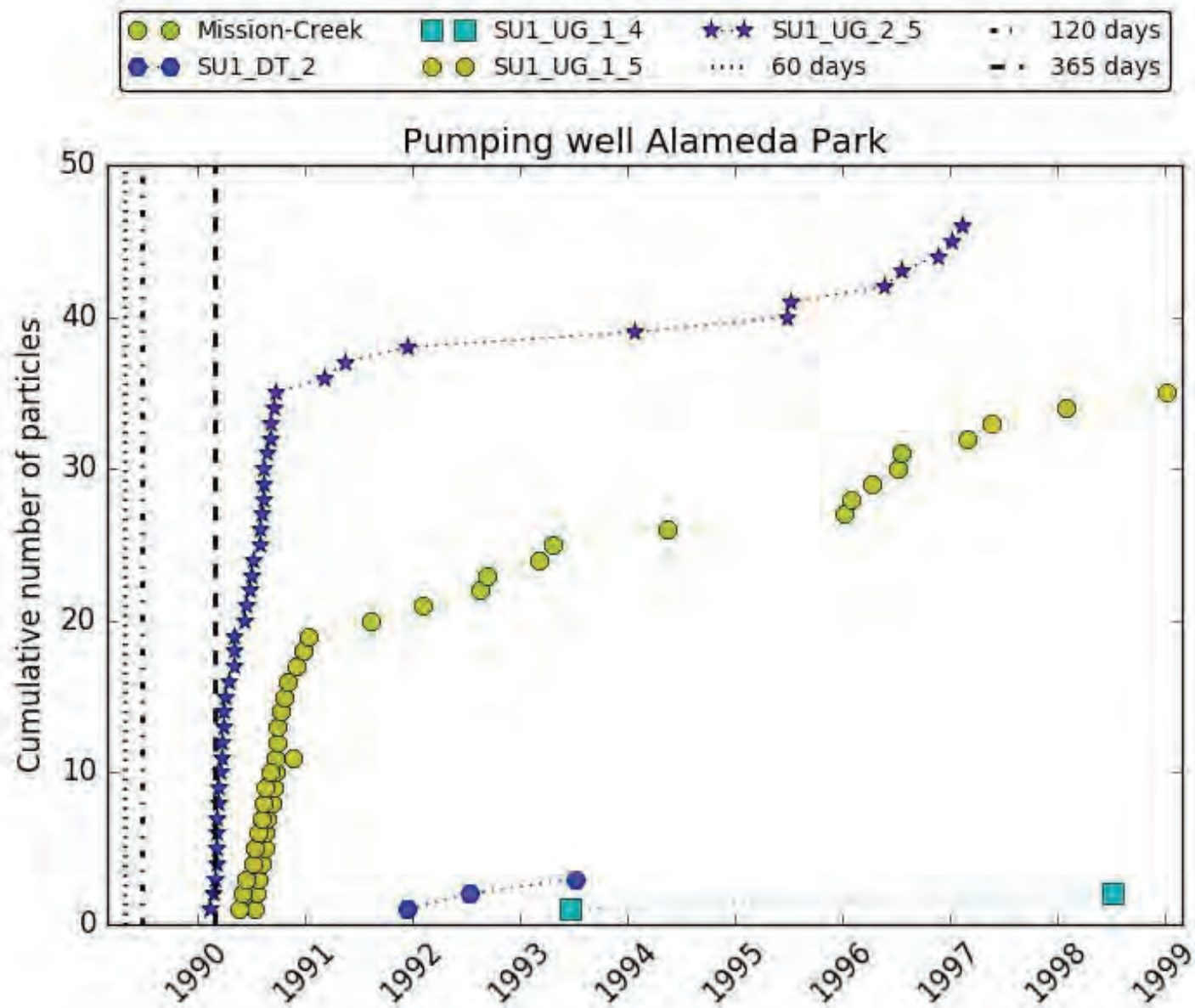


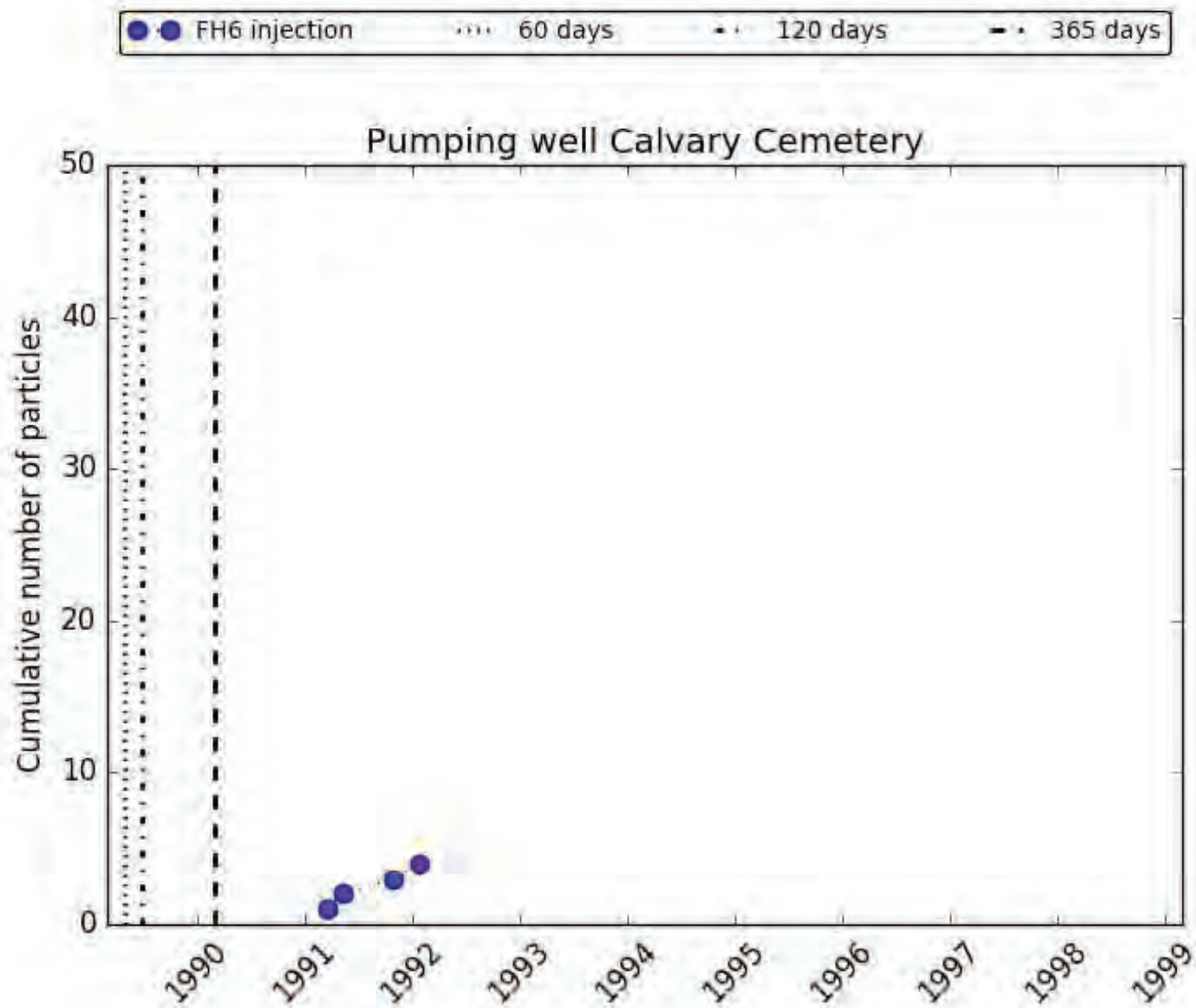
Appendix D: Groundwater Model Particle Tracking Graphs for Alternative 1B

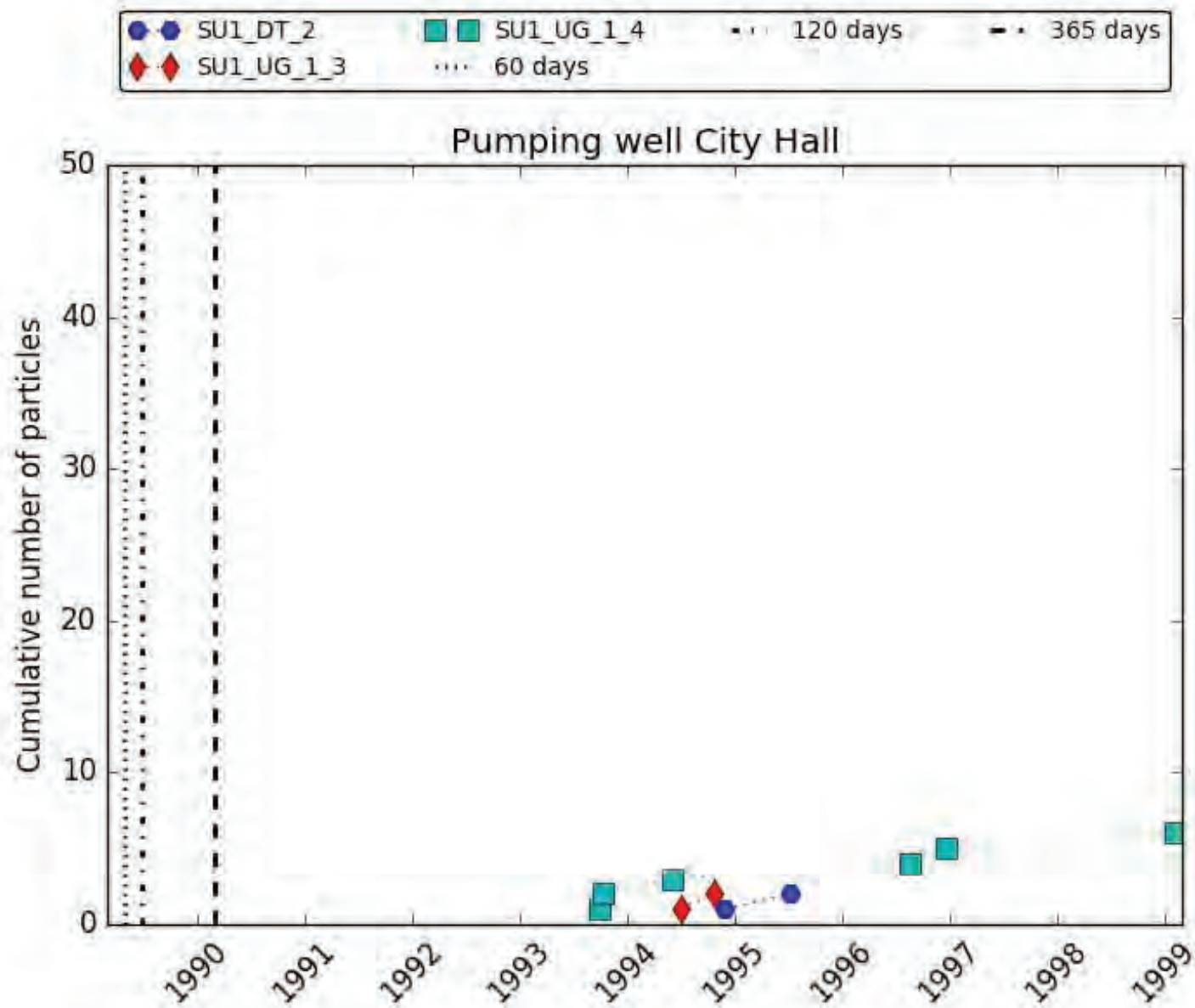
The following particle tracking graphs show arrival times at IPR recovery wells and production wells for recycled water applied at individual sites (surface recharge reaches and IPR injection wells) as simulated by the groundwater model. The graphs provide a visual means of comparing simulated arrival times at pumped wells for fully advanced treatment (FAT) recycled waters applied via injection wells and tertiary treated recycled waters applied via surface recharge reaches to the required residence times for each (60 days residence required for FAT water, 365 days required for tertiary treated water).

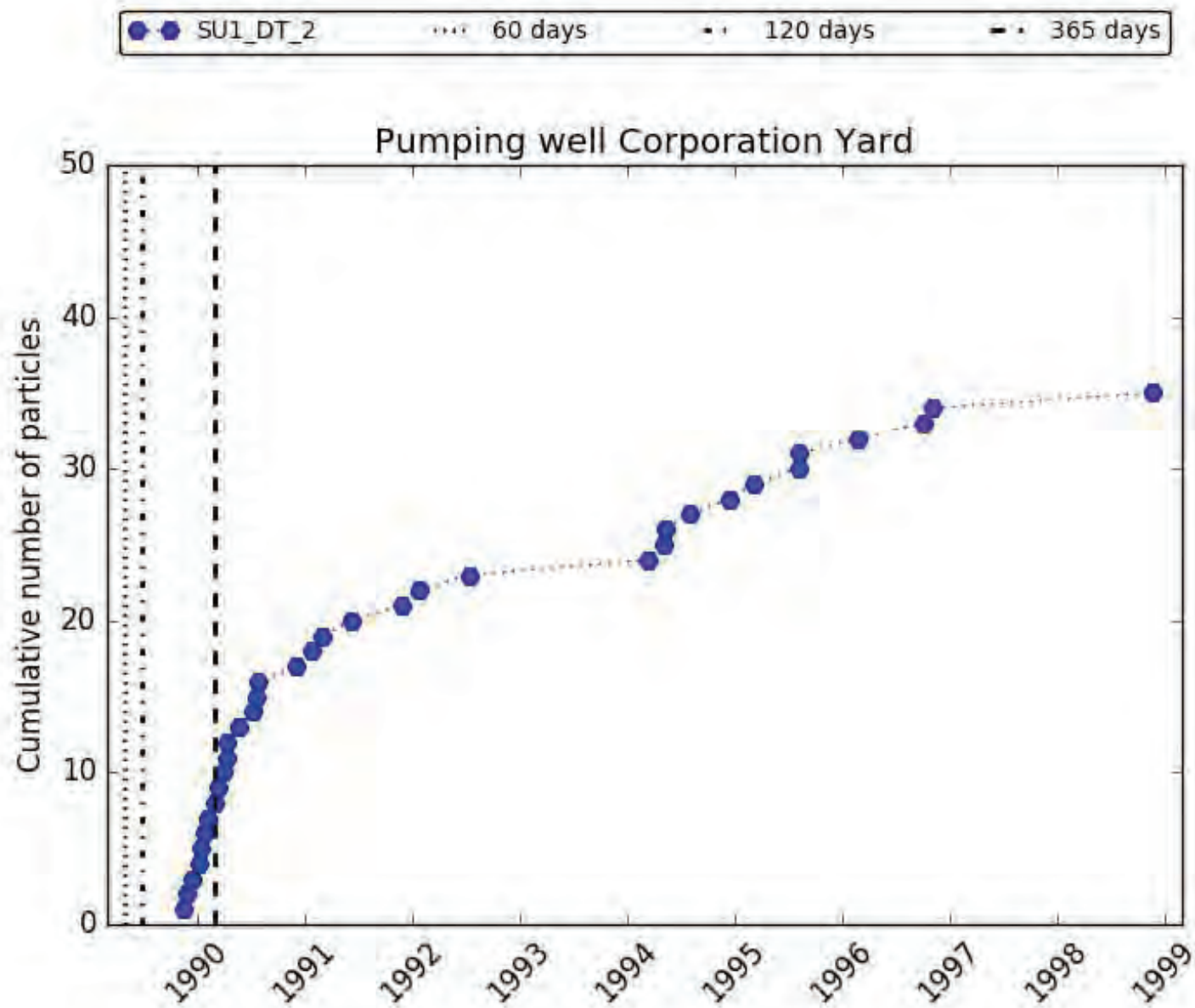
For example, the graph for “Pumping well SU1_4” can be read as follows:

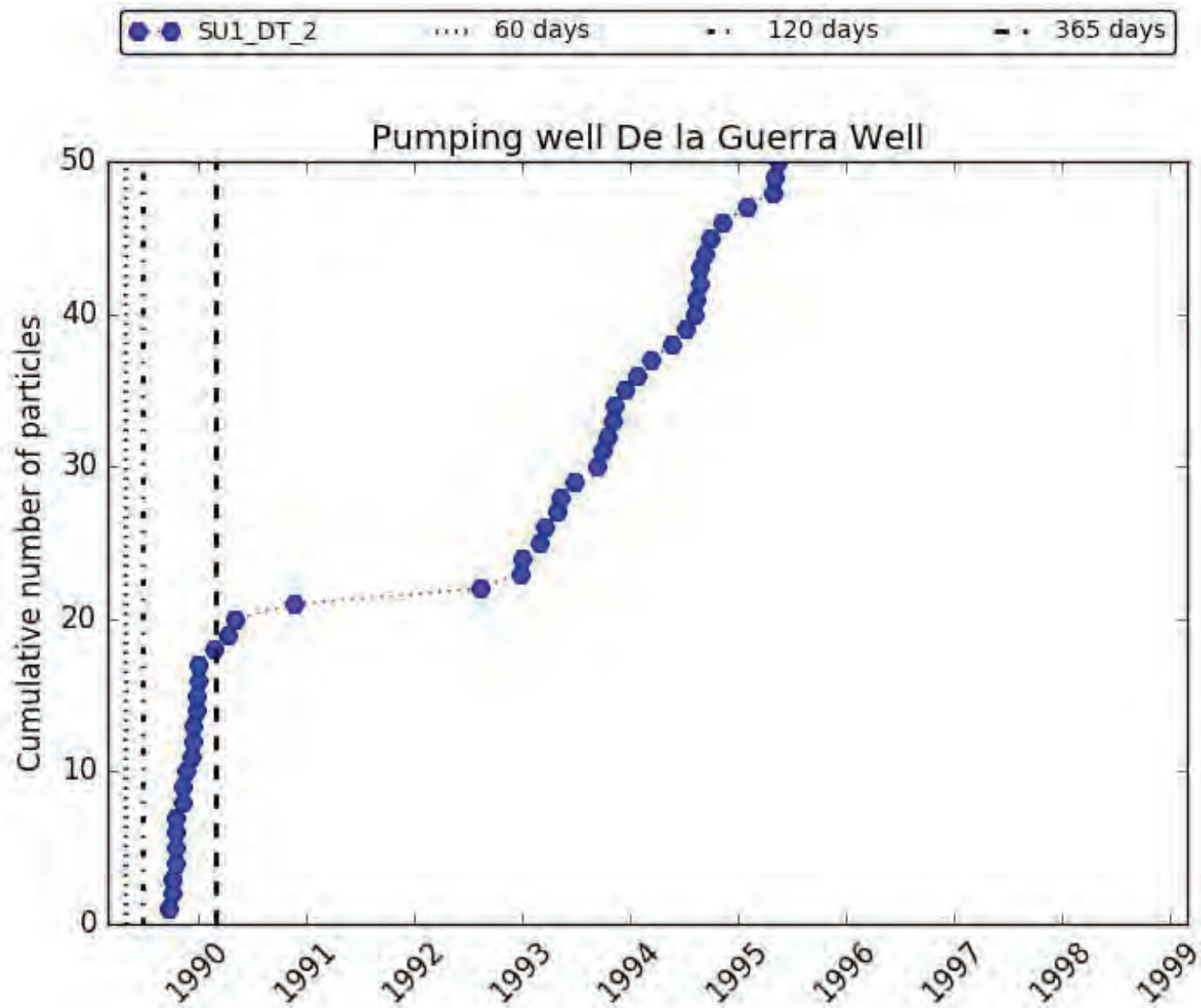
- The first ‘particle’ of water from IPR injection well SU1_UG_2_7 arrives just after 120 days of residence time. The rest of the water ‘particles’ arrive shortly thereafter. Because FAT water would be used for injection, the required residence time of at least 60 days is satisfied.
 - The first ‘particle’ of water from IPR injection well SU1_UG_2_6 arrives after approximately 365 days of residence time. Again, the rest of the water ‘particles’ arrive shortly thereafter. Because FAT water would be used for injection, the required residence time of at least 60 days is satisfied.
 - The first ‘particle’ of water applied via surface recharge in Mission Creek arrives after more than 1.5 years of residence time. The rest of the water ‘particles’ arrive slowly over the next several years. Because tertiary treated water would be used for surface recharge, the required residence time of at least 365 days is satisfied.
 - Only one ‘particle’ of water arrives from injection well SU1_UG_2_5 after more than 2 years of residence time.
-

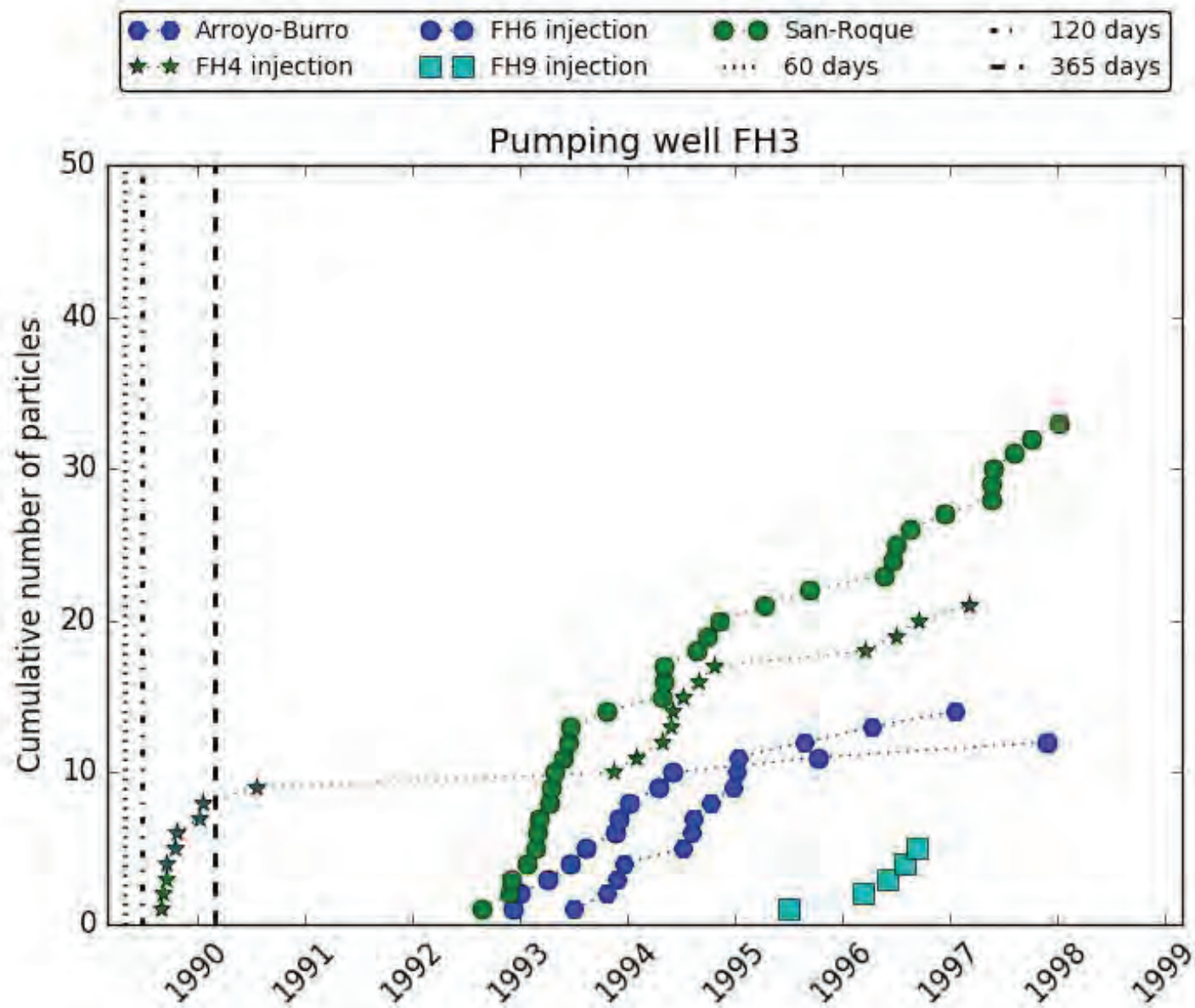


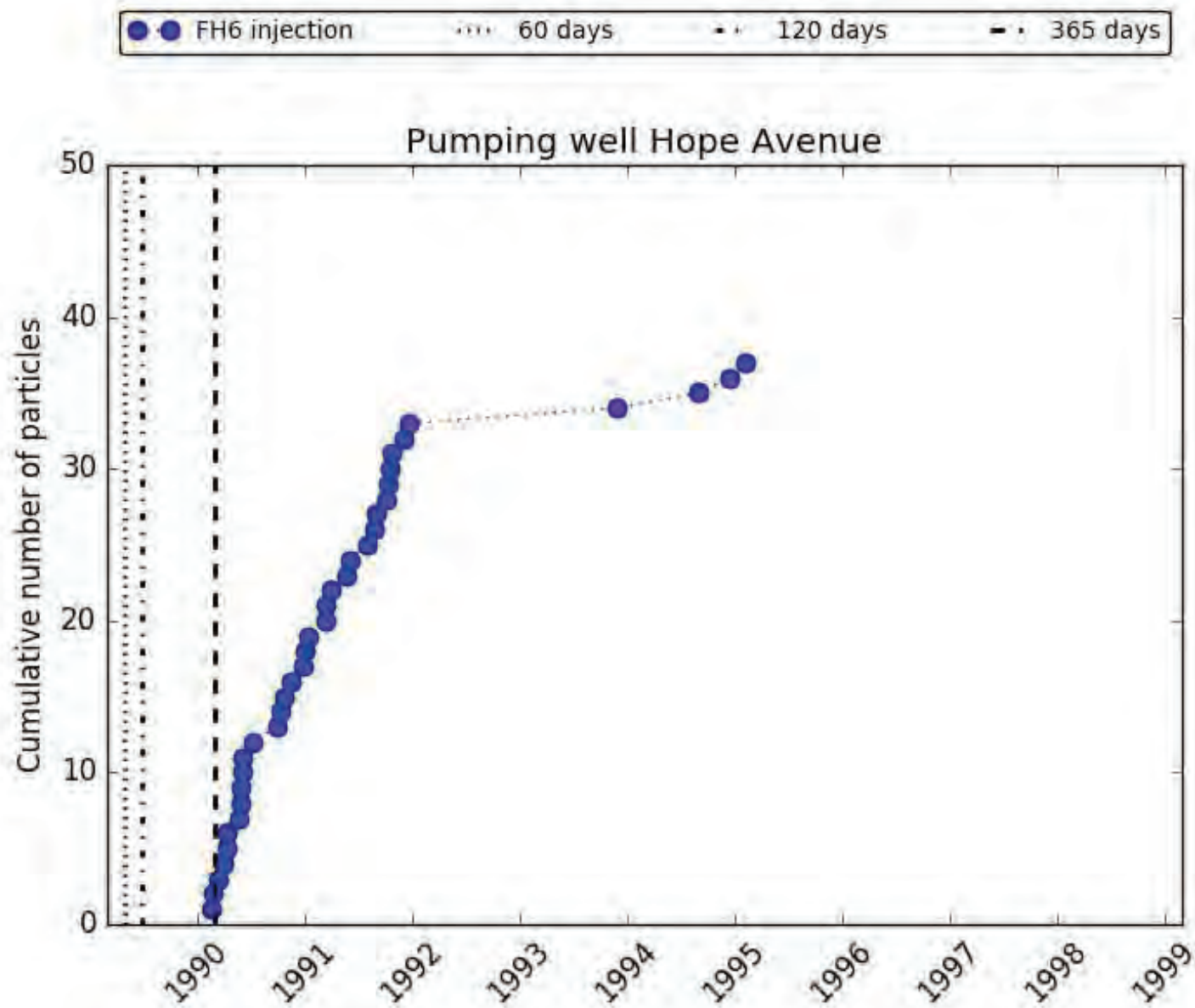


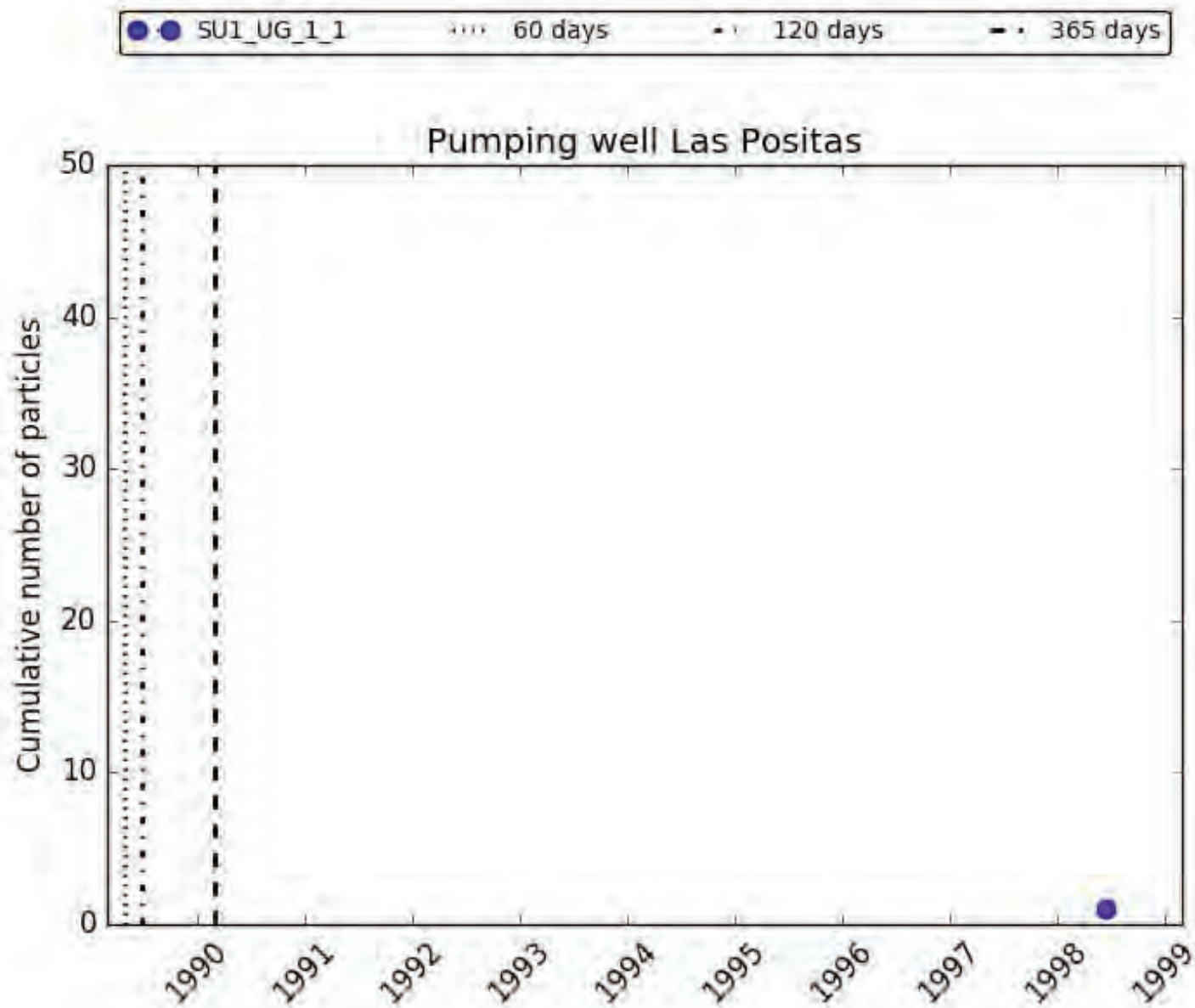






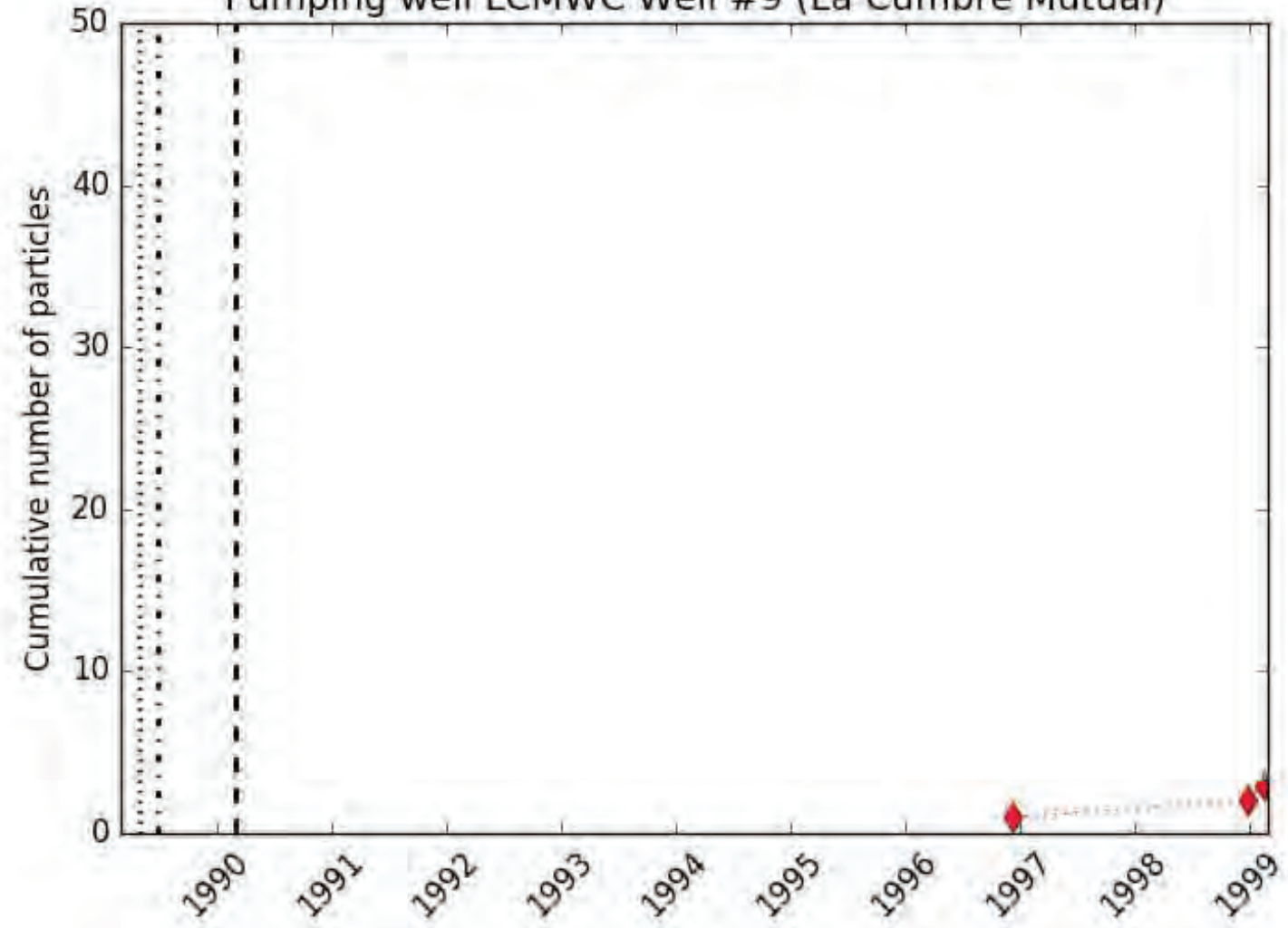


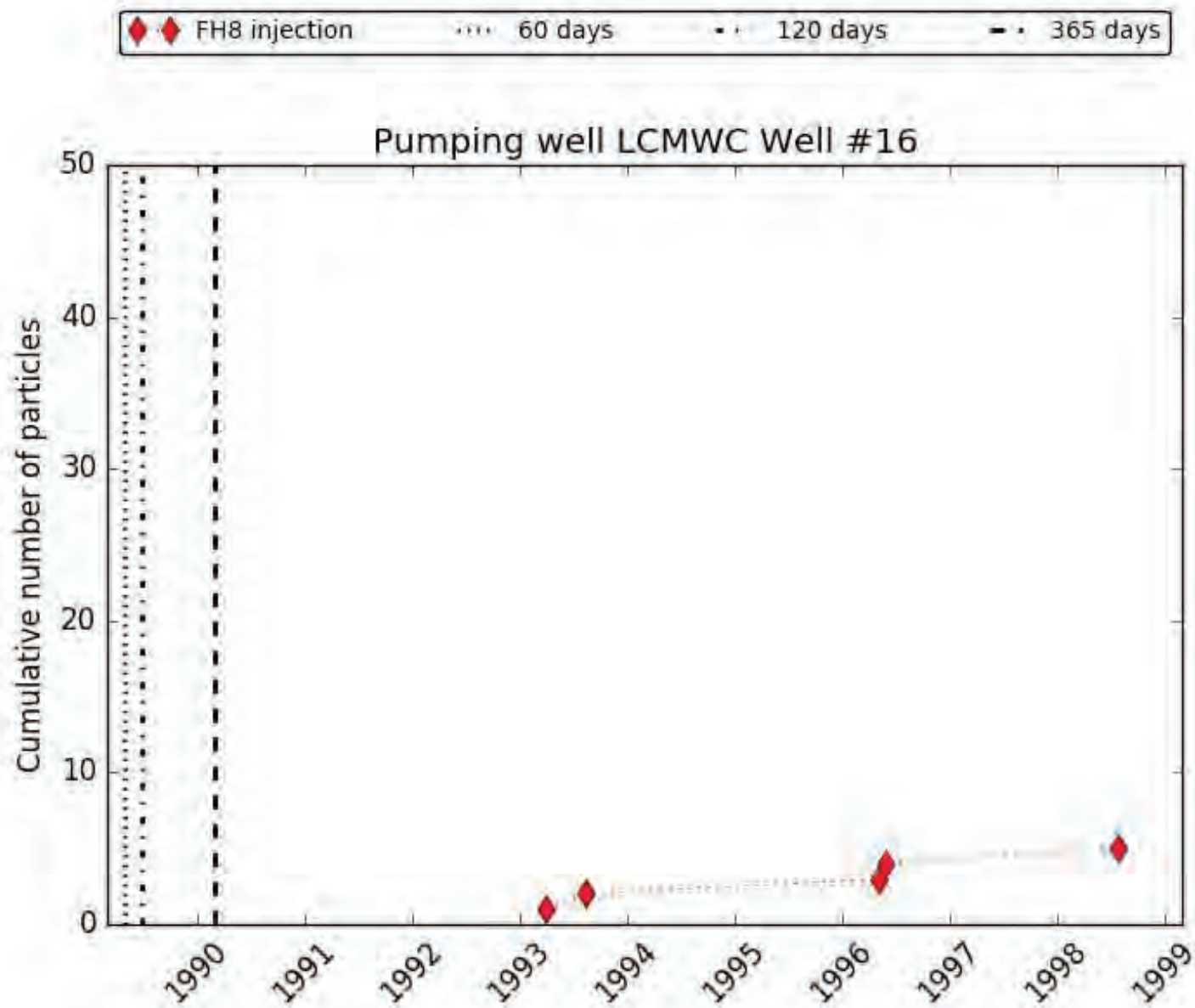


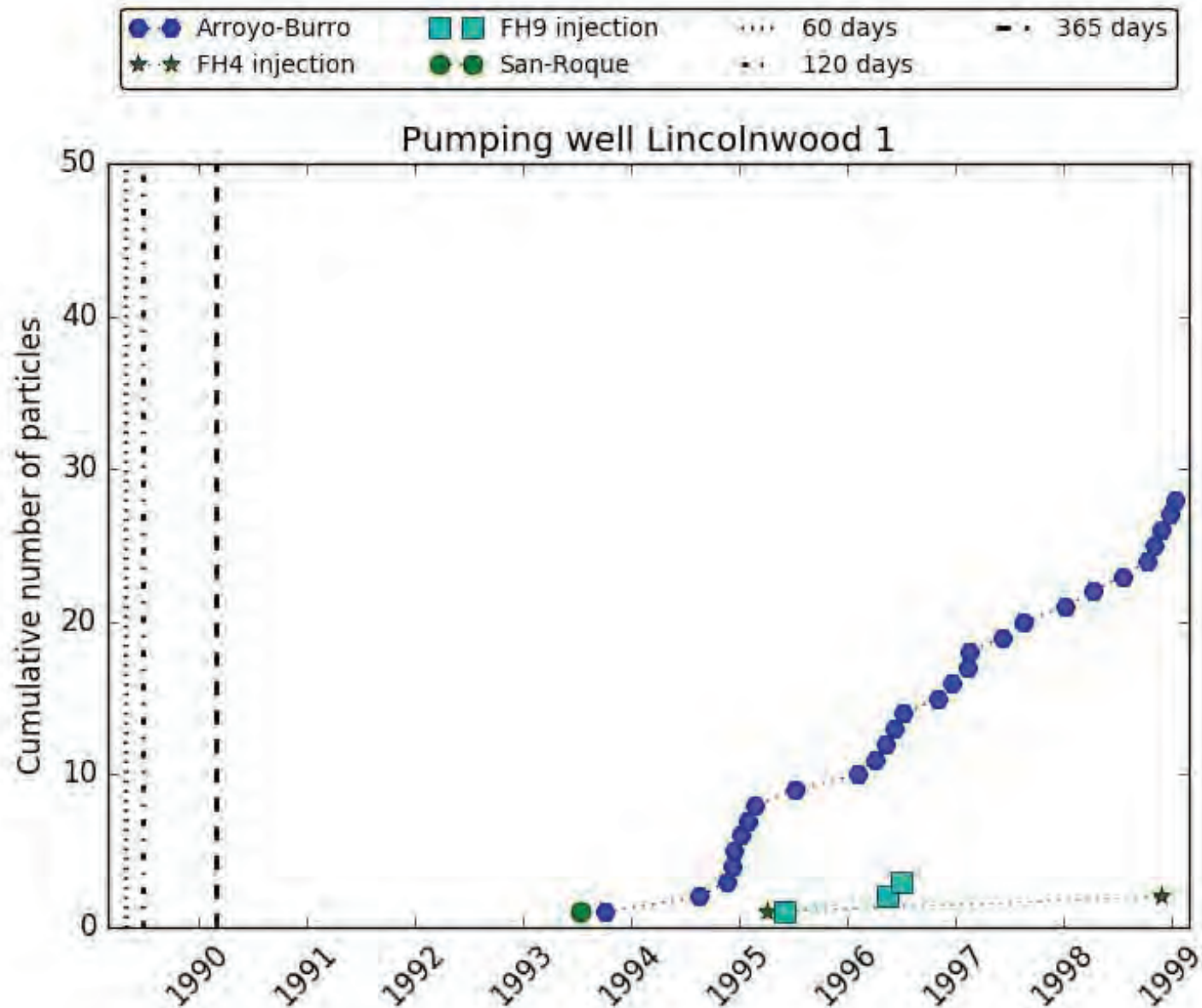


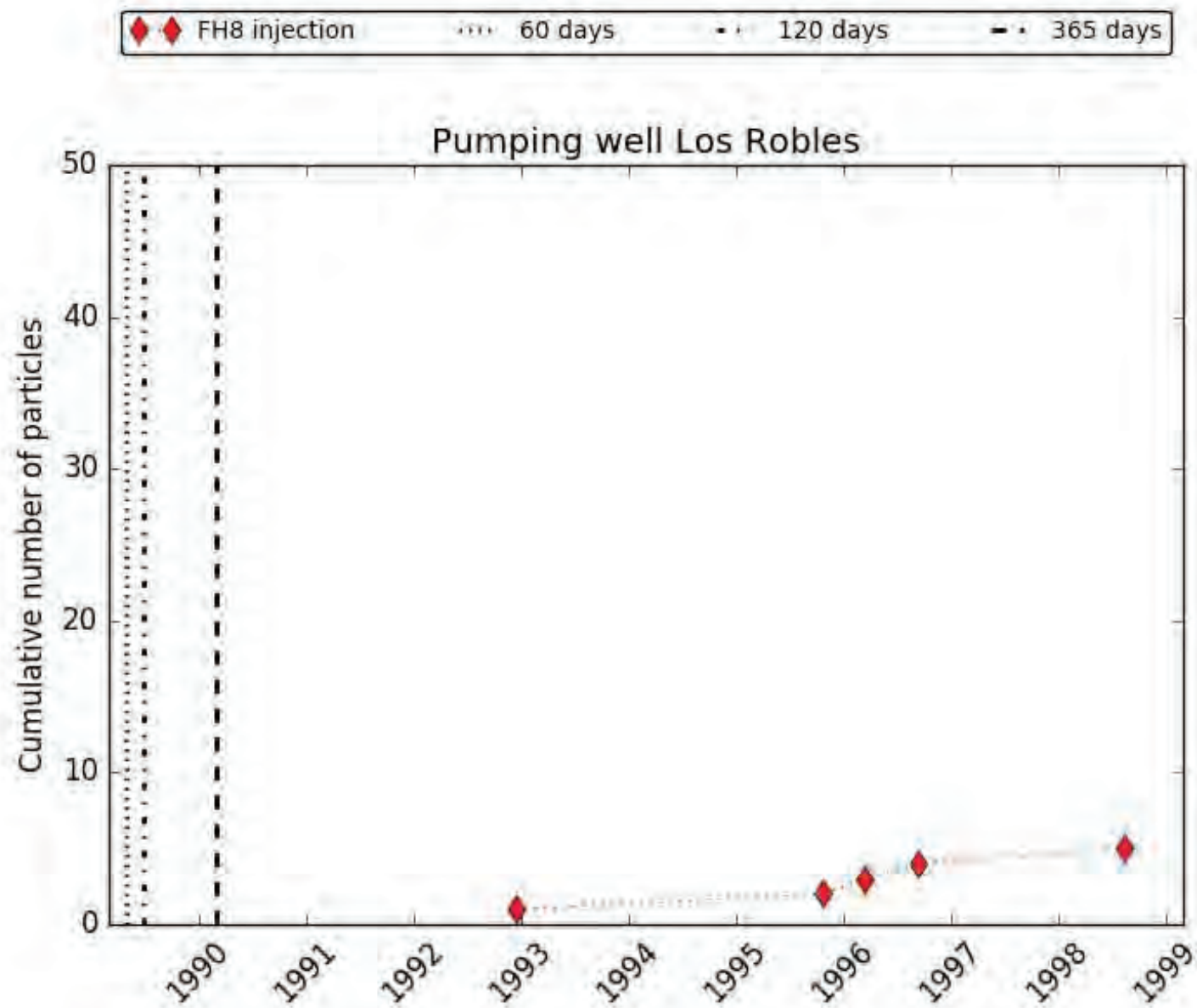
◆ FH8 injection ···· 60 days - · - 120 days - - - 365 days

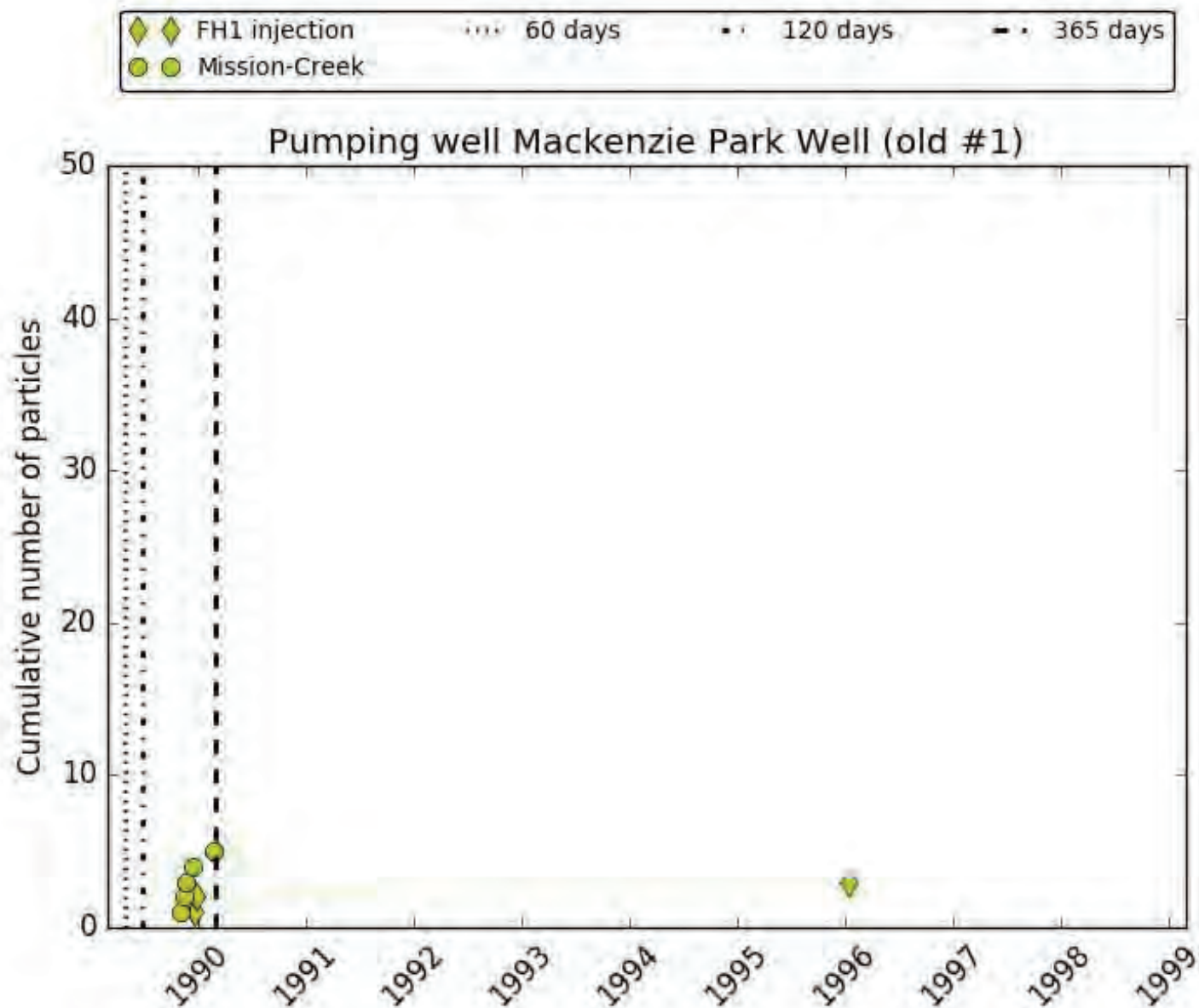
Pumping well LCMWC Well #9 (La Cumbre Mutual)

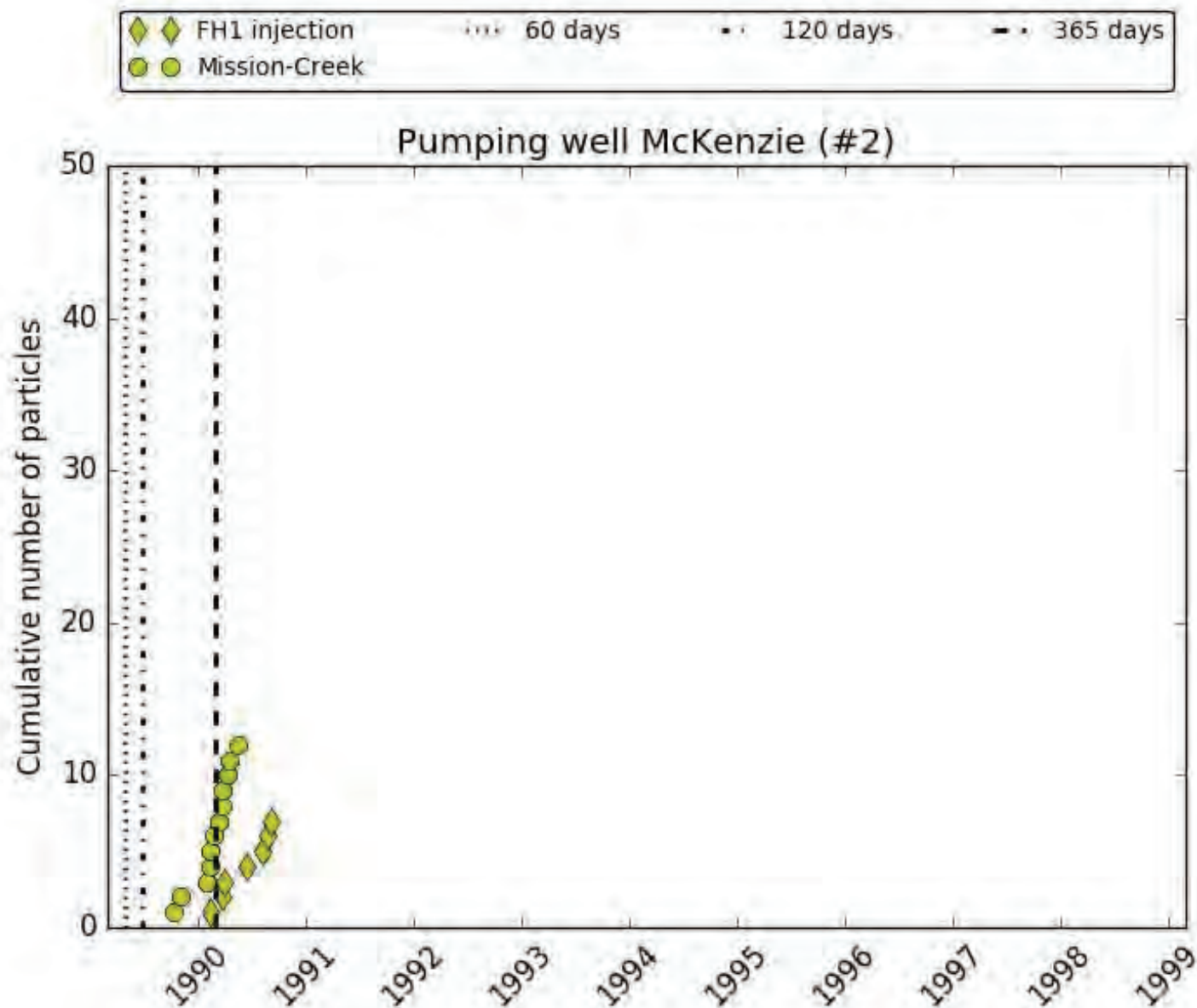


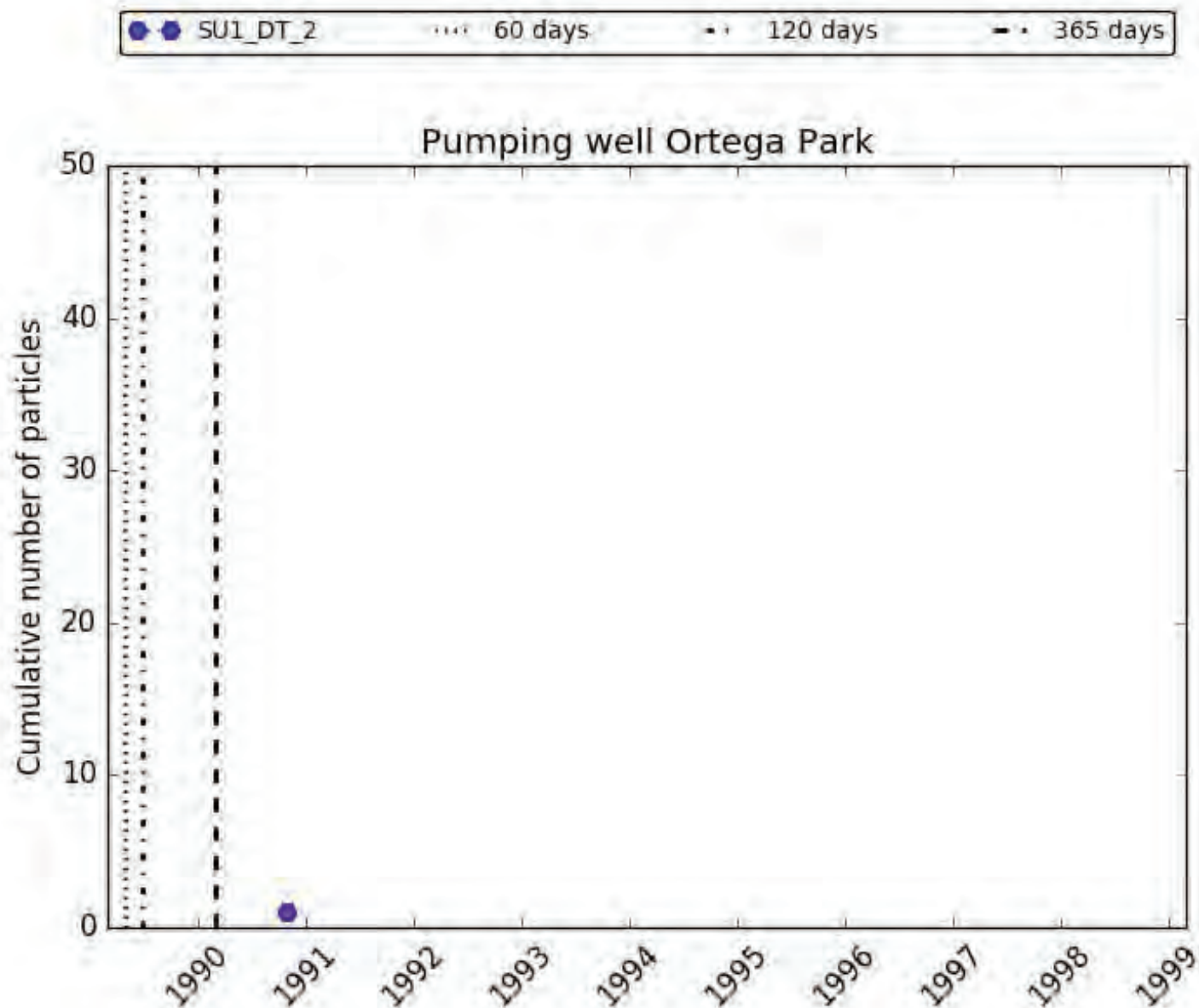


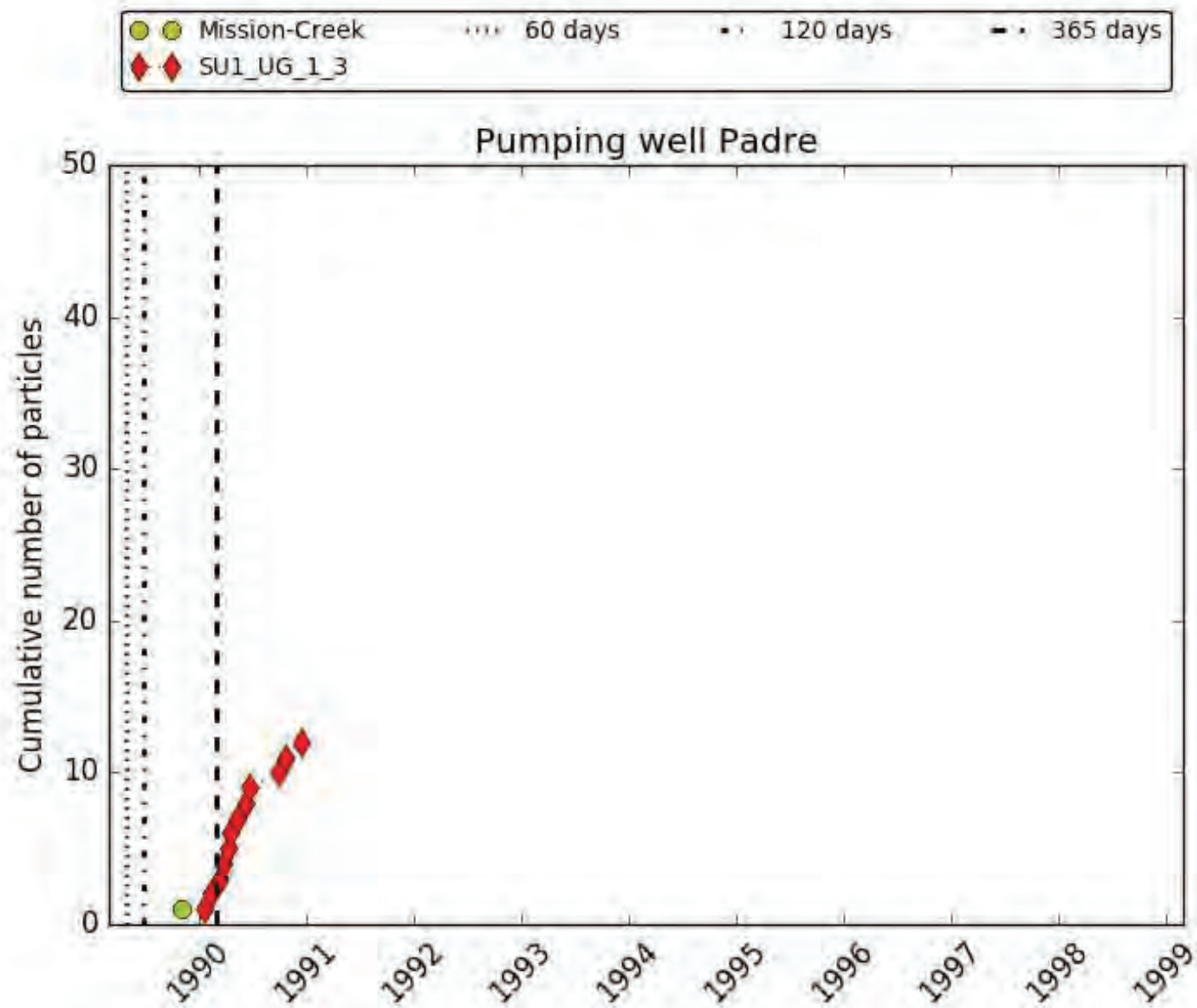




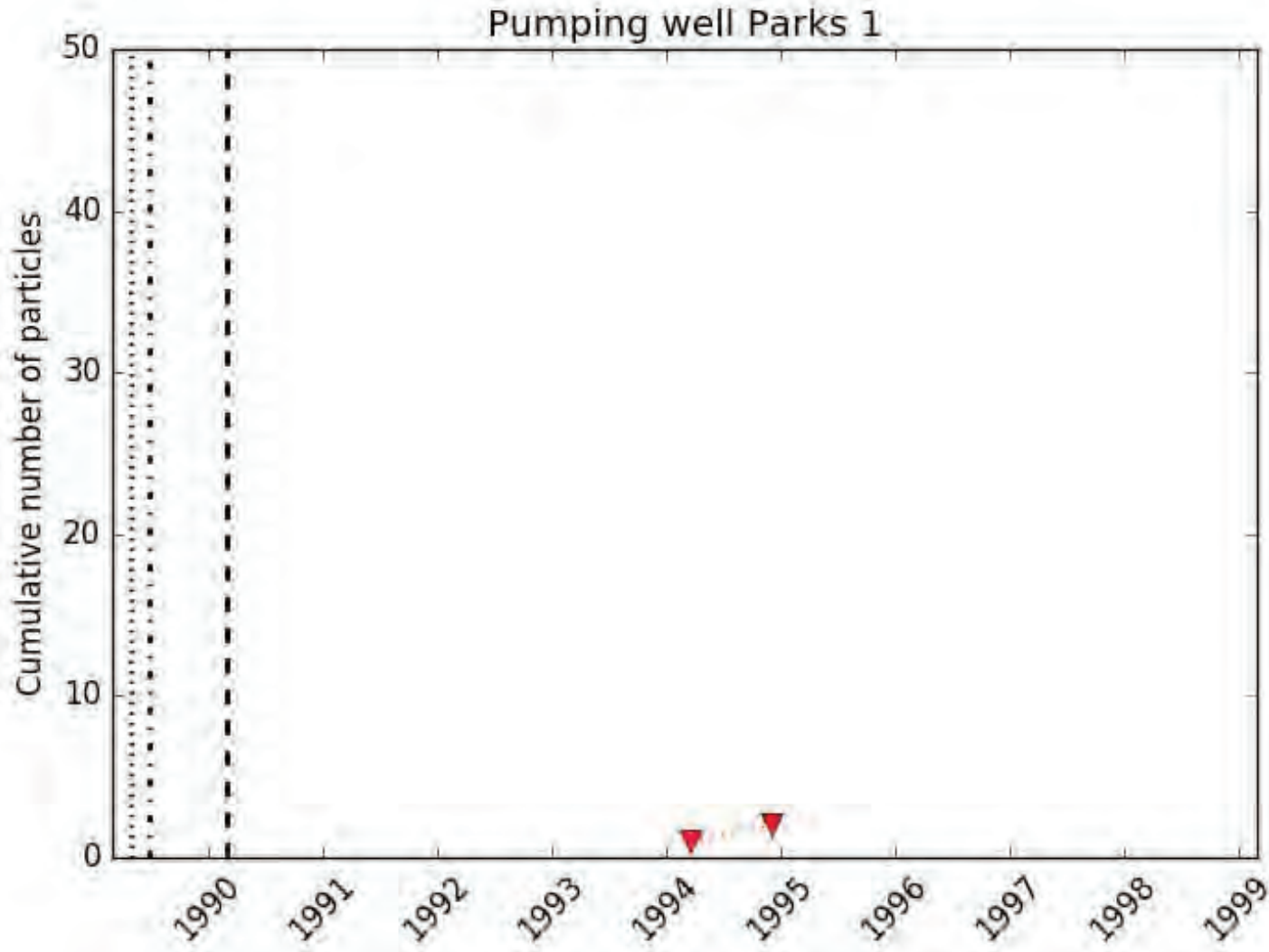


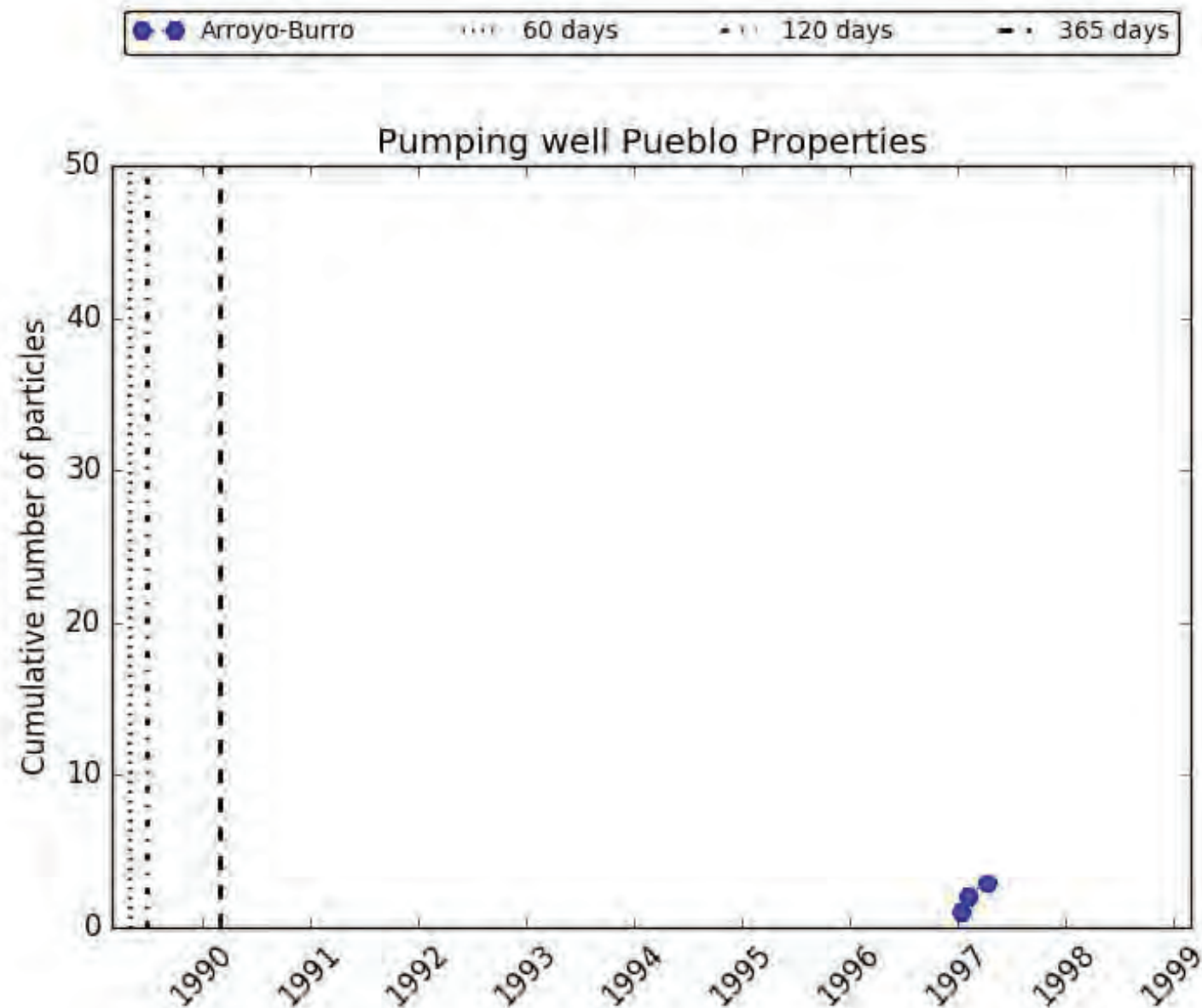


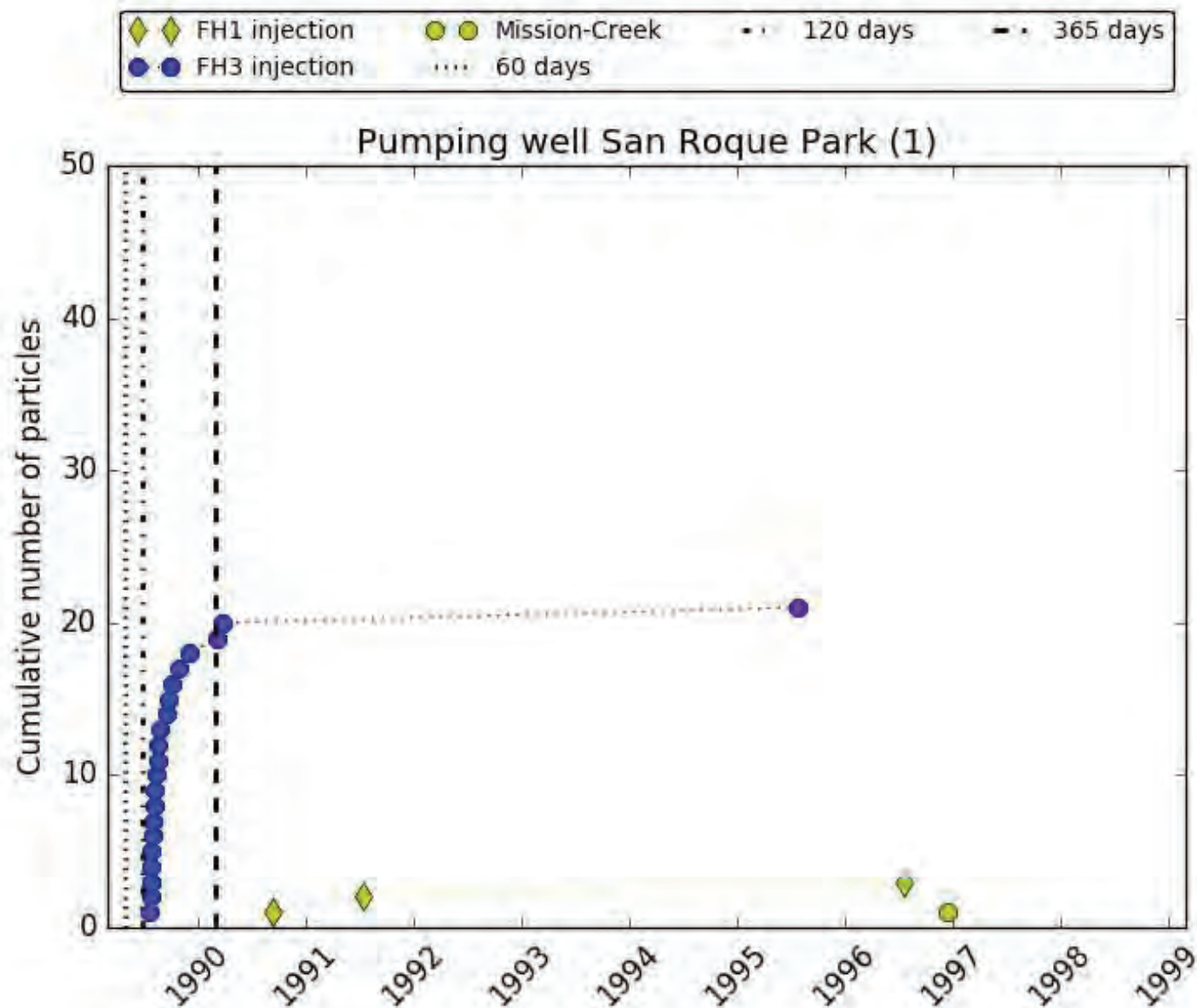


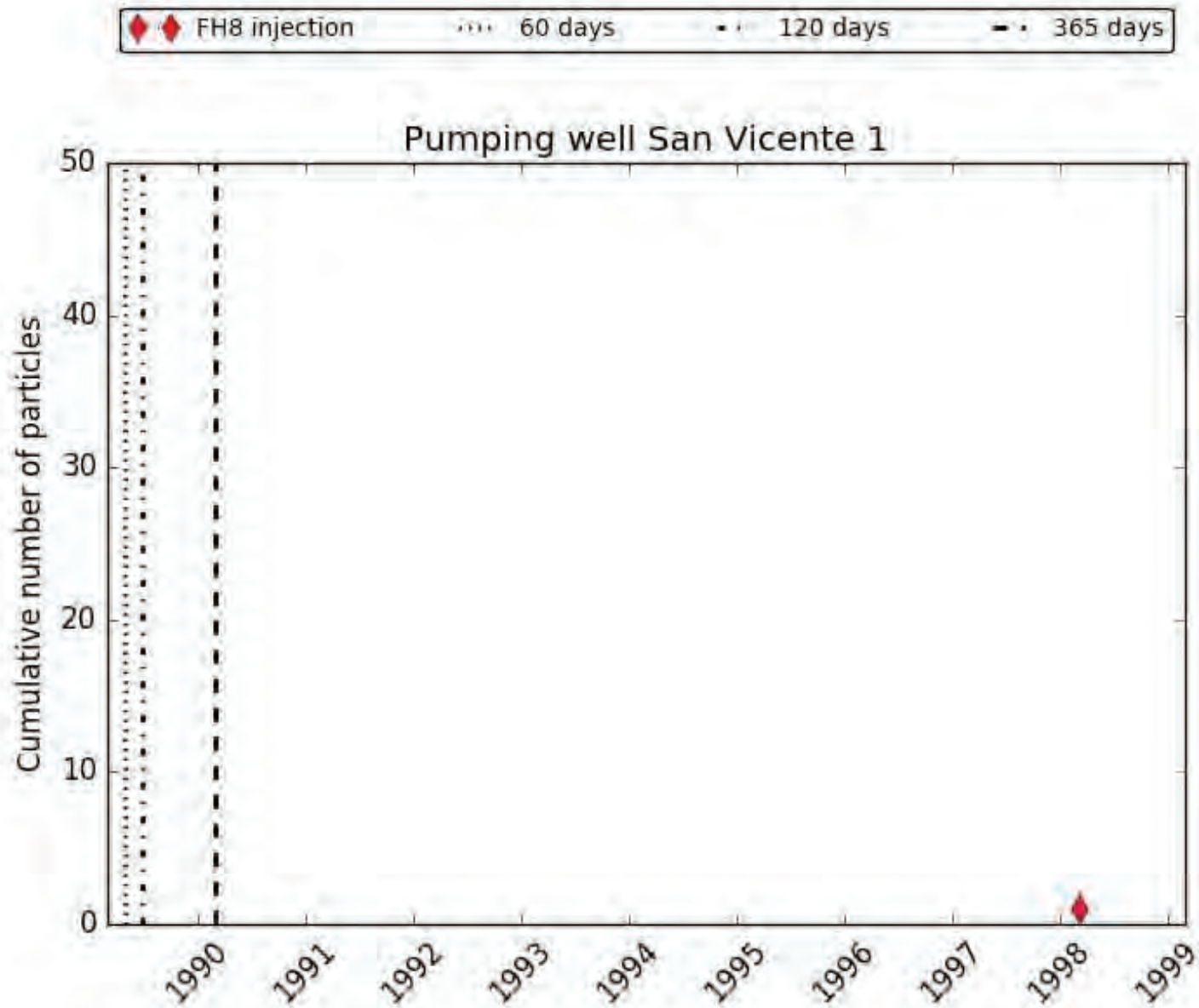


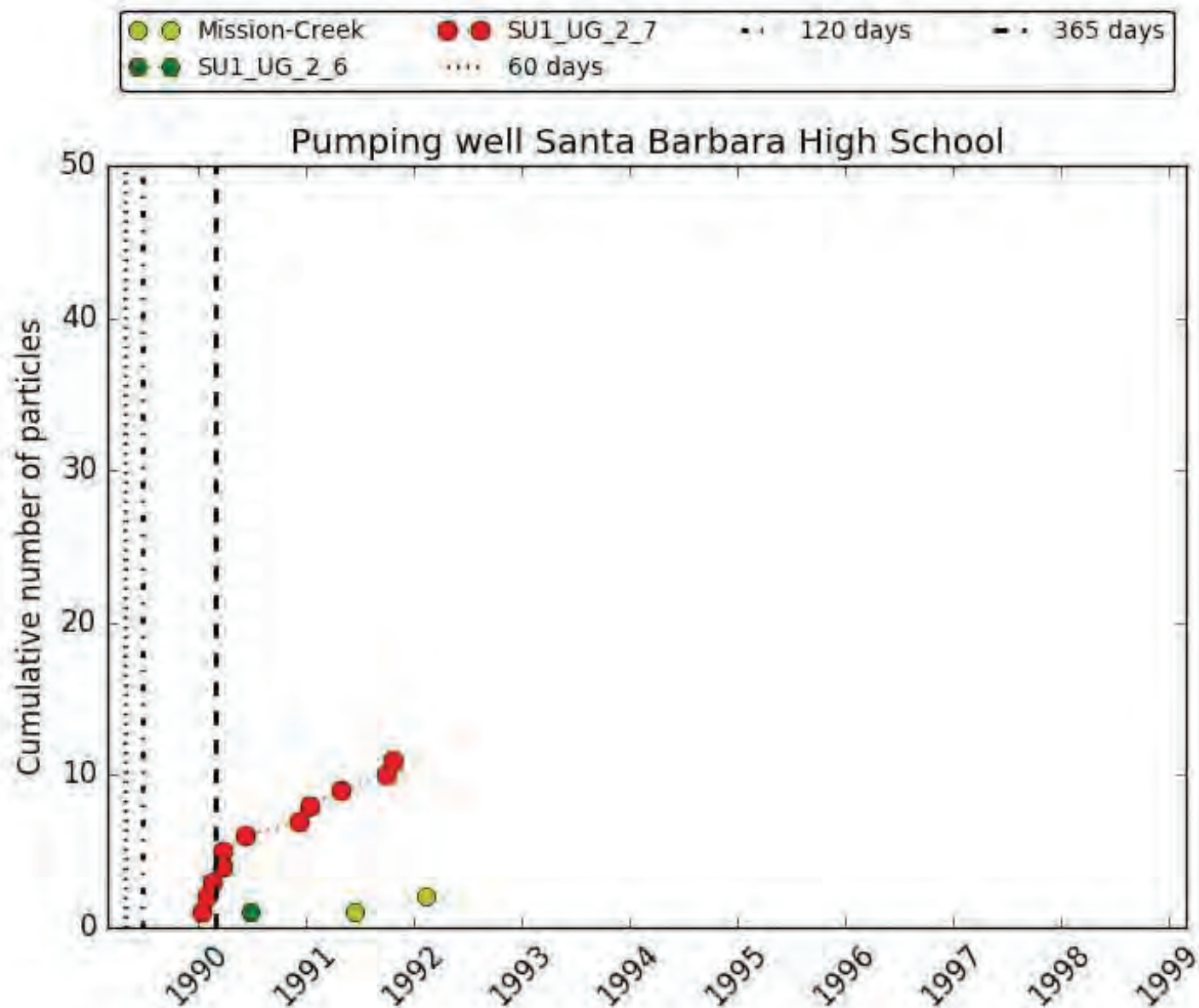
▼ SU1_UG_2_1 60 days 120 days 365 days

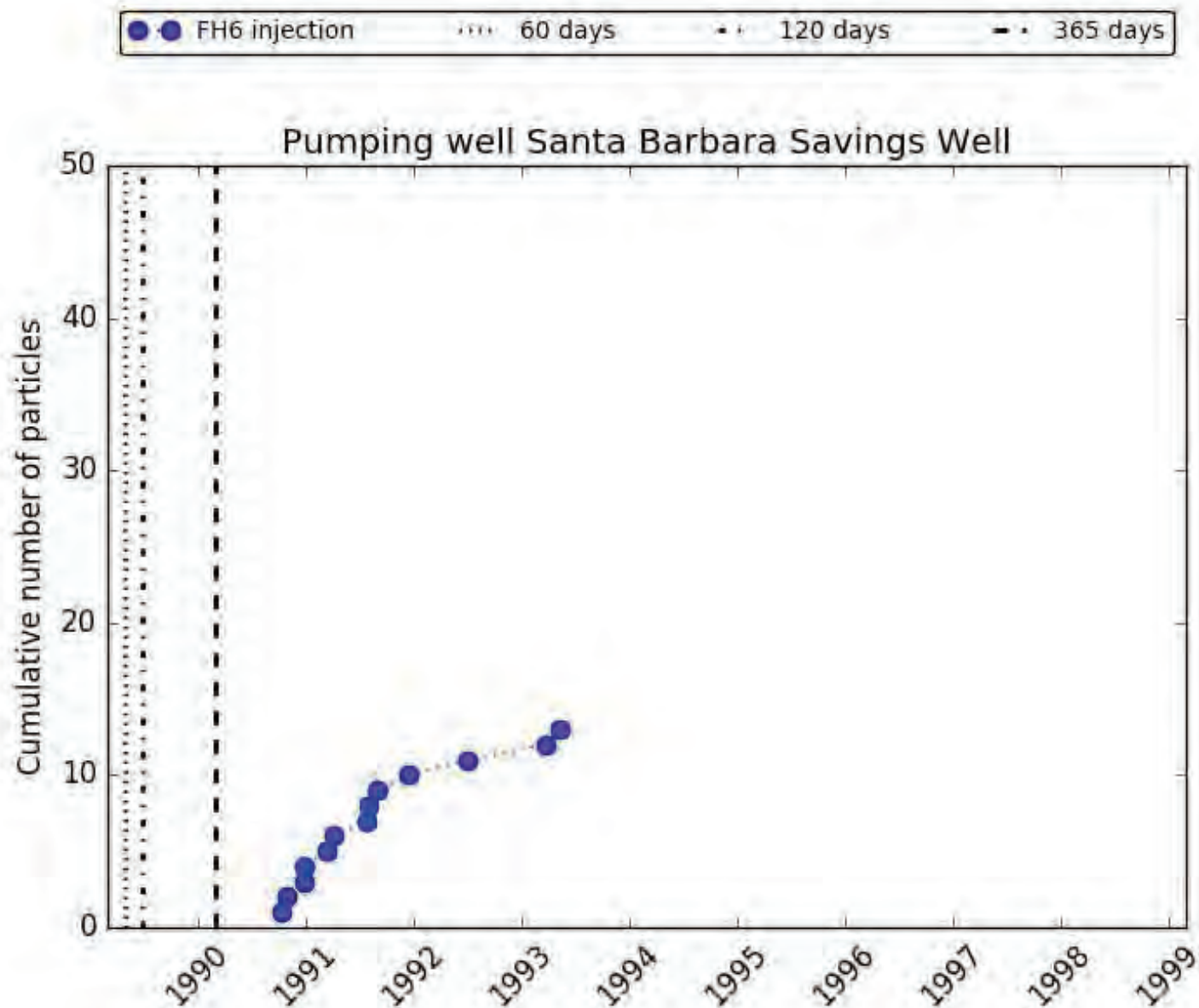


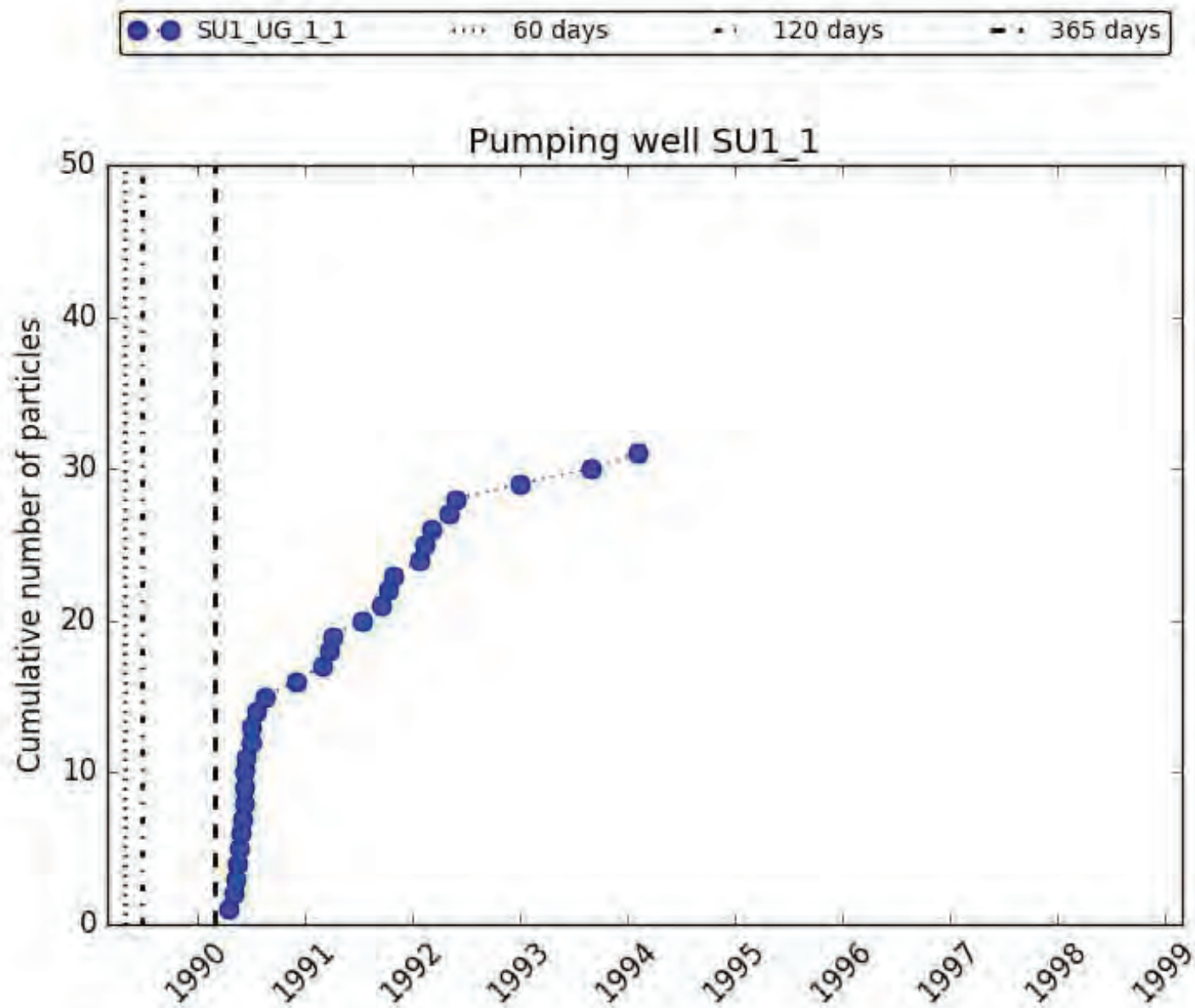


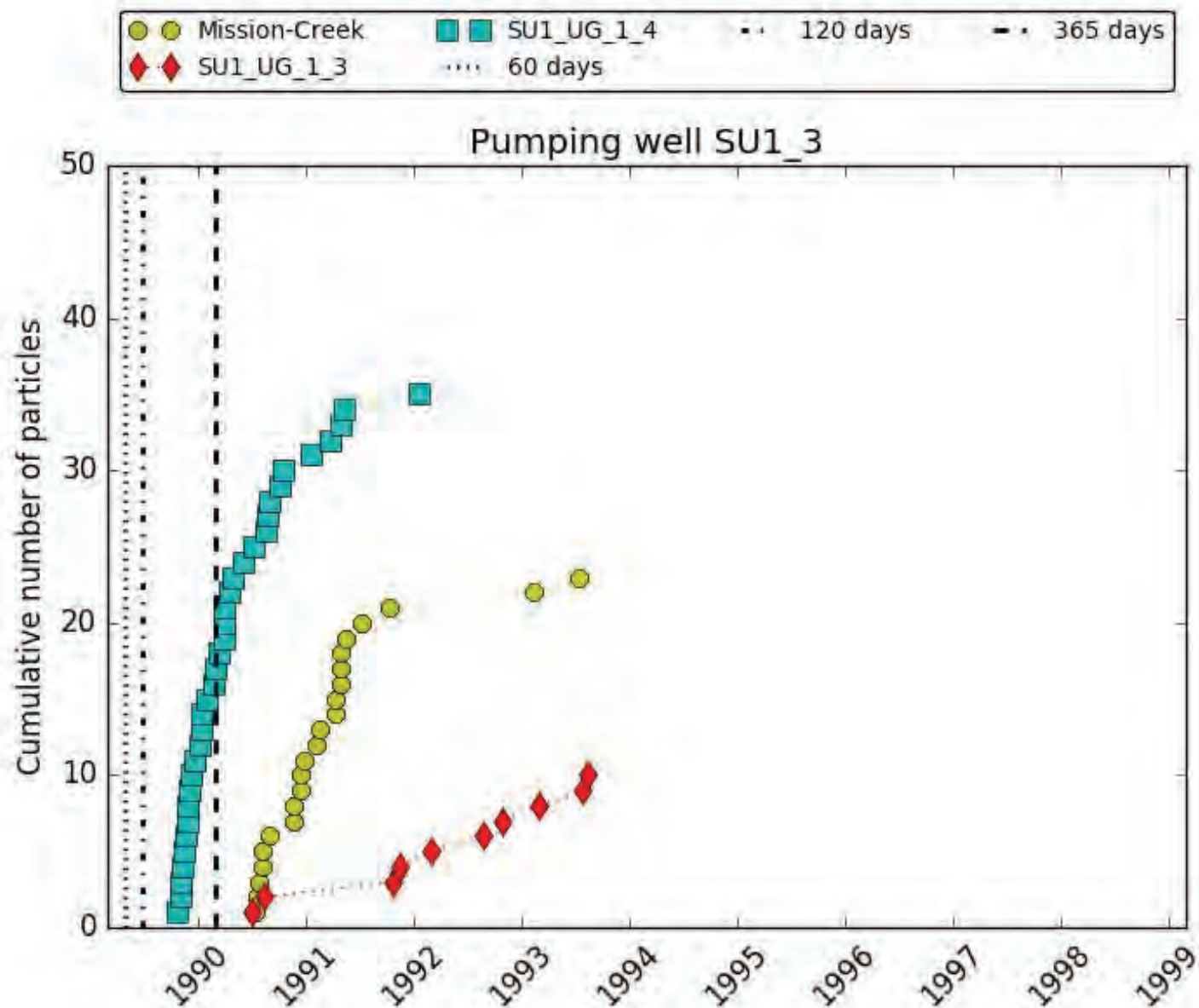


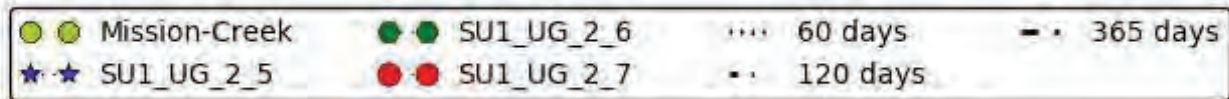




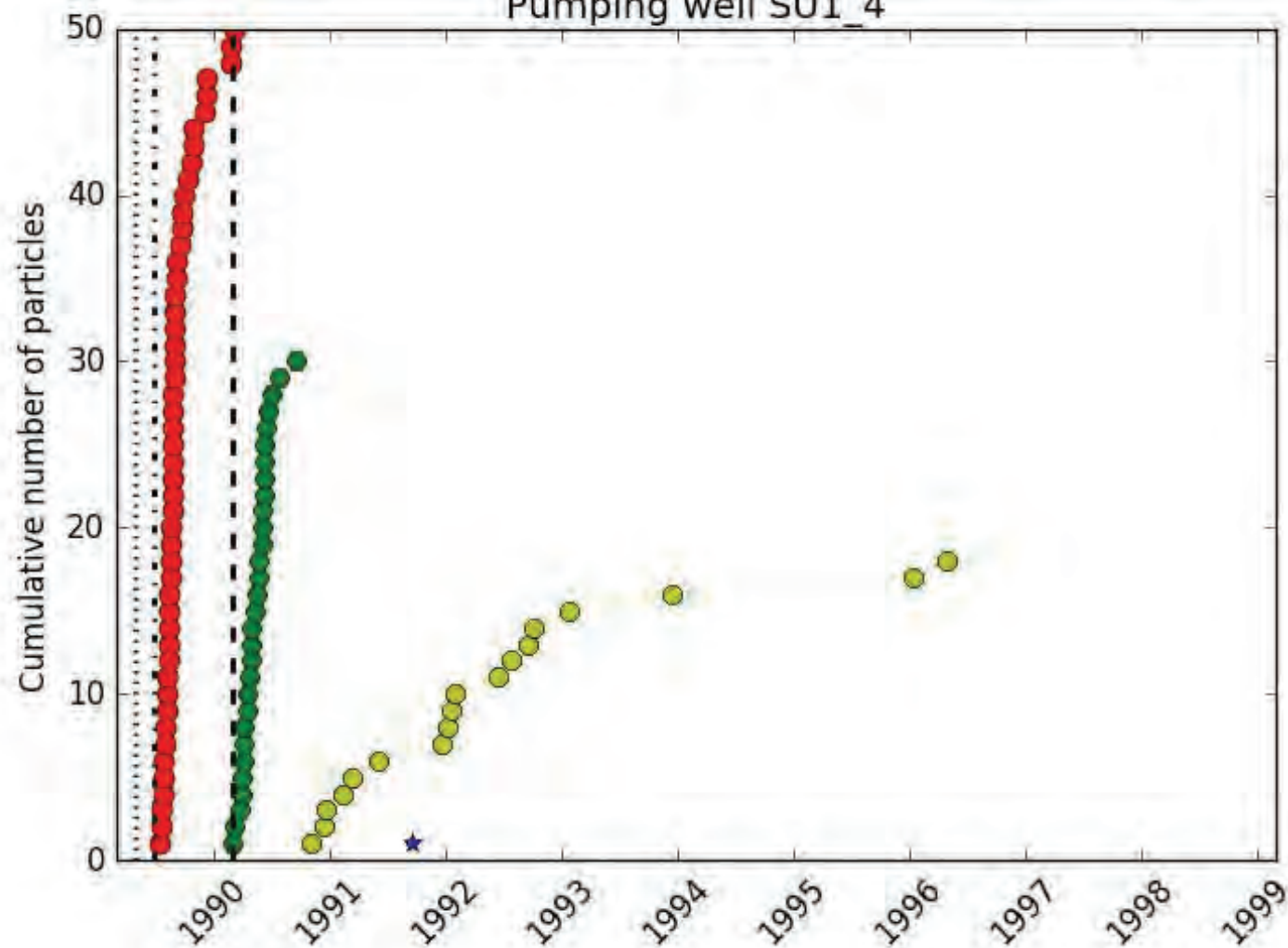


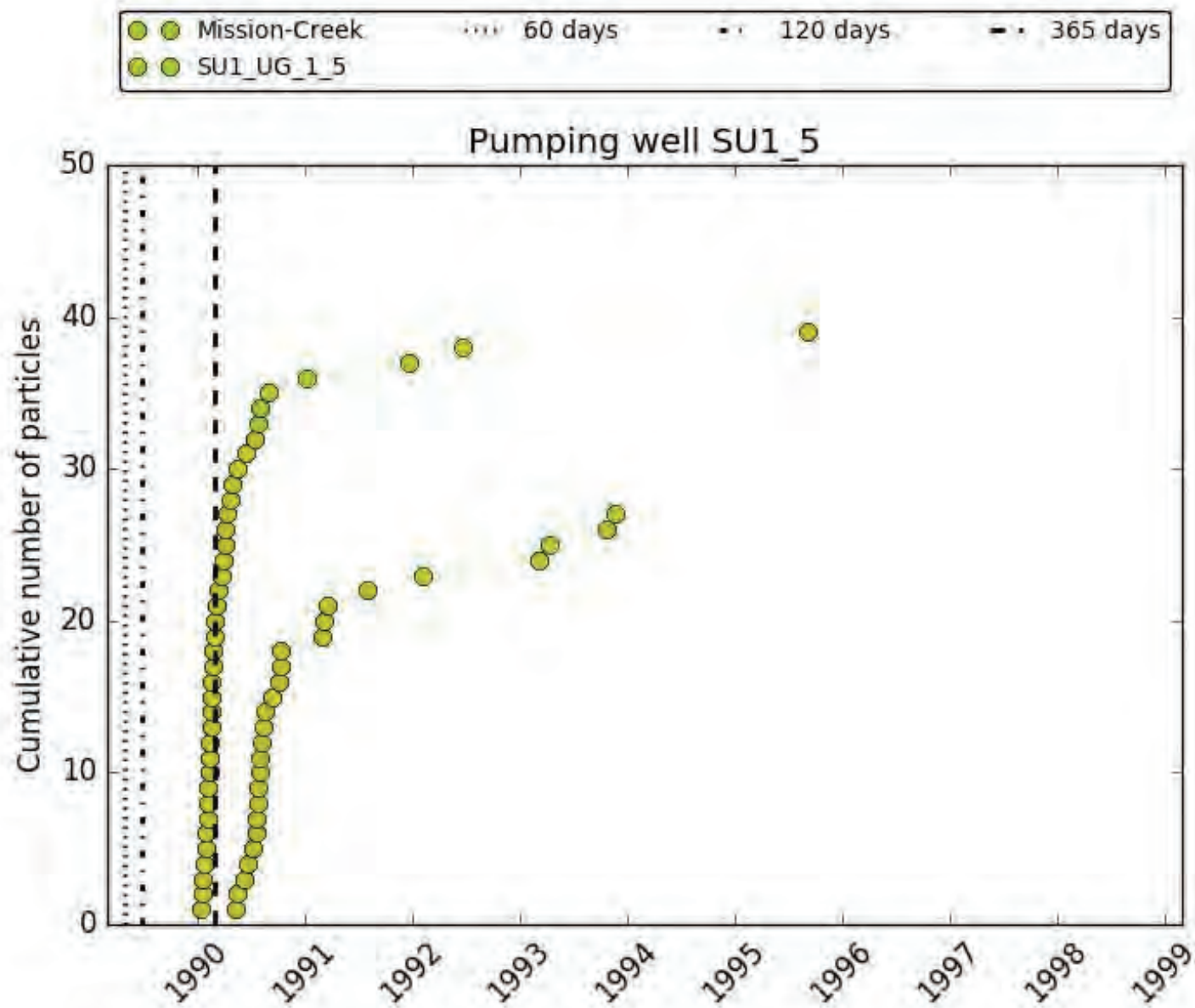


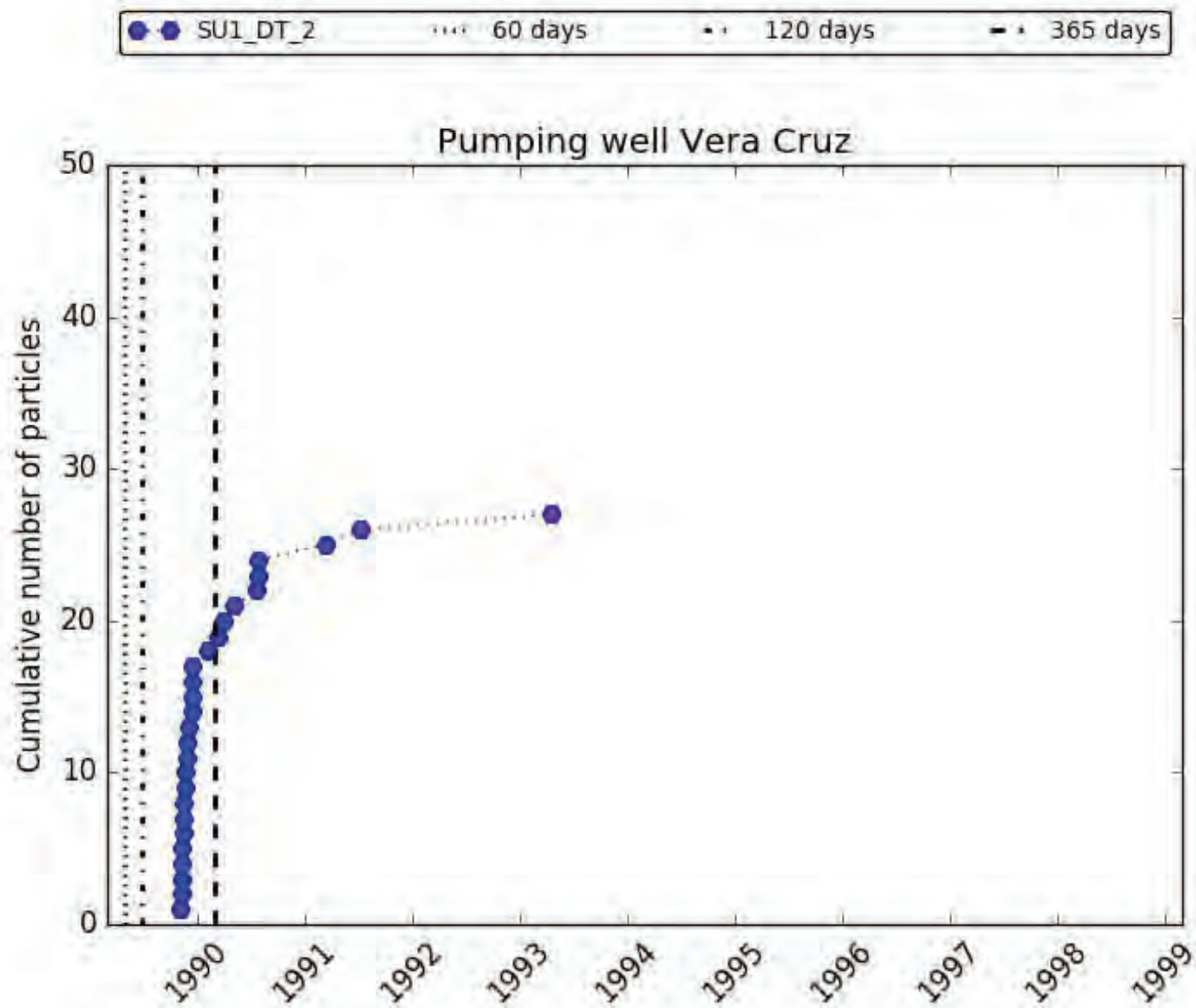




Pumping well SU1_4







Appendix E: Groundwater Pumping Rates from Specific Wells

The following tables show annual groundwater pumping rates for specific wells as simulated by the groundwater model.

Appendix E-1. Baseline Pumping Scenario (Alt 1A) – Annual Pumping Rates in Acre-Feet for Select City Owned Wells, Simulated by the Groundwater Model.

	Alameda	City Hall	Corp Yard 1	Hope Ave	Los Robles	San Roque1	SB High School	Vera Cruz
*1986	0.00	454.78	435.39	0.00	161.60	0.00	0.00	403.09
1987	0.00	174.64	154.69	0.00	249.56	0.00	0.00	59.75
1988	0.00	144.38	135.41	0.00	460.42	0.00	0.00	11.69
1989	0.00	483.16	430.44	0.00	458.85	0.00	0.00	510.31
1990	0.00	620.76	420.60	0.00	390.04	0.00	0.00	772.20
1991	2.19	3.08	11.34	55.98	163.27	4.59	0.00	6.12
1992	1.85	4.34	7.92	4.56	1.70	0.96	0.00	5.65
1993	2.81	12.31	173.31	5.99	4.02	0.00	0.00	5.72
1994	0.00	14.75	7.89	7.97	6.24	0.00	0.00	0.00
1995	0.00	3.53	3.58	1.80	0.00	0.00	0.00	0.00
1996	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	24.19	0.00	0.00	122.58	60.81	0.00	0.00	0.00
1999	133.26	0.00	0.00	125.15	61.40	0.00	0.00	0.00
2000	90.50	0.00	0.00	131.95	95.63	0.00	0.00	0.00
2001	0.00	0.00	0.00	7.37	0.00	0.00	0.00	0.00
2002	36.72	166.95	59.53	30.70	30.68	0.00	0.00	0.00
2003	53.39	125.67	65.67	20.00	20.76	0.00	0.00	0.00
**2004	2.00	3.48	3.70	1.55	3.77	0.00	0.00	0.00
Total	346.91	2,211.81	1,909.46	515.61	2,168.76	5.55	0.00	1,774.52

Notes: *1986 simulated only the months March-December **2004 simulated only the month of January

Appendix E-2. Increased Pumping Scenario (Alt 1B) – Annual Pumping Rates in Acre-Feet for Select City Owned Wells, Simulated by the Groundwater Model.

	Alameda	City Hall	Corp Yard 1	Hope Ave	Los Robles	San Roque1	SB High School	Vera Cruz
*1986	508.02	508.02	1,092.64	278.20	92.73	471.73	251.32	725.74
1987	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
1988	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
1989	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
1990	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
1991	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
1992	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
1993	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
1994	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
1995	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89

	<i>Alameda</i>	<i>City Hall</i>	<i>Corp Yard 1</i>	<i>Hope Ave</i>	<i>Los Robles</i>	<i>San Roque1</i>	<i>SB High School</i>	<i>Vera Cruz</i>
1996	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
1997	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
1998	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
1999	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
2000	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
2001	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
2002	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
2003	609.62	609.62	1,311.17	333.84	111.28	566.08	301.58	870.89
**2004	50.80	50.80	109.26	27.82	9.27	47.17	25.13	72.57
Total	10,922.37	10,922.37	23,491.76	5,981.30	1,993.77	10,142.20	5,403.39	15,603.38

Notes: *1986 simulated only the months March-December **2004 simulated only the month of January

Appendix E-3. Annual Pumping Rates in Acre-Feet for Proposed IPR Recovery Wells, Simulated by the Groundwater Model.

	SU1_1	SU1_3	SU1_4	SU1_5	FH_2	FH_3
*1986	311.97	516.24	427.33	503.70	752.74	1,020.46
1987	374.36	619.48	512.80	604.44	903.28	1,224.56
1988	374.36	619.48	512.80	604.44	903.28	1,224.56
1989	374.36	619.48	512.80	604.44	903.28	1,224.56
1990	374.36	619.48	512.80	604.44	903.28	1,224.56
1991	374.36	619.48	512.80	604.44	903.28	1,224.56
1992	374.36	619.48	512.80	604.44	903.28	1,224.56
1993	374.36	619.48	512.80	604.44	903.28	1,224.56
1994	374.36	619.48	512.80	604.44	903.28	1,224.56
1995	374.36	619.48	512.80	604.44	903.28	1,224.56
1996	374.36	619.48	512.80	604.44	903.28	1,224.56
1997	374.36	619.48	512.80	604.44	903.28	1,224.56
1998	374.36	619.48	512.80	604.44	903.28	1,224.56
1999	374.36	619.48	512.80	604.44	903.28	1,224.56
2000	374.36	619.48	512.80	604.44	903.28	1,224.56
2001	374.36	619.48	512.80	604.44	903.28	1,224.56
2002	374.36	619.48	512.80	604.44	903.28	1,224.56
2003	374.36	619.48	512.80	604.44	903.28	1,224.56
**2004	31.20	51.62	42.73	50.37	75.27	102.05
Total	6,707.29	11,099.10	9,187.65	10,829.49	16,183.83	21,939.97

Notes: *1986 simulated only the months March-December **2004 simulated only the month of January

Appendix E-4. Annual Pumping Rates in Acre-Feet for Non-City Owned Wells, Simulated by the Groundwater Model.

	Calvary Cemetery	El Sueno	LCMWC Well#9	LCMWC Well#16	Lincoln-wood 1	MacKenzie #1	MacKenzie #2	Pueblo Properties	San Roque Park #2	San Vincente 1	San Vincente 2	SB Savings	Sunset Mutual	Westpac Shelter
*1986	29.10	3.21	0.00	284.67	10.11	0.00	492.28	3.21	0.00	28.36	28.36	0.74	16.77	0.00
1987	34.92	3.85	0.00	331.30	12.13	0.00	587.25	3.85	0.00	34.03	34.03	0.89	20.12	0.00
1988	34.92	3.85	0.00	280.48	12.13	0.00	426.10	3.85	0.00	34.03	34.03	0.89	20.12	0.00
1989	34.92	3.85	0.00	248.37	12.13	0.00	224.36	3.85	0.00	34.03	34.03	0.89	20.12	0.00
1990	34.92	3.85	0.00	208.62	12.13	0.00	113.46	3.85	0.00	34.03	34.03	0.89	20.12	0.00
1991	34.92	3.85	0.00	173.31	12.13	0.00	80.42	3.85	0.00	34.03	34.03	0.89	20.12	0.00
1992	34.92	3.85	0.00	222.21	12.13	0.00	2.42	3.85	0.00	34.03	34.03	0.89	20.12	0.00
1993	0.00	0.00	0.00	177.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1994	0.00	0.00	0.00	355.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1995	0.00	0.00	0.00	362.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1996	0.00	0.00	0.00	334.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	0.00	0.00	0.00	328.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	0.00	0.00	0.00	384.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1999	0.00	0.00	0.00	346.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000	0.00	0.00	0.00	336.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2001	0.00	0.00	0.00	128.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2002	0.00	0.00	0.00	287.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2003	0.00	0.00	0.00	184.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
**2004	0.00	0.00	0.00	23.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	238.61	26.29	0.00	4,997.46	82.91	0.00	1,926.28	26.29	0.00	232.54	232.54	6.07	137.50	0.00

Notes: *1986 simulated only the months March-December **2004 simulated only the month of January

Appendix F: Contaminated Sites Located within 1 Mile of IPR Facilities

Appendix F-1. Open Contaminated Sites Affecting Groundwater Located within 1 Mile of IPR Facilities

GeoTracker ID	Site Name	COCs¹	Status	Status Date
SL0608309049	FESS PARKER WATERFRONT HOTEL	MTBE, Arsenic	Open - Remediation	1/24/2013
SL0608328911	SANTA BARBARA DISTRIBUTION BASE	Cyanide, PAHs	Open - Verification Monitoring	2/14/2001
SL0608336671	MCCORMIX CORPORATION	Diesel	Open - Site Assessment	10/1/2003
SL0608371607	FORMER PRINTING IMPRESSIONS	PCE, TCE	Open - Site Assessment	10/26/2015
SL0608378294	FIVE POINTS SHOPPING CENTER	PCE	Open - Verification Monitoring	6/26/2014
SL0608395538	FORMER SCHAUER PRINTING	PCE	Open - Verification Monitoring	4/1/2014
SL203061244	MISSION INDUSTRIES/AMBASSADOR LAUNDRY	PCE, TCE, Vinyl chloride	Open - Assessment & Interim Remedial Action	5/13/2009
SL203341272	Santa Barbara Manufactured Gas Plant	TPH, PAHs, BTEX	Open - Remediation	1/1/2003
SLT3S0241288	CARRILLO PLAZA (former Norvell-Bass Dry Cleaner)	PCE	Open - Verification Monitoring	4/25/2014
SLT3S0391292	Tecknit/ Tube Holding Company	TCE, PCE	Open - Remediation	4/1/1994
SLT3S0491297	GOLDBERG/GOSS-JEWETT	PCE	Open - Site Assessment	5/11/2009
SLT3S0511299	DUTCH MAID CLEANERS	PCE, MTBE / TBA / Other Fuel Oxygenates	Open - Assessment & Interim Remedial Action	5/11/2009
SLT3S2371349	SANTA BARBARA CITY PARKING LOT #12	PCE, TCE, TCA	Open - Verification Monitoring	6/17/2003
T0608300020	S.B. City Police Station	Gasoline	Open - Site Assessment	4/25/2013
T0608300026	Park's Texaco Market	Gasoline	Open - Remediation	2/17/1990
T0608300139	American Contracting Service	Gasoline	Open - Assessment & Interim Remedial Action	3/15/2013
T0608300183	Mobil Oil	Gasoline	Open - Verification Monitoring	12/26/1996
T0608300216	Ingram Paper	Gasoline	Open - Site Assessment	4/20/1989
T0608300489	Dougs Bougs	Gasoline	Open - Remediation	6/1/2007
T0608300587	Mobil Oil Station #11-KRA	Gasoline	Open - Verification Monitoring	4/10/2015
T0608300588	ExxonMobil Oil Corp ss#18-KFK	Gasoline, Waste Oil / Motor / Hydraulic / Lubricating	Open - Remediation	8/14/2013
T0608300624	Shell - Turnpike	Gasoline	Open - Remediation	9/21/2015

GeoTracker ID	Site Name	COCs¹	Status	Status Date
T0608300676	Canon Perdido Car Wash	MTBE / TBA / Other Fuel Oxygenates, Gasoline	Open - Remediation	3/31/2014
<i>T0608300695</i>	<i>Porter Auction Company</i>	<i>Gasoline</i>	<i>Open - Remediation</i>	<i>5/30/2015</i>
T0608300749	Seaside Shell - UST Spill	Gasoline	Open - Remediation	2/12/2012
T0608316772	Educated Car Wash	MTBE / TBA / Other Fuel Oxygenates, Gasoline	Open - Remediation	7/1/2013
T0608323816	Petre Industries	Gasoline, Stoddard solvent / Mineral Spirits / Distillates	Open - Site Assessment	12/17/2002
T0608348535	Gold's Gym	Gasoline	Open - Remediation	7/1/2013
<i>T0608368725</i>	<i>Former Chevron Station</i>	<i>MTBE / TBA / Other Fuel Oxygenates, Gasoline</i>	<i>Open - Site Assessment</i>	<i>3/1/2003</i>
T0608374511	FORMER UNOCAL #0957	Gasoline	Open - Site Assessment	12/2/2003
T0608374992	Pep Boys Store #623	Gasoline	Open - Site Assessment	5/11/2009
<i>T0608386520</i>	<i>MOBIL OIL #11-EP9</i>	<i>Gasoline</i>	<i>Open - Remediation</i>	<i>7/20/2015</i>
<i>T10000000578</i>	<i>Regal Dry Cleaners</i>	<i>PCE</i>	<i>Open - Assessment & Interim Remedial Action</i>	<i>5/13/2010</i>
T10000001599	In & Out Paint and Collision Center	PCE, TCE, Lead	Open - Remediation	3/4/2010
<i>T10000002779</i>	<i>Former Shell Station</i>	<i>Gasoline</i>	<i>Open - Assessment & Interim Remedial Action</i>	<i>5/1/2014</i>
T10000003790	Sri Padma LLC (formerly known as City Block and Phantom Cargo)	Other Solvent or Non-Petroleum Hydrocarbon	Open - Site Assessment	5/19/2012
T10000003938	PRIVATE RESIDENCE	Lead	Open - Site Assessment	5/26/2012
T10000005202	CHASE PALM PARK EXTENSION PROJECT	TPH, PCE, Lead, Arsenic	Open - Site Assessment	7/1/2015
T10000006235	Former Standard Oil Bulk Plant	TPH	Open - Site Assessment	9/19/2014

Notes: ¹ BTEX = benzene, toluene, ethylbenzene, and xylenes, MTBE = methyl tert-butyl ether, PAHs = polynuclear aromatic hydrocarbons, PCE = tetrachloroethylene, TBA = terbutylazine, TCA = 1,1,1-trichloroethane, TCE = trichloroethylene, TPH = total petroleum hydrocarbons

Bold and Italic indicates site located within 1,500 feet of Proposed IPR Well

Appendix F-2. Open Contaminated Sites Affecting Soil Located within 1 Mile of IPR Facilities

GeoTracker ID	Site Name	COCs¹	Status	Status Date
<i>SLT3S0381291</i>	<i>FENN, FORMER DRY CLEANERS</i>	<i>PCE</i>	<i>Open - Verification Monitoring</i>	<i>3/17/2004</i>
T10000005551	El Estero Turtle Pond (A.K.A. El Estero Drain)	Arsenic, Lead, Mercury, PAHs, TPH	Open - Remediation	1/8/2014
<i>T10000005625</i>	<i>City of Santa Barbara Former Parking Lot 6</i>	<i>Lead, TPH, pesticides, PAHs</i>	<i>Open - Site Assessment</i>	<i>2/11/2002</i>
T10000006176	TRANSITION HOUSE PROJECT	Arsenic, Lead, Other Metal	Open - Remediation	12/12/2010
T10000006182	BLACKSMITH SHOP	Lead, TPH	Open - Remediation	8/12/2015
T10000006225	HWY 101 EXPANSION PROJECT	Lead	Open - Site Assessment	3/1/2007
T10000006234	BOYS & GIRLS CLUB OF SANTA BARBARA	PAHs	Open - Remediation	1/1/2013
T10000006273	MTD FACILITY	Cyanide, TPH	Open - Verification Monitoring	3/16/2016
T10000006339	TPG Chapala Tanks	Gasoline	Open - Verification Monitoring	4/19/2016
T10000006599	411 Quarantina St, N - USTs	Gasoline, MTBE / TBA / Other Fuel Oxygenates, BTEX, TPH	Open - Site Assessment	3/26/2015
T10000007248	Miratti Trust Property	Gasoline, TPH	Open - Site Assessment	8/10/2015
T10000007909	Fire Training Facility	TPH	Open - Assessment & Interim Remedial Action	10/27/2015
T10000007943	City Desalination Plant	TPH	Open - Assessment & Interim Remedial Action	11/6/2015
T10000008825	Arlington Village	TPH	Open - Active	2/26/2016

Notes:

¹ BTEX = benzene, toluene, ethylbenzene, and xylenes, MTBE = methyl tert-butyl ether, PAHs = polynuclear aromatic hydrocarbons, PCE = tetrachloroethylene, TBA = terbutylazine, TPH = total petroleum hydrocarbons

Bold and Italic indicates site located within 1,500 feet of Proposed IPR Injection Well

APPENDIX D – CONCEPTUAL DESIGNS

Table 1 Process Flow Rates - DPR Facility Alt 1a Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Direct Potable Reuse Capacities
<u>Source and Finished Water Flows</u>		
City Secondary Effluent	AFY	8,660
City Secondary Effluent	gpm (mgd)	5,369 (7.7)
<u>Process Flows: AWTF/NPR</u>		
Microfiltration		
Recovery	%	94%
Permeate Flow	gpm (mgd)	5,369 (7.7)
Feedwater Flow ¹	gpm (mgd)	5,712 (8.2)
Backwash Flow	gpm (mgd)	343 (0.5)
Pre RO UV System		
Process Flow	gpm (mgd)	5,369 (7.7)
<u>Process Flows: East NPR</u>		
Flow to East NPR System ²	gpm (mgd)	444 (0.6)
<u>Process Flows: AWTF</u>		
Reverse Osmosis		
Recovery	%	80%
Permeate Flow	gpm (mgd)	3,940 (5.7)
Feedwater Flow	gpm (mgd)	4,925 (7.1)
Brine Flow	gpm (mgd)	985 (1.4)
UV / AOP		
Process Flow	gpm (mgd)	3,940 (5.7)
<u>Total Finished Water Flows</u>		
Total NPR Flow	gpm (mgd)	444 (0.6)
Total DPR Flow	gpm (mgd)	3,940 (5.7)
Total Usable Flow	gpm (mgd)	4,384 (6.3)
Total NPR Flow	AFY	716
Total DPR Flow	AFY	6,355
Total Usable Flow	AFY	7,071
Recovery of WWTP Effluent	%	82%
Notes: 1) MF backwash is recycled to head of WWTP. Instantaneous flow is higher than permeate flow. 2) After MF and UV, flow is diverted to satisfy East NPR demand.		

Table 2 DPR - Microfiltration Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>MICROFILTRATION FEED PUMPS</u>		
Number of Pumps		
In-Service	No.	4
Reliability	No.	1
Total	No.	5
Type: Vertical Turbine		
Capacity		
Total	gpm	5,712
Per Pump	gpm	1,428
Total Dynamic Head Required (TDH)		
Water Surface El to Pump Discharge	ft	10
Minimum Discharge Pressure	psi	20
Maximum Discharge Pressure	psi	45
Safety Factor	ft	20
Design Pump TDH	feet	134
Motor Size		
Required	hp	63
Selected	hp	100
Drive	type	VFD
<u>MICROFILTRATION BACKWASH PUMPS</u>		
Number of Pumps		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Type: Vertical Turbine		
Capacity (per pump)		
Design (1.1*Flux Rate)	gpm	984
Maximum (1.5*Flux Rate)	gpm	1,582
Total Dynamic Head Required (TDH)		
Water Surface El to Pump Discharge	ft	10
Minimum Discharge Pressure	psi	10
Maximum Discharge Pressure	psi	30
Safety Factor	ft	20
Design Pump TDH	feet	103
Motor Size		
Required	hp	53
Selected	hp	60
Drive	type	VFD

Table 2 DPR - Microfiltration Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>INFLUENT WET WELL</u>		
Number of Wet Wells	No.	1
Wet Well Dimensions (each)		
Depth	ft	15
Length	ft	62
Width	ft	18
Volume	ft ³	16,740
Volume	gallons	125,215
Storage Time		
Design Flow	Minutes	22

Table 3 DPR - Strainer / Pre-Screen Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Filter (Strainer-type) w/ Automatic Cleaning Mechanism		
Materials: Stainless Steel		
Filter Rating	micron	250
Maximum Pressure Drop		
Clean Filter ⁽¹⁾	psi	3
Before Backwash ⁽²⁾	psi	7
Number of Filters		
In-Service	No.	2
Reliability	No.	1
Total	No.	3
Capacity (Total)	gpm	5,712
Capacity (per Screen)	gpm	2,856
Filter Media Type:	-	Wedgewire
Filter Material:	-	316 SST
Maximum Backwash Flowrate	gpm	310
Backwash Duration	min	1
Total Backwash Waste	gal	310
Housing Design Pressure	psi	150
Motor Size		
Selected	hp	0.33
Drive	type	CS

Table 4 DPR - Microfiltration Train Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara				
Description		Units	Criteria	
General Criteria				
Type: Pressurized, Polymeric hollow fiber Microfiltration or Ultrafiltration ¹				
Operating Strategy: Dead end flow				
Number of Microfiltration Trains				
In-Service	No.		6	
Reliability	No.		1	
Total	No.		7	
Production Criteria				
Train Flux Rate				
Flux at Design Capacity (Net Production)	gfd		30	
Flux at Design Capacity (Instantaneous)	gfd		35	
Train Recovery Rate (Permeate/Feed Flow)				
Minimum	percent		94%	
Train Permeate Flow Rate				
Total	gpm (mgd)	5,369		(7.7)
Design	gpm (mgd)	895		(1.3)
Train Configuration				
Type: Open Platform (Non-proprietary)				
Membrane Manufacturer (No. 1)			Toray	
Module Model Number			2020N	
Membrane Area per Module			775	
Number of Installed Modules per Train	No.		56	
Number of Blank Modules per Train	No.		8	
Number of Total Module Spaces per Train	No.		64	
Backwash Criteria				
Type: Reverse Flow Followed by Simultaneous Air Scour and Drain				
Backwash Interval per Train				
Minimum	minutes		20	
Maximum	minutes		30	
Backwash Supply Flow Rate (Water)				
Flux	gfd		46	
Flow	gpm		1,582	
Backwash Duration	sec		45	
Backwash Supply Flow Rate (Air)	scfm		448	
Volume of Wastewater Produced				
Per Backwash	gallons		1,187	

Table 4 DPR - Microfiltration Train Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>Maintenance Clean Criteria (Typically only hypo clean)</u>		
Maintenance Clean Frequency	days	1
Sodium Hypochlorite Dose	mg/L	300
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Day	gallons	17,500
<u>Clean-in-Place (CIP) Criteria</u>		
CIP Frequency	days	30
Sodium Hypochlorite Dose	mg/L	3,000
Citric Acid Dose	mg/L	5,000
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Month	gallons	17,500
<u>Chemical Neutralization Criteria</u>		
Sodium Bisulfite Dose MC ²	mg/L	450
Sodium Bisulfite Dose CIP ²	mg/L	4,500
Sodium Hydroxide CIP	mg/L	5,000
Notes: 1) Membrane must demonstrate a minimum of 1 log virus removal. 2) Calculated as 1.5 times the sodium hypochlorite dose. Stoichiometric demand is 1.34 mg sodium bisulfite per 1 mg of sodium hypochlorite.		

Table 5 DPR - Microfiltration Backwash Air Scour Blowers Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Rotary Lobe		
Number of Blowers		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Discharge Pressure	psi	13
Air Flow Rate	scfm	
Design	scfm	392
Maximum	scfm	448
Motor Size		
Required	hp	32
Selected	hp	50
Drive	type	VFD

Table 6 DPR - Ultraviolet Disinfection Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Process Type: Low Pressure High Output Ultraviolet Light Reactor		
Manufacturer(s): Wedeco		
Model(s): spektron 4000e w/ 600 watt lamps		
Number of UV Reactors		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Flows		
Total Flow to Reactors	gpm (mgd)	5,369 (7.7)
Flow to Each Reactor	gpm (mgd)	5,369 (7.7)
UV Transmittance (UVT)	percent	90
UV Dose ⁽¹⁾	mJ/cm ²	110
Note:		
1) Dose required to achieve 4-log virus and 4-log protozoa inactivation.		

Table 7 DPR - RO Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>RO HIGH PRESSURE FEED PUMPS</u>		
Number of Pumps		
In-Service	No.	4
Reliability	No.	0
Total	No.	4
Type: Vertical Turbine		
Capacity		
Total	gpm	4,925
Per Pump	gpm	1,231
Total Dynamic Head Required (TDH)		
Average Discharge Pressure	psi	120
Average Pump TDH	feet	297
Maximum Discharge Pressure	psi	145
Maximum Pump TDH	feet	355
Motor Size		
Average operating	hp	116
Required (based on maximum discharge pressure)	hp	138
Selected	hp	150
Drive	type	VFD
<u>WET WELL</u>		
Number of Wet Wells	No.	1
Wet Well Dimensions (each)		
Depth	ft	10
Length	ft	80
Width	ft	15
Volume	ft ³	12,000
Volume	gallons	89,766
Storage Time		
Design Flow	Minutes	18

Table 8 DPR - Reverse Osmosis Trains Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria	
Number of Reverse Osmosis Trains			
In-Service	No.	4	
Reliability	No.	0	
Total	No.	4	
Train Flux Rate ⁽¹⁾	gfd	11	
Recovery (Permeate/Feed Flow)	percent	80%	
Total Permeate Flow	gpm (mgd)	3,940	(7.1)
Total Permeate Flow per Train	gpm (mgd)	985	(1.4)
Brine Flow per Train	gpm (mgd)	246	(0.35)
Number of Array Stages Per Train	No.	2	
1st Stage			
Pressure Vessels per Train	No.	31	
Elements per Pressure Vessel	No.	7	
2nd Stage			
Pressure Vessels per Train	No.	16	
Elements per Pressure Vessel	No.	7	
Number of Elements			
Per Train	No.	329	
Total (In-Service)	No.	1,316	
Membrane Manufacturer(s) ⁽²⁾		Dow FilmTec, Hydranautics, or Toray	
	-		
Membrane Model No. ⁽²⁾		BW30-400/34i, ESPA2-LD, or TML20D-400	
	-		
Membrane Area ⁽²⁾			
Per Element	sq. ft.	400	
Per Train	sq. ft.	131,600	
Total (In-service)	sq. ft.	526,400	

Table 9 DPR - RO Interstage Booster Pump Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Turbine assisted motorized booster pump		
Manufacturer: FEDCO		
Model: LP-HEMI, LPH-240-125T		
LP-HEMI Units Per RO Train	No.	1
Total Number of Units	No.	4
<u>Pump Data</u>		
Stages	No.	1
Flow		
At 80 Percent RO Recovery	gpm	568
Minimum Total Dynamic Head ⁽¹⁾	ft	70
Maximum Total Dynamic Head ⁽²⁾	ft	120
Shaft Power		
Minimum Required	hp	13
Maximum Required	hp	22
<u>Motor Data</u>		
Drive	type	VFD
Position: Vertical		
Power Rating	hp	25
Notes: 1) Clean-membrane (start-up) conditions. 2) Fouled membrane (end of life), worst water quality conditions.		

Table 10 DPR - UV Disinfection / AOP Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
Process Type: Low Pressure High Output Ultraviolet Light Reactor w/ NaOCl AOP		
Manufacturer(s): Wedeco		
Model(s): k143 w/ 600 watt lamps		
Number of UV Reactors		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Flows		
Total Flow to Reactors	gpm (mgd)	3,940 (5.7)
Flow to Each Reactor	gpm (mgd)	3,940 (5.7)
UV Transmittance (UVT)	percent	95
UV Dose ⁽¹⁾	mJ/cm ²	920
NaOCl Dose	mg/L	4
Note:		
1) Dose required to achieve 6-log virus and 6-log protozoa inactivation using hypochlorite for the AOP process.		

Table 11 Direct Potable Reuse Train - Storage and Equalization Tanks Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
<u>ENGINEERED STORAGE TANKS</u>		
Product Flow	gpm	3,940
Number of Tanks	No.	2
Tank Dimensions		
Diameter	ft	70
Height	ft	35
Volume (each)	ft ³	134,696
Volume (each)	gallons	1,007,524
Volume (actual)	gallons	1,000,000
Volume (total)	gallons	2,000,000
Storage Time (w/ one tank out of service)		
Design Flow	Minutes	254
Design Flow	Hours	4
Storage Time (total)		
Design Flow	Minutes	508
Design Flow	Hours	8
Description	Units	Criteria
<u>EQUALIZATION TANKS</u>		
Product Flow	gpm	5,369
Number of Tanks	No.	2
Tank Dimensions		
Diameter	ft	82
Height	ft	35
Volume (each)	ft ³	184,836
Volume (each)	gallons	1,382,570
Volume (actual)	gallons	1,500,000
Volume (total)	gallons	3,000,000
Storage Time (each)		
Design Flow	Minutes	279
Design Flow	Hours	5
Storage Time (total)		
Design Flow	Minutes	559
Design Flow	Hours	9

Table 12 Direct Potable Reuse Train - Finished Water Pump Station Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
<u>FINISHED WATER PUMPS TO GOLF COURSE PS</u>		
Number of Pumps		
In-Service	No.	3
Reliability	No.	1
Total	No.	4
Type: Vertical Turbine		
Capacity		
Total	gpm	3,940
Per Pump	gpm	1,313
Total Dynamic Head Required (TDH)		
Head required to reach reservoir	feet	573
Average Pump TDH	feet	593
Maximum Pump TDH	feet	623
Motor Size		
Average operating	hp	246
Required (based on maximum discharge pressure)	hp	258
Selected	hp	275
Drive	type	VFD
<u>GOLF COURSE PS TO LAURO CANYON RESERVOIR</u>		
Number of Pumps		
In-Service	No.	3
Reliability	No.	1
Total	No.	4
Type: Vertical Turbine		
Capacity		
Total	gpm	3,940
Per Pump	gpm	1,313
Total Dynamic Head Required (TDH)		
Head required to reach reservoir	feet	346
Average Pump TDH	feet	366
Maximum Pump TDH	feet	396
Motor Size		
Average operating	hp	152
Required (based on maximum discharge pressure)	hp	164
Selected	hp	175
Drive	type	VFD

Table 13 Sodium Hypochlorite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Sodium Hypochlorite Characteristics

Concentration:	10.5 %	
Specific Gravity:	1.008	
Solution Strength:	0.88	lb/gal

Parameters	Units	Criteria
<u>Ultraviolet Light / Advanced Oxidation Process</u>		
Chemical Usage		
Location: RO Permeate Before UV Reactors		
Process Flow	MGD	5.7
Chemical Dose	mg/L	4.0
Chemical Usage	lb/day	189
Chemical Feed Rate	gpd	215
Chemical Feed Rate	gph	9.0
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	9.0
<u>MF/UF Maintenance Cleans (MC)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	300
Chemical Usage	lb/day	43.8
Chemical Feed Rate	gpd	49.7
<u>MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	3,000
Chemical Usage	lb/month	438.1
Chemical Feed Rate	gpm	497.2
Chemical Feed Rate	gpd	16.6

Table 13 Sodium Hypochlorite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Parameters	Units	Criteria
<u>Bulk Storage Tanks</u>		
Number of Tanks	No.	2
Tank Capacity, each	gal	4,000
Tank Capacity, total	gal	8,000
UV/AOP Usage	gal/day	215
MF/UF Maintenance Clean	gal/day	49.7
MF/UF CIP	gal/day	16.6
Total Usage	gal/day	281
Storage Time	days	28
Delivery Truck Full Load	gal	3,000
Time Between Delivery	days	11

Table 14 Sulfuric Acid Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Sulfuric Acid Characteristics		
Concentration:	93 %	
Specific Gravity:	1.83	
Solution Strength:	14.17	lb/gal
Parameters	Units	Criteria
<u>DPR RO Pretreatment</u>		
Chemical Usage		
Location: Reverse Osmosis Feed		
Process Flow	MGD	7.1
Chemical Dose	mg/L	115
Chemical Usage	lb/day	6,806
Chemical Feed Rate	gpd	480
Chemical Feed Rate	gph	20.0
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	20.0
<u>Bulk Storage Tanks</u>		
Number of Tanks	No.	2
Tank Capacity, each	gal	8,000
Tank Capacity, total	gal	16,000
Total Usage	gal/day	480
Storage Time	days	33
Delivery Truck Full Load	gal	3,000
Time Between Delivery	days	6

Table 15 Lime Slurry Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Lime Characteristics		
Lime Purity	%	97%
Dry Lime Bulk Density (Storage Value)	lb/cu ft	30
Concentration:	%	35%
Specific Gravity:		1.271
Solution Strength:	lb/gal	3.70
Parameters	Units	Criteria
<u>DPR Post Treatment</u>		
Chemical Usage		
Location: Before Treated Water Wet Well		
Process Flow	MGD	5.7
Chemical Dose	mg/L	25
Chemical Dose (as stored weight)	mg/L	26
Chemical Usage	lb/day	1,220
Chemical Feed Rate	gpd	329
Chemical Feed Rate	gph	13.7
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	13.7
<u>Lime Storage Silos</u>		
Number of Silos	No.	1
Silo Capacity, each	cu ft	2,500
Silo Capacity, each	lbs	75,000
Silo Capacity, total	Tons	37.5
Silo Diameter, each	ft	13
Silo Sideshell Height, each	ft	19
Dry Usage	lbs/day	1,220
Dry Usage	tons/day	0.6
Storage Time	days	61
Delivery Truck Full Load	tons	24
Time Between Delivery	days	39

Table 16 Scale Inhibitor Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Scale Inhibitor Characteristics

Manufacturer/Product: Avista Vitec 3000
Concentration: 100 %
Specific Gravity: 1.2
Solution Strength: 9.99 lb/gal

Parameters	Units	Criteria
<u>DPR - RO Pretreatment</u>		
Chemical Usage		
Location: Reverse Osmosis Feed		
Process Flow	MGD	7.1
Chemical Dose	mg/L	4.0
Chemical Usage	lb/day	237
Chemical Feed Rate	gpd	24
Chemical Feed Rate	gph	1.0
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	1.0
Chemical Feed Rate Per Pump	gpm	0.02
<u>Bulk Storage Totes</u>		
Number of Totes	No.	4
Tote Capacity, each	gal	250
Tote Capacity, total	gal	1,000
DPR RO Pretreatment	gal/day	24
Total Usage	gal/day	24
Storage Time	days	42
Delivery Truck Full Load	gal	250
Time Between Delivery	days	11

Table 17 Citric Acid Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Citric Acid Characteristics		
Concentration:	50 %	
Specific Gravity:	1.15	
Solution Strength:	4.79	lb/gal
Parameters	Units	Criteria
<u>MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	730.2
Chemical Feed Rate	gpm	152.5
Chemical Feed Rate	gpd	5.1
<u>Bulk Storage Totes</u>		
Number of Totes	No.	2
Tote Capacity, each	gal	250
Tote Capacity, total	gal	500
MF/UF CIP	gal/month	152.5
Total Usage	gal/month	152.5
Storage Time	days	98
Delivery Truck Full Load	gal	250
Time Between Delivery	days	49

Table 18 Caustic Soda Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Caustic Soda Characteristics

Concentration:	50 %	
Specific Gravity:	1.53	
Solution Strength:	6.37	lb/gal

Parameters	Units	Criteria
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MF/UF Clean-in-Place (CIP)
(neutralize CA)

Chemical Usage

Location: MF/UF CIP Tank

Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	730.2
Chemical Feed Rate	gpm	114.6
Chemical Feed Rate	gpd	3.8

Bulk Storage Tote

Number of Totes	No.	2
Tote Capacity, each	gal	250
Tote Capacity, total	gal	500

MF/UF CIP	gal/month	114.6
Total Usage	gal/month	114.6
Storage Time	days	131
Delivery Truck Full Load	gal	250
Time Between Delivery	days	65

Table 19 Sodium Bisulfite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Sodium Bisulfite Characteristics		
Concentration:	38 %	
Specific Gravity:	1.3	
Solution Strength:	4.11	lb/gal
Parameters	Units	Criteria
<u>MF/UF Maintenance Cleans (MC)</u>		
Location: MF/UF CIP Tank		
Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	441
Chemical Usage	lb/day	64.4
Chemical Feed Rate	gpd	15.7
<u>MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	4,500
Chemical Usage	lb/month	657.2
Chemical Feed Rate	gpm	159.8
Chemical Feed Rate	gpd	5.3
<u>Bulk Storage Totes</u>		
Number of Totes	No.	4
Tote Capacity, each	gal	250
Tote Capacity, total	gal	1,000
MF/UF Maintenance Clean	gal/day	15.7
MF/UF CIP	gal/day	5.3
Total Usage	gal/day	21
Storage Time	days	48
Delivery Truck Full Load	gal	250
Time Between Delivery	days	12

Table 1 Process Flow Rates - DPR Facility Alt 1b Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara			
Description	Units	Direct Potable Reuse Capacities	
<u>Source and Finished Water Flows</u>			
City Secondary Effluent	AFY	8,660	
City Secondary Effluent	gpm (mgd)	5,369	(7.7)
<u>Process Flows: AWTF</u>			
Microfiltration			
Recovery	%	94%	
Permeate Flow	gpm (mgd)	5,369	(7.7)
Feedwater Flow ¹	gpm (mgd)	5,712	(8.2)
Backwash Flow	gpm (mgd)	343	(0.5)
Pre RO UV System			
Process Flow	gpm (mgd)	5,369	(7.7)
Reverse Osmosis			
Recovery	%	80%	
Permeate Flow	gpm (mgd)	4,295	(6.2)
Feedwater Flow	gpm (mgd)	5,369	(7.7)
Brine Flow	gpm (mgd)	1,074	(1.5)
UV / AOP			
Process Flow	gpm (mgd)	4,295	(6.2)
<u>Total Finished Water Flows</u>			
Total NPR Flow	gpm (mgd)	0	(0.0)
Total DPR Flow	gpm (mgd)	4,295	(6.2)
Total Usable Flow	gpm (mgd)	4,295	(6.2)
Total NPR Flow	AFY	0	
Total DPR Flow	AFY	6,928	
Total Usable Flow	AFY	6,928	
Recovery of WWTP Effluent	%	80%	
Note:			
1) MF backwash is recycled to head of WWTP. Instantaneous flow is higher than permeate flow.			

Table 2 DPR - Microfiltration Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>MICROFILTRATION FEED PUMPS</u>		
Number of Pumps		
In-Service	No.	4
Reliability	No.	1
Total	No.	5
Type: Vertical Turbine		
Capacity		
Total	gpm	5,712
Per Pump	gpm	1,428
Total Dynamic Head Required (TDH)		
Water Surface El to Pump Discharge	ft	10
Minimum Discharge Pressure	psi	20
Maximum Discharge Pressure	psi	45
Safety Factor	ft	20
Design Pump TDH	feet	134
Motor Size		
Required	hp	63
Selected	hp	100
Drive	type	VFD
<u>MICROFILTRATION BACKWASH PUMPS</u>		
Number of Pumps		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Type: Vertical Turbine		
Capacity (per pump)		
Design (1.1*Flux Rate)	gpm	984
Maximum (1.5*Flux Rate)	gpm	1,582
Total Dynamic Head Required (TDH)		
Water Surface El to Pump Discharge	ft	10
Minimum Discharge Pressure	psi	10
Maximum Discharge Pressure	psi	30
Safety Factor	ft	20
Design Pump TDH	feet	103
Motor Size		
Required	hp	53
Selected	hp	60
Drive	type	VFD

Table 2 DPR - Microfiltration Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>INFLUENT WET WELL</u>		
Number of Wet Wells	No.	1
Wet Well Dimensions (each)		
Depth	ft	15
Length	ft	62
Width	ft	18
Volume	ft ³	16,740
Volume	gallons	125,215
Storage Time		
Design Flow	Minutes	22

Table 3 DPR - Strainer / Pre-Screen Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Filter (Strainer-type) w/ Automatic Cleaning Mechanism		
Materials: Stainless Steel		
Filter Rating	micron	250
Maximum Pressure Drop		
Clean Filter ⁽¹⁾	psi	3
Before Backwash ⁽²⁾	psi	7
Number of Filters		
In-Service	No.	2
Reliability	No.	1
Total	No.	3
Capacity (Total)	gpm	5,712
Capacity (per Screen)	gpm	2,856
Filter Media Type:	-	Wedgewire
Filter Material:	-	316 SST
Maximum Backwash Flowrate	gpm	310
Backwash Duration	min	1
Total Backwash Waste	gal	310
Housing Design Pressure	psi	150
Motor Size		
Selected	hp	0.33
Drive	type	CS

Table 4 DPR - Microfiltration Train Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria	
<u>General Criteria</u>			
Type: Pressurized, Polymeric hollow fiber			
Microfiltration or Ultrafiltration			
Operating Strategy: Dead end flow			
Number of Microfiltration Trains			
In-Service	No.	6	
Reliability	No.	1	
Total	No.	7	
<u>Production Criteria</u>			
Train Flux Rate			
Flux at Design Capacity (Net Production)	gfd	30	
Flux at Design Capacity (Instantaneous)	gfd	35	
Train Recovery Rate (Permeate/Feed Flow)			
Minimum	percent	94%	
Train Permeate Flow Rate			
Total	gpm (mgd)	5,369	(7.7)
Design	gpm (mgd)	895	(1.3)
<u>Train Configuration</u>			
Type: Open Platform (Non-proprietary)			
Membrane Manufacturer (No. 1)		Toray	
Module Model Number		2020N	
Membrane Area per Module		775	
Number of Installed Modules per Train	No.	56	
Number of Blank Modules per Train	No.	8	
Number of Total Module Spaces per Train	No.	64	
<u>Backwash Criteria</u>			
Type: Reverse Flow Followed by Simultaneous Air Scour and Drain			
Backwash Interval per Train			
Minimum	minutes	20	
Maximum	minutes	30	
Backwash Supply Flow Rate (Water)			
Flux	gfd	46	
Flow	gpm	1,582	
Backwash Duration	sec	45	
Backwash Supply Flow Rate (Air)	scfm	448	
Volume of Wastewater Produced			
Per Backwash	gallons	1,187	

Table 4 DPR - Microfiltration Train Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
<u>Maintenance Clean Criteria (Typically only hypo clean)</u>		
Maintenance Clean Frequency	days	1
Sodium Hypochlorite Dose	mg/L	300
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Day	gallons	17,500
<u>Clean-in-Place (CIP) Criteria</u>		
CIP Frequency	days	30
Sodium Hypochlorite Dose	mg/L	3,000
Citric Acid Dose	mg/L	5,000
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Month	gallons	17,500
<u>Chemical Neutralization Criteria</u>		
Sodium Bisulfite Dose MC ¹	mg/L	450
Sodium Bisulfite Dose CIP ¹	mg/L	4500
Sodium Hydroxide CIP	mg/L	5,000
Note:		
1) Calculated as 1.5 times the sodium hypochlorite dose. Stoichiometric demand is 1.34 mg sodium bisulfite per 1 mg of sodium hypochlorite.		

Table 5 DPR - Microfiltration Backwash Air Scour Blowers Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Rotary Lobe		
Number of Blowers		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Discharge Pressure	psi	13
Air Flow Rate	scfm	
Design	scfm	392
Maximum	scfm	448
Motor Size		
Required	hp	32
Selected	hp	50
Drive	type	VFD

Table 6 DPR - Ultraviolet Disinfection Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Process Type: Low Pressure High Output Ultraviolet Light Reactor		
Manufacturer(s): Wedeco		
Model(s): spektron 4000e w/ 600 watt lamps		
Number of UV Reactors		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Flows		
Total Flow to Reactors	gpm (mgd)	5,369 (7.7)
Flow to Each Reactor	gpm (mgd)	5,369 (7.7)
UV Transmittance (UVT)	percent	90
UV Dose ⁽¹⁾	mJ/cm ²	110
Note: 1) Dose required to achieve 4-log virus and 4-log protozoa inactivation.		

Table 7 DPR - RO Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara			
Description		Units	Criteria
<u>RO HIGH PRESSURE FEED PUMPS</u>			
Number of Pumps			
In-Service	No.		4
Reliability	No.		0
Total	No.		4
Type: Vertical Turbine			
Capacity			
Total	gpm		5,369
Per Pump	gpm		1,342
Total Dynamic Head Required (TDH)			
Average Discharge Pressure	psi		120
Average Pump TDH	feet		297
Maximum Discharge Pressure	psi		145
Maximum Pump TDH	feet		355
Motor Size			
Average operating	hp		126
Required (based on maximum discharge pressure)	hp		150
Selected	hp		175
Drive	type		VFD
<u>WET WELL</u>			
Number of Wet Wells	No.		1
Wet Well Dimensions (each)			
Depth	ft		10
Length	ft		80
Width	ft		15
Volume	ft ³		12,000
Volume	gallons		89,766
Storage Time			
Design Flow	Minutes		17

Table 8 DPR - Reverse Osmosis Trains Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
Number of Reverse Osmosis Trains		
In-Service	No.	4
Reliability	No.	0
Total	No.	4
Train Flux Rate ⁽¹⁾	gfd	11
Recovery (Permeate/Feed Flow)	percent	80%
Total Permeate Flow	gpm (mgd)	4,295 (7.7)
Total Permeate Flow per Train	gpm (mgd)	1,074 (1.5)
Brine Flow per Train	gpm (mgd)	268 (0.39)
Number of Array Stages Per Train	No.	2
1st Stage		
Pressure Vessels per Train	No.	34
Elements per Pressure Vessel	No.	7
2nd Stage		
Pressure Vessels per Train	No.	17
Elements per Pressure Vessel	No.	7
Number of Elements		
Per Train	No.	357
Total (In-Service)	No.	1,428
Membrane Manufacturer(s) ⁽²⁾		Dow FilmTec, Hydranautics, or Toray
Membrane Model No. ⁽²⁾		BW30-400/34i, ESPA2-LD, or TML20D-400
Membrane Area ⁽²⁾		
Per Element	sq. ft.	400
Per Train	sq. ft.	142,800
Total (In-service)	sq. ft.	571,200

Table 9 DPR - RO Interstage Booster Pump Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Turbine assisted motorized booster pump		
Manufacturer: FEDCO		
Model: LP-HEMI, LPH-240-125T		
LP-HEMI Units Per RO Train	No.	1
Total Number of Units	No.	4
<u>Pump Data</u>		
Stages	No.	1
Flow		
At 80 Percent RO Recovery	gpm	615
Minimum Total Dynamic Head ⁽¹⁾	ft	70
Maximum Total Dynamic Head ⁽²⁾	ft	120
Shaft Power		
Minimum Required	hp	14
Maximum Required	hp	24
<u>Motor Data</u>		
Drive	type	VFD
Position: Vertical		
Power Rating	hp	30
Notes:		
1) Clean-membrane (start-up) conditions.		
2) Fouled membrane (end of life), worst water quality conditions.		

Table 10 DPR - UV Disinfection / AOP Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
Process Type: Low Pressure High Output Ultraviolet Light Reactor w/ NaOCl AOP		
Manufacturer(s): Wedeco		
Model(s): k143 w/ 600 watt lamps		
Number of UV Reactors		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Flows		
Total Flow to Reactors	gpm (mgd)	4,295 (6.2)
Flow to Each Reactor	gpm (mgd)	4,295 (6.2)
UV Transmittance (UVT)	percent	95
UV Dose ⁽¹⁾	mJ/cm ²	920
NaOCl Dose	mg/L	4
Note:		
1) Dose required to achieve 6-log virus and 6-log protozoa inactivation using hypochlorite for the AOP process.		

Table 11 Direct Potable Reuse Train - Storage and Equalization Tanks Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>ENGINEERED STORAGE TANKS</u>		
Product Flow	gpm	4,295
Number of Tanks	No.	2
Tank Dimensions		
Diameter	ft	70
Height	ft	35
Volume (each)	ft ³	134,696
Volume (each)	gallons	1,007,524
Volume (actual)	gallons	1,000,000
Volume (total)	gallons	2,000,000
Storage Time (w/ one tank out of service)		
Design Flow	Minutes	233
Design Flow	Hours	4
Storage Time (total)		
Design Flow	Minutes	466
Design Flow	Hours	8
Description	Units	Criteria
<u>EQUALIZATION TANKS</u>		
Product Flow	gpm	5,369
Number of Tanks	No.	2
Tank Dimensions		
Diameter	ft	82
Height	ft	35
Volume (each)	ft ³	184,836
Volume (each)	gallons	1,382,570
Volume (actual)	gallons	1,500,000
Volume (total)	gallons	3,000,000
Storage Time (each)		
Design Flow	Minutes	279
Design Flow	Hours	5
Storage Time (total)		
Design Flow	Minutes	559
Design Flow	Hours	9

Table 12 Direct Potable Reuse Train - Finished Water Pump Station Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>FINISHED WATER PUMPS TO GOLF COURSE PS</u>		
Number of Pumps		
In-Service	No.	3
Reliability	No.	1
Total	No.	4
Type: Vertical Turbine		
Capacity		
Total	gpm	4,295
Per Pump	gpm	1,432
Total Dynamic Head Required (TDH)		
Head required to reach reservoir	feet	573
Average Pump TDH	feet	593
Maximum Pump TDH	feet	623
Motor Size		
Average operating	hp	268
Required (based on maximum discharge pressure)	hp	282
Selected	hp	300
Drive	type	VFD
<u>GOLF COURSE PS TO LAURO CANYON RESERVOIR</u>		
Number of Pumps		
In-Service	No.	3
Reliability	No.	1
Total	No.	4
Type: Vertical Turbine		
Capacity		
Total	gpm	4,295
Per Pump	gpm	1,432
Total Dynamic Head Required (TDH)		
Head required to reach reservoir	feet	346
Average Pump TDH	feet	366
Maximum Pump TDH	feet	396
Motor Size		
Average operating	hp	165
Required (based on maximum discharge pressure)	hp	179
Selected	hp	200
Drive	type	VFD

Table 13 Sodium Hypochlorite Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Sodium Hypochlorite Characteristics		
Concentration:	10.5 %	
Specific Gravity:	1.008	
Solution Strength:	0.88	lb/gal
Parameters	Units	Criteria
<u>Ultraviolet Light / Advanced Oxidation Process</u>		
Chemical Usage		
Location: RO Permeate Before UV Reactors		
Process Flow	MGD	6.2
Chemical Dose	mg/L	4.0
Chemical Usage	lb/day	206
Chemical Feed Rate	gpd	234
Chemical Feed Rate	gph	9.8
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	9.8
<u>MF/UF Maintenance Cleans (MC)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	300
Chemical Usage	lb/day	43.8
Chemical Feed Rate	gpd	49.7
<u>MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	3,000
Chemical Usage	lb/month	438.1
Chemical Feed Rate	gpm	497.2
Chemical Feed Rate	gpd	16.6

Table 13 Sodium Hypochlorite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Parameters	Units	Criteria
<u>Bulk Storage Tanks</u>		
Number of Tanks	No.	2
Tank Capacity, each	gal	4,000
Tank Capacity, total	gal	8,000
UV/AOP Usage	gal/day	234
MF/UF Maintenance Clean	gal/day	49.7
MF/UF CIP	gal/day	16.6
Total Usage	gal/day	301
Storage Time	days	27
Delivery Truck Full Load	gal	3,000
Time Between Delivery	days	10

Table 14 Sulfuric Acid Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Sulfuric Acid Characteristics		
Concentration:	93 %	
Specific Gravity:	1.83	
Solution Strength:	14.17	lb/gal
Parameters	Units	Criteria
<u>DPR RO Pretreatment</u>		
Chemical Usage		
Location: Reverse Osmosis Feed		
Process Flow	MGD	7.7
Chemical Dose	mg/L	115
Chemical Usage	lb/day	7,419
Chemical Feed Rate	gpd	524
Chemical Feed Rate	gph	21.8
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	21.8
<u>Bulk Storage Tanks</u>		
Number of Tanks	No.	2
Tank Capacity, each	gal	8,000
Tank Capacity, total	gal	16,000
Total Usage	gal/day	524
Storage Time	days	31
Delivery Truck Full Load	gal	3,000
Time Between Delivery	days	6

Table 15 Lime Slurry Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Lime Characteristics		
Lime Purity	%	97%
Dry Lime Bulk Density (Storage Value)	lb/cu ft	30
Concentration:	%	35 %
Specific Gravity:		1.271
Solution Strength:	lb/gal	3.70
Parameters	Units	Criteria
<u>DPR Post Treatment</u>		
Chemical Usage		
Location: Before Treated Water Wet Well		
Process Flow	MGD	6.2
Chemical Dose	mg/L	25
Chemical Dose (as stored weight)	mg/L	26
Chemical Usage	lb/day	1,330
Chemical Feed Rate	gpd	359
Chemical Feed Rate	gph	15.0
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	15.0
<u>Lime Storage Silos</u>		
Number of Silos	No.	1
Silo Capacity, each	cu ft	2,500
Silo Capacity, each	lbs	75,000
Silo Capacity, total	Tons	37.5
Silo Diameter, each	ft	13
Silo Sideshell Height, each	ft	19
Dry Usage	lbs/day	1,330
Dry Usage	tons/day	0.7
Storage Time	days	56
Delivery Truck Full Load	tons	24
Time Between Delivery	days	36

Table 16 Scale Inhibitor Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Scale Inhibitor Characteristics

Manufacturer/Product:	Avista Vitec 3000
Concentration:	100 %
Specific Gravity:	1.2
Solution Strength:	9.99 lb/gal

Parameters	Units	Criteria
<u>DPR - RO Pretreatment</u>		
Chemical Usage		
Location: Reverse Osmosis Feed		
Process Flow	MGD	7.7
Chemical Dose	mg/L	4.0
Chemical Usage	lb/day	258
Chemical Feed Rate	gpd	26
Chemical Feed Rate	gph	1.1
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	1.1
Chemical Feed Rate Per Pump	gpm	0.02
<u>Bulk Storage Totes</u>		
Number of Totes	No.	4
Tote Capacity, each	gal	250
Tote Capacity, total	gal	1,000
DPR RO Pretreatment	gal/day	26
Total Usage	gal/day	26
Storage Time	days	39
Delivery Truck Full Load	gal	250
Time Between Delivery	days	10

Table 17 Citric Acid Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Citric Acid Characteristics		
Concentration:	50 %	
Specific Gravity:	1.15	
Solution Strength:	4.79	lb/gal
Parameters	Units	Criteria
<u>MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	730.2
Chemical Feed Rate	gpm	152.5
Chemical Feed Rate	gpd	5.1
<u>Bulk Storage Totes</u>		
Number of Totes	No.	2
Tote Capacity, each	gal	250
Tote Capacity, total	gal	500
MF/UF CIP	gal/month	152.5
Total Usage	gal/month	152.5
Storage Time	days	98
Delivery Truck Full Load	gal	250
Time Between Delivery	days	49

Table 18 Caustic Soda Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Caustic Soda Characteristics		
Concentration:	50 %	
Specific Gravity:	1.53	
Solution Strength:	6.37	lb/gal
Parameters	Units	Criteria
<u>MF/UF Clean-in-Place (CIP)</u>		
<u>(neutralize CA)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	730.2
Chemical Feed Rate	gpm	114.6
Chemical Feed Rate	gpd	3.8
<u>Bulk Storage Tote</u>		
Number of Totes	No.	2
Tote Capacity, each	gal	250
Tote Capacity, total	gal	500
MF/UF CIP	gal/month	114.6
Total Usage	gal/month	114.6
Storage Time	days	131
Delivery Truck Full Load	gal	250
Time Between Delivery	days	65

Table 19 Sodium Bisulfite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Sodium Bisulfite Characteristics

Concentration:	38 %	
Specific Gravity:	1.3	
Solution Strength:	4.11	lb/gal

Parameters	Units	Criteria
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MF/UF Maintenance Cleans (MC)

Location: MF/UF CIP Tank

Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	441
Chemical Usage	lb/day	64.4
Chemical Feed Rate	gpd	15.7

MF/UF Clean-in-Place (CIP)

Chemical Usage

Location: MF/UF CIP Tank

Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	4,500
Chemical Usage	lb/month	657.2
Chemical Feed Rate	gpm	159.8
Chemical Feed Rate	gpd	5.3

Bulk Storage Totes

Number of Totes	No.	4
Tote Capacity, each	gal	250
Tote Capacity, total	gal	1,000
MF/UF Maintenance Clean	gal/day	15.7
MF/UF CIP	gal/day	5.3
Total Usage	gal/day	21
Storage Time	days	48
Delivery Truck Full Load	gal	250
Time Between Delivery	days	12

Table 1 Process Flow Rates - DPR Facility Alt 2a Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara			
Description	Units	Direct Potable Reuse Capacities	
<u>Source and Finished Water Flows</u>			
City Secondary Effluent	AFY	8,660	
City Secondary Effluent	gpm (mgd)	5,369	(7.7)
<u>Process Flows: AWTF/NPR</u>			
Microfiltration			
Recovery	%	94%	
Permeate Flow	gpm (mgd)	5,414	(7.8)
Feedwater Flow ¹	gpm (mgd)	5,760	(8.3)
Backwash Flow	gpm (mgd)	346	(0.5)
Pre RO UV System			
Process Flow	gpm (mgd)	5,414	(7.8)
<u>Process Flows: NPR</u>			
Flow to NPR System	gpm (mgd)	868	(1.2)
Reverse Osmosis			
Recovery	%	80%	
Permeate Flow	gpm (mgd)	3,637	(5.2)
Feedwater Flow	gpm (mgd)	4,547	(6.6)
Brine Flow	gpm (mgd)	909	(1.3)
UV / AOP			
Process Flow	gpm (mgd)	3,637	(5.2)
<u>Process Flows: WTP</u>			
Microfiltration			
Recovery	%	99%	
Permeate Flow	gpm (mgd)	3,601	(5.2)
Feedwater Flow ¹	gpm (mgd)	3,637	(5.2)
Backwash Flow	gpm (mgd)	36	(0.1)
Post Treatment UV System			
Process Flow ²	gpm (mgd)	3,601	(5.2)
<u>Total Finished Water Flows</u>			
Total NPR Flow	gpm (mgd)	868	(1.2)
Total DPR Flow	gpm (mgd)	3,601	(5.2)
Total Usable Flow	gpm (mgd)	4,469	(6.4)
Total NPR Flow	AFY	1,400	
Total DPR Flow	AFY	5,808	
Total Usable Flow	AFY	7,208	
Recovery of WWTP Effluent	%	83%	
Notes:			
1) MF backwash is recycled to head of WWTP. Instantaneous flow is higher than permeate flow.			
2) New WTP will use UV system capacity included in desalination plant design.			

Table 2 DPR - Microfiltration Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>MICROFILTRATION FEED PUMPS</u>		
Number of Pumps		
In-Service	No.	4
Reliability	No.	1
Total	No.	5
Type: Vertical Turbine		
Capacity		
Total	gpm	5,760
Per Pump	gpm	1,440
Total Dynamic Head Required (TDH)		
Water Surface El to Pump Discharge	ft	10
Minimum Discharge Pressure	psi	20
Maximum Discharge Pressure	psi	45
Safety Factor	ft	20
Design Pump TDH	feet	134
Motor Size		
Required	hp	63
Selected	hp	100
Drive	type	VFD
<u>MICROFILTRATION BACKWASH PUMPS</u>		
Number of Pumps		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Type: Vertical Turbine		
Capacity (per pump)		
Design (1.1*Flux Rate)	gpm	993
Maximum (1.5*Flux Rate)	gpm	1,582
Total Dynamic Head Required (TDH)		
Water Surface El to Pump Discharge	ft	10
Minimum Discharge Pressure	psi	10
Maximum Discharge Pressure	psi	30
Safety Factor	ft	20
Design Pump TDH	feet	103
Motor Size		
Required	hp	53
Selected	hp	60
Drive	type	VFD

Table 2 DPR - Microfiltration Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>INFLUENT WET WELL</u>		
Number of Wet Wells	No.	1
Wet Well Dimensions (each)		
Depth	ft	15
Length	ft	62
Width	ft	18
Volume	ft ³	16,740
Volume	gallons	125,215
Storage Time		
Design Flow	Minutes	22

Table 3 DPR - Strainer / Pre-Screen Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Filter (Strainer-type) w/ Automatic Cleaning Mechanism		
Materials: Stainless Steel		
Filter Rating	micron	250
Maximum Pressure Drop		
Clean Filter ⁽¹⁾	psi	3
Before Backwash ⁽²⁾	psi	7
Number of Filters		
In-Service	No.	2
Reliability	No.	1
Total	No.	3
Capacity (Total)	gpm	5,760
Capacity (per Screen)	gpm	2,880
Filter Media Type:	-	Wedgewire
Filter Material:	-	316 SST
Maximum Backwash Flowrate	gpm	310
Backwash Duration	min	1
Total Backwash Waste	gal	310
Housing Design Pressure	psi	150
Motor Size		
Selected	hp	0.33
Drive	type	CS

Table 4 DPR - Microfiltration Train Design Criteria				
Subsurface Desalination Intake and Potable Reuse Feasibility Studies				
City of Santa Barbara				
Description		Units	Criteria	
<u>General Criteria</u>				
Type: Pressurized, Polymeric hollow fiber				
Microfiltration or Ultrafiltration				
Operating Strategy: Dead end flow				
Number of Microfiltration Trains				
In-Service	No.		6	
Reliability	No.		1	
Total	No.		7	
<u>Production Criteria</u>				
Train Flux Rate				
Flux at Design Capacity (Net Production)	gfd		30	
Flux at Design Capacity (Instantaneous)	gfd		35	
Train Recovery Rate (Permeate/Feed Flow)				
Minimum	percent		94%	
Train Permeate Flow Rate				
Total	gpm (mgd)		5,414	(7.8)
Design	gpm (mgd)		902	(1.3)
<u>Train Configuration</u>				
Type: Open Platform (Non-proprietary)				
Membrane Manufacturer (No. 1)			Toray	
Module Model Number			2020N	
Membrane Area per Module			775	
Number of Installed Modules per Train	No.		56	
Number of Blank Modules per Train	No.		8	
Number of Total Module Spaces per Train	No.		64	
<u>Backwash Criteria</u>				
Type: Reverse Flow Followed by Simultaneous Air				
Scour and Drain				
Backwash Interval per Train				
Minimum	minutes		20	
Maximum	minutes		30	
Backwash Supply Flow Rate (Water)				
Flux	gfd		46	
Flow	gpm		1,582	
Backwash Duration	sec		45	
Backwash Supply Flow Rate (Air)	scfm		448	
Volume of Wastewater Produced				
Per Backwash	gallons		1,187	

Table 4 DPR - Microfiltration Train Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
<u>Maintenance Clean Criteria (Typically only hypo clean)</u>		
Maintenance Clean Frequency	days	1
Sodium Hypochlorite Dose	mg/L	300
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Day	gallons	17,500
<u>Clean-in-Place (CIP) Criteria</u>		
CIP Frequency	days	30
Sodium Hypochlorite Dose	mg/L	3,000
Citric Acid Dose	mg/L	5,000
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Month	gallons	17,500
<u>Chemical Neutralization Criteria</u>		
Sodium Bisulfite Dose MC ¹	mg/L	450
Sodium Bisulfite Dose CIP ¹	mg/L	4,500
Sodium Hydroxide CIP	mg/L	5,000
Note:		
1) Calculated as 1.5 times the sodium hypochlorite dose. Stoichiometric demand is 1.34 mg sodium bisulfite per 1 mg of sodium hypochlorite.		

Table 5 DPR - Microfiltration Backwash Air Scour Blowers Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Rotary Lobe		
Number of Blowers		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Discharge Pressure	psi	13
Air Flow Rate	scfm	
Design	scfm	392
Maximum	scfm	448
Motor Size		
Required	hp	32
Selected	hp	50
Drive	type	VFD

Table 6 DPR - Ultraviolet Disinfection Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Process Type: Low Pressure High Output Ultraviolet Light Reactor		
Manufacturer(s): Wedeco		
Model(s): spektron 4000e w/ 600 watt lamps		
Number of UV Reactors		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Flows		
Total Flow to Reactors	gpm (mgd)	5,414 (7.8)
Flow to Each Reactor	gpm (mgd)	5,414 (7.8)
UV Transmittance (UVT)	percent	90
UV Dose ⁽¹⁾	mJ/cm ²	110

Table 7 DPR - RO Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>RO HIGH PRESSURE FEED PUMPS</u>		
Number of Pumps		
In-Service	No.	4
Reliability	No.	0
Total	No.	4
Type: Vertical Turbine		
Capacity		
Total	gpm	4,547
Per Pump	gpm	1,137
Total Dynamic Head Required (TDH)		
Average Discharge Pressure	psi	120
Average Pump TDH	feet	297
Maximum Discharge Pressure	psi	145
Maximum Pump TDH	feet	355
Motor Size		
Average operating	hp	107
Required (based on maximum discharge pressure)	hp	127
Selected	hp	150
Drive	type	VFD
<u>WET WELL</u>		
Number of Wet Wells	No.	1
Wet Well Dimensions (each)		
Depth	ft	10
Length	ft	80
Width	ft	15
Volume	ft ³	12,000
Volume	gallons	89,766
Storage Time		
Design Flow	Minutes	20

Table 8 DPR - Reverse Osmosis Trains Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria	
Number of Reverse Osmosis Trains			
In-Service	No.	4	
Reliability	No.	0	
Total	No.	4	
Train Flux Rate ⁽¹⁾	gfd	11	
Recovery (Permeate/Feed Flow)	percent	80%	
Total Permeate Flow	gpm (mgd)	3,637	(6.5)
Total Permeate Flow per Train	gpm (mgd)	909	(1.3)
Brine Flow per Train	gpm (mgd)	227	(0.33)
Number of Array Stages Per Train	No.	2	
1st Stage			
Pressure Vessels per Train	No.	28	
Elements per Pressure Vessel	No.	7	
2nd Stage			
Pressure Vessels per Train	No.	14	
Elements per Pressure Vessel	No.	7	
Number of Elements			
Per Train	No.	294	
Total (In-Service)	No.	1,176	
Membrane Manufacturer(s) ⁽²⁾		Dow FilmTec, Hydranautics, or Toray	
	-		
Membrane Model No. ⁽²⁾		BW30-400/34i, ESPA2-LD, or TML20D-400	
	-		
Membrane Area ⁽²⁾			
Per Element	sq. ft.	400	
Per Train	sq. ft.	117,600	
Total (In-service)	sq. ft.	470,400	

Table 9 DPR - RO Interstage Booster Pump Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Turbine assisted motorized booster pump		
Manufacturer: FEDCO		
Model: LP-HEMI, LPH-240-125T		
LP-HEMI Units Per RO Train	No.	1
Total Number of Units	No.	4
<u>Pump Data</u>		
Stages	No.	1
Flow		
At 80 Percent RO Recovery	gpm	538
Minimum Total Dynamic Head ⁽¹⁾	ft	70
Maximum Total Dynamic Head ⁽²⁾	ft	120
Shaft Power		
Minimum Required	hp	12
Maximum Required	hp	21
<u>Motor Data</u>		
Drive	type	VFD
Position: Vertical		
Power Rating	hp	25
Notes:		
1) Clean-membrane (start-up) conditions.		
2) Fouled membrane (end of life), worst water quality conditions.		

Table 10 DPR - UV Disinfection / AOP Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria	
Process Type: Low Pressure High Output Ultraviolet Light Reactor w/ NaOCl AOP			
Manufacturer(s): Wedeco			
Model(s): k143 w/ 600 watt lamps			
Number of UV Reactors			
In-Service	No.	1	
Reliability	No.	1	
Total	No.	2	
Flows			
Total Flow to Reactors	gpm (mgd)	3,637	(5.2)
Flow to Each Reactor	gpm (mgd)	3,637	(5.2)
UV Transmittance (UVT)	percent	95	
UV Dose ⁽¹⁾	mJ/cm ²	920	
NaOCl Dose	mg/L	4	
Note:			
1) Dose required to achieve 6-log virus and 6-log protozoa inactivation using hypochlorite for the AOP process.			

Table 11 Direct Potable Reuse Train - Storage and Equalization Tanks Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
<u>ENGINEERED STORAGE TANKS</u>		
Product Flow	gpm	3,601
Number of Tanks	No.	2
Tank Dimensions		
Diameter	ft	70
Height	ft	35
Volume (each)	ft ³	134,696
Volume (each)	gallons	1,007,524
Volume (actual)	gallons	1,000,000
Volume (total)	gallons	2,000,000
Storage Time (w/ one tank out of service)		
Design Flow	Minutes	278
Design Flow	Hours	5
Storage Time (total)		
Design Flow	Minutes	555
Design Flow	Hours	9
Description	Units	Criteria
<u>EQUALIZATION TANKS</u>		
Product Flow	gpm	5,369
Number of Tanks	No.	2
Tank Dimensions		
Diameter	ft	82
Height	ft	35
Volume (each)	ft ³	184,836
Volume (each)	gallons	1,382,570
Volume (actual)	gallons	1,500,000
Volume (total)	gallons	3,000,000
Storage Time (each)		
Design Flow	Minutes	279
Design Flow	Hours	5
Storage Time (total)		
Design Flow	Minutes	559
Design Flow	Hours	9

Table 12 Sodium Hypochlorite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Sodium Hypochlorite Characteristics

Concentration:	10.5 %	
Specific Gravity:	1.008	
Solution Strength:	0.88	lb/gal

Parameters	Units	Criteria
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Ultraviolet Light / Advanced Oxidation Process

Chemical Usage

Location: RO Permeate Before UV Reactors

Process Flow	MGD	5.2
Chemical Dose	mg/L	4.0
Chemical Usage	lb/day	175
Chemical Feed Rate	gpd	198
Chemical Feed Rate	gph	8.3
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	8.3

AWTF MF/UF Maintenance Cleans (MC)

Chemical Usage

Location: MF/UF CIP Tank

Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	300
Chemical Usage	lb/day	43.8
Chemical Feed Rate	gpd	49.7

AWTF MF/UF Clean-in-Place (CIP)

Chemical Usage

Location: MF/UF CIP Tank

Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	3,000
Chemical Usage	lb/month	438.1
Chemical Feed Rate	gpm	497.2
Chemical Feed Rate	gpd	16.6

WTP MF/UF Maintenance Cleans (MC)

Chemical Usage

Location: MF/UF CIP Tank

Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	5

Table 12 Sodium Hypochlorite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Parameters	Units	Criteria
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	300
Chemical Usage	lb/day	31.3
Chemical Feed Rate	gpd	35.5
<u>WTP MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	5
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	3,000
Chemical Usage	lb/month	312.9
Chemical Feed Rate	gpm	355.1
Chemical Feed Rate	gpd	11.8
<u>Bulk Storage Tanks</u>		
Number of Tanks	No.	2
Tank Capacity, each	gal	5,500
Tank Capacity, total	gal	11,000
UV/AOP Usage	gal/day	198
MF/UF Maintenance Cleans	gal/day	85.2
MF/UF CIPs	gal/day	28.4
Total Usage	gal/day	312
Storage Time	days	35
Delivery Truck Full Load	gal	3,000
Time Between Delivery	days	10

Table 13 Sulfuric Acid Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Sulfuric Acid Characteristics

Concentration:	93 %	
Specific Gravity:	1.83	
Solution Strength:	14.17	lb/gal

Parameters	Units	Criteria
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DPR RO Pretreatment

Chemical Usage

Location: Reverse Osmosis Feed

Process Flow	MGD	6.5
Chemical Dose	mg/L	115
Chemical Usage	lb/day	6,283
Chemical Feed Rate	gpd	443
Chemical Feed Rate	gph	18.5
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	18.5

Bulk Storage Tanks

Number of Tanks	No.	2
Tank Capacity, each	gal	8,000
Tank Capacity, total	gal	16,000
Total Usage	gal/day	443
Storage Time	days	36
Delivery Truck Full Load	gal	3,000
Time Between Delivery	days	7

Table 14 Lime Slurry Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Lime Characteristics		
Lime Purity	%	97%
Dry Lime Bulk Density (Storage Value)	lb/cu ft	30
Concentration:	%	35 %
Specific Gravity:		1.271
Solution Strength:	lb/gal	3.70
Parameters	Units	Criteria
<u>DPR Post Treatment</u>		
Chemical Usage		
Location: Before Treated Water Wet Well		
Process Flow	MGD	5.2
Chemical Dose	mg/L	25
Chemical Dose (as stored weight)	mg/L	26
Chemical Usage	lb/day	1,115
Chemical Feed Rate	gpd	301
Chemical Feed Rate	gph	12.5
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	12.5
<u>Lime Storage Silos</u>		
Number of Silos	No.	1
Silo Capacity, each	cu ft	2,500
Silo Capacity, each	lbs	75,000
Silo Capacity, total	Tons	37.5
Silo Diameter, each	ft	13
Silo Sideshell Height, each	ft	19
Dry Usage	lbs/day	1,115
Dry Usage	tons/day	0.6
Storage Time	days	67
Delivery Truck Full Load	tons	24
Time Between Delivery	days	43

Table 15 Scale Inhibitor Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Scale Inhibitor Characteristics

Manufacturer/Product:	Avista Vitec 3000
Concentration:	100 %
Specific Gravity:	1.2
Solution Strength:	9.99 lb/gal

Parameters	Units	Criteria
<u>DPR - RO Pretreatment</u>		
Chemical Usage		
Location: Reverse Osmosis Feed		
Process Flow	MGD	6.5
Chemical Dose	mg/L	4.0
Chemical Usage	lb/day	219
Chemical Feed Rate	gpd	22
Chemical Feed Rate	gph	0.9
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	0.9
Chemical Feed Rate Per Pump	gpm	0.02
<u>Bulk Storage Totes</u>		
Number of Totes	No.	4
Tote Capacity, each	gal	250
Tote Capacity, total	gal	1,000
DPR RO Pretreatment	gal/day	22
Total Usage	gal/day	22
Storage Time	days	46
Delivery Truck Full Load	gal	250
Time Between Delivery	days	11

Table 16 Citric Acid Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Citric Acid Characteristics

Concentration:	50 %	
Specific Gravity:	1.15	
Solution Strength:	4.79	lb/gal

Parameters	Units	Criteria
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AWTF MF/UF Clean-in-Place (CIP)

Chemical Usage

Location: MF/UF CIP Tank

Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	730.2
Chemical Feed Rate	gpm	152.5
Chemical Feed Rate	gpd	5.1

WTP MF/UF Clean-in-Place (CIP)

Chemical Usage

Location: MF/UF CIP Tank

Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	5
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	521.6
Chemical Feed Rate	gpm	108.9
Chemical Feed Rate	gpd	3.6

Bulk Storage Totes

Number of Totes	No.	2
Tote Capacity, each	gal	250
Tote Capacity, total	gal	500
MF/UF CIP	gal/month	261.5
Total Usage	gal/month	261.5
Storage Time	days	57
Delivery Truck Full Load	gal	250
Time Between Delivery	days	29

Table 17 Caustic Soda Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Caustic Soda Characteristics

Concentration:	50 %	
Specific Gravity:	1.53	
Solution Strength:	6.37	lb/gal

Parameters	Units	Criteria
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AWTF MF/UF Clean-in-Place (CIP) (neutralize CA)

Chemical Usage

Location: MF/UF CIP Tank

Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	730.2
Chemical Feed Rate	gpm	114.6
Chemical Feed Rate	gpd	3.8

WTP MF/UF Clean-in-Place (CIP) (neutralize CA)

Chemical Usage

Location: MF/UF CIP Tank

Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	5
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	521.6
Chemical Feed Rate	gpm	81.9
Chemical Feed Rate	gpd	2.7

Bulk Storage Tote

Number of Totes	No.	2
Tote Capacity, each	gal	250
Tote Capacity, total	gal	500
MF/UF CIPs	gal/month	196.5
Total Usage	gal/month	196.5
Storage Time	days	76
Delivery Truck Full Load	gal	250
Time Between Delivery	days	38

Table 18 Sodium Bisulfite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Sodium Bisulfite Characteristics

Concentration:	38 %	
Specific Gravity:	1.3	
Solution Strength:	4.11	lb/gal

Parameters	Units	Criteria
<u>AWTF MF/UF Maintenance Cleans (MC)</u>		
Chemical Usage (NaOCl Neutralization)		
Location: MF/UF CIP Tank		
Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	441
Chemical Usage	lb/day	64.4
Chemical Feed Rate	gpd	15.7
<u>AWTF MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	4,500
Chemical Usage	lb/month	657.2
Chemical Feed Rate	gpm	159.8
Chemical Feed Rate	gpd	5.3
<u>WTP MF/UF Maintenance Cleans (MC)</u>		
Chemical Usage (NaOCl Neutralization)		
Location: MF/UF CIP Tank		
Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	5
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	441
Chemical Usage	lb/day	46.0
Chemical Feed Rate	gpd	11.2
<u>WTP MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	5
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	4,500

Table 18 Sodium Bisulfite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Parameters	Units	Criteria
Chemical Usage	lb/month	469.4
Chemical Feed Rate	gpm	114.1
Chemical Feed Rate	gpd	3.8
<u>Bulk Storage Totes</u>		
Number of Totes	No.	4
Tote Capacity, each	gal	250
Tote Capacity, total	gal	1,000
MF/UF Maintenance Clean	gal/day	26.8
MF/UF CIP	gal/day	9.1
Total Usage	gal/day	36
Storage Time	days	28
Delivery Truck Full Load	gal	250
Time Between Delivery	days	7

Table 19 DPR - WTP Microfiltration Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara			
Description		Units	Criteria
<u>MICROFILTRATION FEED PUMPS</u>			
Number of Pumps			
In-Service	No.		3
Reliability	No.		1
Total	No.		4
Type: Vertical Turbine			
Capacity			
Total	gpm		3,637
Per Pump	gpm		1,212
Total Dynamic Head Required (TDH)			
Water Surface El to Pump Discharge	ft		10
Minimum Discharge Pressure	psi		20
Maximum Discharge Pressure	psi		45
Safety Factor	ft		20
Design Pump TDH	feet		134
Motor Size			
Required	hp		53
Selected	hp		75
Drive	type		VFD
<u>MICROFILTRATION BACKWASH PUMPS</u>			
Number of Pumps			
In-Service	No.		1
Reliability	No.		1
Total	No.		2
Type: Vertical Turbine			
Capacity (per pump)			
Design (1.1*Flux Rate)	gpm		990
Maximum (1.3*Flux Rate)	gpm		1,567
Total Dynamic Head Required (TDH)			
Water Surface El to Pump Discharge	ft		10
Minimum Discharge Pressure	psi		10
Maximum Discharge Pressure	psi		30
Safety Factor	ft		20
Design Pump TDH	feet		103
Motor Size			
Required	hp		53
Selected	hp		60
Drive	type		VFD

Table 19 DPR - WTP Microfiltration Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>INFLUENT WET WELL</u>		
Number of Wet Wells	No.	1
Wet Well Dimensions (each)		
Depth	ft	15
Length	ft	50
Width	ft	15
Volume	ft ³	11,250
Volume	gallons	84,150
Storage Time		
Design Flow	Minutes	23

Table 20 DPR - WTP Strainer / Pre-Screen Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Filter (Strainer-type) w/ Automatic Cleaning Mechanism		
Materials: Stainless Steel		
Filter Rating	micron	250
Maximum Pressure Drop		
Clean Filter ⁽¹⁾	psi	3
Before Backwash ⁽²⁾	psi	7
Number of Filters		
In-Service	No.	2
Reliability	No.	1
Total	No.	3
Capacity (Total)	gpm	3,637
Capacity (per Screen)	gpm	1,819
Filter Media Type:	-	Wedgewire
Filter Material:	-	316 SST
Maximum Backwash Flowrate	gpm	310
Backwash Duration	min	1
Total Backwash Waste	gal	310
Housing Design Pressure	psi	150
Motor Size		
Selected	hp	0.33
Drive	type	CS

Table 21 DPR - WTP Microfiltration Train Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria	
<u>General Criteria</u>			
Type: Pressurized, Polymeric hollow fiber			
Microfiltration or Ultrafiltration			
Operating Strategy: Dead end flow			
Number of Microfiltration Trains			
In-Service	No.	4	
Reliability	No.	1	
Total	No.	5	
<u>Production Criteria</u>			
Train Flux Rate			
Flux at Design Capacity (Net Production)	gfd	30	
Flux at Design Capacity (Instantaneous)	gfd	40	
Train Recovery Rate (Permeate/Feed Flow)			
Minimum	percent	94%	
Train Permeate Flow Rate			
Total	gpm (mgd)	3,601	(5.2)
Design	gpm (mgd)	900	(1.3)
<u>Train Configuration</u>			
Type: Open Platform (Non-proprietary)			
Membrane Manufacturer (No. 1)		Toray	
Module Model Number		2020N	
Membrane Area per Module		775	
Number of Installed Modules per Train		No.	56
Number of Blank Modules per Train		No.	8
Number of Total Module Spaces per Train		No.	64
<u>Backwash Criteria</u>			
Type: Reverse Flow Followed by Simultaneous Air Scour and Drain			
Backwash Interval per Train			
Minimum	minutes	20	
Maximum	minutes	30	
Backwash Supply Flow Rate (Water)			
Flux	gfd	52	
Flow	gpm	1,567	
Backwash Duration	sec	45	
Backwash Supply Flow Rate (Air)	scfm	448	
Volume of Wastewater Produced			
Per Backwash	gallons	1,175	

Table 21 DPR - WTP Microfiltration Train Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
<u>Maintenance Clean Criteria (Typically only hypo clean)</u>		
Maintenance Clean Frequency	days	3
Sodium Hypochlorite Dose	mg/L	300
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Day	gallons	4,167
<u>Clean-in-Place (CIP) Criteria</u>		
CIP Frequency	days	30
Sodium Hypochlorite Dose	mg/L	3,000
Citric Acid Dose	mg/L	5,000
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Month	gallons	12,500
<u>Chemical Neutralization Criteria</u>		
Sodium Bisulfite Dose MC ¹	mg/L	450
Sodium Bisulfite Dose CIP ¹	mg/L	4500
Sodium Hydroxide CIP	mg/L	5,000

Note:

- 1) Calculated as 1.5 times the sodium hypochlorite dose. Stoichiometric demand is 1.34 mg sodium bisulfite per 1 mg of sodium hypochlorite.

Table 22 DPR - WTP Microfiltration Backwash Air Scour Blowers Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Rotary Lobe		
Number of Blowers		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Discharge Pressure	psi	13
Air Flow Rate	scfm	
Design	scfm	392
Maximum	scfm	448
Motor Size		
Required	hp	32
Selected	hp	50
Drive	type	VFD

Table 23 Direct Potable Reuse Train - Finished Water Pump Station Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara			
Description		Units	Criteria
<u>FINISHED WATER PUMPS TO SOUTH COAST CONDUIT</u>			
Number of Pumps			
In-Service		No.	3
Reliability		No.	1
Total		No.	4
Type: Vertical Turbine			
Capacity			
Total		gpm	3,601
Per Pump		gpm	1,200
Total Dynamic Head Required (TDH)			
Head required to reach reservoir		feet	534
Average Pump TDH		feet	554
Maximum Pump TDH		feet	584
Motor Size			
Average operating		hp	210
Required (based on maximum discharge pressure)		hp	221
Selected		hp	250
Drive		type	VFD

Table 1 Process Flow Rates - DPR Facility Alt 2b Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara			
Description	Units	Direct Potable Reuse Capacities	
<u>Source and Finished Water Flows</u>			
City Secondary Effluent	AFY	8,660	
City Secondary Effluent	gpm (mgd)	5,369	(7.7)
<u>Process Flows: AWTF</u>			
Microfiltration			
Recovery	%	94%	
Permeate Flow	gpm (mgd)	5,423	(7.8)
Feedwater Flow ¹	gpm (mgd)	5,769	(8.3)
Backwash Flow	gpm (mgd)	346	(0.5)
Pre RO UV System			
Process Flow	gpm (mgd)	5,423	(7.8)
Reverse Osmosis			
Recovery	%	80%	
Permeate Flow	gpm (mgd)	4,338	(6.2)
Feedwater Flow	gpm (mgd)	5,423	(7.8)
Brine Flow	gpm (mgd)	1,085	(1.6)
UV / AOP			
Process Flow	gpm (mgd)	4,338	(6.2)
<u>Process Flows: WTP</u>			
Microfiltration			
Recovery	%	99%	
Permeate Flow	gpm (mgd)	4,295	(6.2)
Feedwater Flow ¹	gpm (mgd)	4,338	(6.2)
Backwash Flow	gpm (mgd)	43	(0.1)
Post Treatment UV System			
Process Flow ²	gpm (mgd)	4,295	(6.2)
<u>Total Finished Water Flows</u>			
Total NPR Flow	gpm (mgd)	0	(0.0)
Total DPR Flow	gpm (mgd)	4,295	(6.2)
Total Usable Flow	gpm (mgd)	4,295	(6.2)
Total NPR Flow	AFY	0	
Total DPR Flow	AFY	6,928	
Total Usable Flow	AFY	6,928	
Recovery of WWTP Effluent	%	80%	
Notes:			
1) MF backwash is recycled to head of WWTP. Instantaneous flow is higher than permeate flow.			
2) New WTP will use UV system capacity included in desalination plant design.			

Table 2 DPR - Microfiltration Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>MICROFILTRATION FEED PUMPS</u>		
Number of Pumps		
In-Service	No.	4
Reliability	No.	1
Total	No.	5
Type: Vertical Turbine		
Capacity		
Total	gpm	5,769
Per Pump	gpm	1,442
Total Dynamic Head Required (TDH)		
Water Surface El to Pump Discharge	ft	10
Minimum Discharge Pressure	psi	20
Maximum Discharge Pressure	psi	45
Safety Factor	ft	20
Design Pump TDH	feet	134
Motor Size		
Required	hp	63
Selected	hp	100
Drive	type	VFD
<u>MICROFILTRATION BACKWASH PUMPS</u>		
Number of Pumps		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Type: Vertical Turbine		
Capacity (per pump)		
Design (1.1*Flux Rate)	gpm	994
Maximum (1.5*Flux Rate)	gpm	1,582
Total Dynamic Head Required (TDH)		
Water Surface El to Pump Discharge	ft	10
Minimum Discharge Pressure	psi	10
Maximum Discharge Pressure	psi	30
Safety Factor	ft	20
Design Pump TDH	feet	103
Motor Size		
Required	hp	53
Selected	hp	60
Drive	type	VFD

Table 2 DPR - Microfiltration Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>INFLUENT WET WELL</u>		
Number of Wet Wells	No.	1
Wet Well Dimensions (each)		
Depth	ft	15
Length	ft	62
Width	ft	18
Volume	ft ³	16,740
Volume	gallons	125,215
Storage Time		
Design Flow	Minutes	22

Table 3 DPR - Strainer / Pre-Screen Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Filter (Strainer-type) w/ Automatic Cleaning Mechanism		
Materials: Stainless Steel		
Filter Rating	micron	250
Maximum Pressure Drop		
Clean Filter ⁽¹⁾	psi	3
Before Backwash ⁽²⁾	psi	7
Number of Filters		
In-Service	No.	2
Reliability	No.	1
Total	No.	3
Capacity (Total)	gpm	5,769
Capacity (per Screen)	gpm	2,885
Filter Media Type:	-	Wedgewire
Filter Material:	-	316 SST
Maximum Backwash Flowrate	gpm	310
Backwash Duration	min	1
Total Backwash Waste	gal	310
Housing Design Pressure	psi	150
Motor Size		
Selected	hp	0.33
Drive	type	CS

Table 4				DPR - Microfiltration Train Design Criteria			
				Subsurface Desalination Intake and Potable Reuse Feasibility Studies			
				City of Santa Barbara			
Description		Units		Criteria			
<u>General Criteria</u>							
Type: Pressurized, Polymeric hollow fiber Microfiltration or Ultrafiltration							
Operating Strategy: Dead end flow							
Number of Microfiltration Trains							
In-Service		No.		6			
Reliability		No.		1			
Total		No.		7			
<u>Production Criteria</u>							
Train Flux Rate							
Flux at Design Capacity (Net Production)		gfd		30			
Flux at Design Capacity (Instantaneous)		gfd		35			
Train Recovery Rate (Permeate/Feed Flow)							
Minimum		percent		94%			
Train Permeate Flow Rate							
Total		gpm (mgd)		5,423		(7.8)	
Design		gpm (mgd)		904		(1.3)	
<u>Train Configuration</u>							
Type: Open Platform (Non-proprietary)							
Membrane Manufacturer (No. 1)				Toray			
Module Model Number				2020N			
Membrane Area per Module				775			
Number of Installed Modules per Train		No.		56			
Number of Blank Modules per Train		No.		8			
Number of Total Module Spaces per Train		No.		64			
<u>Backwash Criteria</u>							
Type: Reverse Flow Followed by Simultaneous Air Scour and Drain							
Backwash Interval per Train							
Minimum		minutes		20			
Maximum		minutes		30			
Backwash Supply Flow Rate (Water)							
Flux		gfd		46			
Flow		gpm		1,582			
Backwash Duration		sec		45			
Backwash Supply Flow Rate (Air)		scfm		448			
Volume of Wastewater Produced							
Per Backwash		gallons		1,187			

Table 4 DPR - Microfiltration Train Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>Maintenance Clean Criteria (Typically only hypo clean)</u>		
Maintenance Clean Frequency	days	1
Sodium Hypochlorite Dose	mg/L	300
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Day	gallons	17,500
<u>Clean-in-Place (CIP) Criteria</u>		
CIP Frequency	days	30
Sodium Hypochlorite Dose	mg/L	3,000
Citric Acid Dose	mg/L	5,000
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Month	gallons	17,500
<u>Chemical Neutralization Criteria</u>		
Sodium Bisulfite Dose MC ¹	mg/L	450
Sodium Bisulfite Dose CIP ¹	mg/L	4,500
Sodium Hydroxide CIP	mg/L	5,000
Note: 1) Calculated as 1.5 times the sodium hypochlorite dose. Stoichiometric demand is 1.34 mg sodium bisulfite per 1 mg of sodium hypochlorite.		

Table 5 DPR - Microfiltration Backwash Air Scour Blowers Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Rotary Lobe		
Number of Blowers		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Discharge Pressure	psi	13
Air Flow Rate	scfm	
Design	scfm	392
Maximum	scfm	448
Motor Size		
Required	hp	32
Selected	hp	50
Drive	type	VFD

Table 6 DPR - Ultraviolet Disinfection Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Process Type: Low Pressure High Output Ultraviolet Light Reactor		
Manufacturer(s): Wedeco		
Model(s): spektron 4000e w/ 600 watt lamps		
Number of UV Reactors		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Flows		
Total Flow to Reactors	gpm (mgd)	5,423 (7.8)
Flow to Each Reactor	gpm (mgd)	5,423 (7.8)
UV Transmittance (UVT)	percent	90
UV Dose ⁽¹⁾	mJ/cm ²	110
Note:		
1) Dose required to achieve 4-log virus and 4-log protozoa inactivation.		

Table 7 DPR - RO Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>RO HIGH PRESSURE FEED PUMPS</u>		
Number of Pumps		
In-Service	No.	4
Reliability	No.	0
Total	No.	4
Type: Vertical Turbine		
Capacity		
Total	gpm	5,423
Per Pump	gpm	1,356
Total Dynamic Head Required (TDH)		
Average Discharge Pressure	psi	120
Average Pump TDH	feet	297
Maximum Discharge Pressure	psi	145
Maximum Pump TDH	feet	355
Motor Size		
Average operating	hp	127
Required (based on maximum discharge pressure)	hp	152
Selected	hp	175
Drive	type	VFD
<u>WET WELL</u>		
Number of Wet Wells	No.	1
Wet Well Dimensions (each)		
Depth	ft	10
Length	ft	80
Width	ft	15
Volume	ft ³	12,000
Volume	gallons	89,766
Storage Time		
Design Flow	Minutes	17

Table 8 DPR - Reverse Osmosis Trains Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria	
Number of Reverse Osmosis Trains			
In-Service	No.	4	
Reliability	No.	0	
Total	No.	4	
Train Flux Rate ⁽¹⁾	gfd	11	
Recovery (Permeate/Feed Flow)	percent	80%	
Total Permeate Flow	gpm (mgd)	4,338	(7.8)
Total Permeate Flow per Train	gpm (mgd)	1,085	(1.6)
Brine Flow per Train	gpm (mgd)	271	(0.39)
Number of Array Stages Per Train	No.	2	
1st Stage			
Pressure Vessels per Train	No.	34	
Elements per Pressure Vessel	No.	7	
2nd Stage			
Pressure Vessels per Train	No.	17	
Elements per Pressure Vessel	No.	7	
Number of Elements			
Per Train	No.	357	
Total (In-Service)	No.	1,428	
Membrane Manufacturer(s) ⁽²⁾		Dow FilmTec, Hydranautics, or Toray	
	-		
Membrane Model No. ⁽²⁾		BW30-400/34i, ESPA2-LD, or TML20D-400	
	-		
Membrane Area ⁽²⁾			
Per Element	sq. ft.	400	
Per Train	sq. ft.	142,800	
Total (In-service)	sq. ft.	571,200	

Table 9 DPR - RO Interstage Booster Pump Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Turbine assisted motorized booster pump		
Manufacturer: FEDCO		
Model: LP-HEMI, LPH-240-125T		
LP-HEMI Units Per RO Train	No.	1
Total Number of Units	No.	4
<u>Pump Data</u>		
Stages	No.	1
Flow		
At 80 Percent RO Recovery	gpm	629
Minimum Total Dynamic Head ⁽¹⁾	ft	70
Maximum Total Dynamic Head ⁽²⁾	ft	120
Shaft Power		
Minimum Required	hp	14
Maximum Required	hp	25
<u>Motor Data</u>		
Drive	type	VFD
Position: Vertical		
Power Rating	hp	30
Notes: 1) Clean-membrane (start-up) conditions. 2) Fouled membrane (end of life), worst water quality conditions.		

Table 10 DPR - UV Disinfection / AOP Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria	
Process Type: Low Pressure High Output Ultraviolet Light Reactor w/ NaOCl AOP			
Manufacturer(s): Wedeco			
Model(s): k143 w/ 600 watt lamps			
Number of UV Reactors			
In-Service	No.	1	
Reliability	No.	1	
Total	No.	2	
Flows			
Total Flow to Reactors	gpm (mgd)	4,338	(6.2)
Flow to Each Reactor	gpm (mgd)	4,338	(6.2)
UV Transmittance (UVT)	percent	95	
UV Dose ⁽¹⁾	mJ/cm ²	920	
NaOCl Dose	mg/L	4	
Note:			
1) Dose required to achieve 6-log virus and 6-log protozoa inactivation using hypochlorite for the AOP process.			

Table 11 Direct Potable Reuse Train - Storage and Equalization Tanks Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
<u>ENGINEERED STORAGE TANKS</u>		
Product Flow	gpm	4,295
Number of Tanks	No.	2
Tank Dimensions		
Diameter	ft	70
Height	ft	35
Volume (each)	ft ³	134,696
Volume (each)	gallons	1,007,524
Volume (actual)	gallons	1,000,000
Volume (total)	gallons	2,000,000
Storage Time (w/ one tank out of service)		
Design Flow	Minutes	233
Design Flow	Hours	4
Storage Time (total)		
Design Flow	Minutes	466
Design Flow	Hours	8
Description	Units	Criteria
<u>EQUALIZATION TANKS</u>		
Product Flow	gpm	5,369
Number of Tanks	No.	2
Tank Dimensions		
Diameter	ft	82
Height	ft	35
Volume (each)	ft ³	184,836
Volume (each)	gallons	1,382,570
Volume (actual)	gallons	1,500,000
Volume (total)	gallons	3,000,000
Storage Time (each)		
Design Flow	Minutes	279
Design Flow	Hours	5
Storage Time (total)		
Design Flow	Minutes	559
Design Flow	Hours	9

Table 12 Sodium Hypochlorite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Sodium Hypochlorite Characteristics

Concentration:	10.5 %	
Specific Gravity:	1.008	
Solution Strength:	0.88	lb/gal

Parameters	Units	Criteria
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Ultraviolet Light / Advanced Oxidation Process

Chemical Usage

Location: RO Permeate Before UV Reactors

Process Flow	MGD	6.2
Chemical Dose	mg/L	4.0
Chemical Usage	lb/day	209
Chemical Feed Rate	gpd	237
Chemical Feed Rate	gph	9.9
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	9.9

AWTF MF/UF Maintenance Cleans (MC)

Chemical Usage

Location: MF/UF CIP Tank

Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	300
Chemical Usage	lb/day	43.8
Chemical Feed Rate	gpd	49.7

AWTF MF/UF Clean-in-Place (CIP)

Chemical Usage

Location: MF/UF CIP Tank

Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	3,000
Chemical Usage	lb/month	438.1
Chemical Feed Rate	gpm	497.2
Chemical Feed Rate	gpd	16.6

WTP MF/UF Maintenance Cleans (MC)

Chemical Usage

Location: MF/UF CIP Tank

Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	5

Table 12 Sodium Hypochlorite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Parameters	Units	Criteria
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	300
Chemical Usage	lb/day	31.3
Chemical Feed Rate	gpd	35.5
<u>WTP MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	5
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	3,000
Chemical Usage	lb/month	312.9
Chemical Feed Rate	gpm	355.1
Chemical Feed Rate	gpd	11.8
<u>Bulk Storage Tanks</u>		
Number of Tanks	No.	2
Tank Capacity, each	gal	5,500
Tank Capacity, total	gal	11,000
UV/AOP Usage	gal/day	237
MF/UF Maintenance Cleans	gal/day	85.2
MF/UF CIPs	gal/day	28.4
Total Usage	gal/day	350
Storage Time	days	31
Delivery Truck Full Load	gal	3,000
Time Between Delivery	days	9

Table 13 Sulfuric Acid Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Sulfuric Acid Characteristics		
Concentration:	93 %	
Specific Gravity:	1.83	
Solution Strength:	14.17	lb/gal
Parameters	Units	Criteria
<u>DPR RO Pretreatment</u>		
Chemical Usage		
Location: Reverse Osmosis Feed		
Process Flow	MGD	7.8
Chemical Dose	mg/L	115
Chemical Usage	lb/day	7,494
Chemical Feed Rate	gpd	529
Chemical Feed Rate	gph	22.0
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	22.0
<u>Bulk Storage Tanks</u>		
Number of Tanks	No.	2
Tank Capacity, each	gal	8,000
Tank Capacity, total	gal	16,000
Total Usage	gal/day	529
Storage Time	days	30
Delivery Truck Full Load	gal	3,000
Time Between Delivery	days	6

Table 14 Lime Slurry Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Lime Characteristics		
Lime Purity	%	97%
Dry Lime Bulk Density (Storage Value)	lb/cu ft	30
Concentration:	%	35 %
Specific Gravity:		1.271
Solution Strength:	lb/gal	3.70
Parameters	Units	Criteria
<u>DPR Post Treatment</u>		
Chemical Usage		
Location: Before Treated Water Wet Well		
Process Flow	MGD	6.2
Chemical Dose	mg/L	25
Chemical Dose (as stored weight)	mg/L	26
Chemical Usage	lb/day	1,330
Chemical Feed Rate	gpd	359
Chemical Feed Rate	gph	15.0
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	15.0
<u>Lime Storage Silos</u>		
Number of Silos	No.	1
Silo Capacity, each	cu ft	2,500
Silo Capacity, each	lbs	75,000
Silo Capacity, total	Tons	37.5
Silo Diameter, each	ft	13
Silo Sideshell Height, each	ft	19
Dry Usage	lbs/day	1,330
Dry Usage	tons/day	0.7
Storage Time	days	56
Delivery Truck Full Load	tons	24
Time Between Delivery	days	36

Table 15 Scale Inhibitor Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Scale Inhibitor Characteristics

Manufacturer/Product:	Avista Vitec 3000
Concentration:	100 %
Specific Gravity:	1.2
Solution Strength:	9.99 lb/gal

Parameters	Units	Criteria
<u>DPR - RO Pretreatment</u>		
Chemical Usage		
Location: Reverse Osmosis Feed		
Process Flow	MGD	7.8
Chemical Dose	mg/L	4.0
Chemical Usage	lb/day	261
Chemical Feed Rate	gpd	26
Chemical Feed Rate	gph	1.1
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	1.1
Chemical Feed Rate Per Pump	gpm	0.02
<u>Bulk Storage Totes</u>		
Number of Totes	No.	4
Tote Capacity, each	gal	250
Tote Capacity, total	gal	1,000
DPR RO Pretreatment	gal/day	26
Total Usage	gal/day	26
Storage Time	days	38
Delivery Truck Full Load	gal	250
Time Between Delivery	days	10

Table 16 Citric Acid Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Citric Acid Characteristics		
Concentration:	50 %	
Specific Gravity:	1.15	
Solution Strength:	4.79	lb/gal
Parameters	Units	Criteria
<u>AWTF MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	730.2
Chemical Feed Rate	gpm	152.5
Chemical Feed Rate	gpd	5.1
<u>WTP MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	5
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	521.6
Chemical Feed Rate	gpm	108.9
Chemical Feed Rate	gpd	3.6
<u>Bulk Storage Totes</u>		
Number of Totes	No.	2
Tote Capacity, each	gal	250
Tote Capacity, total	gal	500
MF/UF CIP	gal/month	261.5
Total Usage	gal/month	261.5
Storage Time	days	57
Delivery Truck Full Load	gal	250
Time Between Delivery	days	29

Table 17 Caustic Soda Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Caustic Soda Characteristics		
Concentration:	50 %	
Specific Gravity:	1.53	
Solution Strength:	6.37	lb/gal
Parameters	Units	Criteria
<u>AWTF MF/UF Clean-in-Place (CIP) (neutralize CA)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	730.2
Chemical Feed Rate	gpm	114.6
Chemical Feed Rate	gpd	3.8
<u>WTP MF/UF Clean-in-Place (CIP) (neutralize CA)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	5
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	521.6
Chemical Feed Rate	gpm	81.9
Chemical Feed Rate	gpd	2.7
<u>Bulk Storage Tote</u>		
Number of Totes	No.	2
Tote Capacity, each	gal	250
Tote Capacity, total	gal	500
MF/UF CIPs	gal/month	196.5
Total Usage	gal/month	196.5
Storage Time	days	76
Delivery Truck Full Load	gal	250
Time Between Delivery	days	38

Table 18 Sodium Bisulfite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Sodium Bisulfite Characteristics		
Concentration:	38 %	
Specific Gravity:	1.3	
Solution Strength:	4.11	lb/gal
Parameters	Units	Criteria
<u>AWTF MF/UF Maintenance Cleans (MC)</u>		
Chemical Usage (NaOCl Neutralization)		
Location: MF/UF CIP Tank		
Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	441
Chemical Usage	lb/day	64.4
Chemical Feed Rate	gpd	15.7
<u>AWTF MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	4,500
Chemical Usage	lb/month	657.2
Chemical Feed Rate	gpm	159.8
Chemical Feed Rate	gpd	5.3
<u>WTP MF/UF Maintenance Cleans (MC)</u>		
Chemical Usage (NaOCl Neutralization)		
Location: MF/UF CIP Tank		
Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	5
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	441
Chemical Usage	lb/day	46.0
Chemical Feed Rate	gpd	11.2
<u>WTP MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	5
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	4,500

Table 18 Sodium Bisulfite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Parameters	Units	Criteria
Chemical Usage	lb/month	469.4
Chemical Feed Rate	gpm	114.1
Chemical Feed Rate	gpd	3.8
<u>Bulk Storage Totes</u>		
Number of Totes	No.	4
Tote Capacity, each	gal	250
Tote Capacity, total	gal	1,000
MF/UF Maintenance Clean	gal/day	26.8
MF/UF CIP	gal/day	9.1
Total Usage	gal/day	36
Storage Time	days	28
Delivery Truck Full Load	gal	250
Time Between Delivery	days	7

Table 19 DPR - WTP Microfiltration Feed Pump Station Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
<u>MICROFILTRATION FEED PUMPS</u>		
Number of Pumps		
In-Service	No.	3
Reliability	No.	1
Total	No.	4
Type: Vertical Turbine		
Capacity		
Total	gpm	4,338
Per Pump	gpm	1,446
Total Dynamic Head Required (TDH)		
Water Surface El to Pump Discharge	ft	10
Minimum Discharge Pressure	psi	20
Maximum Discharge Pressure	psi	45
Safety Factor	ft	20
Design Pump TDH	feet	134
Motor Size		
Required	hp	64
Selected	hp	75
Drive	type	VFD
<u>MICROFILTRATION BACKWASH PUMPS</u>		
Number of Pumps		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Type: Vertical Turbine		
Capacity (per pump)		
Design (1.1*Flux Rate)	gpm	1,181
Maximum (1.3*Flux Rate)	gpm	1,567
Total Dynamic Head Required (TDH)		
Water Surface El to Pump Discharge	ft	10
Minimum Discharge Pressure	psi	10
Maximum Discharge Pressure	psi	30
Safety Factor	ft	20
Design Pump TDH	feet	103
Motor Size		
Required	hp	53
Selected	hp	60
Drive	type	VFD

Table 19 DPR - WTP Microfiltration Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>INFLUENT WET WELL</u>		
Number of Wet Wells	No.	1
Wet Well Dimensions (each)		
Depth	ft	15
Length	ft	50
Width	ft	15
Volume	ft ³	11,250
Volume	gallons	84,150
Storage Time		
Design Flow	Minutes	19

Table 20 DPR - WTP Strainer / Pre-Screen Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Filter (Strainer-type) w/ Automatic Cleaning Mechanism		
Materials: Stainless Steel		
Filter Rating	micron	250
Maximum Pressure Drop		
Clean Filter ⁽¹⁾	psi	3
Before Backwash ⁽²⁾	psi	7
Number of Filters		
In-Service	No.	2
Reliability	No.	1
Total	No.	3
Capacity (Total)	gpm	4,338
Capacity (per Screen)	gpm	2,169
Filter Media Type:	-	Wedgewire
Filter Material:	-	316 SST
Maximum Backwash Flowrate	gpm	310
Backwash Duration	min	1
Total Backwash Waste	gal	310
Housing Design Pressure	psi	150
Motor Size		
Selected	hp	0.33
Drive	type	CS

Table 21 DPR - WTP Microfiltration Train Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
<u>General Criteria</u>		
Type: Pressurized, Polymeric hollow fiber Microfiltration or Ultrafiltration		
Operating Strategy: Dead end flow		
Number of Microfiltration Trains		
In-Service	No.	4
Reliability	No.	1
Total	No.	5
<u>Production Criteria</u>		
Train Flux Rate		
Flux at Design Capacity (Net Production)	gfd	36
Flux at Design Capacity (Instantaneous)	gfd	40
Train Recovery Rate (Permeate/Feed Flow)		
Minimum	percent	94%
Train Permeate Flow Rate		
Total	gpm (mgd)	4,295 (6.2)
Design	gpm (mgd)	1,074 (1.5)
<u>Train Configuration</u>		
Type: Open Platform (Non-proprietary)		
Membrane Manufacturer (No. 1)		Toray
Module Model Number		2020N
Membrane Area per Module		775
Number of Installed Modules per Train	No.	56
Number of Blank Modules per Train	No.	8
Number of Total Module Spaces per Train	No.	64
<u>Backwash Criteria</u>		
Type: Reverse Flow Followed by Simultaneous Air Scour and Drain		
Backwash Interval per Train		
Minimum	minutes	20
Maximum	minutes	30
Backwash Supply Flow Rate (Water)		
Flux	gfd	52
Flow	gpm	1,567
Backwash Duration	sec	45
Backwash Supply Flow Rate (Air)	scfm	448
Volume of Wastewater Produced Per Backwash	Gallons	1,175

Table 21 DPR - WTP Microfiltration Train Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>Maintenance Clean Criteria (Typically only hypo clean)</u>		
Maintenance Clean Frequency	days	3
Sodium Hypochlorite Dose	mg/L	300
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Day	gallons	4,167
<u>Clean-in-Place (CIP) Criteria</u>		
CIP Frequency	days	30
Sodium Hypochlorite Dose	mg/L	3,000
Citric Acid Dose	mg/L	5,000
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Month	gallons	12,500
<u>Chemical Neutralization Criteria</u>		
Sodium Bisulfite Dose MC ¹	mg/L	450
Sodium Bisulfite Dose CIP ¹	mg/L	4,500
Sodium Hydroxide CIP	mg/L	5,000
Note: 1) Calculated as 1.5 times the sodium hypochlorite dose. Stoichiometric demand is 1.34 mg sodium bisulfite per 1 mg of sodium hypochlorite.		

Table 22 DPR - WTP Microfiltration Backwash Air Scour Blowers Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara			
Description		Units	Criteria
Type: Rotary Lobe			
Number of Blowers			
In-Service		No.	1
Reliability		No.	1
Total		No.	2
Discharge Pressure		psi	13
Air Flow Rate		scfm	
Design		scfm	392
Maximum		scfm	448
Motor Size			
Required		hp	32
Selected		hp	50
Drive		type	VFD

Table 23 Direct Potable Reuse Train - Finished Water Pump Station Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara			
Description		Units	Criteria
<u>FINISHED WATER PUMPS TO SOUTH COAST CONDUIT</u>			
Number of Pumps			
In-Service		No.	3
Reliability		No.	1
Total		No.	4
Type: Vertical Turbine			
Capacity			
Total		gpm	4,295
Per Pump		gpm	1,432
Total Dynamic Head Required (TDH)			
Head required to reach reservoir		feet	534
Average Pump TDH		feet	554
Maximum Pump TDH		feet	584
Motor Size			
Average operating		hp	250
Required (based on maximum discharge pressure)		hp	264
Selected		hp	275
Drive		type	VFD

Table 1 Process Flow Rates - IPR Facility Alt 3a Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara			
Description	Units	Direct Potable Reuse Capacities	
<u>Source and Finished Water Flows</u>			
City Secondary Effluent	AFY	8,660	
City Secondary Effluent	gpm (mgd)	5,369	(7.7)
<u>Process Flows: AWTF</u>			
Microfiltration			
Recovery	%	94%	
Permeate Flow	gpm (mgd)	5,369	(7.7)
Feedwater Flow ¹	gpm (mgd)	5,712	(8.2)
Backwash Flow	gpm (mgd)	343	(0.5)
<u>Process Flows: NPR</u>			
Flow to NPR System	gpm (mgd)	868	(1.2)
Reverse Osmosis			
Recovery	%	80%	
Permeate Flow	gpm (mgd)	3,601	(5.2)
Feedwater Flow	gpm (mgd)	4,501	(6.5)
Brine Flow	gpm (mgd)	900	(1.3)
UV / AOP			
Process Flow	gpm (mgd)	3,601	(5.2)
<u>Total Finished Water Flows</u>			
Total NPR Flow	gpm (mgd)	868	(1.2)
Total IPR Flow	gpm (mgd)	3,601	(5.2)
Total Usable Flow	gpm (mgd)	4,469	(6.4)
Total NPR Flow	AFY	1,400	
Total IPR Flow	AFY	5,808	
Total Usable Flow	AFY	7,208	
Recovery of WWTP Effluent	%	83%	
Note:			
1) MF backwash is recycled to head of WWTP. Instantaneous flow is higher than permeate flow.			

Table 2 IPR - Microfiltration Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>MICROFILTRATION FEED PUMPS</u>		
Number of Pumps		
In-Service	No.	4
Reliability	No.	1
Total	No.	5
Type: Vertical Turbine		
Capacity		
Total	gpm	5,712
Per Pump	gpm	1,428
Total Dynamic Head Required (TDH)		
Water Surface El to Pump Discharge	ft	10
Minimum Discharge Pressure	psi	20
Maximum Discharge Pressure	psi	45
Safety Factor	ft	20
Design Pump TDH	feet	134
Motor Size		
Required	hp	63
Selected	hp	100
Drive	type	VFD
<u>MICROFILTRATION BACKWASH PUMPS</u>		
Number of Pumps		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Type: Vertical Turbine		
Capacity (per pump)		
Design (1.1*Flux Rate)	gpm	984
Maximum (1.5*Flux Rate)	gpm	1,582
Total Dynamic Head Required (TDH)		
Water Surface El to Pump Discharge	ft	10
Minimum Discharge Pressure	psi	10
Maximum Discharge Pressure	psi	30
Safety Factor	ft	20
Design Pump TDH	feet	103
Motor Size		
Required	hp	53
Selected	hp	60
Drive	type	VFD

Table 2 IPR - Microfiltration Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>INFLUENT WET WELL</u>		
Number of Wet Wells	No.	1
Wet Well Dimensions (each)		
Depth	ft	15
Length	ft	62
Width	ft	18
Volume	ft ³	16,740
Volume	gallons	125,215
Storage Time		
Design Flow	Minutes	22

Table 3 IPR - Strainer / Pre-Screen Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Filter (Strainer-type) w/ Automatic Cleaning Mechanism		
Materials: Stainless Steel		
Filter Rating	micron	250
Maximum Pressure Drop		
Clean Filter ⁽¹⁾	psi	3
Before Backwash ⁽²⁾	psi	7
Number of Filters		
In-Service	No.	2
Reliability	No.	1
Total	No.	3
Capacity (Total)	gpm	5,712
Capacity (per Screen)	gpm	2,856
Filter Media Type:	-	Wedgewire
Filter Material:	-	316 SST
Maximum Backwash Flowrate	gpm	310
Backwash Duration	min	1
Total Backwash Waste	gal	310
Housing Design Pressure	psi	150
Motor Size		
Selected	hp	0.33
Drive	type	CS

Table 4		IPR - Microfiltration Train Design Criteria			
		Subsurface Desalination Intake and Potable Reuse Feasibility Studies			
		City of Santa Barbara			
Description		Units		Criteria	
<u>General Criteria</u>					
Type: Pressurized, Polymeric hollow fiber Microfiltration or Ultrafiltration					
Operating Strategy: Dead end flow					
Number of Microfiltration Trains					
In-Service		No.		6	
Reliability		No.		1	
Total		No.		7	
<u>Production Criteria</u>					
Train Flux Rate					
Flux at Design Capacity (Net Production)		gfd		30	
Flux at Design Capacity (Instantaneous)		gfd		35	
Train Recovery Rate (Permeate/Feed Flow)					
Minimum		percent		94%	
Train Permeate Flow Rate					
Total		gpm (mgd)	5,369	(7.7)	
Design		gpm (mgd)	895	(1.3)	
<u>Train Configuration</u>					
Type: Open Platform (Non-proprietary)					
Membrane Manufacturer (No. 1)				Toray	
Module Model Number				2020N	
Membrane Area per Module				775	
Number of Installed Modules per Train		No.	56		
Number of Blank Modules per Train		No.	8		
Number of Total Module Spaces per Train		No.	64		
<u>Backwash Criteria</u>					
Type: Reverse Flow Followed by Simultaneous Air Scour and Drain					
Backwash Interval per Train					
Minimum		minutes	20		
Maximum		minutes	30		
Backwash Supply Flow Rate (Water)					
Flux		gfd	46		
Flow		gpm	1,582		
Backwash Duration		sec	45		
Backwash Supply Flow Rate (Air)		scfm	448		
Volume of Wastewater Produced					
Per Backwash		gallons	1,187		

Table 4 IPR - Microfiltration Train Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>Maintenance Clean Criteria (Typically only hypo clean)</u>		
Maintenance Clean Frequency	days	1
Sodium Hypochlorite Dose	mg/L	300
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Day	gallons	17,500
<u>Clean-in-Place (CIP) Criteria</u>		
CIP Frequency	days	30
Sodium Hypochlorite Dose	mg/L	3,000
Citric Acid Dose	mg/L	5,000
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Month	gallons	17,500
<u>Chemical Neutralization Criteria</u>		
Sodium Bisulfite Dose MC ¹	mg/L	450
Sodium Bisulfite Dose CIP ¹	mg/L	4,500
Sodium Hydroxide CIP	mg/L	5,000
Note: 1) Calculated as 1.5 times the sodium hypochlorite dose. Stoichiometric demand is 1.34 mg sodium bisulfite per 1 mg of sodium hypochlorite.		

Table 5 IPR - Microfiltration Backwash Air Scour Blowers Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
Type: Rotary Lobe		
Number of Blowers		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Discharge Pressure	psi	13
Air Flow Rate	scfm	
Design	scfm	392
Maximum	scfm	448
Motor Size		
Required	hp	32
Selected	hp	50
Drive	type	VFD

Table 6 IPR - RO Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>RO HIGH PRESSURE FEED PUMPS</u>		
Number of Pumps		
In-Service	No.	4
Reliability	No.	0
Total	No.	4
Type: Vertical Turbine		
Capacity		
Total	gpm	4,501
Per Pump	gpm	1,125
Total Dynamic Head Required (TDH)		
Average Discharge Pressure	psi	120
Average Pump TDH	feet	297
Maximum Discharge Pressure	psi	145
Maximum Pump TDH	feet	355
Motor Size		
Average operating	hp	106
Required (based on maximum discharge pressure)	hp	126
Selected	hp	150
Drive	type	VFD
<u>WET WELL</u>		
Number of Wet Wells	No.	1
Wet Well Dimensions (each)		
Depth	ft	10
Length	ft	80
Width	ft	15
Volume	ft ³	12,000
Volume	gallons	89,766
Storage Time		
Design Flow	Minutes	20

Table 7 IPR - Reverse Osmosis Trains Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria	
Number of Reverse Osmosis Trains			
In-Service	No.	4	
Reliability	No.	0	
Total	No.	4	
Train Flux Rate ⁽¹⁾	gfd	11	
Recovery (Permeate/Feed Flow)	percent	80%	
Total Permeate Flow	gpm (mgd)	3,601	(6.5)
Total Permeate Flow per Train	gpm (mgd)	900	(1.3)
Brine Flow per Train	gpm (mgd)	225	(0.32)
Number of Array Stages Per Train	No.	2	
1st Stage			
Pressure Vessels per Train	No.	28	
Elements per Pressure Vessel	No.	7	
2nd Stage			
Pressure Vessels per Train	No.	1714	
Elements per Pressure Vessel	No.	7	
Number of Elements			
Per Train	No.	294	
Total (In-Service)	No.	1,176	
Membrane Manufacturer(s) ⁽²⁾		Dow FilmTec, Hydranautics, or Toray	
	-	BW30-400/34i, ESPA2-LD, or TML20D-400	
Membrane Model No. ⁽²⁾			
	-		
Membrane Area ⁽²⁾			
Per Element	sq. ft.	400	
Per Train	sq. ft.	117,600	
Total (In-service)	sq. ft.	470,400	

Table 8 IPR - RO Interstage Booster Pump Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Turbine assisted motorized booster pump		
Manufacturer: FEDCO		
Model: LP-HEMI, LPH-240-125T		
LP-HEMI Units Per RO Train	No.	1
Total Number of Units	No.	4
<u>Pump Data</u>		
Stages	No.	1
Flow		
At 80 Percent RO Recovery	gpm	526
Minimum Total Dynamic Head ⁽¹⁾	ft	70
Maximum Total Dynamic Head ⁽²⁾	ft	120
Shaft Power		
Minimum Required	hp	12
Maximum Required	hp	21
<u>Motor Data</u>		
Drive	type	VFD
Position: Vertical		
Power Rating	hp	25
Notes: 1) Clean-membrane (start-up) conditions. 2) Fouled membrane (end of life), worst water quality conditions.		

Table 9 IPR - UV Disinfection / AOP Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria	
Process Type: Low Pressure High Output Ultraviolet Light Reactor w/ NaOCl AOP			
Manufacturer(s): Wedeco			
Model(s): k143 w/ 600 watt lamps			
Number of UV Reactors			
In-Service	No.	1	
Reliability	No.	1	
Total	No.	2	
Flows			
Total Flow to Reactors	gpm (mgd)	3,601	(5.2)
Flow to Each Reactor	gpm (mgd)	3,601	(5.2)
UV Transmittance (UVT)	percent	95	
UV Dose ⁽¹⁾	mJ/cm ²	920	
NaOCl Dose	mg/L	4	
Note:			
1) Dose required to achieve 6-log virus and 6-log protozoa inactivation using hypochlorite for the AOP process.			

Table 10 Indirect Potable Reuse Train - Storage and Equalization Tanks Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
<u>ENGINEERED STORAGE TANKS</u>		
Product Flow	gpm	3,601
Number of Tanks	No.	2
Tank Dimensions		
Diameter	ft	70
Height	ft	35
Volume (each)	ft ³	134,696
Volume (each)	gallons	1,007,524
Volume (actual)	gallons	1,000,000
Volume (total)	gallons	2,000,000
Storage Time (w/ one tank out of service)		
Design Flow	Minutes	278
Design Flow	Hours	5
Storage Time (total)		
Design Flow	Minutes	555
Design Flow	Hours	9
Description	Units	Criteria
<u>EQUALIZATION TANKS</u>		
Product Flow	gpm	5,369
Number of Tanks	No.	2
Tank Dimensions		
Diameter	ft	82
Height	ft	35
Volume (each)	ft ³	184,836
Volume (each)	gallons	1,382,570
Volume (actual)	gallons	1,500,000
Volume (total)	gallons	3,000,000
Storage Time (each)		
Design Flow	Minutes	279
Design Flow	Hours	5
Storage Time (total)		
Design Flow	Minutes	559
Design Flow	Hours	9

Table 11 Sodium Hypochlorite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Sodium Hypochlorite Characteristics

Concentration:	10.5 %	
Specific Gravity:	1.008	
Solution Strength:	0.88	lb/gal

Parameters	Units	Criteria
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Ultraviolet Light / Advanced Oxidation Process

Chemical Usage

Location: RO Permeate Before UV Reactors

Process Flow	MGD	5.2
Chemical Dose	mg/L	4.0
Chemical Usage	lb/day	173
Chemical Feed Rate	gpd	196
Chemical Feed Rate	gph	8.2
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	8.2

MF/UF Maintenance Cleans (MC)

Chemical Usage

Location: MF/UF CIP Tank

Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	300
Chemical Usage	lb/day	43.8
Chemical Feed Rate	gpd	49.7

MF/UF Clean-in-Place (CIP)

Chemical Usage

Location: MF/UF CIP Tank

Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	3,000
Chemical Usage	lb/month	438.1
Chemical Feed Rate	gpm	497.2
Chemical Feed Rate	gpd	16.6

Table 11 Sodium Hypochlorite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Parameters	Units	Criteria
<u>Bulk Storage Tanks</u>		
Number of Tanks	No.	2
Tank Capacity, each	gal	5,500
Tank Capacity, total	gal	11,000
UV/AOP Usage	gal/day	196
MF/UF Maintenance Cleans	gal/day	49.7
MF/UF CIPs	gal/day	16.6
Total Usage	gal/day	263
Storage Time	days	42
Delivery Truck Full Load	gal	3,000
Time Between Delivery	days	11

Table 12 Sulfuric Acid Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Sulfuric Acid Characteristics		
Concentration:	93 %	
Specific Gravity:	1.83	
Solution Strength:	14.17	lb/gal
Parameters	Units	Criteria
<u>IPR RO Pretreatment</u>		
Chemical Usage		
Location: Reverse Osmosis Feed		
Process Flow	MGD	6.5
Chemical Dose	mg/L	115
Chemical Usage	lb/day	6,220
Chemical Feed Rate	gpd	439
Chemical Feed Rate	gph	18.3
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	18.3
<u>Bulk Storage Tanks</u>		
Number of Tanks	No.	2
Tank Capacity, each	gal	8,000
Tank Capacity, total	gal	16,000
Total Usage	gal/day	439
Storage Time	days	36
Delivery Truck Full Load	gal	3,000
Time Between Delivery	days	7

Table 13 Lime Slurry Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Lime Characteristics		
Lime Purity	%	97%
Dry Lime Bulk Density (Storage Value)	lb/cu ft	30
Concentration:	%	35 %
Specific Gravity:		1.271
Solution Strength:	lb/gal	3.70
Parameters	Units	Criteria
<u>IPR Post Treatment</u>		
Chemical Usage		
Location: Before Treated Water Wet Well		
Process Flow	MGD	5.2
Chemical Dose	mg/L	25
Chemical Dose (as stored weight)	mg/L	26
Chemical Usage	lb/day	1,115
Chemical Feed Rate	gpd	301
Chemical Feed Rate	gph	12.5
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	12.5
<u>Lime Storage Silos</u>		
Number of Silos	No.	1
Silo Capacity, each	cu ft	2,500
Silo Capacity, each	lbs	75,000
Silo Capacity, total	Tons	37.5
Silo Diameter, each	ft	13
Silo Sideshell Height, each	ft	19
Dry Usage	lbs/day	1,115
Dry Usage	tons/day	0.6
Storage Time	days	67
Delivery Truck Full Load	tons	24
Time Between Delivery	days	43

Table 14 Scale Inhibitor Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Scale Inhibitor Characteristics

Manufacturer/Product:	Avista Vitec 3000	
Concentration:	100 %	
Specific Gravity:	1.2	
Solution Strength:	9.99	lb/gal

Parameters	Units	Criteria
<u>IPR - RO Pretreatment</u>		
Chemical Usage		
Location: Reverse Osmosis Feed		
Process Flow	MGD	6.5
Chemical Dose	mg/L	4.0
Chemical Usage	lb/day	216
Chemical Feed Rate	gpd	22
Chemical Feed Rate	gph	0.9
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	0.9
Chemical Feed Rate Per Pump	gpm	0.02
<u>Bulk Storage Totes</u>		
Number of Totes	No.	4
Tote Capacity, each	gal	250
Tote Capacity, total	gal	1,000
DPR RO Pretreatment	gal/day	22
Total Usage	gal/day	22
Storage Time	days	46
Delivery Truck Full Load	gal	250
Time Between Delivery	days	12

Table 15 Citric Acid Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Citric Acid Characteristics		
Concentration:	50 %	
Specific Gravity:	1.15	
Solution Strength:	4.79	lb/gal
Parameters	Units	Criteria
<u>MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	730.2
Chemical Feed Rate	gpm	152.5
Chemical Feed Rate	gpd	5.1
<u>Bulk Storage Totes</u>		
Number of Totes	No.	2
Tote Capacity, each	gal	250
Tote Capacity, total	gal	500
MF/UF CIP	gal/month	152.5
Total Usage	gal/month	152.5
Storage Time	days	98
Delivery Truck Full Load	gal	250
Time Between Delivery	days	49

Table 16 Caustic Soda Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Caustic Soda Characteristics		
Concentration:	50 %	
Specific Gravity:	1.53	
Solution Strength:	6.37	lb/gal
Parameters	Units	Criteria
<u>MF/UF Clean-in-Place (CIP) (neutralize CA)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	730.2
Chemical Feed Rate	gpm	114.6
Chemical Feed Rate	gpd	3.8
<u>Bulk Storage Tote</u>		
Number of Totes	No.	2
Tote Capacity, each	gal	250
Tote Capacity, total	gal	500
MF/UF CIPs	gal/month	114.6
Total Usage	gal/month	114.6
Storage Time	days	131
Delivery Truck Full Load	gal	250
Time Between Delivery	days	65

Table 17 Sodium Bisulfite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Sodium Bisulfite Characteristics		
Concentration:	38 %	
Specific Gravity:	1.3	
Solution Strength:	4.11	lb/gal
Parameters	Units	Criteria
<u>MF/UF Maintenance Cleans (MC)</u>		
Chemical Usage (NaOCl Neutralization)		
Location: MF/UF CIP Tank		
Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	441
Chemical Usage	lb/day	64.4
Chemical Feed Rate	gpd	15.7
<u>MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	4,500
Chemical Usage	lb/month	657.2
Chemical Feed Rate	gpm	159.8
Chemical Feed Rate	gpd	5.3
<u>Bulk Storage Totes</u>		
Number of Totes	No.	4
Tote Capacity, each	gal	250
Tote Capacity, total	gal	1,000
MF/UF Maintenance Clean	gal/day	15.7
MF/UF CIP	gal/day	5.3
Total Usage	gal/day	21
Storage Time	days	48
Delivery Truck Full Load	gal	250
Time Between Delivery	days	12

Table 18 Indirect Potable Reuse Train - Finished Water Pump Station Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara			
Description		Units	Criteria
<u>FINISHED WATER PUMPS TO IPR INJECTION WELLS</u>			
Number of Pumps			
In-Service		No.	3
Reliability		No.	1
Total		No.	4
Type: Vertical Turbine			
Capacity			
Total		gpm	3,601
Per Pump		gpm	1,200
Total Dynamic Head Required (TDH)			
Head required to reach reservoir		feet	373
Average Pump TDH		feet	393
Maximum Pump TDH		feet	423
Motor Size			
Average operating		hp	149
Required (based on maximum discharge pressure)		hp	160
Selected		hp	175
Drive		type	VFD

Table 1 Process Flow Rates - IPR Facility Alt 3b Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara			
Description	Units	Direct Potable Reuse Capacities	
<u>Source and Finished Water Flows</u>			
City Secondary Effluent	AFY	8,660	
City Secondary Effluent	gpm (mgd)	5,369	(7.7)
<u>Process Flows: AWTF</u>			
Microfiltration			
Recovery	%	94%	
Permeate Flow	gpm (mgd)	5,369	(7.7)
Feedwater Flow ¹	gpm (mgd)	5,712	(8.2)
Backwash Flow	gpm (mgd)	343	(0.5)
Reverse Osmosis			
Recovery	%	80%	
Permeate Flow	gpm (mgd)	4,295	(6.2)
Feedwater Flow	gpm (mgd)	5,369	(7.7)
Brine Flow	gpm (mgd)	1,074	(1.5)
UV / AOP			
Process Flow	gpm (mgd)	4,295	(6.2)
<u>Total Finished Water Flows</u>			
Total NPR Flow	gpm (mgd)	0	(0.0)
Total IPR Flow	gpm (mgd)	4,295	(6.2)
Total Usable Flow	gpm (mgd)	4,295	(6.2)
Total NPR Flow	AFY	0	
Total IPR Flow	AFY	6,928	
Total Usable Flow	AFY	6,928	
Recovery of WWTP Effluent	%	80%	
Note:			
1) MF backwash is recycled to head of WWTP. Instantaneous flow is higher than permeate flow.			

Table 2 IPR - Microfiltration Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>MICROFILTRATION FEED PUMPS</u>		
Number of Pumps		
In-Service	No.	4
Reliability	No.	1
Total	No.	5
Type: Vertical Turbine		
Capacity		
Total	gpm	5,712
Per Pump	gpm	1,428
Total Dynamic Head Required (TDH)		
Water Surface El to Pump Discharge	ft	10
Minimum Discharge Pressure	psi	20
Maximum Discharge Pressure	psi	45
Safety Factor	ft	20
Design Pump TDH	feet	134
Motor Size		
Required	hp	63
Selected	hp	100
Drive	type	VFD
<u>MICROFILTRATION BACKWASH PUMPS</u>		
Number of Pumps		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Type: Vertical Turbine		
Capacity (per pump)		
Design (1.1*Flux Rate)	gpm	984
Maximum (1.5*Flux Rate)	gpm	1,582
Total Dynamic Head Required (TDH)		
Water Surface El to Pump Discharge	ft	10
Minimum Discharge Pressure	psi	10
Maximum Discharge Pressure	psi	30
Safety Factor	ft	20
Design Pump TDH	feet	103
Motor Size		
Required	hp	53
Selected	hp	60
Drive	type	VFD

Table 2 IPR - Microfiltration Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>INFLUENT WET WELL</u>		
Number of Wet Wells	No.	1
Wet Well Dimensions (each)		
Depth	ft	15
Length	ft	62
Width	ft	18
Volume	ft ³	16,740
Volume	gallons	125,215
Storage Time		
Design Flow	Minutes	22

Table 3 IPR - Strainer / Pre-Screen Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Filter (Strainer-type) w/ Automatic Cleaning Mechanism		
Materials: Stainless Steel		
Filter Rating	micron	250
Maximum Pressure Drop		
Clean Filter ⁽¹⁾	psi	3
Before Backwash ⁽²⁾	psi	7
Number of Filters		
In-Service	No.	2
Reliability	No.	1
Total	No.	3
Capacity (Total)	gpm	5,712
Capacity (per Screen)	gpm	2,856
Filter Media Type:	-	Wedgewire
Filter Material:	-	316 SST
Maximum Backwash Flowrate	gpm	310
Backwash Duration	min	1
Total Backwash Waste	gal	310
Housing Design Pressure	psi	150
Motor Size		
Selected	hp	0.33
Drive	type	CS

Table 4		IPR - Microfiltration Train Design Criteria			
		Subsurface Desalination Intake and Potable Reuse Feasibility Studies			
		City of Santa Barbara			
Description		Units		Criteria	
<u>General Criteria</u>					
Type: Pressurized, Polymeric hollow fiber Microfiltration or Ultrafiltration					
Operating Strategy: Dead end flow					
Number of Microfiltration Trains					
In-Service		No.		6	
Reliability		No.		1	
Total		No.		7	
<u>Production Criteria</u>					
Train Flux Rate					
Flux at Design Capacity (Net Production)		gfd		30	
Flux at Design Capacity (Instantaneous)		gfd		35	
Train Recovery Rate (Permeate/Feed Flow)					
Minimum		percent		94%	
Train Permeate Flow Rate					
Total		gpm (mgd)	5,369	(7.7)	
Design		gpm (mgd)	895	(1.3)	
<u>Train Configuration</u>					
Type: Open Platform (Non-proprietary)					
Membrane Manufacturer (No. 1)				Toray	
Module Model Number				2020N	
Membrane Area per Module				775	
Number of Installed Modules per Train		No.	56		
Number of Blank Modules per Train		No.	8		
Number of Total Module Spaces per Train		No.	64		
<u>Backwash Criteria</u>					
Type: Reverse Flow Followed by Simultaneous Air Scour and Drain					
Backwash Interval per Train					
Minimum		minutes	20		
Maximum		minutes	30		
Backwash Supply Flow Rate (Water)					
Flux		gfd	46		
Flow		gpm	1,582		
Backwash Duration		sec	45		
Backwash Supply Flow Rate (Air)		scfm	448		
Volume of Wastewater Produced					
Per Backwash		gallons	1,187		

Table 4 IPR - Microfiltration Train Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>Maintenance Clean Criteria (Typically only hypo clean)</u>		
Maintenance Clean Frequency	days	1
Sodium Hypochlorite Dose	mg/L	300
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Day	gallons	17,500
<u>Clean-in-Place (CIP) Criteria</u>		
CIP Frequency	days	30
Sodium Hypochlorite Dose	mg/L	3,000
Citric Acid Dose	mg/L	5,000
Maintenance Clean Batch Tank Volume	gallons	2,500
Volume of Wastewater Produced		
Per Train	gallons	2,500
Per Month	gallons	17,500
<u>Chemical Neutralization Criteria</u>		
Sodium Bisulfite Dose MC ¹	mg/L	450
Sodium Bisulfite Dose CIP ¹	mg/L	4,500
Sodium Hydroxide CIP	mg/L	5,000
Note: 1) Calculated as 1.5 times the sodium hypochlorite dose. Stoichiometric demand is 1.34 mg sodium bisulfite per 1 mg of sodium hypochlorite.		

Table 5 IPR - Microfiltration Backwash Air Scour Blowers Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
Type: Rotary Lobe		
Number of Blowers		
In-Service	No.	1
Reliability	No.	1
Total	No.	2
Discharge Pressure	psi	13
Air Flow Rate	scfm	
Design	scfm	392
Maximum	scfm	448
Motor Size		
Required	hp	32
Selected	hp	50
Drive	type	VFD

Table 6 IPR - RO Feed Pump Station Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
<u>RO HIGH PRESSURE FEED PUMPS</u>		
Number of Pumps		
In-Service	No.	4
Reliability	No.	0
Total	No.	4
Type: Vertical Turbine		
Capacity		
Total	gpm	5,369
Per Pump	gpm	1,342
Total Dynamic Head Required (TDH)		
Average Discharge Pressure	psi	120
Average Pump TDH	feet	297
Maximum Discharge Pressure	psi	145
Maximum Pump TDH	feet	355
Motor Size		
Average operating	hp	126
Required (based on maximum discharge pressure)	hp	150
Selected	hp	175
Drive	type	VFD
<u>WET WELL</u>		
Number of Wet Wells	No.	1
Wet Well Dimensions (each)		
Depth	ft	10
Length	ft	80
Width	ft	15
Volume	ft ³	12,000
Volume	gallons	89,766
Storage Time		
Design Flow	Minutes	17

Table 7 IPR - Reverse Osmosis Trains Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Number of Reverse Osmosis Trains		
In-Service	No.	4
Reliability	No.	0
Total	No.	4
Train Flux Rate ⁽¹⁾	gfd	11
Recovery (Permeate/Feed Flow)	percent	80%
Total Permeate Flow	gpm (mgd)	4,295 (7.7)
Total Permeate Flow per Train	gpm (mgd)	1,074 (1.5)
Brine Flow per Train	gpm (mgd)	268 (0.39)
Number of Array Stages Per Train	No.	2
1st Stage		
Pressure Vessels per Train	No.	34
Elements per Pressure Vessel	No.	7
2nd Stage		
Pressure Vessels per Train	No.	17
Elements per Pressure Vessel	No.	7
Number of Elements		
Per Train	No.	357
Total (In-Service)	No.	1,428
Membrane Manufacturer(s) ⁽²⁾		Dow FilmTec, Hydranautics, or Toray
Membrane Model No. ⁽²⁾		BW30-400/34i, ESPA2-LD, or TML20D-400
Membrane Area ⁽²⁾		
Per Element	sq. ft.	400
Per Train	sq. ft.	142,800
Total (In-service)	sq. ft.	571,200

Table 8 IPR - RO Interstage Booster Pump Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Description	Units	Criteria
Type: Turbine assisted motorized booster pump		
Manufacturer: FEDCO		
Model: LP-HEMI, LPH-240-125T		
LP-HEMI Units Per RO Train	No.	1
Total Number of Units	No.	4
<u>Pump Data</u>		
Stages	No.	1
Flow		
At 80 Percent RO Recovery	gpm	615
Minimum Total Dynamic Head ⁽¹⁾	ft	70
Maximum Total Dynamic Head ⁽²⁾	ft	120
Shaft Power		
Minimum Required	hp	14
Maximum Required	hp	24
<u>Motor Data</u>		
Drive	type	VFD
Position: Vertical		
Power Rating	hp	30
Notes:		
1) Clean-membrane (start-up) conditions.		
2) Fouled membrane (end of life), worst water quality conditions.		

Table 9 IPR - UV Disinfection / AOP Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria	
Process Type: Low Pressure High Output Ultraviolet Light Reactor w/ NaOCl AOP			
Manufacturer(s): Wedeco			
Model(s): k143 w/ 600 watt lamps			
Number of UV Reactors			
In-Service	No.	1	
Reliability	No.	1	
Total	No.	2	
Flows			
Total Flow to Reactors	gpm (mgd)	4,295	(6.2)
Flow to Each Reactor	gpm (mgd)	4,295	(6.2)
UV Transmittance (UVT)	percent	95	
UV Dose ⁽¹⁾	mJ/cm ²	920	
NaOCl Dose	mg/L	4	
Note:			
1) Dose required to achieve 6-log virus and 6-log protozoa inactivation using hypochlorite for the AOP process.			

Table 10 Indirect Potable Reuse Train - Storage and Equalization Tanks Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Description	Units	Criteria
<u>ENGINEERED STORAGE TANKS</u>		
Product Flow	gpm	4,295
Number of Tanks	No.	2
Tank Dimensions		
Diameter	ft	70
Height	ft	35
Volume (each)	ft ³	134,696
Volume (each)	gallons	1,007,524
Volume (actual)	gallons	1,000,000
Volume (total)	gallons	2,000,000
Storage Time (w/ one tank out of service)		
Design Flow	Minutes	233
Design Flow	Hours	4
Storage Time (total)		
Design Flow	Minutes	466
Design Flow	Hours	8
Description	Units	Criteria
<u>EQUALIZATION TANKS</u>		
Product Flow	gpm	5,369
Number of Tanks	No.	2
Tank Dimensions		
Diameter	ft	82
Height	ft	35
Volume (each)	ft ³	184,836
Volume (each)	gallons	1,382,570
Volume (actual)	gallons	1,500,000
Volume (total)	gallons	3,000,000
Storage Time (each)		
Design Flow	Minutes	279
Design Flow	Hours	5
Storage Time (total)		
Design Flow	Minutes	559
Design Flow	Hours	9

Table 11 Sodium Hypochlorite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Sodium Hypochlorite Characteristics

Concentration:	10.5 %	
Specific Gravity:	1.008	
Solution Strength:	0.88	lb/gal

Parameters	Units	Criteria
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Ultraviolet Light / Advanced Oxidation Process

Chemical Usage

Location: RO Permeate Before UV Reactors

Process Flow	MGD	6.2
Chemical Dose	mg/L	4.0
Chemical Usage	lb/day	206
Chemical Feed Rate	gpd	234
Chemical Feed Rate	gph	9.8
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	9.8

MF/UF Maintenance Cleans (MC)

Chemical Usage

Location: MF/UF CIP Tank

Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	300
Chemical Usage	lb/day	43.8
Chemical Feed Rate	gpd	49.7

MF/UF Clean-in-Place (CIP)

Chemical Usage

Location: MF/UF CIP Tank

Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	3,000
Chemical Usage	lb/month	438.1
Chemical Feed Rate	gpm	497.2
Chemical Feed Rate	gpd	16.6

Table 11 Sodium Hypochlorite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Parameters	Units	Criteria
<u>Bulk Storage Tanks</u>		
Number of Tanks	No.	2
Tank Capacity, each	gal	4,000
Tank Capacity, total	gal	8,000
UV/AOP Usage	gal/day	234
MF/UF Maintenance Cleans	gal/day	49.7
MF/UF CIPs	gal/day	16.6
Total Usage	gal/day	301
Storage Time	days	27
Delivery Truck Full Load	gal	3,000
Time Between Delivery	days	10

Table 12 Sulfuric Acid Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Sulfuric Acid Characteristics		
Concentration:	93 %	
Specific Gravity:	1.83	
Solution Strength:	14.17	lb/gal
Parameters	Units	Criteria
<u>IPR RO Pretreatment</u>		
Chemical Usage		
Location: Reverse Osmosis Feed		
Process Flow	MGD	7.7
Chemical Dose	mg/L	115
Chemical Usage	lb/day	7,419
Chemical Feed Rate	gpd	524
Chemical Feed Rate	gph	21.8
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	21.8
<u>Bulk Storage Tanks</u>		
Number of Tanks	No.	2
Tank Capacity, each	gal	8,000
Tank Capacity, total	gal	16,000
Total Usage	gal/day	524
Storage Time	days	31
Delivery Truck Full Load	gal	3,000
Time Between Delivery	days	6

Table 13 Lime Slurry Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Lime Characteristics		
Lime Purity	%	97%
Dry Lime Bulk Density (Storage Value)	lb/cu ft	30
Concentration:	%	35 %
Specific Gravity:		1.271
Solution Strength:	lb/gal	3.70
Parameters	Units	Criteria
<u>IPR Post Treatment</u>		
Chemical Usage		
Location: Before Treated Water Wet Well		
Process Flow	MGD	6.2
Chemical Dose	mg/L	25
Chemical Dose (as stored weight)	mg/L	26
Chemical Usage	lb/day	1,330
Chemical Feed Rate	gpd	359
Chemical Feed Rate	gph	15.0
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	15.0
<u>Lime Storage Silos</u>		
Number of Silos	No.	1
Silo Capacity, each	cu ft	2,500
Silo Capacity, each	lbs	75,000
Silo Capacity, total	Tons	37.5
Silo Diameter, each	ft	13
Silo Sideshell Height, each	ft	19
Dry Usage	lbs/day	1,330
Dry Usage	tons/day	0.7
Storage Time	days	56
Delivery Truck Full Load	tons	24
Time Between Delivery	days	36

Table 14 Scale Inhibitor Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Scale Inhibitor Characteristics

Manufacturer/Product:	Avista Vitec 3000	
Concentration:	100 %	
Specific Gravity:	1.2	
Solution Strength:	9.99	lb/gal

Parameters	Units	Criteria
<u>IPR - RO Pretreatment</u>		
Chemical Usage		
Location: Reverse Osmosis Feed		
Process Flow	MGD	7.7
Chemical Dose	mg/L	4.0
Chemical Usage	lb/day	258
Chemical Feed Rate	gpd	26
Chemical Feed Rate	gph	1.1
No. of Standby Pumps	-	1
No. of Pumps in Service	-	1
Chemical Feed Rate Per Pump	gph	1.1
Chemical Feed Rate Per Pump	gpm	0.02
<u>Bulk Storage Totes</u>		
Number of Totes	No.	4
Tote Capacity, each	gal	250
Tote Capacity, total	gal	1,000
DPR RO Pretreatment	gal/day	26
Total Usage	gal/day	26
Storage Time	days	39
Delivery Truck Full Load	gal	250
Time Between Delivery	days	10

Table 15 Citric Acid Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Citric Acid Characteristics		
Concentration:	50 %	
Specific Gravity:	1.15	
Solution Strength:	4.79	lb/gal
Parameters	Units	Criteria
<u>MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	730.2
Chemical Feed Rate	gpm	152.5
Chemical Feed Rate	gpd	5.1
<u>Bulk Storage Totes</u>		
Number of Totes	No.	2
Tote Capacity, each	gal	250
Tote Capacity, total	gal	500
MF/UF CIP	gal/month	152.5
Total Usage	gal/month	152.5
Storage Time	days	98
Delivery Truck Full Load	gal	250
Time Between Delivery	days	49

Table 16 Caustic Soda Design Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara		
Caustic Soda Characteristics		
Concentration:	50 %	
Specific Gravity:	1.53	
Solution Strength:	6.37	lb/gal
Parameters	Units	Criteria
<u>MF/UF Clean-in-Place (CIP) (neutralize CA)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	5,000
Chemical Usage	lb/month	730.2
Chemical Feed Rate	gpm	114.6
Chemical Feed Rate	gpd	3.8
<u>Bulk Storage Tote</u>		
Number of Totes	No.	2
Tote Capacity, each	gal	250
Tote Capacity, total	gal	500
MF/UF CIPs	gal/month	114.6
Total Usage	gal/month	114.6
Storage Time	days	131
Delivery Truck Full Load	gal	250
Time Between Delivery	days	65

Table 17 Sodium Bisulfite Design Criteria
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
City of Santa Barbara

Sodium Bisulfite Characteristics		
Concentration:	38 %	
Specific Gravity:	1.3	
Solution Strength:	4.11	lb/gal
Parameters	Units	Criteria
<u>MF/UF Maintenance Cleans (MC)</u>		
Chemical Usage (NaOCl Neutralization)		
Location: MF/UF CIP Tank		
Number of MC per Day per Rack	No.	1
Number of MC per Day	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	441
Chemical Usage	lb/day	64.4
Chemical Feed Rate	gpd	15.7
<u>MF/UF Clean-in-Place (CIP)</u>		
Chemical Usage		
Location: MF/UF CIP Tank		
Number of CIP per month per Rack	No.	1
Number of CIP per month per Rack	No.	7
Cleaning volume	gallons	2,500
Chemical Dose	mg/L	4,500
Chemical Usage	lb/month	657.2
Chemical Feed Rate	gpm	159.8
Chemical Feed Rate	gpd	5.3
<u>Bulk Storage Totes</u>		
Number of Totes	No.	4
Tote Capacity, each	gal	250
Tote Capacity, total	gal	1,000
MF/UF Maintenance Clean	gal/day	15.7
MF/UF CIP	gal/day	5.3
Total Usage	gal/day	21
Storage Time	days	48
Delivery Truck Full Load	gal	250
Time Between Delivery	days	12

Table 18 Indirect Potable Reuse Train - Finished Water Pump Station Criteria Subsurface Desalination Intake and Potable Reuse Feasibility Studies City of Santa Barbara			
Description		Units	Criteria
<u>FINISHED WATER PUMPS TO IPR INJECTION WELLS</u>			
Number of Pumps			
In-Service		No.	3
Reliability		No.	1
Total		No.	4
Type: Vertical Turbine			
Capacity			
Total		gpm	4,295
Per Pump		gpm	1,432
Total Dynamic Head Required (TDH)			
Head required to reach reservoir		feet	373
Average Pump TDH		feet	393
Maximum Pump TDH		feet	423
Motor Size			
Average operating		hp	
Required (based on maximum discharge pressure)		hp	178
Selected		hp	191
Drive		type	VFD

APPENDIX E – FACILITY MODELING RESULTS



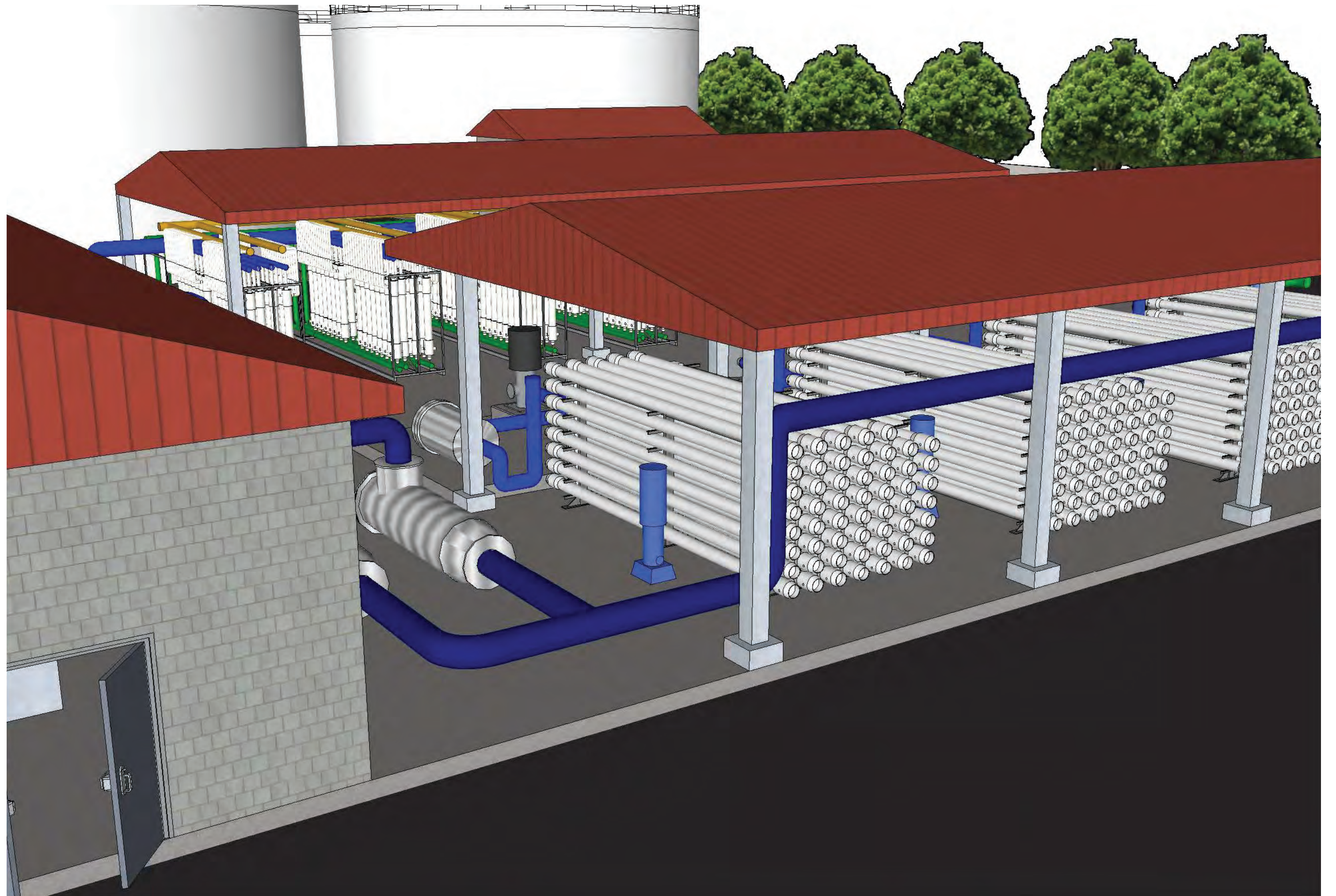
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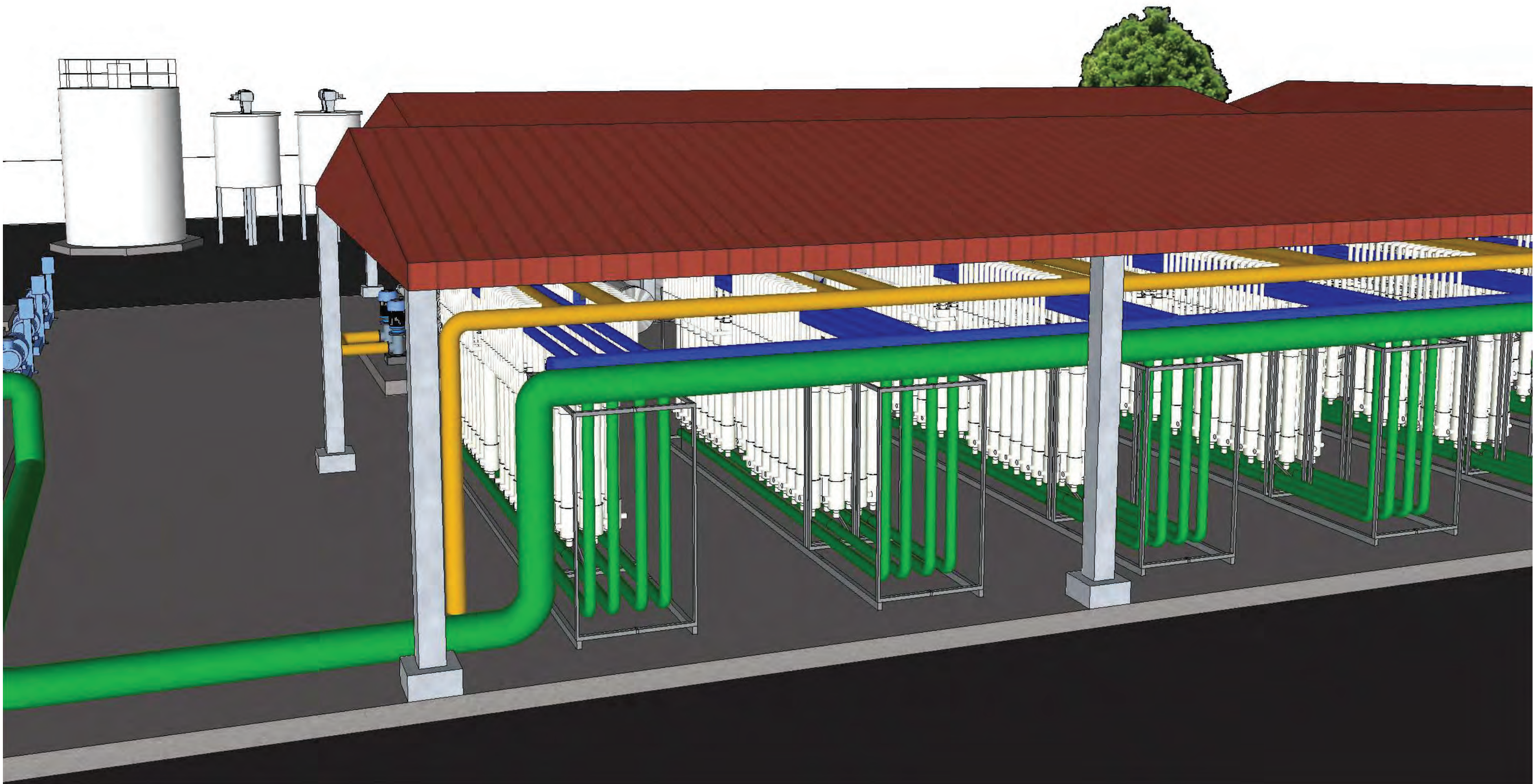
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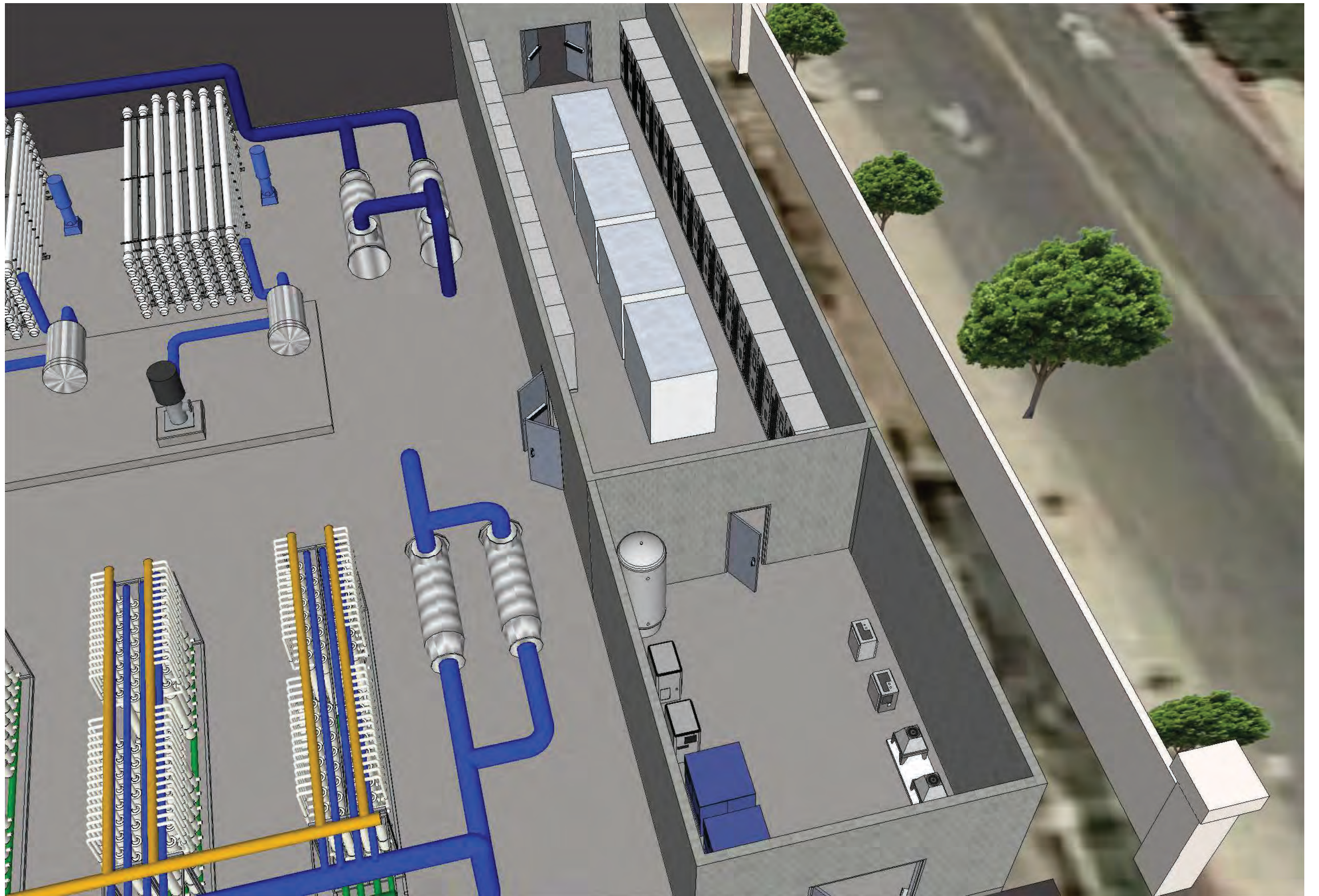


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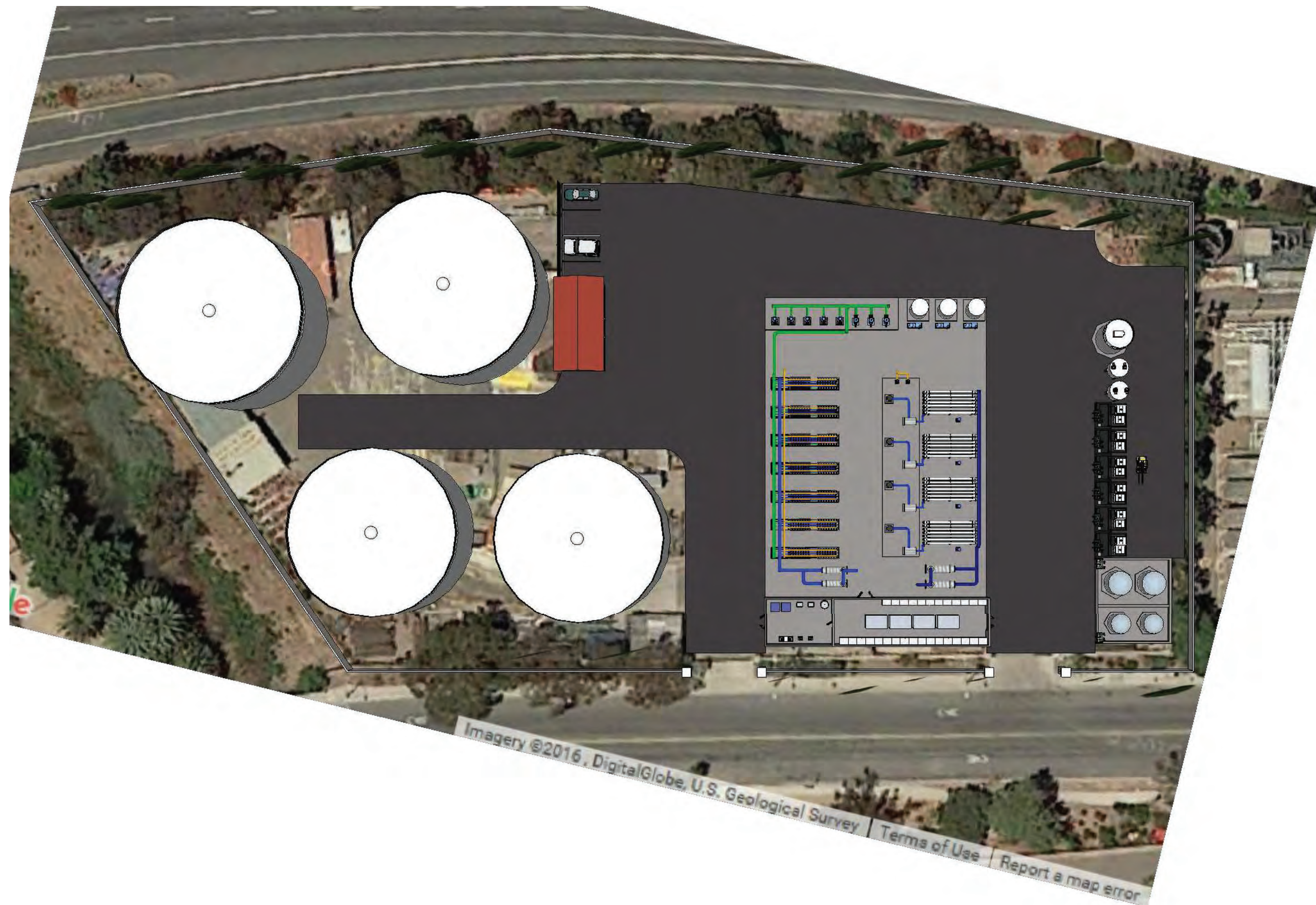




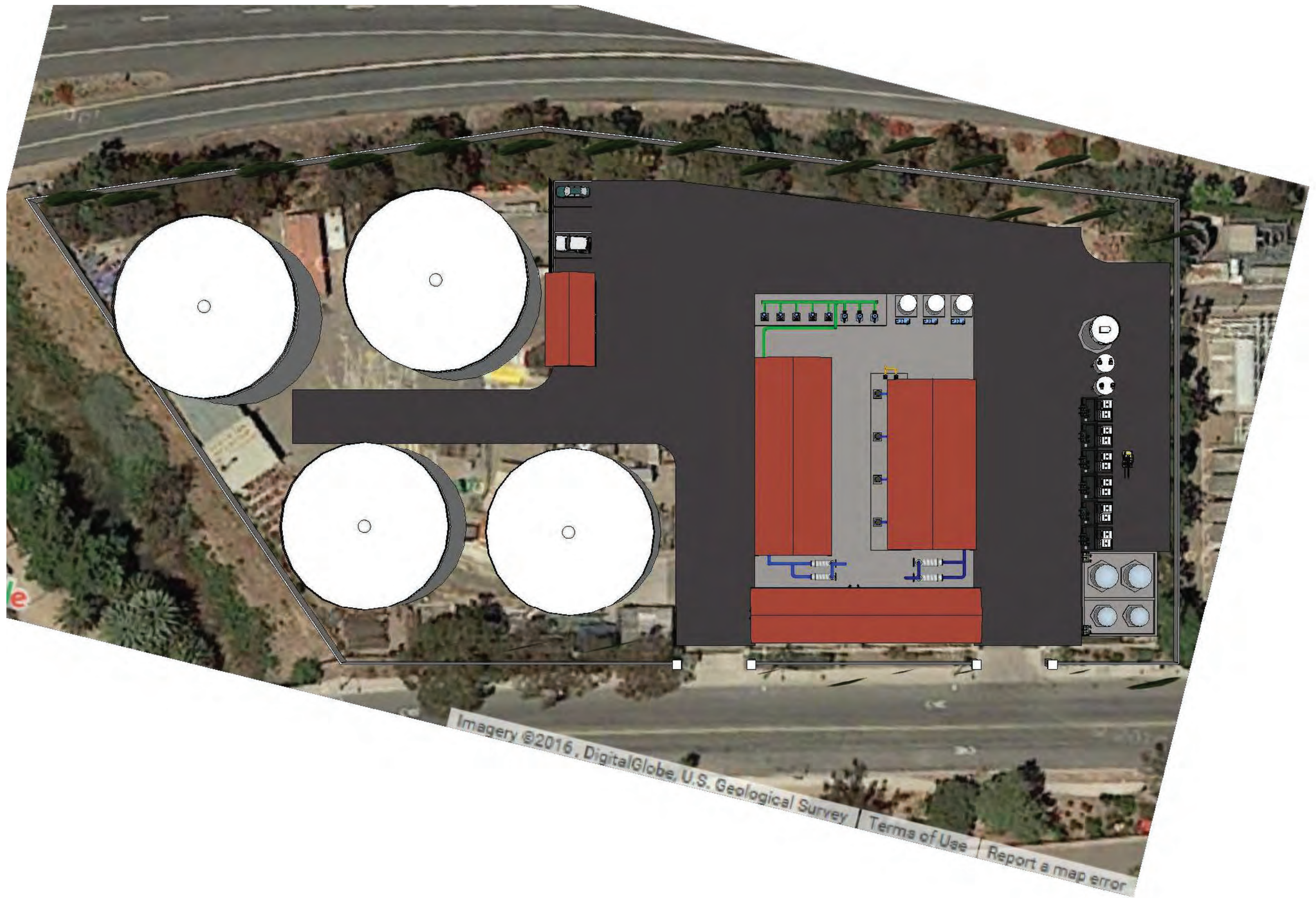








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WTP for Re-treatment







