.5	1.9
		6/10/14	22.0	NA	NA	NA
		6/17/14	22.0	NA	NA	NA
		6/24/14	22.0	NA	NA	NA
		7/01/14	23.0	2.1	0.5	2.2
		7/08/14	23.0	NA	NA	NA
		7/15/14	24.0	NA	NA	NA
		7/16/14	NA	2.6	0.5	2.3
		7/22/14	23.0	NA	NA	NA
		7/29/14	25.0	NA	NA	NA
	WELL 05	7/30/13	17.0	NA	NA	NA
		8/06/13	16.0	1.8	0.6	1.6
		8/13/13	17.0	NA	NA	NA

Purveyor	Well Name	Sample Date	Perchlorate	Carbon Tetrachloride	PCE	TCE
LINCOLN AVENUE WATER CO. (con't)	WELL 05 (con't)	8/20/13	**16.0**	NA	NA	NA
		8/27/13	**17.0**	NA	NA	NA
		9/03/13	**18.0**	**1.9**	**0.6**	**1.8**
		9/10/13	**16.0**	NA	NA	NA
		9/17/13	**16.0**	NA	NA	NA
		9/24/13	**16.0**	NA	NA	NA
		11/05/13	**15.0**	**1.5**	0.5 U	**1.5**
		11/12/13	**14.0**	NA	NA	NA
		11/19/13	**14.0**	NA	NA	NA
		11/26/13	**15.0**	NA	NA	NA
		12/04/13	**14.0**	**1.5**	**0.5**	**1.3**
		12/10/13	**14.0**	NA	NA	NA
		12/17/13	**16.0**	NA	NA	NA
		12/23/13	**13.0**	NA	NA	NA
		2/11/14	**27.0**	NA	NA	NA
		2/20/14	**13.0**	NA	NA	NA
		2/25/14	**13.0**	NA	NA	NA
		3/14/14	**14.0**	**2.5**	**0.8**	**2.0**
		3/18/14	**12.0**	NA	NA	NA
		3/25/14	**11.0**	NA	NA	NA
		4/01/14	**12.0**	**1.5**	**0.6**	**1.6**
		4/08/14	**12.0**	NA	NA	NA
		4/15/14	**13.0**	NA	NA	NA
		4/22/14	**10.0**	NA	NA	NA
		4/29/14	**11.0**	NA	NA	NA
		5/20/14	**11.0**	NA	NA	NA
		5/27/14	**10.0**	NA	NA	NA
		6/03/14	**11.0**	**1.3**	**0.6**	**1.4**
		6/10/14	**10.0**	NA	NA	NA
		6/17/14	**11.0**	NA	NA	NA
		6/24/14	**13.0**	NA	NA	NA
		7/01/14	**11.0**	**1.2**	**0.5**	**1.2**
		7/08/14	**11.0**	NA	NA	NA
		7/15/14	**10.0**	NA	NA	NA
		7/22/14	**9.9**	NA	NA	NA
		7/29/14	**11.0**	NA	NA	NA
RUBIO CANON LAND & WATER ASSOCIATION	WELL 04	7/29/13	4.0 U	NA	NA	NA
		8/05/13	4.0 U	NA	NA	NA
		8/12/13	4.0 U	NA	NA	NA
		8/19/13	4.0 U	NA	NA	NA
		8/26/13	4.0 U	NA	NA	NA
		9/03/13	4.0 U	NA	NA	NA
		9/09/13	4.0 U	NA	NA	NA
		9/16/13	4.0 U	NA	NA	NA
		9/19/13	4.0 U	NA	NA	NA
		9/23/13	4.0 U	NA	NA	NA
		11/04/13	4.0 U	NA	NA	NA
		11/12/13	4.0 U	NA	NA	NA
		11/18/13	4.0 U	NA	NA	NA
		11/25/13	4.0 U	NA	NA	NA
		12/02/13	4.0 U	NA	NA	NA

Purveyor	Well Name	Sample Date	Perchlorate	Carbon Tetrachloride	PCE	TCE
RUBIO CANON LAND & WATER ASSOCIATION (con't)	WELL 04 (con't)	12/09/13	4.0 U	NA	NA	NA
		12/16/13	4.0 U	NA	NA	NA
		12/23/13	4.0 U	NA	NA	NA
		2/10/14	4.0 U	NA	NA	NA
		2/18/14	4.0 U	NA	NA	NA
		2/24/14	4.0 U	NA	NA	NA
		3/03/14	4.0 U	NA	NA	NA
		3/10/14	4.0 U	NA	NA	NA
		3/17/14	4.0 U	NA	NA	NA
		3/24/14	4.0 U	NA	NA	NA
		3/31/14	4.0 U	NA	NA	NA
		4/07/14	4.0 U	NA	NA	NA
		4/14/14	4.0 U	NA	NA	NA
		4/21/14	4.0 U	NA	NA	NA
		4/28/14	4.0 U	NA	NA	NA
		5/19/14	4.0 U	NA	NA	NA
		5/27/14	4.0 U	NA	NA	NA
		6/02/14	4.0 U	NA	NA	NA
		6/09/14	4.0 U	NA	NA	NA
		6/16/14	4.0 U	NA	NA	NA
		6/23/14	4.0 U	NA	NA	NA
		6/30/14	4.0 U	NA	NA	NA
		7/07/14	4.0 U	NA	NA	NA
		7/14/14	4.0 U	NA	NA	NA
		7/21/14	4.0 U	NA	NA	NA
		7/28/14	4.0 U	NA	NA	NA
	WELL 07	7/29/13	4.0 U	NA	NA	NA
		8/05/13	4.0 U	NA	NA	NA
		8/12/13	4.0 U	NA	NA	NA
		8/19/13	4.0 U	NA	NA	NA
		8/26/13	4.0 U	NA	NA	NA
		9/03/13	4.0 U	NA	NA	NA
		9/09/13	4.0 U	NA	NA	NA
		9/16/13	4.0 U	NA	NA	NA
		9/19/13	4.0 U	NA	NA	NA
		9/23/13	4.0 U	NA	NA	NA
		2/10/14	4.0 U	NA	NA	NA
		2/18/14	4.0 U	NA	NA	NA
		2/24/14	4.0 U	NA	NA	NA
		3/03/14	4.0 U	NA	NA	NA
		3/10/14	4.0 U	NA	NA	NA
		3/17/14	4.0 U	NA	NA	NA
		3/24/14	4.0 U	NA	NA	NA
		3/31/14	4.0 U	NA	NA	NA
		4/07/14	4.0 U	NA	0.5 U	NA
		4/14/14	4.0 U	NA	NA	NA
		4/21/14	4.0 U	NA	NA	NA
		4/28/14	4.0 U	NA	NA	NA
		5/19/14	4.0 U	NA	NA	NA
		5/27/14	4.0 U	NA	NA	NA
		6/02/14	4.0 U	NA	NA	NA

Purveyor	**Well Name**	**Sample Date**	**Perchlorate**	**Carbon Tetrachloride**	**PCE**	**TCE**
RUBIO CANON LAND & WATER ASSOCIATION (con't)	WELL 07 (con't)	6/09/14	4.0 U	NA	NA	NA
		6/16/14	4.0 U	NA	NA	NA
		6/23/14	4.0 U	NA	NA	NA
		6/30/14	4.0 U	NA	NA	NA
		7/07/14	4.0 U	NA	**0.6**	NA
		7/14/14	4.0 U	NA	NA	NA
		7/21/14	4.0 U	NA	NA	NA
		7/28/14	4.0 U	NA	NA	NA
LAS FLORES WATER CO.	WELL 02	7/29/13	**4.5**	NA	**0.6**	NA
		8/05/13	**4.0**	NA	0.5 U	NA
		8/12/13	**5.2**	NA	**0.6**	NA
		8/19/13	**5.6**	NA	**0.5**	NA
		8/26/13	**5.3**	NA	**0.6**	NA
		9/03/13	**5.5**	NA	**0.6**	NA
		9/09/13	**5.7**	NA	**0.8**	NA
		9/16/13	**4.8**	NA	**0.7**	NA
		9/23/13	**5.2**	NA	**0.7**	NA
		11/04/13	**5.1**	NA	**1.2**	NA
		11/11/13	**4.8**	NA	**1.3**	NA
		11/18/13	**4.6**	NA	**1.3**	NA
		11/25/13	**4.3**	NA	**1.5**	NA
		12/02/13	4.0 U	NA	**1.5**	NA
		12/09/13	**4.8**	NA	**1.7**	NA
		12/16/13	**4.9**	NA	**1.7**	NA
		12/23/13	**4.8**	NA	**1.8**	NA
		2/10/14	**4.3**	0.5 U	**2.6**	0.5 U
		2/18/14	**5.1**	NA	**2.8**	NA
		2/24/14	**5.0**	NA	**2.6**	NA
		3/03/14	**4.5**	NA	**2.7**	NA
		3/10/14	**5.2**	NA	**4.8**	NA
		3/17/14	**4.2**	NA	**3.9**	NA
		3/24/14	**4.7**	NA	**3.9**	NA
		3/31/14	**5.6**	NA	**4.1**	NA
		4/07/14	**4.7**	NA	**3.1**	NA
		4/14/14	**4.9**	NA	**3.3**	NA
		4/21/14	4.0 U	NA	**3.9**	NA
		4/28/14	**5.4**	NA	**3.4**	NA
		5/19/14	**4.2**	NA	**2.8**	NA
		5/27/14	4.0 U	NA	**3.4**	NA
		6/02/14	**4.3**	NA	**3.8**	NA
		6/09/14	**5.1**	NA	**3.5**	NA
		6/16/14	**4.3**	NA	**3.7**	NA
		6/23/14	**4.9**	NA	**4.2**	NA
		6/30/14	**5.2**	NA	**3.7**	NA
		7/07/14	**4.9**	NA	**3.8**	NA
		7/14/14	**4.8**	NA	**3.4**	NA
		7/21/14	**4.1**	NA	**3.6**	NA
LA CANADA IRRIGATION DIST.	WELL 01	8/19/13	4.0 U	NA	NA	NA
		9/03/13	NA	NA	**0.7**	**1.9**
		11/25/13	4.0 U	NA	NA	NA

Purveyor	Well Name	Sample Date	Perchlorate	Carbon Tetrachloride	PCE	TCE
LA CANADA IRRIGATION DIST. (con't)	WELL 01 (con't)	2/24/14	4.0 U	NA	NA	NA
		5/27/14	4.0 U	NA	NA	NA
		6/23/14	NA	NA	0.5 U	**0.6**
	WELL 06	7/29/13	4.0 U	NA	NA	NA
		9/09/13	NA	NA	0.5 U	0.5 U
		3/17/14	NA	NA	**0.6**	**1.4**
		6/09/14	NA	NA	0.5 U	**0.7**
VALLEY WATER CO.	WELL 01	8/06/13	4.0 U	0.5 U	0.5 U	0.5 U
		9/03/13	**5.2**	0.5 U	**1.8**	**1.3**
		10/03/13	4.0 U	0.5 U	**1.8**	**1.5**
		5/07/14	NA	0.5 U	**2.6**	0.5 U
		6/04/14	4.0 U	0.5 U	**2.5**	0.5 U
		7/02/14	4.0 U	0.5 U	**2.1**	**1.4**
	WELL 02	8/06/13	4.0 U	0.5 U	0.5 U	0.5 U
		9/03/13	**5.3**	0.5 U	**2.2**	**0.8**
		10/03/13	4.0 U	0.5 U	**1.5**	**0.9**
		5/07/14	NA	0.5 U	**3.1**	**0.9**
		6/04/14	**4.4**	0.5 U	**2.0**	**1.1**
		7/02/14	**4.4**	0.5 U	**1.9**	**1.2**
	WELL 03	8/06/13	4.0 U	0.5 U	0.5 U	0.5 U
		9/03/13	**4.1**	NA	NA	NA
		5/07/14	NA	0.5 U	**1.8**	**1.1**
		6/04/14	**4.7**	0.5 U	**1.4**	**1.0**
		7/02/14	**4.8**	0.5 U	**1.5**	**1.0**
	WELL 04	8/06/13	4.0 U	0.5 U	0.5 U	0.5 U
		9/03/13	4.6 U	NA	NA	NA
		5/07/14	NA	0.5 U	**1.5**	**2.0**
		6/04/14	**4.0**	0.5 U	**1.3**	**2.1**
		7/02/14	4.0 U	0.5 U	**1.5**	**1.2**
PASADENA-CITY. WATER DEPT.	ARROYO	8/02/13	**28.5**	**1.6**	0.5 U	**0.6**
		8/06/13	**28.7**	**1.7**	0.5 U	**0.7**
		8/13/13	**29.9**	**1.5**	0.5 U	**0.6**
		8/20/13	**26.9**	**2.4**	0.5 U	**0.6**
		8/27/13	**29.6**	**2.3**	0.5 U	**0.6**
		9/03/13	**26.1**	**1.9**	0.5 U	**0.7**
		9/10/13	**28.5**	**1.5**	0.5 U	**0.7**
		9/17/13	**27.2**	**2.0**	0.5 U	**0.7**
		9/24/13	**23.9**	**1.7**	0.5 U	**0.7**
		11/05/13	**28.3**	**1.4**	0.5 U	**0.6**
		11/13/13	**28.9**	**1.8**	0.5 U	**0.6**
		11/19/13	**26.2**	**1.8**	0.5 U	**0.7**
		11/26/13	**23.9**	**1.8**	0.5 U	**0.7**
		12/03/13	**24.4**	**1.6**	0.5 U	**0.6**
		12/10/13	**25.1**	**1.7**	0.5 U	**0.6**
		12/17/13	**24.3**	**1.9**	0.5 U	**0.7**
		12/24/13	**25.1**	**1.7**	0.5 U	**0.7**
		12/31/13	**24.8**	**1.7**	0.5 U	**0.8**
		2/11/14	**25.2**	**1.5**	0.5 U	**0.7**
		2/18/14	**24.8**	**1.6**	0.5 U	**0.7**
		2/25/14	**23.8**	**1.6**	0.5 U	**0.6**

Purveyor	Well Name	Sample Date	Perchlorate	Carbon Tetrachloride	PCE	TCE
PASADENA-CITY, WATER DEPT. (con't)	ARROYO (con't)	3/11/14	23.1	1.0	0.5 U	0.5 U
		3/18/14	23.8	1.4	0.5 U	0.5
		3/25/14	25.0	1.4	0.5 U	0.5
		4/01/14	25.5	1.3	0.5 U	0.5
		4/08/14	26.0	1.3	0.5 U	0.6
		4/15/14	23.7	1.2	0.5 U	0.6
		4/22/14	NA	1.6	0.5 U	0.7
		4/29/14	NA	1.4	0.5 U	0.6
		5/20/14	21.6	1.5	0.5 U	0.7
		5/27/14	18.6	1.8	0.5 U	0.7
		6/03/14	18.1	1.5	0.5 U	0.7
		6/10/14	19.0	1.7	0.5 U	0.8
		6/24/14	19.5	1.5	0.5 U	0.7
		7/01/14	19.5	1.6	0.5 U	0.8
		7/08/14	19.4	1.9	0.5 U	0.9
		7/15/14	19.3	1.8	0.5 U	0.9
		7/22/14	18.4	1.1	0.5 U	0.7
		7/29/14	18.4	1.7	0.5 U	0.8
	VENTURA	8/14/13	5.9	0.5 U	0.8	4.2
		9/10/13	5.5	0.5 U	1.0	4.6
		11/19/13	4.2	0.5 U	1.0	4.3
		12/19/13	4.6	0.5 U	1.0	4.5
		2/18/14	5.6	0.5 U	1.0	4.3
		2/25/14	4.8	0.5 U	1.0	4.4
		3/11/14	5.7	0.5 U	1.1	4.3
		3/18/14	6.1	0.5 U	1.0	4.2
		3/25/14	7.7	0.5 U	1.0	4.4
		4/01/14	7.7	0.5 U	0.9	4.0
		4/08/14	6.3	0.5 U	0.9	4.2
		4/15/14	5.7	NA	NA	NA
		4/22/14	NA	0.5 U	1.0	4.6
		4/29/14	NA	0.5 U	0.9	4.1
		7/15/14	5.1	0.5 U	1.3	5.2
	WELL 52	8/14/13	7.5	0.5 U	0.8	4.2
		9/10/13	8.0	0.5 U	0.7	2.4
		9/17/13	7.7	0.5 U	0.6	2.2
		9/24/13	6.9	0.5 U	0.6	2.2
		11/05/13	6.8	0.5 U	0.5 U	1.7
		11/13/13	6.5	0.5 U	0.6	2.1
		11/19/13	6.3	0.5 U	0.6	2.1
		11/26/13	5.8	0.5 U	0.6	2.1
		12/03/13	6.3	0.5 U	0.6	2.0
		12/10/13	6.0	0.5 U	0.6	2.1
		12/17/13	5.7	0.5 U	0.7	2.3
		12/24/13	6.1	0.5 U	0.7	2.3
		12/31/13	5.6	0.5 U	0.6	2.1
		2/11/14	7.3	0.5 U	0.7	2.5
		2/18/14	5.9	0.5 U	0.6	2.3
		2/25/14	6.1	0.5 U	0.6	2.2
		3/11/14	6.4	0.5 U	0.6	2.4

Purveyor	Well Name	Sample Date	Perchlorate	Carbon Tetrachloride	PCE	TCE
PASADENA-CITY, WATER DEPT. (con't)	WELL 52 (con't)	3/18/14	**6.7**	0.5 U	**0.6**	**2.3**
		3/25/14	**7.0**	0.5 U	**0.6**	**2.3**
		4/01/14	**6.9**	0.5 U	**0.6**	**2.2**
		4/08/14	**8.2**	0.5 U	**0.6**	**2.2**
		4/15/14	**7.0**	0.5 U	**0.6**	**2.3**
		4/22/14	**7.0**	0.5 U	**0.7**	**2.6**
		4/29/14	NA	0.5 U	**0.7**	**2.6**
		5/20/14	**5.5**	0.5 U	**0.6**	**3.1**
		5/27/14	**4.5**	0.5 U	**0.6**	**2.7**
		6/03/14	**5.2**	0.5 U	**0.6**	**2.7**
		6/10/14	**5.1**	0.5 U	**0.7**	**3.0**
		6/24/14	NA	0.5 U	**0.7**	**2.8**
		7/01/14	**5.3**	0.5 U	**0.7**	**3.3**
		7/08/14	**5.5**	0.5 U	**0.8**	**3.5**
		7/15/14	**5.7**	0.5 U	**0.8**	**3.7**
		7/22/14	**5.8**	0.5 U	**0.7**	**2.8**
		7/29/14	**4.9**	0.5 U	**0.8**	**3.4**
California Maximum Contaminant Level (MCL)			6.0	0.5	5.0	5.0
EPA Region IX Maximum Contaminant Level			NE	5.0	5.0	5.0

Notes

NA	Not analyzed
NE	Not established
Source	California Department of Public Health Drinking Water Program, California Drinking Water Data, January 4, 2005
U	Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

Craig A. Sherman
A Professional Law Corporation

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June 1, 2015

Public Comment for Pasadena City Council
Appeal Hearing June 1, 2015

Project: Arroyo Seco Canyon Project
Appellant: Spirit of the Sage Council, et al.

Spirit of the Sage Council makes this appeal of the March 4, 2015 decision of the BZA to approve a conditional use permit ("CUP") and initial study/mitigated negative declaration ("IS/MND") for the Arroyo Seco Canyon Project ("Project") and incorporates all of the March 4, 2015 public comments given by both Spirit of the Sage Council, Project Soliton, and Hugh Bowles.

In addition to the reasons given in the March 4, 2015 public comment letter, the Project should not be approved for the following reasons:

1) Failure to properly review the Initial Study and proposed Mitigated Negative Declaration; failure to consider new information raised during the appeal process that shows that there are actual and potential significant environmental impacts that either (1) cannot be mitigated; or (2) are not mitigated to less than a significant impact.

2) The CUP should not be issued because findings under the City of Pasadena Zoning Code Section 17.61.050.H do not support the approval of a CUP for the Project.

3) Despite preparation of a MND, there is a fair argument that one or more significant adverse environmental impacts *could* result, despite the findings of the MND and the proposed mitigation;

4) Improper and misuse ("waste") of the government money (see enclosure provided herewith).

The following factual and legal reasons support rejection of the project as currently studied and proposed:

Actual and Potential Significant Impacts

Appellants commented on and brought forth multiple significant impacts and potential impacts including (1) soil contamination; (2) water contamination; (3) biological resources; and (4) native plants and animal species. These significant impacts were dismissed as presenting "no new information . . . that would require the recirculation of the proposed Mitigated Negative Declaration." (Planning and Community Development Department staff report ("Staff Report") at p. 16).

Soil Contamination

The location of the Project next to a Cortese and Superfund site, with admitted contaminants that are present under Area 3 of the Project should be a presumption of a fair argument that actual and potential significant impacts are present that cannot and have not been properly mitigated in the proposed negative declaration. Additionally, the location triggers the strong presumption in favor of preparing an EIR as opposed to an MND. Cortese projects are not categorically exempt from CEQA because they may be more likely to involve significant environmental effects. (*See* Pub. Resources Code, § 21084(d).)

The IS/MND specifically admits groundwater contamination (IS/MND 4-72) and anticipates the potential for the disturbance of contaminated soils (Id.) However, under mitigation measure MM HAZ-2, the IS/MND assumes that any contaminated soils will be discovered by a contractor based upon sight or odor. (IS/MND at p. 1-10.) At the same time, the planned project anticipates using an earth shaker to shake out soil that has not been tested for contaminants. The shaking process potentially exposes both workers and the general public to airborne contaminants. (IS/MND at p. 3-10.)

All activity, particularly in Area Three to grade, dig, shake and/or transport soils without a proper environmental study that includes testing for soil contaminants when the site is known to have contaminants and is located next to the JPL Superfund site creates significant potential impacts that cannot be mitigated by the current IS/MND.

Indirect and Cumulative Impacts

Water Contamination

As stated, the MND admits groundwater contamination. The IS/MND fails to properly take into consideration the indirect and/or cumulative impact of additional water flow into the Monk Hill Groundwater Treatment System. The IS/MND relies on a ten year old JPL modeling study from 2005 and fails to take into account the environmental changes over 10 years and the intervening 2009 Station Fire, which is acknowledged throughout the IS/MND as altering the topography and soils of the entire area. (IS/MND at p. 4-74.)

The IS/MND did not study whether the Monk Hill Treatment System could handle additional water and contaminants from an increase in the Monk Hill subarea, the potential underground movement of the contamination plume and the potential impact on the Pasadena water supply.

Water Collection

The Project contemplates collecting fifty (50) percent or more of the water in the Arroyo Seco Canyon and fails to take into account the direct and/or cumulative significant impacts of the decrease in water in each and every area downstream.

Mandatory Findings of Significance

Under CEQA and the CEQA Guidelines, this Project qualifies for one or more mandatory findings of significance that compels the preparation of an EIR. (*See* PRC §21083(b); 14 Cal Code Regs §15065(a).) Under 14 Cal Code Regs §15065(a), there is a mandatory requirement that this Project has a significant effect on the environment for the following reasons:

1. The Project has the potential to degrade substantially the quality of the environment. (PRC §21083(b)(l); 14 Cal Code Regs §15065(a)(1).)

2. The Project has the potential to achieve short-term environmental goals to the disadvantage of long-term environmental goals. (PRC §21083(b)(l); 14 Cal Code Regs §15065(a)(2).)

3. The Project has possible environmental effects that are individually limited but cumulatively considerable. Pub Res C §21083(b)(2); 14 Cal Code Regs §15065(a)(3).

4. The Project has environmental effects that will cause substantial adverse effects on human beings, either directly or indirectly. Pub Res C §21083(b)(3); 14 Cal Code Regs §15065(a)(4).

All four reasons for the mandatory finding of significant impacts are found in the proposed Project, based upon the arguments and evidence presented by Appellants.

Biological Resources

Removal of Established Trees

The MND relies on findings in the ES that the removal of up to 17 trees for the project has a less than significant impact (ES at 4-24) because the project intends to comply with local ordinance governing the planting of offset trees. While the project may comply with local City ordinance, the removal of mature White Alders, Coast Live Oak, and Arroyo Willows is a significant impact even when replaced because of the required time for trees to mature. These are *at a minimum* unmitigated short term adverse impacts to the environment for which an Environmental Impact Report is required.

Impacts on Species

Because the project will collect and prevent the flow of more than fifty percent (50%) of the water in the Project area, there is a mandatory finding that the Project may have a significant impact under 14 Cal Code Regs § 15065(a)(1) through the downstream reduction of sustainability of habitat for fish and wildlife, and for which an environmental impact report is necessary.

Native plant/animal species

The MND fails to take into account the possible significant impact to vegetation and wildlife. The current restoration project calls for leaving the majority of artificial fill and therefore will not increase the biological resources to the extent claimed. Additionally, the ES relies on findings from the 2003 MEIR, which is now out of date due to the effects of the 2009 wildfire and storm disturbances that significantly altered the topography of the project areas. The February 4, 2015 United States Fish and Wildlife Service visit identified post storm disturbance areas and regrowth of vegetation. The changes to vegetation and habitat are not sufficiently accounted for in an MND and require further study and an EIR to properly determine and mitigate potential significant effects of the project on biological resources. See additional information in the enclosures submitted herewith. On this topic and all others, the City's reliance on the prior MEIR is not proper based upon the significant passage of time, as well as the limitation that it is improper for a MND to tier-off an EIR (especially where adverse impacts were found to exist in the prior study).

Misappropriation and Unlawful Spending (Waste)

It is alleged and believed that the City is not in compliance with "Grant Agreement No. 4600009706 (GLAC-IRWM Proposition 84 Implementation Grant)" along with the related Agreement between LACFCD and the City. The Prop 84 Agreement between Los Angeles County Flood Control District and State states that the Local Project Administrator (City) must also comply with the Agreement, including returning funds not used for the project. In the current project, the City did not reveal in their Prop 84 grant proposal that the project location is adjacent to a federally designated Superfund and Cortese site. The use of funds for this project from Prop 84 as it is now being implemented is a waste and misuse of Prop 84 funds and subject to challenge under California Code of Civil Procedure 526a and other relevant California law.

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Attachments:

1) 1988 - JPL preliminary assessment (44 pages)
2) EPA Superfund Site Overview: Jet Propulsion Laboratory (5 pages)
3) Final CERCLA Sheet (MH Groundwater Wells and Treatment Plant (44 pages)
4) NASA Oct 2014 - 3rd Qtr Groundwater Monitoring Summary (44 pages)
5) Sunset Well PERCHLORATE STUDY (NAS710345A) (29 pages)

From: TDSeifert@aol.com
Sent: Monday, June 01, 2015 3:39 PM
To: Jomsky, Mark
Subject: Please Distribute to our Mayor and City Council
Attachments: ASCPCouncilLetter150601.pdf

Re: **Arroyo Seco Canyon Project**

Dear Mayor Tornek and the City Council:

I call your attention to the attached letter regarding the Arroyo Seco Canyon Project to which I add my strongest support. As former Chair of the Hahamonga Watershed Park Advisory Committee, I had numerous dealing with the Spirit of the Sage Council and their predatory types of lawsuits against the City of Pasadena. Their appeal has been unanimously denied by the Board of Zoning Appeals and it is time to put it to rest.

I urge you to deny the appeal and to adopt the Conditional Use Permit and Mitigated Negative Declaration for the Arroyo Seco Canyon Project.

Thank you.

Thomas D. Seifert, Chair
Arroyo Seco Foundation
626-577-6000
626-818-4580 cell

Arroyo Seco Foundation

May 28, 2015

Mayor Terry Tornek and Members of the Pasadena City Council
City Hall
100 N. Garfield Avenue
Pasadena, Ca 91109

RE: Arroyo Seco Canyon Project

Dear Mayor Tornek and Members of the City Council:

As the Pasadena City Council considers the most appropriate drought response on Monday, you will also have the opportunity to take a significant step to increase local water resources and to do so in an environmentally-beneficial way.

The Arroyo Seco Canyon Project is a model project, resulting from a partnership between the Arroyo Seco Foundation (ASF) and the Pasadena Water & Power Department (PWP). ASF developed the groundwork for this project and secured $3.27 million dollar in funding for it from the California Integrated Water Resources Management Program. We have worked closely with PWP staff to develop and implement the program, so we strongly support the program that is being presented to you for your review and approval.

The benefits of the program are considerable. The Canyon project will:

1. Increase local water supply quickly by allowing Pasadena to take full advantage of existing water rights;
2. Improve conditions for fish and aquatic species in the Arroyo Seco;
3. Enhance water quality by providing a public restroom at the top of Hahamongna Watershed Park;
4. Restore aquatic and riparian habitat damaged by the Station Fire and subsequent floods;
5. Improve passive recreational opportunities for local residents;
6. Provide a community nursery for native plants; and
7. Educate Pasadena and our region about integrated water programs for a sustainable future.

Throughout the planning process, the benefits and impacts of the program have been carefully evaluated by the project team and outstanding technical experts. There have been numerous opportunities for public participation in the program, and significant changes have been made based on that input. The Conditional Use Permit (CUP) and Mitigated Negative Declaration (MND) were approved by the Pasadena Planning hearing officer on January 7, 2015. An appeal was then filed by the

Spirit of the Sage Council, a non-profit organization based in North Carolina, Project Soliton, a related non-profit organization, and an Altadena resident, Hugh Bowles. The Board of Zoning Appeals denied their appeal on March 4, 2015 by a unanimous vote, and they have now brought their appeal to the City Council. It is difficult to respond to the issues raised by the appellants because they are vague and poorly documented. Many of their issues have nothing to do with the CUP or the MND. Others reflect a lack of understanding of water conservation, water quality, groundwater management and water rights, all issues that have been diligently and thoroughly analyzed by professionals in the preparation of the two documents.

Faced with a severe drought, Pasadena and Southern California need to adopt integrated, environmentally-sensitive water programs like the Arroyo Seco Canyon Project for a sustainable future. The Arroyo Seco Canyon Project is the most immediate and effective step that Pasadena can take to expand local water supplies. We urge you to act decisively to reject the appeal and to adopt the Conditional Use Permit and Mitigated Negative Declaration for the Arroyo Seco Canyon Project so that we can complete this vital project soon.

Sincerely yours,

Tim Brick

Tim Brick
Managing Director