System Performance Test for Monk Hill Treatment System

Upon completion of plant start up operations, Calgon Carbon will assist PWP with a "system performance test". The objectives of this test are to demonstrate that the treatment system has adequately removed the VOCs and perchlorate from the groundwater for the full range of operations, and nitrosamines are not discharging off the ion exchange resin. Treated water will meet the requirements specified in Tables A-1 and A-2 provided in Appendix A of this document.

The well operating sequence for this procedure is defined in Table 1:

Table 1: Operating Sequence for Startup Testing Procedure

Order	Name (Scenario)	Flow rate (GPM)	ClO_4^- (ppb)	Treatment Systems Required	
				# of IX Trains	# of LGAC Trains
1	Ventura	1,600	9	1	2
2	Windsor	1,400	10	1	2
3	Well 52	1,800	20	1	2
4	Combined	7,000	45	4	5
5	Arroyo + Well 52	4,000	75	3	3 or 4
6	Arroyo	2,200	120	2	3

The steps required to test each of the listed scenarios are as follows:

1. Sequence valving to operate the specified number of treatment trains

2. Bring the specified well(s) online including the Ventura Booster station

3. Take water samples at the locations and frequencies in accordance with Table 2. Final discharge to the Arroyo Seco will comply with the procedures and requirements in the March 2010 Discharge Protocol for Discharges to Arroyo Seco from the Monk Hill Treatment System, NASA.

4. Record the following data on the supplied log file:
   - Sample number (1, 2, 3,…..)
   - Date
   - Time
   - Operating scenario from Table 1
   - Sample ID (e.g., AW-001, 301A-001, etc.)
   - Location where sample(s) were taken (e.g., lead bed effluent 301A)

   For example: Sample #1, 16 Aug 2010, 1100 hrs, Arroyo + Well 52 (5), IX-001,, IX combined effluent.

5. Instantaneous and total flow at the following points (production wells and booster station)

- Each production well flow meter (e.g., FIT-102). Record totalizer meter at beginning of day and at end of day.
- Booster station flow meter (e.g., FIT-100). Record totalizer meter at beginning of day and at end of day.

6. Pressures and levels at the following points (production wells and booster station)
   - Discharge pressure from each production well (e.g., PI-102)
   - Water level in each production well (e.g., LIT-102)
   - Discharge pressure at booster station (e.g., PI-100)
   - Water level in booster sump (e.g., LIT-100)

7. Instantaneous and total flow at the following points (IX system):
   - Each lead IX bed that is online (e.g. FIT-301A). Record totalizer meter at beginning of day and at end of day.
   - Each lag IX bed that is online (e.g. FIT-301B). Record totalizer meter at beginning of day and at end of day.

8. Pressures at the following points (pre-filters and IX system):
   - Pressure at inlet to pre-filters (PIT-200)
   - Differential pressure across the pre-filters (PDIT-201)
   - Pressure at discharge of pre-filter and prior to IX treatment system (PI-202)
   - Inlet pressure to each lead bed that is online (e.g. PI-301AA)
   - Outlet pressure for each lead bed that is online (e.g. PI-301A)
   - Differential pressure across each online IX vessel (e.g. PDIT-301A, PDIT-301B)
   - Outlet pressure for each lag vessel (e.g. PI-301B)

9. Instantaneous and total flow at the following points (LGAC system):
   - Each lead LGAC bed that is online (e.g. FIT-401A). Record totalizer meter at beginning of day and at end of day.
   - Each lag LGAC bed that is online (e.g. FIT-401B). Record totalizer meter at beginning of day and at end of day.

10. Pressures at the following points (LGAC system) :
    - Inlet pressure to each lead bed that is online (e.g. PI-401AA)
    - Outlet pressure for each lead bed that is online (e.g. PI-401A)
    - Differential pressure across each online GAC vessel (e.g. PDIT-401A, PDIT-401B)
    - Outlet pressure for each lag vessel (e.g. PI-401B)

11. Disinfection system (potable water is used in lieu of ammonium hydroxide for testing)
    - Flow rate of mechanical pump(s) for Ammonium hydroxide system

- Discharge pressure at mechanical pump for Ammonium hydroxide system
- Level in ammonia tank (LIT-800)

12. Sample ports
    - Open and close all sample ports (25%, 50%, and 75%) for IX and LGAC vessels. Note if water flows unconstructively and valves shut tight.

13. Instantaneous and total flow at the final discharge point:
    - 24-inch line to sandbox (FIT-502) and 10-inch line to sand box (FIT-501). Record totalizer meter at beginning of day and at end of day.

Pressure, flow rates, totalizer, and ON/OFF modes, etc. should be observed and recorded from SCADA and compared to observed remote reads (mechanical, analog or digital) for accuracy and calibration if necessary.

Water samples taken will be tested for analysis for the relevant components represented in Table 2. Nitrosamines will be tested per EPA Method EPA-521. Each operating scenario will be conducted for one day. Samples will be taken and data recorded at startup and at the end of the day, unless noted otherwise. The lab performing the analysis of the water samples will provide a report detailing if any samples fail to meet the requirements of Appendix and/or EPA / CDPH requirements for nitrosamines. Samples taken at the discharges to the sandbox (M-001, M-002, and SB-001) will be according to the discharge protocol (March 2010 Discharge Protocol for Discharges to Arroyo Seco from the Monk Hill Treatment System, NASA).

TABLE 2: SYSTEM PERFORMANCE TEST FOR MONK HILL TREATMENT SYSTEM - STARTUP MONITORING PLAN

Order	Scenario (Well On-Line)	No. of IX & LGAC Pairs Online (ID Online)	Sample Name	Sample ID	VOCs (EPA 524.2) Sample Frequency	VOCs (EPA 524.2) Number of Samples	1,2,3-TCP (EPA 504.1) Sample Frequency	1,2,3-TCP (EPA 504.1) Number of Samples	CLO4 (EPA 314.0) Sample Frequency	CLO4 (EPA 314.0) Number of Samples	Nitrosamine (EPA 521) Sample Frequency	Nitrosamine (EPA 521) Number of Samples	Nitrate (EPA 300.0) Sample Frequency	Nitrate (EPA 300.0) Number of Samples	Total Coliform (SM9223) Sample Frequency	Total Coliform (SM9223) Number of Samples	HPC (SM9215B) Sample Frequency	HPC (SM9215B) Number of Samples
1	Ventura	1 IX & 2 LGAC	Ventura	VW-001	S	1	S	1	S	1	S	1	S	1	S	1	S	1
		(302A & 302B)	IX combined influent	PF-001														
			4 IX LEAD vessel effluent	301A-001….304A-001														
			4 IX LAG vessel effluent	301B-001….304B-001														
			IX combined effluent	IX-001					2xD	2	3xD	3	1xD	1	1xD	1	1xD	1
		(401A & 401B)	5 GAC LEAD vessel effluent	401A-001….405A-001									1xD[a]	1				
		(402A & 402B)	5 GAC LAG vessel effluent	401B-001….405B-001									1xD[a]	1				
			LGAC combined effluent	LG-001	2xD	2									1xD	1	1xD	1
2	Windsor	1 IX & 2 LGAC	Windsor	WW-001	S	1	S	1	S	1	S	1	S	1	S	1	S	1
		(303A & 303B)	IX combined influent	PF-001														
			4 IX LEAD vessel effluent	301A-001….304A-001														
			4 IX LAG vessel effluent	301B-001….304B-001														
			IX combined effluent	IX-001					2xD	2			1xD	1	1xD	1	1xD	1
		(403A & 403B)	5 GAC LEAD vessel effluent	401A-001….405A-001									1xD[a]	1				
		(404A & 404B)	5 GAC LAG vessel effluent	401B-001….405B-001									1xD[a]	1				
			LGAC combined effluent	LG-001	2xD	2									1xD	1	1xD	1
3	Well 52	1 IX & 2 LGAC	Well 52	52-001	S	1	S	1	S	1	S	1	S	1	S	1	S	1
		(304A & 304B)	IX combined influent	PF-001														
			4 IX LEAD vessel effluent	301A-001….304A-001														
			4 IX LAG vessel effluent	301B-001….304B-001														
			IX combined effluent	IX-001					2xD	2			1xD	1	1xD	1	1xD	1
		(401A & 401B)	5 GAC LEAD vessel effluent	401A-001….405A-001														
		(405A & 405B)	5 GAC LAG vessel effluent	401B-001….405B-001														
			LGAC combined effluent	LG-001	2xD	2									1xD	1	1xD	1
4	Combined Arroyo Well 52 Ventura Windsor	4 IX & 5 LGAC	Arroyo	AW-001	S	1	S	1	S	1	S	1	S	1	S	1	S	1
		(301A & 301B	IX combined influent	PF-001	1xD	1	1xD	1	2xD	2	3xD	3	1xD	1				
		(302A & 302B)	4 IX LEAD vessel effluent	301A-001….304A-001														
		(303A & 303B)	4 IX LAG vessel effluent	301B-001….304B-001														
		(304A & 304B)	IX combined effluent	IX-001	2xD	2			2xD	2	3xD	3	1xD	1	1xD	1	1xD	1
		(401A & 401B)	5 GAC LEAD vessel effluent	401A-001….405A-001														
		(402A & 402B)	5 GAC LAG vessel effluent	401B-001….405B-001														
		(403A & 403B)	LGAC combined effluent	LG-001	2xD	2	1xD	1							1xD	1	1xD	1
		(404A & 404B)																
		(405A & 405B)																
5	Arroyo & Well 52	3 IX & 4 LGAC																
		(302A & 302B)	IX combined influent	PF-001	1xD	1			2xD	2			1xD	1				
		(303A & 303B)	4 IX LEAD vessel effluent	301A-001….304A-001														
		(304A & 304B)	4 IX LAG vessel effluent	301B-001….304B-001														
			IX combined effluent	IX-001	2xD	2			2xD	2			1xD	1				
		(402A & 402B)	5 GAC LEAD vessel effluent	401A-001….405A-001														
		(403A & 403B)	5 GAC LAG vessel effluent	401B-001….405B-001														
		(404A & 404B)	LGAC combined effluent	LG-001	2xD	2												
		(405A & 405B)																
6	Arroyo	2 IX & 3 LGAC	Arroyo															
		(301A & 301B)	IX combined influent	PF-001					2xD	2			1xD	1				
		(304A & 304B)	4 IX LEAD vessel effluent	301A-001….304A-001														
			4 IX LAG vessel effluent	301B-001….304B-001														
			IX combined effluent	IX-001	2xD	2			2xD	2			1xD	1				
		(401A & 401B)	5 GAC LEAD vessel effluent	401A-001….405A-001														
		(402A & 402B)	5 GAC LAG vessel effluent	401B-001….405B-001														
		(403A & 403B)	LGAC combined effluent	LG-001	2xD	2												
TOTAL SAMPLES						**24**		**6**		**22**		**13**		**17**		**12**		**12**

For nitrosamine the 7 compounds are NDMA, NDEA,NDPA, NDBA, NPYR, NMEA, and NPIP.
S: At startup only.
1xD: Once daily, at the end of each day (8th hour ~ 4:00 PM)
2xD: Twice daily, at the beginning and end of each day.
3xD: Three daily at the 4th hour, 8th hour, and 24th hour.

a: The NO3 samples are to be taken at effluent for the LGAC **lead** vessels only. The sample points are 401A-001, 402A-001, 403A-001, and 404A-001.

Appendix A

Table A-1: Required Water Quality Treatment Objectives

Analyte	Influent Concentration	Treatment objective
Perchlorate	45 µg/L	<4 µg/L
Nitrate (as NO3)	24 mg/L	36 mg/L
Chloride	53 mg/L	60 mg/L
Sulfate	55 mg/L	60 mg/L
Total Dissolved Solids	430 mg/l	430 mg/L
Trichloroethene (TCE)	3.2 µg/L	<0.5 µg/L
Tetrachloroethene (PCE)	0.59 µg/L	<0.5 µg/L
1,2-Dichloroethane (1,2-DCA)	0.46 µg/L	<0.5 µg/L
Carbon Tetrachloride	2.7 µg/L	<0.5 µg/L
1,2,3-Trichloropropane (1,2,3-TCP)	0.02 µg/L	<0.005 µg/L
Additional Water Quality Information		
Chloroform	3.4 ug/L	N/A
Methylene Chloride	0.33 ug/L	N/A
Bicarbonate	230 mg/L	N/A
Total Alkalinity	188 mg/L	N/A
Arsenic	0.004 mg/L	N/A
Barium	0.11 mg/L	N/A
Chromium	0.006 mg/L	N/A
Phosphorus	0.106 mg/L	N/A
Selenium	0.005 mg/L	N/A
Silica	ND -3	N/A
Vanadium	0.027 mg/L	N/A
Fluoride	0.629 mg/L	N/A
Lead	2.5 ug/L	N/A
Gross alpha	4.5 pCi/L	N/A
Gross beta	1.9 pCi/L	N/A
Natural uranium	4.6 pCi/L	N/A
Uranium	3.2 pCi/L	N/A
Combined Ra 226+228	1.5 pCi/L	N/A
Total alpha	5.6 pCi/L	N/A
Total beta	8.7 pCi/L	N/A

Source: September 11, 2006 RFP for Design and Installation of IX & LGAC Treatment Systems for Removal of Perchlorate and VOCs from the Monk Hills Wells, Table 1

Table A-2: Effluent Limitations for Surface Water Discharge

Parameters	Units	Effluent Limitations	
		Average Monthly	Maximum Daily
Total Flow	Gal/day	--	continuously
pH	S.U.	--	6.5 – 8.5
Temperature	F	--	100
Total Dissolved Solids	mg/L	--	1,550
Total Suspended Solids	mg/L	50	150
Turbidity	NTU	50	150
BODs 20°C	mg/L	20	30
Oil and Grease	mg/L	10	15
Settleable Solids	ml/L	0.1	0.3
Sulfides	mg/L	--	1.0
Phenols	mg/L	--	1.0
Residual Chlorine	mg/L	--	0.1
Sulfate	mg/L	--	350
Chloride	mg/L	--	150
Nitrogen as NO3	mg/L	--	15(1)
Acetone	µg/L	--	700
Acrolein	µg/L	--	100
Acrylonitrile	µg/L	--	0.059
Benzene	µg/L	--	1.0
Bromoform	µg/L	--	4.3
Cadmium	µg/L	1.6	3.1
Carbon tetrachloride	µg/L	--	0.25(2)
Chlorobenzene	µg/L	--	30
Chlorodibromomethane	µg/L	--	0.401(2)
Chloroethane	µg/L	--	100
Chloroform	µg/L	--	100
Copper	µg/L	11	22
Dichlorobromomethane	µg/L	--	0.56
1,1-Dichloroethane	µg/L	--	5
1,2-Dichloroethane	µg/L	--	0.38(2)
1,1-Dichloroethylene	µg/L	--	0.057(2)
1,2-Dichloropropane	µg/L	--	0.52
1,3-Dichloropropylene	µg/L	--	0.5
Di-isopropyl ether (DIPE)	µg/L	--	0.8
1,4-Dioxane	µg/L	--	3
Ethylbenzene	µg/L	--	700
Ethylene dibromide	µg/L	--	0.05(2)
Lead, Total Recoverable	µg/L	2.6	5.2

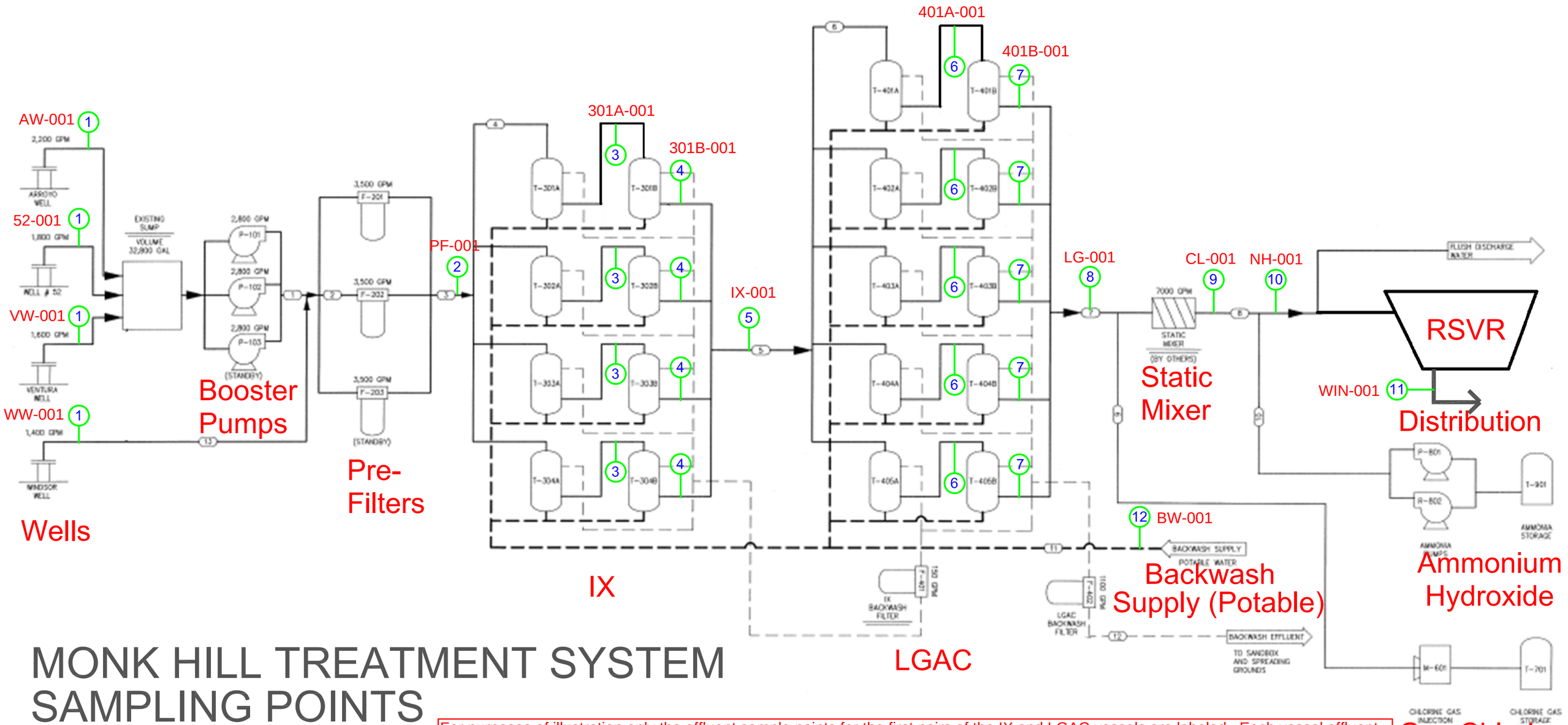
Table A-2: Continuation

Parameters	Units	Effluent Limitations	
		Average Monthly	Maximum Daily
Chromium III, Total Recoverable	µg/L	50	50
Chromium VI, Total Recoverable	µg/L	8	16
Methyl bromide	µg/L	--	10
Methyl chloride	µg/L	--	3
Methylene chloride	µg/L	--	4.7
Methlyene Blue Active Substance (MBAS)	µg/L	--	0.5
Methyl ethyl ketone (MEK)	µg/L	--	700
Methyl tertiary butyl ether (MTBE)	µg/L	--	5
Naphthalene	µg/L	--	21
N-Nitrosodimethyl amine (NDMA)	µg/L	--	0.00069(2)
Perchlorate	µg/L	--	4
Tertiary butyl alcohol (TBA)	µg/L	--	12
1,1,2,2- Tetrachloroethane	µg/L	--	0.17(2)
Tetrachloroethylene	µg/L	--	0.8
Toluene	µg/L	--	150
Total petroleum hydrocarbons(3)	µg/L	--	100
1,2- Trans-trichloroethylene	µg/L	--	10
1,1,1- Trichloroethane	µg/L	--	200
1,1,2- Trichloroethane	µg/L	--	0.6
Trichloroethylene	µg/L	--	2.7
Vinyl chloride	µg/L	--	0.5
Xylenes	µg/L	--	1750
Zinc	µg/L	80	159
Acute Toxicity(4)	-	--	90%

Source: March 2010 Discharge Protocol for Discharges to Arroyo Seco From the Monk Hill Treatment System, NASA, Table 1

Notes:

1. Nitrogen effluent limit consistent with the concentration in the Monk Hill Subarea groundwater.
2. If reported detection level is greater than effluent limit, then a non-detect result using 0.5 mg/L detection level is deemed to be in compliance.
3. Toxicity of this chemical increases with decreasing hardness concentrations. The figure in the table is determined based on effluent $CaCO_3$ concentration of 100 mg/L.
4. The acute toxicity of the effluent shall be such that the average survival in the undiluted effluent for any three (3) consecutive 96-hour static or continuous flow bioassay tests shall be at least 90%, with no single test less than 70% survival.



MONK HILL TREATMENT SYSTEM SAMPLING POINTS

For purposes of illustration only the effluent sample points for the first pairs of the IX and LGAC vessels are labeled. Each vessel effluent follows the same convention named by the vessel ID#-001 (i.e 302A-001, 302B-001, 402A-001, 402B-001). For purposes of internal monitoring, the 25%, 50%, and 75% ports are labeled by the vessel ID#-002, 003, 004 respectively. These sample locations are not labeled in the figure above. The combined effluent from each treatment system (IX and LGAC) are labeled IX-001 and LG-001.

CL-001 and NH-001 are sample locations for the on-site chlorine residual and ammonia analayzers respectively. The sample locations are for purposes of internal monitoring and disinfectant system calibration..

PASADENA WATER AND POWER
MONK HILL TREATMENT SYSTEM START UP REPORT
FEBRUARY 10, 2011

BACKGROUND

Pasadena Water and Power (PWP) owns and operates 4 wells – Arroyo, Well 52, Ventura, and Windsor – that extracts groundwater from the Monk Hill Sub-basin of the Raymond Basin aquifer. These wells are collectively referred to as the Monk Hill wells. The groundwater source for these wells was contaminated with volatile organic chemicals (VOCs) and perchlorate, a component of solid rocket propellants, by the Jet Propulsion Laboratory prior to the mid-1960s.

In the 1980s, VOCs were discovered in the groundwater and by 1990 a temporary VOC treatment plant was installed consisting of air stripping with granular activated carbon for off-gassing. The air stripping plant treated the Monk Hill wells with a capacity of 7,000 gallons per minute (gpm). In 1997, perchlorate was discovered in the groundwater and levels from Arroyo Well exceeded the State of California Department of Public Health's (CDPH) Notification Level (NL) of 18 micrograms per liter or parts per billion (ppb). The remaining 3 wells - Well 52, Ventura, and Windsor – could safely operate below the NL. In early January 2002 the 3 wells were shut down due to mechanical problems and prior to CDPH lowering the NL from 6 to 4 ppb. In October 2007, CDPH adopted a Maximum Contaminant Level (MCL) of 6 ppb. Since January 2002 shutdown the 4 wells continued to remain inactive until recently.

TREATMENT PLANT

In 2006, PWP and National Aeronautical and Space Administration began collaborating on a technical solution to treat for VOCs and perchlorate. The design incorporated a 7,000 gpm facility consisting of ion-exchange to remove perchlorate and liquid granular activated carbon to remove VOCs from the 4 wells[1]. The fixed bed treatment plant consisting of 18 steel vessels was designed and manufactured by Calgon Carbon Corporation and was installed in 2010 adjacent to PWP's existing Windsor Reservoir. In addition to the treatment plant a chloramine facility was also constructed to match the type of disinfection used in the City's imported water supplied by the Metropolitan Water District of Southern California. In general, the entire treatment train and supporting infrastructure consist of the following:

1. Four existing groundwater wells (Arroyo, Well 52, Ventura, and Windsor) with a maximum pumping capacity of 7,000 gpm. Since these wells have been off-line for over 10 years a significant rehabilitation program was instituted for each well. New pumps, motors, lining (for 3 wells), electrical system, etc. were installed for each well;
2. Ventura Booster consisting of 3 pumps (2 on plus 1 standby) with a capacity of 5,600 gpm. Arroyo, Well 52, and Ventura pump directly into a wet well and are

[1] The air stripping VOC treatment plant was decommissioned in 2007 because VOC removal using granular activated carbon is more effective and removes a wider range of organic compounds.

boosted by 2 pumps into the treatment plant. Windsor Well pumps directly into the treatment plant;

3. Pre-filters consisting of 3 filters (2 on plus 1 standby) with a capacity of 7,000 gpm. The filters remove fine sediment prior to the water entering the treatment plant;
4. Ion-exchange (IX) consisting of 4 pairs of steel vessels whereby each pair are operated in a lead and lag configuration. Each vessel contains approximately 353 cubic feet of resin to remove perchlorate;
5. Liquid granular activated carbon (LGAC) consisting of 5 pairs of steel vessels. Similar to the IX system, each pair is operated in a lead and lag configuration. Each vessel contains 40,000 pounds of granular activated carbon to remove VOCs;
6. Disinfection facility utilizing chlorine and ammonium hydroxide to form chloramines. Each chemical is injected separately in the treated water downstream of VOC removal; and
7. Windsor Reservoir is an existing 4.75 million gallon storage facility. The treated and disinfected water is stored in this facility prior to distribution to the public.

SYSTEM PERFORMANCE TESTING (SPT)

The system performance testing (SPT) is a program that identifies 6 scenarios or orders, which represents the full range of operating conditions the treatment plant would undertake. The intent of the testing is to demonstrate the IX and LGAC treatment systems will adequately remove perchlorate and VOCs respectively. In addition, a number of other compounds are to be sampled and analyzed including nitrosamines, nitrates, 1,2,3-Trichloropropane (1,2,3-TCP), and bacteria (coliforms and HPCs).

The six scenarios (Orders 1 to 6) covered a wide range of treatment flows from a single well at 1,400 gpm to 4 wells at 7,000 gpm. In general as each of the scenarios is performed the samples are collected for analysis at various sampling points throughout the treatment plant. The 6 scenarios are:

- Order 1: Ventura Well at 1,600 gpm
- Order 2: Windsor Well at 1,400 gpm
- Order 3: Well 52 at 1,800 gpm
- Order 4: 4 wells at 7,000 gpm
- Order 5: Arroyo Well and Well 52 at 4,000 gpm
- Order 6: Arroyo Well at 2,200 gpm.

Prior to initiating the SPT, each of the wells was super (shock) chlorinated. The objective is to disinfect the steel casing and liner, filter pack, well pump and column, and surrounding aquifer for bacteria. The wells are then purged of any residual chlorine prior to collecting bacteriological samples. During the SPT and other operations, the treated water is not served to the public but is discharged to the City's spreading grounds in the Arroyo Seco so that the water is returned to the aquifer.

SUMMARY RESULTS

Each scenario took a day to perform with the first test taking place on December 21, 2010 and the last test on January 31, 2011. Depending on the scenarios, the

operations and sampling ran from 8 to 24 hours. The length of run time was dictated by the type of sampling and analysis.

The following table summarizes the range (low to high) of the water quality results. There are over 330 sampling results.

Results for Various Compounds Tested						
Compound	**Compound Type** (See 1)	**Units**	**Wells** (See 2)	**Effluent of IX System**	**Effluent of LGAC System**	**MCL**
Perchlorate		ppb	5.34 – 45.4	ND		6
Trichloroethylene	VOC	ppb	0.87 – 2.53		ND	5
Tetrachloroethylene	VOC	ppb	0.72 – 2.82		ND	5
Carbon Tetrachloride	VOC	ppb	ND		ND	0.5
1,2-Dichloroethane	VOC	ppb	ND		ND	0.5
Bromodichloromethane	VOC	ppb	ND – 2.02		ND	See (3)
Chloroform	VOC	ppb	0.80 – 3.52		ND	See (3)
Dibromochlormethane	VOC	ppb	ND – 1.33		ND	See (3)
m,p-Xylenes	VOC	ppb	ND		ND - 1.74	See (4)
o-Xylene	VOC	ppb	ND		ND - 0.70	See (4)
1,2,3-Trichloropropane		ppt	ND		ND	---
N-Nitrosodimethylamine (NDMA)	Nitrosamine	ppt	ND	ND		See (5)
N-Nitrosodiethylamine (NDEA)	Nitrosamine	ppt	ND – 3.1	ND		See (5)
N-Nitrosodi-n-propylamine (NDPA)	Nitrosamine	ppt	ND	ND		See (5)
N-Nitrosodi-n-butylamine (NDBA)	Nitrosamine	ppt	ND	11 - 110		---
N-Nitrosopyrollidine (NPYR)	Nitrosamine	ppt	ND	ND		---
N-Nitrosomethylamine (NMEA)	Nitrosamine	ppt	ND	ND		---
N-Nitrosopiperidine (NPIP)	Nitrosamine	ppt	ND	ND		---
N-Nitrosomorpholine	Nitrosamine	ppt	ND – 2.7	ND – 2.3		---
Nitrate (as NO_3)		ppm	23 - 52			45
Total Coliform		P or A	A	See (6)	See (6)	---
Heterotrophic Plate Count		CFU	12 – 2,700	275 – 2,100	350 – 1,300	---

ppm: Parts per million or milligrams per liter
ppb: Parts per billion or micrograms per liter
ppt: Parts per trillion or nanograms per liter
MCL: Maximum Contaminant Level
ND: None Detect
P or A: Present or Absent
CFU: Coliform Forming Units

(1) There are 32 volatile organic compounds tested and analyzed. The table highlights VOCs that have historically been detected in the wells or were detected during the SPT.
(2) The results may represent samples taken at the discharge of the well or (A) Upstream of the LGAC treatment system for VOC or (B) Upstream of the IX treatment system for all others.
(3) Bromodichloromethane, Bromoform, Chloroform (Trichloromethane), and Dibromochlormethane are collectively referred to as total Trihalomethane (TTHMs). The MCL for TTHMs is 80 ppb. There is no individual MCL for each of the compounds that make up TTHMs.
(4) The combined MCL for m,p-Xylenes and o-Xylenes is 1,750 ppb.
(5) There is no MCL for nitrosamines. NDMA, NDEA, and NDPA have a notification level of 10 ppt.
(6) There were 1 present and 3 absent total coliforms. The present samples were identified as none e-coli species.

- Perchlorate
  During the SPT, the levels of perchlorate from the 4 wells varied between 5.34 and 45.4 ppb. In all scenarios, the perchlorate levels following IX treatment were non detect or ND.

  PWP operates a state certified water quality laboratory with sophisticated equipment, trained chemists, microbiologist, and technicians. PWP performs its own analysis for perchlorate and monitors periodically per CDPH's requirements and for purposes of internal monitoring. By operating its own water quality laboratory, response times are shortened between when results are known and if necessary taking action due to a breakthrough in perchlorate or other compounds. This is a significant advantage.

  PWP will monitor and trend perchlorate levels in the lead and lag vessels. In addition the data will be shared with Calgon, which is the supplier of the resin. The data sharing provides insight to the resin performance and when the media requires replacement.

- VOCs
  The primary VOC compounds that historically were detected in one or more of the 4 wells were carbon tetrachloride (CTC), trichloroethylene (TCE), tetrachloroethylene (PCE), and 1,2-Dichloroethane (1,2-DCA). The concentration levels varied historically. During the SPT, the only VOCs detected from the wells were TCE, PCE, and one or more forms of total Trihalomethane (TTHMs), which is a disinfection by product. The 6 compounds were ND at the effluent of the LGAC system.

  Two VOCs (m,p-Xylenes and o-Xylene) were ND upstream of the LGAC treatment system but detected at the effluent (< 2 ppb). The MCL for these 2 VOCs combined is 1,750 ppb. The 2 compounds were detected during 1 of 6 scenarios. The VOC results for 2 scenarios that followed had no detection of these compounds. It was also observed during the VOC sampling when the compounds were detected, the sample port which is shared with an air release and air vacuum (AR/AV) valve was recently painted. A known possible source of Xylenes is coatings such as paints. Also all the pipes and vessels are internally coated.

  The primary VOC compounds (TCE, PCE, CTC, 1,2-DCA, and TTHMs) were removed by the LGAC treatment system. The 2 VOC compounds (m,p-Xylenes and o-Xylene) detected at the effluent of the LGAC treatment system will continue to be monitored as part of the overall VOC sampling program to ensure that the source was indeed the recent painting of the AR/AV valve or the internal system coating.

  PWP's water quality laboratory employs specialized equipment and trained staff to analyze for VOCs. Monitoring occurs frequently for meeting CDPH's requirements and for purpose of internal monitoring. Similar to perchlorate monitoring and

sampling at the vessels, the data will provide insight to the carbon performance and signifies in advance when the media requires replacement.

- Nitrosamines
  Nitrosamines were detected from 2 wells (Arroyo and Well 52 at levels below 10 ppt) and coming off the IX treatment system. Depending on the resin manufacture, pre-treatment process, on-site handling and maintenance, one or more forms of nitrosamines may emit (leach) from the resin. Specifically, for N-Nitrosodi-n-butylamine or NDBA, the levels varied from 11 to 110 ppt at the effluent of the IX treatment system, yet ND at the 4 well heads. Nitrosamines leaching from virgin resins are typically the highest prior to running well water through it, and levels diminish rapidly thereafter as water flows. At system start up the level was 110 ppt and within a 24 hour period had reduced to 11 ppt.

  A factor that may increase the formation of nitrosamines is maintenance related activities to protect the resin from bacteriological growth during non-operating conditions (i.e. treatment plant off line). In anticipation of the SPT, the resins were installed weeks ahead of the testing. As a result the resin sat in the vessels unutilized at least 1 month, if not longer, prior to exposing the resin to testing. Calgon recommended a weekly practice to flush chlorinated potable water through the vessels. The objective to flushing the resin was to minimize or limit bacteriological growth in the vessels. The drawback, however, is chlorine in contact with resin may increase the possibility of nitrosamine formation.

  There is a notification level (NL) of 10 nanograms per liter (ppt) for 3 forms of nitrosamines - NDMA, NDEA, and NDPA. However, NDBA does not have a NL. To address the levels of NDBA, the following are suggested actions:

  1. Minimize the use of chlorinated water to flush the resin. When the treatment plant is fully permitted and operating, it may be possible to use treated water coming off the effluent of the LGAC treatment system and upstream of the disinfection system to flush the resin. This source water will be absent of disinfectant thus reducing the formation of nitrosamines. However there maybe instances when the only source available is chlorinated water. These instances the flushing would be minimized based on the Calgon's recommendation.

  2. Nitrosamine formation is highest for virgin resin. During initial startup, all 4 pairs of lead and lag IX vessels are loaded with virgin resins. When the individual lead vessels are exhausted, the resin replacement will occur. Since it is highly unlikely that all vessels will simultaneously require resin replacement, the nitrosamine in the combined effluent will be greatly reduced by blending the treated water from the vessels filled with virgin resin with the treated water from the remaining vessels.

  3. New resin will be initially rinsed prior to placing it in service. The resin vendor will be required to provide recommendations for the volume of rinse water.

4. Perform subsequent monitoring for nitrosamines. Analyzing nitrosamines require sophisticated equipment and intense quality control protocols. PWP's water quality laboratory has a contract with a CDPH approved water quality laboratory that is certified for testing nitrosamines.

5. Initiate discussions with Calgon to identify best practices for onsite maintenance activities to minimize the formation of nitrosamines.

6. Incorporate language into the specifications for future resin replacement contracts that the supplier must pre-rinse the resin off-site. When the resin is loaded into the vessels it requires less on-site flushing since the pre-rinse removed portions of the nitrosamines.

- Nitrate

  During the SPT, levels of nitrate detected at the wellheads varied between 23 to 52 milligrams per liter or ppm (as measured as nitrate). Historically, the average nitrate levels were 10 ppm at Arroyo and 19 ppm at Well 52. Ventura and Windsor had the highest levels. The average nitrate levels were 39 ppm at Ventura and 23 ppm at Windsor. During the 7,000 gpm testing (Order 4) the nitrate level for the blend was 41 ppm. The MCL for nitrate is 45 ppm.

  To address the levels of nitrate, the following actions are currently in place or will be taken during plant operation. This is a general highlight of the various actions. Specific detailed actions are noted in the CDPH approved Nitrate Blending Plan for Windsor Reservoir, dated January 2011.

  1. The blending plan requires the wells are started in a specific sequence (Arroyo → Well 52 → Windsor → Ventura) and are shut down in the opposite sequence (Ventura → Windsor → Well 52 → Arroyo). The rationale is at start up there would always be a lower level nitrate water source(s) in Windsor Reservoir to blend with the next higher level nitrate water(s). At shutdown, the higher level nitrate source(s) are taken off-line prior to the lower level nitrate source(s) thereby minimizing the nitrate concentration in the reservoir.

  2. PWP operates a state certified water quality laboratory. Nitrate samples from Windsor Reservoir will be collected daily and analyzed using a UV-VIS Spectrophotometer. Weekly sampling at the reservoir will be tested utilizing ion chromatography.

  3. A blending calculation will be updated when new data is available whereby the formula theoretically predicts levels of nitrate in the reservoir. If the calculated level reach or exceed 80% of the MCL (36 ppm), water quality staff will notify the Operation Superintendent and the Engineering Manager so that operational changes may be made.

It is also noted that historically when a well sat idle for an extended period of time the nitrate levels at start up are at the highest and reduce over time. These wells were sampled shortly after they were rehabilitated and prior they had sat idle for nearly a decade. Arroyo would be off line for 14 years in July 2011. It is anticipated the nitrate levels will return back to historical levels after the wells have operated for some time.

- Bacteriological
  In general bacteriological testing involves a two step process. The first step is to analyze the sample for the presence or absence of total coliforms. If the sample was present total coliforms the following step was to identify if it was an e-coli species which maybe harmful to humans or a benign species. Two of the 16 samples taken were present total coliform but absent e-coli. The second step is to identify the number of heterotrophic plate counts or HPC. The ranges for HPC varied at sampling points. Upstream of the IX treatment system the HPC ranged from 12 to 2,700 cfu/mL At the effluent of the IX treatment systems it ranged between 275 o 2,100 cfu/mL, and at the effluent of the LGAC treatment system it ranged between 350 to 1,300 cfu/mL.

  HPC may vary for a number of reasons including but not limited to various source water quality, maintenance and handling of the well or plant, sampling procedures, etc. HPC is not regulated by the CDPH. Elevated or significant increases in HPCs indicate biological growth on the media. Although not necessarily harmful to humans, a rise may affect treatment system performance.

  The following processes are in place to monitor for total coliforms and HPC.

  1. PWP has a state certified water quality laboratory operated by a well trained microbiologist. In addition, PWP has a contract with an environmentally approved water quality laboratory as an emergency back up.

  2. Water samples are collected regularly as required by CDPH and for purposes of internal monitoring. Presence of coliforms or elevated HPCs after IX or LGAC processes triggers PWP follow up actions. Weekly monitoring is required at the Windsor Reservoir (entry point) to ensure the water is absent for coliforms

  3. PWP installed a new disinfection facility as part of the overall project. It injects chlorine and ammonium hydroxide to form chloramines. The disinfection occurs down stream of the LGAC treatment system and prior to the treated water flowing into Windsor Reservoir. The disinfectant in the water will have a minimal residual of 2.5 ppm in the reservoir to ensure bacteria are killed before the water is served to the public.

CONCLUSION

Overall the treatment system was successful with removing perchlorate and VOCs. The plant did exactly what it was designed to do. There were a few notable exceptions for

other compounds in particular nitrosamines and bacteria. Procedures and actions were identified to mitigate nitrosamine formations and presence of bacteria. PWP operates a CDPH approved water quality laboratory equipped with sophisticated testing equipment and well trained staff. Water operators are knowledgeable and experienced state certified water treatment and/or distribution operators. On going training programs, updated operation manuals for reference, continuous water quality monitoring and testing, and regularly scheduled maintenance, are in place to minimize the potential for exceeding CDPH drinking water regulations and requirements.

PASADENA WATER AND POWER
MONK HILL TREATMENT SYSTEM
SYSTEM PERFORMANCE TEST RESULT
Order 2 – Windsor Well
January 10, 2011

Description

The System Performance Test (SPT) for the Monk Hill Treatment System (MHTS), see attachment, describes 6 orders (scenarios) for testing the treatment plant under various flow and well conditions. The following describes Order 2 – Windsor Well.

Background – Order 2

Windsor was the first well rehabilitated and prepared to operate utilizing a temporary motor. A new permanent motor will be installed in the weeks to follow. In general, purging a well to waste that has been inactive for a while is the typical practice of Pasadena Water and Power (PWP). It is a good practice, depending on the situation, to collect bacteriological samples prior to placing the well into the drinking system. Windsor, however, cannot discharge directly to waste due to groundwater discharge requirements. Therefore, it was necessary to collect the bacteriological samples from Windsor as the water flowed through the treatment system for removal of perchlorate and volatile organic compounds (VOC) prior to obtaining the results for the bacteriological samples. Each day this well operates through the treatment plant provides greater certainty the MHTS will be permitted by the California Department of Public Health (DPH) and in service prior to a March 2011 scheduled shut down by Metropolitan Water District. Also during the purging step it provides an excellent opportunity to begin sampling the plant for the constituents noted in the SPT.

Windsor was shock chlorinated on December 9, 2010. On December 13, Windsor was turned on (1,300 to 1,500 gpm) to directly discharge to waste into the sand box blending with potable system water to meet the discharge requirements. PWP can afford short term blending using potable water while the well's chlorine residual is detectable. Blending with potable water is only a short term solution because of the high cost and lack of unlimited storage supply. Applied on a long term basis would be too costly and would require shutting off Windsor to allow the system water storage to fill. Once the residual was 0 mg/L the well water was directed to the IX and LGAC treatment system.

Originally, the plan for purging the well would utilize a low flow injection of sodium hypochlorite upstream of the treatment system providing a 1 to 1.5 mg/L residual at point of injection. The intent was to mitigate or minimize the introduction of organisms into the vessels. However, this concept was **not** employed because of concerns from Calgon. Instead Windsor was sent directly into the treatment system without any chlorine injection.

Around 4:00 pm on December 15, Windsor began flowing at 1,350 gpm through a single unit each for the pre-filter, ion-exchange (IX) (lead vessel only), liquid granular activated carbon (LGAC) (lead vessel only), and to the sand box to waste. Only the lead vessels are utilized (1) to minimize introducing organisms into more vessels than necessary and (2) the treated water is directed to waste therefore not necessitating the need for a polishing step in the lag vessels.

Depending on the constituent, samples were collected on December 17 and 21.

December 17, 2010 Sampling

Bacteriological samples were collected directly from the discharge of Windsor and at the 50% ports of the IX vessel (303A) and LGAC vessel (403A). Four samples from Windsor were collected within a 30 minute period after confirming there was 0 mg/L residual of chlorine, and the water was visibly clear to the naked eye. One sample each was collected at ports 303A-003 (50% port for IX) and 403A-003 (50% port for LGAC). The total coliform (TC) was absent from Windsor and the 2 vessels. The heterotrophic plate counts (HPC) for the 6 samples were greater than 500 Coliform Forming Units (CFU). PWP intends to continue sampling, monitoring, and trending for HPC.

At the 8th hour of run time through the treatment plant, nitrate samples were collected at the IX combined effluent (IX-001) and at the effluent of LGAC vessel 403A (403A-001). There was a reduction in the nitrate concentration at the LGAC effluent port versus the influent indicating the possibility of absorption of nitrate onto the carbon. See table for results.

December 21, 2010 Sampling

A second set of 4 bacteriological samples from Windsor and one sample each from the IX and LGAC vessels were collected. In addition samples were collected to test for perchlorate, nitrate, VOCs, 1,2,3-TCP, and nitrosamines. Once again TC was absent in all 6 samples. The HPC for the same samples were all above 500 CFU. PWP intends to continue sampling and monitoring for HPC. See table for results.

The SPT specified collecting some samples in the morning after well start up (~8:00 am) and at the close of business (~4:00 pm). Specifically for perchlorate and VOCs, afternoon samples were not collected. The rationale for omitting this step is because at the time of collecting the morning samples on December 21st it represented more than 100 hours of run time through the plant which far exceeds the 8 hours (8 am to 4 pm) as specified in the SPT. The nitrate roll off sampling for LGAC vessel 404A was not collected since only a single lead vessel was in service. However, nitrate samples were collected at the well discharge (WW-001), IX combined effluent (IX-001), and at the effluent of LGAC vessel 403A (403A-001). In all samples the nitrate concentration remained constant. Further nitrate roll off sampling will occur for Order 1 – Ventura Well sampling.

PASADENA WATER AND POWER: MONK HILL TREATMENT SYSTEM

ORDER 2 - WINDSOR WELL - SAMPLED ON DECEMBER 21, 2010 UNLESS NOTED OTHERWISE[2]

Compound Name	Compound Formula	Units	MCL	DLR	Sample Results by Sample ID						
					WW-001	IX-001		403A-001	404A-001	LG-001	
					Start[5]	Morn[5]	End (8th)	End (8th)	End (8th)	Morn[5]	End (8th)
Trichloroethylene	TCE	ug/L	5	0.5	2.1					ND	See 2
Tetrachloroethylene	PCE	ug/L	5	0.5	1.2					ND	See 2
Carbon Tetrachloride	CCL_4	ug/L	0.5	0.5	ND					ND	See 2
1,2-Dichloroethane	1,2-DCA	ug/L	0.5	0.5	ND					ND	See 2
Chloroform (Trichloromethan)	$CHCl_3$	ug/L	---	1.0	0.8					ND	See 2
1,2,3-Trichloropropane	1,2,3-TCP	ng/L	---	5.0	ND						
Perchlorate	CLO_4	ug/L	6	4.0	5.34	ND	See 2				
N-Nitrosodimethylamine	NDMA	ng/L	---	1.6	ND						
N-Nitrosodiethylamine	NDEA	ng/L	---	1.6	ND						
N-Nitrosodi-n-propylamine	NDPA	ng/L	---	1.6	ND						
N-Nitrosodi-n-butylamine	NDBA	ng/L	---	---	ND						
N-Nitrosopyrollidine	NPYR	ng/L	---	---	ND						
N-Nitrosomethylamine	NMEA	ng/L	---	---	ND						
N-Nitrosopiperidine	NPIP	ng/L	---	---	ND						
Nitrate (as Nitrogen)	NO_3	mg/L	45	2.0	See IX-001		4.2[1]	0.2[1]	See 3		
Nitrate (as Nitrogen)	NO_3	mg/L	45	2.0	49		49	49			
Total Coliform	TC	P/A*	---	---	See 4		Absent				Absent
Heterotrophic Plate Count	HPC	CFU	---		See 4		1,500				1,300

mg/L: Milligrams per liter or parts per million
ug/L: Micrograms per liter or parts per billion
ng/L: Nanograms per liter or parts per trillion

1,2,3-TCP notification level at 5 ng/L
NDMA, NDEA, and NDPA notification level at 10 ng/L

MCL: Maximum Contaminant Level
NL: Notification Level
DLR: Detection Limit for Reporting

P/A*: Present/Absent for all samples with the exception for wells which will be reported as the Most Probable Number (MPN)
CFU: Coliform Forming Units

Notes:

(1) Windsor began pumping into vessels 303A and 403A on 12.15.2010 @ 4:10 pm. On the 8th hour (12.16.2010 @ 12:10 am) the NO3 samples were collected.

(2) Samples collected on 12.21.2010 represent approximately 113 hours of run time through vessels 303A and 403A. The 8th hour samples were not collected, unless noted otherwise, since at the 12.21.2010 sampling it far exceeded (on the conservative side) the 8th hour of run time as originally specified in the SPT.

(3) Windsor Well water is running only through the lead vessel (403A).

(4) A series of 4 bacteriological samples for Windsor were taken at 2 separate times. Each series consisted of collecting 4 samples within 30 minutes.

Series 1 Sampled 12.17.2010	TC	HPC	
Sample 1	Absent	2,000	Estimate
Sample 2	Absent	2,400	Estimate
Sample 3	Absent	2,700	Estimate
Sample 4	Absent	2,600	Estimate

Series 2 Sampled 12.21.2010	TC	HPC	
Sample 1	Absent	2,400	Actual
Sample 2	Absent	2,500	Actual
Sample 3	Absent	2,400	Actual
Sample 4	Absent	2,200	Actual

(5) Start and Morn (morning) samples - see note 2 above.

PASADENA WATER AND POWER
MONK HILL TREATMENT SYSTEM
SYSTEM PERFORMANCE TEST RESULT
Order 1 – Ventura Well
February 1, 2011

Description

The System Performance Test (SPT) for the Monk Hill Treatment System (MHTS), see attachment, describes 6 orders (scenarios) for testing the treatment plant under various flow and well conditions. The following describes Order 1 – Ventura Well.

Background – Order 1

Ventura, similar to Windsor Well, was rehabilitated in 2010 with a new motor installed for the SPT. Ventura used a number of various alternatives for the initial purging, which included blending with Windsor treated water if available, blending with potable water, or running it through the MHTS after passing bacteriological.

December 28, 2010 Sampling

Ventura was initially shock chlorinated on December 16, 2010. On December 27, Ventura was turned on (1,500 to 1,600 gpm) to discharge directly to waste while blending with either treated water from Windsor Well running through the MHTS or with City potable water. After achieving 0 mg/L chlorine residual and the water was visibly clear to the naked eye, a series of 4 samples were collected within a 30 minute period. Three of the 4 samples was present in total coliform (TC). The heterotrophic plate counts (HPC) for the 4 samples were less than 500 Coliform Forming Units (CFU).

January 12, 2011 Sampling

Between January 7 and January 10, 2011, Ventura ran for approximately 70 hours directly to waste blending with City potable water. On January 10, the well was shock chlorinated for a second time. The well was started on January 11 pumping to waste while blending with City potable water. Applying the same protocol as the December 28, 2010 sampling, a series of 4 samples were collected on January 12 for bacteriological. The 4 samples were absent TC and the HPC were less than or equal to 10 CFU. Ventura was prepared for Order 1 SPT.

January 14 and January 15, 2011 Sampling

Between January 11 and January 14, Ventura ran for an additional 62 hours primarily blending with City potable water to waste. On January 14, 2011 at 7:30 am, Ventura was started and ran 1-1/2 hours through the MHTS for purging the Ventura Sump, pipelines, and pre-filters of non-Ventura water. Ventura was directed away from the selected vessels under Order 1 of the SPT. The intent was to remove water in the system that was not representative of Ventura Well without affecting the media in the selected vessels. At 9:00 am sampling began and the treatment system valves were adjusted in order for Ventura water to begin running through the 6 selected vessels identified in Order 1 of the SPT – IX vessels 302A and 302B, and LGAC vessels 401A, 401B, 402A and 402B. It was anticipated by the time samples were collected at the designated sample ports at the treatment system (between 9:30 and 10:00 am) non-Ventura water in the selected vessels would be replaced with water representative of Ventura Well.

The SPT specified collecting some samples in the morning after well start up (~8:00 am) and at the close of business (~4:00 pm). Due to system purging, sampling did not begin until 9:00 am and concluded around 4:45 pm. In addition to bacteriological testing, samples were collected to test for perchlorate, nitrate, VOCs, 1,2,3-TCP, and nitrosamines. Nitrate roll off sampling for LGAC lead vessel 401A (401A-001) and 402A (402A-001) were collected at approximately 8 hours of run time through the carbon.

A total of 5 samples were collected for nitrosamines. In the morning, samples were collected at the well (VW-001) and 1 hour after Ventura water ran through the IX vessels (IX-001). The afternoon samples included the 4th and 8th hour of run times through the IX vessels (IX-001). On January 15, 2011 following 24 hours of run time through the IX vessels (IX-001) the last nitrosamine sample was collected.

For the tabulated results see the attached table.

PASADENA WATER AND POWER: MONK HILL TREATMENT SYSTEM
ORDER 1 - VENTURA WELL - SAMPLED ON JANUARY 14 & 15, 2011 UNLESS NOTED OTHERWISE[1]

					Sample Results by Sample ID								
					VW-001	IX-001				401A-001	402A-001	LG-001	
Compound Name	Compound Formula	Units	MCL	DLR	Start[2]	1st Hr	4th Hr	End (8th Hr)	24th Hr	End (8th Hr)	End (8th Hr)	1st Hr	End (8th Hr)
Trichloroethylene	TCE	ug/L	5	0.5	1.77							ND	ND
Tetrachloroethylene	PCE	ug/L	5	0.5	0.891							ND	ND
Carbon Tetrachloride	CCL_4	ug/L	0.5	0.5	ND							ND	ND
1,2-Dichloroethane	1,2-DCA	ug/L	0.5	0.5	ND							ND	ND
Bromodichloromethane	CHB_rCl_2	ug/L	---	0.5	0.534							ND	ND
Chloroform (Trichloromethan)	$CHCl_3$	ug/L	---	0.5	1.71							ND	ND
1,2,3-Trichloropropane	1,2,3-TCP	ng/L	---	5.0	ND								
Perchlorate	CLO_4	ug/L	6	4.0	5.79	ND		ND					
N-Nitrosodimethylamine	NDMA	ng/L	---	1.6	ND	ND	ND	ND	ND				
N-Nitrosodiethylamine	NDEA	ng/L	---	1.6	ND	ND	ND	ND	ND				
N-Nitrosodi-n-propylamine	NDPA	ng/L	---	1.6	ND	ND	ND	ND	ND				
N-Nitrosodi-n-butylamine	NDBA	ng/L	---	---	ND	110	55	42	13				
N-Nitrosopyrollidine	NPYR	ng/L	---	---	ND	ND	ND	ND	ND				
N-Nitrosomethylamine	NMEA	ng/L	---	---	ND	ND	ND	ND	ND				
N-Nitrosopiperidine	NPIP	ng/L	---	---	ND	ND	ND	ND	ND				
Nitrate (as NO_3)	NO_3	mg/L	45	2.0	52			ND		ND	ND		
Total Coliform[3]	TC	P/A*	---	---	A			A					A
Heterotrophic Plate Count[3]	HPC	CFU	---		12			710					500

mg/L: Milligrams per liter or parts per million
ug/L: Micrograms per liter or parts per billion
ng/L: Nanograms per liter or parts per trillion

MCL: Maximum Contaminant Level
NL: Notification Level
DLR: Detection Limit for Reporting

1,2,3-TCP notification level at 5 ng/L
NDMA, NDEA, and NDPA notification level at 10 ng/L

P/A*: Present/Absent for all samples with the exception for wells which will be reported as the Most Probable Number (MPN)
CFU: Coliform Forming Units

Notes:

(1) Ventura began pumping into vessels 302A, 302B, 401A, 401B, 402A, and 402B on January 14th, 2011 at 9:00 am. The well ran through these vessels for approximately 40 minutes prior to collecting samples at the vessels. This was to ensure water in the

(2) Start - Ventura was turned on at approximately 7:30 am. Approximatley 2 hours into the run time samples were collected from the well discharge.
(3) A series of 4 bacteriological samples for Ventura were taken at 2 separate times. Each series consisted of collecting 4 samples within 30 minutes.

Series 1 Sampled 12.28.2010	TC	HPC	
Sample 1	Present	460	Actual
Sample 2	Present	430	Actual
Sample 3	Present	460	Actual
Sample 4	Absent	440	Actual

Series 2 Sampled 01.12.2011	TC	HPC	
Sample 1	Absent	6	Actual
Sample 2	Absent	6	Actual
Sample 3	Absent	8	Actual
Sample 4	Absent	10	Actual

PASADENA WATER AND POWER
MONK HILL TREATMENT SYSTEM
SYSTEM PERFORMANCE TEST RESULT
Order 3 – Well 52
February 1, 2011

Description

The System Performance Test (SPT) for the Monk Hill Treatment System (MHTS), see attachment, describes 6 orders (scenarios) for testing the treatment plant under various flow and well conditions. The following describes Order 3 – Well 52.

Background – Order 3

Well 52 was rehabilitated in 2010 with a new motor installed for the SPT. Purging of Well 52 began on January 14, 2011 by blending the well water with either treated water from Ventura Well running through the MHTS or with City potable water. The intent was to begin pumping the initial water from the well in preparation of bacteriological sampling without exposing the MHTS and the media to the potential of harmful bacteria.

January 18, 2011 Sampling

Well 52 was initially shock chlorinated on December 28 and 29, 2010. The well was purged on January 14, 2011 and allowed to run for a few days. On January 18th with residual levels of 0 mg/L and the discharge water visibly clear to the naked eye, a series of 4 samples were collected within a 30 minute period. The 4 samples were absent total coliform (TC) and the heterotrophic plate counts (HPC) were less than 500 Coliform Forming Units. Well 52 was prepared for Order 3 SPT.

January 20, 2011 Sampling

On January 20th at 7:00 am Well 52 was started and ran at least 1 hour through the MHTS for purging the Ventura Sump, pipelines, pre-filters, and selected vessels (IX vessels 301A and 301B, and LGAC vessels 404A, 404B, 405A and 405B) for the intent of displacing water in the system that was not representative of the well under testing but with water from Well 52. At approximately 8:15 am sampling began at the well and the MHTS. The SPT specified collecting some samples in the morning after well start up (~8:00 am) and at the close of business (~4:00 pm). In addition to bacteriological testing, samples were collected to test for perchlorate, nitrate, VOCs, 1,2,3-TCP, and nitrosamines.

A bacteriological sample at the 8th hour run time from the combined IX effluent (IX-001) indicated the presence of TC (absent E.coli) and the HPC was 2,100 (estimate) CFU. The IX vessels in service were 301A and 301B. Follow up bacteriological samples were collected on January 24 directly from the vessels 50% ports (301A-003 and 301B-003). The results were absent TC, but the HPC counts increased. On going bacteriological testing will occur to monitor the progress.

For the tabulated results see the attached table.

FINAL

PASADENA WATER AND POWER: MONK HILL TREATMENT SYSTEM

ORDER 3: WELL 52 - SAMPLED ON JANUARY 20, 2011 UNLESS NOTED OTHERWISE[1]

Compound Name	Compound Formula	Units	MCL	DLR	Sample Results by Sample ID				
					52-001	IX-001		LG-001	
					Start[2]	1st Hr	End (8th Hr)	1st Hr	End (8th Hr)
Trichloroethylene	TCE	ug/L	5	0.5	0.869			ND	ND
Tetrachloroethylene	PCE	ug/L	5	0.5	0.806			ND	ND
Carbon Tetrachloride	CCL_4	ug/L	0.5	0.5	ND			ND	ND
1,2-Dichloroethane	1,2-DCA	ug/L	0.5	0.5	ND			ND	ND
Bromodichloromethane	CHB_rCl_2	ug/L	---	0.5	ND			ND	ND
Chloroform (Trichloromethan)	$CHCl_3$	ug/L	---	0.5	0.880			ND	ND
1,2,3-Trichloropropane	1,2,3-TCP	ng/L	---	5.0	ND				
Perchlorate	CLO_4	ug/L	6	4.0	9.47	ND	ND		
N-Nitrosodimethylamine	NDMA	ng/L	---	1.6	ND				
N-Nitrosodiethylamine	NDEA	ng/L	---	1.6	ND				
N-Nitrosodi-n-propylamine	NDPA	ng/L	---	1.6	ND				
N-Nitrosodi-n-butylamine	NDBA	ng/L	---	---	ND				
N-Nitrosopyrollidine	NPYR	ng/L	---	---	ND				
N-Nitrosomethylamine	NMEA	ng/L	---	---	ND				
N-Nitrosopiperidine	NPIP	ng/L	---	---	ND				
N-Nitrosomorpholine	---	ng/L	---	---	*2.7*				
Nitrate (as NO_3)[4]	NO_3	mg/L	45	2.0	42		ND		
Total Coliform[2]	TC	P/A*	---	---	Absent		Present (See 3)		Absent
Heterotrophic Plate Count[2]	HPC	CFU	---		470 (Est)		2,100 (Est)		350

mg/L: Milligrams per liter or parts per million
ug/L: Micrograms per liter or parts per billion
ng/L: Nanograms per liter or parts per trillion

1,2,3-TCP notification level at 5 ng/L
NDMA, NDEA, and NDPA notification level at 10 ng/L

MCL: Maximum Contaminant Level
NL: Notification Level
DLR: Detection Limit for Reporting
P/A*: Present/Absent for all samples with the exception for wells which will be reported as the Most Probable Number (MPN)
CFU: Coliform Forming Units

Notes:

(1) Well 52 began pumping into vessels 301A, 301B, 404A, 404B, 405A, and 405B on January 20, 2011 at approximately 7:00 am. The well ran through these vessels for at least 1 hour prior to collecting samples at the vessels. This was to ensure water in the vessels were representative of Well 52.

(2) A single set of 4 bacteriological samples for Well 52 were collected over a 30 minute period.

Series 1 Sampled 01.18.2011	TC	HPC	
Sample 1	Absent	320	Actual
Sample 2	Absent	360	Actual
Sample 3	Absent	300	Actual
Sample 4	Absent	310	Actual

(3) TC is present but absent E.coli. Follow up bacteriological samples from the 50% ports for each of the IX vessels in service were taken on January 24, 2011 (port ID 301A-003 and 301B-003).

Series 1 Sampled 01.24.2011	TC	HPC	
301A-003 (50% Port)	Absent	1,700	Estimate
301B-003 (50% Port)	Absent	15,000	Estimate

(4) On January 25, 2011 during Order 5 SPT (Arroyo and Well 52 combined flow) a second NO_3 sample was collected from Well 52 (sample ID 52-001). The sample was collected at the end of day (8th hour) run. The result was 43 ppm (as NO_3).

PASADENA WATER AND POWER
MONK HILL TREATMENT SYSTEM
SYSTEM PERFORMANCE TEST RESULT
Order 5 – Arroyo Well and Well 52
February 1, 2011

Description

The System Performance Test (SPT) for the Monk Hill Treatment System (MHTS), see attachment, describes 6 orders (scenarios) for testing the treatment plant under various flow and well conditions. The following describes Order 5 – Arroyo Well and Well 52.

Background – Order 5

The four Monk Hill wells, consisting of Arroyo, Well 52, Ventura, and Windsor, have completed and passed the bacteriological sampling and ran individually through the MHTS. The SPT results for each of the wells (Orders 1, 2, 3 and 6) were submitted to the State of California Department of Public Health prior to initiating Order 5. Order 5 incorporates the flow from 2 wellheads (~3,800 to 3,900 gpm) through the MHTS.

January 25, 2011 Sampling

On January 25th at approximately 7:25 am Arroyo and Well 52 were started and ran approximately 1 hour through the MHTS for purging the Ventura Sump, pipelines, pre-filters, and selected vessels (IX vessels 301A, 301B, 302A, 302B, 303A and 303B and LGAC vessels 402A, 402B, 403A, 403B, 404A, 404B, 405A and 405B) for the intent of displacing water in the system that was not representative of the wells under testing but with water from Arroyo and Well 52. At approximately 8:30 am sampling began at the wells and the MHTS. The SPT specified collecting some samples in the morning after well start up (~8:00 am) and at the close of business (~4:00 pm). The primary constituents collected for analysis were perchlorate, nitrate, and VOCs.

For the tabulated results see the attached table.

FINAL

PASADENA WATER AND POWER: MONK HILL TREATMENT SYSTEM
ORDER 5: ARROYO & WELL 52 - SAMPLED ON JANUARY 25, 2011[1]

Compound Name	Compound Formula	Units	MCL	DLR	Sample Results by Sample ID					
					PF-001		IX-001 (See Note 2)		LG-001 (See Note 2)	
					1st Hr	End (8th Hr)	1st Hr	End (8th Hr)	1st Hr	End (8th Hr)
Trichloroethylene	TCE	ug/L	5	0.5		1.175	1.299	1.247	ND	ND
Tetrachloroethylene	PCE	ug/L	5	0.5		0.924	0.767	0.864	ND	ND
Carbon Tetrachloride	CCL_4	ug/L	0.5	0.5		ND	ND	ND	ND	ND
1,2-Dichloroethane	1,2-DCA	ug/L	0.5	0.5		ND	ND	ND	ND	ND
Bromodichloromethane	CHB_rCl_2	ug/L	---	0.5		ND	ND	ND	ND	ND
Chloroform (Trichloromethan)	$CHCl_3$	ug/L	---	0.5		2.617	2.276	2.466	ND	ND
1,2,3-Trichloropropane	1,2,3-TCP	ng/L	---	5.0						
Perchlorate	CLO_4	ug/L	6	4.0	31.6	33.2	ND	ND		
N-Nitrosodimethylamine	NDMA	ng/L	---	1.6						
N-Nitrosodiethylamine	NDEA	ng/L	---	1.6						
N-Nitrosodi-n-propylamine	NDPA	ng/L	---	1.6						
N-Nitrosodi-n-butylamine	NDBA	ng/L	---	---						
N-Nitrosopyrollidine	NPYR	ng/L	---	---						
N-Nitrosomethylamine	NMEA	ng/L	---	---						
N-Nitrosopiperidine	NPIP	ng/L	---	---						
Nitrate (as NO_3)	NO_3	mg/L	45	2.0		32		22		
Total Coliform	TC	P/A*	---	---						
Heterotrophic Plate Count	HPC	CFU	---							

mg/L: Milligrams per liter or parts per million
ug/L: Micrograms per liter or parts per billion
ng/L: Nanograms per liter or parts per trillion
MCL: Maximum Contaminant Level
NL: Notification Level
DLR: Detection Limit for Reporting
P/A*: Present/Absent for all samples with the exception for wells which will be reported as the Most Probable Number (MPN)
CFU: Coliform Forming Units

1,2,3-TCP notification level at 5 ng/L
NDMA, NDEA, and NDPA notification level at 10 ng/L

Notes:

(1) Arroyo Well and Well 52 began pumping into vessels 301A, 301B, 302A, 302B, 303A, 303B, 402A, 402B, 403A, 403B, 404A, 404B, 405A, and 405B on January 25, 2011 at approximately 7:25 am. The wells ran through these vessels for approximately 60 minutes prior to collecting samples at the vessels. This was to ensure water in the vessels were representative of Arroyo and Well 52.

(2) Tentative Identified Compounds

TENTATIVE IDENTIFIED COMPOUNDS

Sample ID & Time: IX-001 at 1st Hr			Sample ID & Time: IX-001 at End (8th Hr)			Sample ID & Time: LG-001 at 1st Hr		
Compound	Retention Time (Min)	Results (ug/L)	Compound	Retention Time (Min)	Results (ug/L)	Compound	Retention Time (Min)	Results (ug/L)
Unknown	13.044	0.9	Unknown	13.054	0.7	2-Butanone	10.991	0.6
4-Methyl-1-Heptene	16.032	0.3	4-methyl-1-Heptene	16.048	0.3	Methyl Isobutyl ketone	17.436	0.2
Unknown	16.382	0.4	Unknown	16.387	0.3	Acetic Acid, butyl ester	20.235	0.3
Unknown	24.483	1.5	Unknown	24.488	1.1			
Unknown	28.648	0.8	Unknown	28.684	0.2			
(1-methoxylethyl) benzene	29.385	0.3	1,2,3,4-Tetramethyl benzene	32.429	0.2			
1,2,3,4-Tetramethyl benzene	32.414	0.3	Unknown	33.086	0.8			
Unknown	33.064	2	Unknown	34.984	0.2			
Unknown	35.372	0.9	Unknown	35.408	0.5			
Unknown	34.957	0.4						
Unknown	35.081	0.2						
Unknown	35.612	0.3						
Unknown	35.714	0.4						

PASADENA WATER AND POWER
MONK HILL TREATMENT SYSTEM
SYSTEM PERFORMANCE TEST RESULT
Order 6 – Arroyo Well
February 4, 2011

Description

The System Performance Test (SPT) for the Monk Hill Treatment System (MHTS), see attachment, describes 6 orders (scenarios) for testing the treatment plant under various flow and well conditions. The following describes Order 6 – Arroyo Well.

Background – Order 6

Arroyo Well was rehabilitated in 2010 with a new motor installed for the SPT. Purging of Arroyo Well began on January 22, 2011 by blending its water with treated water from MHTS and with City potable water. The intent was to begin pumping the initial water from the well in preparation of bacteriological sampling without exposing the MHTS and the media to the potential of harmful bacteria.

January 20, 2011 Sampling

Arroyo was initially shock chlorinated on January 19, 2011. Upon initial purging on January 22, 2011 with chlorine residual levels at 0 mg/L and the discharge water visibly clear to the naked eye, a series of 4 samples were collected within a 30 minute period. The 4 samples were absent total coliform (TC) and the heterotrophic plate counts (HPC) were less than 500 Coliform Forming Units. Arroyo was prepared for Order 6 SPT.

January 24, 2011 Sampling

On January 24th at 7:36 am Arroyo was started to the Ventura Sump. By 7:48 am Arroyo began flowing through the MHTS for purging the Ventura Sump, pipelines, pre-filters, and selected vessels (IX vessels 302A, 302B, 303A and 303B and LGAC vessels 401A, 401B, 402A, 402B, 403A and 403B) for the intent of displacing water in the system that was not representative of the well under testing but with water from Arroyo. At approximately 8:45 am sampling began at the well and by 9:15 am sampling occurred at the MHTS. The SPT specified collecting some samples in the morning after well start up (~8:00 am) and at the close of business (~4:00 pm). In addition to bacteriological testing, samples were collected to test for perchlorate, nitrate, VOCs, 1,2,3-TCP, and nitrosamines.

For the tabulated results see the attached table.

FINAL

PASADENA WATER AND POWER: MONK HILL TREATMENT SYSTEM

ORDER 6: ARROYO WELL - SAMPLED ON JANUARY 24, 2011 UNLESS NOTED OTHERWISE[1]

Compound Name	Compound Formula	Units	MCL	DLR	Sample Results by Sample ID					
					AW-001	PF-001	IX-001 (See Note 4)		LG-001	
					Start[2]	End (8th Hr)	1st Hr	End (8th Hr)	1st Hr	End (8th Hr)
Trichloroethylene	TCE	ug/L	5	0.5	2.516			1.491	ND	ND
Tetrachloroethylene	PCE	ug/L	5	0.5	2.820			0.918	ND	ND
Carbon Tetrachloride	CCL_4	ug/L	0.5	0.5	ND			ND	ND	ND
1,2-Dichloroethane	1,2-DCA	ug/L	0.5	0.5	ND			ND	ND	ND
Bromodichloromethane	CHB_rCl_2	ug/L	---	0.5	ND			ND	ND	ND
Chloroform (Trichloromethan)	$CHCl_3$	ug/L	---	0.5	1.362			2.167	ND	ND
m,p-Xylenes		ug/L	---	0.5	ND			ND	1.742	ND
o-Xylene		ug/L	---	0.5	ND			ND	0.700	ND
1,2,3-Trichloropropane	1,2,3-TCP	ng/L	---	5.0	*ND*					
Perchlorate	CLO_4	ug/L	6	4.0	37.6	45.4	ND	ND		
N-Nitrosodimethylamine	NDMA	ng/L	---	1.6	*ND*					
N-Nitrosodiethylamine	NDEA	ng/L	---	1.6	*3.1*					
N-Nitrosodi-n-propylamine	NDPA	ng/L	---	1.6	*ND*					
N-Nitrosodi-n-butylamine	NDBA	ng/L	---	---	*ND*					
N-Nitrosopyrollidine	NPYR	ng/L	---	---	*ND*					
N-Nitrosomethylamine	NMEA	ng/L	---	---	*ND*					
N-Nitrosopiperidine	NPIP	ng/L	---	---	*ND*					
N-Nitrosomorpholine	---	ng/L	---	---	*2.2*					
Nitrate (as $NO_{3)}$	NO_3	mg/L	45	2.0	*23*	*23*		*28*		
Total Coliform[3]	TC	P/A*	---	---	Absent					
Heterotrophic Plate Count[3]	HPC	CFU	---		530 (Est)					

mg/L: Milligrams per liter or parts per million
ug/L: Micrograms per liter or parts per billion
ng/L: Nanograms per liter or parts per trillion

1,2,3-TCP notification level at 5 ng/L
NDMA, NDEA, and NDPA notification level at 10 ng/L

MCL: Maximum Contaminant Level
NL: Notification Level
DLR: Detection Limit for Reporting

P/A*: Present/Absent for all samples with the exception for wells which will be reported as the Most Probable Number (MPN)
CFU: Coliform Forming Units

Notes:

(1) Arroyo began pumping into vessels 302A, 302B, 303A, 303B, 401A, 401B, 402A, 402B, 403A, and 403B on January 24, 2011 at 7:48 am. The well ran through these vessels for approximately 85 minutes prior to collecting samples at the vessels. This was to

(2) Start - Arroyo Well was turned on at approximately 7:36 am. Approximately 1 hour into the run time samples were collected from the well dishcarge.

(3) A single set of 4 bacteriological samples for Arroyo Well were collected within a 30 minute period.

Series 1 Sampled 01.22.2011	TC	HPC	
Sample 1	Absent	2	Actual
Sample 2	Absent	< 2	Actual
Sample 3	Absent	2	Actual
Sample 4	Absent	4	Actual

(4) Tentative Identified Compounds

TENTATIVE IDENTIFIED COMPOUNDS		
Sample ID & Time: IX-001 at End (8th Hr)		
Compound	Retention Time (Min)	Results (ug/L)
Unknown	13.054	0.4
Unknown	24.512	0.7
Unknown alkyl benzene	32.428	0.3
Unknown	33.087	0.5
Unknown phthalate	34.024	0.2
1,2,3,4-tetramethyl benzene	34.147	0.2
Unknown	35.392	0.4

PASADENA WATER AND POWER
MONK HILL TREATMENT SYSTEM
SYSTEM PERFORMANCE TEST RESULT
Order 4 – Arroyo Well, Well 52, Ventura Well, and Windsor Well
February 4, 2011

Description

The System Performance Test (SPT) for the Monk Hill Treatment System (MHTS), see attachment, describes 6 orders (scenarios) for testing the treatment plant under various flow and well conditions. The following describes Order 4 – Arroyo Well, Well 52, Ventura Well, and Windsor Well. The 4 wells are collectively referred to as the Monk Hill wells.

Background – Order 4

The four Monk Hill wells have each completed and passed the bacteriological sampling and ran individually through the MHTS. The SPT results for each of the wells and a 2 wellhead combined flow (Orders 1, 2, 3, 5, and 6) were submitted to the State of California Department of Public Health prior to initiating Order 4. Order 4 incorporates the flow from 4 wellheads (~6,500 to 6,800 gpm) through the MHTS.

January 30 to 31, 2011 Sampling

On January 30th at approximately 7:15 am, the Monk Hill wells were started and ran approximately 1 hour through the MHTS for purging the Ventura Sump, pipelines, pre-filters, and selected vessels (IX vessels 301A, 301B, 302A, 302B, 303A, 303B, 304A and 304B, and LGAC vessels 401A, 401B, 402A, 402B, 403A, 403B, 404A, 404B, 405A and 405B) for the intent of displacing water in the system that was not representative of the wells under testing but with water from the 4 wells. At approximately 8:15 am sampling began at the wells and the MHTS. The SPT specified collecting some samples in the morning after well start up (~8:00 am), during mid-day (~12:00 pm), at the close of business (~4:00 pm), and after 24 hours of runtime through the MHTS (~8:00 am the following day). The primary constituents collected for analysis were perchlorate, nitrate, VOCs, 1,2,3-TCP, nitrosamines, and bacteriological. Nitrosamines were the only compounds analyzed for the 24 hour run time.

For the tabulated results see the attached table.

FINAL

PASADENA WATER AND POWER: MONK HILL TREATMENT SYSTEM
ORDER 4: ARROYO, WELL 52, VENTURA & WINDSOR - SAMPLED ON JANUARY 30 & 31, 2011[1]

Compound Name	Compound Formula	Units	MCL	DLR	PF-001				IX-001				LG-001	
					1st Hr	4th Hr	End (8th Hr)	24th Hr	1st Hr[3]	4th Hr	End (8th Hr)[3]	24th Hr	1st Hr	End (8th Hr)
Trichloroethylene	TCE	ug/L	5	0.5			1.729		1.166		1.637		ND	ND
Tetrachloroethylene	PCE	ug/L	5	0.5			1.027		0.706		0.895		ND	ND
Carbon Tetrachloride	CCL_4	ug/L	0.5	0.5			ND		ND		ND		ND	ND
1,2-Dichloroethane	1,2-DCA	ug/L	0.5	0.5			ND		ND		ND		ND	ND
Bromodichloromethane	CHB_rCl_2	ug/L	---	0.5			0.633		2.016		0.791		ND	ND
Chloroform (Trichloromethan)	$CHCl_3$	ug/L	---	0.5			2.831		3.517		2.788		ND	ND
Dibromochlormethane	$CHBr_2Cl$	ug/L	---	0.5			ND		1.332		0.504		ND	ND
1,2,3-Trichloropropane	1,2,3-TCP	ng/L	---	5.0			ND							ND
Perchlorate	CLO_4	ug/L	6	4.0	29.6		28.8		ND		ND			
N-Nitrosodimethylamine	NDMA	ng/L	---	1.6		ND	ND	ND		ND	ND	ND		
N-Nitrosodiethylamine	NDEA	ng/L	---	1.6		ND	ND	ND		ND	ND	ND		
N-Nitrosodi-n-propylamine	NDPA	ng/L	---	1.6		ND	ND	ND		ND	ND	ND		
N-Nitrosodi-n-butylamine	NDBA	ng/L	---	---		ND	ND	ND		30	23	11		
N-Nitrosopyrollidine	NPYR	ng/L	---	---		ND	ND	ND		ND	ND	ND		
N-Nitrosomethylamine	NMEA	ng/L	---	---		ND	ND	ND		ND	ND	ND		
N-Nitrosopiperidine	NPIP	ng/L	---	---		ND	ND	ND		ND	ND	ND		
N-Nitrosomorpholine	---	ng/L	---	---		ND	2.0	ND		ND	ND	2.3		
Nitrate (as NO_3)	NO_3	mg/L	45	2.0			41				28			
Total Coliform	TC	P/A*	---	---			Absent				Absent			Present (See 2)
Heterotrophic Plate Count	HPC	CFU	---	---			300				275			530 (Estimate)

mg/L: Milligrams per liter or parts per million
ug/L: Micrograms per liter or parts per billion
ng/L: Nanograms per liter or parts per trillion
MCL: Maximum Contaminant Level
NL: Notification Level
DLR: Detection Limit for Reporting
P/A*: Present/Absent for all samples with the exception for wells which will be reported as the Most Probable Number (MPN)
CFU: Coliform Forming Units

Notes:

(1) On January 30, 2011 at 7:15 am, Arroyo, Well 52, Ventura, and Windsor began flowing into vessels 301A, 301B, 302A, 302B, 303A, 303B, 304A, 304B, 401A, 401B, 402A, 402B, 403A, 403B, 404A, 404B, 405A and 405B. The wells ran through these vessels for approximately 1 hour prior to collecting samples at the vessels. This was to ensure water in the vessels and system were representative of the wells under testing.

(2) TC is present and absent E.coli.

(3) Tentative Identified Compounds

TENTATIVE IDENTIFIED COMPOUNDS

Sample ID & Time: IX-001 at 1st Hr			Sample ID & Time: IX-001 at End (8th Hr)		
Compound	Retention Time (Min)	Results (ug/L)	Compound	Retention Time (Min)	Results (ug/L)
Unknown	13.060	0.5	2,2,3,3-tetramethylbutane	13.058	0.6
Unknown	16.392	0.3	Unknown	16.052	0.3
Unknown	24.499	1.1	Unknown	16.390	0.3
Unknown	24.745	1.0	Unknown	24.493	1.0
2,3,-Dimethyl-2-Butene	26.976	0.5	Unknown	28.666	0.3
Unknown	28.664	1.1	(1-methoxyethyl) benzene	29.420	0.2
(1-methoxylethyl) benzene	29.394	1.9	1-methyl-4-(1-methylethyl) benzene	32.434	0.3
1-methyl-4-(1-methylethyl) benzene	32.419	0.3	Unknown	33.091	0.5
2-ethyl-1,3-dimethylbenzene	32.429	0.3	Unknown phthalate	34.036	0.2
1,2,3,5-tetramethylbenzene	34.141	0.2	1,2,3,4-tetramethylbenzene	34.148	0.2

Engineering Report

To Accompany Permit Amendment 1910124PA-003

For the Consideration of an Amended Water Supply Permit for
The City of Pasadena Water and Power Department
Serving the City of Pasadena and Environs
Los Angeles County

March 17, 2011

Southern California
Drinking Water Field Operations Branch
California Department of Public Health

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1. INTRODUCTION

1.1 Purpose of Report

The City of Pasadena Water and Power Department (hereinafter, PWP) has submitted an application dated February 9, 2010, to the Department of Public Health (Department) to amend the existing domestic water supply permit to include treatment of contaminated groundwater at the new Monk Hill Treatment System (MHTS) and distribution of the treated water for domestic purposes. A copy of the permit application is included in Appendix A of this report. The groundwater source of the proposed project is a portion of the Monk Hill Sub-basin of the Raymond Basin. The production wells are located downgradient to Jet Propulsion Laboratory (JPL) which the United States Environmental Protection Agency (USEPA) placed on the National Priority List (NPL) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The groundwater in the area around the JPL is designated Operable Unit 3 (OU-3) and is known to contain contaminants, primarily perchlorate (ClO_4) and carbon tetrachloride (CTC). The pumping and subsequent treatment of the groundwater is consistent with the groundwater cleanup plan developed by USEPA for the NPL site. Two other Operable Units exist for on-site groundwater (OU1) and on-site soil (OU2).

In the permit amendment application, PWP indicates that the 7,000 gpm water treatment facilities, known as the MHTS, would be supplied by four rehabilitated production wells: Arroyo Well, Well 52, Ventura Well, and Windsor Well (Monk Hill production wells). Windsor Well is located at the same site as Windsor Reservoir, on a City-owned parcel, which also is the site of the new MHTS. A map showing the locations of JPL and the City facilities is included in Appendix B. The remaining three wells are located on the east side of the Arroyo Seco, to the southeast of JPL. Depending on available water rights and system demand, PWP may operate the MHTS year round, or on a seasonal basis.

The proposed treatment technologies, removal of perchlorate using single use ion exchange resin, and absorption of organic chemicals using liquid phase granular activated carbon (LGAC), are established best available technologies, and have been successfully used at a number of other water systems. The same type of equipment have been successfully used since July 2004 at the Lincoln Avenue Water System, on water that is also drawn from the Monk Hill sub basin, downgradient from PWP's four Monk Hill production wells, also for the removal of CTC and perchlorate.

For PWP, the primary contaminants of concern are CTC and perchlorate, but very low levels of other organic contaminants may be present will also be removed by LGAC. The MHTS consists of four parallel pairs of ion exchange vessels for the removal of perchlorate. Each pair of vessels will operate in a lead-lag configuration. Following ion exchange treatment, there are five pairs of liquid phase granular activated carbon vessels for the removal of volatile organic chemicals (VOCs). Each LGAC pair will also operate in the lead-lag configuration.

Due to the nature of the contamination, a report entitled CDPH Policy Memorandum 97-005 Documentation, Raymond Basin, Monk Hill Subarea (hereinafter, referred as the 97-005 Technical Report) was prepared by the Environmental Restoration Department of the Battelle Memorial Institute (Battelle) for the National Aeronautics and Space Administration (NASA) and submitted on behalf of PWP. The 97-005 Technical Report was prepared in accordance with the Department's Policy Memorandum No. 97-005 entitled "Guidance for Direct Domestic Use of Extremely Impaired Sources", which is provided in Appendix C of this report.

The purpose of this Engineering Report is to document the engineering review, evaluate the design and operation of the four Monk Hill production wells, MHTS, and accompanying 97-005 Technical Report; and to make recommendations regarding the issuance of an amendment to PWP's domestic water supply permit.

1.2 Background and Brief Description of System

PWP operates the City of Pasadena water system under the authority of Domestic Water Supply Permit No. 04-15-99P-010 which was issued by the Department on November 9, 1999. Since then, the permit has been amended twice to add Well 58 on August 12, 2002 and Well 59 on January 15, 2003.

PWP served approximately 169,000 persons through 37,232 metered service connections in 2009. The number of connections has remained within about three (3) percent of 37,000 for the last 40 years. PWP serves water to six (6) hospitals, four (4) golf courses, four (4) hotels, and one (1) steam generating plant. The rest of the connections are to residential and commercial customers. PWP sells water to seven (7) other water utilities. The amount of water sold to these utilities accounts for about two (2) percent of the total water produced and purchased by PWP each year.

PWP's water supply system consists of 11 active deep wells with a combined capacity of approximately 25 MGD, one (1) standby well (Eaton Canyon) pending repairs, five (5) connections with the Metropolitan Water District of Southern California (MWD) that are capable of delivering up to 80 MGD, 22 storage reservoirs with a combined storage capacity of 109.2 million gallons (MG), and 19 booster pumping stations. The total source capacity of the system is approximately 105 MGD. Table 1 below provides a list of PWP's current approved groundwater sources. PWP's distribution system is comprised of 23 different pressure zones. Restoration of the four Monk Hill production wells (Arroyo, Well 52, Ventura and Windsor) would add an additional 10 MGD of supply.

Table 1. Groundwater Sources

Source	Primary Station Code	Status	Treatment
Arroyo	1910124-001	Active	Ion exchange for perchlorate removal and activated carbon adsorption for organics removal and chloramination at MHTS
Bangham Well	1910124-028	Active	Blending VOCs, perchlorate, and nitrate at Sunset Reservoir
Chapman Well	1910124-005	Active	Chlorination
Copelin Well	1910124-006	Active	Blending VOCs, perchlorate, and nitrate at Sunset Reservoir
Craig Well	1910124-007	Active	Chlorination
Eaton Canyon Well	1910124-009	Other	Pending return to Standby Status. See Provision No. 7 of 1999 permit.
Garfield Well	1910124-010	Active	Blending VOCs, perchlorate, and nitrate at Sunset Reservoir
Monte Vista Well	1910124-014	Active	Chlorination
Sunset Well	1910124-018	Active	Blending VOCs, perchlorate, and nitrate at Sunset Reservoir
Ventura Well	1910124-019	Active	Ion exchange for perchlorate removal and activated carbon adsorption for organics removal and chloramination at MHTS
Villa Well	1910124-020	Active	Blending VOCs, perchlorate, and nitrate at Sunset Reservoir
Well No. 52	1910124-021	Active	Ion exchange for perchlorate removal and activated carbon adsorption for organics removal and chloramination at MHTS
Windsor Well	1910124-022	Active	Ion exchange for perchlorate removal and activated carbon adsorption for organics removal and chloramination at MHTS
Woodbury Well	1910124-023	Active	Chlorination
Well 58	1910124-045	Active	Chlorination
Well 59	1910124-047	Active	Chlorination
Metropolitan Water District (MWD)-P1 Connection	1910124-033	Active	N/A
MWD-P2 Connection	1910124-034	Active	N/A
MWD-P3 Connection	1910124-035	Active	N/A
MWD-P4 Connection	1910124-036	Active	N/A
MWD-P5 Connection	1910124-037	Active	N/A

The distribution system has interconnections with seven (7) other water systems. Five (5) of the systems, including the Lincoln Avenue Water Company, Kinneloa Irrigation

District, California American Water Company, Valley Water Company, and Foothill Municipal Water District, can supply water to PWP. PWP can supply water to the City of South Pasadena, Rubio Cañon Land and Water Company, and each of the five (5) systems listed above. Additionally, PWP has an emergency interconnection with the City of Sierra Madre. Appendix B contains a hydraulic schematic of the water system.

All of the PWP's wells are located in the Raymond Basin which is an adjudicated basin.

2. INVESTIGATION AND FINDINGS

Information used to prepare this report was gathered from the files of the Department's Southern California Drinking Water Field Operations Branch, Southern California Section, Metropolitan District; PWP personnel; the Remedial Design/Remedial Action (RD/RA) Workplan for the MHTS dated June 2009 (Appendix D), and the 97-005 Technical Report prepared by Battelle dated April 2010 (Appendix E). Battelle serves as NASA's engineering consultant for JPL cleanup project. The 97-005 Technical Report included a source water assessment, a raw water quality characterization, a review of source protection programs, an evaluation of the proposed monitoring and treatment, a risk assessment of the potential failure of the proposed treatment system, and identification of alternatives to the proposed treatment.

In addition, key documents supporting and referenced in the RD/RA Workplan and 97-005 Technical Report include the CERCLA Remedial Investigation (RI) Reports prepared in 1999 and 2000 by the Foster Wheeler Environmental Corporation (FWEC) and reports of monitoring well sampling analysis beginning in 1994.

These reports and others can be accessed through the NASA Groundwater Cleanup Program Website http://jplwater.nasa.gov. The site includes a searchable information repository database including quicklinks to groundwater monitoring reports.

For the OU-2 RI report: http://jplwater.nasa.gov/NMOWeb/Docs/NAS70991.htm
For the OU-1/3 RI report: http://jplwater.nasa.gov/NMOWeb/Docs/NAS71001.htm

Mr. Alan Sorsher, P.E., former Associate Sanitary Engineer with the Metropolitan District, and Ms. Karen Wong, P.E., Associate Sanitary Engineer with the Metropolitan District, undertook the investigation, analysis, and preparation of this report. The report was reviewed and approved by Mr. Jeff O'Keefe, P.E., District Engineer, Metropolitan District and Mr. Kurt Souza, P.E., Section Chief, Southern California Section.

2.1 Superfund Background

The following information is taken from Section 1 of the RD/RA Workplan in Appendix D and is printed in *italics*.

"The Jet Propulsion Laboratory (JPL) is a Federally Funded Research and Development Center in Pasadena, California, currently operated under contract by the California Institute of Technology (Caltech) for the National Aeronautics and Space Administration (NASA). NASA has been investigating and taking actions to clean up the groundwater associated with historic practices since the mid-1980s. In 1992, JPL was placed on the National Priorities List (NPL) of sites governed by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The JPL facility has been divided into three Operable Units (OUs). OU-1 is on-facility groundwater at JPL; OU-2 is on-facility vadose zone soil at JPL; and OU-3 is off-facility groundwater adjacent to the JPL property.

Located in Los Angeles County, JPL adjoins the incorporated cities of La Cañada-Flintridge and Pasadena, and is bordered on the east by the unincorporated community of Altadena. A NASA-owned facility, JPL encompasses approximately 176 acres of land and more than 150 buildings and other structures. Of the JPL facility's 176 acres, approximately 156 acres are federally owned. The remaining land is leased for parking from the City of Pasadena and the Flintridge Riding Club. Development at JPL is primarily located on the southern half, in two regions: an early-developed northeastern area and a later-developed southwestern area. Figure 1-1 shows the location and boundaries of the JPL facility. The facility is bordered by the San Gabriel Mountains to the north, an equestrian club and Fire Station to the southwest, residential neighborhoods to the west, and the Arroyo Seco wash to the east and southeast. JPL is located in the Monk Hill Subarea of the Raymond Basin, which serves as a source of drinking water for several communities in the area. Using data from the United States Census 2000, it is estimated that approximately 44,000 people reside within 3 miles of JPL.

To address chemicals in off-facility groundwater, NASA will fund removal of target chemicals (perchlorate and volatile organic compounds [VOCs]) from the aquifer at four City of Pasadena, Water and Power Department (PWP) drinking water wells by adding a treatment facility to treat pumped groundwater. Additional information regarding the site characteristics (i.e., site setting, nature and extent of chemicals, fate and transport, and exposure pathways) can be found in the Record of Decision (ROD) for OU-3 (NASA, 2007).

The proposed treatment facility will be known as the Monk Hill Treatment System (MHTS). In this remedy, NASA will directly administer the work associated with designing, permitting, and constructing the MHTS. PWP will be funded by NASA to lease treatment equipment and operate the system. Groundwater from four PWP drinking water wells (i.e., Arroyo Well, Well 52, Windsor Well, and Ventura Well) will be cleaned in this new treatment facility using a liquid-phase granular activated carbon (GAC) system to remove VOCs, and an ion exchange system to remove perchlorate. The system is proposed to be located adjacent to the Windsor Well and Windsor Reservoir (see Figure 1-2).

The MHTS is part of the OU-3 response action and NASA's multi-phased approach to develop a comprehensive remedy that will successfully remediate chemicals in

groundwater. This includes on-facility treatment of source area groundwater and off-facility treatment of groundwater extracted from drinking water wells owned by Lincoln Avenue Water Company (LAWC) and the City of Pasadena (NASA, 2006; NASA, 2007)."

2.2 JPL OU Site Characteristics

OU-1, OU-2 and OU-3 are collectively referred to as the JPL OU. The following information was excerpted from the 97-005 Technical Report in Appendix E of this report.

2.2.1 Geologic Setting

"The San Gabriel Valley is divided into distinct groundwater basins. The Raymond Basin, where the production wells are 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 sub-areas as shown on Figure 2-1: the Pasadena Sub-basin, the Santa Anita Sub-basin, and the Monk Hill Subarea. All nine production wells under discussion in this document are located in the Monk Hill Subarea, which provides potable groundwater for several communities in the area including Pasadena, La Cañada-Flintridge, and Altadena (Foster Wheeler Environmental Corporation [FWEC], 2000).

2.2.2 Hydrogeologic Setting

In the Raymond Basin, a confluence of groundwater flow regimes occurs within the Monk Hill Subarea. Within the western portion of the Monk Hill Subarea the groundwater flow is predominantly to the southeast, and at the eastern portion of the Monk Hill Subarea the groundwater flow is predominantly to the south. However, the presence and operation of groundwater recharge basins (spreading grounds) in the Arroyo Seco and municipal groundwater production wells locally influence groundwater flow directions.

The Monk Hill Subarea is generally considered to be an unconfined aquifer. However, vertical hydraulic head (water level) differences with depth are observed between well screens in deep multi-level monitoring wells located near the production wells. The head differences are caused by the presence of relatively thin, silt-rich layers located throughout the alluvial aquifer that inhibit vertical flow of groundwater (FWEC, 1999a). These data indicate that the aquifer does not exhibit unconfined conditions. Therefore, the aquifer can be divided into four groundwater modeling unit layers, based primarily on how these silt-rich intervals influence the hydraulic heads in the aquifer during pumping of the nearby municipal wells. Throughout this document, these layers are interchangeably referred to as modeling unit layers or aquifer layers. These layers are discussed in further detail in the following paragraphs and in subsequent sections.

A surface geologic map of the study area produced by the California Division of Mines and Geology and five geologic cross sections are provided in Figures 2-2 and 2-3. The

cross sections were constructed by correlating lithologic logs, geophysical logs, and water-level and hydraulic-head data from the deep JPL multiport monitoring wells. The geologic formations and cross sections present within the study area are included in Figure 2-3.

The lithologic columns and geophysical logs depicted on the cross sections represent the boring logs and geophysical logs obtained during the Remedial Investigation (RI) for OU-1 and OU-3 (FWEC, 1999a). The correlation between wells was complicated by the variable nature of alluvial fan-type deposits present at JPL. Correlation between wells of generally similar lithologic sequences at similar depths was made whenever possible, as opposed to attempting to correlate individual sand and silt layers. Correlation between wells also was made between sections of the aquifer that had similar responses to pumping of nearby municipal production wells (similar amounts of drawdown). Historical hydrographs from JPL monitoring wells are included on the cross sections (Figure 2-3). The cross sections presented in Figure 2-3 do not include MW-3; therefore, two additional cross sections have been generated: Figure 2-4 shows the formations between wells MW-24 through MW-8, MW-3, Arroyo Well, MW-17, LAWC #3 and Figure 2-5 presents the wells located along the eastern side of JPL, from MW-21 through MW-5, MW-4, MW-12, 9, 15, and 1.

Four primary aquifer layers were delineated for the study area above the crystalline basement complex. The primary aquifer layers present in the study area were identified based on geologic formations published by the California Division of Mines and Geology and the United States Geological Survey (USGS). The four aquifer layers in the study area include the upper and lower sections of the Older Fanglomerate Series (Aquifer Layers 1 and 2, respectively), the Pacoima Formation (Aquifer Layer 3), and the Saugus Formation (Aquifer Layer 4). Although Layer 4 is part of the aquifer, it is not present beneath the area of interest and is therefore not discussed further in this report (NASA, 2004).

Groundwater elevation measurements have been recorded routinely to characterize aquifer conditions as part of the CERCLA program at JPL. Water-table elevations in JPL monitoring wells located at the mouth of the Arroyo Seco (MW-1, MW-9, and MW-15) have been consistently higher than water-table elevations in other JPL monitoring wells, indicating the presence of a significant groundwater mound. This mound is typically between 80 and 120 ft higher than the surrounding water table and is a result of recharge from the mouth of the Arroyo Seco, and possibly the presence of unmapped low-permeability physical barriers (FWEC, 1999a).

The groundwater surface has been measured in the JPL monitoring wells at depths ranging from approximately 22 to 270 ft below ground surface (bgs). This wide range of depths to groundwater can primarily be attributed to the relatively steep topography present in the area and local groundwater mounding at the mouth of the Arroyo Seco. It also can be attributed to seasonal groundwater recharge from nearby spreading grounds and the extraction of groundwater from nearby municipal production wells (FWEC, 2000).

2.2.3 Groundwater Flow Conditions

The groundwater flow conditions near the production wells are affected by various natural and anthropogenic influences that include the following: (1) pumping from other nearby municipal production wells, (2) groundwater recharge from Arroyo Seco spreading basins, (3) seasonal and regional groundwater recharge from precipitation, and (4) regional groundwater flow.

Potentiometric surface maps that represent groundwater flow conditions during operational and non-operational periods of nearby production wells (14 production wells and two aquifer storage and recovery wells) are shown in Figures 2-6 through 2-9. The September 1996 data are the most appropriate for the potentiometric surface maps associated with operational periods because more recent data do not exist since the Arroyo Well was shut down in 1997 (Figure 2-6). Pumping rates for the production wells have been included on Figure 2-6. Please refer to the Groundwater Modeling Report (NASA, 2004) for specific detail regarding pumping rates and production well usage. More recent water level data (November 2006) were used to create potentiometric surface maps for Aquifer Layers 1, 2, and 3 for non-operational periods (Figures 2-7, 2-8, and 2-9, respectively). Historical groundwater elevations in Layers 1, 2, and 3 are illustrated in Figures 2-10, 2-11, and 2-12, respectively. These figures also show the correlation between changes in the groundwater elevations measured in multi-level monitoring wells during operational cycles of the nearby municipal production wells.

Groundwater flow in the capture zones is primarily to the southeast. However, changes in the groundwater flow direction may occur temporarily during periods of high recharge at the Arroyo Seco spreading basins (typically between the months of January and March), combined with the non-operation of City of Pasadena wells. During these times, the groundwater mound at the mouth of the Arroyo Seco apparently expands locally, changing the groundwater gradient to the west across parts of the area where the Arroyo Well and Well 52 capture zones are located. A study found that localized groundwater gradient (water-table) changes were observed each year with durations ranging from approximately 9 days to 16 weeks (FWEC, 1999a). These shallow aquifer gradient changes are localized and the duration of the changes primarily depends on pumping schedules of City of Pasadena wells, precipitation, and rates of groundwater recharge in the Arroyo Seco spreading basins (FWEC, 2000)."

2.3 JPL OU Groundwater Contamination

The contaminants of primary concern are ClO_4 and CTC, and to a lesser degree, TCE, PCE, and chloroform. All four of these chlorinated organics were reportedly used at the JPL facility and chloroform also may result from the breakdown of CTC. Chloroform was frequently detected in the Monk Hill production wells and in the monitoring wells but at concentrations well below the disinfection byproduct TTHM MCL of 0.080 mg/L.

In response to exceedances of VOCs in the Monk Hill production wells beginning in the mid-1980s, JPL leased two air strippers for PWP, which were adjacent to Ventura Well.

Between 1997 and 2002, all four Monk Hill production wells were taken out of service due to high levels of perchlorate.

During the RI, a network of 24 monitoring wells was installed on the JPL property and in the surrounding areas. Two additional monitoring wells were later installed to the south, towards PWP's Sunset Wellfield. Figure 2-9 in the 97-005 Technical Report shows the location of the monitoring wells with respect to the JPL property, the four Monk Hill production wells, and other production wells.

The main inorganic contaminant of concern is perchlorate. Nitrate is also a concern throughout the Verdugo Basin to the northwest and Monk Hill Sub-area. However, nitrate has been successfully controlled by blending of PWP's Monk Hill production wells in Windsor Reservoir in the past when the wells were in service.

Historically, concentrations in groundwater as high as 14,000 µg/L ClO_4 were found at limited areas on the JPL property, about 2,000 feet to the northwest of the Arroyo Well. Onsite biological treatment has greatly reduced the concentrations of ClO_4 and CTC in the central area of the JPL property. Limited ClO_4 analysis of the Monk Hill production wells is available with the highest one-time result found at the Arroyo Well (160 µg/L), and lesser peak amounts at Well 52 (39 µg/L), Ventura Well (9 µg/L) and the Windsor Well (11 µg/L). More recent data collected during start-up testing are provided in Section 2.4 of this report.

The 97-005 Technical Report acknowledges that, "*The source water aquifer is vulnerable to chemicals, primarily VOCs and perchlorate, that have been associated with historic activities at the JPL facility. Also, the source water is vulnerable to the upgradient groundwater, which is known to contain VOCs, nitrate, and perchlorate.*"

The report also identifies potential additional sources, "*Other potential sources of chemical releases were identified from a database search. Based on this search, the groundwater was determined to be potentially vulnerable to at least 14 facilities located directly within the capture zone. These 14 facilities are primarily comprised of automotive service/repair shops and dry cleaners. Of the 14 facilities identified within the capture zone, only five facilities (Pacific Bell, and four automotive service/repair shops) in addition to JPL have had reported releases to the environment. Petroleum hydrocarbons and chlorinated solvents are common chemical constituents associated with all five facilities.*"

As noted above, organic chemicals of concern are CTC, TCE, PCE, and chloroform (CCl_3). In addition, the 97-005 Technical Report identifies a number of additional organic chemicals that are or were present in monitoring wells on or near the JPL facility. These include 1,2,3-trichloropropane (1,2,3-TCP), several nitrosamines, 1,4-dioxane, explosives, phthalates and nitrobenzene. These chemicals of <u>potential</u> concern are not expected to reach the Monk Hill production wells in detectable concentrations, but nevertheless should be monitored for on an appropriate frequency. If they were to reach the production wells, they would be treated by the activated carbon. In addition, the 97-005 Technical Report lists chlorate as a potential

contaminant of concern. Monitoring for chlorate should also be performed to ensure it is well below its Notification Level (NL) of 0.8 mg/L.

Since the four Monk Hill production wells have been out of service for the past 9 to 14 years, and have not been sampled during that timeframe, estimation of the contaminant concentrations in the treatment plant influent were made based on historical data. Figures 3-1 through 3-4 in the 97-005 Technical Report provide time series graphs of the previous concentrations of ClO_4, CTC, TCE and PCE for each of the Monk Hill production wells. Tables 3-1 through 3-5 in the 97-005 Technical Report summarize the water quality analyses for the Monk Hill production wells from 1985 until shortly after each was taken out of service. Table 2 below summarizes the statistics for the contaminants of concern in the production wells.

Table 2. Contaminants of Concern in Monk Hill Production Wells

Analyte, Unit		Number of Detects	Number of Samples	Frequency of Detection (%)	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean	Standard Deviation
Perchlorate, µg/L	Arroyo	12	12	100	42	160	96.18	40.29
	Well 52	277	287	97	2.97	38.8	20.98	6.837
	Ventura	131	187	70	2.72	9	3.725	2.3
	Windsor	91	186	49	1.87	10.71	2.523	2.415
Carbon tetrachloride, µg/L	Arroyo	52	58	90	0.24	15	4.249	3.365
	Well 52	82	115	71	0.24	4.8	1.245	1.028
	Ventura	5	109	5	0.2	0.5	0.2546	0.05449
	Windsor	4	136	3	0.5	2.29	0.271	0.1791
Tetrachloroethene (PCE), µg/L	Arroyo	16	53	30	0.1	1.13	0.3309	0.1968
	Well 52	26	110	24	0.1	3.76	0.4062	0.4844
	Ventura	65	112	58	0.31	1.3	0.4774	0.2291
	Windsor	94	142	66	0.5	2.6	0.7978	0.4992
Trichloroethene (TCE), µg/L	Arroyo	55	59	93	0.26	15	4.078	3.262
	Well 52	115	118	97	1.27	7.34	3.043	1.106
	Ventura	92	116	79	0.22	1.8	0.703	0.3413
	Windsor	94	141	67	0.1	3.35	0.8621	0.5713
Chloroform, µg/L	Arroyo	50	56	89	1.2	10.1	4.258	3.074
	Well 52	102	106	96	0.5	5.6	1.089	0.6059
	Ventura	47	109	43	0.4	21.7	0.6438	2.059
	Windsor	77	117	66	0.44	6.54	0.705	0.716

Table 5-3 from the 97-005 Technical Report, presented below, represents the estimated concentration of these contaminants in the treatment plant influent. These concentrations were derived by using the historical average concentrations from each of the four wells and the flow rate of each well.

Table 5-3 from the 97-005 Technical Report. MHTS Treatability Assessment

Analytes Detected that Exceed MCLs or NLs	*Units*	*Estimated Influent Concentration (1)*	*CA Primary MCL*	*CA Secondary MCL*	*DPH Notification Level*	*Treatability Assessment*	*Treatment Method*
PERCHLORATE	*µg/L*	*37.0*	*6*			*Yes*	*Ion Exchange*
CHLOROFORM	*µg/L*	*1.91*	*80(2)*			*Yes*	*LGAC*
CARBON TETRACHLORIDE	*µg/L*	*1.77*	*0.5*			*Yes*	*LGAC*
TRICHLOROETHYLENE	*µg/L*	*2.40*	*5.0*			*Yes*	*LGAC*
TETRACHLOROETHYLENE	*µg/L*	*0.48*	*5.0*			*Yes*	*LGAC*

Notes:

CA = California MCL = maximum contaminant level DPH = Department of Public Health µg/L = micrograms per liter

(1) 1/2 the detection limit was used for nondetect values in calculating the average concentration for each well. Influent concentration was estimated by multiplying the average concentration by the average flow rate for each well, summing these products together and dividing by the total flow rate. Assumes all four wells contribute proportionally to the total flow rate. The flow rate for Arroyo is 2200 gal/min, the flow rate for Well 52 is 1800 gal/min, the flow rate for Windsor is 1400 gal/min, and the flow rate for Ventura is 1600 gal/min.

(2) Based on the MCL for total trihalomethanes.

2.3.1 Nitrate Contamination

Nitrate contamination above the MCL (45 mg/L as NO_3) has been a known regional concern throughout the Verdugo and Raymond basins. Historical data indicates that nitrate levels at Ventura and Windsor Wells have been higher than those detected at Arroyo Well and Well 52. In November 2005, Battelle submitted a technical memorandum report (included as Appendix C in the 97-005 Technical Report) entitled, Nitrate Occurrence in the Monk Hill Subarea which concluded "Based on the results of the groundwater flow evaluation, it is anticipated that nitrate concentrations comparable to historical concentrations (before 2002) will be observed once the production wells have been in operation for some period of time."

Prior to 2002, Arroyo and Windsor Wells, and Well 52 were consistently below the MCL, but Ventura Well ranged above and below the MCL. The Department has allowed blending for regional contaminants such as nitrate which are not related to a specific contamination source. Therefore, PWP has been required to include a blending plan for nitrate as part of its Operation, Maintenance and Monitoring Plan for the MHTS. The blending plan includes monthly testing of the high and low nitrate sources, daily projections of the nitrate concentration in the blend, and weekly laboratory confirmation tests of the blend concentration.

2.4 Start-up Testing

After all four Monk Hill production wells were rehabilitated and MHTS construction completed, start-up testing was performed from December 2010 to February 2011. The goals of the start-up testing were to determine the current water quality of the four Monk Hill production wells and to demonstrate that the MHTS can reliably and effectively remove perchlorate and VOCs to below their respective detection limits.

The start-up testing consisted of six different scenarios that covered a wide range of treatment flows from a single well at 1,400 gpm to all four Monk Hill production wells at 7,000 gpm. To characterize the raw water quality entering the IX vessels, all four Monk Hill production wells and the combined plant influent were sampled for VOCs, perchlorate, nitrate, nitrosamines, 1,2,3-TCP, as well as for bacteria including total coliform and HPC. Depending on the scenario being tested, the IX combined effluent was also sampled periodically for some of the same constituents with the exception of 1,2,3-TCP. The LGAC combined effluent was periodically sampled for VOCs; and in some of the scenarios, monitoring for bacteria was also included. In the scenario where all four wells were in service, the IX combined effluent was periodically sampled for VOCs, perchlorate, nitrate, nitrosamines, and bacteria while the LGAC combined effluent was periodically sampled for VOCs, bacteria, as well as 1,2,3-TCP, which was again found to be non-detect.

During the start-up testing, the Monk Hill production wells were detected in the range of 5 to 45 ug/L for perchlorate and below the detection limit for CTC. The combined plant influent concentrations when all four wells were in service were 30 ug/L for perchlorate and non-detect for CTC. These current perchlorate and CTC levels were lower compared to the levels detected a decade ago prior to the shutdown of the Monk Hill production wells. Furthermore, these levels are within the design parameters for the MHTS and as expected, the start-up monitoring results show that the MHTS is capable of reliably and effectively removing perchlorate and VOCs to below the detection limits. A summary of the start-up test results is provided in Appendix I of this report.

As projected by the 97-005 Technical Report, the start-up test results also show that nitrate was detected at 23 to 52 mg/L at the Monk Hill production wells. In the scenario where all four wells were in service, the nitrate concentrations were 41 mg/L in the treatment plant influent before entering the IX vessels and dropped to 28 mg/L in the IX treatment effluent, which suggests that some nitrate removal may be occurring in the IX plant. To ensure that the nitrate level in the finished water is below 80% of the MCL for nitrate prior to distribution to the customers, PWP has submitted a formal blending plan for nitrate treatment in the Windsor Reservoir.

2.5 Description of Project

The following project description is taken from Section 2 of the RD/RA Workplan in Appendix D and is printed in *italics*. Figures and appendices in *italics* refer to the respective item in the RD/RA Workplan. Data sheets for the Monk Hill production wells,

the pump station, the disinfection, the ion exchange, and the liquid phase granular activated carbon as well as the specifications for the ion exchange resin, LGAC media, and disinfection monitoring equipment are included in Appendix F of this report.

It should be noted that the proposed treatment technologies, removal of perchlorate using single use ion exchange resin, and absorption of organic chemicals using granular activated carbon, are established best available technologies, and have been successfully used at a number of other water systems. The same type of equipment has been successfully used since July 2004 at the Lincoln Avenue Water System, on water that is also drawn from the Monk Hill sub basin, downgradient from Pasadena's four Monk Hill production wells.

2.5.1 Technology Overview

The MHTS will treat groundwater in the Monk Hill Subarea from four PWP production wells (Arroyo Well, Well 52, Ventura Well, and Windsor Well) with a maximum total capacity of 7,000 gallons per minute (gpm). The proposed treatment train includes two stages of chemical removal: perchlorate removal using ion exchange and VOC removal using GAC. The treatment system design influent and effluent criteria are shown in Table 2-1.

Table 2-1* from RD/RA Workplan. *Water Quality Design Criteria

Constituent	*Estimated Influent Concentration*	*Maximum Effluent Concentration*	*Units*
Nitrate	*24*	*36*	*mg/L*
Sulfate	*55*	*60*	*mg/L*
Chloride	*53*	*60*	*mg/L*
Bicarbonate	*230*	*NA*	*mg/L*
Perchlorate	*45*	*<4*	*µg/L*
Trichloroethene	*3.2*	*<0.5*	*µg/L*
Tetrachloroethene	*0.59*	*<0.5*	*µg/L*
1,2-Dichloroethane	*0.46*	*<0.5*	*µg/L*
Carbon Tetrachloride	*2.7*	*<0.5*	*µg/L*
1,2,3-Trichloropropane	*0.02*	*<0.005*	*µg/L*

NA = not applicable

Water pumped from the four production wells will be passed through two parallel 10-micron cartridge filters to remove sediment and particulates which may be discharged from the well pumps to prevent fouling and excessive pressure drop across the treatment system. The filtered water will then be directed and distributed between four fixed bed ion exchange systems. Each ion exchange system will include two Calgon Carbon Corporation (CCC) Model 12 vessels operating in a lead/lag configuration.

The effluent water from the perchlorate removal system will be distributed between five fixed bed GAC adsorber systems. Each GAC adsorber system will consist of two vessels operating in a lead/lag configuration. In order for the treated water from the MHTS to be supplied as drinking water for the City of Pasadena, PWP will disinfect the water using chloramine and send the disinfected water to the Windsor Reservoir.

2.5.2 Extraction Wells

The municipal production wells (Arroyo, Well 52, Windsor, and Ventura) are owned by the City of Pasadena. These wells are adjacent to JPL and have not been operational since being shut down when perchlorate concentrations in groundwater exceeded the California Department of Public Health (DPH) action level in 1997 (for Arroyo Well) and 2002 (for Well 52, Windsor, and Ventura wells). The four production wells will be evaluated and rehabilitated as part of the MHTS construction activities. Figure 2-1 shows the relative locations of the four production wells to each other and the JPL facility. Well characteristics are summarized in Table 2-2 and discussed in detail in the following subsections.

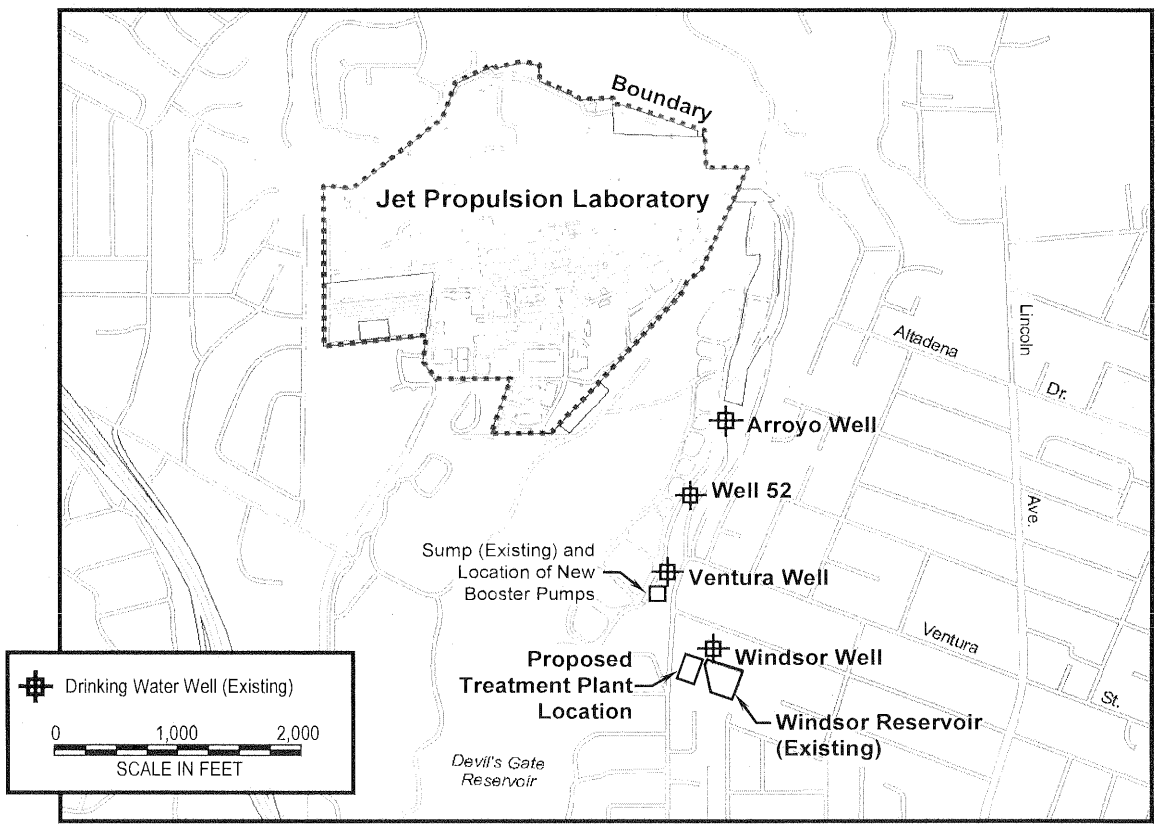

Figure 2-1 from RD/RA Workplan. Location of Production Wells, Sump, and Treatment Plant

Table 2-2 from RD/RA Workplan. Summary of Production Well Characteristics

Well	Completion Date	Depth (ft bgs)	Diameter (inches)	Screened Intervals (ft bgs)	Well Casing	Production Rate Goal (gpm)
Arroyo	1930	668	20[(a)]	127-299 306-331 367-372 398-401 457-485 488-503 508-521 538-554 568-594 598-624	#8 steel gauge	2,200
52	1977	647	20	250-360 360-367 372-556 556-630	#8 steel gauge	1,800
Windsor	1969	600	20	320-344 374-384 426-450 474-485 497-585	#8 steel gauge	1,400
Ventura	1924	473	26	102-141 164-218 241-311 410-468	#8 steel gauge	1,600

(a) Well originally constructed with a 26-in diameter – modified in 1975 with a 20-in diameter liner.
bgs = below ground surface

2.5.2.1 Arroyo Well (No. 25)

The Arroyo Well is located on the eastern side of the JPL east parking lot access road (see Figure 2-1). The well is located 126 feet south of the JPL east parking lot fence, and approximately 1,350 feet north of the intersection of Windsor Avenue and Ventura Street. The property consists of a small well house (approximate dimensions: 18 ft × 23 ft) that houses the well and associated ancillary piping and electrical equipment, and is surrounded by a chain-link fence (61 ft × 32 ft) (see Figures 2-2 and 2-3). There are two access gates located on the eastern and southern perimeter.

The Arroyo Well was constructed in October 1930 and consists of 26-inch diameter No. 8 gauge steel casing. The casing was extended by approximately 5 feet and the shaft was filled with gravel in 1967. The well was re-lined in October 1975 with 324 feet of 20-inch steel liner with the bottom 100 feet perforated (i.e., 0 to 224 feet blank casing and 224 to 324 feet perforated casing). The total depth of the well is 668 feet bgs; the well was sounded November 30, 1971 and recorded a total depth of only 643 feet bgs due to a buildup of fines in the base of the borehole. Characteristics of the Arroyo Well are summarized in Table 2-2 and a boring log is presented in Appendix A.

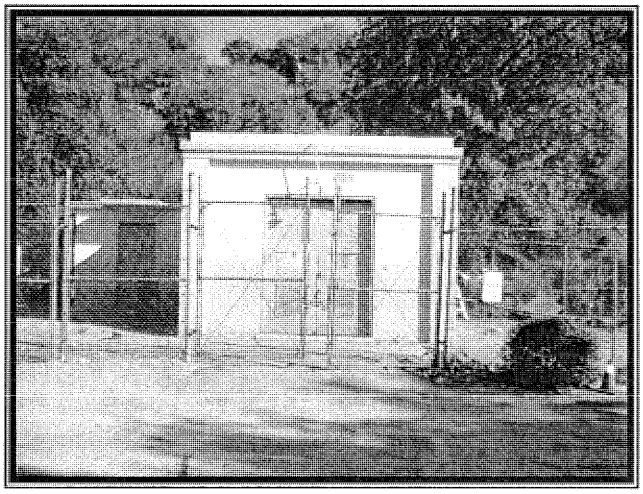

Figure 2-2 from RD/RA Workplan Arroyo Well (East View)

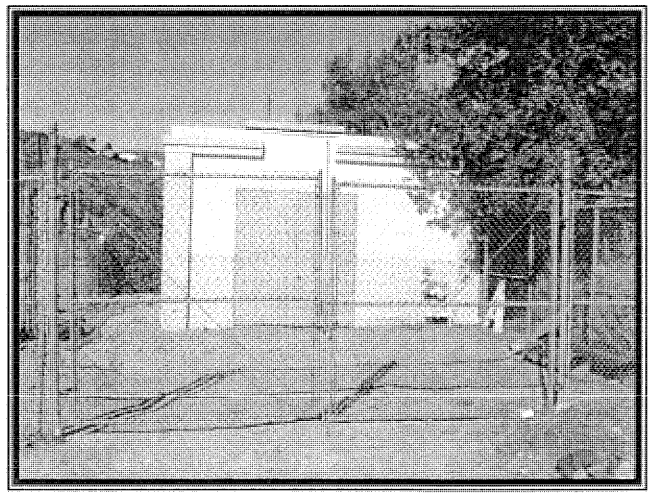

Figure 2-3 from RD/RA Workplan Arroyo Well (North View)

Operation of the Arroyo Well ceased in 1997. In the two years prior to system shutdown, the median monthly groundwater production rate from the Arroyo Well was 2,400 gpm, with an associated depth to water of approximately 145 ft bgs. The pump and associated equipment was removed from the well in September 2003 by General Pump Company, and video and geophysical logging of the well was completed by Pacific Surveys.

The production rate goal for this well is 2,200 gpm.

2.5.2.2 Well 52

Well 52 is located on the east side of Karl Johnson Parkway (the City of Pasadena maintenance access road located east of the spreading grounds which extends from the JPL east parking lot access road [to the north] all the way to the Devil's Gate dam). The well is located 462 ft due south of the intersection of Karl Johnson Parkway and the east parking lot. The well site consists of two attached buildings constructed of brick and cinder blocks (see Figure 2-4). The actual wellhead is located outside, and the associated electrical equipment and panels are located inside the northern building. The well site is surrounded by a chain-link fence (north side: 71-ft; south side: 51-ft; east side: 106-ft; west side: 113-ft; height: 8-ft) with three gates located on the north, west, and south sides.

Well 52 was constructed in 1977 and consists of 20-inch diameter double No. 8 gauge steel casing. The conductor casing consists of three-ply No. 8 gauge steel and extends from the ground surface to 24 feet bgs. Characteristics of Well 52 are summarized in Table 2-2 and a boring log is presented in Appendix A.

Operation of Well 52 ceased in January 2002. In the two years prior to system shutdown, the median monthly groundwater production rate from Well 52 was 1,600 gpm, with an associated depth to water of approximately 170 ft bgs. The pump and associated equipment were removed from the well in September 2003 by General Pump Company, and video and geophysical logging of the well was completed by Pacific Surveys.

The production rate goal for this well is 1,800 gpm.

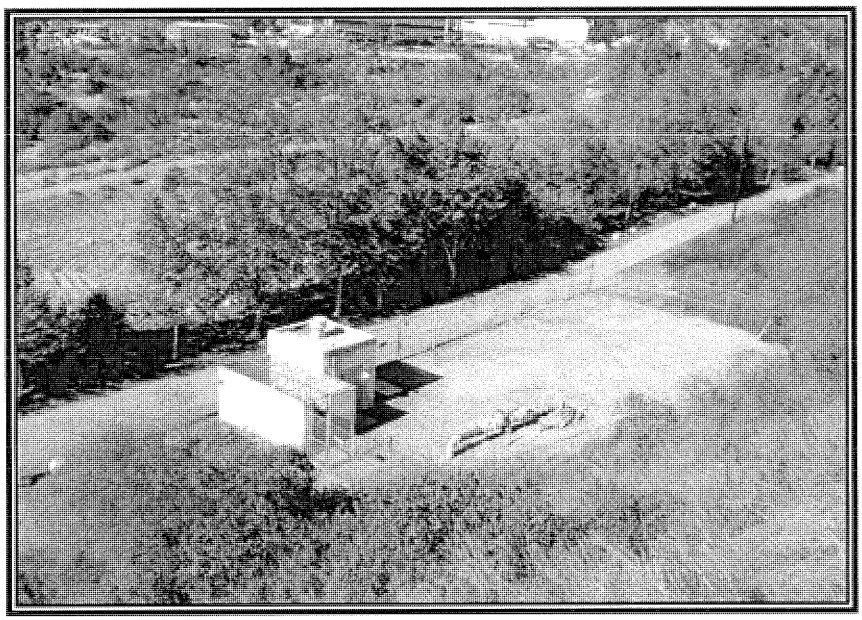

Figure 2-4 from RD/RA Workplan. Northwest Aerial View of Well 52

2.5.2.3 Ventura Well

The Ventura Well is located on the east side of Karl Johnson Parkway, and is located approximately 1,350 ft due south of the intersection of Karl Johnson Parkway and the JPL east parking lot access road. The well site consists of two attached buildings constructed of brick and cinder blocks with a removable roof (see Figure 2-5). The wellhead is housed in the northernmost building (see Figure 2-6). The entrance to the buildings is encompassed in a fenced lot that is roughly 172-ft × 40-ft in size. The fenced lot currently houses two concrete-lined sumps that are located immediately north of the well buildings and have a combined volume of 38,000 gallons. The remainder of the fenced lot is currently empty.

The Ventura Well was constructed in 1924 and consists of 26-inch diameter double No. 8 gauge steel casing. The conductor casing consists of double ¼-inch gauge steel and extends from the ground surface to 30 feet bgs. Characteristics of the Ventura Well are summarized in Table 2-2 and a boring log is presented in Appendix A. Operation was ceased in January 2002. The production rate goal for this well is 1,600 gpm.

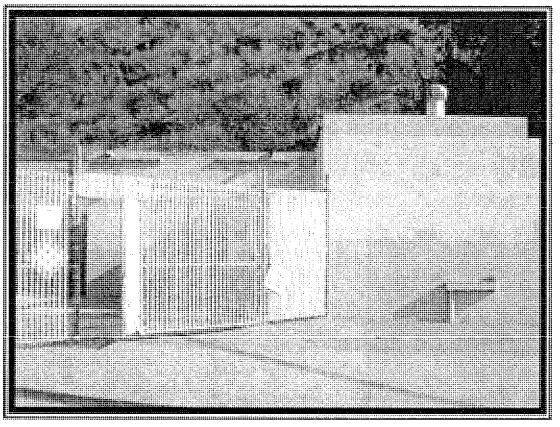

Figure 2-5 from RD/RA Workplan Ventura Well Building

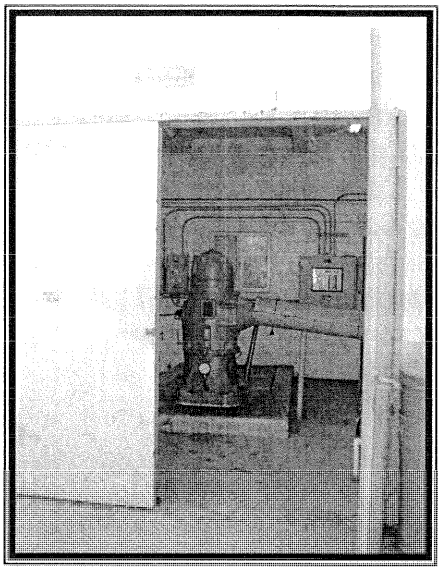

Figure 2-6 from RD/RA Workplan Ventura Well

2.5.2.4 Windsor Well (No. 48)

The Windsor Well (No. 48) is located in the northeast corner of the Windsor Avenue reservoir yard. The well is located approximately 325-ft due east of the Windsor Avenue north gate. The well is not enclosed in a well house (see Figure 2-7).

The Windsor Well was constructed in 1969, and consists of 20-inch diameter double No. 8 gauge steel casing. The conductor casing consists of ¼-inch gauge steel and extends from the ground surface to 50 feet bgs. Characteristics of the Windsor Well are summarized in Table 2-2 and a boring log is presented in Appendix A. Operation was ceased in January 2002. The production rate goal for this well is 1,400 gpm.

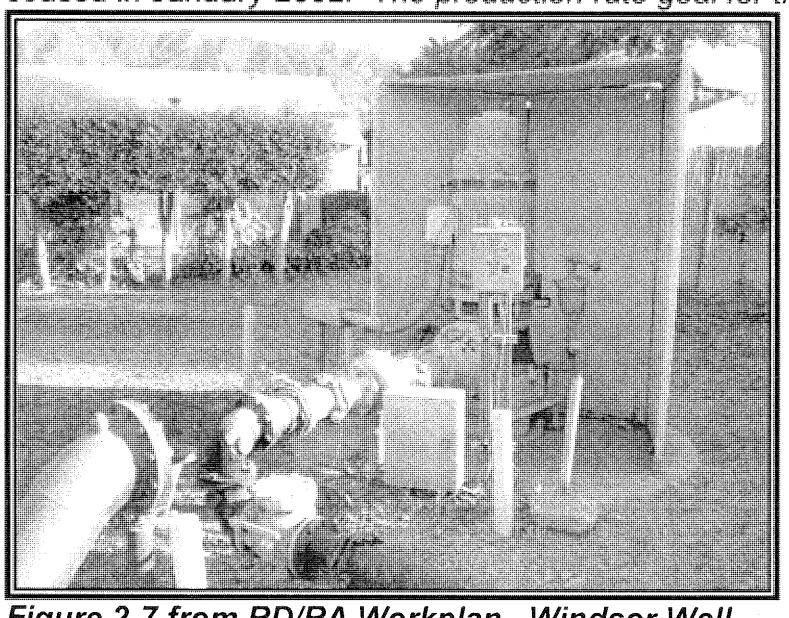

Figure 2-7 from RD/RA Workplan. Windsor Well

2.5.3 Treatment System Piping

The MHTS layout along with the location of influent and effluent piping at the Windsor Site is shown on Design Drawing C-102 in Appendix P. Extracted groundwater from the Arroyo Well, Well 52 and Ventura Well will be pumped to the two existing equalization sumps (the former air stripper discharge sumps) via existing pipelines. The two equalization sumps have a combined volume of 38,000 gallons and will be used to remove sand and air from the extracted groundwater. Water from the equalization sumps will be pumped to the proposed treatment system at the Windsor Reservoir site via an existing 16-inch steel transfer pipeline. The water from Windsor Well will be transferred directly to the new treatment system through an existing 12-inch steel line. A desanding unit may be installed at Windsor Well to remove sand and air from the extracted groundwater depending on the results of well rehabilitation efforts. A new section of 24-inch ductile iron pipe will be installed to connect the existing 16-inch steel influent pipeline from the equalization sumps and the existing 12-inch steel influent pipeline from Windsor Well to the MHTS.

All existing pipelines were inspected by Closed Circuit Television in order to assess the condition of the pipelines and determine if they will be suitable for continued use. The inspected pipelines include a 12-inch transite, 12-inch ductile iron, 12-inch steel, 16-inch steel, 24-inch cast iron, and 30-inch hume. Overall, the pipes were found to be in good condition; however, additional pressure testing was recommended on two of the pipes to further evaluate their condition. The pressure testing was performed on 1,100 feet of the 16-inch steel pipeline (from Ventura Well to the proposed connection point) and 255 feet of the 12-inch ductile iron pipeline (from Windsor Well to a location just east of the north driveway at the Windsor Site). Both pipelines passed the pressure tests. A short section of existing pipeline, approximately 20 feet in length, and meter from Arroyo Well could not be video logged due to obstructions in the pipeline (meter and tee). This section of pipeline and meter may require replacement and will be determined during the construction. A summary of the Closed Circuit Television video investigation, as well as results of the pipeline pressure testing, are included as Appendix B.

The existing 30-inch pipeline along Windsor Avenue will be used to transfer treated water to the Arroyo Seco spreading basins. Discharge of treated water to the spreading basins will be necessary during periods of startup and testing, when the water cannot be sent to the Windsor Reservoir (see Section 4.1.3). The existing 30-inch pipeline which runs from the Windsor Reservoir site to the Arroyo Well and beyond will be connected to an existing concrete outfall located along the Windsor Avenue extension to allow discharge to Basin No. 5. A section of pipe, approximately 50 feet long, will be installed from the existing 30-inch pipe near the Arroyo Well, under the Windsor Avenue extension, and to the existing concrete outfall location on the other side of the road.

2.5.4 Treatment Equipment

A process flow diagram (PFD) of the proposed treatment system is shown in Design Drawing G-103. Influent and effluent design flow rates and water quality are also shown

in Design Drawing G-103. The treatment equipment vessel layout is shown on Design Drawing TPM-101, and cross sections of the vessel layout are shown on Design Drawings TPM-102 through TPM-105. All exposed tanks, piping, equipment, and new facilities shall be a neutral (or earth-toned) color to help the MHTS blend with the existing area views. Design information for the proposed treatment equipment is provided in the following subsections. All Design Drawings are provided in Appendix P.

2.5.4.1 Feed Pumps

Three feed (sump) pumps will be installed to transfer water to the treatment plant, across the treatment vessels and associated piping, valves, and fittings, and into Windsor Reservoir. Two pumps will be operational with the third one in standby mode serving as a backup. The total pressure drop through the MHTS is expected to be in the range of 70 to 90 pounds per square inch (psi) (clean versus dirty filters). Design Drawing G-103 provides details on pressure drops through each stage of the MHTS (see Appendix P). A sound enclosure will be installed around the feed pumps to ensure that the noise generated by the pumps is reduced to comply with Pasadena Municipal Code Section 9.36.100. In addition, potential vibrations associated with the pumps will be attenuated with shock absorbers and proper alignment to the satisfaction of the City of Pasadena Director of Planning and Community Development.

By modifying the existing pipelines to allow Windsor Well to by-pass the equalization sumps and pump directly to the treatment plant (Section 2.3), the maximum flow rate requirement of the feed (sump) pumps is reduced from 7,000 gpm to 5,600 gpm, and 250 horsepower pumps can be used instead of 300 horsepower pumps. A technical memorandum evaluating the energy and cost savings associated with pumping the Windsor Well directly to the MHTS is included as Appendix C.

2.5.4.2 Inlet Water Filter

The inlet water filter system will be a triplex (three vessel) filter. Each filter will be designed with a 3,500 gpm capacity, and two filters will operate in parallel under normal flow conditions. Each filter will contain 155 polypropylene pleated filter cartridges rated at 10 micron to prevent particles from building up in the media treatment vessels downstream. Each vessel will be 42 inches in diameter and 100 inches tall. They will be constructed of carbon steel with an NSF International (NSF)-certified, two part epoxy internal coating and rated at 150 psi at 300 °F. The filter vessels will have a full diameter top access port secured by 23 heavy duty closure bolts. The top access will have a bearing assisted davit cover lift for access to the filter elements. The filter system will be equipped with a filter vessel operation platform approximately 6 feet high and 10 feet by 25 feet 3 inches long, which will be accessible by stairs. The platform grating will be fiberglass and the support structure will be steel with polyurethane finish paint. The expected pressure drop is 5 psi through the clean filter and 25 psi through the dirty filter.

2.5.4.3 Ion Exchange System Header Piping

Following the filtration stage, the water will be directed and distributed between four fixed bed ion exchange vessel pairs. The ion exchange system header piping will be a 24-inch carbon steel pipe with a NSF-certified epoxy based interior lining. All flowrates to individual vessels will be adjusted manually.

2.5.4.4 Ion Exchange Vessels

The ion exchange system will consist of eight High Flow Modular Model 12 water treatment system vessels. The system will be arranged with four parallel pairs of vessels, each operated in a lead/lag configuration. Each vessel will be 12-foot in diameter with an overall height of approximately 16 feet and 4 inches, and will be constructed of carbon steel. The interior surfaces of each vessel will be lined to meet requirements for certification for use in potable water systems per NSF/American National Standards Institute (ANSI) Standard 61. The structural aspects of the vessels will be sufficient to meet the Uniform Building Code (UBC) requirements for Seismic Zone 4.

Each vessel will be designed with the necessary piping connections for operation of the vessels in a lead/lag configuration, as well as for backwashing of the vessels. Conical strainers will be installed on the effluent end of each vessel to provide protection of downstream equipment in the case of an unexpected release of media. Each vessel will also be provided with one 20-inch manway and three 2-inch sample nozzles for use with in-bed water sample probes at 25%, 50%, and 75% of the media bed depth.

Each pair of ion exchange vessels will be designed with a maximum treatment capacity of 1,750 gpm. The pressure drop across each pair of ion exchange vessels will be approximately 22.2 psi at 1,750 gpm. Each individual ion exchange vessel will contain approximately 353 cubic feet of CalRes 2109 Anion Exchange Resin, a single-use ion exchange resin for perchlorate removal. CalRes 2109 has been certified for potable water use by the Water Quality Association according to "Drinking Water System Components – Health Effects," NSF/ANSI-61 for drinking water system components. Perchlorate breakthrough curves are provided in Appendix D. Specifications and drawings for the ion exchange vessels and ion exchange resin are presented in Appendix E. 12-foot diameter ion exchange vessels with CalRes 2109 are successfully operated at up to 2,000 gpm for perchlorate removal at the Lincoln Avenue Water Company with influent concentrations as high as 35 µg/L.

Table 3 summarizes the specifications for CalRes 2109 resin.

Table 3. Specifications for CalRes 2109 Resin

Properties	Specifications
Type	Strong Base Anion
Structure	Macroporous
Functional Group	N-Tributyl Amine

Properties	Specifications
Ionic Form	Chloride
Wet Volume Capacity, Cl form, meq/ml	Minimum 0.6
Water Retention Capacity, Cl form, %.	50 - 65
Bulk Density, Kg/L	0.68 – 0.72
Particle Density, g/mL	1.05 – 1.15
Whole Bead, %	90
U.S. Sieve Series, %	100% max through 14 mesh, 3% max on 16 mesh, and 5% max through 40 mesh
Effective bead size, mm	0.35 – 0.65

2.5.4.5 GAC System Header Piping

Following ion exchange treatment, the water will be directed and distributed between five fixed bed GAC systems. The GAC system header piping will be a 24-inch carbon steel pipe with a NSF/ANSI-certified epoxy based interior lining. All flowrates to individual vessels will be adjusted manually.

2.5.4.6 GAC System

The GAC system will consist of 10 Extended Capacity Modular Model 12 Carbon Adsorption system vessels. The system will be arranged with five parallel pairs of vessels, each operated in a lead/lag configuration. Each vessel will be 12-foot in diameter with an overall height of approximately 22 feet, 7 inches, and will be constructed of carbon steel. The interior surfaces of each vessel will be lined to meet requirements for certification for use in potable water systems per NSF/ANSI Standard 61. The structural aspects of the vessels will be sufficient to meet the UBC requirements for Seismic Zone 4.

Each vessel will be designed with the necessary piping connections for operation of the vessels in a lead/lag configuration, as well as for backwashing of the vessels. Conical strainers will be installed on the effluent end of each vessel to provide protection of downstream equipment in the case of an unexpected release of GAC media. Each vessel will also be provided with one 20-inch manway and three 2-inch sample nozzles for use with in-bed water sample probes at 25%, 50%, and 75% of the carbon bed depth.

Each GAC vessel pair will be designed with a maximum treatment capacity of 1,400 gpm and an empty bed contact time of 7.5 min/bed. The pressure drop across each pair of GAC vessels at 1,400 gpm will be approximately 13.4 psi. Each individual GAC vessel will contain 40,000 pounds of Filtrasorb 300 GAC. Filtrasorb 300 GAC has been certified for potable water use by the Water Quality Association according to "Drinking Water System Components – Health Effects," NSF/ANSI-61 for drinking water system components. GAC specifications are provided in Appendix F. Specifications and drawings for the GAC vessels are provided as Appendix G."

Table 4 summarizes the specifications for Filtrasorb 300 GAC.

Table 4. Specifications for Filtrasorb 300 GAC

Properties	Specifications
Type	Bituminous Coal
Screen Size by weight, US Sieve Series	8X30 mesh, 15% max. on 8 mesh, 4% max. through 30 mesh.
Iodine Number, mg /g	900 min.
Abrasion Number	78 min.
Mean Particle Diameter, mm	1.5 – 1.7
Effective Size, mm	0.8-1.0
Uniformity Coefficient	2.1 max.
Moisture as Packed, wt%	2% max.
Trace Capacity Number	10 mg/cc (min)
Apparent Density, g/cc	0.56
Total Ash Content, wt.%	7% max.

2.5.4.7 Chloramination System

The disinfection facility (DF) is designed to maintain a 2.5 mg/L target chloramine residual in the distribution system. Gas chlorine will be injected first into the 24-inch plant effluent line, followed by injection of 19% ammonium hydroxide. The DF will disinfect flows from 1,000 gpm (from one well running at reduced capacity) to 7,000 gpm (all 4 wells running). Any time that treated water will not be used and sent back to the Arroyo spreading grounds, the DF will not be utilized.

The DF includes a 45 ft x 30 ft x 20 ft high concrete masonry building with locked security doors, exterior lights, automatic fire sprinklers, smoke detection and fire alarm systems. The DF is equipped with automatic chlorine and ammonia systems with flow control systems based on the treatment system flow rates and free chlorine residual. An emergency scrubber (Purolite) will be located outside the chlorine room. This emergency scrubber is sized to treat the release of one 150 pound chlorine gas cylinder (automatically placed in service set at a detection level of 3 ppm of gas chlorine in the room). The DF also has a 30 kilo-watt emergency diesel generator to sustain power for the necessary equipment in case of power outage.

Ammonium hydroxide and gas chlorine are incompatible chemicals so each chemical will be isolated and secured in separate rooms. The chlorine room has two 4-feet wide doors and one 20 foot roll-up door for servicing. Three eye wash units have been installed.

The chlorine system includes two banks each containing eight 150-pound gas cylinders all maintained on-line with a switchover valve. Each cylinder operates under vacuum with a separate vacuum regulator valve, three Drager leak detectors, with visual and audible alarms adjacent to each bank of cylinders and at scrubber exhaust. A free chlorine analyzer (HACH CL-17) obtains samples downstream of the chlorine injection

point, after a static mixer downstream of the chlorine injection point and upstream of the ammonia injection point. An additional total chlorine analyzer at the discharge of Windsor Reservoir is provided to verify the residual level entering the distribution system.

The ammonia system includes one polyethylene upright single wall ammonia tank open to the atmosphere to store 1,090 gallons of 19% ammonium hydroxide, a berm around the tank to contain spills, piping, control valves, etc. The tank will have an ultrasonic level indicator with low and high level alarms, overfill protection, 3-inch vent line, 2-inch stainless steel fill and vapor return lines between the tank and service-fill connection fitting. The ammonia room is temperature controlled with an air conditioning unit. The ammonia room has one 4 foot wide door and one 12 foot wide roll-up door.

The ammonia system also includes 2 peristaltic pumps (one in service, one stand-by) with a maximum service capacity of 2 gallons per hour, 2 calibration columns installed to verify the pumping rate, 2 back-pressure sustaining valves, 2 Drager leak detectors – one for the ammonia tank and one for leaks in the underground portion of the pipe between the tank and the injection point. The ammonia feed rate will be controlled by the HACH APA6000 analyzer.

The analyzers (HACH CL-17 and HACH APA6000) that monitor free chlorine and chloramine in the plant effluent pipe are connected to PWP's SCADA system, and would cause the SCADA system to shut down the wells, and thereby the flow through the treatment plant, in the event that chlorine or chloramine levels were out of range. Similarly, the leak detectors in the chlorine and ammonia storage rooms, and inside the double walled ammonia pipe, are also connected to the SCADA system.

A data sheet for disinfection system and an application note on the HACH APA6000 ammonia/monochloramine analyzer are included in Appendix F.

2.5.4.8 SCADA Interface

A Supervisory Control and Data Acquisition (SCADA) junction box will be installed to receive all of the signals from the monitoring instrumentation and will include a 24 volt direct current (VDC) power supply for the system instrumentation (see Section 2.5). The City will provide power to, and pick up all signals from this junction box. The existing remote terminal units (RTU) will be used to connect this SCADA to the City's existing SCADA.

2.5.5 Instrumentation and Controls

Piping and instrumentation diagrams (P&ID) are provided in design drawings PID-101 through PID-108 (Appendix P). These P&IDs show the piping, valves and instrumentation for the proposed system. Monitoring instrumentation on the treatment system will be interfaced with the existing SCADA system and electrical service. Instrumentation on the treatment system will monitor only; no devices will require return

control signals. Table 2-3 lists all instrumentation provided throughout the system, including that for the production wells, feed pumps, equalization sump, and treatment equipment.

Instrumentation associated with the MHTS equipment primarily includes flow meters, differential pressure gauges, and rupture disk alarms. Magnetic flow meters will be installed on each of the treatment vessels (ion exchange and GAC) to monitor and totalize flow. Flow will be measured on the vessel influent/backwash discharge line to detect flow both entering and exiting (under backwash conditions) the vessel. The magnetic flow meters will be powered by 24 VDC from the SCADA junction box. The flow meters will each source a 4 to 20 mili-Amp (mA) DC signal for input to the SCADA interface. All flow control through the system will be manually adjusted using the appropriate flow control valves.

There will be one differential pressure transmitter on each of the treatment vessels (ion exchange and GAC) to monitor pressure drop across each pair of vessels. The differential pressure transmitter will provide a 4-20 mA signal for input to the SCADA interface. The differential pressure transmitters will be powered by 24 VDC from the SCADA junction box. In addition, the process piping will be equipped with pressure gauges to indicate the water pressure entering each pair of treatment vessels (ion exchange and GAC). The pressure gauges will have a range of 1 to 200 psi. Rupture disks will also be provided with each vessel, and will incorporate burst indicators to allow remote indication of rupture disk status.

Differential pressure transmitters will also be provided for the inlet filter system. One differential pressure transmitter will be provided to measure the pressure drop across the filter vessels. The combined effluent line from the GAC units will also be equipped with a magnetic flow meter to monitor and totalize flow. The flow meter will be powered by 24 VDC from the SCADA junction box, and will source a 4-20 mA DC signal for input to the SCADA interface.

Table 2-3 from RD/RA Workplan. Summary of Equipment Instrumentation and Alarms

LOCATION	INST #	SERVICE	LOCAL PANEL/READOUT	RTU	RTU/LOCATION	SCADA/REMOTE
PRODUCTION WELLS	FIT-10X	WELL DISCHARGE FLOWTRANSMITTER		X	ARROYO BLDG	X
	LIT-10X	WELL LEVEL TRANSMITTER		X	ARROYO BLDG	X
	PI-10X	WELL DISCHARGE PRESSURE INDICATOR/MANUAL	X			
	PIT-10X	WELL DISCHARGE PRESSURE INDICATOR/TRENDING		X	ARROYO BLDG	X
	PS-10X/TD3	PUMP FAILURE ALARM	X	X	ARROYO BLDG	X
	HPS-10X	HIGH PRESSURE ALARM		X	ARROYO BLDG	X
	TD5	MOTOR OVERHEAT	X	X	ARROYO BLDG	X
	CR8	POWER FAILURE	X	X	ARROYO BLDG	X
	CR6	PUMP LIGHT LOAD ALARM	X	X	ARROYO BLDG	X
	OL	PUMP OVER LOAD ALARM	X			
	CR7	PUMPING WATER STATUS		X	ARROYO BLDG	X
	CR4	WELL MOTOR RUN STATUS	X	X	ARROYO BLDG	X
	CR5	PUMP CALL	X	X	ARROYO BLDG	X
	HOA	HAND OFF AUTO STATUS	X	X	ARROYO BLDG	X
VENTURA BOOSTER STATION	FS-100	SUMP OVERFLOW SENSOR TO SPREADING GROUNDS				
	FA-100	SUMP OVERFLOW INDICATION ALARM		X	VENTURA ELEC BLDG	X
	FIT-100	PUMP DISCHARGE FLOW TRANSMITTER		X	VENTURA ELEC BLDG	X
	XA	PUMP FAULT INDICATION ALARM (P-101 ; P-102; P-103)	X			
	LIT-100	SUMP LEVEL TRANSMITTER	X			
	LIT-101	SUMP LEVEL TRANSMITTER	X			
	LAL-101	SUMP LEVEL LOW ALARM	X			
	LAH-101	SUMP LEVEL HIGH ALARM	X			
	LS-101	SUMP LEVEL FLOAT	X			
	LAL-101	SUMP LEVEL LOW LOW ALARM	X			
	PIT-100	PUMP DISCHARGE PRESURE	X			

Table 2-3 from RD/RA Workplan. Summary of Equipment Instrumentation and Alarms

LOCATION	INST #	SERVICE	LOCAL PANEL/READOUT	RTU	RTU/LOCATION	SCADA/REMOTE
		TRANSMITTER				
	PI-100	PUMP DISCHARGE INDICATOR	X			
	PAL-100	PUMP DISCHARGE LOW PRESSURE ALARM	X			
	PAH-100	PUMP DISCHARGE HIGH PRESSURE ALARM	X			
	LS-102	SUMP LEVEL FLOAT	X			
	LAH-102	SUMP LEVEL HIGH HIGH ALARM	X			
	ZA-104	RELIEF VALVE OPEN INDICATION ALARM	X			
	YLA	PUMP FAILURE ALARM (P-101 ; P-102; P-103)	X			
	TAH	PUMP HIGH TEMPERATURE ALARM (P-101 ; P-102; P-103)	X			
INFLUENT FILTERS	PIT-200	PRESSURE TRANSMITTER/RECORDING	X	X	WINDSOR ELEC BLDG	X
	PAL-200B	LOW PRESSURE ALARM		X	WINDSOR ELEC BLDG	X
	PAH-200A	HIGH PRESSURE ALARM		X	WINDSOR ELEC BLDG	X
	PDIT-201	DIFFERENTIAL PRESSURE INDICATOR	X	X	WINDSOR ELEC BLDG	X
	PDAH-201A	DIFFERENTIAL PRESSURE HIGH ALARM		X	WINDSOR ELEC BLDG	X
	PDIR-201B	DIFFERENTIAL PRESSURE RECORDER		X	WINDSOR ELEC BLDG	X
FILTERED EFFLUENT	PI-202	PRESSURE TRANSMITTER	X			
INFLUENT TO IX VESSELS	PDIT-30XA	DIFFERENTIAL PRESSURE INDICATOR	X	X	WINDSOR ELEC BLDG	X
	PDAH-30XA1	DIFFERENTIAL PRESSURE HIGH ALARM		X	WINDSOR ELEC BLDG	X
	PDIR-30XA2	DIFFERENTIAL PRESSURE RECORDER		X	WINDSOR ELEC BLDG	X

Table 2-3 from RD/RA Workplan. Summary of Equipment Instrumentation and Alarms

LOCATION	INST #	SERVICE	LOCAL PANEL/READOUT	RTU	RTU/LOCATION	SCADA/REMOTE
	PI-30XA	PRESSURE INDICATOR	X			
	PI-30XAA	PRESSURE INDICATOR	X			
	PDIT-30XB	DIFFERENTIAL PRESSURE INDICATOR	X	X	WINDSOR ELEC BLDG	X
	PDAH-30XB1	DIFFERENTIAL PRESSURE HIGH ALARM		X	WINDSOR ELEC BLDG	X
	PDIR-30XB2	DIFFERENTIAL PRESSURE RECORDER		X	WINDSOR ELEC BLDG	X
	PI-30XB	PRESSURE INDICATOR	X			
	FIE-30XA	RUPTURE DISK SENSOR				
	FIA-30XA	DISK RUPTURE ALARM		X	WINDSOR ELEC BLDG	X
	FIE-30XB	RUPTURE DISK SENSOR				
	FIA-30XB	DISK RUPTURE ALARM		X	WINDSOR ELEC BLDG	X
IX VESSEL EFFLUENT	FIT-30XA	FLOW TRANSMITTER		X	WINDSOR ELEC BLDG	X
	FIR-30XA	FLOW RECORDER		X	WINDSOR ELEC BLDG	X
	FIT-30XB	FLOW TRANSMITTER		X	WINDSOR ELEC BLDG	X
	FIR-30XB	FLOW RECORDER		X	WINDSOR ELEC BLDG	X
INFLUENT TO LGAC VESSELS	PDIT-40XA	DIFFERENTIAL PRESSURE INDICATOR	X	X	WINDSOR ELEC BLDG	X
	PDAH-40XA1	DIFFERENTIAL PRESSURE HIGH ALARM		X	WINDSOR ELEC BLDG	X
	PDIR-40XA2	DIFFERENTIAL PRESSURE RECORDER		X	WINDSOR ELEC BLDG	X
	PI-401XA	PRESSURE INDICATOR	X			
	PI-401XAA	PRESSURE INDICATOR	X			
	PDIT-40XB	DIFFERENTIAL PRESSURE INDICATOR	X	X	WINDSOR ELEC BLDG	X
	PDAH-40XB1	DIFFERENTIAL PRESSURE HIGH ALARM		X	WINDSOR ELEC BLDG	X

Table 2-3 from RD/RA Workplan. Summary of Equipment Instrumentation and Alarms

LOCATION	INST #	SERVICE	LOCAL PANEL/READOUT	RTU	RTU/LOCATION	SCADA/REMOTE
	PDIR-40XB2	DIFFERENITIAL PRESSURE RECORDER		X	WINDSOR ELEC BLDG	X
	PI-40XB	PRESSURE INDICATOR	X			X
	FIE-40XA	RUPTURE DISK SENSOR				
	FIA-40XA	DISK RUPTURE ALARM		X	WINDSOR ELEC BLDG	X
	FIE-40XB	RUPTURE DISK SENSOR				
	FIA-40XB	DISK RUPTURE ALARM		X	WINDSOR ELEC BLDG	X
LGAC VESSEL EFFLUENT	FIT-40XA	FLOW TRANSMITTER		X	WINDSOR ELEC BLDG	X
	FIR-40XA	FLOW RECORDER		X	WINDSOR ELEC BLDG	X
	FIT-40XB	FLOW TRANSMITTER		X	WINDSOR ELEC BLDG	X
	FIR-40XB	FLOW RECORDER		X	WINDSOR ELEC BLDG	X
CLEAN WATER TO WINDSOR RES	FIT-500	FLOW TRANSMITTER/TRENDING		X	WINDSOR ELEC BLDG	X
	FIR-500	FLOW RECORDER		X	WINDSOR ELEC BLDG	X
DISCHARGE WATER TO SAND BOX	FIT-502	FLOW TRANSMITTER/TRENDING		X	WINDSOR ELEC BLDG	X
	FIR-502	FLOW RECORDER		X	WINDSOR ELEC BLDG	X
BACKWASH DISCHARGE	FIT-501	FLOW TRANSMITTER/TRENDING		X	WINDSOR ELEC BLDG	X
	FIR-501	FLOW RECORDER		X	WINDSOR ELEC BLDG	X

2.5.6 Treatment Equipment Pad and Access Driveways

The MHTS equipment will be placed on a new concrete pad with maximum dimensions of 100-feet by 150-feet, as shown on Design Drawing TPS-101 (Appendix P). The concrete pad will be located in the south central portion of the Windsor Reservoir site. The location of the plant is being proposed based on its proximity to the Monk Hill Wells and Windsor Reservoir, the accessibility of the location for routine maintenance needs, as well as the results of topographical and geophysical surveys, and a geotechnical study that was conducted at the site.

Design of the pad will take into account equipment loading as well as the seismic conditions of the area. The concrete pad thickness will vary depending on the loading. In addition to the equipment, (one set of three influent filters, four pairs of ion exchange vessels, and five pairs of GAC vessels) the pad must also support maintenance vehicles. There will be access for vehicles in the center of the pad. Details on the pad thickness and reinforcement are shown on Design Drawings TPS-102 (Appendix P). Design and construction of the concrete pad will also take into consideration the completed geotechnical investigation which recommends that soil preparation for the pad include 2 ft of over excavation and compaction of native material at 95% relative density below the foundation and extending at least 2 ft horizontally beyond the foundation perimeter.

Paved driveways will be built to provide truck access to the treatment pad. The main access road running between the north and south entrance gates and along the west side of the treatment pad will be 20-feet wide. The center of the pad will be accessible to vehicles from this main access road. A secondary 15-foot wide access road will also be built around the north, south, and east sides of the treatment pad. A portion of Windsor Avenue, located just below the south gate, will be widened to provide easy access for delivery trucks. Design Drawing C-110 shows the layout of the treatment pad and access driveways, as well as the rough grading plan for the site (see Appendix P).

2.5.7 Environmental Impact Concerns

In accordance with the Environmental Policy Guidelines of the City of Pasadena, an Initial Study was prepared to determine whether this proposed project may have a significant effect on the environment. Several Mitigation Measures are included as part of the project design and noted the Initial Study to minimize potential significant effects on the environment. The proposed Mitigation Measures and required Mitigation Monitoring are summarized in Attachment B of the Conditional Use Permit Staff Report (Appendix I). All Mitigation Measures have been incorporated into the MHTS design, construction, and operational requirements.

Therefore, the Initial Study determined that the proposed project will have less than significant environmental impacts with the incorporation of the proposed Mitigation Measures.

Appendix A of this report includes the CEQA documents prepared by PWP as lead agency. More details about the CEQA process are provided in Section 2.8 of this report.

2.6 Operation and Maintenance

2.6.1 Operation Maintenance and Monitoring Plan

PWP has submitted a document entitled, "Pasadena Water and Power, Monk Hill Treatment System, Operating, Maintenance, and Monitoring Plan" dated January 2011. The OMMP outlines the proposed inspections, and operations at MHTS and includes groundwater monitoring at the source wells, blended raw water and treated water monitoring for CTC, perchlorate, nitrate and bacteriological quality.

Operations, maintenance and monitoring of the wells, pump station and treatment equipment must be conducted in accordance to the approved OMMP. The OMMP shall include checklists of inspected items for each treatment process using a daily, weekly or other identified frequency. If there is any conflict between the OMMP and PWP's water system permit, the permit and its amendments shall take precedent.

After one (1) year of operation, the OMMP for the MHTS shall be updated based on the first year's operational experience. The updated plan shall be submitted for approval within 15 months after the MHTS begins supplying potable water. The OMMP shall be revised and updated to more accurately describe the operational experiences and emergency procedures, monitoring program and reporting requirements. PWP may also modify the OMMP at any time to accommodate changing conditions; however, any modifications made must be submitted to and be approved by the Department prior to implementation. At any time, the Department can require PWP to modify the OMMP due to changing conditions, change of laws or regulations, or concerns of the public.

As preventive maintenance, periodic inspection of the ion exchange and LGAC vessel internal parts should be made to ensure that the underdrain, vessel lining, and nozzles are in good condition. As a minimum, each vessel should be inspected once a year, or during media transfers if the on-line period exceeds one year. PWP should maintain records of all service or inspection of equipment performed. All malfunctions and corrective actions taken should be documented.

In addition, Sections 5.3.1 through 5.3.4 of the RD/RA Workplan discusses media loading and operation of the ion exchange and LGAC beds, valve operation, and utility water treatment including annual well startup and purge water and water generated during periodic system maintenance activities. Annual well startup activities including disinfection of the wells would be needed if PWP operates the MHTS on a seasonal

basis. Sections 5.3.5 through 5.3.7 discuss short term and extended system shutdown requirements and preventive maintenance.

2.6.2 Reliability, Alarms and Safeguards

As stated above, the proposed treatment technologies, removal of perchlorate using single use ion exchange resin, and absorption of organic chemicals using granular activated carbon, are established best available technologies, and have been successfully used at a number of other water systems. These same types of equipment have been successfully used for 5 years at the Lincoln Avenue Water System, on water that is also drawn from the Monk Hill sub basin, downgradient from Pasadena's four Monk Hill production wells.

Additionally, PWP must also submit an annual performance report on the treatment system.

2.6.2.1 Process Monitoring and Alarms

Other than the disinfection facility, the entire treatment facility starts up and operates in manual mode. Flow through the treatment plant is controlled by manually set valves. The operator must follow the procedures listed in the OMMP and verify all the equipment and power switches are on.

As described above in Sections 2.5.4.8 through 2.5.5, the entire process from the wells through the treatment equipment and discharge of the treated water to the Windsor Reservoir or back to the Arroyo Seco, is monitored by instrumentation, alarms, and visually by on duty operators. In addition to the local panel readouts at the equipment, the instrumentation is tied in to the City's central SCADA system. As discussed above, any problem with the disinfection facility will automatically cause the wells to shut down and flow through the treatment plant will cease.

During times when the SCADA system is unmanned, any alarm at the MHTS will trigger an auto-dialer to call the on duty operator who can reach the plant in 15 to 20 minutes during normal weekday business hours and in 30 to 45 minutes during evenings, weekends, and holidays. If necessary, the operator can manually shut down part or all of the MHTS.

The wells and treatment facility are also monitored through daily site visits by PWP operating staff. Any visual abnormality and/or inability to make corrections can cause the facility to be taken off line until the failure can be investigated and corrected.

In addition to the visual inspections and electronic alarms, the water flowing through the MHTS will be sampled and analyzed regularly as discussed in Section 2.7 to confirm proper removal of contaminants.

2.6.3 Maintenance

The MHTS is capable of year round operation, but because of water rights and other economic issues, PWP may operate the MHTS during the six months of each year when water demand is highest. During these periods the MHTS is expected to operate 24 hours a day, 7 days a week, except during periods required for maintenance. The rest of the year, prolonged downtime will give PWP ample time to perform any needed maintenance. PWP must follow all manufacturers' recommendations for calibrating and maintaining alarms, monitoring instrumentation and flow meters. PWP must also follow manufacturers' recommendations for inspection and maintenance.

Detailed maintenance requirements are also outlined in the manufacturers' O&M manuals. PWP is responsible for verifying all routine maintenance is completed in a timely manner in accordance with the manufacturers' schedule.

2.6.4 Operator Certification

The Monk Hill Treatment System is classified as a T-4 treatment facility in accordance with the Operator Certification Regulations (please refer to Appendix G, Treatment Plant Classification Worksheet). The regulations, which were adopted on January 1, 2001, establish treatment facility classification based upon influent water characteristics, treatment processes, and treatment plant capacity. Operator certification requirements for a T4 facility include chief operator(s) with T4 certification and shift operators with at least T3 certification. Therefore, any operator designated as the chief operator for the MHTS must hold a valid T4 certificate, and any operator designated as the shift operator must hold at least a valid T3 certificate issued by the Department's Operator Certification Program.

2.7 Water Quality Monitoring Requirements

PWP should conduct the required monitoring according to the approved OMMP. The monitoring requirements can be broken down into 4 elements: the upgradient surveillance wells, the Monk Hill production wells, the MHTS (influent, effluent, and intermediate samples), and the Windsor Reservoir. Each element of the monitoring program has its own goal or objective. The monitoring program may be modified as additional data is generated.

PWP operates its own laboratory that is certified through the California Environmental Laboratory Accreditation Program (ELAP) for VOCs by GC/MS, perchlorate, TC, HPC, THMs, Anions (i.e. NO_3, NO_2, F^-, Cl^-, and SO4), most wet chemistry analyses, turbidity, color, and TDS. PWP can normally get lab results in 2 days, and has arrangements with a back-up laboratory. If needed, PWP's laboratory can produce preliminary results, without QA/QC evaluations, in 24 hours. When using GC/MS analysis for VOCs or SVOCs, the laboratory shall be instructed to report any tentatively identified compounds (TICs) and other unknown peaks that are not known to be equipment or column artifacts.

A description of the monitoring requirements for each element follows:

2.7.1 Early Warning (Surveillance) Wells

Based on modeling done for the 97-005 Technical Report, Battelle has selected MW-3, MW-4, MW-5, MW-10, MW-17, MW-18 and MW-19 as early warning surveillance wells. These existing monitoring wells are already part of the on-going JPL groundwater monitoring program. Under the JPL program, monitoring wells are generally sampled and analyzed on a quarterly basis. The first four of these wells listed are located near the easterly boundary of the JPL facility on the west side of the Arroyo Seco. The last three wells are located to the east of the Arroyo Seco in residential neighborhoods near the four Monk Hill production wells. The locations of these early warning surveillance wells are shown in Figure 1 in Appendix B.

The purpose of monitoring these wells is to provide an early warning if concentrations of contaminants are rising to extraordinarily high levels or if any additional contaminants of concern or potential concern may be approaching the Monk Hill production wells at significant concentrations. Many of the contaminants in this monitoring program have been used or released or detected sporadically on the JPL property, but fate and transport assumptions and calculations project that they will not reach the Monk Hill production wells in detectable concentrations. Another goal of this monitoring is to confirm the fate and transport modeling. In order to achieve this goal, these early warning surveillance wells shall be tested for selected constituents on the following frequencies as described below, in addition to the JPL long-term monitoring program, which includes quarterly monitoring of perchlorate, VOCs, and other contaminants of concern.

Monitoring wells MW-5, MW-10, MW-3 (screen 2), MW-4 (screen 2), MW-17 (screen 3), MW-18 (screen 4), and MW-19 (screen 2), shall be monitored annually for explosives (TNT, HMX, and RDX), nitrosamines, fluoride, 1,4-dioxane, MTBE and related oxygenates (ETBE, TBA, and TAME), 1,2,3-TCP, total and hexavalent chromium, and triennially for semi-volatile organics (including PAHs, phthalates, PCBs, and phenol), total petroleum hydrocarbons, and 2,3,7,8-TCDD.

The estimated interpolated travel time between the monitoring Well MW3 and the Arroyo Well is approximately 3.5 years (Tables 2-22 and 2-23 in the 97-005 Technical Report). This should allow PWP sufficient time to prepare for any significant changes to the water quality in the Monk Hill production wells. If any of the above-mentioned chemicals is detected consistently at a high concentration in any of the early warning surveillance wells, PWP should conduct a treatability assessment immediately.

After carrying out this monitoring program for 10 years, PWP should evaluate the effectiveness of this program and propose appropriate changes to the Department.

2.7.2 Monk Hill Production Wells

PWP shall monitor the water quality in Monk Hill production wells in accordance with the California Code of Regulations (CCR), Title 22 monitoring requirements as well as the current Vulnerability Assessment Table for the Raymond Basin issued by the Department. Each of the four Monk Hill production wells shall also be monitored monthly for VOCs, nitrate, perchlorate, coliform bacteria and heterotrophic plate count (HPC); and quarterly for chlorate, 1,4-dioxane and low level 1,2,3-TCP. A copy of the current Vulnerability Assessment Table for the Raymond Basin is included in Appendix H.

The current Vulnerability Assessment Table for the Raymond Basin in general lists the basin as non-vulnerable for atrazine (MCL 1µg/L) and simazine (MCL 4µg/L). However, during the RI monitoring from June 1994 through February 1998, low levels of atrazine (maximum 0.3µg/L) was detected in 22% of the samples collected, and low levels of simazine (maximum 0.2µg/L) was detected in 15% of the samples. These included a few detections of each in the Arroyo and Ventura production wells. Therefore, the four Monk Hill production wells should be tested for atrazine and simazine within 120 days of activation of the wells and once every three years thereafter.

If any additional contaminant is consistently found in one or more of the early warning surveillance wells, it should be tested for in the closest Monk Hill production wells. If the additional contaminant is detected in any of the Monk Hill production wells, it should be verified by sampling that it is removed in the treatment equipment.

2.7.3 Ion Exchange (IX) System

In order to verify the removal efficiency of the IX System, weekly perchlorate samples shall be collected at the combined influent to the IX vessels (the plant influent after the influent cartridge filters) and twice weekly at the IX combined effluent (PS Code: 1910124-051). Twice weekly perchlorate testing is recommended due to the potentially high perchlorate concentration in the influent water (see the discussion in Section 3.6). If the influent perchlorate concentration is reliably and consistently below 18µg/L, the IX combined effluent may be tested weekly. The perchlorate concentration of the IX combined effluent shall be operated to achieve a treatment goal of below California's Detection Limit for Reporting (DLR).

In order to reliably maintain a perchlorate concentration of less than DLR at the IX combined effluent, a perchlorate level above DLR at the IX combined effluent will require PWP to sample each lag vessel effluent. Any vessel pair found to be discharging greater than DLR for perchlorate from the lag vessel shall be taken out of service and the lag vessel switched to the lead position, and fresh resin placed in the former lead vessel. Weekly perchlorate samples will also be collected at each lead vessel effluent, which is the cross-over point between the lead and lag vessels. The resin in the lead vessel will be changed out when the lead vessel effluent perchlorate concentration reaches the MCL of 6 ug/L.

Additionally, HPC and coliform samples shall be collected weekly and following any changeout or prolonged shutdown at the IX combined effluent to ensure no bacteriological contamination is occurring in the IX process. The IX combined effluent shall be free of total coliforms. If coliforms are detected, PWP shall inform the Department within 24 hours and begin weekly total coliform and HPC monitoring at the individual IX lead and lag vessels. The Department may require additional investigation. If monitoring results indicate a sudden or significant increase in coliform bacteria or HPC, the Department may require PWP to shut down the treatment facility and disinfect the resin and vessel.

2.7.4 LGAC System

In order to verify the removal efficiency of the LGAC System, weekly VOCs samples shall be collected at the combined influent to the LGAC vessels (PS Code: 1910124-051) and the LGAC combined effluent prior to chloramination (PS Code: 1910124-050). If any VOCs are detected in the LGAC combined effluent above their respective DLRs, each lag vessel effluent must be tested and if breakthrough from one or more of the lag vessels has occurred, the LGAC in the associated lead vessel shall be replaced and that vessel then placed in the lag position.

In order to ensure that VOCs are not detected in the LGAC combined effluent, monthly samples should be collected at the 25 percent bed depth port of each lead vessel. Once any VOC is detected at a 25 percent port, the 50 percent sampling port should be immediately sampled and analyzed; sampling of the 50 percent port should continue weekly until any VOC is detected. Upon detection at the 50 percent port, the 75 percent port should immediately be tested; sampling of the 75 percent port should continue weekly until any VOC is detected. Upon VOC detection at the 75 percent port, the lead vessel effluent must be sampled immediately for VOCs and weekly thereafter. Detection of any VOC at the 75 percent sampling point shall trigger PWP to arrange for the replacement of the lead vessel bed, which will then become the lag bed.

As PWP gains experience with the LGAC behavior and the actual levels of VOC, the frequency of operational monitoring may be modified upon request to the Department.

Additionally, HPC and coliform samples shall be collected weekly and following any changeout or prolonged shutdown at the LGAC combined effluent to ensure no bacteriological contamination is occurring in the LGAC process. The LGAC combined effluent shall be free of total coliforms. If coliforms are detected, PWP shall inform the Department within 24 hours and begin weekly total coliform and HPC monitoring at the individual LGAC lead and lag vessels. The Department may require additional investigation. If monitoring results indicate a sudden or significant increase in coliform bacteria or HPC, the Department may require PWP to shut down the treatment facility and disinfect the media and vessel.

2.7.5 Windsor Reservoir Compliance Monitoring

Windsor Reservoir (PS Code: 1910124-025) shall be the compliance monitoring location for MHTS. Weekly samples of nitrate, perchlorate, VOCs, total coliform, and HPC, and a monthly sample of chlorate shall be collected at Windsor Reservoir.

Compliance with nitrate MCL shall be based on the results of the weekly samples collected at Windsor Reservoir (PS Code: 1910124-025). PWP shall be deemed in violation of the nitrate MCL if a weekly sample, consisting of one result or the average of an initial result and a confirmation result, exceeds 45 mg/L. After laboratory notification of a sample that exceeds the nitrate MCL, a confirmation sample must be collected and analyzed within 24 hours. PWP shall require the laboratory to notify PWP within 24 hours whenever the level of nitrate in a single sample exceeds the MCL, and shall ensure that a contact person is available to receive such analytical results 24 hours a day. PWP must require the laboratory to immediately notify the Department of any acute nitrate MCL exceedance if the laboratory cannot make direct contact with the designated PWP contact person within 24 hours. Failure of the laboratory to make such notifications is a monitoring and reporting violation and could subject PWP to citation and civil penalties. Department notification and Tier 1 public notification are required within 24 hours of a confirmed nitrate MCL exceedance.

Compliance with the perchlorate MCL shall be based on the results of the weekly samples collected at Windsor Reservoir (PS Code: 1910124-025). PWP shall be deemed in violation of the perchlorate MCL if a weekly sample, consisting of one result or the average of an initial result and a confirmation result, exceeds 6 ug/L. After laboratory notification of a sample that exceeds the perchlorate MCL, a confirmation sample must be collected and analyzed within 48 hours. PWP shall require the laboratory to notify PWP within 48 hours whenever the level of perchlorate in a single sample exceeds the MCL, and shall ensure that a contact person is available to receive such analytical results 24 hours a day. PWP must require the laboratory to immediately notify the Department of any perchlorate MCL exceedance if the laboratory cannot make direct contact with the designated PWP contact person within 48 hours. Failure of the laboratory to make such notifications is a monitoring and reporting violation and could subject PWP to citation and civil penalties. Department notification and Tier 1 public notification are required within 24 hours of a confirmed perchlorate MCL exceedance.

All monitoring shall be performed by a State certified laboratory. All results shall be submitted to the Department on a monthly monitoring report by the 20th of the following month. With the exception of total coliforms, all laboratory analyzed results shall also be submitted to the Department by electronic data transfer (EDT).

2.8 Environmental Review

In compliance with the California Environmental Quality Act (CEQA), PWP prepared an Initial Study to determine whether this proposed project may have a significant effect on

the environment. Several mitigation measures were included as part of the project design and noted in the Initial Study to minimize potential significant effects on the environment. These mitigation measures have been incorporated into the MHTS design, construction, and operational requirements. With the incorporation of these mitigation measures, the Initial Study determined that the proposed project will have less than significant impacts on the environment.

As the lead agency under CEQA, PWP prepared a Mitigated Negative Declaration (MND) for this project. The document was distributed to the public and circulated through the State Clearinghouse (SCH# 2008061056) for a 30-day review period beginning on June 10, 2008 and ending on July 9, 2008. Three written comments were received during the review period. The project was approved by PWP on July 10, 2008 and a Notice of Determination (NOD) was filed by PWP through the Los Angeles County Clerk Office on July 11, 2008.

As a responsible agency, CDPH has considered the MND and hereby makes the following findings for the permit amendment:

- The project will not result in any significant impacts.
- The recommended permit conditions are as follows:

  PWP shall adhere to mitigation measures that have been incorporated into project design, construction, and operational requirements within the final environmental document.

A Notice of Determination (NOD) will be filed with the Governor's Office of Planning and Research within five days of permit issuance. A copy of the proposed NOD is provided in Appendix A along with other pertinent CEQA documents.

3. APPRAISAL OF SANITARY HAZARDS AND SAFEGUARDS

3.1 Evaluation of Policy Memo No. 97-005 Submittal

On November 5, 1997, the Department issued Policy Memo No. 97-005 to address projects involving the direct domestic use of extremely impaired sources. A copy of this memorandum is included in Appendix A of 97-005 Technical Report and also in Appendix C of this report. The purpose of this guidance is to set forth the position and process by which the Department would evaluate proposals, establish appropriate permit conditions, and approve the operation of an extremely impaired source for any direct potable use. The policy lists six areas that must be addressed in the permit application.

On behalf of the NASA Management Office at the JPL and the City of Pasadena, Battelle prepared the 97-005 Documentation (Technical Report) dated April 2010 in accordance with the policy. The document covers the Monk Hill Subarea of the

Raymond Basin, with the emphasis on the four wells owned by PWP, which are closest to JPL. This technical report was submitted by PWP in support of PWP's permit amendment application for the Monk Hill Treatment System.

The technical documentation report covers these items:

1. Introduction
2. Source Water Assessment
3. Characterization of Raw Water Quality
4. Source Protection
5. Effective Monitoring and Treatment
6. Human Health Risks Associated with Failure of the Proposed Treatment
7. Identification of Alternatives to the Use of the Impaired Sources

Battelle was able to incorporate, utilize, and reference many of the studies and remedial investigation reports previously prepared under the CERCLA activities for the JPL Operable Units.

Each section of the 97-005 Technical Report is summarized and evaluated below.

3.2 Source Water Assessment

This section requires an examination of the vulnerability of the aquifer to contaminating activities, in terms of known and potential contaminant sources, the chemicals used or released, aquifer properties and capture zones of the proposed wells.
Battelle utilized information that had previously been developed on the aquifer characteristics, groundwater modeling, groundwater quality and chemical usage as a result of the USEPA's investigations and NASA's CERCLA related studies. Simplified fate and transport modeling was also conducted to predict if chemicals detected in JPL monitoring wells might reach the Monk Hill production wells at concentrations of concern.

Battelle's report provides:

- A hydrogeological description of the Monk Hill Subarea including the general depth and direction of groundwater flow.
- A discussion of the capture zones, including computer modeling and the associated maps.
- The locations of past known sources of contamination and of reported chemical usage.
- Identification of types of businesses with typical chemical usage.
- A summary of water quality throughout the contaminated area, including lists of all chemicals and water quality parameters which have been analyzed for in the CERCLA Remedial Investigation (RI) groundwater database and a list of chemicals used in the area.
- A discussion of estimated distributions and trends of perchlorate and VOCs including CTC, tetrachloroethylene (PCE) and trichloroethylene (TCE).

Evaluation of Source Water Assessment

Since 1988, NASA has been conducting environmental investigations to identify and define the extent of contamination on and around the JPL facility, and has initiated soil and groundwater cleanup programs to address site-related chemicals of interest, including CTC and perchlorate. In 1992, JPL was placed on the National Priorities List (NPL) and became subject to the provisions of CERCLA.

Groundwater flow beneath the JPL is generally to the southeast, under the Arroyo Seco and into the Monk Hill Sub-area of the Raymond Basin, and is significantly influenced by pumping of local production wells located east of the Arroyo Seco.

Groundwater beneath the JPL has been characterized as high in perchlorate and CTC with lesser amounts of other VOCs such as PCE, TCE and chloroform. Beginning in the late 1980s and continuing during the Remedial Investigation during the 1990s, NASA installed a system of groundwater monitoring wells on and around the JPL property. These monitoring wells are regularly monitored and a report is generated on a quarterly basis. Quarterly reports indicate that the most historically contaminated area is in the interior of the property, near MW-7, which was as high as 13,300 µg/L of perchlorate and as high as 208 µg/L of CTC. (Concentrations in the interior "source area" have greatly diminished since 2005 when the OU-1 biological treatment system began operation to extract, treat and re-inject the most contaminated groundwater.)

Other chemicals, such as 1,2,3-TCP, nitrosamines, 1,4-dioxane, and explosives, have been sporadically detected in on-site groundwater monitoring wells, often at low concentrations, and are unlikely to be detectable in PWP production wells. Nevertheless, monitoring and production wells will be checked for these contaminants in accordance with the approved Operations, Maintenance, and Monitoring Plan (OMMP), since the production wells' capture zones (especially for the Arroyo Well and Well 52) extend into previously contaminated areas on the JPL property.

The report also identifies 14 additional potential sources of chemical releases within the capture zones of the Monk Hill production wells. These are primarily comprised of automotive service/repair shops and dry cleaners and potential contaminants are chlorinated solvents and petroleum products. These chemicals are monitored under the required monitoring program and removed by the activated carbon if detected.

3.3 Characterization of Raw Water Quality

This section requires a thorough characterization of the raw water which would be entering the MHTS. Battelle's report provides:

- An evaluation of the raw water quality based on historical production well data. The report discusses perchlorate and VOC concentrations actually found in the four Monk Hill production wells while they were in service between 1997 and 2002. The concentrations are graphed in Figures 3-1 to 3-

4 of the 97-005 Technical Report. The production wells were taken out of service between 1997 and 2002, due to high perchlorate levels at which point sampling of those wells stopped.

- Estimates of the concentrations of chemicals in the influent streams using Arroyo and Well 52, the Ventura and Windsor Wells, Lincoln Avenue Water Company's Wells 3 and 5, as well as Rubio Cañon's Wells 4 and 7, and Las Flores Well #2. These are presented in Tables 3-11 through 3-15 of the 97-005 Technical Report.

  For the combined Arroyo Well and Well 52, the identified chemicals of concern and estimated influent concentrations if just these two wells are operating are perchlorate, 62 µg/L, CTC, 2.9 µg/L, chloroform, 2.8 µg/L, and TCE, 3.6 µg/L.

  A similar estimate for the Ventura/Windsor wells is perchlorate, 3 µg/L, chloroform, 0.7 µg/L, PCE, 0.7 µg/L, and TCE at 0.8 µg/L.

  The MCLs for these chemicals are 6 ug/L for perchlorate, 5 ug/L for PCE and TCE, 0.5 ug/L for CTC, and 80 ug/L for chloroform.

- A discussion of the variability of chemical concentrations, including nitrate, based on historical production well data.

- Over the course of the CERCLA Remedial Investigation (RI), a database was created for the results of 26 RI monitoring wells on and around the JPL property. Battelle prepared a statistical summary of these results. The report discusses traces of other chemicals in monitoring wells (Table 2-6 of the 97-005 Technical Report) that might potentially reach the production wells. Battelle used this information to prepare a list of the contaminants that may potentially be present in the Monk Hill production wells.

- To assist in estimating the future concentration, variability and trends of perchlorate and VOCs in the production wells, Battelle also plotted the time series for these compounds in the monitoring wells (Figures 2-19 to 2-25 in the report). Also, Battelle grouped and plotted average annual concentrations of monitoring wells based on their locations, for example, Group C monitoring wells are near the JPL perimeter, upgradient of the Monk Hill production wells, and Group D monitoring wells are located off site, near the production wells.

  Battelle concludes, "The concentration trends observed in monitoring well Groups C and D would most likely reflect the trends in the capture zones of the production wells. As shown on Figure 2-25, concentrations are generally decreasing over time, but punctuated by occasionally elevated concentration spikes of perchlorate."

In addition, the patterns of fluctuating concentration seen in the past make it unlikely that more than one production well will exhibit a concentration spike at the same time. In any case, an increase in the influent concentration of contaminant would result in the absorptive media (ion exchange resin and granular activated carbon) becoming saturated quicker, and therefore necessitating an early change of media, without affecting the effluent quality.

Evaluation of Raw Water Quality Characterization

PWP's Monk Hill production wells have not produced drinking water for 9 to 14 years; therefore, the raw water quality characterization provided in the 97-005 Technical Report is limited to data obtained prior to the wells' shutdowns between 1997 and 2002 and examination of trends in upgradient monitoring wells. The monitoring wells' time series show patterns of very high concentration spikes preceded and followed by periods of much lower perchlorate and CTC concentrations.

Particularly for the Arroyo Well, the limited perchlorate data (Figure 3-1 of the 97-005 Technical report) appears to represent a concentration spike from around 40µg/L up to 160µg/L and then quickly back down towards 40µg/L.

During a high demand period, PWP plans to operate all four Monk Hill production wells simultaneously, which will result in lower plant influent concentrations since the Ventura and Windsor wells are much less contaminated than the Arroyo Well and Well 52.

Using the historical average concentrations and considering the flow rate of each well calculates to an estimated influent of 37µg/L for perchlorate and 2µg/L for CTC. In their request for proposal, PWP had the equipment supplier design for 45µg/L perchlorate and for 2.7µg/L CTC.

Since the 97-005 Technical Report had very limited production well data for the Monk Hill production wells from a decade ago, CDPH required extensive start-up monitoring of the production wells in order to provide good representation of current water quality. Start-up monitoring was conducted from December 2010 to February 2011. During this period, the four Monk Hill production wells were detected in the range of 5 to 45 ug/L for perchlorate and below the detection limit for CTC. The combined plant influent concentrations when all four wells were in service and operating at their full capacities were 30 ug/L for perchlorate and non-detect for CTC. These current perchlorate and CTC levels were lower compared to the levels detected a decade ago prior to the shutdown of the wells. Furthermore, these levels are within the design parameters for the MHTS and as expected, the start-up monitoring results show that the MHTS is capable of reliably and effectively removing perchlorate and VOCs to below the detection limits.

In addition, NASA has been working to remove perchlorate and VOC contamination from areas on the JPL property that have had the highest concentrations (referred to as OU1). NASA has completed a soil vapor extraction program which has removed VOC

vapors from the unsaturated zone around the center of the JPL property (OU-2). Since 2005, NASA has successfully operated a LGAC unit and a fluidized bed biological reactor to remove VOCs and perchlorate from shallow groundwater beneath an area near the north-central part of the property (OU-1). These remediation activities are expected to accelerate the overall cleanup and to lower the potential for high levels of VOCs and perchlorate to reach the Monk Hill production wells and other wells in the basin.

3.4 Source Protection

This section requires a program to control the level of contamination, both from any known existing sources and from any potential new contamination sources.

Battelle's report provides:

- A discussion of JPL's compliance with stringent waste disposal regulations, and steps to recycle and reduce waste.
- Actions taken to remove perchlorate and VOCs from groundwater beneath the JPL site (OU-1), and a soil vapor extraction system for removal of VOCs in the soil at JPL (OU-2).
- Actions by the City of La Cañada-Flintridge and by Metropolitan Water District (MWD) of Southern California
- Discussions of the Community Involvement Plan and the Federal Facilities Agreement.

The 97-005 Technical Report enumerates the various regulatory programs for the identification and remediation of groundwater contamination areas, management of hazardous wastes, storage tanks (both underground and aboveground), chemical spill prevention and response, storm water discharges, landfill and water and wastewater programs. PWP also participates in local water associations' activities and reviews city councils and the Los Angeles Regional Water Quality Control Board's (LARWQCB) agendas to keep informed on activities that could impact water quality in the Basin.

Evaluation of Source Protection

The most serious threat to the Monk Hill production wells is the perchlorate and VOC plumes migrating from the JPL property. The remediation measures taken for OU1 and OU2 described in the report appear to be appropriate and adequate mitigation measures.

When establishing a new commercial or industrial water connection, PWP should also review such facilities for risks to the City's groundwater resources.

3.5 Effective Monitoring and Treatment

This part of the policy guidance requires that treatment processes are commensurate with the degree of risk associated with the contaminants and that the treatment must be reliable and optimized. Best available treatment technology (BAT) for the contaminant(s) must also be utilized. Other required elements are:

- No bypassing of the treatment process
- The use of multi-barrier treatment processes when appropriate
- Process optimization to produce water with the lowest concentration of contaminants feasible
- Appropriate performance, process monitoring, operations and reporting
- Surveillance monitoring between the contamination source areas and the extraction wells
- Blending of the treated water with other water sources prior to entry into the distribution system as an additional safety factor is recommended.

The 97-005 Technical Report includes:

- A description of the proposed treatment process for PWP's Monk Hill production wells
- A discussion of the performance standards which the plant will achieve
- A discussion of the operations and reliability features
- Process monitoring covering influent and effluent of the LGAC and IX
- Failure responses and shut down triggers
- A monitoring program covering the upgradient surveillance monitoring wells, the production wells, and the treatment plant as well as the finished water

The report also describes similar features at the Lincoln Avenue Water Company, and the LGAC treatment and blending for Los Flores Well 2. Treatment of Rubio Canyon wells is not currently necessary, but the wells are monitored closely and a contingency plan has been prepared.

Evaluation of Monitoring and Treatment Proposal

The MHTS was designed for the removal of perchlorate and VOCs (primarily CTC) using ion exchange and liquid phase granular activated carbon adsorption respectively, both of which are considered Best Available Technologies. Both ion exchange and carbon adsorption processes are proven effective treatment technologies with a long history of use within the water industry. Ion exchange for perchlorate removal has been reliably and successfully used in Southern California at least since 2002, and several perchlorate treatment plants have come online since then.

Start-up performance testing conducted from December 2010 to February 2011 successfully demonstrated that the MHTS is capable of reliably treating the water down

to non-detectable levels for perchlorate and VOCs. PWP has provided the MHTS start-up performance test report which summarizes the start-up monitoring.

There are no major moving parts within the MHTS; booster pumps at the Ventura Booster Facility and the Windsor Well will provide enough pressure for the water to flow through the filters and treatment vessels to the Windsor Reservoir. Flow and pressures through the plant will be controlled by simple manual valves. The MHTS is equipped with numerous flow and pressure sensors and transmitters to local and remote alarms and any unusual signal would trigger investigation and shut down of the plant. Samples can be easily obtained during each step of the treatment process, so removal efficiency can be easily monitored.

Following removal of perchlorate and VOCs, gaseous chlorine and a liquid ammonia solution will be metered into the water to produce a chloramine disinfectant which is compatible with the chloramine concentrations used in the rest of PWP's water system. This treated water with a disinfectant residual will flow into the Windsor Reservoir prior to its distribution to PWP's customers. During times when the plant will be operating in a testing or maintenance mode, or if the water is not needed, PWP has the capability to send the treated water, without disinfectant, back to the Arroyo spreading basins for infiltration into the groundwater basin.

Both the ion exchange process for the removal of perchlorate and the granular activated carbon process for the removal of organic contaminants will use vessels in the "lead-lag" arrangement. For the ion exchange process, the total flow will be divided into 4 pairs of ion exchange vessels. Each pair of vessels will receive 25% of the total flow and water will first flow through the lead bed (1st bed) and then through the lag bed (2nd bed). This increases the reliability since the bulk of the contaminant would be removed in the lead bed, and the lag bed is to provide redundancy in case the lead bed does not function properly. When the first bed is exhausted, it is replaced with fresh resin, and the valves are adjusted so that the former lag bed now serves in the lead position, and the fresh bed serves in the lag position.

In addition, since only 25% of the water flows through any one pair of ion exchange vessels, in the unlikely event that there is a problem with one pair of vessels, it would only impact 25% of the flow, the remaining 75% would be treated normally. The LGAC would work similarly, but with 5 pairs of vessels, each pair treating 20% of the total flow.

Due to historical high naturally occurring nitrate levels in the Windsor and Ventura Wells, nitrate blending of the four Monk Hill production wells will be implemented in the Windsor Reservoir following the ion exchange and LGAC treatment processes at the MHTS. This blending treatment will reduce the nitrate level to below 36 mg/L (80% of nitrate MCL of 45 mg/L) in the Windsor Reservoir prior to distribution to the customers. This will be accomplished by blending lower nitrate level water sources (Arroyo Well and Well 52) with the higher nitrate level water sources (Windsor and Ventura Wells).

As mentioned above, several drinking water treatment plants are using ion exchange for perchlorate removal and activated carbon for organics removal. Specifically the Lincoln Avenue Water Company has been successfully using lead-lag ion exchange for perchlorate removal for about 5 years and parallel flow carbon absorption for organics removal for many more years. Although PWP's wells, especially the Arroyo Well, may have higher concentrations of perchlorate, the water characteristics of Lincoln Avenue's wells should be very similar to that of PWP's Monk Hill production wells since both extract water from the same groundwater sub-basin, and are located only a short distance apart. Lincoln Avenue's successful experience with these treatment technologies gives further confidence that the MHTS will also be reliable and effective in producing safe drinking water for PWP's customers.

3.6 Human Health Risk Associated With Failure of the Proposed Treatment

The policy guidance calls for an evaluation of the risks of failure of the proposed treatment system and an assessment of potential health risks associated with such failure.

In the 97-005 Technical Report, Battelle has discussed potential failure scenarios and made assumptions about the frequency of occurrence. Health risk calculations were made for PWP, Lincoln Avenue, Las Flores, and Rubio Cañon systems.

For the health risk calculations, Battelle assumed a worst case scenario whereby only the Arroyo Well and Well 52 are supplying water to the MHTS with a combined perchlorate concentration of 62 µg/L and CTC and chloroform concentrations of 2.9 µg/L and 2.8 µg/L, respectively, and a total system failure occurs once every five years over a 20-year period. Battelle also used EPA's Regional Screening Levels (RSLs) for cancer and non-cancer endpoints, and assumed weekly sampling of plant effluent and a 7-day laboratory turn-around time, resulting in a 14-day maximum time span between failure and detection.
Battelle also explains why the estimations of exposure via drinking water to constituents of concern are conservative to be health protective:

- Influent concentrations will very likely decrease over the years of system operation.
- The calculation does not factor in any mixing of MHTS water with other water in the distribution system prior to reaching any customer.
- The likelihood of a complete system failure is extremely low given the redundancy in treatment plant design and the automation (alarms) and programming capabilities used in the design.

Evaluation of Human Health Risk Assessment

Battelle also incorporated US EPA's Regional Screening Levels (RSLs) in the calculations yielding an estimated cancer risk of 2×10^{-7} (2 additional cancer cases in 10 million individuals, assuming 70 years exposure) under the assumptions. Cancer

risks less than 1.0 x 10^{-6} are considered the *de minimis* cancer risk by the EPA and mean that the excess risk posed by the contaminant is one in a million over an individual's lifetime risk of developing cancer. The non-cancer risk is estimated by the Hazard Quotient (HQ). The HQ for the MHTS is 4, which indicates a potential for non-cancer adverse risk. All individual HQs are less than 1, except for perchlorate which was 2.38.

A re-calculation using California Public Health Goals (PHGs) with the same operational assumptions resulted in an estimated cancer risk of 1.3 x10^{-6} which is also considered *de minimis*, and an HQ of 11.9. The majority of the HQ in excess of 1 is due to perchlorate (HQ = 10.3).

The Department agrees that the exposure estimates are overly conservative and conclude that the overall health risks associated with the MHTS are minimized. In addition, actual influent concentrations are likely to be lower and potential exposure periods are likely to be shorter than those assumed because:

- Remediation activities discussed under Source Protection have removed significant quantities of perchlorate and VOCs from soil and groundwater beneath the JPL property, which prevents these chemicals from reaching the production wells to the east. Contaminant concentrations will likely continue to trend lower.
- Battelle's assumption of a complete plant failure or bypass once every 5 years is extremely conservative. Other plants have operated for many years and never experienced such a failure. As discussed above, even if one pair of ion exchange vessels failed in lead-lag mode, the other 75% of the plant flow would be treated in the other pairs.
- Battelle also assumed 14 days of exposure between sampling and reporting of results. Since PWP operates its own certified laboratory, it will normally have only a 48 hour turnaround time. The permit amendment will require twice weekly perchlorate sampling of the plant effluent to minimize any chance of exposure. PWP has also indicated that preliminary results of rush samples can be obtained in 24 hours. In addition, PWP has established and will be required to maintain an arrangement with an outside laboratory as backup.
- The permit amendment will require that the MHTS is operated and daily inspected by experienced, knowledgeable certified water treatment operators in order to quickly detect any unusual flow or pressure readings that would indicate a severe problem. Flow rates, pressures, and alarms are also transmitted by SCADA to a central monitoring station or operator on duty.

Normally, treatment plants are monitored weekly for the contaminants being removed. In this case, due to the potential for high perchlorate concentrations in the raw water, perchlorate should be monitored twice weekly, and the plant inspected daily. In the future, the Department could consider a reduction to weekly testing of perchlorate in the effluent, if influent levels are consistently and reliably below 18µg/L.

3.7 Identification of Alternatives to the Use of the Impaired Sources

The policy guidance calls for an identification of alternative sources of drinking water and a comparison of the potential health risks.

Evaluation of Alternatives to the Use of the Impaired Sources

Battelle's report discusses alternatives to the Monk Hill production wells, evaluation of these sources in terms of water quality, assurance of supply, potential interruptions to service, and evaluation of alternate disposal of treated water, along with conclusions and recommendations.

The primary alternative to using groundwater extracted from production wells in the Raymond Basin, including water treated at the PWP, LAWC, Rubio Cañon Land and Water Association, and Las Flores Water Company, is the purchase and use of imported water from the MWD.

Battelle's report also discusses the policy of increasing the extraction of groundwater from new wells in the Raymond Basin, but many of the other existing wells in the basin already have detectable levels of contaminants and treatment is planned, so this is not a viable alternative resource to consider. Furthermore, the MHTS is necessary for containment of the contaminant plume originating from JPL and will prevent high concentrations of perchlorate and CTC from migrating to neighboring potable sources.

Battelle also compared water quality of other wells in the Raymond Basin, imported MWD water and the expected MHTS plant effluent, and concluded that the MHTS treated water will be better than or equal to the current tap water. The carbon treatment at the MHTS will remove precursors to disinfection byproducts and should result in lower concentrations of disinfection byproducts in the distribution system compared to MWD's filtered surface water.

In addition to allowing PWP to utilize its water rights in the Monk Hill sub-basin, the MHTS would provide a reliable source of water compared to MWD in case of major earthquake or of mandated cutbacks of MWD water.

3.8 Public Comment Period and Public Hearing

As part of the permitting process for extremely impaired sources, PWP informed its customers about the proposed operation of the MHTS, the public comment period, and the repository locations of the project documents. A public notice (provided in Appendix J) solicited comments and instructed interested parties to submit written comments to the Department's Glendale office via either US mail or e-mail. The 30-day public comment period began on February 11, 2011 and ended on March 13, 2011 at 5:00 p.m. Project documents, including the Department's Project Evaluation Summary, the 97-005 Technical Report, and the MHTS Start-Up Report, were available for review at the Pasadena Central Library, Altadena Main Library, as well as online at PWP's

website. A public hearing was held on February 24, 2011 from 7 to 9pm at the Altadena Community Center. CDPH received four written or email comments during the comment period in addition to the oral comments during the public hearing. CDPH has considered all public comments before issuing a permit amendment for the MHTS. These public comments along with CDPH's response and a transcript of the public hearing question and answer period are provided in Appendix J.

3.9 Overall Evaluation

The MHTS utilizes Best Available Technologies (BATs) for removal of VOCs and perchlorate. LGAC is considered a BAT for VOC removal. As designed and constructed, the LGAC vessels are capable of reliably removing VOCs to below the detection limits. The ion exchange process is a BAT for perchlorate removal. A similar system was constructed at the Lincoln Avenue's Wells 3 and 5 and several other sites within California. As designed and constructed, the IX system is capable of removing perchlorate to below the detection limit.

Start-up testing conducted from December 2010 to February 2011 has confirmed that the MHTS can treat all contaminants of concern to below the regulatory reporting levels. Data collected during the start-up testing demonstrate the facility could easily meet the nitrate blending goal. The long-term reliability and effectiveness of this treatment system should be confirmed over time through the monitoring program as also demonstrated at similar treatment systems elsewhere.

The MHTS is equipped with various instrumentation and alarm features to notify system operators of any failure that may occur in the treatment process. The treatment efficiency of each unit process can be easily monitored by sampling and analysis. The operational status of each unit process can be monitored on site or remotely. PWP has developed a comprehensive OMMP, including daily inspections, that outlines all operational requirements, maintenance procedures and monitoring requirements to ensure proper operations of all processes. Water quality monitoring requirements are outlined to ensure that treatment goals are met and that treated water meets all MCLs and NLs.

PWP has experienced and knowledgeable certified water treatment operators to oversee operations and maintenance of the MHTS. With all the reliability features, operations, monitoring and maintenance programs, and an extensive water quality monitoring program in place, the chances of a failure at the MHTS have been minimized. The MHTS should be able to reliably produce water that has no detectable perchlorate and VOCs and meets all other MCLs and NLs.

4. CONCLUSIONS AND RECOMMENDATIONS

The Department of Public Health finds that the sources of supply, treatment works, and operation as described in this report are capable of reliably producing a safe, wholesome and potable water supply. The quality of the water served and PWP's Monk Hill facilities and operations adequately meet State standards. Issuance of an amended domestic water supply permit to the Pasadena Department of Water and Power is recommended subject to the following conditions:

GENERAL

1. This document amends and adds to the domestic water supply permit issued to Pasadena Water and Power (PWP) for the City of Pasadena's public water system on November 9, 1999 by the Department, and the subsequent amendments on August 12, 2002, and January 15, 2003. If any condition of this amendment conflicts with the permit and its subsequent amendments, the conditions of this amendment shall be followed.

2. PWP shall comply with all the requirements set forth in the California Safe Drinking Water Act, California Health and Safety Code and any regulations, standards or orders adopted thereunder. All water supplied by PWP for domestic purposes shall meet all Maximum Contaminant Levels (MCLs) established by the State Department of Public Health.

3. If the water quality does not comply with the California Drinking Water Standards, treatment shall be provided to meet standards. The plans and specifications for the proposed treatment facilities shall be submitted to the Department for review and approval prior to construction.

4. The only sources approved for potable water supply are those listed in Tables 1 and 2.

Table 1. Groundwater Sources

Source	Primary Station Code	Status	Treatment
Arroyo	1910124-001	Active	Ion exchange for perchlorate removal and activated carbon adsorption for organics removal and chloramination at MHTS
Bangham Well	1910124-028	Active	Blending VOCs, perchlorate, and nitrate at Sunset Reservoir
Chapman Well	1910124-005	Active	Chlorination
Copelin Well	1910124-006	Active	Blending VOCs, perchlorate, and nitrate at Sunset Reservoir
Craig Well	1910124-007	Active	Chlorination
Eaton Canyon Well	1910124-009	Other	Pending return to Standby Status. See Provision No. 7 of 1999 permit.
Garfield Well	1910124-010	Active	Blending VOCs, perchlorate, and nitrate at Sunset Reservoir

Source	Primary Station Code	Status	Treatment
Monte Vista Well	1910124-014	Active	Chlorination
Sunset Well	1910124-018	Active	Blending VOCs, perchlorate, and nitrate at Sunset Reservoir
Ventura Well	1910124-019	Active	Ion exchange for perchlorate removal and activated carbon adsorption for organics removal and chloramination at MHTS
Villa Well	1910124-020	Active	Blending VOCs, perchlorate, and nitrate at Sunset Reservoir
Well No. 52	1910124-021	Active	Ion exchange for perchlorate removal and activated carbon adsorption for organics removal and chloramination at MHTS
Windsor Well	1910124-022	Active	Ion exchange for perchlorate removal and activated carbon adsorption for organics removal and chloramination at MHTS
Woodbury Well	1910124-023	Active	Chlorination
Well 58	1910124-045	Active	Chlorination
Well 59	1910124-047	Active	Chlorination
Metropolitan Water District (MWD)-P1 Connection	1910124-033	Active	N/A
MWD-P2 Connection	1910124-034	Active	N/A
MWD-P3 Connection	1910124-035	Active	N/A
MWD-P4 Connection	1910124-036	Active	N/A
MWD-P5 Connection	1910124-037	Active	N/A

The following are the only approved interconnections for receiving water from other water systems:

Table 2. Interconnections with Other Systems

Water System	Location	Nominal Capacity (gpm)
Lincoln Avenue Water Company	Canyon Crest Road	500
Kinneloa Irrigation District	Kinneloa Canyon Road	1200
California American Water Company	Lamanda Park Reservoir	2500
Valley Water Company	St. Katherine Place	1500
Valley Water Company	Normandy Drive	1200
Foothill Municipal Water District	CalTrans Yard	4000
City of Sierra Madre	Michillinda Avenue	300

5. The only approved treatment facilities are those listed in Table 3. The treatment facility and distribution system shall be operated by personnel who have been certified in accordance with Chapter 13, Title 22, California Code of Regulations (CCR) - Operator Certification. The minimum certification requirements for the chief and shift operator(s) for each PWP treatment facility are listed in Table 3. For MHTS, PWP will meet T4 chief operator certification requirement within two years of receiving this permit amendment.

Table 3. Approved Treatment Facilities and Minimum Operator Certification Requirements

Treatment Facility	PS Code	Treatment Facility Classification	Min. Treatment Grade Required	
			Chief Operator	Shift Operator
Sunset Reservoir - Nitrate, perchlorate and VOCs blending for Bangham, Copelin, Garfield, Sunset, and Villa Wells	1910124-030 (Sunset Reservoir 1 effluent) 1910124-031 (Sunset Reservoir 2 effluent)	T3	T3	T2
Chapman Well – Chlorination	1910124-038	T1	T1	T1
Craig Well - Chlorination	1910124-039	T1	T1	T1
Monte Vista Well - Chlorination	1910124-042	T1	T1	T1
Woodbury Well - Chlorination	1910124-044	T1	T1	T1
Well 58 - Chlorination	1910124-046	T1	T1	T1
Well 59 - Chlorination	1910124-048	T1	T1	T1
Monk Hill Treatment Facility (MHTS) – Arroyo, Ventura, Windsor Wells and Well 52 • Ion exchange (IX) for perchlorate removal • Liquid phase granular activated carbon adsorption (LGAC) for organics removal • Chloramination • Nitrate blending at Windsor Reservoir	1910124-051 (IX combined effluent) 1910124-050 (LGAC combined effluent) 1910124-025 (Windsor Reservoir Compliance Point for nitrate, perchlorate and VOCs)	T4	T4	T3

6. No changes, additions, or modifications shall be made to the sources or treatment mentioned in Conditions 4 and 5 unless an amended water supply permit has first been obtained from the Department.

7. PWP shall comply with Title 17, CCR, to prevent the water system and treatment facilities from being contaminated by possible cross-connections. PWP shall maintain a program for the protection of the domestic water system against backflow from premises having dual or unsafe water systems in accordance with Title 17. All backflow prevention devices shall be tested annually.

8. PWP shall monitor all active groundwater sources in accordance with the current Vulnerability Assessment and Monitoring Guidelines issued by the Department or as specified in this permit amendment.

9. Pursuant to Sections 64590 and 64591, Title 22 of the California Code of Regulations, no chemical or product shall be added to drinking water as a part of the treatment process unless it has been certified as meeting the specifications of American National Standard Institute/National Sanitation Foundation (ANSI/NSF) Standard 60, and no indirect additive shall be used unless it has been certified as meeting the specifications of ANSI/NSF Standard 61. PWP may use an uncertified chemical, material, or product if the requirements specified in Section 64593 are met.

MONK HILL TREATMENT SYSTEM (MHTS)

10. Water leaving the MHTS shall not exceed any MCLs or Notification Levels (NLs) established by the Department. In addition, the MHTS should be operated to achieve a treatment goal of non-detect for perchlorate and VOCs.

11. Arroyo Well, Well 52, Ventura Well and the Windsor Well shall be the only sources for the MHTS. The entire flow from the wells shall be treated by all unit processes (ion exchange and granular activated carbon adsorption) of the MHTS prior to distribution as a domestic water supply. No treatment process shall be bypassed at any time.

12. The overall plant flow rate shall not exceed 7,000 gpm without written permission from the Department.

13. Except as specified in this permit amendment, the MHTS shall be operated in accordance with an Operations, Monitoring, and Maintenance Plan (OMMP) approved by this Department. All additions, deletions, or amendments to the OMMP shall be approved by the Department prior to implementation. PWP is responsible for ensuring that the OMMP is, at all times, representative of the operations, maintenance, and monitoring of the facility and appropriate changes to the OMMP are submitted to the Department for approval in a timely manner.

14. The MHTS shall be removed from service if concentrations of chemicals of concern in the plant influent significantly exceed the design concentration. PWP shall conduct an evaluation and make necessary operational adjustment, and/or plant modification, and obtain an approval from the Department before placing the treatment facility back into service. Permit amendment might be required depending on the extent of the required modification.

ION EXCHANGE SYSTEM

15. PWP shall operate and maintain the inlet filters of the ion exchange system in a manner to minimize the build-up of solids within the media beds.

16. Each pair of ion exchange vessels shall be operated at not less than 350 gpm (1 gpm/ft^3 of media) and not more than 2,000 gpm, with a planned design capacity of 1,750 gpm when the plant is operating at 7,000 gpm. The vessels shall be operated in a down-flow mode, with two vessels operated in series (lead-lag).

17. At least 353 ft^3 of virgin CalRes 2109 resin that meets the specifications identified in the approved OMMP shall be used in each ion exchange vessel. Any change in resin employed shall be approved in writing by the Department. Only resin certified as meeting NSF Standard 61 may be used.

18. After virgin resin is installed, PWP shall flush the resin and conduct nitrosamine monitoring, using EPA method 521, to characterize the duration and extent of nitrosamine formation. Based on the monitoring results, PWP may modify the resin installation and flushing procedures to minimize the risk of producing water with nitrosamines and revise the OMMP accordingly.

19. Compliance with the perchlorate MCL shall be based on the results of the weekly samples collected at Windsor Reservoir (PS Code: 1910124-025). PWP shall be deemed in violation of the perchlorate MCL if a weekly sample, consisting of one result or the average of an initial result and a confirmation result, exceeds 6 µg/L. Department notification and Tier 1 public notification are required within 24 hours of a confirmed perchlorate MCL exceedance.

20. PWP shall ensure that the laboratory notifies PWP operators and management within 48 hours whenever the level of perchlorate in a single sample exceeds the MCL, and shall ensure that a contact person is available to receive such analytical results 24 hours a day. PWP shall also require the laboratory to immediately notify the Department of any perchlorate MCL exceedance if the laboratory cannot make direct contact with the designated contact person within 48 hours.

LIQUID-PHASE GRANULAR ACTIVATED CARBON (LGAC) TREATMENT

21. When delivering treated water to Windsor Reservoir and the distribution system, each train of LGAC vessels shall not be operated above its maximum design capacity of 1,400 gpm. In addition, they shall not be operated below 200 gpm. The empty bed contact time for each LGAC vessel shall be at least 7.1 minutes at all times. The vessels should be operated in a down-flow mode, with two vessels operated in series in each train.

22. The granular activated carbon utilized in the LGAC vessels shall be 40,000 pounds of virgin Filtrasorb 300 per vessel. Both the initial and replacement carbons shall meet the manufacturer's specifications. Any change of carbon specifications shall be approved in writing by the Department.

23. The replacement carbon shall be virgin or reactivated carbon that is NSF Standard 61 certified for use as drinking water system component.

24. PWP shall minimize system downtime by scheduling carbon changeouts in a timely manner. After changeout, PWP shall monitor for total coliform and HPCs.

25. The LGAC adsorption system shall be maintained according to the manufacturer's recommendations.

NITRATE BLENDING

26. If any of the Monk Hill Wells exceeds 40 mg/L nitrate, PWP shall implement nitrate blending treatment in accordance with the approved OMMP.

27. PWP's blending plan shall include performing a daily blending projection, using the most recent wellhead water quality analysis results to determine the proper flowrate that shall be produced from each well, then control the pumping from each well so that the blended effluent is reliably below 80% of the nitrate MCL.

28. Compliance with the nitrate MCL shall be based on the results of the weekly samples collected at Windsor Reservoir (PS Code: 1910124-025). PWP shall be deemed in violation of the nitrate MCL if a sample, consisting of one result or the average of an initial result and a confirmation result, exceeds 45 mg/L. Department notification and Tier 1 public notification are required within 24 hours of a confirmed nitrate MCL exceedance.

29. PWP shall ensure that the laboratory notifies PWP operators and management within 24 hours whenever the level of nitrate in a single sample exceeds the MCL, and shall ensure that a contact person is available to receive such analytical results 24 hours a day. PWP shall also require the laboratory to immediately notify the Department of any nitrate MCL exceedance if the laboratory cannot make direct contact with the designated contact person within 24 hours.

MONITORING

General

30. All water samples for compliance purposes shall be analyzed by a laboratory certified by the Department's Environmental Laboratory Accreditation Program (ELAP) for each analytical technique. If no certification is available for a particular compound, the method and detection limit shall be submitted for approval by the Department on a case-by-case basis.

31. Except for bacteriological analyses and constituents without chemical storet numbers, all water quality monitoring results obtained from a certified laboratory shall be submitted to the Department by Electronic Data Transfer (EDT) using the PS Codes listed in Table 4.

Table 4. MHTS Sampling Points

Location	Description	PS Code
Arroyo Well	Arroyo Well Discharge	1910124-001
Well 52	Well 52 Discharge	1910124-021
Ventura Well	Ventura Well Discharge	1910124-019
Windsor Well	Windsor Well Discharge	1910124-022
IX Combined Effluent	Combined Ion Exchange Plant Effluent	1910124-051
LGAC Combined Effluent	Combined Plant Effluent after LGAC and before Disinfection	1910124-050
Windsor Reservoir	Compliance Point for Nitrate, Perchlorate, and VOCs	1910124-025

32. Monitoring requirements for the Monk Hill production wells, MHTS, and Windsor Reservoir are provided in Table 5 and also described in Provisions 40 through 56.

Table 5. Monitoring Requirements

Monitoring Location	P.S. Code	Constituent	Frequency
Monk Hill Production Wells			
Arroyo Well Well 52 Ventura Well Windsor Well	1910124-001 1910124-021 1910124-019 1910124-022	VOCs, nitrate, perchlorate, total coliform, HPC	Monthly
		Chlorate, 1,4-dioxane, and low level 1,2,3-TCP	Quarterly
		Atrazine, simazine	Initially within 120 days of well activation and triennial thereafter
		Inorganic per Table 64431-A; general mineral per Section 64449 (b)(2); and secondary standard chemicals per Tables 64449A&B	Per recent vulnerability assessment and monitoring frequency guidelines
		Radionuclides including gross alpha, uranium, radium 226 and 228	Four consecutive quarterly samples; subsequent monitoring requirements TBD
Ion Exchange (IX)			
Combined influent to IX vessels (after influent cartridge filters)	N/A	Perchlorate	Weekly
		Nitrate	Weekly when nitrate blending plan is implemented
Each lead vessel effluent	N/A	Perchlorate	Weekly
IX combined effluent	1910124-051	Perchlorate	Twice weekly or weekly if combined influent perchlorate is consistently below 18 ug/L
		Total coliform, HPC	Weekly and following any changeout or prolonged shutdown
Each lag vessel effluent	N/A	Perchlorate	Sample if detected at combined effluent (1910124-051)
Each lead and lag vessel effluent	N/A	Total coliform, HPC	Sample if combined effluent (1910124-051) is detected with total coliform

Monitoring Location	P.S. Code	Constituent	Frequency
Liquid Phase Granular Activated Carbon (LGAC)			
Combined influent to LGAC vessels	19101240-051	VOCs	Weekly
LGAC combined effluent (prior to chloramination)	1910124-050	VOCs	Weekly
		Total coliform, HPC	Weekly and following any changeout or prolonged shutdown
		Nitrate	Weekly when nitrate blending plan is implemented
Each lag vessel effluent	N/A	VOCs	Sample if detected at combined effluent (1910124-050)
Each lead vessel 25% port			Monthly until detected
Associated lead vessel 50% port with VOC detection in its 25% port			Monitor 50% port immediately following detection at 25% Port; Continue weekly until detected
Associated lead vessel 75% port with VOC detection in its 50% port			Monitor 75% port immediately following detection at 50% port; Continue weekly until detected
Associated lead vessel effluent with VOC detection in its 75% port			Monitor lead vessel effluent immediately following detection at 75% port; Continue weekly until detected
Each lead and lag vessel effluent	N/A	Total coliform, HPC	Sample if combined effluent (1910124-050) is detected with total coliform

Monitoring Location	P.S. Code	Constituent	Frequency
Compliance Monitoring Location for Monk Hill Treatment System			
Windsor Reservoir	1910124-025	VOCs, nitrate, perchlorate, total coliform, HPC	Weekly
		Chlorate	Monthly

33. The laboratory performing the analyses shall be instructed to report all calibrated peaks on gas chromatographic/mass spectroscopic (GC/MS) analyses. Uncalibrated peaks on chromatographic analyses shall be reported according to CDPH guidance documents Analysis and Reporting of Volatile Non-Target Organic Compounds in Extremely Impaired Water Sources and Recycled Water by Methods 524.2, and Analysis and Reporting of Non-Target Semi-Volatile Organic Compounds in Extremely Impaired Water Sources and Recycled Water Using Methods 3510C/8270 C.

    http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Drinkingwaterlabs/nt-vocs.pdf and

    http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Drinkingwaterlabs/nt-svocs.pdf

    If the TIC or unknown compound is repeatedly detected and not a one-time event, the Department may require and allow time for additional work to positively identify the compound(s) and/or additional testing of the MHTS plant effluent to verify removal of the compound(s).

    Records of the mass spectra, sample date and sample location for all TICs and unknown chemical species described above shall be maintained by PWP.

34. PWP shall comply with any additional monitoring and treatment requirements the Department deems necessary based on any newly identified constituents. If necessary, the Department may modify the monitoring provisions specified herein based on additional information. PWP may request a modification of any monitoring provision based upon substantiating data at any time.

35. Where specified, low level analysis for 1,2,3-trichloropropane (1,2,3-TCP) shall be performed by an ELAP certified laboratory with the lowest achievable reporting limit.

36. When analysis for metals is required, PWP shall follow The Protocol for Characterizing Severely Impaired Water Sources Through Elemental Analysis located on the Department's website:

http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Drinkingwaterlabs/ProceduresforElementalAnalysis.pdf

All detected metals shall be reported.

37. Prior to proceeding with the requirements for further monitoring following a detection of a VOC, PWP may first confirm the analytical result, as follows: Within seven (7) days (24 hours for LGAC ports, LGAC effluent and Windsor Reservoir effluent) from the notification of an initial detection from a laboratory reporting the presence of one or more VOCs in a water sample, PWP may collect and analyze one or two additional samples to confirm the initial finding. Confirmation of the initial finding shall be shown by the presence of the VOC in either the first or second additional sample, and the detected level of the VOC for compliance purposes, if applicable, shall be the average of the initial and the confirmation sample(s). The initial finding shall be disregarded if two additional samples do not show the presence of the VOC.

38. PWP shall be responsible for, and require, the timely notification from the laboratory by telephone or fax of analytical results, particularly those which trigger additional sampling within time limits.

Upgradient Surveillance Wells Monitoring

39. Monitoring wells MW-5, MW-10, MW-3 (screen 2), MW-4 (screen 2), MW-17 (screen 3), MW-18 (screen 4), and MW-19 (screen 2), shall be monitored annually for explosives (TNT, HMX, and RDX), nitrosamines, fluoride, 1,4-dioxane, MTBE and related oxygenates (ETBE, TBA, and TAME), low level 1,2,3-TCP, total and hexavalent chromium, and triennially for semi-volatile organics (including PAHs, phthalates, PCBs, and phenol), total petroleum hydrocarbons, and 2,3,7,8-TCDD.

    Sampling should be coordinated with the long-term quarterly groundwater monitoring program implemented by NASA, which includes quarterly monitoring of perchlorate, VOC, and other contaminants of concern. Initial sampling shall be done within 120 days of issuance of this permit amendment.

Monk Hill Production Wells Monitoring

40. Each of the four Monk Hill production wells shall be sampled in accordance with the current Vulnerability Assessment table issued to PWP by the Department.

41. Each of the four Monk Hill production wells shall also be sampled in accordance with the raw water monitoring scheduled outlined in the approved OMMP, which includes monthly monitoring of VOCs, nitrate, perchlorate, coliform bacteria and heterotrophic plate count (HPC); and quarterly for chlorate, 1,4-dioxane, and low level 1,2,3-TCP.

    The four Monk Hill production wells shall also be tested for atrazine and simazine within 120 days of activation of the wells and once every three years thereafter.

42. PWP shall begin initial radionuclide monitoring at each of the Monk Hill production wells within one quarter of initiating water service from the MHTS to the public.

43. PWP shall revise its raw water monitoring plan 1) if additional chemicals are detected in any upgradient surveillance well which might threaten the quality of the water produced by the Monk Hill production wells, 2) if new chemicals are detected in the production wells, or 3) if the monitoring data indicates a rapid change in a contaminant's concentration which warrants more frequent monitoring.

44. If any additional contaminant is consistently found in one or more of the surveillance wells, it should be tested for in the closest production wells. If the additional contaminant is detected in any of the production wells, it should be verified by sampling that it is removed by the treatment equipment.

Ion Exchange Treatment Monitoring

45. The perchlorate concentration of the IX combined effluent shall be operated to achieve a treatment goal of below California's Detection Limit for Reporting (DLR).

46. In order to verify the removal efficiency of the IX System, weekly perchlorate samples shall be collected at the combined influent to the IX vessels (the plant influent after the influent cartridge filters) and twice weekly at the IX combined effluent (PS Code: 1910124-051). If the influent concentration is reliably and consistently below 18µg/L, the IX combined effluent may be tested weekly.

47. Weekly perchlorate samples shall be collected at each lead vessel effluent, which is the cross-over point between the lead and lag vessels. The resin in the lead vessel will be changed out when the lead vessel effluent perchlorate concentration reaches the perchlorate MCL of 6 µg/L.

48. If perchlorate is detected above DLR at the IX combined effluent (PS Code: 1910124-051), sample each lag vessel effluent. Any vessel pair found to be discharging greater than DLR from the lag vessel shall be taken out of service and the lag vessel switched to the lead position, and fresh resin placed in the former lead vessel.

49. HPC and coliform samples shall be collected weekly and following any changeout or prolonged shutdown at the IX combined effluent to ensure no bacteriological contamination is occurring in the IX process. The IX combined effluent shall be free of total coliforms. If coliforms are detected, PWP shall inform the Department within 24 hours and begin weekly total coliform and HPC monitoring at the individual IX lead and lag vessels. The Department may require additional investigation. If monitoring results indicate a sudden or significant increase in coliform bacteria or HPC, the Department may require PWP to shut down the treatment facility and disinfect the resin and vessel.

LGAC Treatment Monitoring

50. Concentrations of all VOCs in the LGAC combined effluent (PS Code: 1910124-050) shall be operated to achieve a treatment goal of below their respective Detection Limits for Reporting (DLR).

51. In order to verify the removal efficiency of the LGAC System, weekly VOCs samples shall be collected at the combined influent to the LGAC vessels (PS Code: 1910124-051) and the LGAC combined effluent prior to chloramination (PS Code: 1910124-050).

52. If any VOCs are detected in the LGAC combined effluent above their respective DLRs, each lag vessel effluent must be tested and if breakthrough from one or more of the lag vessels has occurred, the LGAC in the associated lead vessel shall be replaced and that vessel then placed in the lag position.

53. In order to ensure that VOCs are not detected in the LGAC combined effluent, monthly samples should be collected at the 25 percent bed depth port of each lead vessel. Once any VOC is detected at a 25 percent port, the 50 percent sampling port should be immediately sampled and analyzed; sampling of the 50 percent port should continue weekly until any VOC is detected. Upon detection of the 50 percent port, the 75 percent port should immediately be tested; sampling of the 75 percent port should continue weekly until any VOC is detected. Upon VOC detection at the 75 percent port, the lead vessel effluent must be sampled immediately for VOCs and weekly thereafter. Detection of any VOC at the 75 percent sampling port shall trigger PWP to arrange for the replacement of the lead vessel bed, which will then become the lag bed.

    As PWP gains experience with the LGAC behavior and the actual levels of VOC, PWP may request a modification of the frequency of operational monitoring.

54. HPC and coliform samples shall be collected weekly and following any changeout or prolonged shutdown at the LGAC combined effluent to ensure no bacteriological contamination is occurring in the LGAC process. The LGAC combined effluent shall be free of total coliforms. If coliforms are detected, PWP shall inform the Department within 24 hours and begin weekly total coliform and HPC monitoring at the individual LGAC lead and lag vessels. The Department may require additional investigation. If monitoring results indicate a sudden or significant increase in coliform bacteria or HPC, the Department may require PWP to shut down the treatment facility and disinfect the media and vessel.

Nitrate Blending Monitoring

55. Nitrate blend shall be operated to achieve a treatment goal of 36 mg/L and less than the nitrate MCL of 45 mg/L at the Windsor Reservoir effluent (PS Code: 1910124-25) at all times. Nitrate blending monitoring shall be implemented in accordance with the approved OMMP.

Windsor Reservoir Compliance Monitoring

56. Windsor Reservoir (PS Code: 1910124-025) shall be the compliance monitoring location for MHTS. Weekly samples of nitrate, perchlorate, VOCs, total coliform, and HPC, and a monthly sample of chlorate shall be collected at Windsor Reservoir. These results shall be used to determine compliance with nitrate, perchlorate, and VOCs MCLs.

OPERATION AND MAINTENANCE

57. The status of the Monk Hill production wells shall be recorded daily, and the treatment facilities shall be inspected daily, when in use, for any abnormal occurrences including, but not limited to, leaks, unusual noises, vibrations, pressure and flow readings. A checklist of items to be examined shall be filled out daily and maintained for a minimum of five years.

58. All instruments, including but not limited to chemical analyzers and flow meters, shall be calibrated at the frequencies and by the methods recommended by their respective manufacturers. Records for all instrument calibrations shall be maintained by PWP for at least five years and made available to the Department when requested.

59. Sampling ports for the Monk Hill production wells, LGAC vessels, ion exchange vessels, and Windsor Reservoir's inlets/outlets shall be maintained in good operating condition.

60. PWP shall update the OMMP to reflect the monitoring parameters, frequencies, and compliance locations as specified in this permit.

61. At the conclusion of the first year of operation, PWP shall prepare and submit to the Department an evaluation of the performance of the MHTS and any proposed revisions to the OMMP for review.

RECORDS AND REPORTING

62. A monthly report of the MHTS shall be submitted to the Department by the 20th day of the following month. As a minimum, the report shall include:

    a) A summary of analytical results received by PWP in the reporting calendar month, including any results from the upgradient monitoring wells enumerated in this permit amendment.

    b) A summary of the bacteriological quality of water leaving the Monk Hill production wells, ion exchange combined effluent, LGAC combined effluent, and Windsor Reservoir.

63. PWP shall keep the following operational records for the MHTS:

a) The daily operation and production of the Monk Hill production wells;

b) Daily flowrate of the LGAC and ion exchange vessels;

c) Daily disinfectant residual of the effluent leaving Windsor reservoir

64. The records shall also document any emergency and/or scheduled or unscheduled interruptions, including:

a) Location of interruption,

b) Cause of interruption,

c) Date, approximate time, and duration of interruption,

d) Precautions taken to minimize contamination of the supply and notification of the affected users, and

e) Solution/resolution of the interruption and steps taken to prevent a reoccurrence.

65. Copies of reports, inspections and all records shall be kept for at least five years. Water quality records shall be kept for ten years.

66. Within 24 hours of receiving notification from the laboratory, PWP shall notify the Department of any exceedance of an MCL or NL in the finished water leaving the MHTS.

67. PWP shall prepare annual report to the Department, which shall include compliance with the permit provisions, the treatment plant's status, condition, and performance and any problems or difficulties and any proposed revisions to the OMMP for review. This report shall be due by March 30th of the following year.

The annual report shall also provide an evaluation and technical review of the water quality data gathered from the upgradient surveillance monitoring wells listed in Condition 39, the Monk Hill production wells, the removal efficiency and reliability of the MHTS, and an evaluation of any changes in the characteristics of the contaminant concentrations and the possible impacts on the MHTS.