Las Virgenes - Triunfo
Joint Powers Authority

Recycled Water Seasonal Storage | September 2016

BASIS OF DESIGN REPORT

APPENDICES

Prepared by:

MWH now part of Stantec

Joint Powers Authority
Las Virgenes Municipal Water District
Triunfo Sanitation District

Basis of Design Report
Appendices

September 2016

Appendix A –

Guiding Principals

Recycled Water Seasonal Storage Project Guiding Principles

A seasonal storage reservoir for recycled water would allow the JPA to balance supply and demands. Excess recycled water could be placed in the reservoir during the winter months for use during the high demand summer period. Additional demands for recycled water would need to be developed to ensure that the reservoir could be drawn down each year, making room for needed storage in the wintertime. Since the first Recycled Water Master Plan was completed in the 1970s, seasonal storage has been envisioned to fully use the JPA's recycled water. Most recently in 2012, the JPA completed a Recycled Water Seasonal Storage Feasibility Study.

The JPA desires to fully and beneficially reuse its recycled water by moving forward with investigation of seasonal storage guided by the following principles.

1. Maximize Beneficial Reuse by:

1.1. Being an environmental steward
1.2. Reducing existing potable water use
1.3. Reducing discharge to Malibu Creek and Los Angeles River
1.4. Encouraging infill use in both service areas
1.5. Providing regional benefits
1.6. Creating water supply reliability

2. Seek Cost Effective Solutions by:

2.1. Seeking funding from grants, matching funds and partnerships
2.2. Engaging permitting and regulatory agencies early and often
2.3. Each partner sharing in outside funding
2.4. Each partner funding their share
2.5. Being on time, on schedule and within budget
2.6. Analyzing impacts and benefits of the project from each partners perspective

3. Seek Partnerships beyond the JPA by:

3.1. Considering multiple uses such as;
3.1.1. Recreation
3.1.2. Education
3.1.3. Creation of open space
3.2. Engaging stakeholders early and often
3.3. Considering additional partners that will purchase recycled water

4. Gain Community Support by:

4.1. Engaging and educating the public and stakeholders
4.2. Being transparent
4.3. Making public safety a top priority

5. ***Govern with a Partnership by:***
   - 5.1. *Using the JPA Agreement as a guiding document*
   - 5.2. *Communicating openly and frequently*
   - 5.3. *Being committed to the project*
   - 5.4. *Equitably allocating costs and sharing benefits from both partners perspective*

6. ***Be Forward Thinking by considering the possibilities of:***
   - 6.1. *Expanding the recycled water system beyond the JPA service area*
   - 6.2. *Exterior residential reuse*
   - 6.3. *Exterior and interior use for new and remodeled commercial projects*
   - 6.4. *Indirect potable reuse*

Direct potable reuse

Appendix B –

Data Collection Summary

Data Collection Summary	
Description	**Provided By**
GIS Files for JPA Potable Water System	LVMWD
GIS Files for JPA Recycled Water System	LVMWD
GIS Files for JPA Wastewater Collection System	LVMWD
Hydraulic Model for JPA Potable Water System	LVMWD
Hydraulic Model for JPA Recycled Water System	LVMWD
Supply and demand records for drinking water system	LVMWD
Supply and demand records for recycled water system	LVMWD
Recycled Water Quality Records	LVMWD
Key water quality parameters for Las Virgenes Reservoir	LVMWD
Inflow and Outflow of Las Virgenes Reservoir	LVMWD
Estimated Seepage for Las Virgenes Reservoir	LVMWD
Evaporation Losses for Las Virgenes Reservoir	LVMWD
Vertical Profile data for Las Virgenes Reservoir	LVMWD
Area-storage-Elevation data for Las Virgenes Reservoir	LVMWD
Dam Facilities on Las Virgenes Reservoir	LVMWD
Source Control Program for the sewer collection system	LVMWD
Discharge to Malibu Creek from Tapia	LVMWD
Potable Supplement	LVMWD
Well Operation	LVMWD
Potable Water Master Plan (2014)	LVMWD
Sanitation Master Plan (2014)	LVMWD
Recycled Water Master Plan (2014)	LVMWD
Integrated Master Plan (2014)	LVMWD
Urban Water Management Plan (2010)	LVMWD
LADWP piping system drawings in the vicinity of and connecting to	LADWP
Estimated Seepage for Encino Reservoir	LADWP
Area-storage-Elevation data for Encino Reservoir	LADWP
Dam Facilities on Encino Reservoir	LADWP
Reservoir bathymetry for Encino Reservoir	LADWP
Treatment Plant Schematics	LADWP
Dam Performance Data -Latest DOSD Evaluation	LADWP

Appendix C –

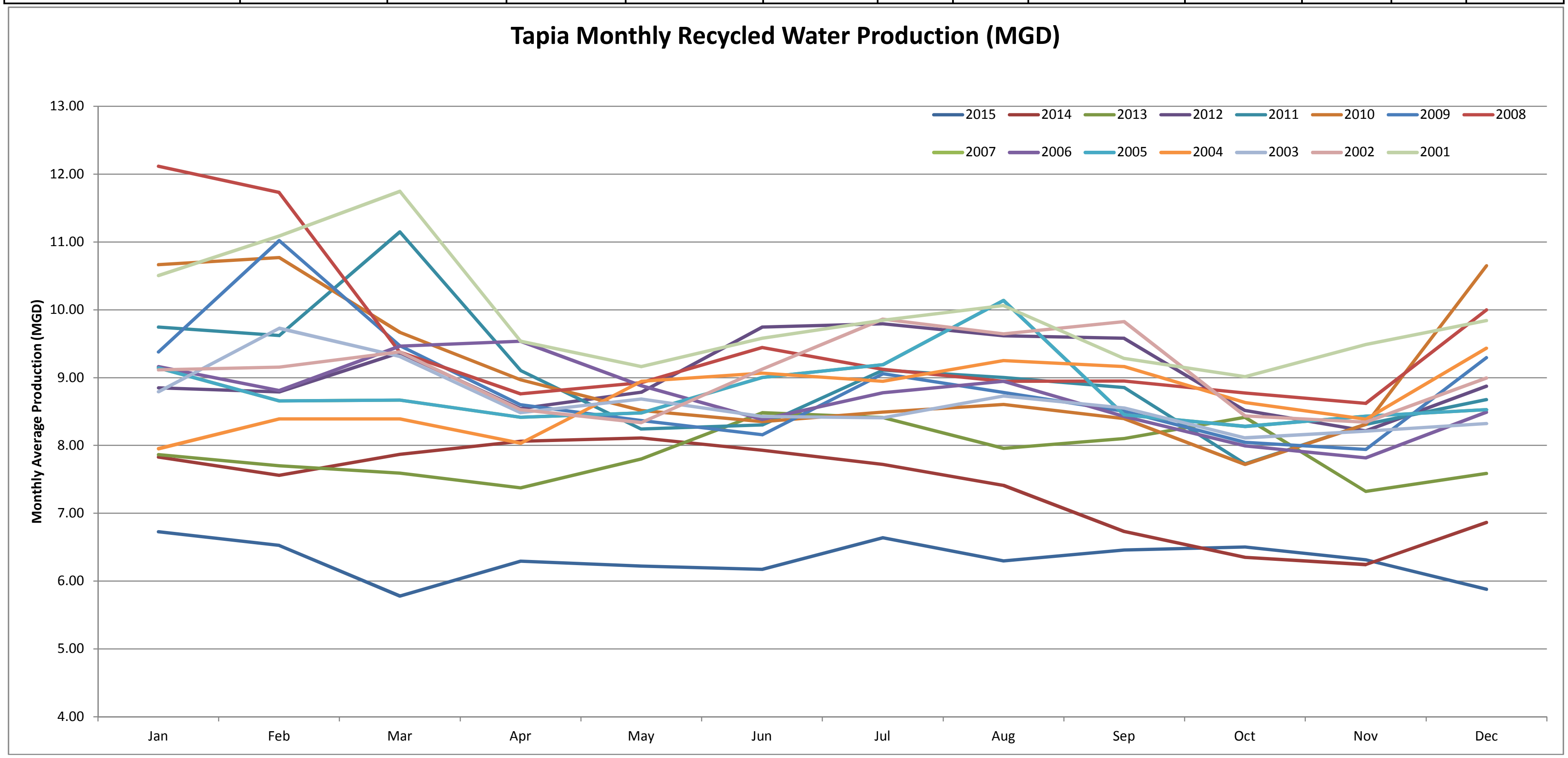
Engineering Calculations

Supply/Demand Calculations

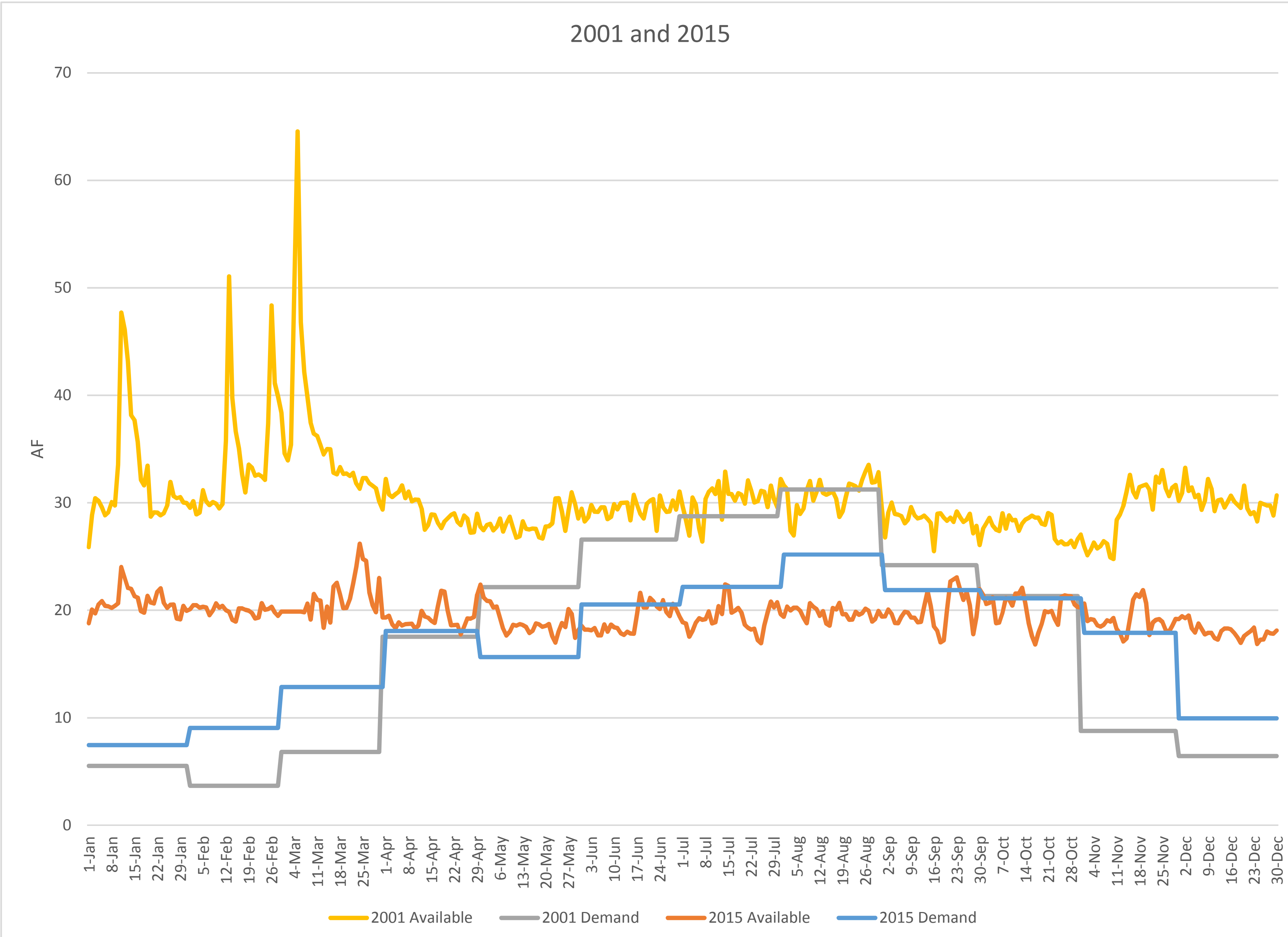
Tapia Production 2001-2015

Tapia Recycled Water Production Monthly Average MGD

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	6.73	6.53	5.78	6.30	6.22	6.17	6.64	6.30	6.46	6.50	6.31	5.88
2014	7.83	7.56	7.87	8.06	8.11	7.93	7.72	7.41	6.73	6.35	6.24	6.87
2013	7.86	7.70	7.59	7.37	7.80	8.48	8.41	7.96	8.10	8.42	7.32	7.59
2012	8.85	8.79	9.37	8.54	8.79	9.74	9.80	9.62	9.58	8.52	8.22	8.87
2011	9.75	9.62	11.15	9.11	8.24	8.30	9.11	9.00	8.85	7.73	8.31	8.68
2010	10.67	10.77	9.67	8.97	8.51	8.35	8.49	8.60	8.40	7.72	8.31	10.65
2009	9.38	11.02	9.47	8.60	8.37	8.16	9.06	8.78	8.50	8.05	7.94	9.30
2008	12.12	11.73	9.38	8.76	8.93	9.44	9.12	8.95	8.95	8.77	8.62	10.00
2007	9.14	8.66	8.67	8.42	8.48	9.00	9.19	10.14	8.45	8.28	8.43	8.53
2006	9.16	8.81	9.46	9.54	8.88	8.38	8.78	8.95	8.43	7.99	7.82	8.49
2005	9.14	8.66	8.67	8.42	8.48	9.00	9.19	10.14	8.45	8.28	8.43	8.53
2004	7.95	8.39	8.39	8.03	8.95	9.07	8.95	9.25	9.16	8.63	8.39	9.43
2003	8.79	9.73	9.31	8.49	8.68	8.43	8.41	8.73	8.55	8.11	8.21	8.32
2002	9.12	9.15	9.38	8.53	8.34	9.13	9.86	9.65	9.83	8.44	8.34	8.99
2001	10.50	11.09	11.75	9.54	9.16	9.58	9.85	10.06	9.28	9.02	9.49	9.84



Tapia 2001 and 2015 Production Graph



2001 and 2015
AF
70
60
50
40
30
20
10
0
1-Jan
8-Jan
15-Jan
22-Jan
29-Jan
5-Feb
12-Feb
19-Feb
26-Feb
4-Mar
11-Mar
18-Mar
25-Mar
1-Apr
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15-Apr
22-Apr
29-Apr
6-May
13-May
20-May
27-May
3-Jun
10-Jun
17-Jun
24-Jun
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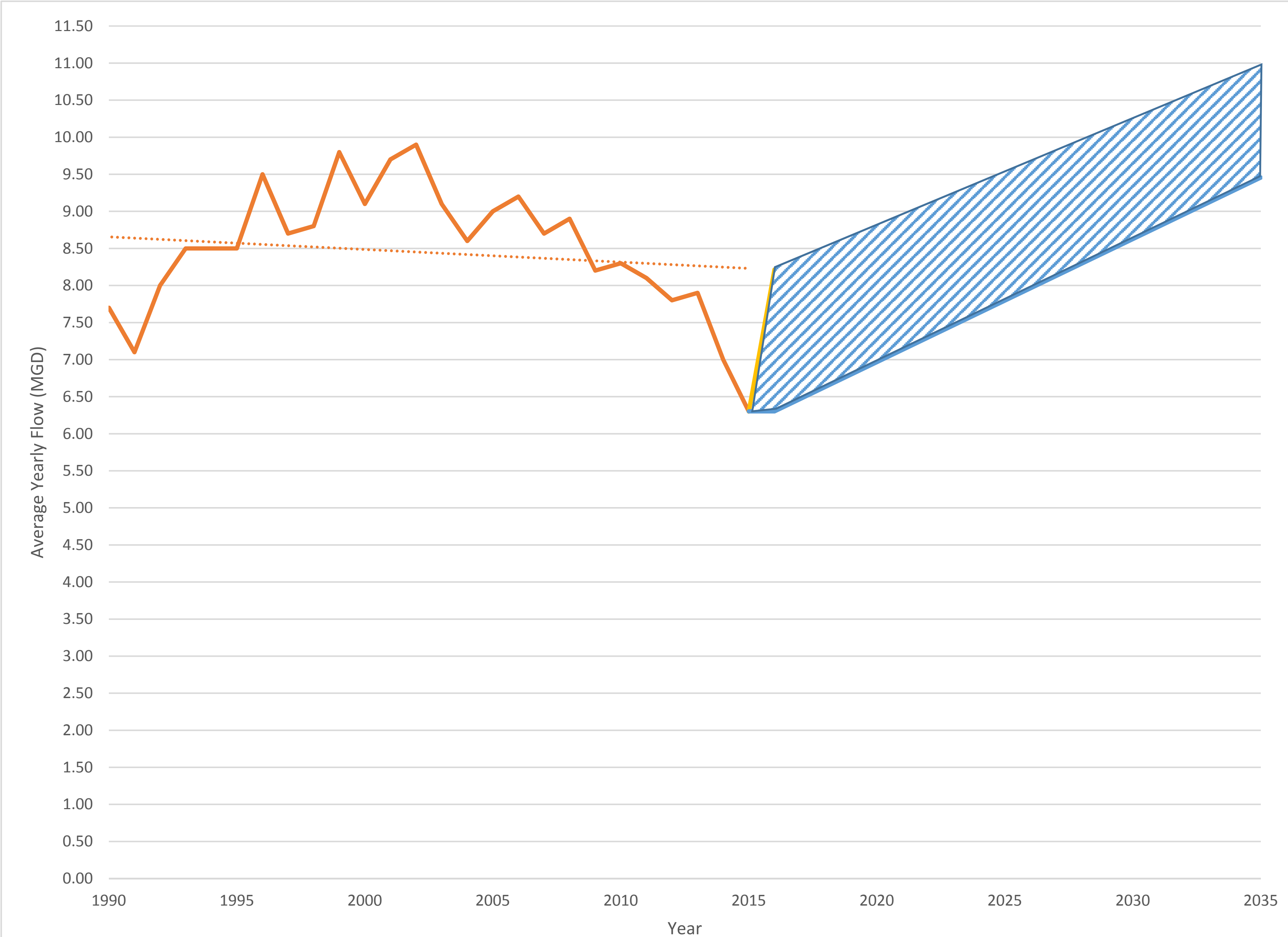
29-Jul
5-Aug
12-Aug
19-Aug
26-Aug
2-Sep
9-Sep
16-Sep
23-Sep
30-Sep
7-Oct
14-Oct
21-Oct
28-Oct
4-Nov
11-Nov
18-Nov
25-Nov
2-Dec
9-Dec
16-Dec
23-Dec
30-Dec
2001 Available
2001 Demand
2015 Available
2015 Demand

Tapia Projection Calculations

Projections for LVMWD Supply													
Year	**LV Valley**	**Recycled***	**Potable**	**Recycled***	**Morr**	**WELLS**	**TOTAL**	**TRIUNFO**	**Total Demand**	**Influent (MG)**	**Total Supp**	**Projection Starting at Trendline (with no drought recovery)**	**Projection Starting with Current Total**
1989	280	913	690	2,878			4,071	992	**5,753**	7.30	690		
1990	549	1,153	397	3,019		-	4,721	840	**5,958**	7.70	397		
1991	334	1,094	12	2,502		-	3,929	479	**4,420**	7.10	12		
1992	303	1,144	131	2,515		-	3,962	486	**4,579**	8.00	131		
1993	464	1,209	65	2,499		194	4,172	279	**4,710**	8.50	260		
1994	548	1,542	173	2,473		578	4,562	458	**5,771**	8.50	750		
1995	391	1,376	18	2,201	-	0	3,968	487	**4,473**	8.50	18		
1996	371	1,562	124	2,392	-	139	4,326	1,580	**6,169**	9.50	263		
1997	195	1,502	187	2,748	-	0	4,445	1,462	**6,095**	8.70	187		
1998	269	1,215	-	2,031	-	-	3,516	1,049	**4,565**	8.80	144		
1999	269	1,577	101	2,572	-	-	4,224	1,517	**5,842**	9.80	101		
2000	449	2,014	239	2,441	-	-	4,904	1,710	**6,853**	9.10	239		
2001	342	1,792	88	2,265	-	-	4,509	1,602	**6,200**	9.70	88		
2002	249	2,217	166	2,628	5	-	5,094	1,830	**7,095**	9.90	170		
2003	265	2,327	102	2,502	9	-	5,094	1,309	**6,513**	9.10	111		
2004	285	2,429	159	2,606	18	-	5,320	1,480	**6,977**	8.60	177		
2005	245	2,197	123	2,440	14	256	4,882	1,436	**6,711**	9.00	393		
2006	249	2,458	194	2,575		80	5,282	1,269	**6,825**	9.20	274		
2007	371	2,627	188	2,851	51	449	5,849	1,353	**7,890**	8.70	688		
2008	306	2,151	367	2,868	141	314	5,325	1,798	**7,945**	8.90	822		
2009	257	1,983	190	2,757	166	329	4,998	1,093	**6,775**	8.20	684		
2010	195	1,844	8	2,315	51	220	4,354	1,339	**5,972**	8.30	280		
2011	180	1,900	16	2,291	56	190	4,370	1,485	**6,117**	8.10	261		
2012	272	2,093	33	3,031	131	182	5,395	1,713	**7,454**	7.80	346		
2013	280	2,075	101	3,124	379	267	5,480	1,844	**8,070**	7.90	747		
2014	331	1,950	55	2,834	353	298	5,115	1,918	**7,738**	7.00	705		
2015	285	1,306	457	2,132	73	258	3,722	1,642	**6,151**	6.30	788	6.30	6.30
2016									**6,527**	6.30		8.2143	6.30
2035									**7,138**	9.90		10.92	9.46
avg	316	1,765	162	2,574	72	144	4,651	1,276	6,282	8	360		
												2035 CONVERTED TO AFY	
												12,233.38	10,591.32

Tapia Projection Graph



11.50
11.00
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4.50
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3.00
2.50
2.00
1.50
1.00
0.50
0.00
Average Yearly Flow (MGD)
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
Year

Recycled Water Sales

	RETAIL RECYCLED WATER DELIVERIES									NOTE: Included in "C"										
Calendar		CALABASAS		WESTERN			LV			005 Discharge	**FISCAL**		CALABASAS		WESTERN			LV		
Year	LV Valley	Recycled*	Potable	Recycled*	Morr	WELLS	TOTAL	TRIUNFO	TOTAL		**YEAR**	LV Valley	Recycled*	Potable	Recycled*	Morr	WELLS	TOTAL	TRIUNFO	TOTAL
1/1/2015	18	62.3	21.6	104.1	6.7	0	184.4	46.8	231.2	0.000	Jul-15	34.5	122.6	80.4	218	12.5	46.02	375.1	173.7	548.8
2/1/2015	9.4	75.6	45	104.1	1.7	0	189.1	64.2	253.3	0.000	Aug	33.5	68.7	153.7	230.5	20.5	52.94	332.7	221.1	553.8
3/1/2015	23.4	113.1	20.7	149	0.9	8.9	285.5	104.3	389.8	0.000	Sep	31.5	110.7	77.2	207.7	19.6	40.74	349.9	169.1	519
4/1/2015	27.4	163.4	0	192.8	0	11.4	383.6	147.2	530.8	0.000	Oct	20.6	151.6	22.3	219.6	6.5	40.8	391.8	193	584.8
5/1/2015	19.4	185.9	1.6	172.5	0	11.95	377.8	134.4	472.9	39.300	Nov	18	162	3.3	201.1	0.3	14.18	381.1	138.1	519.2
6/1/2015	29.8	178.2	30.8	208.9	2.7	30.79	416.9	168.5	585.4	0.000	Dec	19.1	70.8	0	135.4	1.8	0	225.3	81.2	306.5
7/1/2015	34.5	203	80.4	230.6	12.5	46.02	468.1	173.7	641.8	0.000	Jan-16	4.7	21.3	0	52.6	0	0	78.6	23.3	101.9
8/1/2015	33.5	222.4	153.7	251.1	20.5	52.94	507.0	221.1	728.1	0.000	Feb	11	78.7	0	89.3	0	0	179	108.3	287.3
9/1/2015	31.5	202.1	77.2	227.4	19.6	40.74	461.0	169.1	615.9	14.200	Mar			0				0		0
10/1/2015	20.6	174	22.3	226.1	6.5	40.8	420.7	193	613.7	0.000	Apr							0		0
11/1/2015	18	165.3	3.3	201.4	0.3	14.18	384.7	138.1	522.8	0.000	May							0		0
12/1/2015	19.1	70.8	0	137.2	1.8	0	227.1	81.2	308.3	0.000	Jun							0		0
TOTAL	284.6	1816.1	456.6	2205.2	73.2	257.72	4305.90	1641.6	5894		**TOTAL**	172.9	786.4	336.9	1354.2	61.2	194.68	2313.50	1107.8	3421.3
Jan-14	30.9	134.2	0	199	0	0	364.1	123	487.1	0.000	Jul-14	47.5	251.1	169.3	375.8	86	49.55	674.4	255.8	930.2
2/1/2014	6.2	91.8	0.7	134.7	0	0	232.7	75.9	308.6	0.000	Aug	35.4	238.1	163.7	345.4	65.4	51.85	618.9	244.3	863.2
Mar-14	9.3	100.1	0	144.2	0	0	253.6	86.1	339.7	0.000	Sep	36.2	195.8	117.9	323.1	78.5	51.05	555.1	226.6	781.7
4/1/2014	33.2	168.7	0	220.3	0	0	422.2	158.6	580.8	0.000	Oct	21.6	169.9	52.5	240	13.8	28.28	431.5	171.9	603.4
May-14	44.6	229.1	62.3	331.1	36.2	58.17	604.8	221.4	826.2	0.000	Nov	18.9	138.1	0	172.5	0	4.72	329.5	97.6	427.1
6/1/2014	30.8	225.2	101.7	345.3	73.2	54.05	601.3	243.8	845.1	0.000	Dec	16.3	13	0	39.2	0	0	68.5	12.6	81.1
Jul-14	47.5	251.1	169.2	375.8	86	49.55	674.4	255.8	930.2	0.000	Jan-15	18	40.7	21.6	97.4	6.7	0	156.1	46.8	202.9
8/1/2014	35.4	238.1	163.8	345.4	65.4	51.85	618.9	244.3	863.2	0.000	Feb	9.4	30.6	44.9	102.4	1.7	0	142.4	64.2	206.6
Sep-14	36.2	195.8	117.9	323.1	78.5	51.05	555.1	226.6	781.7	0.000	Mar	23.4	92.3	20.8	148	0.9	8.9	263.7	104.3	368
10/1/2014	21.6	169.9	52.5	240	13.8	28.28	431.5	181.9	613.4	0.000	Apr	27.4	163.4	0	192.8	0	11.4	383.6	147.2	530.8
Nov-14	18.9	138.1	0	172.5	0	4.72	329.5	97.6	427.1	0.000	May	19.4	145.1	1.6	172.5	0	11.95	337	134.4	471.4
12/1/2014	16.3	13	0	39.2	0	0	68.5	12.6	81.1	0.000	Jun	29.8	147.3	30.5	206.2	2.7	30.79	383.3	168.5	551.8
TOTAL	330.9	1955.1	668.1	2870.6	353.1	297.67	5156.60	1927.6	7084.2		**TOTAL**	303.3	1625.4	622.8	2415.3	255.7	248.49	4344	1674.2	6018.2
Jan-13	4.6	60.6	0	116.9	0	0.07	182.1	59.9	242.0	0.000	Jul-13	44.3	270.8	144.2	457.5	105.9	55.8	772.6	176.8	949.4
2/1/2013	6.4	88.4	0	110.2	0	0	205	56	261.0	0.000	Aug	9.8	247.2	138.6	395.1	114.9	52.5	652.1	253	905.1
Mar-13	13.2	136.1	0	161.3	4.6	0.03	310.6	107.6	418.2	0.000	Sep	46.4	228.7	157.8	355.6	90.3	47.7	630.7	235	865.7
4/1/2013	20	212.4	0.08	239.7	11.5	0	472.1	152.1	607.7	16.500	Oct	31.6	171.1	35.6	284.2	30.7	33.1	486.9	196.4	683.3
May-13	39.7	272	0	251.3	0	11.57	563	180.3	723.8	19.500	Nov	25.1	129.4	5.9	196.1	0	5.2	350.6	104.1	454.7
6/1/2013	33	237.4	123.6	314.5	6.9	40.65	584.9	218.8	803.7	0.000	Dec	20.7	110.7	0	177.7	0	0	309.1	97.5	406.6
Jul-13	44.3	270.8	144.1	457.5	105.9	55.84	772.6	176.8	949.4	0.000	Jan-14	30.9	134.2	0	199	0	0	364.1	123	487.1
8/1/2013	9.8	269.8	138.5	395.1	114.9	52.53	674.7	253	927.7	0.000	Feb	6.2	91.1	0.7	134.7	0	0	232	75.9	307.9
Sep-13	46.4	242.7	157.9	355.6	90.3	47.66	644.7	235	879.7	0.000	Mar	9.3	100.1	0	144.2	0	0	253.6	86.1	339.7
10/1/2013	31.6	171.1	35.6	284.2	30.7	33.14	486.9	196.4	683.3	0.000	Apr	33.2	168.7	0	220.3	0	0	422.2	158.6	580.8
Nov-13	25.1	129.4	5.9	196.1	0	5.23	350.6	104.1	454.7	0.000	May	44.6	224.5	62.3	294.9	36.2	58.17	564	221.4	785.4
12/1/2013	20.7	110.7	0	177.7	0	0	309.1	97.5	406.6	0.000	Jun	30.8	225.2	101.7	345.3	73.2	54.05	601.3	243.8	845.1
TOTAL	294.8	2201.4	605.68	3060.1	364.8	246.7	5556.3	1837.5	7357.8		**TOTAL**	332.9	2101.7	646.8	3204.6	451.2	306.52	5639.2	1971.6	7610.8
Jan-12	7.1	87.9	0.1	98.9	0	0.02	193.9	111.2	305.1	0.000	Jul-12	39.6	269.5	88.3	355.3	41.2	55.6	664.4	236.6	901
2/1/2012	2.7	96.4	0	113.7	0	0	212.8	111.2	324.0	0.000	Aug	40	291.4	168	384.1	42	52.8	715.5	247	962.5
Mar-12	14.3	75.4	0	135.9	7	0	225.6	69.6	295.2	0.000	Sep	34.4	245.8	119.5	555.3	19.2	58	835.5	217	1052.5
4/1/2012	17.6	224.7	0	141.5	0	0	383.8	66.4	349.2	101.000	Oct	16.8	189.4	26.6	414.7	7.7	15.9	620.9	158	778.9
May-12	39.7	272	0	251.3	0	11.57	563	180.3	681.2	62.100	Nov	19.4	260.5	0	235.3	2.3	0	515.2	81.4	596.6
6/1/2012	38.3	232.3	39.2	300.7	11.6	46.77	571.3	199.4	770.7	0.000	Dec	1.7	13.3	0	62.4	0	0	77.4	15.8	93.2
Jul-12	39.6	269.5	88.3	355.3	41.2	55.54	664.4	236.6	901.0	0.000	Jan-13	4.6	60.6	0	176.8	0	0	242	59.9	301.9
8/1/2012	40	291.4	168	384.1	42	52.82	715.5	247	962.5	0.000	Feb	6.4	88.4	0	110.2	0	0	205	56	261
Sep-12	34.4	245.8	119.5	357.4	19.2	50.44	637.6	217	854.6	0.000	Mar	13.2	136.1	0	156.7	4.6	0	306	107.6	413.6
10/1/2012	16.8	189.4	26.6	264.4	7.7	15.93	470.6	158	628.6	0.000	Apr	20	195.8	0.8	228.3	11.5	0	444.1	152.1	596.2
Nov-12	19.4	260.5	0	156.3	2.3	0	436.2	81.4	412.5	105.100	May	25.1	218.1	13	278.4	14	32.2	521.6	186.7	708.3
12/1/2012	1.7	13.3	0	46.6	0	0	61.6	15.8	77.4	0.000	Jun	33	218.4	123.6	307.6	6.9	40.6	559	218.8	777.8
TOTAL	271.6	2258.6	441.7	2606.1	131	233.09	5136.3	1693.9	6562		**TOTAL**	254.2	2187.3	539.8	3265.1	149.4	255.1	5706.6	1736.9	7443.5
Jan-11	2.7	63.9	0	96.6	0	0	163.2	44.7	207.9		Jul-11	29.5	260.8	44.5	323.3	6.9	65	613.6	228.1	841.7
FEB	2.4	60	0	79.5	0	0	141.9	41.1	183		Aug	36.5	276.5	79.2	353.1	30	52.8	666.1	226.7	892.8
MAR	2.8	48.6	0	78.1	4.9	0	129.5	20.7	150.2		Sep	33	240.8	33.8	303.5	19.1	42.8	577.3	214.6	791.9
APR	10.2	169.6	0	181.8	0	0.02	361.6	97.3	458.9		Oct	5.2	173.3	0	203.4	0	0	381.9	159.8	541.7
MAY	28	226.2	0	229.6	0	23.2	483.8	155.7	639.5		Nov	3.1	86.3	0	82.6	0	0	172	55.4	227.4
JUN	24.3	216.4	0	254	0	5.8	494.7	161.5	656.2		Dec	2.1	76.9	0	105.4	0	0	184.4	79.5	263.9
JUL	29.5	298.4	44.5	323.3	6.9	65	651.2	228.1	879.3		Jan-12	7.1	87.9	0.1	98.9	0	0.02	193.9	111.2	305.1
AUG	36.5	349.8	79.2	353.1	30	52.8	739.4	226.7	966.1		Feb	2.7	96.4	0	113.7	0	0	212.8	111.2	324
SEP	33	272.1	33.8	303.5	19.1	42.8	608.6	214.6	823.2		Mar	14.3	75.4	0	135.9	7	0	225.6	69.6	295.2
OCT	5.2	173.3	0	203.4	0	0	381.9	159.8	541.7		Apr	17.6	123.7	0	141.5	0	0	282.8	66.4	349.2
NOV	3.1	86.3	0	82.6	0	0	172	55.4	227.4		May	39.7	209.8	0	251.3	0	11.57	500.8		500.8
DEC	2.1	76.9	0	105.4	0	0	184.4	79.5	263.9		Jun	38.3	229.4	39.2	289.1	11.6	46.77	556.8		556.8
TOTAL	179.8	2041.5	157.5	2290.9	60.9	189.62	4512.2	1485.1	5997.3		**TOTAL**	229.1	1937.2	196.8	2401.7	74.6	218.96	4568	1322.5	5890.5
Jan-10	3.2	42.1	0	81.9	0	0	127.2	32.5	159.7		Jul-10	36	285.4	38.8	319.6	8.9	65.24	641	205.7	846.7
FEB	0.7	19.1	0	35.1	0.3	0	54.9	9.9	64.8		Aug	29.8	287.9	26.4	374.1	31.7	64.1	691.8	230.1	921.9
MAR	5.5	91.5	0	120.5	10.6	0.02	217.5	51.4	268.9		Sep	25.7	262.9	31.7	314.1	0	49.23	602.7	191.8	794.5
APR	23	148	0	162.2	0	0.71166	333.2	69.4	402.6		Oct	8.2	161.3	17.3	152.6	0.2	6.14	322.1	98.1	420.2
MAY	42.3	214	0	243.3	0	10.91	499.6	173.5	673.1		Nov	6.8	139	0	143.3	0	0.07	289.1	64.1	353.2
JUN	10.2	245.4	8.3	299.9	0	23.53	555.5	184	739.5		Dec	3.6	44.4	0	68.1	0	0	116.1	28.4	144.5
JUL	36	285.4	38.8	319.6	8.9	65.24	641	205.7	846.7		Jan-11	2.7	63.9	0	96.6	0	0	163.2	44.7	207.9
AUG	29.8	287.9	26.4	374.1	31.7	64.1	691.8	230.1	921.9		Feb	2.4	60	0	79.5	0	0	141.9	41.1	183
SEP	25.7	262.9	31.7	314.1	0	49.23	602.7	191.8	794.5		Mar	2.8	48.6	0	78.1	4.9	0	129.5	20.7	150.2

OCT	8.2	161.3	17.3	152.6	0.2	6.14	322.1	98.1	420.2
NOV	6.8	139	0	143.3	0	0.07	289.1	64.1	353.2
DEC	3.6	44.4	0	68.1	0	0	116.1	28.4	144.5
TOTAL	195	1941	122.5	2314.7	51.7	219.95166	4450.7	1338.9	5789.6
Jan-09	13.2	97.2		129.4	0	0	239.8	8.8	248.6
FEB	2.1	38.1		62.6	4.9	0.07	102.8	2.5	105.3
MAR	6.8	101.7	0.5	138.7	37	0	247.2	0.5	247.7
APR	32.6	176.5	4.2	259.8	27	0	468.9	70.6	539.5
MAY	28.8	243.5	0.2	295.4	0	0	567.7	61.2	628.9
JUN	18.7	232.2	0.7	246.6	1	6	497.5	48.3	545.8
JUL	45	264.2	45.2	377.5	29.8	183.25	686.7	227.1	913.8
AUG	32.9	209.8	54.2	361.8	35.9	65.59	604.5	211.3	815.8
SEP	36.2	244.9	78.4	357.6	28.8	60.01	638.7	201.2	839.9
OCT	13.9	173	6.1	224.2	0.2	14.07	411.1	117.2	528.3
NOV	23.6	152.7	0	211.4	1.3	0	387.7	108.4	496.1
DEC	3.6	49		92.4	0	0	145	35.9	180.9
TOTAL	257.4	1982.8	189.5	2757.4	165.9	328.99	4997.6	1093	6090.6
Jan-08	4.5	42.3		53.2	0	0	100	30.9	130.9
FEB	3.3	44.3		74.6	1.6	0	122.2	27.3	149.5
MAR	14.7	120		182.6	0	0	317.3	122.8	440.1
APR	31.9	216.4	51.5	239.9	17.6	9.72	488.2	170.8	659
MAY	43.7	247.9	14	230.5	5.3	61.02	522.1	194.9	717
JUN	43.5	281.1	90.2	370.1	20	89.23	694.7	246.6	941.3
JUL	47.2	321.8	164.1	399.3	50.4	46.91	768.3	256.2	1024.5
AUG	40	189.2	14.5	437.9	29	46.43	667.1	225.4	892.5
SEP	23.1	249.6	30.8	309.6	10.1	41.31	582.3	198.4	780.7
OCT	31.2	234.5	2	299.4	6.6	19.37	565.1	208.6	773.7
NOV	21.8	154.6	0	183.2	0	0	359.6	94.4	454
DEC	1.4	49.1	0	87.4	0	0	137.9	21.8	159.7
Total	306.3	2150.8	367.1	2867.7	140.6	313.99	5324.8	1798.1	7122.9
Jan-07	18.9	135.8		149.3	0	0	304	65.5	369.5
Feb-07	2.2	50.3		71.6	0	0.04	124.1	19.9	144
Mar-07	13.7	160		196.7	0	0	370.4	79.9	450.3
Apr-07	16.4	202.7	2.9	221.3	0	0	440.4	98.5	538.9
May-07	42.8	272.7	0.8	331.6	0	18.18	647.1	127.6	774.7
Jun-07	44	300.9	20.7	382.4	0	46.6	727.3	131.6	858.9
Jul-07	102	362.8	72.8	387	8.5	144.88	851.8	177.5	1029.3
Aug-07	44	341	53	382	37.8	57.34	767	159	926
Sep-07	47	313.4	38.1	274.2	4.6	90.68	634.6	167.2	801.8
Oct-07	18	234.2		218.2	0	44.48	470.4	169.4	639.8
Nov-07	17.7	187.1		184.9	0	47.04	389.7	118	507.7
Dec-07	3.8	65.7		52.2	0	0	121.7	39	160.7
Total	370.5	2626.6	188.3	2851.4	50.9	449.24	5848.5	1353.1	7201.6
Jan-06	3	67.7		100.5	3.5	0	171.2	65	236.2
Feb-06	5.8	136.5		140.3	0	0	282.6	94.2	376.8
Mar-06	5.7	24.8		50.3	0	0.25	80.8	33.9	114.7
Apr-06	0.8	86.7		84	0	0.02	171.5	43.2	214.7
May-06	21.7	213.6		228.2	0	0.02	463.5	107.4	570.9
Jun-06	31.6	244		298.3	0	0	573.9	121.9	695.8
Jul-06	44.3	361.9	70	370	0	22.33	776.2	156.9	933.1
Aug-06	40.6	420.1	64.3	350.3	0	38.51	811	179.4	990.4
Sep-06	40.6	337.5	58.2	344.1	0	17.62	722.2	132.5	854.7
Oct-06	28.4	238.2	1.5	252.4	0	0	519	168.8	687.8
Nov-06	22.7	211.2		218.1	0	1.6	452	106.4	558.4
Dec-06	3.6	115.5		138.8	0	0	257.9	59.4	317.3
Total	248.8	2457.7	194	2575.3	3.5	80.35	5281.8	1269	6550.8
Jan-05	1.7	22.6		26.4	0	0	50.7	11.1	61.8
Feb-05	0.7	45.2		37.6	0	0	83.5	18.3	101.8
Mar-05	0.8	34.5		46.1	0	0	81.4	26.6	108
Apr-05	19.9	203.5	4	197.7	0	0	421.1	122.7	543.8
May-05	26.9	217.3		276.2	0	0	520.4	135.4	655.8
Jun-05	44.8	249.6	7.3	291	3.8	16.87	585.4	213.3	798.7
Jul-05	40.9	328.3	36.3	337.1	4.8	57.34	706.3	180.2	886.5
Aug-05	38.4	340	49.8	371	9.6	90.68	749.4	190.8	940.2
Sep-05	45.4	293.7	18.6	310.4	0	44.48	649.5	166.8	816.3
Oct-05	7	193.4	6.9	223.6	0	47.04	424	155	579
Nov-05	8.1	148.1		180	0	0	336.2	113.1	449.3
Dec-05	10.1	120.6		143.3	0	0	274	102.7	376.7
Total	244.7	2196.8	122.9	2440.4	18.2	256.41	4881.9	1436	6317.9
Jan-04	5.4	90.2		117.8			213.4	66.5	279.9
Feb-04	2.4	63.9		86.5			152.8	13.8	166.6
Mar-04	8.7	138.1		166.8			313.6	74.1	387.7
Apr-04	20.5	192.3	10.5	234	1.3		446.8	135.4	582.2
May-04	47.8	279.6	13.2	343.1			670.5	192.3	862.8
Jun-04	47.7	295.4	16.6	335.1			678.2	145.8	824
Jul-04	45.4	328.6	38.8	322.2			696.2	170.4	866.6
Aug-04	50.3	343.9	47.2	323.4	0.4		717.6	208.3	925.9
Sep-04	43.8	302.6	32.3	303.9	3.7		650.3	227	877.3

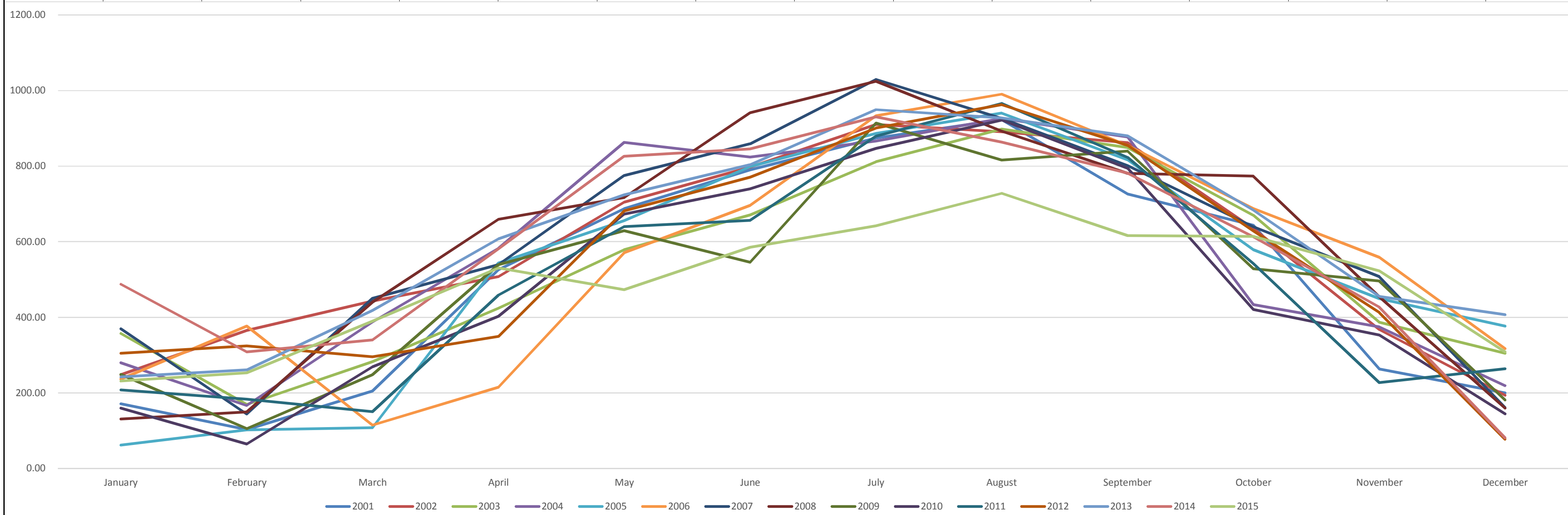
Apr	10.2	169.6	0	181.8	0	0.02	361.6	97.3	458.9
May	28	226.2	0	229.6	0	23.2	483.8	155.7	639.5
Jun	24.3	216.4	0	254	0	5.8	494.7	161.5	656.2
TOTAL	180.5	1965.6	114.2	2291.4	45.7	213.8	4437.5	1339.2	5776.7
Jul-09	45	264.2	45.2	377.5	29.8	183.25	686.7	227.1	913.8
Aug	32.9	209.8	54.2	361.8	35.9	65.59	604.5	211.3	815.8
Sep	36.2	244.9	78.4	357.6	28.8	60.01	638.7	201.2	839.9
Oct	13.9	173	6.1	224.2	0.2	14.07	411.1	117.2	528.3
Nov	23.6	152.7	0	211.4	1.3	0	387.7	108.4	496.1
Dec	3.6	49	0	92.4	0	0	145	35.9	180.9
Jan-10	3.2	42.1	0	81.9	0	0	127.2	32.5	159.7
Feb	0.7	19.1	0	35.1	0.3	0	54.9	9.9	64.8
Mar	5.5	91.5	0	120.5	10.6	0.02	217.5	51.4	268.9
Apr	23	148	0	162.2	0	0.7116621	333.2	69.4	402.6
May	42.3	214	0	243.3	0	10.91	499.6	173.5	673.1
Jun	10.2	245.4	8.3	299.9	0	23.53	555.5	184	739.5
TOTAL	240.1	1853.7	192.2	2567.8	106.9	358.09166	4661.6	1421.8	6083.4
Jul-08	47.2	321.8	164.1	399.3	50.4	46.91	768.3	256.2	1024.5
Aug	40	314.4	139.7	437.9	29	46.43	792.3	225.4	1017.7
Sep	23.1	249.6	30.8	309.6	10.1	41.31	582.3	198.4	780.7
Oct	31.2	234.5	2	299.4	6.6	19.37	565.1	208.6	773.7
Nov	21.8	154.6	0	183.2	0	0	359.6	94.4	454
Dec	1.4	49.1	0	87.4	0	0	137.9	21.8	159.7
Jan-09	13.2	97.2		129.4	0	0	239.8	8.8	248.6
Feb	2.1	38.1		62.6	4.9	0.07	102.8	2.5	105.3
Mar	6.8	101.7	0.5	138.7	37	0	247.2	0.5	247.7
Apr	32.6	176.5	4.2	259.8	27	0	468.9	70.6	539.5
May	28.8	243.5	0.2	295.4	0	0	567.7	61.2	628.9
Jun	18.7	232.2	0.7	246.6	1	6	497.5	48.3	545.8
TOTAL	266.9	2213.2	342.2	2849.3	166	160.09	5329.4	1196.7	6526.1
Jul-07	68	362.8	72.8	387	8.5	85.44	817.8	177.5	995.3
Aug-07	44	341	53	382	37.8	71.77	767	159	926
Sep-07	47	313.4	38.1	274.2	4.6	43.4	634.6	167.2	801.8
Oct-07	18	234.2		218.2	0	0	470.4	169.4	639.8
Nov-07	17.7	187.1		184.9	0	0	389.7	118	507.7
Dec-07	3.8	65.7		52.2	0	0	121.7	39	160.7
Jan-08	4.5	42.3		53.2	0	0	100	30.9	130.9
Feb-08	3.3	44.3		74.6	1.6	0	122.2	27.3	149.5
Mar-08	14.7	120		182.6	0	0	317.3	122.8	440.1
Apr-08	31.9	216.4	51.5	239.9	17.6	9.72	488.2	170.8	659
May-08	43.7	247.9	14	230.5	5.3	61.02	522.1	194.9	717
JUN	43.5	281.1	90.2	370.1	20	89.23	694.7	246.6	941.3
TOTAL	340.1	2456.2	319.6	2649.4	95.4	360.58	5445.7	1623.4	7069.1
Jul-06	44.3	361.9	70	370	0	22.33	776.2	156.9	933.1
Aug-06	40.6	420.1	64.3	350.3	0	38.51	811	179.4	990.4
Sep-06	40.6	337.5	58.2	344.1	0	17.62	722.2	132.5	854.7
Oct-06	28.4	238.2	1.5	252.4	0	0	519	168.8	687.8
Nov-06	22.7	211.2		218.1	0	1.6	452	106.4	558.4
Dec-06	3.6	115.5		138.8	0	0	257.9	59.4	317.3
Jan-07	18.9	135.8		149.3	0	0	304	65.5	369.5
Feb-07	2.2	50.3		71.6	0	0.04	124.1	19.9	144
Mar-07	13.7	160		196.7	0	0	370.4	79.9	450.3
Apr-07	16.4	202.7	2.9	221.3	0	0	440.4	98.5	538.9
May-07	42.8	272.7	0.8	331.6	0	18.18	647.1	127.6	774.7
Jun-07	44	300.9	20.7	382.4	0	46.6	727.3	131.6	858.9
TOTAL	318.2	2806.8	218.4	3026.6	0	144.88	6151.6	1326.4	7478
Jul-05	40.9	328.3	36.3	337.1	4.8	57.34	706.3	180.2	886.5
Aug-05	38.4	340	49.8	371	9.6	90.68	749.4	190.8	940.2
Sep-05	45.4	293.7	18.6	310.4	0	44.48	649.5	166.8	816.3
Oct-05	7	193.4	6.9	223.6	0	47.04	424	155	579
Nov-05	8.1	148.1		180	0	0	336.2	113.1	449.3
Dec-05	10.1	120.6		143.3	0	0	274	102.7	376.7
Jan-06	3	67.7		100.5	3.5	0	171.2	65	236.2
Feb-06	5.8	136.5		140.3	0	0	282.6	94.2	376.8
Mar-06	5.7	24.8		50.3	0	0.25	80.8	33.9	114.7
Apr-06	0.8	86.7		84	0	0.02	171.5	43.2	214.7
May-06	21.7	213.6		228.2	0	0.02	463.5	107.4	570.9
Jun-06	31.6	244		298.3	0	0	573.9	121.9	695.8
TOTAL	218.5	2197.4	111.6	2467	17.9	239.83	4882.9	1374.2	6257.1
Jul-04	45.4	328.6	38.8	322.2			696.2	170.4	866.6
Aug-04	50.3	343.9	47.2	323.4	0.4		717.6	208.3	925.9
Sep-04	43.8	302.6	32.3	303.9	3.7		650.3	227	877.3
Oct-04	7.9	153.1		163.3	12.9		324.3	109.1	433.4
Nov-04	3.7	166.7		127.8			298.2	76.2	374.4
Dec-04	1.6	74.7		82			158.3	61.1	219.4
Jan-05	1.7	22.6		26.4			50.7	11.1	61.8
Feb-05	0.7	45.2		37.6			83.5	18.3	101.8
Mar-05	0.8	34.5		46.1			81.4	26.6	108

Oct-04	7.9	153.1		163.3	12.9		324.3	109.1	433.4
Nov-04	3.7	166.7		127.8			298.2	76.2	374.4
Dec-04	1.6	74.7		82			158.3	61.1	219.4
Total	285.2	2429.1	158.6	2605.9	18.3	0	5320.2	1480	6800.2
Jan-03	8.7	135.1		144.9			288.7	68.3	357
Feb-03	2.8	61.7		70.6			135.1	34.3	169.4
Mar-03	4.90	116.10		114.30			235.30	47.30	282.60
Apr-03	7.4	167	6.4	170.1			344.5	79.8	424.3
May-03	12.4	216	2.2	225.1			453.5	125	578.5
Jun-03	36.7	231	0	249	N/A		516.7	154	670.7
Jul-03	42.4	291	23.5	315.3			648.7	162.6	811.3
Aug-03	49.6	339.2	43	340.9	0.5		729.7	168.1	897.8
Sep-03	63.6	300.7	26.5	312.3	8.8		676.6	172.4	849
Oct-03	17.1	242.9		277.3			537.3	132.6	669.9
Nov-03	13.5	128.4		159.8			301.7	85.2	386.9
Dec-03	6	98		122			226	78.9	304.9
TOTAL	265.1	2327.1	*101.6*	2501.6	*9.3*	*0*	5093.8	1308.5	6402.3
Jan-02	0.920728923	120.56	*0*	76.78			198.26073	49.94	248.200729
Feb-02	2.762186768	143.17	*0*	126.32			272.25219	93.06	365.312187
Mar-02	4.910554254	132.64	*0*	174.08			311.63055	131.48	443.110554
Apr-02	9.207289227	149.37	*55.46*	204.21			362.787	145.01	507.797289
May-02	32.53242193	207.16	*4.45*	268.54			508.232	196.62	704.852422
Jun-02	23	257.1	*13.19*	287.49			567.59	229.64	797.23
Jul-02	34.4	287.74	*27.63*	340.09			662.23	248	910.23
Aug-02	30.1	281.2	*23.2*	344.42			655.72	234.76	890.48
Sep-02	24.9	269.4	*35.1*	328.6	*4.6*		622.9	238.9	861.8
Oct-02	22.8	201.7	*6.6*	252			476.5	158	634.5
Nov-02	61.4	88.6		140.2			290.2	77.1	367.3
Dec-02	1.8	78.6		85.4	*0.2*		165.8	27.7	193.5
TOTAL	248.7331811	2217.24	*165.63*	2628.13	*4.8*	*0*	5094.1032	1830.21	6924.31318
Jan-01	11.35565671	48.64	*0*	67.95			127.94566	43	170.945657
Feb-01	2.762186768	21	*0*	46.63			70.392187	32.5	102.892187
Mar-01	2.148367486	60.51	*0*	101.92			164.57837	40.05	204.628367
Apr-01	35.90842798	109.27	*0*	146			400.85843	125.56	526.418428
May-01	62.3	204.75	*0*	255.68	N/A		522.73	164.48	687.21
Jun-01	42.7	229.53	*7.53*	308.17			580.4	209.69	790.09
Jul-01	43.27425937	257.17	*17.55*	313.33			613.77426	260.15	873.924259
Aug-01	67.520121	262.97	*45.54*	335.36			665.85012	257.04	922.890121
Sep-01	27.62186768	215.9	*0*	271.54			515.06187	211.03	726.091868
Oct-01	29.15641588	193.57	*17.73*	249.7			472.42642	171.12	643.546416
Nov-01	14.73166276	92.95	*0*	106.58			214.26166	48.84	263.101663
Dec-01	2.455277127	96.18	*0*	62.19			160.82528	38.68	199.505277
TOTAL	341.9342428	1792.44	*88.35*	2265.05	*0*	*0*	4509.1042	1602.14	6111.24424
Jan-00	16.26621097	58.05	*0*	112.12			186.43621	56.82	243.256211
Feb-00	1.841457845	28.46	*0*	38.6			68.901458	19.8	88.7014578
Mar-00	2.455277127	64.48	*0*	90.8			157.73528	53.89	211.625277
Apr-00	30.07714481	152.63	*26.86*	179.56			362.26714	113.76	476.027145
May-00	48.18481362	172.92	*0*	258.07			479.17481	189.73	668.904814
Jun-00	69.0546692	317.23	*135.03*	322.78	N/A		709.06467	250.91	959.974669
Jul-00	63.53029566	241.3	*0*	321.27			626.1003	268.08	894.180296
Aug-00	54.93682572	374.89	*63.78*	335.27			765.09683	213.95	979.046826
Sep-00	89.3	227.65	*0.46*	305.69			622.64	228.03	850.67
Oct-00	29.4	124.5	*0*	174.3			328.2	134.61	462.81
Nov-00	27.9	133.44	*12.6*	168.5			329.84	94.95	424.79
Dec-00	15.96	118.66	*0*	134.05			268.67	85.19	353.86
TOTAL	448.906695	2014.21	*238.73*	2441.01	*0*	*0*	4904.1267	1709.72	6613.84669
Jan-99	7.365831381	66.73	*2.6*	119.63			`	63.91	63.91
Feb-99	5.831283177	37.64	*0.17*	67.37			110.84128	31.51	142.351283
Mar-99	3.989825332	54.8	*0.04*	98.76			157.54983	36.52	194.069825
Apr-99	3.069096409	67.18	*0*	122.03			192.2791	82.01	274.289096
May-99	19.33530738	30.53	*0*	235.71			285.57531	147.99	433.565307
Jun-99	18.72148809	186	*0*	288.59	N/A		493.31149	138.61	631.921488
Jul-99	30.69096409	243.62	*54.34*	384.74			659.05096	204.55	863.600964
Aug-99	75.49977166	261.34	*27.57*	363.85			700.68977	247.62	948.309772
Sep-99	31.91860265	222.14	*16.2*	264.27			518.3286	203.09	721.418603
Oct-99	30.38405445	191.58	*0*	266.56			488.52405	171.55	660.074054
Nov-99	25.16659055	107.69	*0*	183.46			316.31659	84.4	400.716591
Dec-99	17.49384953	107.5	*0*	176.85			301.84385	105.43	407.27385
TOTAL	269.4666647	1576.75	*100.92*	2571.82	*0*	*0*	4224.3108	1517.19	5741.50083
Jan-98	12.88099763	19.21	0	45.89		*0*	77.980998	14.45	92.4309976
Feb-98	15.26568554	0		8.510604342		*0*	23.77629	3.29007135	27.0663612
Mar-98	45.75	20.22		45.62		*0*	111.59	13.24	124.83
Apr-98	0.491055425	43.46147425	0	93.53992035		*0*	137.49245	35.9790172	173.471467
May-98	21.13072878	86.33061289		119.2589483		*0*	226.72029	68.56668287	295.286973
Jun-98	15.40072578	127.5792686		241.2800833		*0*	384.26008	133.3307553	517.590833
Jul-98	20.09951238	207.98		324.34		*0*	552.41951	220.8	773.219512
Aug-98	81.94487412	233.56		350.09		*0*	665.59487	197.84	863.434874
Sep-98	23.63204235	176.65		294.65		*0*	494.93204	102.39	597.322042

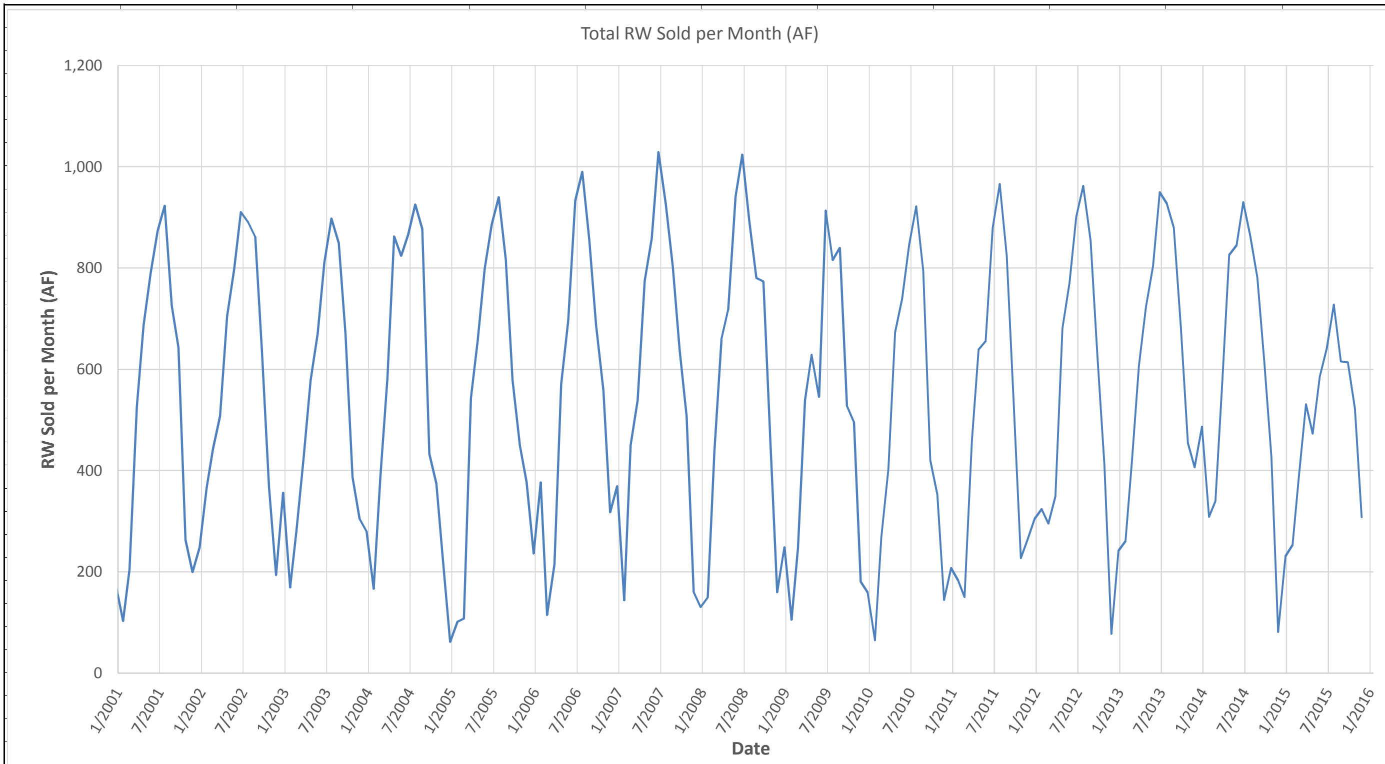
Apr-05	19.9	203.5	4	197.7			421.1	122.7	543.8
May-05	26.9	217.3		276.2			520.4	135.4	655.8
Jun-05	44.8	249.6	7.3	291	3.8	16.87	585.4	213.3	798.7
TOTAL	247.5	2142.3	129.6	2197.6	20.8	16.87	4587.4	1379.5	5966.9
Jul-03	42.4	291	23.5	315.3			648.7	162.6	811.3
Aug-03	49.6	339.2	43	340.9	0.5		729.7	168.1	897.8
Sep-03	63.6	300.7	26.5	312.3	8.8		676.6	172.4	849
Oct-03	17.1	242.9		277.3			537.3	132.6	669.9
Nov-03	13.5	128.4		159.8			301.7	85.2	386.9
Dec-03	6	98		122			226	78.9	304.9
Jan-04	5.4	90.2		117.8			213.4	66.5	279.9
Feb-04	2.4	63.9		86.5			152.8	13.8	166.6
Mar-04	8.7	138.1		166.8			313.6	74.1	387.7
Apr-04	20.5	192.3	10.5	234	1.3		446.8	135.4	582.2
May-04	47.8	364.8	98.4	343.1			755.7	192.3	948
Jun-04	47.7	402.9	124.1	335.1			785.7	145.8	931.5
TOTAL	324.7	2652.4	326	2810.9		0	5788	1427.7	7215.7
Jul-02	34.4	**287.7**	*27.6*	340.1			662.2	248.0	910.2
Aug-02	30.1	**281.2**	*23.2*	344.4			655.7	234.8	890.5
Sep-02	24.9	**269.4**	*35.1*	328.6	*4.6*		622.9	238.9	861.8
Oct-02	22.8	**201.7**	*6.6*	252.0			476.5	158.0	634.5
Nov-02	61.4	88.6		140.2			290.2	77.1	367.3
Dec-02	1.8	78.6		85.4	*0.2*		165.8	27.7	193.5
Jan-03	8.7	**135.1**		144.9			288.7	68.3	357.0
Feb-03	2.8	61.7		70.6			135.1	34.3	169.4
Mar-03	4.90	116.10		114.30			235.30	47.30	282.60
Apr-03	7.40	167.00	6.40	170.10			344.50	79.80	*424.30*
May-03	12.40	216.00	2.20	225.10			453.50	125.00	*578.50*
Jun-03	36.70	231.00		249.00			516.70	154.00	*670.70*
TOTAL	248.3	2134.14	101.13	2464.71		*0*	4847.15	*1493.16*	*6340.31*
Jul-01	43.247	257.16	*17.54*	313.33			613.737	260.15	873.887
Aug-01	67.520121	262.97	45.54	335.36		*0*	665.850121	257.04	922.890121
Sep-01	27.62186768	215.9	0	271.54			515.0618677	211.03	726.0918677
Oct-01	29.15641588	193.57	17.73	249.7			472.4264159	171.12	643.5464159
Nov-01	14.73166276	92.95	0	106.58			214.2616628	48.84	263.1016628
Dec-01	2.455277127	96.18	0	62.19			160.8252771	38.68	199.5052771
Jan-02	0.920728923	120.56	*0*	76.78			198.2607289	49.94	248.2007289
Feb-02	2.762186768	143.17	*0*	126.32			272.2521868	93.06	365.3121868
Mar-02	4.910554254	132.64	*0*	174.08			311.6305543	131.48	443.1105543
Apr-02	9.207289227	149.37	*55.46*	204.21			362.7872892	145.01	507.7972892
May-02	32.53242193	207.16	*4.45*	268.54			508.2324219	196.62	704.8524219
Jun-02	23	257.1	*13.19*	287.49			567.59	229.64	797.23
TOTAL	258.0655256	2128.73	*153.91*	2476.12		*0*	4862.915526	1832.61	6695.525526
Jul-00	63.53029566	241.3	*0*	321.27		*0*	626.1002957	268.08	894.1802957
Aug-00	54.93682572	374.89	*63.78*	335.27		*0*	765.0968257	213.95	979.0468257
Sep-00	89.3	227.65	*0.46*	305.69			622.64	228.03	850.67
Oct-00	29.4	124.5	*0*	174.3			328.2	134.61	462.81
Nov-00	27.9	133.44	*12.6*	168.5			329.84	94.95	424.79
Dec-00	15.96	118.66	*0*	134.05			268.67	85.19	353.86
Jan-01	11.35565671	48.64	*0*	67.95	N/A		127.9456567	43	170.9456567
Feb-01	2.762186768	21	*0*	46.63			70.39218677	32.5	102.8921868
Mar-01	2.148367486	60.51	*0*	101.92			164.5783675	40.05	204.6283675
Apr-01	35.90842798	109.27	*0*	146			291.178428	125.56	416.738428
May-01	62.3	204.75	*0*	255.68			522.73	164.48	687.21
Jun-01	42.7	229.53	*7.53*	308.17			580.4	209.69	790.09
TOTAL	438.2017603	1894.14	*84.37*	2365.43		*0*	4697.77176	1640.09	6337.86176
Jul-99	30.69096409	243.62	*54.34*	384.74			659.0509641	204.55	863.6009641
Aug-99	75.49977166	261.34	*27.57*	363.85			700.6897717	247.62	948.3097717
Sep-99	31.91860265	222.14	*16.2*	264.27			518.3286027	203.09	721.4186027
Oct-99	30.38405445	191.58	*0*	266.56			488.5240544	171.55	660.0740544
Nov-99	25.16659055	107.69	*0*	183.46			316.3165906	84.4	400.7165906
Dec-99	17.49384953	107.5	*0*	176.85			301.8438495	105.43	407.2738495
Jan-00	16.26621097	58.05	*0*	112.12	N/A		186.436211	56.82	243.256211
Feb-00	1.841457845	28.46	*0*	38.6			68.90145785	19.8	88.70145785
Mar-00	2.455277127	64.48	*0*	90.8			157.7352771	53.89	211.6252771
Apr-00	30.07714481	152.63	*26.86*	179.56			362.2671448	113.76	476.0271448
May-00	48.18481362	172.92	*0*	258.07			479.1748136	189.73	668.9048136
Jun-00	69.0546692	317.23	*135.03*	322.78			709.0646692	250.91	959.9746692
TOTAL	379.0334065	1927.64	*260*	2641.66		*0*	4948.333407	1701.55	6649.883407
Jul-98	20.09951238	207.98	*0*	545.14		*0*	773.2195124	220.8	994.0195124
Aug-98	81.94487412	233.56	*0*	350.09		*0*	665.5948741	197.84	863.4348741
Sep-98	23.63204235	176.65	*0*	294.65		*0*	494.9320423	102.39	597.3220423
Oct-98	18.72148809	140.04	*0*	227.35		*0*	386.1114881	113.44	499.5514881
Nov-98	6.7520121	103.41	*0*	164.32		*0*	274.4820121	85.99	360.4720121
Dec-98	7.365831381	56.98	*0*	116.11		*0*	180.4558314	60.04	240.4958314
Jan-99	7.365831381	66.73	*2.6*	119.63		*0*	193.7258314	63.91	257.6358314
Feb-99	5.831283177	37.64	*0.17*	67.37		*0*	110.8412832	31.51	142.3512832
Mar-99	3.989825332	54.8	*0.04*	98.76		*0*	157.5498253	36.52	194.0698253

Recycled Water Monthly Sales

Recycled Water Monthly Sales															
month	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
January	170.95	248.20	357.00	279.90	61.80	236.20	369.50	130.90	248.60	159.70	207.90	305.10	242.00	487.10	231.20
February	102.89	365.31	169.40	166.60	101.80	376.80	144.00	149.50	105.30	64.80	183.00	324.00	261.00	308.60	253.30
March	204.63	443.11	282.60	387.70	108.00	114.70	450.30	440.10	247.70	268.90	150.20	295.20	418.20	339.70	389.80
April	526.42	507.80	424.30	582.20	543.80	214.70	538.90	659.00	539.50	402.60	458.90	349.20	607.70	580.80	530.80
May	687.21	704.85	578.50	862.80	655.80	570.90	774.70	717.00	628.90	673.10	639.50	681.20	723.80	826.20	472.90
June	790.09	797.23	670.70	824.00	798.70	695.80	858.90	941.30	545.80	739.50	656.20	770.70	803.70	845.10	585.40
July	873.92	910.23	811.30	866.60	886.50	933.10	1029.30	1024.50	913.80	846.70	879.30	901.00	949.40	930.20	641.80
August	922.89	890.48	897.80	925.90	940.20	990.40	926.00	892.50	815.80	921.90	966.10	962.50	927.70	863.20	728.10
September	726.09	861.80	849.00	877.30	816.30	854.70	801.80	780.70	839.90	794.50	823.20	854.60	879.70	781.70	615.90
October	643.55	634.50	669.90	433.40	579.00	687.80	639.80	773.70	528.30	420.20	541.70	628.60	683.30	613.40	613.70
November	263.10	367.30	386.90	374.40	449.30	558.40	507.70	454.00	496.10	353.20	227.40	412.50	454.70	427.10	522.80
December	199.51	193.50	304.90	219.40	376.70	317.30	160.70	159.70	180.90	144.50	263.90	77.40	406.60	81.10	308.30



Recycled Water Sales and Projection Graph



Total RW Sold per Month (AF)
RW Sold per Month (AF)
1,200
1,000
800
600
400
200
0
1/2001
7/2001
1/2002
7/2002
1/2003
7/2003
1/2004
7/2004
1/2005
7/2005
1/2006
7/2006
1/2007
7/2007
1/2008
7/2008
1/2009
7/2009
1/2010
7/2010
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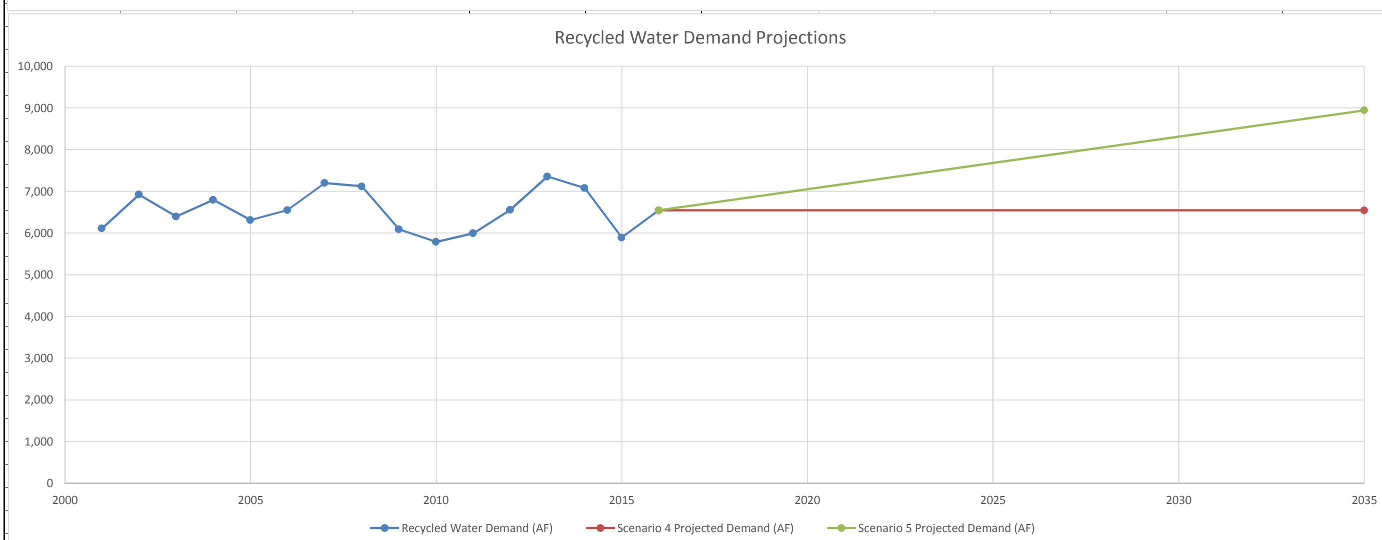
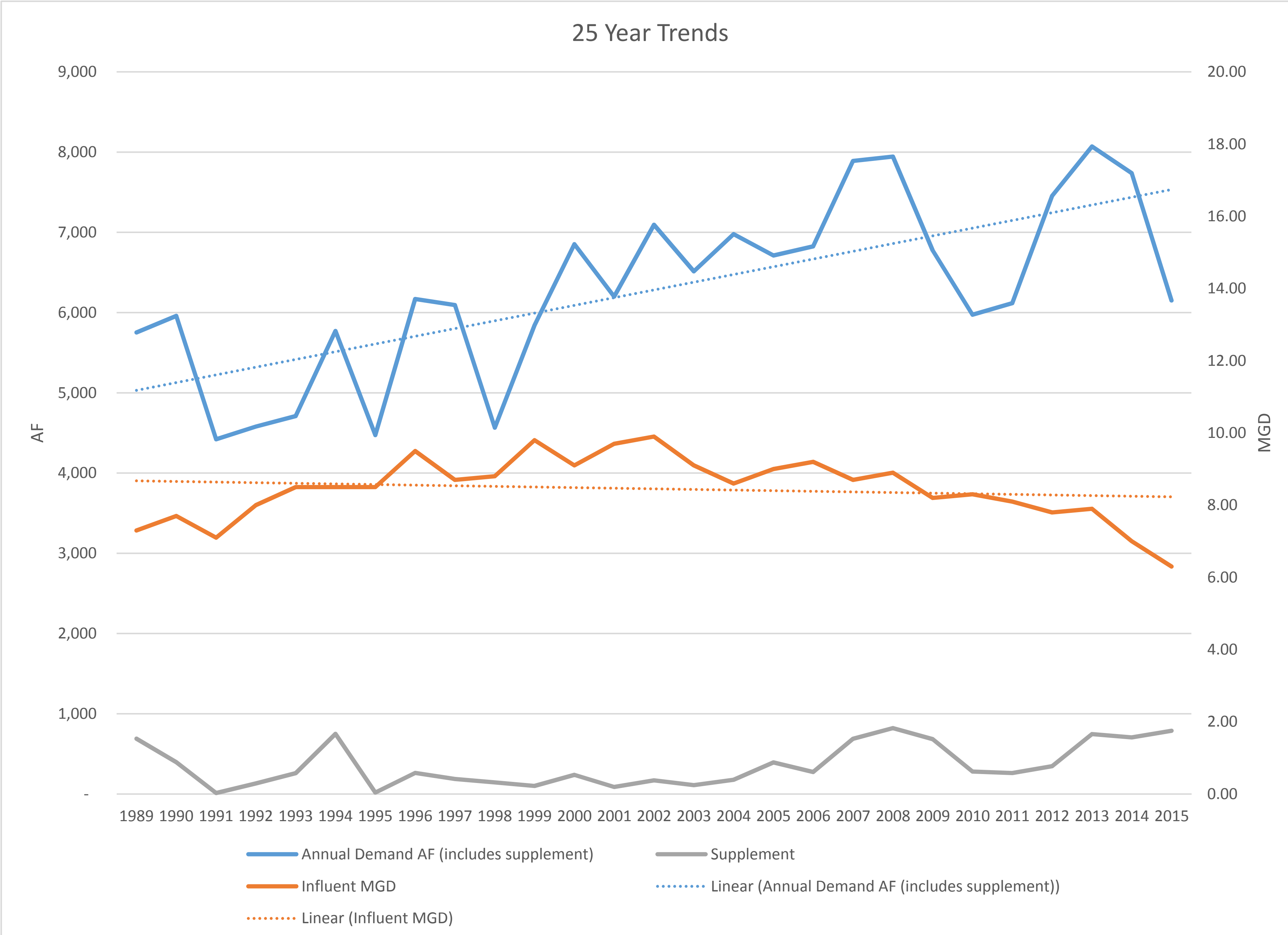
1/2015
7/2015
1/2016
Date



Recycled Water Demand Projections
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2000
2005
2010
2015
2020
2025
2030
2035
Recycled Water Demand (AF)
Scenario 4 Projected Demand (AF)
Scenario 5 Projected Demand (AF)

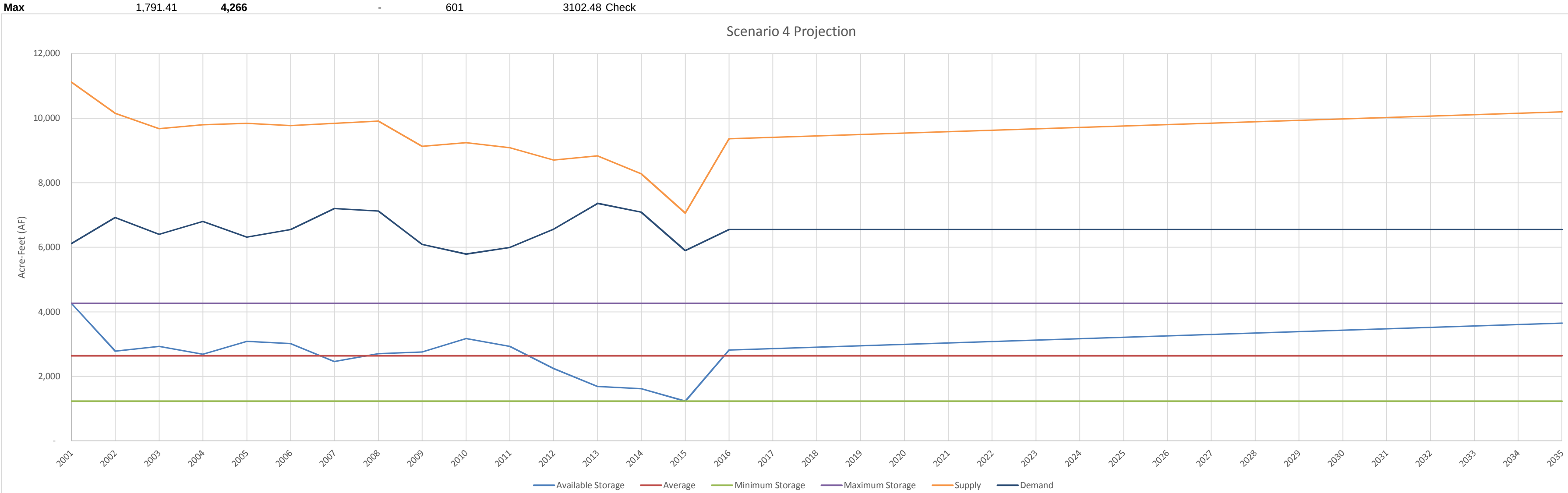


25 Year Trends
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
-
AF
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
MGD
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Annual Demand AF (includes supplement)
Supplement
Influent MGD
Linear (Annual Demand AF (includes supplement))
Linear (Influent MGD)

Scenario 4 Supply and Demand

Las Virgenes Reservoir Supply and Demand

	Total Storage																		
	Positive	AF	# of Days	Negative	Deficit AF	# of Days		Average	Min	Max	Supply	Demand	Check (Supply - Demand)	Check (%)	Date		Potable Supplement Calced (AF)	Surplus No Brine	Deficit No Brine
2001	1,389.89	4,266	355	-3.26176101	10	10	365.00	2,637.10	1,230.43	4,265.71	11,118	6,111	5,007	0.0000000%	6/1/2001	9.924787032	12	5018.48	12
2002	904.89	2,777	344	-9.75403815	30	21	365.00	2,637.10	1,230.43	4,265.71	10,156	6,924	3,232	0.0000000%	6/1/2002	9.066407445	35	3267.28	35
2003	954.03	2,928	295	-46.6594596	143	70	365.00	2,637.10	1,230.43	4,265.71	9,679	6,402	3,276	0.0000000%	6/1/2003	8.639854339	168	3444.71	168
2004	876.27	2,689	279	-46.0282991	141	87	366.00	2,637.10	1,230.43	4,265.71	9,798	6,800	2,998	0.0000000%	6/1/2004	8.746452219	166	3163.95	166
2005	1,004.09	3,082	291	-28.4908203	87	74	365.00	2,637.10	1,230.43	4,265.71	9,840	6,318	3,523	0.0000000%	6/1/2005	8.78442734	103	3625.46	103
2006	981.44	3,012	278	-88.5519934	272	87	365.00	2,637.10	1,230.43	4,265.71	9,775	6,551	3,224	0.0000000%	6/1/2006	8.72573897	320	3543.68	320
2007	802.53	2,463	263	-71.6808906	220	102	365.00	2,637.10	1,230.43	4,265.71	9,840	7,202	2,639	0.0000000%	6/1/2007	8.78442734	259	2897.71	259
2008	879.89	2,700	247	-108.540001	333	119	366.00	2,637.10	1,230.43	4,265.71	9,908	7,123	2,785	0.0000000%	6/1/2008	8.84471227	392	3177.03	392
2009	898.10	2,756	282	-57.5350562	177	83	365.00	2,637.10	1,230.43	4,265.71	9,126	6,091	3,035	0.0000000%	6/1/2009	8.146273743	208	3242.76	208
2010	1,033.51	3,172	252	-78.3765316	241	113	365.00	2,637.10	1,230.43	4,265.71	9,238	5,790	3,449	0.0000000%	6/1/2010	8.246860841	283	3731.69	283
2011	954.30	2,929	273	-100.238355	308	92	365.00	2,637.10	1,230.43	4,265.71	9,081	5,997	3,084	0.0000000%	6/1/2011	8.106495254	362	3445.69	362
2012	731.55	2,245	250	-138.002709	424	116	366.00	2,637.10	1,230.43	4,265.71	8,705	6,562	2,143	0.0000000%	6/1/2012	7.770917833	498	2641.43	498
2013	550.66	1,690	239	-141.716675	435	126	365.00	2,637.10	1,230.43	4,265.71	8,834	7,358	1,477	0.0000000%	6/1/2013	7.886292521	512	1988.28	512
2014	526.60	1,616	200	-195.665487	601	165	365.00	2,637.10	1,230.43	4,265.71	8,279	7,084	1,195	0.0000000%	6/1/2014	7.390615588	706	1901.41	706
2015	400.91	1,230	248	-77.9395131	239	117	365.00	2,637.10	1,230.43	4,265.71	7,060	5,894	1,166	0.0000000%	6/1/2015	6.302461492	281	1447.56	281
2016	-	2,815.44	0	0	-	0	-	2,637.10	1,230.43	4,265.71	9,363	6547.1	2,815	17.6470588%					
2035		3,646.89	0	0	-	0	0.00	2,637.10	1,230.43	4,265.71	10,194	6547.1	3,647	17.6470588%					
Average	953.20	**2,637.10**		(79.50)	244		3102.48	Check		**Averages:**	**9,363**	**6547**	**2815**		**Averages:**		**287.0**	**3102**	**287**
Min	400.91	**1,230**		(195.67)	10		3102.48	Check		**Monthly Average:**		**546**			**Supply - Potable Supplement**		**9,650**	**3,102**	**Check**
Max	1,791.41	**4,266**		-	601		3102.48	Check											



Scenario 5 Supply and Demand

Encino Reservoir Supply and Demand

Total Storage

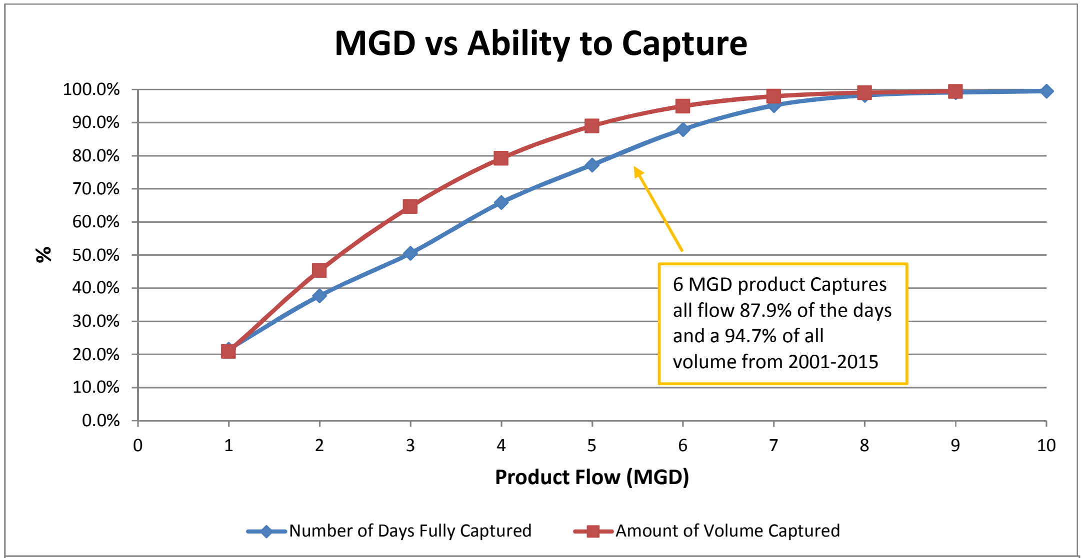
	Positive (MG)	**AF - seepage**	**# of Days**	**Negative**	**AF**	**Days**		**Average**	**Min**	**Max**	**Supply**	**Demand**	**Check**	**Check**	**Storage assuming max deficit**	**Gross Surplus**
2001	1,635.17	4,618	355	-3.8373659	12	10	365.00	3,102.48	1,447.56	5,018.48	11118	6111.2	4606.702564	0.0000000%	4,618.48	5,018
2002	1,064.57	2,867	344	-11.475339	35	21	365.00	3,102.48	1,447.56	5,018.48	10156	6924.3	2832.059483	0.0000000%	2,867.28	3,267
2003	1,122.39	3,045	295	-54.893482	168	70	365.00	3,102.48	1,447.56	5,018.48	9679	6402.3	2876.239263	0.0000000%	3,044.71	3,445
2004	1,030.90	2,764	279	-54.15094	166	87	366.00	3,102.48	1,447.56	5,018.48	9798	6800.2	2597.75236	0.0000000%	2,763.95	3,164
2005	1,181.28	3,225	291	-33.518612	103	74	365.00	3,102.48	1,447.56	5,018.48	9840	6317.9	3122.592858	0.0000000%	3,225.46	3,625
2006	1,154.63	3,144	278	-104.17882	320	87	365.00	3,102.48	1,447.56	5,018.48	9775	6550.8	2823.94896	0.0000000%	3,143.68	3,544
2007	944.16	2,498	263	-84.330459	259	102	365.00	3,102.48	1,447.56	5,018.48	9840	7201.6	2238.892858	0.0000000%	2,497.71	2,898
2008	1,035.17	2,777	247	-127.69412	392	119	366.00	3,102.48	1,447.56	5,018.48	9908	7122.9	2385.125253	0.0000000%	2,777.03	3,177
2009	1,056.59	2,843	282	-67.688301	208	83	365.00	3,102.48	1,447.56	5,018.48	9126	6090.6	2635.020314	0.0000000%	2,842.76	3,243
2010	1,215.89	3,332	252	-92.207684	283	113	365.00	3,102.48	1,447.56	5,018.48	9238	5789.6	3048.700012	0.0000000%	3,331.69	3,732
2011	1,122.71	3,046	273	-117.92748	362	92	365.00	3,102.48	1,447.56	5,018.48	9081	5997.3	2683.759648	0.0000000%	3,045.69	3,446
2012	860.65	2,241	250	-162.35613	498	116	366.00	3,102.48	1,447.56	5,018.48	8705	6562.0	1743.139046	0.0000000%	2,241.43	2,641
2013	647.84	1,588	239	-166.7255	512	126	365.00	3,102.48	1,447.56	5,018.48	8834	7357.8	1076.5841	0.0000000%	1,588.28	1,988
2014	619.53	1,501	200	-230.19469	706	165	365.00	3,102.48	1,447.56	5,018.48	8279	7084.2	794.9167932	0.0000000%	1,501.41	1,901
2015	471.66	1,048	248	-91.693545	281.42	117	365.00	3,102.48	1,447.56	5,018.48	7060	5894.0	766.1446052	0.0000000%	1,047.56	1,448
2016	1,143.10	2,702.48		-79.792313	244.89	0	-	3,102.48	1,447.56	5,018.48	9362.6	6547.1	2,415.44	1.7448766%	2,702.48	
2035		4,761.46	0	0	-	0	-	-	1,447.56	5,018.48	14103.6	8942.1	4,761.46	0.0000000%	5,467.94	
	MG	AF														
Average	1,143.10	**2,702**		(79.79)	280					TOTALS	**9,363**	**6,547**			Total	**3,102**
Min	471.66	**1,048**		(3.84)	12										Min	**1,448**
Max	2,107.54	**4,618**		(230.19)	706										Max	**5,018**

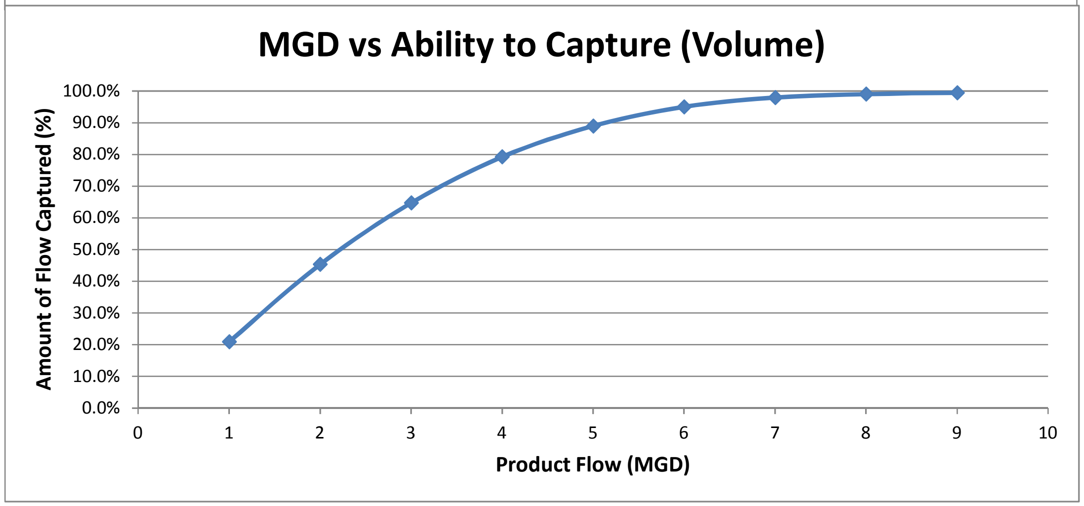
AWT Ability to Capture

Analysis of Percent of Days Captured by AWT Plant

Flow (MGD)	**Count If**		**% of Total Captured**	**Percent of Days AWT able to capture full flow (%)**
0	4096			
1	3210		0.783691406	21.6%
2	2549		0.622314453	37.8%
3	2024		0.494140625	50.6%
4	1396		0.340820313	65.9%
5	931		0.227294922	77.3%
6	492		0.120117188	88.0%
7	197		0.048095703	95.2%
8	72		0.017578125	98.2%
9	36		0.008789063	99.1%
10	20		0.004882813	99.5%

	Total Flow Un	Total Flow Un	Total Flow Captured %	
Total Flow	11696.22476			
Total Flow>6	582.2853434			
Total Flow>1	9250.039667	0.790856867	20.9%	
Total Flow>2	6393.563627	0.546634813	45.3%	
Total Flow>3	4129.893696	0.353096301	64.7%	
Total Flow>4	2428.663527	0.20764508	79.2%	
Total Flow>5	1289.118628	0.110216643	89.0%	
Total Flow>6	582.2853434	0.049784042	95.0%	
Total Flow>7	240.3735092	0.020551376	97.9%	
Total Flow>8	114.616443	0.009799439	99.0%	
Total Flow>9	61.96583212	0.005297934	99.5%	





AWT Design Calculations

Flow Projections and Tank Sizing

	HRT (min)	V total (gal)	D (ft)	H (ft)	V check (gal)
MF feed tank	20	103333	28	24	110547.2168
RO feed tank	20	98167	28	24	110547.2168
RO flush tank	20	83442	28	24	110547.2168

Demo flow projections (influent - mgd, per train)

MF	7.44	95%
RO	7.07	**85%**
AOP	6.01	100%

LVMWD - MF System Sizing

Total Required Area

$Q := 7.5\ mgd$

$gfd := \frac{gal}{day \cdot ft^2}$ $J_{Design} := 30\ gfd$

$A_{Required} := \frac{Q}{J_{Design}} = 250000\ ft^2$

Number of Modules

$A_{Module} := 775\ ft^2$ Assume Toray HFU-2020N modules

$N_{Modules} := \text{ceil}\left(\frac{A_{Required}}{A_{Module}}\right)$ $N_{Modules} = 323$

Number of Racks

$N_{Modules.Rack} := 86$ Assume 86-modules H2O innovation filter rack assembly.

$N_{Racks.Demo} := \frac{N_{Modules}}{N_{Modules.Rack}}$ $\text{ceil}\left(N_{Racks.Demo}\right) + 1 = 5$

5 parallel racks, includes some redundancy.

MWH
BUILDING A BETTER WORLD

Calc by: RTH 12/31/15
Check by:
Update: RTH 6/14/16

1. Train Number and Configuration

Number of RO Trains

$N_{Trains.Primary} := 3$ $N_{Trains.Recovery} := 3$

$N_{Trains.Primary.Online} := N_{Trains.Primary} - 0 = 3$

$N_{Trains.Recovery.Online} := N_{Trains.Recovery} - 0 = 3$

Number of primary and recovery trains (n+0 arrangement)

Online Factors

$OF_{Primary} := \frac{N_{Trains.Primary.Online}}{N_{Trains.Primary}}$ $OF_{Primary} = 100\%$

$OF_{Recovery} := \frac{N_{Trains.Recovery.Online}}{N_{Trains.Recovery}}$ $OF_{Recovery} = 100\%$

Number of Vessels and Elements per Train

$N_{Vessels.Stage1} := 42$ $N_{Elements.Vessel} := 6$

$N_{Vessels.Stage2} := 21$ $A_{Element} := 400\ ft^2$

$N_{Vessels.Stage3} := 10$

Assume 6 elements per pressure vessel and 400 sf area per element, typical for BWRO systems.

$N_{Vessels.Primary} := N_{Vessels.Stage1} + N_{Vessels.Stage2}$ $N_{Vessels.Primary} = 63$

$N_{Vessels.Recovery} := N_{Vessels.Stage3} = 10$ $N_{Vessels.Recovery} = 10$

$N_{Elements.Primary} := N_{Vessels.Primary} \cdot N_{Elements.Vessel}$ $N_{Elements.Primary} = 378$

$N_{Elements.Recovery} := N_{Vessels.Recovery} \cdot N_{Elements.Vessel}$ $N_{Elements.Recovery} = 60$

Total Element Area per Train

$A_{Primary} := N_{Elements.Primary} \cdot A_{Element}$ $A_{Primary} = 151200\ ft^2$

$A_{Recovery} := N_{Elements.Recovery} \cdot A_{Element}$ $A_{Recovery} = 24000\ ft^2$

2. System Flow Rates and Average Flux

Permeate Requirement and Target Recoveries

$Q_{Influent} := 7.43 \cdot mgd$ Total Plant Influent

$R_{MF.Overall} := 95\%$ Target recovery, MF system

$R_{Overall} := 85\%$ Target recovery, RO, overall and for each system (Design Criteria)

$R_{Primary} := 75\%$ $R_{Recovery} := 40\%$

$Q_{ROP.Overall} := Q_{Influent} \cdot R_{MF.Overall} \cdot R_{Overall} = 6\ mgd$ Total permeate (Design Criteria)

Primary RO Feed, Permeate, and Concentrate

$Q_{ROF.Overall} := \frac{Q_{ROP.Overall}}{R_{Overall}}$ $Q_{ROF.Overall} = 7.1\ mgd$

$Q_{ROF.Primary.Train} := \frac{Q_{ROF.Overall}}{N_{Trains.Primary.Online}}$ $Q_{ROF.Primary.Train} = 1633.91\ gpm$

$Q_{ROP.Primary.Total} := R_{Primary} \cdot Q_{ROF.Overall}$ $Q_{ROP.Primary.Total} = 5.3\ mgd$

$Q_{ROP.Primary.Train} := R_{Primary} \cdot Q_{ROF.Primary.Train}$ $Q_{ROP.Primary.Train} = 1225.4\ gpm$

$Q_{ROC.Primary.Total} := \left(1 - R_{Primary}\right) \cdot Q_{ROF.Overall}$ $Q_{ROC.Primary.Total} = 1.8\ mgd$

$Q_{ROC.Primary.Train} := \left(1 - R_{Primary}\right) \cdot Q_{ROF.Primary.Train}$ $Q_{ROC.Primary.Train} = 0.6\ mgd$

Primary RO Average Flux

$$J_{Primary} := \frac{Q_{ROP.Primary.Train}}{A_{Primary}}$$ $$J_{Primary} = 11.7 \ \frac{gal}{day \cdot ft^2}$$ OK - <12 gfd

Recovery RO Feed, Permeate, and Concentrate

$$Q_{ROF.Recovery.Total} := Q_{ROC.Primary.Total}$$ $$Q_{ROF.Recovery.Total} = 1.8 \ mgd$$

$$Q_{ROF.Recovery.Train} := \frac{Q_{ROF.Recovery.Total}}{N_{Trains.Recovery.Online}}$$ $$Q_{ROF.Recovery.Train} = 0.59 \ mgd$$

$$Q_{ROP.Recovery.Total} := R_{Recovery} \cdot Q_{ROF.Recovery.Total}$$ $$Q_{ROP.Recovery.Total} = 0.71 \ mgd$$

$$Q_{ROP.Recovery.Train} := R_{Recovery} \cdot Q_{ROF.Recovery.Train}$$ $$Q_{ROP.Recovery.Train} = 0.24 \ mgd$$

$$Q_{ROC.Overall} := \left(1 - R_{Recovery}\right) \cdot Q_{ROF.Recovery.Total}$$ $$Q_{ROC.Overall} = 1.06 \ mgd$$

$$Q_{ROC.Recovery.Train} := \left(1 - R_{Recovery}\right) \cdot Q_{ROF.Recovery.Train}$$ $$Q_{ROC.Recovery.Train} = 0.35 \ mgd$$

Recovery RO Average Flux

$$J_{Recovery} := \frac{Q_{ROP.Recovery.Train}}{A_{Recovery}}$$ $$J_{Recovery} = 9.8 \ \frac{gal}{day \cdot ft^2}$$ OK - <10 gfd

3. Footprint and Layout

Footprint of Each Train

$W_{Train.Primary\&Recovery} := 27 \ ft$ $L_{Train.Primary\&Recovery} := 19.5 \ ft$ Estimated based on vendor data (H2O Innovation)

$S_{Trains} := 6.75 \ ft$ $S_{Aisle} := 15 \ ft$ $S_{Elec} := 10 \ ft$ Spacing for trains, aisles, and electrical

RO Area Envelope

$L_{RO.Area} := 3 \cdot L_{Train.Primary\&Recovery} + 2 \cdot S_{Trains} + 2 \cdot S_{Aisle}$ $\qquad L_{RO.Area} = 102\ ft$

$W_{RO.Area} := 1 \cdot W_{Train.Primary\&Recovery} + 2 \cdot S_{Aisle}$ $\qquad W_{RO.Area} = 57\ ft$

4. Flush Tank and Clean-in-Place Tank Sizing

Total Flush Volume

$Vol_{Flush.Element} := 10\ gal$ — Flush volume per element (H2O Innovation flush guide)

$Vol_{Flush.Piping} := 20\%$ — Allowance for piping

Size the flush tank to be able to flush the entire RO system, primary and secondary, including standby trains. Provide sufficient volume to do this twice during the design case - once for a full shutdown and again to provide feed water for startup.

$$Vol_{Flush} := 2 \cdot \left(N_{Trains.Primary} \cdot N_{Elements.Primary} + N_{Trains.Recovery} \cdot N_{Elements.Recovery}\right) \cdot Vol_{Flush.Element}$$

$$Vol_{Flush.Require} := \left(1 + Vol_{Flush.Piping}\right) \cdot Vol_{Flush}$$

$Vol_{Flush.Require} = 31536\ gal$ --> Select $Vol_{Flush.Design} := 32000\ gal$

Flush Tank Dimensions

$D_{FlushTank} := 20\ ft$

$A_{FlushTank} := \frac{1}{4} \cdot \pi \cdot D_{FlushTank}^{\ 2} = 314.159\ ft^2$

Assume a cylindrical tank outside the building, downstream of UV-AOP

$$HW_{FlushTank.Required} := \frac{Vol_{Flush.Design}}{A_{FlushTank}}$$ $\qquad HW_{FlushTank.Required} = 13.6\ ft$

$H_{FlushTank.Excess} := 2\ ft$ — Space for freeboard and excess volume

$$H_{FlushTank} := \text{ceil}\left(\frac{HW_{FlushTank.Required} + H_{FlushTank.Excess}}{ft}\right) \cdot ft$$ $\qquad H_{FlushTank} = 16\ ft$

Total Clean-in-Place Volume

$Vol_{CIP.Element} := 9\ gal$

CIP volume per element (H2O Innovation CIP guide)

$Vol_{CIP.Piping} := 20\%$ $Vol_{CIP.Flush} := 20\%$

Allowance for piping and flushing out permeate

Size the CIP tank to be able to clean an entire RO train.

$$Vol_{CIP} := \left(N_{Vessels.Primary} + N_{Vessels.Recovery}\right) \cdot N_{Elements.Vessel} \cdot Vol_{CIP.Element}$$

$$Vol_{CIP.Require} := \left(1 + Vol_{CIP.Piping}\right) \cdot \left(1 + Vol_{CIP.Flush}\right) \cdot Vol_{CIP}$$

$Vol_{CIP.Require} = 5676\ gal$ --> Select $Vol_{CIP.Design} := 6000\ gal$

Clean-in-Place Tank Dimensions

$D_{CIPTank} := 10 \cdot ft$

Assume a cylindrical at-grade FRP tank.

$$A_{CIPTank} := \frac{\pi \cdot D_{CIPTank}^{2}}{4} = 78.54\ ft^2$$

$$HW_{CIPTank} := \frac{Vol_{CIP.Design}}{A_{CIPTank}}$$

$HW_{CIPTank} = 10.2\ ft$

$H_{CIPTank.Excess} := 1.5\ ft$

Space for freeboard and excess volume

$$H_{CIPTank} := \text{ceil}\left(\frac{HW_{CIPTank} + H_{CIPTank.Excess}}{ft}\right) \cdot ft$$

$H_{CIPTank} = 12\ ft$

Clean and Flush Flow Rates

$Q_{Flush.Vessel.Low} := 30\ gpm$

$Q_{Flush.Vessel.High} := 50\ gpm$

Flush / clean flow rate per 8" RO pressure vessel (H2O Innovation CIP guide)

$$Q_{Flush.Train} := Q_{Flush.Vessel.Low} \cdot \left(N_{Vessels.Primary} + N_{Vessels.Recovery}\right)$$

$$Q_{Flush.Train} = 2190 \ gpm$$

--> Use one pump at the flush tank sized for 1600 gpm. One pump will be adequate to flush one RO train at greater than 30 gpm per vessel.

$$Q_{CIP.Train} := Q_{Flush.Vessel.High} \cdot \left(N_{Vessels.Primary} + N_{Vessels.Recovery}\right)$$

$$Q_{CIP.Train} = 3650 \ gpm$$

--> Use one pump at the CIP tank sized for 2600 gpm, equipped with a VFD. One pump will be adequate to flush one RO train at 50 gpm per vessel.

Flush and CIP Time

$$t_{Flush} := \frac{\left(1 + Vol_{Flush.Piping}\right) \cdot \left(N_{Elements.Primary} + N_{Elements.Recovery}\right) \cdot Vol_{Flush.Element}}{Q_{Flush.Train}}$$

$$t_{Flush} = 2.4 \ min$$

$$t_{CIP.Recirc} := \frac{Vol_{CIP.Design}}{Q_{CIP.Train}}$$

$$t_{CIP.Recirc} = 1.64 \ min$$

CIP Heater Sizing

$T_{Feed} := 19 \ °C$ $\quad T_{CIP} := 45 \ °C$ $\quad t_{CIP.Heat} := 2 \ hr$

Minimum feed temperature, target CIP temperature, and desired heating time

$c_{Water} := 4.184 \ \frac{J}{gm \cdot K}$ $\quad \rho_{Water} := 1000 \ \frac{kg}{m^3}$

Water properties

$$P_{Heater} := \frac{Vol_{CIP.Design} \cdot c_{Water} \cdot \rho_{Water} \cdot \left(T_{CIP} - T_{Feed}\right)}{t_{CIP.Heat}}$$

$P_{Heater} = 343\ kW$

Brine Discharge Calculations

AWT Plant Brine Discharge

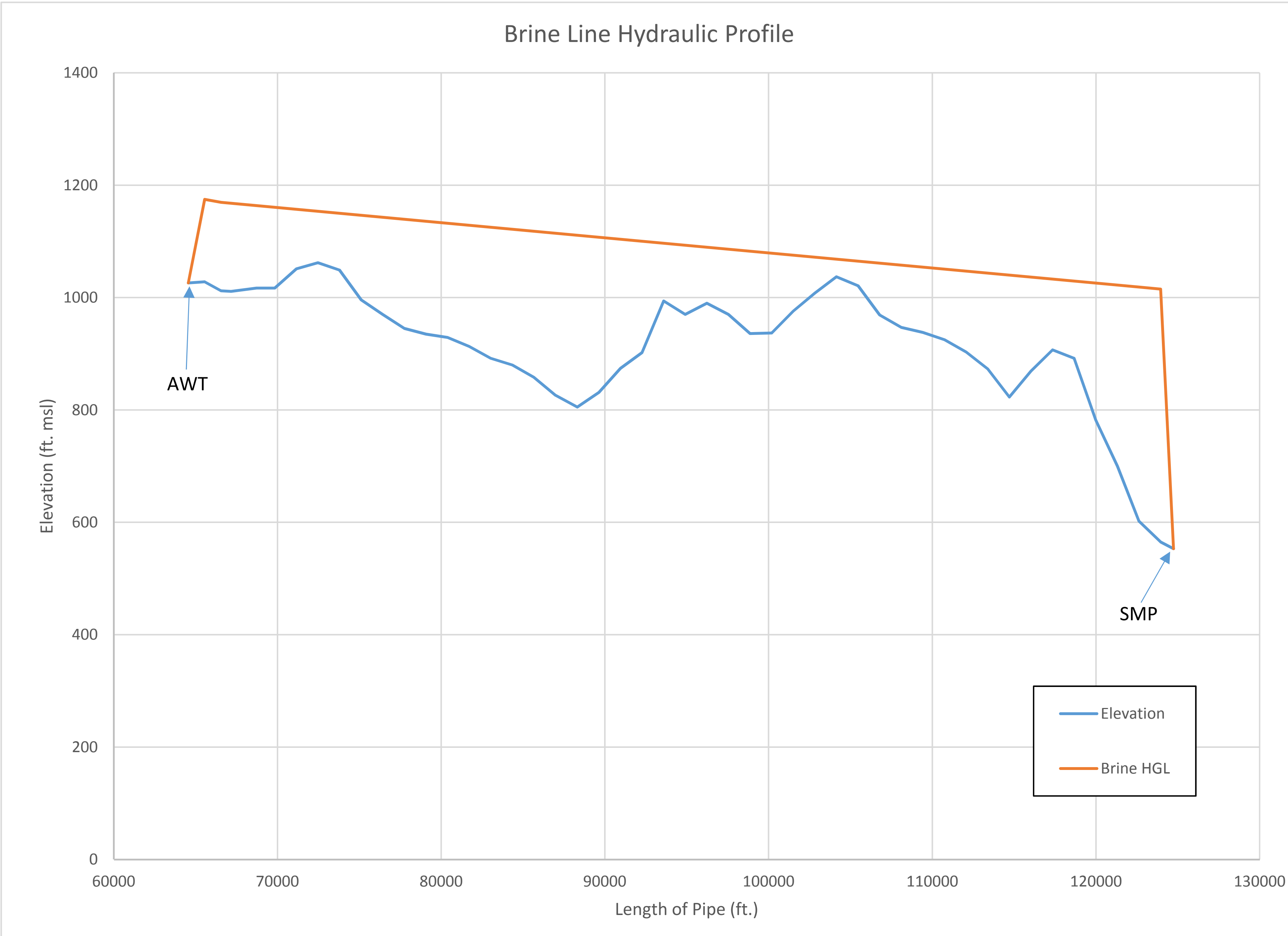
AWT Plant	1013.0	ft
High Point	1062.0	ft
SMP	553.0	ft
Discharge Pressure Required	25.0	psi
Discharge Head Required	20.0	
Static Hea	69.0	ft

Flow rate (high) =	1.7	mgd
Flow rate (high) =	1,146	gpm
Flow rate (low) =	0.3	mgd
Flow rate (low) =	229	gpm
Steel C (High)	120	
Steel C (Low)	100	
Plastic C (High)	130	
Plastic C (Low)	110	
Distance =	11.4	Miles

Friction Loss	72.81304
Minor Loss (est)	20
Total Headloss (Including Static)=	161.8

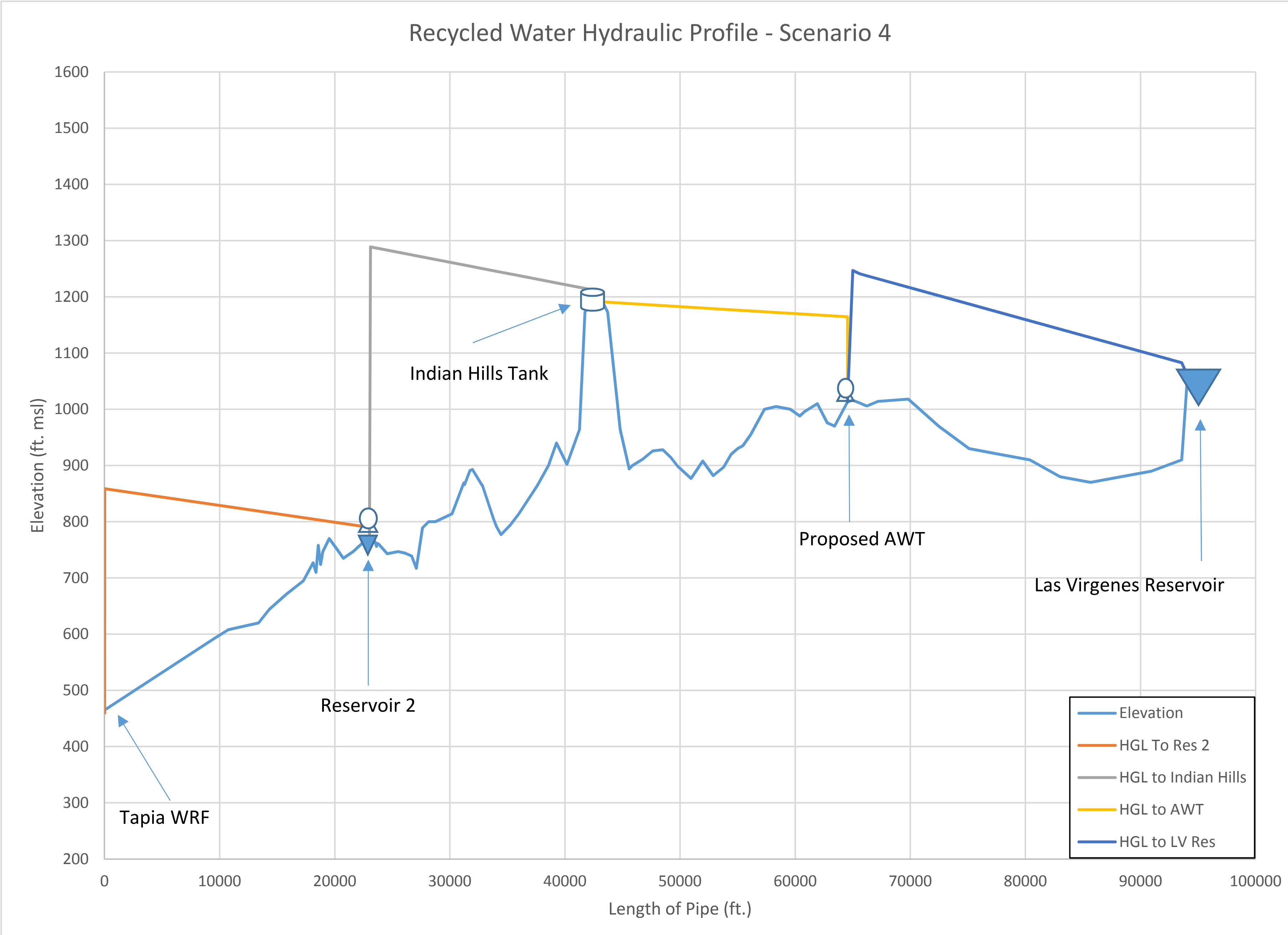
BRINE DISCHARGE

Description	To	To Elev	From	From Elev	Length	"Station"	Elevation	Diameter	Material	HGL
TO and Lindero (AWT Site)	#N/A	#N/A	#N/A	#N/A	0	64548.73	1026	8	Steel	1026.0
					1000	65548.73	1028	8		1174.8
					1000	66548.73	1012	8		1169.4
					616	67164.73	1011	8		1167.8
					1555.2	68719.93	1017	8		1163.6
					1108.8	69828.73	1017	8		1160.6
					1320	71148.73	1051	8		1157.1
					1320	72468.73	1062	8		1153.5
					1320	73788.73	1049	8		1150.0
					1320	75108.73	996	8		1146.4
					1320	76428.73	970	8		1142.9
					1320	77748.73	945	8		1139.3
					1320	79068.73	935	8		1135.8
					1320	80388.73	929	8		1132.2
					1320	81708.73	913	8		1128.7
					1320	83028.73	892	8		1125.1
					1320	84348.73	880	8		1121.6
					1320	85668.73	858	8		1118.0
					1320	86988.73	826	8		1114.5
					1320	88308.73	805	8		1110.9
					1320	89628.73	831	8		1107.4
					1320	90948.73	874	8		1103.8
					1320	92268.73	902	8		1100.3
					1320	93588.73	994	8		1096.7
					1320	94908.73	970	8		1093.2
					1320	96228.73	990	8		1089.6
					1320	97548.73	970	8		1086.1
					1320	98868.73	936	8		1082.5
					1320	100188.73	937	8		1079.0
					1320	101508.73	976	8		1075.5
					1320	102828.73	1008	8		1071.9
					1320	104148.73	1037	8		1068.4
					1320	105468.73	1021	8		1064.8
					1320	106788.73	969	8		1061.3
					1320	108108.73	947	8		1057.7
					1320	109428.73	938	8		1054.2
					1320	110748.73	925	8		1050.6
					1320	112068.73	903	8		1047.1
					1320	113388.73	873	8		1043.5
					1320	114708.73	823	8		1040.0
					1320	116028.73	869	8		1036.4
					1320	117348.73	907	8		1032.9
					1320	118668.73	892	8		1029.3
					1320	119988.73	782	8		1025.8
					1320	121308.73	700	8		1022.2
					1320	122628.73	602	8		1018.7
					1320	123948.73	565	8		1015.1
Connection to SMP					790	124738.73	553	8		553.0



Brine Line Hydraulic Profile
1400
1200
1000
800
600
400
200
0
Elevation (ft. msl)
60000
70000
80000
90000
100000
110000
120000
130000
Length of Pipe (ft.)
AWT
SMP
Elevation
Brine HGL

Pumping Calculations



Recycled Water Hydraulic Profile - Scenario 4
Elevation (ft. msl)
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000
Length of Pipe (ft.)
Indian Hills Tank
Proposed AWT
Las Virgenes Reservoir
Reservoir 2
Tapia WRF
Elevation
HGL To Res 2
HGL to Indian Hills
HGL to AWT
HGL to LV Res

Resevoir 2

Static Head

Tapia Elevation	460.0	ft
High Point	770.0	ft
Reservoir 2 Site	770.0	ft
Discharge Pressure Required	25.0	psi
Discharge Head Required	20.0	
Static Head	330.0	ft

Major and Minor Losses

Flow rate (high) =	11.0	mgd
Flow rate (high) =	7,639	gpm
Flow rate (low) =	6.5	mgd
Flow rate (low) =	4,514	gpm
Steel C (High)	120	
Steel C (Low)	100	
Plastic C (High)	140	
Plastic C (Low)	110	
Distance =	4.4	Miles

Dia (in)	Description	No.	Flow GPM	Pipe Length	K	Vel fps	Friction Loss	Minor Loss
24	Pipe Length	1	4514	22990		3.20	28.7	
18	Pipe Length	1	4514	20		5.69	0.1	
							28.8	20.0

Total Headloss (Including Static)= 378.8 ft
164.0 psi

Dia (in)	Description	No.	Flow GPM	Pipe Length	K	Vel fps	Friction Loss	Minor Loss
24	Pipe Length	1	4514	16360		3.20	20.4	
16	Pipe Length	1	4514	798.25		3.20	7.2	
10	Pipe Length	1	4514	6.0		3.20	0.5	
24	Loss Through PS	1	4514			3.20		10.0
20	Pipe Length	1	4514	1222		4.61	3.7	
							31.8	25.0

Total Headloss (Including Static)= 498.8 ft
215.9 psi

Indian Hills Tank

Static Head

Reservoir 2 Site	770.0	ft
High Point	1192.0	ft
Indian Hills Tank	1192.0	ft
Discharge Pressure Required	25.0	psi
Discharge Head Required	20.0	
Static Head	442.0	ft

Major and Minor Losses

Flow rate (high) =	11.0	mgd
Flow rate (high) =	7,639	gpm
Flow rate (low) =	6.5	mgd
Flow rate (low) =	4,514	gpm
Steel C (High)	120	
Steel C (Low)	100	
Plastic C (High)	140	
Plastic C (Low)	110	
Distance =	3.7	Miles

Indian Hills to AWT

Static Head

Indian Hills Tank	1192.0	ft
High Point	1192.0	ft
AWT Plant	1013.0	ft
Discharge Pressure Required	25.0	psi
Discharge Head Required	20.0	
Static Head	-159.0	ft

Major and Minor Losses

Flow rate (high) =	11.0	mgd
Flow rate (high) =	7,639	gpm
Flow rate (low) =	6.5	mgd
Flow rate (low) =	4,514	gpm
Steel C (High)	120	
Steel C (Low)	100	
Plastic C (High)	140	
Plastic C (Low)	110	
Distance =	4.2	Miles

Friction Loss	27.54543
Minor Loss (est)	20
Total Headloss (Including Static)=	-111.5

LV Res from AWT Plant

Static Head

AWT Plant	1013.0	ft
High Point	1060.0	ft
LV Res	1060.0	ft
Discharge Pressure Required	25.0	psi
Discharge Head Required	20.0	
Static Head	67.0	ft

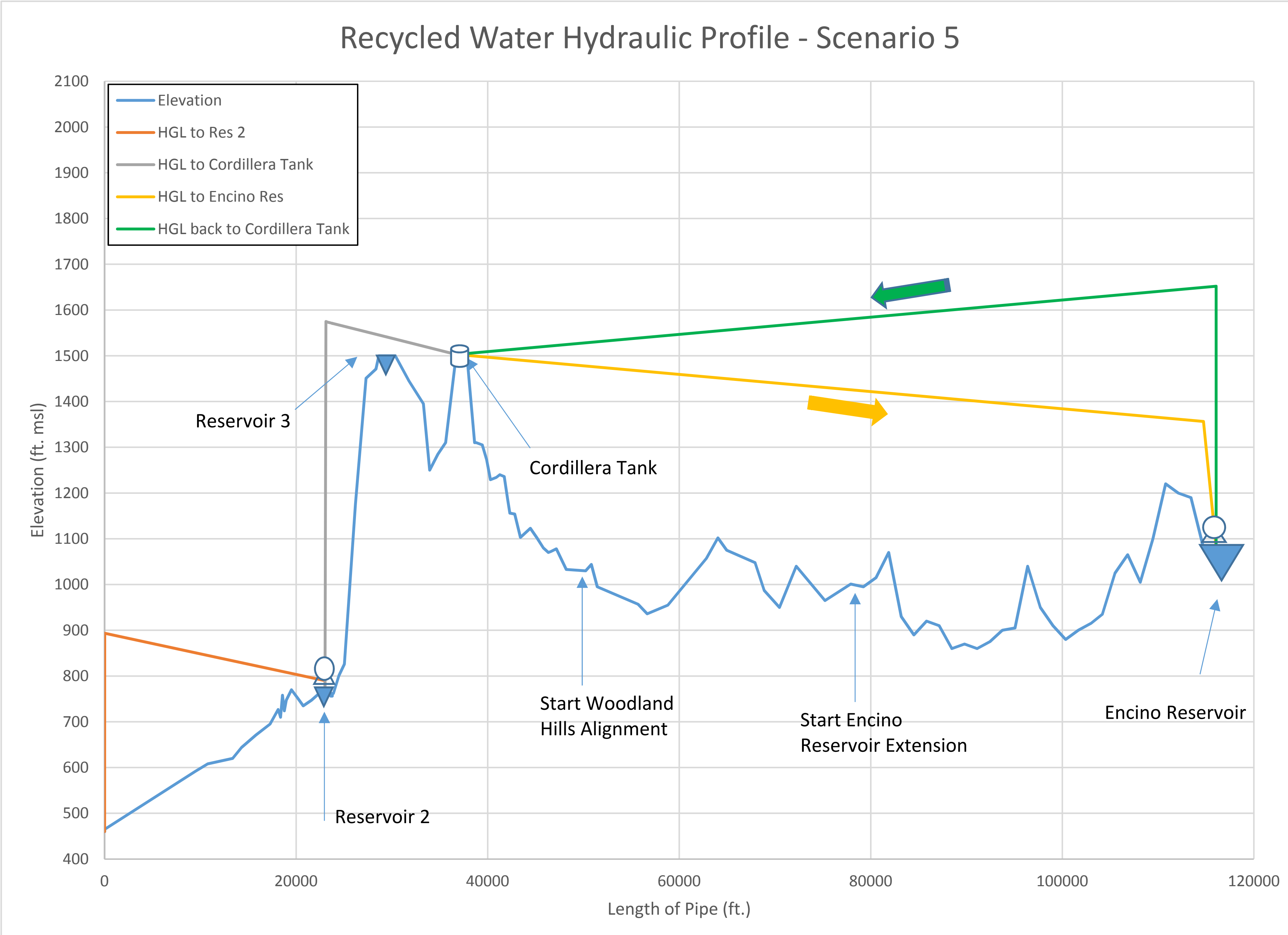
Major and Minor Losses

Flow rate (high) =	9.4	mgd
Flow rate (high) =	6,493	gpm
Flow rate (low) =	5.5	mgd
Flow rate (low) =	3,837	gpm
Steel C (High)	120	
Steel C (Low)	100	
Plastic C (High)	130	
Plastic C (Low)	110	
Distance =	5.6	Miles

Friction Loss	126.9213
Minor Loss (est)	20
Total Headloss (Including Static)=	213.9

Description	Model Id	To	To Elev	From	From Elev	Length	"Station"	Elevation	Diameter	Material	HGL
Tapia	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0	460	18	Steel	460.0
P-L-008	1920	1417	470	1438	460	15	15	460	18	Steel	858.8
P-L-009	1904	1438	460	1223	467	5	20	467	18	Steel	858.7
PF-L-1000	2010	1223	467	1300	467	130.07	150.07	467	24	Steel	858.4
PF-L-1005	2007	1300	467	816	592	9355.63	9505.7	592	24	Steel	830.4
P-L-126	1509	816	592	817	608	1255.5	10761.2	608	24	Steel	826.6
P-L-127	1510	817	608	818	620	2610.09	13371.29	620	24	Steel	818.8
P-L-128	1511	818	620	819	644	931.81	14303.1	644	24	Steel	816.0
P-L-129	1512	819	644	820	671	1493.98	15797.08	671	24	Steel	811.6
P-L-130	1513	820	671	821	695	1481.97	17279.05	695	24	Steel	807.1
P-L-139	1514	821	695	822	727	841	18120.05	727	24	Steel	804.6
P-L-140	1515	822	727	823	710	244.28	18364.33	710	24	Steel	803.9
P-L-141	1516	823	710	824	758	203.07	18567.4	758	24	Steel	803.3
P-L-142	1517	824	758	825	724	198.02	18765.42	724	24	Steel	802.7
P-L-143	1518	825	724	826	747	198.33	18963.75	747	24	Steel	802.1
P-L-144	1519	826	747	828	770	550.99	19514.74	770	24	Steel	800.5
P-L-250	2041	828	770	1311	750	714.04	20228.78	750	24	Steel	798.3
P-L-145	2042	1311	750	827	735	512.11	20740.89	735	24	Steel	796.8
P-L-146	1870	827	735	1201	747	852.19	21593.08	747	24	Steel	794.2
P-L-147	1876	1201	747	829	760	709.81	22302.89	760	24	Steel	792.1
P-L-151	2065	829	760	1320	765	210.77	22513.66	765	24	Steel	791.5
P-L-149	2066	1320	765	1205	770	391.59	22905.25	770	24	Steel	790.3
P-L-150	1899	1426	768	1205	770	104.56	23009.81	770	24	Steel	790.0
Res. 2	#N/A	#N/A	#N/A	#N/A	#N/A	0	23009.81	770		Steel	770.0
P-L-200	1898	1426	#N/A	1206	770	95.38	23105.19	770	16	Steel	1288.8
P-L-198	2003	1206	770	1298	770	257.32	23362.51	770	16	Steel	1287.8
P-L-199	2004	1298	770	1224	762	168.7	23531.21	762	16	Steel	1287.1
P-L-194	1907	1224	762	1225	756	83	23614.21	756	16	Steel	1286.8
P-L-204	1906	1208	756	1225	756	18	23632.21	756	16	Steel	1286.7
P-L-205	1909	1208	756	1444	#N/A	3	23635.21	756	10	Steel	1286.7
West 2	#N/A	#N/A	#N/A	#N/A	#N/A	0	23635.21	762	10	Steel	1286.7
P-W-010	1910	1444	#N/A	1209	762	3	23638.21	762	10	Steel	1286.7
P-W-014	2055	1209	762	1316	760	175.85	23814.06	760	18	Steel	1286.0
P-W-016	2056	1316	760	964	743	742.75	24556.81	743	24	Steel	1283.1
P-W-017	1643	964	743	965	747	947.57	25504.38	747	24	Steel	1279.3
P-W-019	1644	965	747	966	744	612.3	26116.68	744	24	Steel	1276.9
P-W-022	1645	966	744	967	739	561.51	26678.19	739	24	Steel	1274.7
P-W-024	1646	967	739	968	717	410.56	27088.75	717	24	Steel	1273.0
P-W-025	1647	968	717	969	789	527.5	27616.25	789	24	Steel	1270.9
P-W-028	1648	969	789	970	800	538.86	28155.11	800	24	Steel	1268.8
P-W-037	1880	987	799	970	800	588.67	28743.78	800	24	Steel	1266.5
P-W-039	1659	987	799	982	814	1436.7	30180.48	814	24	Steel	1260.8
P-W-068	1674	982	814	995	869	1020.52	31201	869	24	Steel	1256.7
P-W-061	1666	995	869	996	866	75.71	31276.71	866	24	Steel	1256.4
P-W-079	1676	996	866	1005	891	466.31	31743.02	891	24	Steel	1254.6
P-W-080	1677	1005	891	1006	893	219.7	31962.72	893	24	Steel	1253.7
P-W-082	1678	1006	893	1007	865	827.81	32790.53	865	24	Steel	1250.4
P-W-083	1895	1222	865	1007	865	32.08	32822.61	865	24	Steel	1250.3
P-W-084	1894	1222	865	1008	804	991.56	33814.17	804	24	Steel	1246.4
P-W-085	1681	1008	804	1011	791	241.44	34055.61	791	24	Steel	1245.4
P-W-088	1683	1011	791	1012	777	385.28	34440.89	777	24	Steel	1243.9
P-W-089	1684	1012	777	1013	794	803.63	35244.52	794	24	Steel	1240.7
P-W-090	1685	1013	794	1014	814	748.68	35993.2	814	24	Steel	1237.7
P-W-093	1686	1014	814	1015	864	1594.08	37587.28	864	24	Steel	1231.4
P-W-096	1687	1015	864	1016	900	977.43	38564.71	900	24	Steel	1227.5
P-W-098	1688	1016	900	1017	940	697.87	39262.58	940	24	Steel	1224.8
P-W-100	1689	1017	940	1018	902	911.95	40174.53	902	24	Steel	1221.2
P-W-105	1690	1018	902	1019	964	1087.8	41262.33	964	20	Steel	1216.8
P-W-106	1691	1019	964	1021	1173	470.48	41732.81	1173	20	Steel	1215.0
P-W-108	1692	1021	1173	1020	1192	746.07	42478.88	1192	20	Steel	1212.0
P-W-110	1897	1425	#N/A	1020	1192	5	42483.88	1192	20	Steel	1212.0
Indian Hills	#N/A	#N/A	#N/A	#N/A	#N/A	0	42483.88	1192		Steel	1192.0
P-W-110	1897	1425	#N/A	1020	1192	5	42488.88	1192	20	Steel	1192.0
P-W-108	1692	1021	1173	1020	1192	746.07	43234.95	1192	20	Steel	1191.1
P-W-106	1691	1019	964	1021	1173	470.48	43705.43	1173	20	Steel	1190.5
P-W-105	1690	1018	902	1019	964	1087.8	44793.23	964	20	Steel	1189.1
P-W-114	1693	1018	902	1022	894	783.34	45576.57	894	24	Steel	1188.1
P-W-115	1694	1022	894	1023	900	285.78	45862.35	900	24	Steel	1187.8
P-W-120	1696	1023	900	1025	911	876.39	46738.74	911	24	Steel	1186.7
P-W-125	1697	1025	911	1026	926	889.61	47628.35	926	24	Steel	1185.6
P-W-157	1706	1026	926	1035	928	864.79	48493.14	928	24	Steel	1184.5
P-W-158	1707	1035	928	1036	914	710.19	49203.33	914	24	Steel	1183.6
P-W-159	1718	1036	914	1047	899	578	49781.33	899	24	Steel	1182.9
P-W-175	1719	1047	899	1048	877	1167.87	50949.2	877	24	Steel	1181.4
P-W-200	1720	1048	877	1049	896	635.33	51584.53	896	24	Steel	1180.6

P-W-202	2022	1049	896	1305	902	185.6	51770.13	902	24	Steel	1180.4
P-W-203	2023	1305	902	1306	906	136.21	51906.34	906	24	Steel	1180.2
P-W-204	2024	1306	906	1050	908	59.51	51965.85	908	24	Steel	1180.2
P-W-205	1722	1050	908	1051	882	913.31	52879.16	882	24	Steel	1179.0
P-W-230	1734	1051	882	1063	897	905.07	53784.23	897	24	Steel	1177.9
P-W-236	1736	1063	897	1065	920	648.04	54432.27	920	24	Steel	1177.1
P-W-237	2027	1065	920	1307	925	274.64	54706.91	925	24	Steel	1176.7
P-W-238	2029	1307	925	1308	930	296.64	55003.55	930	24	Steel	1176.4
P-W-239	2030	1308	930	1066	935	436.36	55439.91	935	24	Steel	1175.8
P-W-240	1737	1066	935	1067	955	702.17	56142.08	955	24	Steel	1174.9
P-W-241	1738	1067	955	1068	1000	1197.84	57339.92	1000	24	Steel	1173.5
P-W-242	1739	1068	1000	1069	1005	1008.45	58348.37	1005	24	Steel	1172.2
P-W-244	1770	1069	1005	1100	1000	1230.94	59579.31	1000	24	Steel	1170.7
P-W-245	1771	1100	1000	1101	988	821.32	60400.63	988	24	Steel	1169.6
P-W-336	1775	1101	988	1105	996	424.43	60825.06	996	24	Steel	1169.1
P-W-340	1777	1105	996	1107	1010	1100.36	61925.42	1010	24	Steel	1167.7
P-W-342	1778	1107	1010	1108	976	863.06	62788.48	976	24	Steel	1166.7
P-W-345	1779	1108	976	1110	970	635.98	63424.46	970	24	Steel	1165.9
P-W-347	1780	1110	970	1109	1013	1124.27	64548.73	1013	24	Steel	1164.5
TO and Lindero (A	#N/A	#N/A	#N/A	#N/A	#N/A	0	64548.73	1013		Steel	1013.0
P-W-350	1781	1109	1013	1111	1016	451.91	65000.64	1016	24	Steel	1246.9
P-W-352	1782	1111	1016	1112	1011	632.44	65633.08	1011	24	Steel	1240.8
P-W-353	1783	1112	1011	1113	1007	450.47	66083.55	1007	24	Steel	1238.2
P-W-355	1784	1113	1007	1114	1006	155.96	66239.51	1006	24	Steel	1237.4
PF-W-1095	1980	1115	1013	1274	1024	943.74	67183.25	1014	24	Steel	1232.0
New Pipe						2640	69823.25	1018	18	Steel	1217.1
New Pipe						2640	72463.25	970	18	Steel	1202.2
New Pipe						2640	75103.25	930	18	Steel	1187.3
New Pipe						2640	77743.25	920	18	Steel	1172.3
New Pipe						2640	80383.25	910	18	Steel	1157.4
New Pipe						2640	83023.25	880	18	Steel	1142.5
New Pipe						2640	85663.25	870	18	Steel	1127.6
New Pipe						2640	88303.25	880	18	Steel	1112.7
New Pipe						2640	90943.25	890	18	Steel	1097.7
New Pipe						2640	93583.25	910	18	Steel	1082.8
LV Reservoir						500	94083.25	1060	18	Steel	1060.0



Recycled Water Hydraulic Profile - Scenario 5
Elevation
HGL to Res 2
HGL to Cordillera Tank
HGL to Encino Res
HGL back to Cordillera Tank
Elevation (ft. msl)
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
0
20000
40000
60000
80000
100000
120000
Length of Pipe (ft.)
Reservoir 3
Cordillera Tank
Start Woodland
Hills Alignment
Start Encino
Reservoir Extension
Encino Reservoir
Reservoir 2

Resevoir 2

Static Head		
Tapia Elevation	460.0	ft
High Point	770.0	ft
Reservoir 2 Site	770.0	ft
Discharge Pressure Required	25.0	psi
Discharge Head Required	20.0	
Static Head	330.0	ft
Major and Minor Losses		
Flow rate (high) =	11.0	mgd
Flow rate (high) =	7,639	gpm
Flow rate (low) =	6.5	mgd
Flow rate (low) =	4,514	gpm
Steel C (High)	120	
Steel C (Low)	100	
Plastic C (High)	140	
Plastic C (Low)	110	
Distance =	4.4	Miles
Friction Loss	53.53015	
Minor Loss (est)	30	
Total Headloss (Including Static)=	413.5	

Cordellera Tank

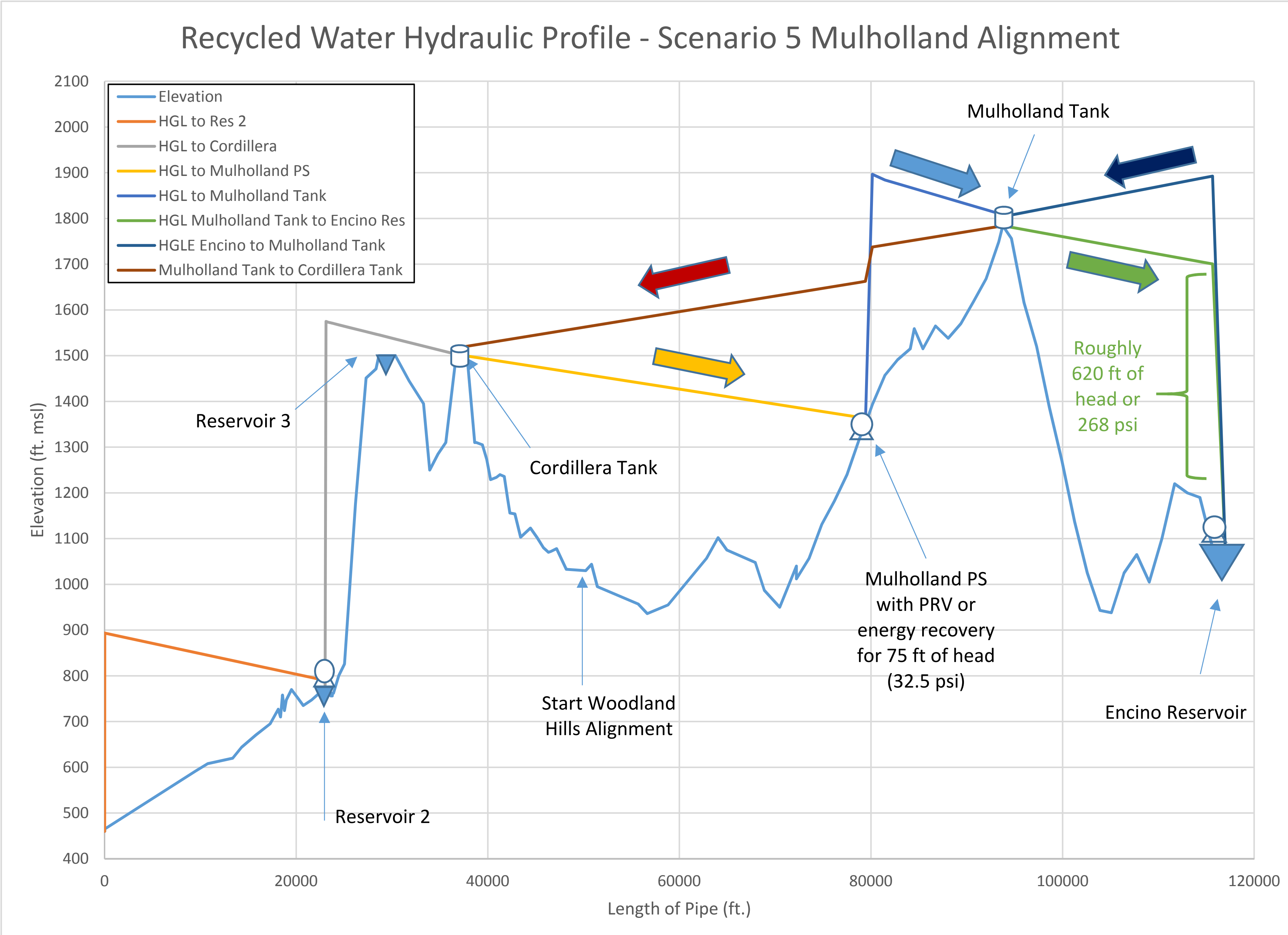
Static Head		
Res 2 elevation	770.0	ft
High Point	1503.0	ft
Cordellera tank	1503.0	ft
Discharge Pressure Required	25.0	psi
Discharge Head Required	20.0	
Static Head	753.0	ft
Major and Minor Losses		
Flow rate (high) =	11.0	mgd
Flow rate (high) =	7,639	gpm
Flow rate (low) =	6.5	mgd
Flow rate (low) =	4,514	gpm
Steel C (High)	120	
Steel C (Low)	100	
Plastic C (High)	140	
Plastic C (Low)	110	
Distance =	2.6	Miles
Friction Loss	31.88883	
Minor Loss (est)	20	
Total Headloss (Including Static)=	804.9	

Encino Res

Static Head		
Cordellera	1503.0	ft
High Point	1220.0	ft
Encino Res	1081.0	ft
Discharge Pressure Required	25.0	psi
Discharge Head Required	20.0	
Static Hea	-263.0	ft
Major and Minor Losses		
Flow rate (high) =	11.0	mgd
Flow rate (high) =	7,639	gpm
Flow rate (low) =	6.5	mgd
Flow rate (low) =	4,514	gpm
Steel C (High)	120	
Steel C (Low)	100	
Plastic C (High)	140	
Plastic C (Low)	110	
Distance =	15.0	Miles
Friction Loss	99.05667	
Minor Loss (est)	50	
Total Headloss (Including Static)=	-113.9	

Description	Model Id	To	To Elev	From	From Elev	Length	"Station"	Elevation	Diameter	HGL	HGL Back
Tapia	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0		18	460	
P-L-008	1920	1417	470	1438	460	15	15	460	18	893.5	
P-L-009	1904	1438	460	1223	467	5	20	467	18	893.4402	
PF-L-1000	2010	1223	467	1300	467	130.07	150.07	467	24	892.8549	
PF-L-1005	2007	1300	467	816	592	9355.63	9505.7	592	24	850.7603	
P-L-126	1509	816	592	817	608	1255.5	10761.2	608	24	845.1113	
P-L-127	1510	817	608	818	620	2610.09	13371.29	620	24	833.3675	
P-L-128	1511	818	620	819	644	931.81	14303.1	644	24	829.1749	
P-L-129	1512	819	644	820	671	1493.98	15797.08	671	24	822.4529	
P-L-130	1513	820	671	821	695	1481.97	17279.05	695	24	815.7849	
P-L-139	1514	821	695	822	727	841	18120.05	727	24	812.0009	
P-L-140	1515	822	727	823	710	244.28	18364.33	710	24	810.9018	
P-L-141	1516	823	710	824	758	203.07	18567.4	758	24	809.9881	
P-L-142	1517	824	758	825	724	198.02	18765.42	724	24	809.0972	
P-L-143	1518	825	724	826	747	198.33	18963.75	747	24	808.2048	
P-L-144	1519	826	747	828	770	550.99	19514.74	770	24	805.7257	
P-L-250	2041	828	770	1311	750	714.04	20228.78	750	24	802.5129	
P-L-145	2042	1311	750	827	735	512.11	20740.89	735	24	800.2088	
P-L-146	1870	827	735	1201	747	852.19	21593.08	747	24	796.3744	
P-L-147	1876	1201	747	829	760	709.81	22302.89	760	24	793.1807	
P-L-151	2065	829	760	1320	765	210.77	22513.66	765	24	792.2324	
P-L-149	2066	1320	765	1205	770	391.59	22905.25	770	24	790.4705	
P-L-150	1899	1426	768	1205	770	104.56	23009.81	770	24	790	
Res. 2	#N/A	#N/A	#N/A	#N/A	#N/A	0	23009.81	770		770.00	
P-L-200	1898	1426	#N/A	1206	770	95.38	23105.19	770	16	1574.89	
P-L-198	2003	1206	770	1298	770	257.32	23362.51	770	16	1573.039	
P-L-199	2004	1298	770	1224	762	168.7	23531.21	762	16	1572.154	
P-L-194	1907	1224	762	1225	756	83	23614.21	756	16	1571.719	
P-L-210	2033	1225	756	1309	756	149.97	23764.18	756	14	1570.933	
P-L-208	2035	1309	756	1441	#N/A	6	23770.18	756	8	1570.901	
P-E-010	2038	1441	#N/A	1310	762	5	23775.18	762	8	1570.875	
P-E-015	2040	1310	762	1210	762	122.88	23898.06	762	14	1570.23	
P-E-020	2006	1210	762	830	801	562.73	24460.79	801	14	1567.279	
P-E-040	1520	830	801	831	826	579.03	25039.82	826	14	1564.242	
P-E-043	1521	831	826	832	1176	1146.67	26186.49	1176	14	1558.229	
P-E-045	1522	832	1176	833	1451	1112.8	27299.29	1451	14	1552.392	
P-E-050	1523	833	1451	834	1471	1033.1	28332.39	1471	14	1546.974	
P-E-055	1524	834	1471	835	1500	295.68	28628.07	1500	14	1545.424	
P-E-057	1918	1463	#N/A	1427	#N/A	3	28631.07	1500	14	1545.408	
Res 3	#N/A	#N/A	#N/A	#N/A	#N/A	0	28631.07	1500		1545.408	
P-E-063	1900	1427	#N/A	836	1500	5	28636.07	1500	14	1545.382	
PF-E-1122	2000	1295	1445	836	1500	1717.61	30353.68	1500	18	1536.374	
PF-E-1120	1999	1243	1395	1295	1445	1431.51	31785.19	1445	18	1528.866	
PF-E-1115	1998	1294	1250	1243	1395	1502.51	33287.7	1395	18	1520.986	
PF-W-1775	2135	1241	1285	1294	1250	649.68	33937.38	1250	18	1517.579	
PF-W-1765	2133	1363	1310	1241	1285	862.53	34799.91	1285	18	1513.055	
P-W-1760	2132	1215	1365	1363	1310	810.6	35610.51	1310	24	1508.804	
P-E-100	1887	1215	1365	1216	1503	1101.64	36712.15	1503	24	1503.026	
P-E-101	1901	1428	#N/A	1216	1503	5	36717.15	1503	24	1503	
Cordillera Tank	#N/A	#N/A	#N/A	#N/A	#N/A	0	36717.15	1503		1503	1503
P-E-101	1901	1428	#N/A	1216	1503	5	36722.15	1503	24	1502.991	1503.009
P-E-100	1887	1215	1365	1216	1503	1101.64	37823.79	1503	24	1500.921	1505.079
P-W-1760	2132	1215	1365	1363	1310	810.6	38634.39	1310	24	1499.398	1506.602
P-W-1770	2134	1240	1305	1363	1310	180.52	38814.91	1310	24	1499.059	1506.941
P-E-1085	1945	1239	1278	1240	1305	625	39439.91	1305	24	1497.885	1508.115
P-E-086	1944	1239	1278	843	1273	456.81	39896.72	1273	18	1497.027	1508.973
P-E-126	1532	843	1273	845	1229	392.28	40289	1229	18	1496.29	1509.71
P-E-128	1533	845	1229	846	1234	610.7	40899.7	1234	14	1495.143	1510.857
P-E-130	1534	846	1234	847	1240	367.96	41267.66	1240	14	1494.452	1511.548
P-E-176	1535	847	1240	848	1238	223.97	41491.63	1238	14	1494.031	1511.969
P-E-177	1536	848	1238	849	1236	232.38	41724.01	1236	14	1493.595	1512.405
P-E-178	1553	849	1236	867	1186	357.42	42081.43	1186	14	1492.923	1513.077
P-E-179	1554	867	1186	868	1156	225.46	42306.89	1156	14	1492.5	1513.5
P-E-180	1555	868	1156	869	1154	519.78	42826.67	1154	14	1491.523	1514.477
P-E-182	1556	869	1154	870	1103	593.52	43420.19	1103	14	1490.408	1515.592
P-E-183	1557	870	1103	871	1123	1031.49	44451.68	1123	14	1488.471	1517.529
P-E-185	1558	871	1123	872	1102	696.46	45148.14	1102	14	1487.162	1518.838
P-E-189	1559	872	1102	873	1080	660.61	45808.75	1080	14	1485.921	1520.079
P-E-190	1560	873	1080	874	1070	521.22	46329.97	1070	14	1484.942	1521.058
P-E-192	2013	874	1070	1302	1072	260	46589.97	1072	14	1484.454	1521.546
P-E-194	2014	1302	1072	906	1078	584.1	47174.07	1078	12	1483.356	1522.644
P-E-195	1591	906	1078	907	1033	1024.83	48198.9	1033	12	1481.431	1524.569
P-E-197	1600	907	1033	916	1030	2023.83	50222.73	1030	12	1477.629	1528.371
Woodland Hills Extension						0	50222.73	1030		1477.629	1528.371
1						600	50822.73	1044	24	1476.502	1529.498
1						615	51437.73	995	24	1475.347	1530.653

2	4262.885	55700.62	957	24	1467.339	1538.661
4A	950.9326	56651.55	936	24	1465.553	1540.447
5	2164.562	58816.11	955	24	1461.487	1544.513
8	4021.756	62837.87	1057	24	1453.932	1552.068
	1200	64037.87	1102	24	1451.677	1554.323
9	915	64952.87	1075	24	1449.959	1556.041
10	2969.257	67922.12	1048	24	1444.381	1561.619
10	946.4772	68868.6	987	24	1442.603	1563.397
10	1601.114	70469.71	950	24	1439.595	1566.405
	1750	72219.71	1040	24	1436.308	1569.692
12	3002	75221.71	965	24	1430.668	1575.332
13	2683.276	77904.99	1001	24	1425.628	1580.372
	1320	79224.99	995	24	1423.148	1582.852
	1320	80544.99	1015	24	1420.668	1585.332
	1320	81864.99	1070	24	1418.189	1587.811
	1320	83184.99	930	24	1415.709	1590.291
	1320	84504.99	890	24	1413.229	1592.771
	1320	85824.99	920	24	1410.75	1595.25
	1320	87144.99	910	24	1408.27	1597.73
	1320	88464.99	860	24	1405.791	1600.209
	1320	89784.99	870	24	1403.311	1602.689
	1320	91104.99	860	24	1400.831	1605.169
	1320	92424.99	875	24	1398.352	1607.648
	1320	93744.99	900	24	1395.872	1610.128
	1320	95064.99	905	24	1393.392	1612.608
	1320	96384.99	1040	24	1390.913	1615.087
	1320	97704.99	950	24	1388.433	1617.567
	1320	99024.99	910	24	1385.953	1620.047
	1320	100345	880	24	1383.474	1622.526
	1320	101665	900	24	1380.994	1625.006
	1320	102985	915	24	1378.514	1627.486
	1200	104185	935	24	1376.26	1629.74
	1320	105505	1025	24	1373.781	1632.219
	1320	106825	1065	24	1371.301	1634.699
	1320	108145	1005	24	1368.821	1637.179
	1320	109465	1100	24	1366.342	1639.658
	1320	110785	1220	24	1363.862	1642.138
	1320	112105	1200	24	1361.382	1644.618
	1320	113425	1190	24	1358.903	1647.097
	1320	114745	1080	24	1356.423	1649.577
Encino Res	1320	116065	1081	24	1081	1652.1
		116065				1081



Recycled Water Hydraulic Profile - Scenario 5 Mulholland Alignment
Elevation
HGL to Res 2
HGL to Cordillera
HGL to Mulholland PS
HGL to Mulholland Tank
HGL Mulholland Tank to Encino Res
HGLE Encino to Mulholland Tank
Mulholland Tank to Cordillera Tank
Mulholland Tank
Reservoir 3
Cordillera Tank
Roughly 620 ft of head or 268 psi
Mulholland PS with PRV or energy recovery for 75 ft of head (32.5 psi)
Start Woodland Hills Alignment
Encino Reservoir
Reservoir 2
Elevation (ft. msl)
Length of Pipe (ft.)
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
0
20000
40000
60000
80000
100000
120000

Resevoir 2

Static Head		
Tapia Elevation	460.0	ft
High Point	770.0	ft
Reservoir 2 Site	770.0	ft
Discharge Pressure Required	8.7	psi
Discharge Head Required	20.0	
Static Head	330.0	ft
Major and Minor Losses		
Flow rate (high) =	11.0	mgd
Flow rate (high) =	7,639	gpm
Flow rate (low) =	6.5	mgd
Flow rate (low) =	4,514	gpm
Steel C (High)	120	
Steel C (Low)	100	
Plastic C (High)	140	
Plastic C (Low)	110	
Distance =	4.4	Miles
Friction Loss	53.53015	
Minor Loss (est)	30	
Total Headloss (Including Static)=	413.5	

Cordellera Tank

Static Head		
Res 2 eleva	770.0	ft
High Point	1503.0	ft
Cordellera	1503.0	ft
Discharge Pressure Required	8.7	psi
Discharge Head Required	20.0	
Static Hea	753.0	ft
Major and Minor Losses		
Flow rate (high) =	11.0	mgd
Flow rate (high) =	7,639	gpm
Flow rate (low) =	6.5	mgd
Flow rate (low) =	4,514	gpm
Steel C (High)	120	
Steel C (Low)	100	
Plastic C (High)	140	
Plastic C (Low)	110	
Distance =	2.6	Miles
Friction Loss	31.88883	
Minor Loss (est)	20	
Total Headloss (Including Static)=	804.9	

Cordillera to new Mul PS

Static Head		
Cordellera	1503.0	ft
High Point	1503.0	ft
New Mulho	1350.0	ft
Discharge Pressure Required	8.7	psi
Discharge Head Required	20.0	
Static Hea	20.0	ft
Major and Minor Losses		
Flow rate (high) =	11.0	mgd
Flow rate (high) =	7,639	gpm
Flow rate (low) =	6.5	mgd
Flow rate (low) =	4,514	gpm
Steel C (High)	120	
Steel C (Low)	100	
Plastic C (High)	140	
Plastic C (Low)	110	
Distance =	8.2	Miles
Friction Loss	72.09674	
Minor Loss (est)	50	
Total Headloss (Including Static)=	142.1	

Mulholland PS to New Mulholland Tank

Static Head		
New Mulhollanc	1350.0	ft
High Point	1784	ft
Mulholland Tan	1784	ft
Discharge Pressure Required	17.3	psi
Discharge Head Required	40.0	
Static Head	474.0	ft
Major and Minor Losses		
Flow rate (high) =	11.0	mgd
Flow rate (high) =	7,639	gpm
Flow rate (low) =	6.5	mgd
Flow rate (low) =	4,514	gpm
Steel C (High)	120	
Steel C (Low)	100	
Plastic C (High)	140	
Plastic C (Low)	110	
Distance =	2.6	Miles
Friction Loss	22.61798	
Minor Loss (est)	50	
Total Headloss (Including Static)=	546.6	

Mulholland Tank to Encino Res

Static Head		
Mulholland	1784	ft
High Point	1784.0	ft
Encino Res	1081.0	ft
Discharge Pressure Required	8.7	psi
Discharge Head Required	20.0	
Static Hea	20.0	ft
Major and Minor Losses		
Flow rate (high) =	11.0	mgd
Flow rate (high) =	7,639	gpm
Flow rate (low) =	6.5	mgd
Flow rate (low) =	4,514	gpm
Steel C (High)	120	
Steel C (Low)	100	
Plastic C (High)	140	
Plastic C (Low)	110	
Distance =	4.4	Miles
Friction Loss	38.54939	
Minor Loss (est)	50	
Total Headloss (Including Static)=	108.5	

Encino Reservoir to Mulholland Tank

Static Head		
Encino Res	1081.0	ft
High Point	1784	ft
Mulholland	1784	ft
Discharge Pressure Required	8.7	psi
Discharge Head Required	20.0	
Static Hea	723.0	ft
Major and Minor Losses		
Flow rate (high) =	11.0	mgd
Flow rate (high) =	7,639	gpm
Flow rate (low) =	6.5	mgd
Flow rate (low) =	4,514	gpm
Steel C (High)	120	
Steel C (Low)	100	
Plastic C (High)	140	
Plastic C (Low)	110	
Distance =	4.4	Miles
Friction Loss	38.54939	
Minor Loss (est)	50	
Total Headloss (Including Static)=	811.5	

Mulholland Tank to Cordillera

Static Head		
Mulholland Tan	1784	ft
High Point	1784	ft
Cordellera tank	1503.0	ft
Discharge Pressure Required	8.7	psi
Discharge Head Required	20.0	
Static Head	20.0	ft
Major and Minor Losses		
Flow rate (high) =	11.0	mgd
Flow rate (high) =	7,639	gpm
Flow rate (low) =	6.5	mgd
Flow rate (low) =	4,514	gpm
Steel C (High)	120	
Steel C (Low)	100	
Plastic C (High)	140	
Plastic C (Low)	110	
Distance =	10.8	Miles
Friction Loss	94.71472	
Minor Loss (est)	100	
Total Headloss (Including Static)=	214.7	

Description	Model Id	To	To Elev	From	From Elev	Length	"Station"	Elevation	Diameter	HGL	HGL back
Tapia	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0		18	460	
P-L-008	1920	1417	470	1438	460	15	15	460	18	893.5	
P-L-009	1904	1438	460	1223	467	5	20	467	18	893.4402	
PF-L-1000	2010	1223	467	1300	467	130.07	150.07	467	24	892.8549	
PF-L-1005	2007	1300	467	816	592	9355.63	9505.7	592	24	850.7603	
P-L-126	1509	816	592	817	608	1255.5	10761.2	608	24	845.1113	
P-L-127	1510	817	608	818	620	2610.09	13371.29	620	24	833.3675	
P-L-128	1511	818	620	819	644	931.81	14303.1	644	24	829.1749	
P-L-129	1512	819	644	820	671	1493.98	15797.08	671	24	822.4529	
P-L-130	1513	820	671	821	695	1481.97	17279.05	695	24	815.7849	
P-L-139	1514	821	695	822	727	841	18120.05	727	24	812.0009	
P-L-140	1515	822	727	823	710	244.28	18364.33	710	24	810.9018	
P-L-141	1516	823	710	824	758	203.07	18567.4	758	24	809.9881	
P-L-142	1517	824	758	825	724	198.02	18765.42	724	24	809.0972	
P-L-143	1518	825	724	826	747	198.33	18963.75	747	24	808.2048	
P-L-144	1519	826	747	828	770	550.99	19514.74	770	24	805.7257	
P-L-250	2041	828	770	1311	750	714.04	20228.78	750	24	802.5129	
P-L-145	2042	1311	750	827	735	512.11	20740.89	735	24	800.2088	
P-L-146	1870	827	735	1201	747	852.19	21593.08	747	24	796.3744	
P-L-147	1876	1201	747	829	760	709.81	22302.89	760	24	793.1807	
P-L-151	2065	829	760	1320	765	210.77	22513.66	765	24	792.2324	
P-L-149	2066	1320	765	1205	770	391.59	22905.25	770	24	790.4705	
P-L-150	1899	1426	768	1205	770	104.56	23009.81	770	24	790	
Res. 2	#N/A	#N/A	#N/A	#N/A	#N/A	0	23009.81	770		770.00	
P-L-200	1898	1426	#N/A	1206	770	95.38	23105.19	770	16	1574.89	
P-L-198	2003	1206	770	1298	770	257.32	23362.51	770	16	1573.039	
P-L-199	2004	1298	770	1224	762	168.7	23531.21	762	16	1572.154	
P-L-194	1907	1224	762	1225	756	83	23614.21	756	16	1571.719	
P-L-210	2033	1225	756	1309	756	149.97	23764.18	756	14	1570.933	
P-L-208	2035	1309	756	1441	#N/A	6	23770.18	756	8	1570.901	
P-E-010	2038	1441	#N/A	1310	762	5	23775.18	762	8	1570.875	
P-E-015	2040	1310	762	1210	762	122.88	23898.06	762	14	1570.23	
P-E-020	2006	1210	762	830	801	562.73	24460.79	801	14	1567.279	
P-E-040	1520	830	801	831	826	579.03	25039.82	826	14	1564.242	
P-E-043	1521	831	826	832	1176	1146.67	26186.49	1176	14	1558.229	
P-E-045	1522	832	1176	833	1451	1112.8	27299.29	1451	14	1552.392	
P-E-050	1523	833	1451	834	1471	1033.1	28332.39	1471	14	1546.974	
P-E-055	1524	834	1471	835	1500	295.68	28628.07	1500	14	1545.424	
P-E-057	1918	1463	#N/A	1427	#N/A	3	28631.07	1500	14	1545.408	
Res 3	#N/A	#N/A	#N/A	#N/A	#N/A	0	28631.07	1500		1545.408	
P-E-063	1900	1427	#N/A	836	1500	5	28636.07	1500	14	1545.382	
PF-E-1122	2000	1295	1445	836	1500	1717.61	30353.68	1500	18	1536.374	
PF-E-1120	1999	1243	1395	1295	1445	1431.51	31785.19	1445	18	1528.866	
PF-E-1115	1998	1294	1250	1243	1395	1502.51	33287.7	1395	18	1520.986	
PF-W-1775	2135	1241	1285	1294	1250	649.68	33937.38	1250	18	1517.579	
PF-W-1765	2133	1363	1310	1241	1285	862.53	34799.91	1285	18	1513.055	
P-W-1760	2132	1215	1365	1363	1310	810.6	35610.51	1310	24	1508.804	
P-E-100	1887	1215	1365	1216	1503	1101.64	36712.15	1503	24	1503.026	
P-E-101	1901	1428	#N/A	1216	1503	5	36717.15	1503	24	1503	
Cordillera Tank	#N/A	#N/A	#N/A	#N/A	#N/A	0	36717.15	1503		1503	1503
P-E-101	1901	1428	#N/A	1216	1503	5	36722.15	1503	24	1502.986	1516.76
P-E-100	1887	1215	1365	1216	1503	1101.64	37823.79	1503	24	1499.379	1520.52
P-W-1760	2132	1215	1365	1363	1310	810.6	38634.39	1310	24	1496.726	1523.287
P-W-1770	2134	1240	1305	1363	1310	180.52	38814.91	1310	24	1496.135	1523.903
P-E-1085	1945	1239	1278	1240	1305	625	39439.91	1305	24	1494.09	1526.037
P-E-086	1944	1239	1278	843	1273	456.81	39896.72	1273	18	1492.595	1527.596
P-E-126	1532	843	1273	845	1229	392.28	40289	1229	18	1491.311	1528.935
P-E-128	1533	845	1229	846	1234	610.7	40899.7	1234	14	1489.313	1531.019
P-E-130	1534	846	1234	847	1240	367.96	41267.66	1240	14	1488.109	1532.275
P-E-176	1535	847	1240	848	1238	223.97	41491.63	1238	14	1487.376	1533.04
P-E-177	1536	848	1238	849	1236	232.38	41724.01	1236	14	1486.615	1533.833
P-E-178	1553	849	1236	867	1186	357.42	42081.43	1186	14	1485.446	1535.053
P-E-179	1554	867	1186	868	1156	225.46	42306.89	1156	14	1484.708	1535.823
P-E-180	1555	868	1156	869	1154	519.78	42826.67	1154	14	1483.007	1537.597
P-E-182	1556	869	1154	870	1103	593.52	43420.19	1103	14	1481.065	1539.623
P-E-183	1557	870	1103	871	1123	1031.49	44451.68	1123	14	1477.689	1543.144
P-E-185	1558	871	1123	872	1102	696.46	45148.14	1102	14	1475.41	1545.521
P-E-189	1559	872	1102	873	1080	660.61	45808.75	1080	14	1473.248	1547.776
P-E-190	1560	873	1080	874	1070	521.22	46329.97	1070	14	1471.543	1549.555
P-E-192	2013	874	1070	1302	1072	260	46589.97	1072	14	1470.692	1550.442
P-E-194	2014	1302	1072	906	1078	584.1	47174.07	1078	12	1468.781	1552.436
P-E-195	1591	906	1078	907	1033	1024.83	48198.9	1033	12	1465.427	1555.934
P-E-197	1600	907	1033	916	1030	2023.83	50222.73	1030	12	1458.804	1562.842
Woodland Hills Extension						0	50222.73	1030		1458.804	1562.842
1						600	50822.73	1044	24	1456.841	1564.89

1	615	51437.73	995	24	1454.828	1566.989
2	4262.885	55700.62	957	24	1440.878	1581.54
4A	950.9326	56651.55	936	24	1437.766	1584.786
5	2164.562	58816.11	955	24	1430.683	1592.174
8	4021.756	62837.87	1057	24	1417.522	1605.902
	1200	64037.87	1102	24	1413.595	1609.998
9	915	64952.87	1075	24	1410.601	1613.121
10	2969.257	67922.12	1048	24	1400.884	1623.257
10	946.4772	68868.6	987	24	1397.787	1626.487
10	1601.114	70469.71	950	24	1392.548	1631.952
	1750	72219.71	1040	24	1386.821	1637.926
		72219.71	1012	24	1386.821	1637.926
	1320	73539.71	1057	24	1382.501	1642.431
	1320	74859.71	1131	24	1378.182	1646.937
	1320	76179.71	1182	24	1373.862	1651.443
	1320	77499.71	1240	24	1369.542	1655.948
	1320	78819.71	1320	24	1365.223	1660.454
New Mulholland PS	600	79419.71	1350	24	1350	1662.502
	720	80139.71	1393	24	1896.62	1737.502
	1320	81459.71	1457	24	1884.023	1742.008
	1320	82779.71	1491	24	1875.873	1746.513
	1320	84099.71	1515	24	1867.724	1751.019
	422.4	84522.11	1559	24	1865.116	1752.461
	897.6	85419.71	1515	24	1859.574	1755.524
	1320	86739.71	1565	24	1851.425	1760.03
	1320	88059.71	1538	24	1843.275	1764.536
	1320	89379.71	1570	24	1835.125	1769.041
	1320	90699.71	1618	24	1826.976	1773.547
	1320	92019.71	1668	24	1818.826	1778.053
	1320	93339.71	1749	24	1810.676	1782.558
New Mulholland Tank	422.4	93762.11	1784	24	1784	1784
	897.6	94659.71	1756	24	1780.577	1807.63
	1320	95979.71	1616	24	1775.542	1812.968
	1320	97299.71	1520	24	1770.508	1818.305
	1320	98619.71	1387	25	1765.474	1823.643
	1320	99939.71	1270	26	1760.439	1828.981
	1320	101259.7	1137	27	1755.405	1834.319
	1320	102579.7	1025	28	1750.371	1839.657
	1320	103899.7	943	29	1745.336	1844.994
	1200	105099.7	938	24	1740.76	1849.847
	1320	106419.7	1025	24	1735.725	1855.185
	1320	107739.7	1065	24	1730.691	1860.523
	1320	109059.7	1005	24	1725.657	1865.86
	1320	110379.7	1100	24	1720.622	1871.198
	1320	111699.7	1220	24	1715.588	1876.536
	1320	113019.7	1200	24	1710.554	1881.874
	1320	114339.7	1190	24	1705.519	1887.212
	1320	115659.7	1080	24	1700.485	1892.5
Encino Res	1320	116979.7	1081	24	1081	1081
		116979.7				

Appendix D –

SWSAP Regulated Chemicals

Industrial Effluent Quality Limitations

Constituents	Local Effluent Limits (mg/L)
Arsenic (Total)	0.05
Beriylium	0.005
Boron	1.50
Cadmium (Total)	0.02(4)
Chloride	175(4)
Chromium (Total)	0.07(4)
Copper (Total)	0.30(4)
Cyanide (Total)	0.02(4)
Cyanide (Amenable) (3)	--
Dissolved Sulfide	0.10
Fluoride	1.20(4)
Lead (Total)	0.20(4)
Mercury	0.002
Nickel (Total)	0.50(4)
Oil & Grease	100(4)
pH Range	6-10(4)
Selenium	0.02(4)
Silver (Total)	0.08(4)
Sulfate	325(4)
Temperature	140°F(4)
Total Dissolved Solids (TDS)	1,000(4)
Total Toxic Organics (TTO)	--
Zinc (Total)	0.50(4)

Inorganic Chemical	*Maximum Contaminant Level, mg/L*	*Currently Sampled*
Aluminum	1.	
Antimony	0.006	X
Arsenic	0.010	X
Asbestos	7 MFL*	
Barium	1.	X
Beryllium	0.004	X
Cadmium	0.005	X
Chromium	0.05	X
Cyanide	0.15	X

Fluoride	2.0	X
Mercury	0.002	X
Nickel	0.1	X
Nitrate (as NO3)	45.	
Nitrate+Nitrite (sum as nitrogen)	10.	X
Nitrite (as nitrogen)	1.	X
Perchlorate	0.006	X
Selenium	0.05	X
Thallium	0.002	X
Radionuclide	***MCL***	***Currently Sampled***
Radium-226 Radium–228	5 pCi/L (combined radium-226 & -228)	
Gross Alpha particle activity	15 pCi/L	
Uranium	20 pCi/L	
Beta/photon emitters	4 millirem/year annual dose equivalent to the total body or any internal organ	
Strontium-90	8 pCi/L (= 4 millirem/yr dose to bone marrow)	
Tritium	20,000 pCi/L (= 4 millirem/yr dose to total body)	
Organic Chemicals	***MCL***	***Currently Sampled***
(a) Volatile Organic Chemicals (VOCs)		
Benzene	0.001	X
Carbon Tetrachloride	0.0005	X
1,2-Dichlorobenzene	0.6	X
1,4-Dichlorobenzene	0.005	X
1,1-Dichloroethane	0.005	X
1,2-Dichloroethane	0.0005	X
1,1-Dichloroethylene	0.006	X
cis-1,2-Dichloroethylene	0.006	
trans-1,2-Dichloroethylene	0.01	X
Dichloromethane	0.005	
1,2-Dichloropropane	0.005	
1,3-Dichloropropene	0.0005	X
Ethylbenzene	0.3	X
Methyl-*tert*-butyl ether	0.013	
Monochlorobenzene	0.07	
Styrene	0.1	
1,1,2,2-Tetrachloroethane	0.001	X
Tetrachloroethylene	0.005	X

Toluene	0.15	X
1,2,4-Trichlorobenzene	0.005	X
1,1,1-Trichloroethane	0.200	X
1,1,2-Trichloroethane	0.005	X
Trichloroethylene	0.005	X
Trichlorofluoromethane	0.15	
1,1,2-Trichloro-1,2,2-Trifluoroethane	1.2	
Vinyl Chloride	0.0005	X
Xylenes.	1.750*	
(b) Non-Volatile Synthetic Organic		
Alachlor	0.002	
Atrazine	0.001	X
Bentazon	0.018	
Benzo(a)pyrene	0.0002	X
Carbofuran	0.018	
Chlordane	0.0001	X
2,4-D	0.07	X
Dalapon	0.2	
Dibromochloropropane	0.0002	
Di(2-ethylhexyl)adipate	0.4	
Di(2-ethylhexyl)phthalate	0.004	
Dinoseb	0.007	
Diquat	0.02	
Endothall	0.1	
Endrin	0.002	X
Ethylene Dibromide	0.00005	
Glyphosate	0.7	
Heptachlor	0.00001	X
Heptachlor Epoxide	0.00001	X
Hexachlorobenzene	0.001	X
Hexachlorocyclopentadiene	0.05	X
Lindane	0.0002	X
Methoxychlor.	0.03	X
Molinate	0.02	
Oxamyl	0.05	
Pentachlorophenol	0.001	X
Picloram	0.5	
Polychlorinated Biphenyls	0.0005	X
Simazine	0.004	X
Thiobencarb	0.07	
Toxaphene	0.003	X
2,3,7,8-TCDD (Dioxin)	3×10^{-8}	X
2,4,5-TP (Silvex)	0.05	X
Disinfection Byproduct	***MCL***	***Currently Sampled***

Total trihalomethanes (TTHM)	0.080	X
Bromodichloromethane		
Bromoform		
Chloroform		
Dibromochloromethane		
Haloacetic acids (five) (HAA5)	0.060	
Monochloroacetic Acid		
Dichloroacetic Acid		
Trichloroacetic Acid		
Monobromoacetic Acid		
Dibromoacetic Acid		
Bromate	0.010	
Chlorite	1.0	
Lead		X
Copper		X

Secondary Drinking Water Contaminants

Constituents	***Maximum Contaminant Levels/Units***		
Aluminum	0.2 mg/L		
Color	15 Units		
Copper	1.0 mg/L		
Foaming Agents (MBAS)	0.5 mg/L		
Iron	0.3 mg/L		
Manganese	0.05 mg/L		
Methyl-*tert*-butyl ether (MTBE)	0.005 mg/L		
Odor—Threshold	3 Units		
Silver	0.1 mg/L		
Thiobencarb	0.001 mg/L		
Turbidity	5 Units		
Zinc	5.0 mg/L		
	Recommended	***Upper***	***Short Term***
Total Dissolved Solids, mg/L	500	1,000	1,500
or			
Specific Conductance, µS/cm	900	1,600	2,200
Chloride, mg/L	250	500	600
Sulfate, mg/L	250	500	600

Appendix E –
Brine Quality Projections

AWTP Design Parameters	
Capacity (MGD)	6
Recovery (%)	85%
Rejection (%)	15%

Flow Data	MGD
Tapia Effluent	10
AWTP Brine	0.9

Summary Table: AWTP Brine Quality vs. SMP Discharge Limits (Full Calculations Below)

		WATER QUALITY DATA		Does AWTP Brine comply with SMP Discharge Limits? (Y/N) (Is Average Brine Quality less than relevant discharge limit?)	DISCHARGE LIMITS					
		AWTP Brine			Relevant Discharge Limit	SMP Discharge Limits				
Parameter	Units	Average	Max			Average Monthly	Average Weekly	Daily Maximum	Instantaneous Maximum	6-Month Median
BOD (5-day @ 20° C)	mg/L	8	31	Y	45	30	45	--	--	--
Settleable Solids	mL/L	--	0.67	Y	1.00	1	1.5	--	3	--
Total Suspended Solids	mg/L	11	66	Y	60	60	--	--	--	--
Turbidity	NTU	--	47	Y	75	75	100	--	225	--
Ammonia (as N)	µg/L	648	2,933	Y	44,000	--	--	180,000	440,000	44,000
Antimony (Total Recoverable)	µg/L	1	7	Y	88,000	88,000	--	--	--	--
Arsenic (Total Recoverable)	µg/L	7	20	Y	370	--	--	2,100	5,600	370
Cadmium (Total Recoverable)	µg/L	1	3	Y	73	--	--	290	730	73
Chromium III (Total Recoverable)	µg/L	0.4	13	Y	14,000,000	1.40E+07	--	--	--	--
Chromium VI (Total Recoverable)	µg/L	0.5	2	Y	150	--	--	580	1,500	150
Copper (Total Recoverable)	µg/L	33	107	Y	730	--	--	730	2,000	75
Lead (Total Recoverable)	µg/L	1	8	Y	150	--	--	580	1,500	150
Mercury (Total Recoverable)	µg/L	0.004	0.13	Y	2.9	--	--	12	29	2.9
Nickel (Total Recoverable)	µg/L	23	33	Y	370	--	--	1,500	3,700	370
Selenium (Total Recoverable)	µg/L	--	20	Y	1100	--	--	4,400	11,000	1,100
Zinc (Total Recoverable)	µg/L	250	600	Y	880	--	--	5,300	14,000	880
Cyanide	µg/L	--	67	Y	73	--	--	290	730	73
Chlorodibromomethane	µg/L	118	180	Y	630	630	--	--	--	--
Chloroform	µg/L	304	607	Y	9500	9,500	--	--	--	--
Dichlorobromomethane	µg/L	258	582	Y	450	450	--	--	--	--
Bis(2-Ethylhexyl)Phthalate	µg/L	--	147	Y	260	260	--	--	--	--
Boron	mg/L	2.57	3.20	--	--	--	--	--	--	--
TDS	mg/L	5000	6080	--	--	--	--	--	--	--
Sulfate	mg/L	1280	1873	--	--	--	--	--	--	--
Chloride	mg/L	1067	1213	--	--	--	--	--	--	--
[Nitrate + Nitrite] (as N)	mg/L	44	66	--	--	--	--	--	--	--
Nitrite (as N)	mg/L	0.15	0.60	--	--	--	--	--	--	--

Compounds with established SMP Limits, but not enough water quality data to confirm compliance:

Oil and Grease	Benzidine	Heptachlor
Total Residual Chlorine	PAH*	Heptachlor Epoxide
Chronic Toxicity	Bis(2-Chloroethoxy)Methan	PCBs*
Beryllium (Total Recoverable)	Bis(2-Chloroethyl)Ether	Toxaphene
Silver (Total Recoverable)	Bis(2-chloroisopropyl)Ether	Tributyltin
Thallium (Total Recoverable)	Dichlorobenzenes	
Non-chlorinated Phenolic Compound	1,4-Dichlorobenzene	
Chlorinated Phenolics*	3,3’-Dichlorobenzidine	
TCDD Equivalents*	Diethyl Phthalate	
Acrolein	Dimethyl Phthalate	
Acrylonitrile	Di-n-Butyl Phthalate	
Benzene	2,4-Dinitrotoluene	
Carbon Tetrachloride	1,2-Diphenylhydrazine	
Chlorobenzene	Fluoranthene	
1,2-Dichloroethane	Hexachlorobenzene	
1,1-Dichloroethylene	Hexachlorobutadiene	
1,3-Dichloropropylene (1,3-Dichlorop	Hexachlorocyclopentadiene	
Ethylbenzene	Hexachloroethane	
Halomethanes*	Isophorone	
Dichloromethane (Methylene Chloric	Nitrobenzene	
1,1,2,2-Tetrachloroethane	N-Nitrosodimethylamine	
Tetrachloroethylene	N-Nitrosodi-N-Propylamine	
Toluene	N-Nitrosodiphenylamine	
1,1,1-Trichloroethane	Aldrin	
1,1,2-Trichloroethane	HCH*	
Trichloroethylene	Chlordane	
Vinyl Chloride	DDT*	
4,6-dinitro-2-methylphenol	Dieldrin	
2,4-Dinitrophenol	Endosulfan	
2,4,6-Trichlorophenol	Endrin	

Calculations

		WATER QUALITY DATA				Does AWTP Brine comply with SMP Discharge Limits? (Y/N)	DISCHARGE LIMITS					
		Tapia Effluent		AWTP Brine				SMP Discharge Limits				
Parameter	Units	Average	Max	Average	Max	(Is Average Brine Quality less than relevant discharge limit?)	Relevant Discharge Limit	Average Monthly	Average Weekly	Daily Maximum	Instantaneous Maximum	6-Month Median
BOD (5-day @ 20° C)	mg/L	1.17	4.6	8	31	Y	45	30	45	--	--	--
Settleable Solids	mL/L	<0.1	0.1	--	0.67	Y	1.00	1	1.5	--	3	--
Total Suspended Solids	mg/L	1.69	9.9	11	66	Y	60	60	--	--	--	--
Turbidity	NTU	<1	7	--	47	Y	75	75	100	--	225	--
Ammonia (as N)	µg/L	97	440	648	2,933	Y	44,000	--	--	180,000	440,000	44,000
Antimony (Total Recoverable)	µg/L	0.111	1	1	7	Y	88,000	88,000	--	--	--	--
Arsenic (Total Recoverable)	µg/L	1.058	3	7	20	Y	370	--	--	2,100	5,600	370
Cadmium (Total Recoverable)	µg/L	0.12111	0.4	1	3	Y	73	--	--	290	730	73
Chromium III (Total Recoverable)	µg/L	0.06667	2	0.4	13	Y	14,000,000	1.40E+07	--	--	--	--
Chromium VI (Total Recoverable)	µg/L	0.075	0.3	0.5	2	Y	150	--	--	580	1,500	150
Copper (Total Recoverable)	µg/L	4.974	16	33	107	Y	730	--	--	730	2,000	75
Lead (Total Recoverable)	µg/L	0.15	1.2	1	8	Y	150	--	--	580	1,500	150
Mercury (Total Recoverable)	µg/L	0.001	0.02	0.004	0.13	Y	2.9	--	--	12	29	2.9
Nickel (Total Recoverable)	µg/L	3.5	5	23	33	Y	370	--	--	1,500	3,700	370
Selenium (Total Recoverable)	µg/L	0.41	3	--	20	Y	1100	--	--	4,400	11,000	1,100
Zinc (Total Recoverable)	µg/L	38	90	250	600	Y	880	--	--	5,300	14,000	880
Cyanide	µg/L	1.82	10	--	67	Y	73	--	--	290	730	73
Chlorodibromomethane	µg/L	18	27	118	180	Y	630	630	--	--	--	--
Chloroform	µg/L	46	91	304	607	Y	9500	9,500	--	--	--	--
Dichlorobromomethane	µg/L	39	87.3	258	582	Y	450	450	--	--	--	--
Bis(2-Ethylhexyl)Phthalate	µg/L	5.1	22	--	147	Y	260	260	--	--	--	--
Oil and Grease	mg/L	<5	<5	--	--	--	25	25	40	--	75	--
Total Residual Chlorine	µg/L	<100	<100	--	--	--	150	--	--	580	4,400	150
Chronic Toxicity	P/F % Effect	--	--	--	--	--	Pass	Pass	--	Pass or % Effect < !	--	--
Beryllium (Total Recoverable)	µg/L	<0.2	<0.2	--	--	--	2.4	2.4	--	--	--	--
Silver (Total Recoverable)	µg/L	<1	<1	--	--	--	40	--	--	190	500	40
Thallium (Total Recoverable)	µg/L	<0.2	<0.2	--	--	--	150	150	--	--	--	--
Non-chlorinated Phenolic Compounds*	µg/L	--	--	--	--	--	2200	--	--	8,800	22,000	2,200
Chlorinated Phenolics*	µg/L	--	--	--	--	--	73	--	--	290	730	73
TCDD Equivalents*	µg/L	--	--	--	--	--	0.00000028	2.80E-07	--	--	--	--
Acrolein	µg/L	<5	<5	--	--	--	16000	16,000	--	--	--	--
Acrylonitrile	µg/L	<2	<5	--	--	--	7	7.3	--	--	--	--
Benzene	µg/L	<0.5	<1	--	--	--	430	430	--	--	--	--
Carbon Tetrachloride	µg/L	<0.5	<1	--	--	--	66	66	--	--	--	--
Chlorobenzene	µg/L	<0.5	<1	--	--	--	42000	42,000	--	--	--	--
1,2-Dichloroethane	µg/L	<0.5	<1	--	--	--	2000	2,000	--	--	--	--
1,1-Dichloroethylene	µg/L	<0.5	<1	--	--	--	66	66	--	--	--	--
1,3-Dichloropropylene (1,3-Dichloropropene)	µg/L	<0.5	<1	--	--	--	650	650	--	--	--	--
Ethylbenzene	µg/L	<0.5	<1	--	--	--	300000	3.00E+05	--	--	--	--
Halomethanes*	µg/L	--	--	--	--	--	9500	9,500	--	--	--	--
Dichloromethane (Methylene Chloride)	µg/L	<2	<2	--	--	--	33000	33,000	--	--	--	--
1,1,2,2-Tetrachloroethane	µg/L	<0.5	<1	--	--	--	170	170	--	--	--	--
Tetrachloroethylene	µg/L	<0.5	<1	--	--	--	150	150	--	--	--	--
Toluene	µg/L	<0.5	<1	--	--	--	6200000	6.20E+06	--	--	--	--
1,1,1-Trichloroethane	µg/L	<0.5	<1	--	--	--	39000000	3.90E+07	--	--	--	--
1,1,2-Trichloroethane	µg/L	<0.5	<1	--	--	--	690	690	--	--	--	--
Trichloroethylene	µg/L	<0.5	<1	--	--	--	2000	2,000	--	--	--	--
Vinyl Chloride	µg/L	<0.5	<1	--	--	--	2600	2,600	--	--	--	--
4,6-dinitro-2-methylphenol	µg/L	<5	<5	--	--	--	16000	16,000	--	--	--	--
2,4-Dinitrophenol	µg/L	<10	<10	--	--	--	290	290	--	--	--	--
2,4,6-Trichlorophenol	µg/L	<1	<1	--	--	--	21	21	--	--	--	--
Benzidine	µg/L	<10	<10	--	--	--	0.01	0.005	--	--	--	--
PAH*	µg/L	--	--	--	--	--	0.64	0.64	--	--	--	--
Bis(2-Chloroethoxy)Methane	µg/L	<1	<1	--	--	--	320	320	--	--	--	--
Bis(2-Chloroethyl)Ether	µg/L	<1	<1	--	--	--	3.30	3.3	--	--	--	--
Bis(2-chloroisopropyl)Ether	µg/L	<1	<1	--	--	--	88000	88,000	--	--	--	--
Dichlorobenzenes	µg/L	--	--	--	--	--	370000	3.70E+05	--	--	--	--
1,4-Dichlorobenzene	µg/L	<0.5	<1	--	--	--	1300	1,300	--	--	--	--
3,3'-Dichlorobenzidine	µg/L	<5	<5	--	--	--	0.6	0.59	--	--	--	--
Diethyl Phthalate	µg/L	<1	<1	--	--	--	2400000	2.40E+06	--	--	--	--
Dimethyl Phthalate	µg/L	<1	<1	--	--	--	60000000	6.00E+07	--	--	--	--
Di-n-Butyl Phthalate	µg/L	<1	<1	--	--	--	260000	2.60E+05	--	--	--	--
2,4-Dinitrotoluene	µg/L	<1	<1	--	--	--	190	190	--	--	--	--
1,2-Diphenylhydrazine	µg/L	--	--	--	--	--	12	12	--	--	--	--
Fluoranthene	µg/L	<1	<1	--	--	--	1100	1,100	--	--	--	--
Hexachlorobenzene	µg/L	<1	<1	--	--	--	0.015	0.015	--	--	--	--
Hexachlorobutadiene	µg/L	<1	<1	--	--	--	1000	1,000	--	--	--	--
Hexachlorocyclopentadiene	µg/L	<5	<5	--	--	--	4200	4,200	--	--	--	--
Hexachloroethane	µg/L	<1	<1	--	--	--	180	180	--	--	--	--
Isophorone	µg/L	<1	<1	--	--	--	53000	53,000	--	--	--	--
Nitrobenzene	µg/L	<1	<1	--	--	--	360	360	--	--	--	--
N-Nitrosodimethylamine	µg/L	<1	<1	--	--	--	530	530	--	--	--	--
N-Nitrosodi-N-Propylamine	µg/L	<1	<1	--	--	--	28	28	--	--	--	--
N-Nitrosodiphenylamine	µg/L	<1	<1	--	--	--	180	180	--	--	--	--
Aldrin	µg/L	<0.005	<0.005	--	--	--	0.002	0.0016	--	--	--	--
HCH*	µg/L	--	--	--	--	--	0.290	--	--	0.58	0.88	0.29
Chlordane	µg/L	<0.1	<0.1	--	--	--	0.002	0.0017	--	--	--	--
DDT*	µg/L	--	--	--	--	--	0.012	0.012	--	--	--	--
Dieldrin	µg/L	<0.01	<0.01	--	--	--	0.003	0.0029	--	--	--	--
Endosulfan	µg/L	--	--	--	--	--	0.660	--	--	1.3	2	0.66
Endrin	µg/L	<0.01	<0.01	--	--	--	0.150	--	--	0.29	0.44	0.15
Heptachlor	µg/L	<0.01	<0.01	--	--	--	0.004	0.0037	--	--	--	--
Heptachlor Epoxide	µg/L	<0.01	<0.01	--	--	--	0.002	0.0015	--	--	--	--
PCBs*	µg/L	--	--	--	--	--	0.00140	0.0014	--	--	--	--
Toxaphene	µg/L	<0.5	<0.5	--	--	--	0.01500	0.015	--	--	--	--
Tributyltin	µg/L	--	--	--	--	--	0.100	0.1	--	--	--	--
MBAS	mg/L	--	--	--	--	--						
	lbs/day	--	--	--	--	--						
Boron	mg/L	0.39	0.48	2.57	3.20	--						
TDS	mg/L	750	912	5000	6080	--						
Sulfate	mg/L	192	281	1280	1873	--						
Chloride	mg/L	160	182	1067	1213	--						
[Nitrate + Nitrite] (as N)	mg/L	7	9.9	44	66	--						
Nitrite (as N)	mg/L	0.02	0.09	0.15	0.60	--						
4,4-DDD	µg/L	<0.05	<0.05	--	--	--						
4,4-DDE	µg/L	<0.05	<0.05	--	--	--						
4,4-DDT	µg/L	<0.01	<0.01	--	--	--						
Diazinon		<2	<2	--	--	--						

Appendix F –

DigAlert Contact Information

Scenario 4 DigAlert

Design Lookup

County LOS ANGELES
Place AGOURA HILLS
Page or Grids 0557C07 0557D06 0557D07 0557E05 0557E06 0557F04 0557F05 0557G03

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dvarney@calwater.com

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OAK PARK WATER SERVICE
CHUM SENIVONGS
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VENTURA, CA 93003
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chumsenivongs@vrsd.com

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SC GAS - SIMI
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DHENSLEY@SEMPRAUTILITIES.COM

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TRENT HORVATH
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UTILIQUEST FOR SC EDISON-TELECOMMUNIC
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UVZSTABAR

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Scenario 5 DigAlert

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Appendix G –

Geotechnical Investigation

Scenario 4 Geotechnical Investigation

MOORPARK

DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA-GRAY DAVIS, GOVERNOR
THE RESOURCES AGENCY-MARY D. NICHOLS, SECRETARY
DEPARTMENT OF CONSERVATION-DARRYL W. YOUNG, DIRECTOR

SEISMIC HAZARD ZONE
Thousand Oaks Quadrangle

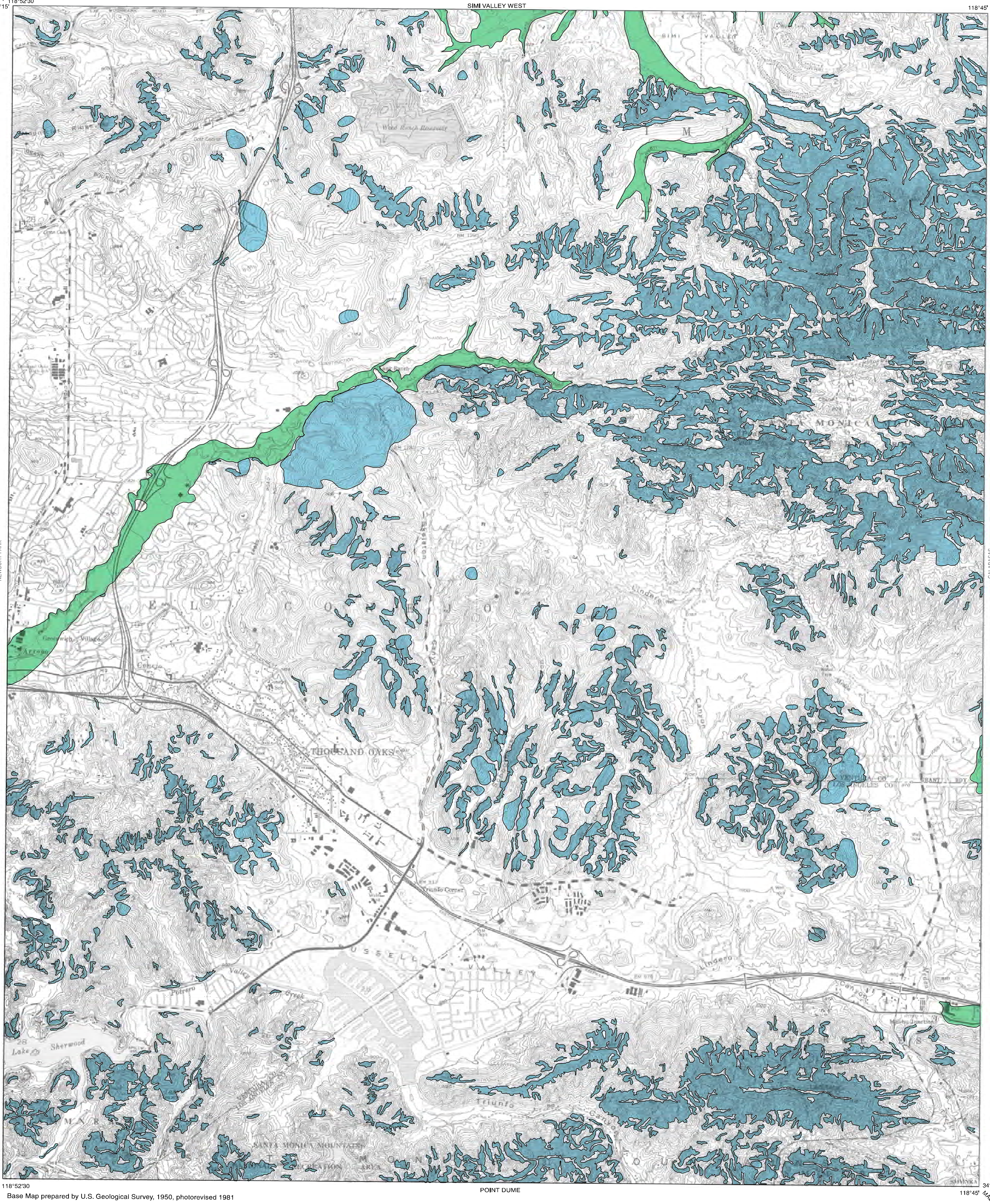
SIMI VALLEY EAST

34°15' 118°52'30

SIMI VALLEY WEST

118°45' 34°15'

NEWBURY PARK



CALABASAS

34°07'30" 118°52'30

TRIFUNO PASS

Base Map prepared by U.S. Geological Survey, 1950, photorevised 1981

POINT DUME

34°07'30 118°45'

MALIBU BEACH

PURPOSE OF MAP

This map will assist cities and counties in fulfilling their responsibilities for protecting the public safety from the effects of earthquake-triggered ground failure as required by the Seismic Hazards Mapping Act (Public Resources Code Sections 2690-2699.6).

For information regarding the scope and recommended methods to be used in conducting the required site investigations, see DMG Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards in California.

For a general description of the Seismic Hazards Mapping Program, the Seismic Hazards Mapping Act and regulations, and related information, please refer to the draft User's Guide (see http://www.consrv.ca.gov/dmg/shezp/userguid/).User's Guide

Production of this map was funded by the Federal Emergency Management Agency's Hazard Mitigation Program and the Department of Conservation in cooperation with the Governor's Office of Emergency Services.

IMPORTANT - PLEASE NOTE

1) This map may not show all areas that have the potential for liquefaction, landsliding, strong earthquake ground shaking or other earthquake and geologic hazards. Also, single earthquake capable of causing liquefaction or triggering landslide failure will not uniformly affect the entire area zoned.

2) Liquefaction zones may also contain areas susceptible to the effects of earthquake-induced landslides. This situation typically exists at or near the toe of existing landslides, downslope from rockfall or debris flow source areas, or adjacent to steep stream banks.

3) This map does not show Alquist-Priolo earthquake fault zones, if any, that may exist in this area. Please refer to the latest official map of earthquake fault zones for disclosures and other actions that are required by the Alquist-Priolo Earthquake Fault Zoning Act. For more information on this subject and an index to available maps, see DMG Special Publication 42.

4) Landslide zones on this map were determined, in part, by adapting methods originally developed by the U.S. Geological Survey (USGS). Landslide hazard maps prepared by the USGS typically use experimental approaches to assess earthquake-induced and other types of landslide hazards. Although aspects of these new methodologies may be incorporated in future CDMG seismic hazard zone maps, USGS maps should not be used as substitutes Official SEISMIC HAZARD ZONES maps.

5) U.S. Geological Survey base map standards provide that 90 percent of cultural feature be located within 40 feet (horizontal accuracy) at the scale of this map. The identification and location of liquefaction and earthquake-induced landslide zones are based on available data. However, the quality of data used is varied. The zone boundaries depicted have been drawn as accurately as possible at this scale.

6) Information on this map is not sufficient to serve as a substitute for the geologic and geotechnical site investigations required under Chapters 7.5 and 7.8 of Division 2 of the Public Resources Code.

7) DISCLAIMER: The State of California and the Department of Conservation make no representations or warranties regarding the accuracy of the data from which these maps were derived. Neither the State nor the Department shall be liable under any circumstances for any direct, indirect, special, incidental or consequential damages with respect to any claim by any user or any third party on account of or arising from the use of this map.

SCALE 1:24,000

1 .5 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

STATE OF CALIFORNIA
SEISMIC HAZARD ZONES

Delineated in compliance
Chapter 7.8, Division 2 of the California Public Resources
(Seismic Hazards Mapping

THOUSAND OAKS QUADRANGLE

OFFICIAL MAP

Released: November 17, 2000

STATE GEOLOGIST

MAP EXPLANATION

Zones of Required Investigation:

Liquefaction

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Earthquake-Induced Landslides

Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

DATA AND METHODOLOGY USED TO DEVELOP
THIS MAP ARE PRESENTED IN THE FOLLOWING:

Seismic Hazard Evaluation of the Thousand Oaks 7.5 minute quadrangle, Ventura County, California: California Division of Mines and Geology, Open-File Report 2000-008.

For additional information on seismic hazards in this map area, the rationale used for zoning, and additional references consulted, refer to DMG's World Wide Web site (http://www.consrv.ca.gov/dmg/).

SEISMIC HAZARD ZONE REPORT FOR THE THOUSAND OAKS 7.5-MINUTE QUADRANGLE, VENTURA AND LOS ANGELES COUNTIES, CALIFORNIA

2000

DEPARTMENT OF CONSERVATION
Division of Mines and Geology

STATE OF CALIFORNIA
GRAY DAVIS
GOVERNOR

THE RESOURCES AGENCY
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SECRETARY FOR RESOURCES

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DARRYL YOUNG
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DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, *STATE GEOLOGIST*

SEISMIC HAZARD ZONE REPORT 042

SEISMIC HAZARD ZONE REPORT FOR THE THOUSAND OAKS 7.5-MINUTE QUADRANGLE, VENTURA AND LOS ANGELES COUNTIES, CALIFORNIA

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List of Revisions – Thousand Oaks SHZR 042	
2001	Text updated
8/24/05	BPS address corrected, web links updated, Figure 3.5 added
1/9/06	Correct plate 1.1 and 1.2 placed
1/17/06	Bay Area Regional Office and Southern California Regional Office addresses updated

CONTENTS

ILLUSTRATIONS

EXECUTIVE SUMMARY

This report summarizes the methods and sources of information used to prepare the Seismic Hazard Zone Map for the Thousand Oaks 7.5-minute Quadrangle, Ventura and Los Angeles counties, California. The map displays the boundaries of Zones of Required Investigation for liquefaction and earthquake-induced landslides over an area of approximately 62 square miles at a scale of 1 inch = 2,000 feet.

The Thousand Oaks Quadrangle is located about 35 miles west of the Los Angeles Civic Center and 27 miles east of the Ventura County Civic Center. It includes parts of the cities of Thousand Oaks, Simi Valley, Agoura Hills, and Westlake Village and the unincorporated communities of Oak Park and Lake Sherwood. The northern and central part of the quadrangle is dominated by hilly to mountainous terrain of the Simi Hills, where elevations reach 2403 feet at Simi Peak, and Mountclef Ridge. The southern part of the quadrangle includes Russell Valley and the steep, rugged northern slopes of the Santa Monica Mountains. Commercial development is concentrated in the low-lying areas along the major highways and streets. Residential development has spread from the lowland areas into the hills and mountains where extensive grading is in process. Other current land uses include National parkland (Santa Monica Mountains National Recreation Area) in the Simi Hills and Santa Monica Mountains, regional parkland, golf courses, and several reservoirs. U.S. Highway 101 and State Highway 23 are the major transportation routes through the project area.

The map is prepared by employing geographic information system (GIS) technology, which allows the manipulation of three-dimensional data. Information considered includes topography, surface and subsurface geology, borehole data, historical ground-water levels, existing landslide features, slope gradient, rock-strength measurements, geologic structure, and probabilistic earthquake shaking estimates. The shaking inputs are based upon probabilistic seismic hazard maps that depict peak ground acceleration, mode magnitude, and mode distance with a 10% probability of exceedance in 50 years.

In the Thousand Oaks Quadrangle the liquefaction zone is restricted to the Conejo Creek stream valley, a small area along Cheeseboro Creek at the eastern boundary and several north-trending canyons and stream valleys at the northern boundary of the quadrangle. The combination of dissected hills and weak rocks has produced widespread and abundant landslides, especially in the Simi Hills and the Santa Monica Mountains. These conditions contribute to an earthquake-induced landslide zone that covers about 18 percent of the quadrangle.

How to view or obtain the map

Seismic Hazard Zone Maps, Seismic Hazard Zone Reports and additional information on seismic hazard zone mapping in California are available on the Division of Mines and Geology's Internet page: http://www.conservation.ca.gov/CGS/index.htm

Paper copies of Official Seismic Hazard Zone Maps, released by DMG, which depict zones of required investigation for liquefaction and/or earthquake-induced landslides, are available for purchase from:

BPS Reprographic Services
945 Bryant Street
San Francisco, California 94105
(415) 512-6550

Seismic Hazard Zone Reports (SHZR) summarize the development of the hazard zone map for each area and contain background documentation for use by site investigators and local government reviewers. These reports are available for reference at DMG offices in Sacramento, San Francisco, and Los Angeles. **NOTE: The reports are not available through BPS Reprographic Services.**

INTRODUCTION

The Seismic Hazards Mapping Act (the Act) of 1990 (Public Resources Code, Chapter 7.8, Division 2) directs the California Department of Conservation (DOC), Division of Mines and Geology (DMG) to delineate seismic hazard zones. The purpose of the Act is to reduce the threat to public health and safety and to minimize the loss of life and property by identifying and mitigating seismic hazards. Cities, counties, and state agencies are directed to use the seismic hazard zone maps in their land-use planning and permitting processes. They must withhold development permits for a site within a zone until the geologic and soil conditions of the project site are investigated and appropriate mitigation measures, if any, are incorporated into development plans. The Act also requires sellers (and their agents) of real property within a mapped hazard zone to disclose at the time of sale that the property lies within such a zone. Evaluation and mitigation of seismic hazards are to be conducted under guidelines established by the California State Mining and Geology Board (DOC, 1997; also available on the Internet at http://gmw.consrv.ca.gov/shmp/webdocs/sp117.pdf).

The Act also directs SMGB to appoint and consult with the Seismic Hazards Mapping Act Advisory Committee (SHMAAC) in developing criteria for the preparation of the seismic hazard zone maps. SHMAAC consists of geologists, seismologists, civil and structural engineers, representatives of city and county governments, the state insurance commissioner and the insurance industry. In 1991 SMGB adopted initial criteria for delineating seismic hazard zones to promote uniform and effective statewide implementation of the Act. These initial criteria provide detailed standards for mapping regional liquefaction hazards. They also directed DMG to develop a set of probabilistic seismic maps for California and to research methods that might be appropriate for mapping earthquake-induced landslide hazards.

In 1996, working groups established by SHMAAC reviewed the prototype maps and the techniques used to create them. The reviews resulted in recommendations that 1) the process for zoning liquefaction hazards remain unchanged and 2) earthquake-induced landslide zones be delineated using a modified Newmark analysis.

This Seismic Hazard Zone Report summarizes the development of the hazard zone map. The process of zoning for liquefaction uses a combination of Quaternary geologic mapping, historical ground-water information, and subsurface geotechnical data. The process for zoning earthquake-induced landslides incorporates earthquake loading, existing landslide features, slope gradient, rock strength, and geologic structure. Probabilistic seismic hazard maps, which are the underpinning for delineating seismic hazard zones, have been prepared for peak ground acceleration, mode magnitude, and mode distance with a 10% probability of exceedance in 50 years (Petersen and others, 1996) in accordance with the mapping criteria.

This report summarizes seismic hazard zone mapping for potentially liquefiable soils and earthquake-induced landslides in the Thousand Oaks 7.5-minute Quadrangle.

SECTION 1
LIQUEFACTION EVALUATION REPORT

Liquefaction Zones in the Thousand Oaks 7.5-Minute Quadrangle, Ventura and Los Angeles Counties, California

By
Ralph C. Loyd

California Department of Conservation
Division of Mines and Geology

PURPOSE

The Seismic Hazards Mapping Act (the Act) of 1990 (Public Resources Code, Chapter 7.8, Division 2) directs the California Department of Conservation (DOC), Division of Mines and Geology (DMG) to delineate Seismic Hazard Zones. The purpose of the Act is to reduce the threat to public health and safety and to minimize the loss of life and property by identifying and mitigating seismic hazards. Cities, counties, and state agencies are directed to use seismic hazard zone maps developed by DMG in their land-use planning and permitting processes. The Act requires that site-specific geotechnical investigations be performed prior to permitting most urban development projects within seismic hazard zones. Evaluation and mitigation of seismic hazards are to be conducted under guidelines adopted by the California State Mining and Geology Board (SMGB) (DOC, 1997; also available on the Internet at http://gmw.consrv.ca.gov/shmp/webdocs/sp117.pdf).

This section of the evaluation report summarizes seismic hazard zone mapping for potentially liquefiable soils in the Thousand Oaks 7.5-minute Quadrangle. This section, along with Section 2 (addressing earthquake-induced landslides), and Section 3 (addressing potential ground shaking), form a report that is one of a series that summarizes production of similar seismic hazard zone maps within the state (Smith, 1996). Additional information on seismic hazards zone mapping in California is on DMG's Internet web page: http://www.conservation.ca.gov/CGS/index.htm

BACKGROUND

Liquefaction-induced ground failure historically has been a major cause of earthquake damage in southern California. During the 1971 San Fernando and 1994 Northridge earthquakes, significant damage to roads, utility pipelines, buildings, and other structures in the Los Angeles area was caused by liquefaction-induced ground displacement.

Localities most susceptible to liquefaction-induced damage are underlain by loose, water-saturated, granular sediment within 40 feet of the ground surface. These geological and ground-water conditions exist in parts of southern California, most notably in some densely populated valley regions and alluviated floodplains. In addition, the potential for strong earthquake ground shaking is high because of the many nearby active faults. The combination of these factors constitutes a significant seismic hazard in the southern California region in general, including areas in the Thousand Oaks Quadrangle.

METHODS SUMMARY

Characterization of liquefaction hazard presented in this report requires preparation of maps that delineate areas underlain by potentially liquefiable sediment. The following were collected or generated for this evaluation:

- Existing geologic maps were used to provide an accurate representation of the spatial distribution of Quaternary deposits in the study area. Geologic units that generally are susceptible to liquefaction include late Quaternary alluvial and fluvial sedimentary deposits and artificial fill

- Construction of shallow ground-water maps showing the historically highest known ground-water levels

- Quantitative analysis of geotechnical data to evaluate liquefaction potential of deposits

- Information on potential ground shaking intensity based on DMG probabilistic shaking maps

The data collected for this evaluation were processed into a series of geographic information system (GIS) layers using commercially available software. The liquefaction zone map was derived from a synthesis of these data and according to criteria adopted by the SMGB (DOC, 2000).

SCOPE AND LIMITATIONS

Evaluation for potentially liquefiable soils generally is confined to areas covered by Quaternary (less than about 1.6 million years) sedimentary deposits. Such areas within the Thousand Oaks Quadrangle consist mainly of alluviated valleys, floodplains, and canyons. DMG's liquefaction hazard evaluations are based on information on earthquake ground shaking, surface and subsurface lithology, geotechnical soil properties, and ground-water depth, which is gathered from various sources. Although selection of data used in this evaluation was rigorous, the quality of the data used varies. The State of California and the Department of Conservation make no representations or warranties regarding the accuracy of the data obtained from outside sources.

Liquefaction zone maps are intended to prompt more detailed, site-specific geotechnical investigations, as required by the Act. As such, liquefaction zone maps identify areas where the potential for liquefaction is relatively high. They do not predict the amount or direction of liquefaction-related ground displacements, or the amount of damage to facilities that may result from liquefaction. Factors that control liquefaction-induced ground failure are the extent, depth, density, and thickness of liquefiable materials, depth to ground water, rate of drainage, slope gradient, proximity to free faces, and intensity and duration of ground shaking. These factors must be evaluated on a site-specific basis to assess the potential for ground failure at any given project site.

Information developed in the study is presented in two parts: physiographic, geologic, and hydrologic conditions in PART I, and liquefaction and zoning evaluations in PART II.

PART I

PHYSIOGRAPHY

Study Area Location and Physiography

The Thousand Oaks Quadrangle covers approximately 62 square miles in southeastern Ventura and western Los Angeles counties. The project area is located about 35 miles west of the Los Angeles Civic Center and 27 miles east of the Ventura County Civic Center and includes parts of the cities of Thousand Oaks, Simi Valley, Agoura Hills, and Westlake Village and the unincorporated communities of Oak Park and Lake Sherwood. The northern and central part of the quadrangle is dominated by hilly to mountainous terrain of the Simi Hills and Mountclef Ridge. Within and surrounding the Simi Hills are areas where erosion has produced gently sloping mountain valleys and dissected lowlands containing small hills and knobs of bedrock. Narrow canyons cut the steeper mountainous areas. The southernmost part of the quadrangle includes the gently sloping to flat-lying terrain of Russell Valley and the steep, rugged northern slopes of the Santa Monica Mountains, which form the southern boundary of the project area. Elevations range from 500 feet at the northwestern corner of the quadrangle to 2403 feet at Simi Peak. Major drainages in the area include Arroyo Conejo/Conejo Creek, which drains west into Conejo Valley, and Medea Creek and Triunfo Canyon, which drain south and southeast through the Santa Mountains into Malibu Creek.

U.S. Highway 101 and State Highway 23 are the major transportation routes through the project area. Primary access roads within the area include Thousand Oaks and Westlake boulevards, and Moorpark, Lindero Canyon, Kanan, and Olsen roads. Fire roads provide access to remote areas. Commercial development is concentrated in the low-lying areas along the major highways and streets. Residential development has spread from the lowland areas into the hills and mountains where extensive grading is in process. Other current land uses include National parkland (Santa Monica Mountains National Recreation Area) in the Simi Hills and Santa Monica Mountains, regional parkland, golf courses, and several reservoirs.

GEOLOGY

Surficial Geology

Geologic units that generally are susceptible to liquefaction include late Quaternary alluvial and fluvial sedimentary deposits and artificial fill. A recently compiled U.S. Geological Survey (USGS) geologic map (Yerkes and Showalter, 1991) was obtained in digital form (Yerkes and Campbell, 1995) for the Thousand Oaks Quadrangle. In addition, William Lettis and Associates (1999) provided new Quaternary geologic mapping in digital form for use in this study. This map was merged with the digital bedrock map compiled by Yerkes and Campbell (1995) to provide a common geologic map for zoning liquefaction and earthquake-induced landslides. The combined map was further modified based on work by Dibblee (1993) and Weber (1984), along with aerial photo interpretation by project staff. Nomenclature for labeling Quaternary geologic units followed that used by the Southern California Areal Mapping Project (Morton and Kennedy, 1989). Quaternary geologic mapping of the Thousand Oaks Quadrangle is presented as Plate 1.1.

As illustrated on Plate 1.1, Quaternary sedimentary deposits mapped within the Thousand Oaks Quadrangle are restricted to canyons, narrow stream courses, small valleys, and dissected lowlands all of which occupy less than 20 percent of the local terrain. The Quaternary surficial alluvial units are divided into older alluvium (Pleistocene), younger alluvium (latest Pleistocene to Holocene), and modern deposits. They are then further subdivided on the basis of their depositional environment and relative ages (Table 1.1).

Quaternary Map Units	Environment of Deposition	Age
Qw	Wash	Historic time
Qf	Alluvial Fan	Historic time
Qc	Colluvium	Historic – Holocene
Qya1, Qya2	Alluvium	Holocene
Qyf1, Qyf2	Alluvial Fan	Holocene
Qoa	Alluvium	Pleistocene
Qof	Alluvial Fan	Pleistocene
Qoc	Colluvium	Pleistocene

Table 1.1. Quaternary Geologic Nomenclature of the Southern California Areal Mapping Project (SCAMP) Applied in the Thousand Oaks Quadrangle.

ENGINEERING GEOLOGY

Information on subsurface geology and engineering characteristics of flatland deposits was obtained from borehole logs collected from reports on geotechnical projects. For this investigation, more than 175 borehole logs were collected from the City of Thousand Oaks, the County of Ventura, Los Angeles County Public Works, California Department of Transportation (CalTrans), and the Southern California Regional Water Quality Control Board. Data from the borehole logs were entered into a DMG geotechnical GIS database. Locations of all exploratory boreholes considered in this investigation are shown on Plate 1.2.

Standard Penetration Test (SPT) data provide a standardized measure of the penetration resistance of a geologic deposit and commonly are used as an index of density. Many geotechnical investigations record SPT data, including the number of blows by a 140-pound drop weight required to drive a sampler of specific dimensions one foot into the soil. Recorded blow counts for non-SPT geotechnical sampling, where the sampler diameter, hammer weight or drop distance differ from those specified for an SPT (ASTM D1586), were converted to SPT-equivalent blow count values and entered into the DMG GIS. The actual and converted SPT blow counts were normalized to a common reference effective overburden pressure of one atmosphere (approximately one ton per square foot) and a hammer efficiency of 60% using a method described by Seed and Idriss (1982) and Seed and others (1985). This normalized blow count is referred to as $(N_1)_{60}$.

Evaluation of the borehole logs indicates that the thickness of young Quaternary deposits throughout the Thousand Oaks Quadrangle is not great, usually ranging from a few feet to no more than 20 feet. These young deposits normally overlie Pleistocene deposits that range in thickness from a few feet in canyon areas to about 40 feet. Lithologic descriptions provided in the logs indicate that most of the young Quaternary deposits in the quadrangle are dominated by high plasticity clay, clayey silt and clayey sand. The abundant clay within these deposits is derived mainly from the surrounding exposures of Tertiary clay-rich shale of the Modelo Formation and as weathering products of the Conejo Volcanics. A notable exception is the presence of young Quaternary sand and silty sand beds deposited in the northeast-trending Conejo Creek stream valley north of U.S. Highway 101. The alluvial sand beds in this basin are derived in part from erosion of sandstone and sand-rich beds of the Cretaceous Chatsworth Formation and the Miocene Topanga Formation, which are exposed in the drainage basin of Conejo Creek.

GROUND-WATER CONDITIONS

Liquefaction hazard may exist in areas where depth to ground water is 40 feet or less. DMG uses the highest known ground-water levels because water levels during an earthquake cannot be anticipated because of the unpredictable fluctuations caused by natural processes and human activities. A historical-high ground-water map differs from most ground-water maps, which show the actual water table at a particular time. Plate 1.2 depicts a hypothetical ground-water table within alluviated areas.

Ground-water conditions were investigated in the Thousand Oaks Quadrangle to evaluate the depth to saturated materials. Saturated conditions reduce the effective normal stress, thereby increasing the likelihood of earthquake-induced liquefaction (Youd, 1973). The evaluation was based on first-encountered water levels penetrated by boreholes and selected water wells. The depths to first-encountered unconfined ground water were plotted onto a map of the project area to constrain the estimate of historically shallowest ground water. Water depths from boreholes known to penetrate confined aquifers were not utilized.

Historical ground-water levels in the alluviated stream valley and lowland areas of the Thousand Oaks Quadrangle are generally shallow, commonly at or near a depth of 10 feet. Shallow ground-water conditions commonly exist in these types of depositional environments because they tend to receive and accumulate heavy runoff and near-surface ground water derived from surrounding highlands.

PART II

LIQUEFACTION POTENTIAL

Liquefaction may occur in water-saturated sediment during moderate to great earthquakes. Liquefied sediment loses strength and may fail, causing damage to buildings, bridges, and other structures. Many methods for mapping liquefaction hazard have been proposed. Youd (1991) highlights the principal developments and notes some of the widely used criteria. Youd and Perkins (1978) demonstrate the use of geologic criteria as a qualitative characterization of liquefaction susceptibility and introduce the mapping technique of combining a liquefaction susceptibility map and a liquefaction opportunity map to produce a liquefaction potential map. Liquefaction susceptibility is a function of the capacity of sediment to resist liquefaction. Liquefaction opportunity is a function of the potential seismic ground shaking intensity.

The method applied in this study for evaluating liquefaction potential is similar to that of Tinsley and others (1985). Tinsley and others (1985) applied a combination of the techniques used by Seed and others (1983) and Youd and Perkins (1978) for their mapping of liquefaction hazards in the Los Angeles region. This method combines geotechnical analyses, geologic and hydrologic mapping, and probabilistic earthquake shaking estimates, but follows criteria adopted by the SMGB (DOC, 2000).

LIQUEFACTION SUSCEPTIBILITY

Liquefaction susceptibility reflects the relative resistance of a soil to loss of strength when subjected to ground shaking. Physical properties of soil such as sediment grain-size distribution, compaction, cementation, saturation, and depth govern the degree of resistance to liquefaction. Some of these properties can be correlated to a sediment's geologic age and environment of deposition. With increasing age, relative density may increase through cementation of the particles or compaction caused by the weight of the overlying sediment. Grain-size characteristics of a soil also influence susceptibility to liquefaction. Sand is more susceptible than silt or gravel, although silt of low plasticity is treated as liquefiable in this investigation. Cohesive soils generally are not considered susceptible to liquefaction. Such soils may be vulnerable to strength loss with remolding and represent a hazard that is not addressed in this investigation. Soil characteristics and processes that result in higher measured penetration resistances generally indicate lower liquefaction susceptibility. Thus, blow count and cone penetrometer values are useful indicators of liquefaction susceptibility.

Saturation is required for liquefaction, and the liquefaction susceptibility of a soil varies with the depth to ground water. Very shallow ground water increases the susceptibility to liquefaction (soil is more likely to liquefy). Soils that lack resistance (susceptible soils) typically are saturated, loose and sandy. Soils resistant to liquefaction include all soil types that are dry, cohesive, or sufficiently dense.

DMG's map inventory of areas containing soils susceptible to liquefaction begins with evaluation of geologic maps and historical occurrences, cross-sections, geotechnical test data, geomorphology, and ground-water hydrology. Soil properties and soil conditions such as type, age, texture, color, and consistency, along with historical depths to ground water are used to identify, characterize, and correlate susceptible soils. Because Quaternary geologic mapping is based on similar soil observations, liquefaction susceptibility maps typically are similar to Quaternary geologic maps. DMG's qualitative susceptible soil inventory is summarized on Table 1.2.

Geologic Map Unit	Sediment Type	Environment of Deposition	Consistency	Susceptible to Liquefaction?*
Qw	Clayey sand, silty sand, and sand	Active stream channels	Loose	Yes**
Qf,	Clay, clayey silt, and clayey sand	Alluvial fans	Loose	Yes**
Qyf1-2, Qya1-2,	Clay, clayey silt and clayey sand	Alluvium	Loose to moderately dense	Yes**
Qc	Clay, silt, and cobbles	Colluvium	Soft to firm	Low likelihood
Qoa, Qof, Qoc	Clay, silt, sand, gravel	Older alluvium, alluvial fan, and colluvium deposits	Dense to very dense	Not likely

* When saturated.
** Depending on clay content

Table 1.2. General Geotechnical Characteristics and Liquefaction Susceptibility of Quaternary Sedimentary Units in the Thousand Oaks Quadrangle.

LIQUEFACTION OPPORTUNITY

Liquefaction opportunity is a measure, expressed in probabilistic terms, of the potential for strong ground shaking. Analyses of in-situ liquefaction resistance require assessment of liquefaction opportunity. The minimum level of seismic excitation to be used for such purposes is the level of peak ground acceleration (PGA) with a 10% probability of exceedance over a 50-year period (DOC, 2000). The earthquake magnitude used in DMG's analysis is the magnitude that contributes most to the calculated PGA for an area.

For the Thousand Oaks Quadrangle, PGAs ranging between 0.43 and 0.48 g, resulting from an earthquake of magnitude 7.3, were used for liquefaction analyses. The PGA and magnitude values were based on de-aggregation of the probabilistic hazard at the 10% in 50-year hazard level (Petersen and others, 1996; Cramer and Petersen, 1996). See the ground motion section (3) of this report for further details.

Quantitative Liquefaction Analysis

DMG performs quantitative analysis of geotechnical data to evaluate liquefaction potential using the Seed-Idriss Simplified Procedure (Seed and Idriss, 1971; Seed and others, 1983; National Research Council, 1985; Seed and others, 1985; Seed and Harder, 1990; Youd and Idriss, 1997). Using the Seed-Idriss Simplified Procedure one can calculate soil resistance to liquefaction, expressed in terms of cyclic resistance ratio (CRR), based on SPT results, ground-water level, soil density, moisture content, soil type, and sample depth. CRR values are then compared to calculated earthquake-generated shear stresses expressed in terms of cyclic stress ratio (CSR). The Seed-Idriss

Simplified Procedure requires normalizing earthquake loading relative to a M7.5 event for the liquefaction analysis. To accomplish this, DMG's analysis uses the Idriss magnitude scaling factor (MSF) (Youd and Idriss, 1997). It is convenient to think in terms of a factor of safety (FS) relative to liquefaction, where: FS = (CRR / CSR) * MSF. FS, therefore, is a quantitative measure of liquefaction potential. DMG uses a factor of safety of 1.0 or less, where CSR equals or exceeds CRR, to indicate the presence of potentially liquefiable soil. While an FS of 1.0 is considered the "trigger" for liquefaction, for a site specific analysis an FS of as much as 1.5 may be appropriate depending on the vulnerability of the site and related structures. The DMG liquefaction analysis program calculates an FS for each geotechnical sample for which blow counts were collected. Typically, multiple samples are collected for each borehole. The lowest FS in each borehole is used for that location. FS values vary in reliability according to the quality of the geotechnical data used in their calculation. FS, as well as other considerations such as slope, presence of free faces, and thickness and depth of potentially liquefiable soil, are evaluated in order to construct liquefaction potential maps, which are then used to make a map showing zones of required investigation.

Of the 175 geotechnical borehole logs reviewed in this study (Plate 1.2), 102 include blow-count data from SPTs or from penetration tests that allow reasonable blow count translations to SPT-equivalent values. Non-SPT values, such as those resulting from the use of 2-inch or 2½-inch inside-diameter ring samplers, were translated to SPT-equivalent values if reasonable factors could be used in conversion calculations. The reliability of the SPT-equivalent values varies. Therefore, they are weighted and used in a more qualitative manner. Few borehole logs, however, include all of the information (e.g. soil density, moisture content, sieve analysis, etc.) required for an ideal Seed-Idriss Simplified Procedure. For boreholes having acceptable penetration tests, liquefaction analysis is performed using recorded density, moisture, and sieve test values or using averaged test values of similar materials.

The Seed-Idriss Simplified Procedure for liquefaction evaluation was developed primarily for clean sand and silty sand. As described above, results depend greatly on accurate evaluation of in-situ soil density as measured by the number of soil penetration blow counts using an SPT sampler. However, many of the Holocene alluvial deposits in the study area contain a significant amount of gravel. In the past, gravelly soils were considered not to be susceptible to liquefaction because the high permeability of these soils presumably would allow the dissipation of pore pressures before liquefaction could occur. However, liquefaction in gravelly soils has been observed during earthquakes, and recent laboratory studies have shown that gravelly soils are susceptible to liquefaction (Ishihara, 1985; Harder and Seed, 1986; Budiman and Mohammadi, 1995; Evans and Zhou, 1995; and Sy and others, 1995). SPT-derived density measurements in gravelly soils are unreliable and generally too high. They are likely to lead to overestimation of the density of the soil and, therefore, result in an underestimation of the liquefaction susceptibility. To identify potentially liquefiable units where the N values appear to have been affected by gravel content, correlations were made with boreholes in the same unit where the N values do not appear to have been affected by gravel content.

LIQUEFACTION ZONES

Criteria for Zoning

Areas underlain by materials susceptible to liquefaction during an earthquake were included in liquefaction zones using criteria developed by the Seismic Hazards Mapping Act Advisory Committee and adopted by the SMGB (DOC, 2000). Under those guideline criteria, liquefaction zones are areas meeting one or more of the following:

1. Areas known to have experienced liquefaction during historical earthquakes

2. All areas of uncompacted artificial fill containing liquefaction-susceptible material that are saturated, nearly saturated, or may be expected to become saturated

3. Areas where sufficient existing geotechnical data and analyses indicate that the soils are potentially liquefiable

4. Areas where existing geotechnical data are insufficient

In areas of limited or no geotechnical data, susceptibility zones may be identified by geologic criteria as follows:

a) Areas containing soil deposits of late Holocene age (current river channels and their historic floodplains, marshes and estuaries), where the M7.5-weighted peak acceleration that has a 10% probability of being exceeded in 50 years is greater than or equal to 0.10 g and the water table is less than 40 feet below the ground surface; or

b) Areas containing soil deposits of Holocene age (less than 11,000 years), where the M7.5-weighted peak acceleration that has a 10% probability of being exceeded in 50 years is greater than or equal to 0.20 g and the historical high water table is less than or equal to 30 feet below the ground surface; or

c) Areas containing soil deposits of latest Pleistocene age (11,000 to 15,000 years), where the M7.5-weighted peak acceleration that has a 10% probability of being exceeded in 50 years is greater than or equal to 0.30 g and the historical high water table is less than or equal to 20 feet below the ground surface.

Application of SMGB criteria to liquefaction zoning in the Thousand Oaks Quadrangle is summarized below.

Areas of Past Liquefaction

No areas of documented historic liquefaction are known to have occurred in the Thousand Oaks Quadrangle. Neither have areas showing evidence of paleoseismic liquefaction been reported.

Artificial Fills

In the Thousand Oaks Quadrangle, artificial fill areas large enough to show at the scale of mapping (1:24000) consist of engineered fill for home development, elevated freeways, and reservoir dams. Since these fills are generally considered to be properly engineered, zoning for liquefaction in such areas depends on soil conditions in underlying strata.

Areas with Sufficient Existing Geotechnical Data

Geotechnical data obtained during this study are considered sufficient to zone liquefaction potential in those parts of the Thousand Oaks Quadrangle underlain by young Quaternary sedimentary deposits. These areas consist of Russell Valley (Westlake Village) and the canyons and stream valleys that cut through the Simi Hills and Santa Monica Mountains. Of these, only the stream valley occupied by Conejo Creek is found to contain loose, saturated, sandy beds that are zoned as being potentially liquefiable.

Areas with Insufficient Existing Geotechnical Data

It was necessary to apply SMGB criteria for zoning areas lacking sufficient geotechnical data to the short segment of the Cheeseboro Creek stream valley at the eastern edge of the quadrangle along U.S. Highway 101. The sediments deposited by the Creek are derived in large part from Palo Comado and Cheeseboro Canyons, which were zoned for liquefaction in the adjacent Calabasas Quadrangle. Similarly, Long Canyon and adjacent canyons along the northern margin of the quadrangle are zoned for liquefaction. These canyons extend north into the Simi Valley West Quadrangle where they were zoned for liquefaction.

Summary

Less than 10 percent of the Thousand Oaks Quadrangle is covered by young Quaternary alluvial deposits. Borehole log data indicate that alluvial sediments deposited in lowland basins, canyons, and stream valleys are generally dominated by plastic clay, clayey silt, and clayey sand. The abundant clay within these deposits is derived mainly from weathering products of the surrounding Miocene Conejo Volcanics and shale of the Miocene Modelo Formation. Overall potential for liquefaction in these areas is considered to be low. An exception is the northeast-trending, 500- to 1500-foot-wide stream valley occupied by Conejo Creek where several test borehole logs indicate the widespread occurrence of young loose sand and silty sand beds deposited in the uppermost 10 to 20 feet. Historical ground-water depths within the basin are estimated to be about 10 feet. The sand-rich sediments deposited within this stream valley are most likely derived from sandstone of the Cretaceous Chatsworth Formation and the, locally, sand-rich layers of the Topanga Formation exposed in the drainage basin of Conejo Creek. Based on geologic evaluation and analysis of test data, the young Quaternary alluvial deposits of the Conejo Creek stream valley are zoned as being potentially liquefiable.

A small alluviated area along Cheeseboro Creek at the eastern margin of the quadrangle is zoned for liquefacton using SMGB criteria for zoning areas lacking sufficient geotechnical data. The extension of these deposits in the adjacent Calabasas Quadrangle was similarly zoned by California Department of Conservation, Division of Mines and Geology. Likewise, several north-trending canyons and stream valleys at the northern boundary of the quadrangle that extend into the adjoining Simi Valley West Quadrangle are zoned for liquefaction. These alluvial deposits are also derived in part from sandstone of the Cretaceous Chatsworth Formation.

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SECTION 2
EARTHQUAKE-INDUCED LANDSLIDE EVALUATION REPORT

Earthquake-Induced Landslide Zones in the Thousand Oaks 7.5-Minute Quadrangle, Ventura and Los Angeles Counties, California

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PURPOSE

The Seismic Hazards Mapping Act (the Act) of 1990 (Public Resources Code, Chapter 7.8, Division 2) directs the California Department of Conservation (DOC), Division of Mines and Geology (DMG) to delineate Seismic Hazard Zones. The purpose of the Act is to reduce the threat to public health and safety and to minimize the loss of life and property by identifying and mitigating seismic hazards. Cities, counties, and state agencies are directed to use seismic hazard zone maps prepared by DMG in their land-use planning and permitting processes. The Act requires that site-specific geotechnical investigations be performed prior to permitting most urban development projects within the hazard zones. Evaluation and mitigation of seismic hazards are to be conducted under guidelines established by the California State Mining and Geology Board (DOC, 1997; also available on the Internet at http://gmw.consrv.ca.gov/shmp/webdocs/sp117.pdf).

This section of the evaluation report summarizes seismic hazard zone mapping for earthquake-induced landslides in the Thousand Oaks 7.5-minute Quadrangle. This section, along with Section 1 (addressing liquefaction), and Section 3 (addressing earthquake shaking), form a report that is one of a series that summarizes the preparation of seismic hazard zone maps within the state (Smith, 1996). Additional information on seismic hazard zone mapping in California can be accessed on DMG's Internet web page: http://www.conservation.ca.gov/CGS/index.htm.

BACKGROUND

Landslides triggered by earthquakes historically have been a significant cause of earthquake damage. In California, large earthquakes such as the 1971 San Fernando, 1989 Loma Prieta, and 1994 Northridge earthquakes triggered landslides that were responsible for destroying or damaging numerous structures, blocking major transportation corridors, and damaging life-line infrastructure. Areas that are most susceptible to earthquake-induced landslides are steep slopes in poorly cemented or highly fractured rocks, areas underlain by loose, weak soils, and areas on or adjacent to existing landslide deposits. These geologic and terrain conditions exist in many parts of California, including numerous hillside areas that have already been developed or are likely to be developed in the future. The opportunity for strong earthquake ground shaking is high in many parts of California because of the presence of numerous active faults. The combination of these factors constitutes a significant seismic hazard throughout much of California, including the hillside areas of the Thousand Oaks Quadrangle.

METHODS SUMMARY

The mapping of earthquake-induced landslide hazard zones presented in this report is based on the best available terrain, geologic, geotechnical, and seismological data. If unavailable or significantly outdated, new forms of these data were compiled or generated specifically for this project. The following were collected or generated for this evaluation:

- Digital terrain data were used to provide an up-to-date representation of slope gradient and slope aspect in the study area
- Geologic mapping was used to provide an accurate representation of the spatial distribution of geologic materials in the study area. In addition, a map of existing landslides, whether triggered by earthquakes or not, was prepared
- Geotechnical laboratory test data were collected and statistically analyzed to quantitatively characterize the strength properties and dynamic slope stability of geologic materials in the study area
- Seismological data in the form of DMG probabilistic shaking maps and catalogs of strong-motion records were used to characterize future earthquake shaking within the mapped area

The data collected for this evaluation were processed into a series of GIS layers using commercially available software. A slope stability analysis was performed using the Newmark method of analysis (Newmark, 1965), resulting in a map of landslide hazard potential. The earthquake-induced landslide hazard zone was derived from the landslide hazard potential map according to criteria developed in a DMG pilot study (McCrink and Real, 1996) and adopted by the State Mining and Geology Board (DOC, 2000).

SCOPE AND LIMITATIONS

The methodology used to make this map is based on earthquake ground-shaking estimates, geologic material-strength characteristics and slope gradient. These data are gathered from a variety of outside sources. Although the selection of data used in this evaluation was rigorous, the quality of the data is variable. The State of California and the Department of Conservation make no representations or warranties regarding the accuracy of the data gathered from outside sources.

Earthquake-induced landslide zone maps are intended to prompt more detailed, site-specific geotechnical investigations as required by the Act. As such, these zone maps identify areas where the potential for earthquake-induced landslides is relatively high.

Due to limitations in methodology, it should be noted that these zone maps do not necessarily capture all potential earthquake-induced landslide hazards. Earthquake-induced ground failures that are not addressed by this map include those associated with ridge-top spreading and shattered ridges. It should also be noted that no attempt has been made to map potential run-out areas of triggered landslides. It is possible that such run-out areas may extend beyond the zone boundaries. The potential for ground failure resulting from liquefaction-induced lateral spreading of alluvial materials, considered by some to be a form of landsliding, is not specifically addressed by the earthquake-induced landslide zone or this report. See Section 1, Liquefaction Evaluation Report for the Thousand Oaks Quadrangle, for more information on the delineation of liquefaction zones.

The remainder of this report describes in more detail the mapping data and processes used to prepare the earthquake-induced landslide zone map for the Thousand Oaks Quadrangle. The information is presented in two parts. Part I covers physiographic, geologic and engineering geologic conditions in the study area. Part II covers the preparation of landslide hazard potential and landslide zone maps.

PART I

PHYSIOGRAPHY

Study Area Location and Physiography

The Thousand Oaks Quadrangle covers approximately 62 square miles in southeastern Ventura and western Los Angeles counties. The project area is located about 35 miles west of the Los Angeles Civic Center and 28 miles east of Ventura and includes parts of the cities of Thousand Oaks, Simi Valley, Agoura Hills, and Westlake Village and the unincorporated communities of Oak Park and Lake Sherwood. The northern and central part of the quadrangle is dominated by hilly to mountainous terrain of the Simi Hills and Mountclef Ridge. Within and surrounding the Simi Hills are areas where erosion has produced gently sloping mountain valleys and dissected lowlands containing small hills and knobs of bedrock. The steeper mountainous areas are cut by narrow canyons. The southernmost part of the quadrangle includes the gently sloping to flat-lying terrain of Russell Valley and the steep, rugged northern slopes of the Santa Monica Mountains, which form the southern boundary of the project area. Elevations range from 500 feet at the northwestern corner of the quadrangle to 2403 feet at Simi Peak. Major drainages in the area include Arroyo Conejo/Conejo Creek, which drains west into Conejo Valley, and Medea Creek and Triunfo Canyon, which drain south and southeast through the Santa Mountains into Malibu Creek.

U.S. Highway 101 and State Highway 23 are the major transportation routes through the project area. Primary access roads within the area include Thousand Oaks and Westlake boulevards, and Moorpark, Lindero Canyon, Kanan, and Olsen roads. Access to remote areas is provided by fire roads. Commercial development is concentrated in the low-lying areas along the major highways and streets. Residential development has spread from the lowland areas into the hills and mountains where extensive grading is on-going. Other current land uses include National parkland (Santa Monica Mountains National Recreation Area) in the Simi Hills and Santa Monica Mountains, regional parkland, golf courses, and several reservoirs.

Digital Terrain Data

The calculation of slope gradient is an essential part of the evaluation of slope stability under earthquake conditions. An accurate slope gradient calculation begins with an up-to-date map representation of the earth's surface. Within the Thousand Oaks Quadrangle, a Level 2 digital elevation model (DEM) was obtained from the USGS (U.S. Geological Survey, 1993). This DEM, which was prepared from the 7.5-minute quadrangle topographic contours that are based on 1947 aerial photography, has a 10-meter horizontal resolution and a 7.5-meter vertical accuracy.

To update the terrain data to reflect areas that have recently undergone large-scale grading, graded areas in the hilly portions of the Thousand Oaks Quadrangle were identified from NAPP 1994 aerial photographs. Terrain data for these areas were obtained from an airborne interferometric radar (TOPSAR) DEM flown and processed in August 1994 by NASA's Jet Propulsion Laboratory (JPL), and processed by Calgis, Inc. (GeoSAR Consortium, 1995; 1996). The terrain data were also smoothed and filtered prior to analysis. Plate 2.2 shows the area where the topography is updated to 1994 grading conditions.

A slope map was made from the DEMs using a third-order, finite difference, center-weighted algorithm (Horn, 1981). The DEM was also used to make a slope aspect map. The manner in which the slope and aspect maps were used to prepare the zone map will be described in subsequent sections of this report.

GEOLOGY

Bedrock and Surficial Geology

A recently compiled U.S. Geological Survey (USGS) geologic map (Yerkes and Showalter, 1991) was obtained in digital form (Yerkes, 1995) for the Thousand Oaks Quadrangle. Landslide deposits were deleted from the digital map so that the distribution of bedrock formations and the landslide inventory would exist on separate layers for the hazard analysis. The bedrock geology was modified to include more detail and reflect more recent mapping. DMG staff then merged the bedrock contacts on this map with a digital Quaternary geologic map prepared by William Lettis and Associates (1999). The contacts between bedrock and Quaternary surficial deposits on the merged map were then modified based on air-photo interpretation and field reconnaissance by DMG. In the field, observations were made of exposures, aspects of weathering, and general surface expression of the geologic units. In addition, the relation of the various geologic units to development and abundance of landslides was noted.

The oldest geologic unit mapped in the Thousand Oaks Quadrangle is the Upper Cretaceous Chatsworth Formation (Kc), which forms spectacular tilted outcrops in the northeast quarter of the quadrangle in the Simi Hills. The Chatsworth Formation consists of well-cemented, thick-bedded, arkosic marine sandstone and minor conglomerate interbedded with thin-bedded siltstone and mudstone.

The Chatsworth Formation is overlain by a sequence of lower Tertiary marine and non-marine clastic rocks, which crop out on the northern flank of the Simi Hills. The lower part of this sequence includes the Paleocene Simi Conglomerate (Tsc), a non-marine to marine pebble-cobble conglomerate with discontinuous sandstone lenses, and the Las Virgenes Sandstone (Tlv), a non-marine, weakly to moderately indurated sandstone and mudstone. Overlying these strata are the upper Paleocene to lower Eocene Santa Susana Formation (Tss), which consists of marine sandstone, siltstone, conglomerate, fossiliferous concretionary sandstone, and shell-hash beds, and the lower to middle Eocene Llajas Formation (Tl), composed of marine silty sandstone and siltstone and non-marine to shallow-marine conglomerate. The Llajas Formation is overlain by the upper Eocene to lower Miocene Sespe Formation (Ts) at the northern edge of the map area. The Sespe Formation consists of non-marine pebble-cobble conglomerate, massive to thick-bedded sandstone, and thin-bedded siltstone and claystone.

The north-dipping Upper Cretaceous through lower Miocene strata that form the Simi Hills are overlapped on the west and south by volcanic and marine clastic rocks of the middle Miocene Topanga Group and deep-marine clastic and biogenic rocks of the upper Miocene Modelo Formation. For the purposes of this study, the sedimentary rocks of the Topanga Group were informally divided into a unit that is predominantly conglomerate and sandstone (Ttc1) and a unit that is predominantly siltstone and claystone with minor sandstone (Ttc2). These sedimentary rocks are interlayered with and/or intruded by volcanic rocks of the Conejo Volcanics (Tc, undifferentiated; Tcbb, basalt/andesite flows; Tcab, andesite-dacite breccias; and Ti, basaltic/andesitic/dacitic dikes and sills). Conejo Volcanics form the steep northern flank of the Santa Monica Mountains in the southern part of the quadrangle and the hilly to mountainous terrain of Mountclef Ridge in the northwest corner of the map area. The Modelo Formation (Tm) is exposed as an arcuate band that cuts diagonally across the area from northwest to southeast and is composed of resistant siliceous shale and calcareous shale, clay shale, diatomaceous shale, siltstone, and minor sandstone.

Quaternary surficial deposits cover the floor and margins of small valleys and relatively low-lying areas in the Thousand Oaks Quadrangle and are also present in the larger canyons that drain the Simi Hills and Santa Monica Mountains. These Pleistocene to Holocene sediments consist of older and younger alluvial-fan and valley deposits, older and younger colluvium, active alluvial fans, and active stream deposits (Qoa, Qof, Qyf, Qoc, Qc, Qf, and Qw). Landslides are widespread in the central portion of the Thousand Oaks Quadrangle, primarily in the tightly folded weaker members of the Modelo Formation. Landslides also occur in the other fine-grained Tertiary sedimentary units, especially where bedding planes are inclined in the same direction as the slope (a dip slope). Landslide deposits are not shown on the bedrock/Quaternary geologic map, but are included on a separate landslide inventory map (Plate 2.1). A more detailed discussion of the Quaternary deposits in the Thousand Oaks Quadrangle can be found in Section 1.

Landslide Inventory

The evaluation of earthquake-induced landsliding requires an up-to-date and complete picture of the previous occurrence of landsliding. An inventory of existing landslides in the Thousand Oaks Quadrangle was prepared (Irvine, unpublished) by using previous work done in the area (Irvine, 1990 and Weber, 1984) and by combining field observations, analysis of aerial photos, and interpretation of landforms on current and older topographic maps. The aerial photos that were used for landslide interpretation are listed under Air Photos in References. Also consulted during the mapping process were the following maps and reports that contain geologic and landslide data: Dibblee (1993); Fugro West (2000); Harp and Jibson (1995); Parker (1985); Squires (1983); Stoney Miller Consultants (2000a and b); Weber and Wills (1983); and Weber and others (1973).

Landslides were mapped and digitized at a scale of 1:24,000. For each landslide included on the map a number of characteristics (attributes) were compiled. These characteristics include the confidence of interpretation (definite, probable and questionable) and other properties, such as activity, thickness, and associated geologic unit(s). Landslides rated as definite and probable were carried into the slope stability analysis. Landslides rated as questionable were not carried into the slope stability analysis due to the uncertainty of their existence. All landslides on the digital geologic map (Yerkes, 1995) were verified or re-mapped during preparation of the inventory map. To keep the landslide inventory of consistent quality, all landslides originally depicted on the digitized geologic map were deleted, and only those included in the final DMG inventory were incorporated into the hazard-evaluation process. A version of this landslide inventory is included with Plate 2.1.

ENGINEERING GEOLOGY

Geologic Material Strength

To evaluate the stability of geologic materials under earthquake conditions, the geologic map units described above were ranked and grouped on the basis of their shear strength. Generally, the primary source for rock shear-strength measurements is geotechnical reports prepared by consultants on file with local government permitting departments. Shear-strength data for the rock units identified on the Thousand Oaks Quadrangle geologic map were obtained from the City of Thousand Oaks (see Appendix A). The locations of rock and soil samples taken for shear testing by consultants are shown on Plate 2.1. When available, shear tests from adjacent quadrangles were used to augment data for geologic formations that had little or no shear test information.

Within the Thousand Oaks Quadrangle, no shear tests were available for Tcab, Tcbb, Tcvb, Ti, Tl, Tlv, Tms, Ts, and Tss. Shear test data for Tms from the Calabasas Quadrangle, for Ts from the Moorpark Quadrangle, and Tcvb from the Newbury Park Quadrangle were used to assign these units to existing strength groups. Additional shear tests for Kc from the Calabasas Quadrangle, and for Qoa, Qya1, Tc, Tm, Ttc1 and Ttc2 from the Newbury Park Quadrangle were used. Tcab, Tcbb, Ti, Tl, Tlv, Tsc, and Tss were added to existing groups on the basis of lithologic and stratigraphic similarities.

Shear strength data gathered from the above sources were compiled for each geologic map unit. Geologic units were grouped on the basis of average angle of internal friction (average phi) and lithologic character. Average (mean and median) phi values for each geologic map unit and corresponding strength group are summarized in Table 2.1. For most of the geologic strength groups in the map area, a single shear strength value was assigned and used in our slope stability analysis. A geologic material strength map was made based on the groupings presented in Tables 2.1 and 2.2, and this map provides a spatial representation of material strength for use in the slope stability analysis.

Adverse Bedding Conditions

Adverse bedding conditions are an important consideration in slope stability analyses. Adverse bedding conditions occur where the dip direction of bedded sedimentary rocks is roughly the same as the slope aspect, and where the dip magnitude is less than the slope gradient. Under these conditions, landslides can slip along bedding surfaces due to a lack of lateral support.

To account for adverse bedding in our slope stability evaluation, we used geologic structural data in combination with digital terrain data to identify areas with potentially adverse bedding, using methods similar to those of Brabb (1983). The structural data, derived from the geologic map database, was used to categorize areas of common bedding dip direction and magnitude. The dip direction was then compared to the slope aspect and, if the same, the dip magnitude and slope gradient categories were compared. If the dip magnitude was less than or equal to the slope gradient category but greater than 25% (4:1 slope), the area was marked as a potential adverse bedding area.

The formations, which contain interbedded sandstone and shale, were subdivided based on shear strength differences between coarse-grained (higher strength) and fine-grained (lower strength) lithologies. Shear strength values for the fine- and coarse-grained lithologies were then applied to areas of favorable and adverse bedding orientation, which were determined from structural and terrain data as discussed above. It was assumed that coarse-grained material (higher strength) dominates where bedding dips into a slope (favorable bedding) while fine-grained (lower strength) material dominates where bedding dips out of a slope (adverse bedding). The geologic material strength map was modified by assigning the lower, fine-grained shear strength values to areas where potential adverse bedding conditions were identified. The favorable and adverse bedding shear strength parameters for the formations are included in Table 2.1.

Existing Landslides

The strength characteristics of existing landslides (Qls) must be based on tests of the materials along the landslide slip surface. Ideally, shear tests of slip surfaces formed in each mapped geologic unit would be used. However, this amount of information is rarely available, and for the preparation of the earthquake-induced landslide zone map it has been assumed that all landslides within the quadrangle have the same slip surface strength parameters. We collect and use primarily "residual" strength parameters from laboratory tests of slip surface materials tested in direct shear or ring shear test equipment. Back-calculated strength parameters, if the calculations appear to have been performed appropriately, have also been used.

The results of the grouping of geologic materials in the Thousand Oaks Quadrangle are in Tables 2.1 and 2.2.

THOUSAND OAKS QUADRANGLE
SHEAR STRENGTH GROUPS

	Formation Name	Number Tests	Mean/Median Phi (deg)	Mean/Median Group Phi (deg)	Mean/Median Group C (psf)	No Data: Similar Lithology	Phi Values Used in Stability Analyses
GROUP 1	Tm(fbc)	23	40/39	36	433	Tcbb, Ti	36
	Tcvb	13	38/37			Tsc, Tcab	
	Tc	24	35/35				
	Ttc1	23	34/35				
GROUP 2	Kc(fbc)	45	33/35	33	591	Tl(fbc)	33
	Ts(fbc)	13	32/33			Tlv	
	Ttc2	17	33/31			Tss(fbc)	
	Tms	12	32/34				
GROUP 3	Kc(abc)	18	27/30	29	476	af	29
	Qoa	34	30/28			Qoc?	
	Qof	1	31				
	Tm(abc)	34	30				
GROUP 4	Qya1	10	24/25	25	530	Qc, Qc?, Qc/Qya1	25
	Ts(abc)	5	24/25			Qf, Qya2, Qyf2	
						Qw, Tl(abc)	
						Tss(abc)	
GROUP 5	Qls			10		Qls	10

abc = adverse bedding condition, fine-grained material strength
fbc = favorable bedding condition, coarse-grained material strength

Table 2.1. Summary of the Shear Strength Statistics for the Thousand Oaks Quadrangle.

SHEAR STRENGTH GROUPS FOR THE THOUSAND OAKS QUADRANGLE				
GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5
Tc	Kc(fbc)	af	Qc	Qls
Tc?	Tl(fbc)	Kc(abc)	Qc?	
Tcab	Tlv	Qoa	Qc/Qya1	
Tcbb	Tms	Qoc?	Qf	
Tcvb	Ts(fbc)	Qof	Qya1	
Ti	Tss(fbc)	Tm(abc)	Qya2	
Tm(fbc)	Ttc2		Qyf2	
Tsc			Qw	
Ttc1			Tl(abc)	
			Ts(abc)	
			Tss(abc)	

Table 2.2. Summary of the Shear Strength Groups for the Thousand Oaks Quadrangle.

PART II

EARTHQUAKE-INDUCED LANDSLIDE HAZARD POTENTIAL

Design Strong-Motion Record

To evaluate earthquake-induced landslide hazard potential in the study area, a method of dynamic slope stability analysis developed by Newmark (1965) was used. The Newmark method analyzes dynamic slope stability by calculating the cumulative down-slope displacement for a given earthquake strong-motion time history. As implemented for the preparation of earthquake-induced landslide zones, the Newmark method necessitates the selection of a design earthquake strong-motion record to provide the "ground shaking opportunity." For the Thousand Oaks Quadrangle, selection of a strong motion record was based on an estimation of probabilistic ground motion parameters for modal magnitude, modal distance, and peak ground acceleration (PGA). The parameters were estimated from maps prepared by DMG for a 10% probability of being exceeded in 50 years (Petersen and others, 1996). The parameters used in the record selection are:

Modal Magnitude:	6.9 to 7.3
Modal Distance:	3.3 to 7.5 km
PGA:	0.43 to 0.60 g

The strong-motion record selected for the slope stability analysis in the Thousand Oaks Quadrangle was the Corralitos record from the magnitude 6.9 (M_w) 1989 Loma Prieta earthquake (Shakal and others, 1989). This record had a source to recording site distance of 5.1 km and a peak ground acceleration (PGA) of 0.64 g. The selected strong-motion record was not scaled or otherwise modified prior to its use in the analysis.

Displacement Calculation

The design strong-motion record was used to develop a relationship between landslide displacement and yield acceleration (a_y), defined as the earthquake horizontal ground acceleration above which landslide displacements take place. This relationship was prepared by integrating the design strong-motion record twice for a given acceleration value to find the corresponding displacement, and the process was repeated for a range of acceleration values (Jibson, 1993). The resulting curve in Figure 2.1 represents the full spectrum of displacements that can be expected for the design strong-motion record. This curve provides the required link between anticipated earthquake shaking and estimates of displacement for different combinations of geologic materials and slope gradient, as described in the Slope Stability Analysis section below.

The amount of displacement predicted by the Newmark analysis provides an indication of the relative amount of damage that could be caused by earthquake-induced landsliding. Displacements of 30, 15 and 5 cm were used as criteria for rating levels of earthquake-induced landslide hazard potential based on the work of Youd (1980), Wilson and Keefer (1983), and a DMG pilot study for earthquake-induced landslides (McCrink and Real, 1996). Applied to the curve in Figure 2.1, these displacements correspond to yield accelerations of 0.086, 0.133 and 0.234g. Because these yield acceleration values are derived from the design strong-motion record, they represent the ground shaking opportunity thresholds that are significant in the Thousand Oaks Quadrangle.

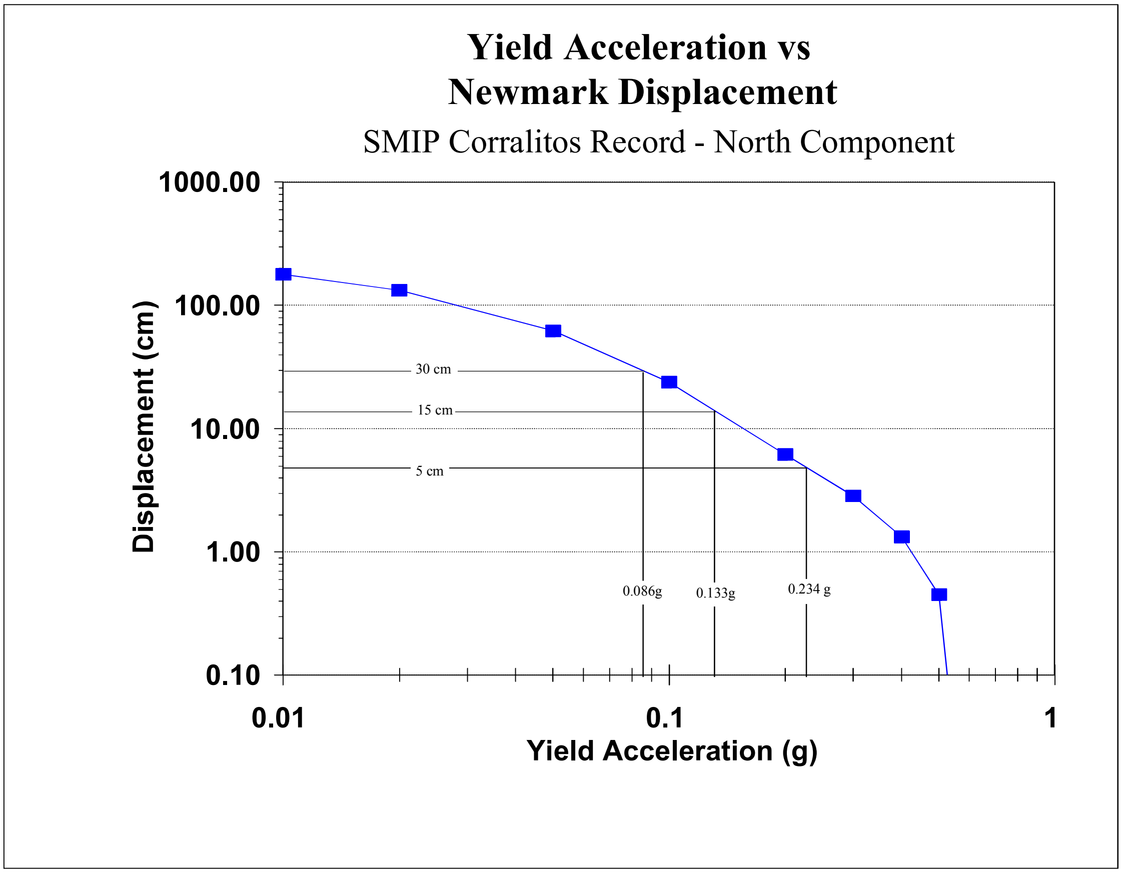

Figure 2.1. Yield Acceleration vs. Newmark Displacement for the 1989 Loma Prieta Earthquake Corralitos Record. Record from California Strong Motion Instrumentation Program (CSMIP) Station 57007.

Slope Stability Analysis

A slope stability analysis was performed for each geologic material strength group at slope increments of 1 degree. An infinite-slope failure model under unsaturated slope conditions was assumed. A factor of safety was calculated first, followed by the calculation of yield acceleration from Newmark's equation:

$$a_y = (FS - 1)g \sin \alpha$$

where FS is the Factor of Safety, g is the acceleration due to gravity, and α is the direction of movement of the slide mass, in degrees measured from the horizontal, when displacement is initiated (Newmark, 1965). For an infinite slope failure α is the same as the slope angle.

The yield accelerations resulting from Newmark's equations represent the susceptibility to earthquake-induced failure of each geologic material strength group for a range of slope gradients. Based on the relationship between yield acceleration and Newmark displacement shown in Figure 2.1, hazard potentials were assigned as follows:

1. If the calculated yield acceleration was less than 0.086g, Newmark displacement greater than 30 cm is indicated, and a HIGH hazard potential was assigned (H on Table 2.3)

2. If the calculated yield acceleration fell between 0.086g and 0.133g, Newmark displacement between 15 cm and 30 cm is indicated, and a MODERATE hazard potential was assigned (M on Table 2.3)

3. If the calculated yield acceleration fell between 0.133g and 0.234g, Newmark displacement between 5 cm and 15 cm is indicated, and a LOW hazard potential was assigned (L on Table 2.3)

4. If the calculated yield acceleration was greater than 0.234g, Newmark displacement of less than 5 cm is indicated, and a VERY LOW potential was assigned (VL on Table 2.3)

Table 2.3 summarizes the results of the stability analyses. The earthquake-induced landslide hazard potential map was prepared by combining the geologic material-strength map and the slope map according to this table.

THOUSAND OAKS QUADRANGLE HAZARD POTENTIAL MATRIX

Geologic Material Group	MEAN PHI	SLOPE CATEGORY (% SLOPE) I 0-23	II 23-32	III 32-36	IV 36-40	V 40-46	VI 46-49	VII 49-55	VIII 55-58	IX 58-68	X >68
1	36	VL	VL	VL	VL	VL	VL	L	L	M	H
2	33	VL	VL	VL	VL	L	L	M	H	H	H
3	29	VL	VL	L	L	M	H	H	H	H	H
4	25	VL	L	M	H	H	H	H	H	H	H
5	10	M	H	H	H	H	H	H	H	H	H

Table 2.3. Hazard Potential Matrix for Earthquake-Induced Landslides in the Thousand Oaks Quadrangle. Shaded area indicates hazard potential levels included within the hazard zone. H = High, M = Moderate, L = Low, VL = Very Low.

EARTHQUAKE-INDUCED LANDSLIDE HAZARD ZONE

Criteria for Zoning

Earthquake-induced landslide zones were delineated using criteria adopted by the California State Mining and Geology Board (DOC, 2000). Under these criteria, earthquake-induced landslide hazard zones are defined as areas that meet one or both of the following conditions:

1. Areas that have been identified as having experienced landslide movement in the past, including all mappable landslide deposits and source areas as well as any landslide that is known to have been triggered by historic earthquake activity.

2. Areas where the geologic and geotechnical data and analyses indicate that the earth materials may be susceptible to earthquake-induced slope failure.

These conditions are discussed in further detail in the following sections.

Existing Landslides

Existing landslides typically consist of disrupted soils and rock materials that are generally weaker than adjacent undisturbed rock and soil materials. Previous studies indicate that existing landslides can be reactivated by earthquake movements (Keefer, 1984). Earthquake-triggered movement of existing landslides is most pronounced in steep head scarp areas and at the toe of existing landslide deposits. Although reactivation of deep-seated landslide deposits is less common (Keefer, 1984), a significant number of deep-seated landslide movements have occurred during, or soon after, several recent earthquakes. Based on these observations, all existing landslides with a definite or probable confidence rating are included within the earthquake-induced landslide hazard zone.

No earthquake-triggered landslides had been identified in the Thousand Oaks Quadrangle prior to the Northridge earthquake. The Northridge earthquake caused a number of relatively small, shallow slope failures in and adjacent to the Thousand Oaks Quadrangle (Harp and Jibson, 1995). Soil falls, debris falls, and debris slides occurred in poorly indurated or highly fractured sedimentary rock on steep slopes and along roadcuts. Seismic shaking also enhanced previously existing headscarps of massive bedrock landslides and created additional cracks on steep slopes and ridge tops. Landslides attributed to the Northridge earthquake covered approximately 20 acres of land in the quadrangle, which is less than ½ of 1 percent of the total area covered by the map. Of the area covered by these Northridge earthquake landslides, 76% falls within the area of the hazard zone based on a computer comparison of the zone map and the Harp and Jibson (1995) inventory.

Geologic and Geotechnical Analysis

Based on the conclusions of a pilot study performed by DMG (McCrink and Real, 1996), it has been concluded that earthquake-induced landslide hazard zones should encompass all areas that have a High, Moderate or Low level of hazard potential (see Table 2.3). This would include all areas where the analyses indicate earthquake displacements of 5 centimeters or greater. Areas with a Very Low hazard potential, indicating less than 5 centimeters displacement, are excluded from the zone.

As summarized in Table 2.3, all areas characterized by the following geologic strength group and slope gradient conditions are included in the earthquake-induced landslide hazard zone:

1. Geologic Strength Group 5 is included for all slope gradient categories. (Note: Geologic Strength Group 5 includes all mappable landslides with a definite or probable confidence rating).

2. Geologic Strength Group 4 is included for all slopes steeper than 23 percent.

3. Geologic Strength Group 3 is included for all slopes steeper than 32 percent.

4. Geologic Strength Group 2 is included for all slopes steeper than 40 percent.

5. Geologic Strength Group 1 is included for all slopes greater than 49 percent.

This results in approximately 18 percent of the quadrangle lying within the earthquake-induced landslide hazard zone for the Thousand Oaks Quadrangle.

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Fairchild Aerial Surveys, Inc.; Flight 9800; October 24, 1945; Frames 1-46 to 55, 1-67 to 77, 1-100 to 110, 1-134 to 144, 1-160 to 166, 15-1578 to 1581, 7-640 to 647, and 7-610 to 614; Black and White; Vertical; scale 1:14,400.

NASA (National Aeronautics and Space Administration) 04689; Flight 94-002-02; January 22, 1994; Frames 36-40, 41-44, 546-555, and 868-873; Black and White; Vertical; scale 1:15,000.

PACWAS (Pacific Western Aerial Surveys); Flight PW VEN6; September 29, 1988; Frames 42-47, 68-71, and 95-100; Color; Vertical; scale 1: 24,000.

PACWAS (Pacific Western Aerial Surveys); Flight PW VEN2; May 16, 1978; Frames 113-118 and 140-146; Color; Vertical; scale 1:24,000.

USDA (U.S. Department of Agriculture); Flight AXI; August 21,1959; Frames 10W-168 to 177, 11W-11 to 20, 11W-54 to 64, 11W-80 to 90, and 18W-42 to 51; Black and White; Vertical; scale 1:20,000.

APPENDIX A
SOURCE OF ROCK STRENGTH DATA

SOURCE	NUMBER OF TESTS SELECTED
City of Thousand Oaks	**192**
Ventura County	**18**
Calabasas Quadrangle	**62**
Total Number of Shear Tests	**272**

SECTION 3
GROUND SHAKING EVALUATION REPORT

Potential Ground Shaking in the Thousand Oaks 7.5-Minute Quadrangle, Ventura and Los Angeles Counties, California

By

Mark D. Petersen*, Chris H. Cramer*, Geoffrey A. Faneros, Charles R. Real, and Michael S. Reichle

California Department of Conservation
Division of Mines and Geology
***Formerly with DMG, now with U.S. Geological Survey**

PURPOSE

The Seismic Hazards Mapping Act (the Act) of 1990 (Public Resources Code, Chapter 7.8, Division 2) directs the California Department of Conservation (DOC), Division of Mines and Geology (DMG) to delineate Seismic Hazard Zones. The purpose of the Act is to reduce the threat to public health and safety and to minimize the loss of life and property by identifying and mitigating seismic hazards. Cities, counties, and state agencies are directed to use the Seismic Hazard Zone Maps in their land-use planning and permitting processes. The Act requires that site-specific geotechnical investigations be performed prior to permitting most urban development projects within the hazard zones. Evaluation and mitigation of seismic hazards are to be conducted under guidelines established by the California State Mining and Geology Board (DOC, 1997; also available on the Internet at http://gmw.consrv.ca.gov/shmp/webdocs/sp117.pdf).

This section of the evaluation report summarizes the ground motions used to evaluate liquefaction and earthquake-induced landslide potential for zoning purposes. Included are ground motion and related maps, a brief overview on how these maps were prepared, precautionary notes concerning their use, and related references. The maps provided herein are presented at a scale of approximately 1:150,000 (scale bar provided on maps), and show the full 7.5-minute quadrangle and portions of the adjacent eight quadrangles. They can be used to assist in the specification of earthquake loading conditions ***for the analysis of ground failure*** according to the "Simple Prescribed Parameter Value" method (SPPV) described in the site investigation guidelines (California Department of Conservation, 1997). Alternatively, they can be used as a basis for comparing levels of ground motion determined by other methods with the statewide standard.

This section and Sections 1 and 2 (addressing liquefaction and earthquake-induced landslide hazards) constitute a report series that summarizes development of seismic hazard zone maps in the state. Additional information on seismic hazard zone mapping in California can be accessed on DMG's Internet homepage: http://www.conservation.ca.gov/CGS/index.htm.

EARTHQUAKE HAZARD MODEL

The estimated ground shaking is derived from the statewide probabilistic seismic hazard evaluation released cooperatively by the California Department of Conservation, Division of Mines and Geology, and the U.S. Geological Survey (Petersen and others, 1996). That report documents an extensive 3-year effort to obtain consensus within the scientific community regarding fault parameters that characterize the seismic hazard in California. Fault sources included in the model were evaluated for long-term slip rate, maximum earthquake magnitude, and rupture geometry. These fault parameters, along with historical seismicity, were used to estimate return times of moderate to large earthquakes that contribute to the hazard.

The ground shaking levels are estimated for each of the sources included in the seismic source model using attenuation relations that relate earthquake shaking with magnitude, distance from the earthquake, and type of fault rupture (strike-slip, reverse, normal, or subduction). The published hazard evaluation of Petersen and others (1996) only considers uniform firm-rock site conditions. In this report, however, we extend the hazard analysis to include the hazard of exceeding peak horizontal ground acceleration (PGA) at 10% probability of exceedance in 50 years on spatially uniform conditions of rock, soft rock, and alluvium. These soil and rock conditions approximately correspond to site categories defined in Chapter 16 of the Uniform Building Code (ICBO, 1997), which are commonly found in California. We use the attenuation relations of Boore and others (1997), Campbell (1997), Sadigh and others (1997), and Youngs and others (1997) to calculate the ground motions.

The seismic hazard maps for ground shaking are produced by calculating the hazard at sites separated by about 5 km. Figures 3.1 through 3.3 show the hazard for PGA at 10% probability of exceedance in 50 years assuming the entire map area is firm rock, soft rock, or alluvial site conditions respectively. The sites where the hazard is calculated are represented as dots and ground motion contours as shaded regions. The quadrangle of interest is outlined by bold lines and centered on the map. Portions of the eight adjacent

THOUSAND OAKS 7.5 MINUTE QUADRANGLE AND PORTIONS OF ADJACENT QUADRANGLES

10% EXCEEDANCE IN 50 YEARS PEAK GROUND ACCELERATION (g)

1998

FIRM ROCK CONDITIONS

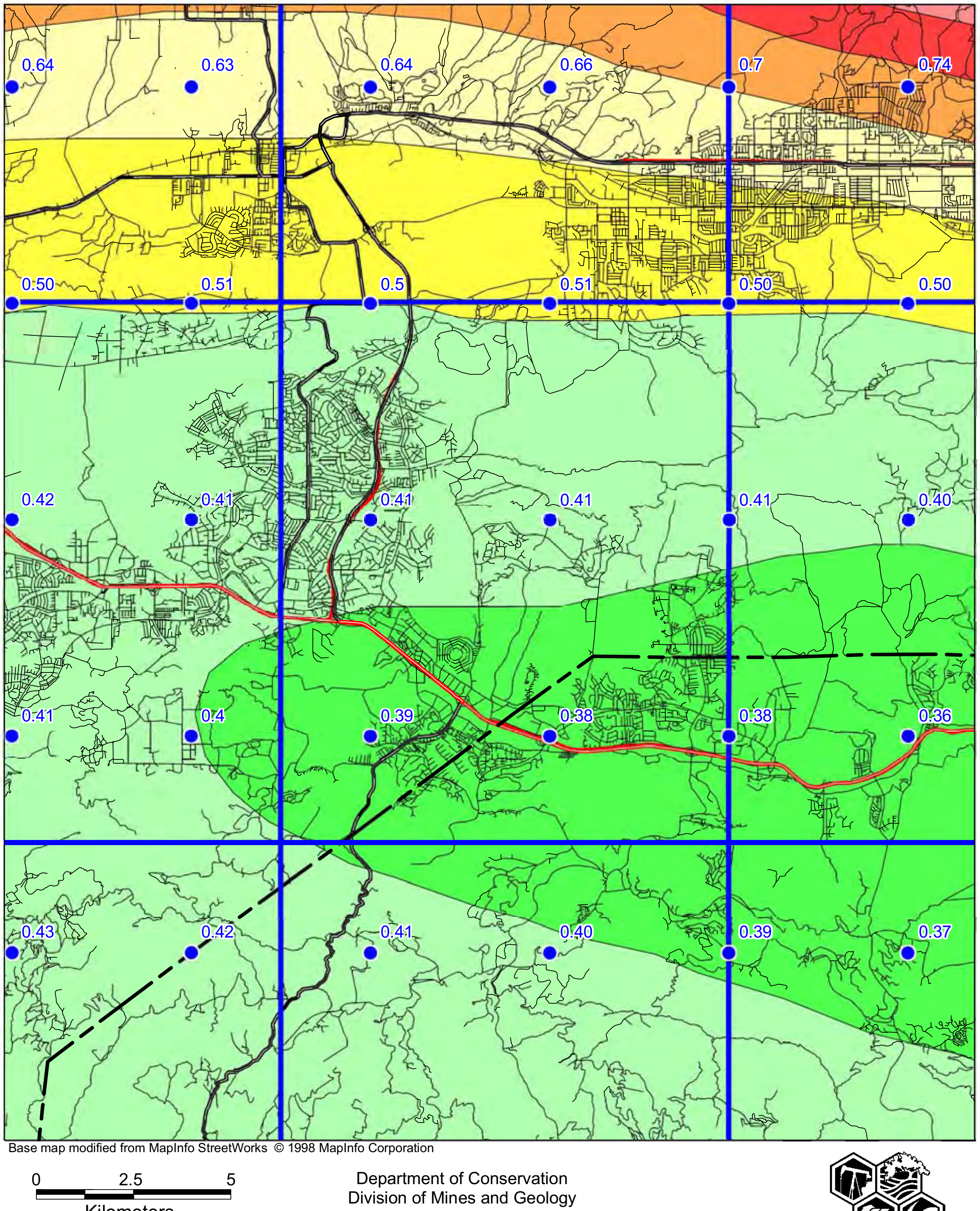

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Figure 3.1

THOUSAND OAKS 7.5 MINUTE QUADRANGLE AND PORTIONS OF ADJACENT QUADRANGLES

10% EXCEEDANCE IN 50 YEARS PEAK GROUND ACCELERATION (g)

1998

SOFT ROCK CONDITIONS

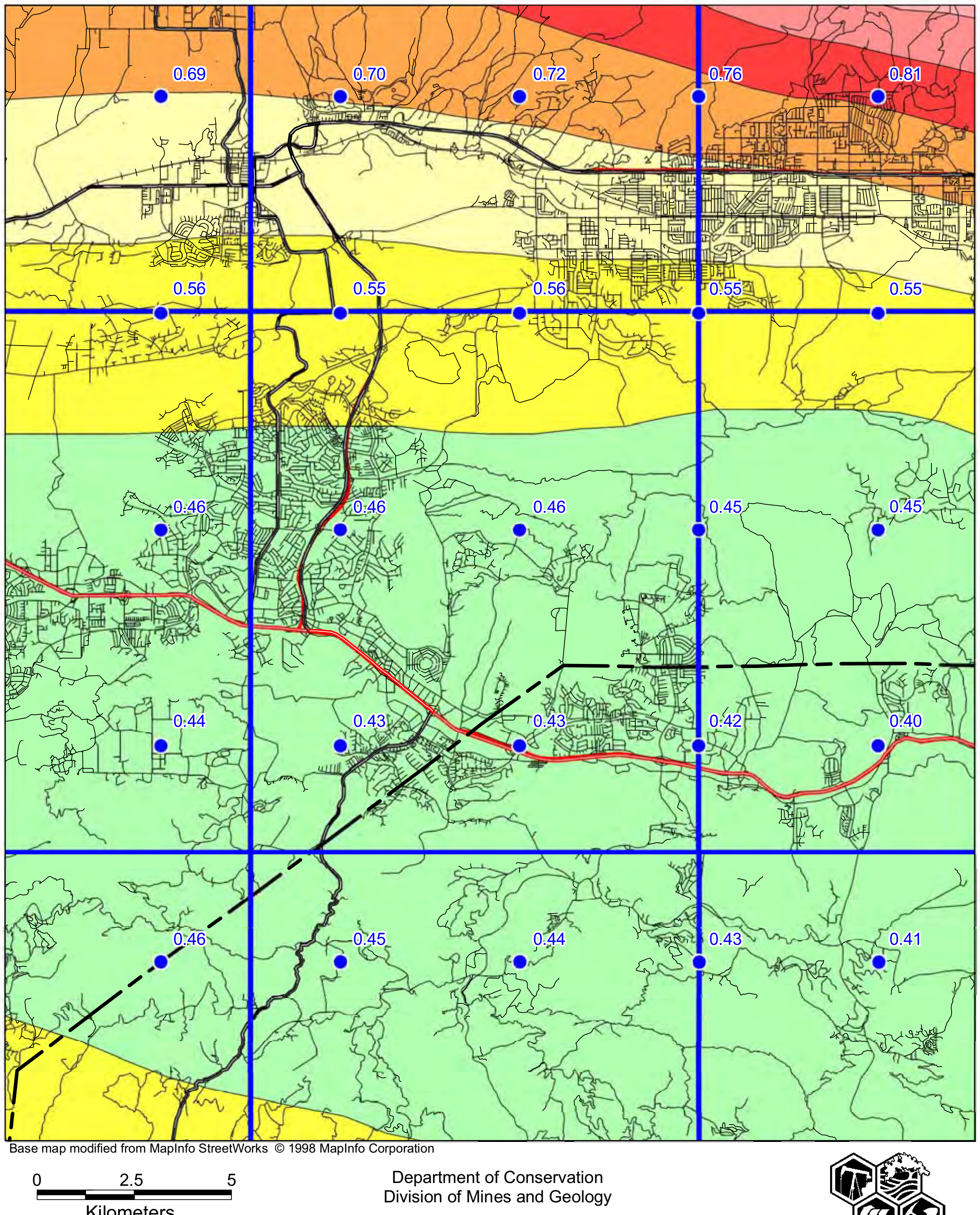

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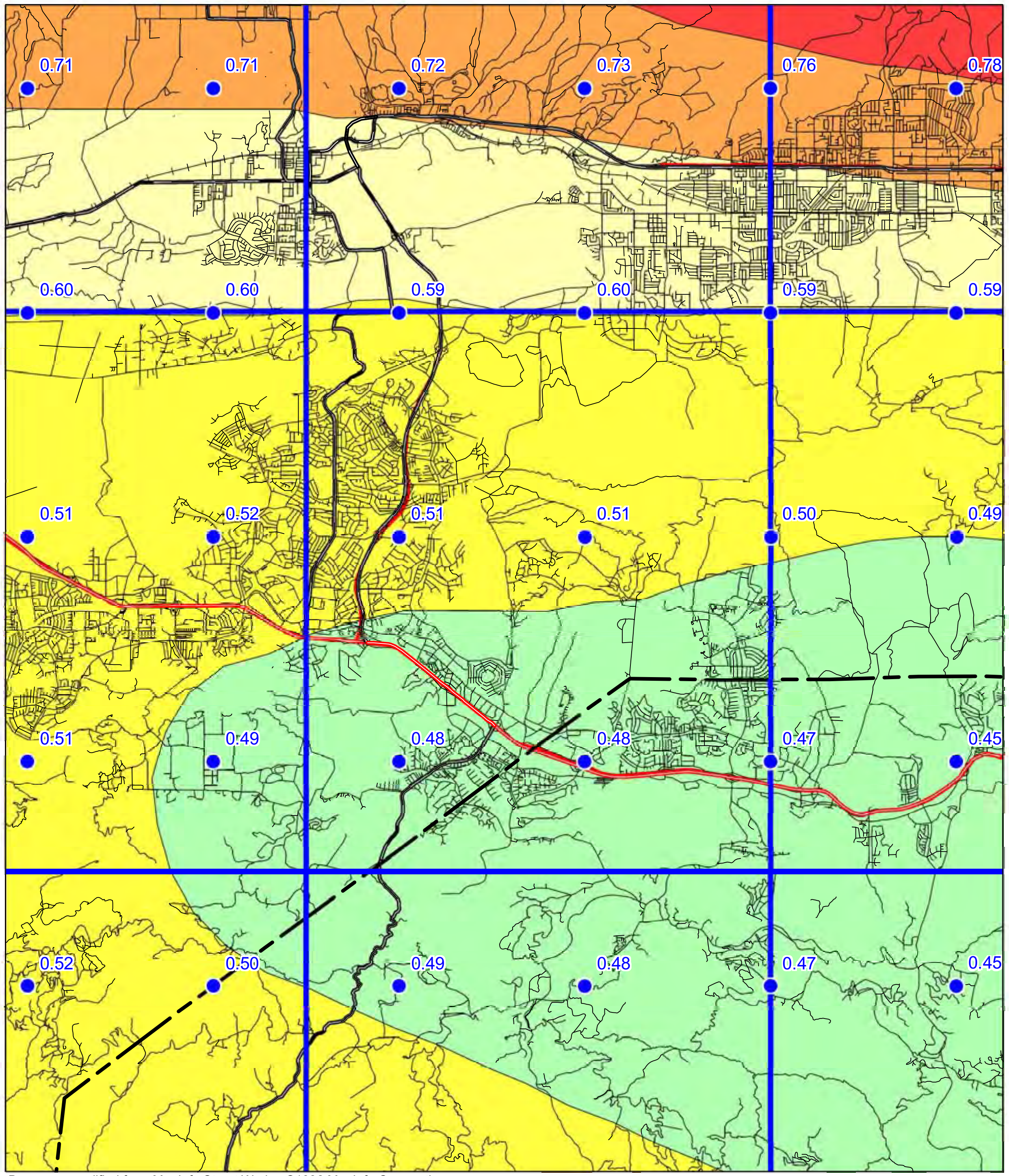
Figure 3.2

THOUSAND OAKS 7.5 MINUTE QUADRANGLE AND PORTIONS OF ADJACENT QUADRANGLES

10% EXCEEDANCE IN 50 YEARS PEAK GROUND ACCELERATION (g)

1998

ALLUVIUM CONDITIONS



Base map modified from MapInfo Street Works ©1998 MapInfo Corporation

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Division of Mines and Geology

Figure 3.3

quadrangles are also shown so that the trends in the ground motion may be more apparent. We recommend estimating ground motion values by selecting the map that matches the actual site conditions, and interpolating from the calculated values of PGA rather than the contours, since the points are more accurate.

APPLICATIONS FOR LIQUEFACTION AND LANDSLIDE HAZARD ASSESSMENTS

Deaggregation of the seismic hazard identifies the contribution of each of the earthquakes (various magnitudes and distances) in the model to the ground motion hazard for a particular exposure period (see Cramer and Petersen, 1996). The map in Figure 3.4 identifies the magnitude and the distance (value in parentheses) of the earthquake that contributes most to the hazard at 10% probability of exceedance in 50 years on alluvial site conditions (*predominant earthquake*). This information gives a rationale for selecting a seismic record or ground motion level in evaluating ground failure. However, it is important to keep in mind that more than one earthquake may contribute significantly to the hazard at a site, and those events can have markedly different magnitudes and distances. For liquefaction hazard the predominant earthquake magnitude from Figure 3.4 and PGA from Figure 3.3 (alluvium conditions) can be used with the Youd and Idriss (1997) approach to estimate cyclic stress ratio demand. For landslide hazard the predominant earthquake magnitude and distance can be used to select a seismic record that is consistent with the hazard for calculating the Newmark displacement (Wilson and Keefer, 1983). When selecting the predominant earthquake magnitude and distance, it is advisable to consider the range of values in the vicinity of the site and perform the ground failure analysis accordingly. This would yield a range in ground failure hazard from which recommendations appropriate to the specific project can be made. Grid values for predominant earthquake magnitude and distance should **not** be interpolated at the site location, because these parameters are not continuous functions.

A preferred method of using the probabilistic seismic hazard model and the “simplified Seed-Idriss method” of assessing liquefaction hazard is to apply magnitude scaling probabilistically while calculating peak ground acceleration for alluvium. The result is a “magnitude-weighted” ground motion (liquefaction opportunity) map that can be used directly in the calculation of the cyclic stress ratio threshold for liquefaction and for estimating the factor of safety against liquefaction (Youd and Idriss, 1997). This can provide a better estimate of liquefaction hazard than use of predominate magnitude described above, because all magnitudes contributing to the estimate are used to weight the probabilistic calculation of peak ground acceleration (Real and others, 2000). Thus, large distant earthquakes that occur less frequently but contribute *more* to the liquefaction hazard are appropriately accounted for.

Figure 3.5 shows the magnitude-weighted alluvial PGA based on Idriss’ weighting function (Youd and Idriss, 1997). It is important to note that the values obtained from this map are pseudo-accelerations and should be used in the formula for factor of safety without any magnitude-scaling (a factor of 1) applied.

THOUSAND OAKS 7.5 MINUTE QUADRANGLE AND PORTIONS OF ADJACENT QUADRANGLES

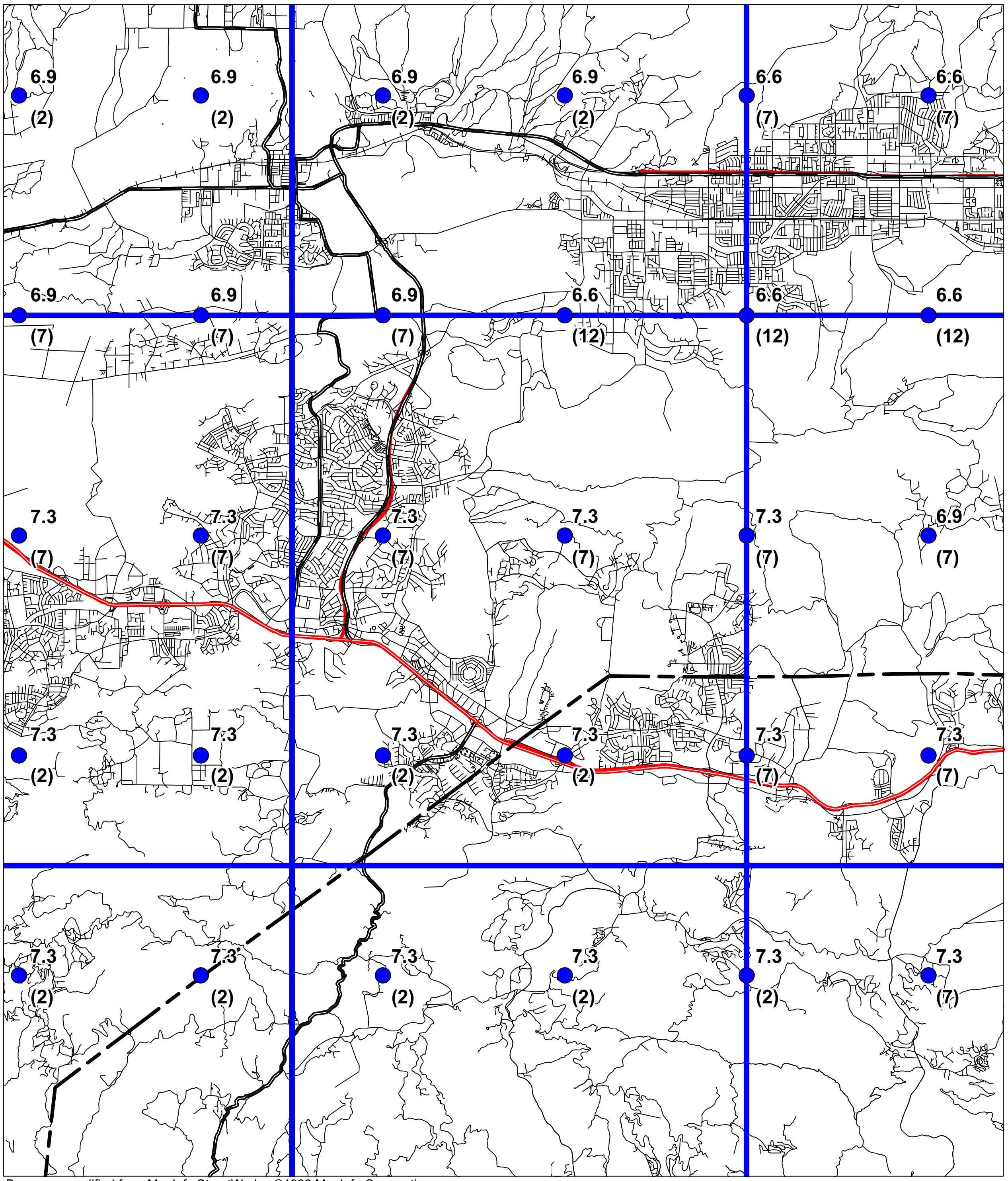
10% EXCEEDANCE IN 50 YEARS PEAK GROUND ACCELERATION

1998

PREDOMINANT EARTHQUAKE

Magnitude (Mw)

(Distance (km))



Base map modified from MapInfo StreetWorks ©1998 MapInfo Corporation

0 2.5 5
Kilometers

Department of Conservation
Division of Mines and Geology

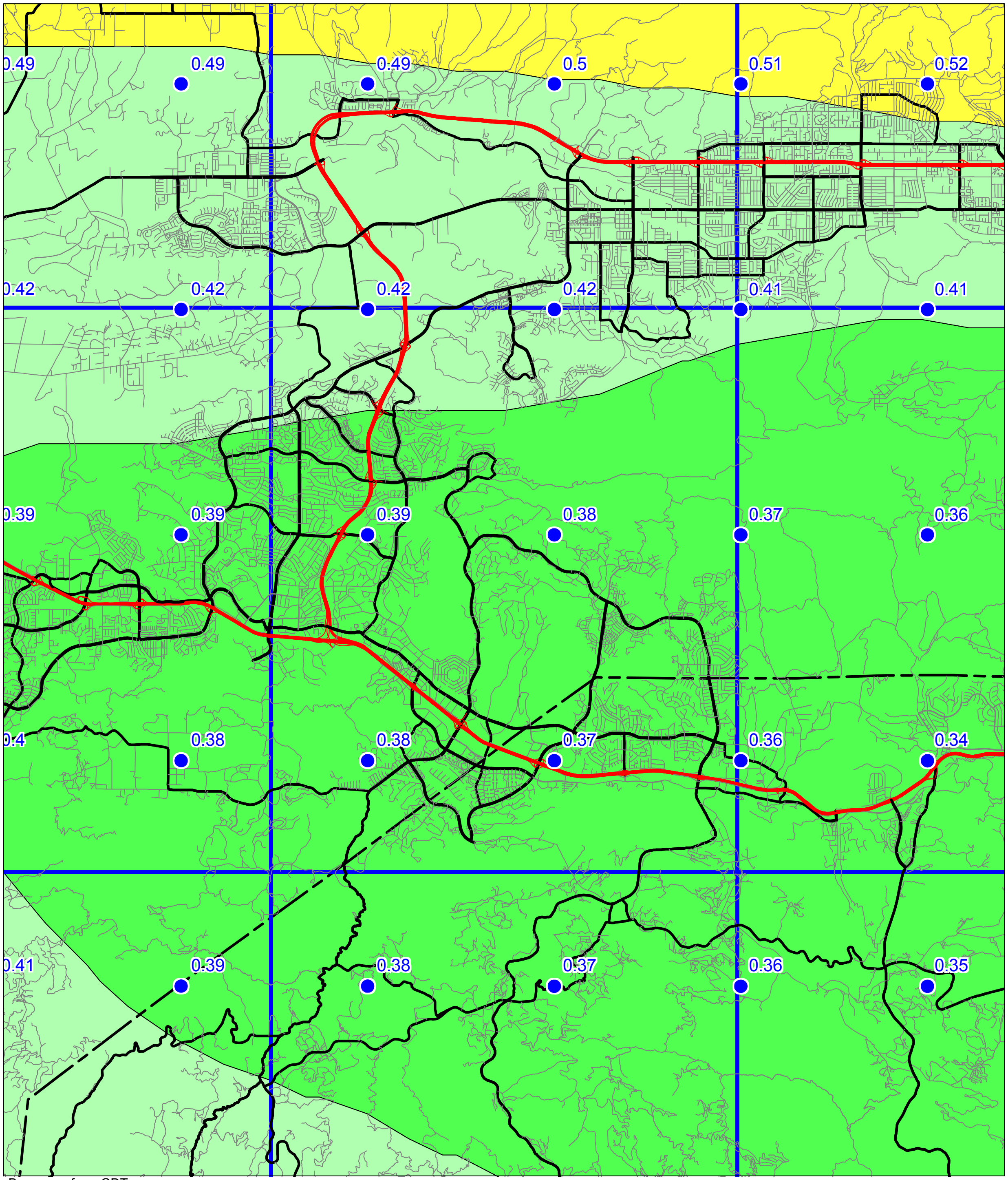
Figure 3.4

THOUSAND OAKS 7.5-MINUTE QUADRANGLE AND PORTIONS OF ADJACENT QUADRANGLES

10% EXCEEDANCE IN 50 YEARS MAGNITUDE-WEIGHTED PSEUDO-PEAK ACCELERATION (g) FOR ALLUVIUM

1998

LIQUEFACTION OPPORTUNITY



Base map from GDT

0 1.5 3
Miles

Department of Conservation
California Geological Survey

Figure 3.5

USE AND LIMITATIONS

The statewide map of seismic hazard has been developed using regional information and is ***not appropriate for site specific structural design applications***. Use of the ground motion maps prepared at larger scale is limited to estimating earthquake loading conditions for preliminary assessment of ground failure at a specific location. We recommend consideration of site-specific analyses before deciding on the sole use of these maps for several reasons.

1. The seismogenic sources used to generate the peak ground accelerations were digitized from the 1:750,000-scale fault activity map of Jennings (1994). Uncertainties in fault location are estimated to be about 1 to 2 kilometers (Petersen and others, 1996). Therefore, differences in the location of calculated hazard values may also differ by a similar amount. At a specific location, however, the log-linear attenuation of ground motion with distance renders hazard estimates less sensitive to uncertainties in source location.

2. The hazard was calculated on a grid at sites separated by about 5 km (0.05 degrees). Therefore, the calculated hazard may be located a couple kilometers away from the site. We have provided shaded contours on the maps to indicate regional trends of the hazard model. However, the contours only show regional trends that may not be apparent from points on a single map. Differences of up to 2 km have been observed between contours and individual ground acceleration values. *We recommend that the user interpolate PGA between the grid point values rather than simply using the shaded contours*.

3. Uncertainties in the hazard values have been estimated to be about +/- 50% of the ground motion value at two standard deviations (Cramer and others, 1996).

4. Not all active faults in California are included in this model. For example, faults that do not have documented slip rates are not included in the source model. Scientific research may identify active faults that have not been previously recognized. Therefore, future versions of the hazard model may include other faults and omit faults that are currently considered.

5. A map of the predominant earthquake magnitude and distance is provided from the deaggregation of the probabilistic seismic hazard model. However, it is important to recognize that a site may have more than one earthquake that contributes significantly to the hazard. Therefore, in some cases earthquakes other than the predominant earthquake should also be considered.

Because of its simplicity, it is likely that the SPPV method (DOC, 1997) will be widely used to estimate earthquake shaking loading conditions for the evaluation of ground failure hazards. It should be kept in mind that ground motions at a given distance from an earthquake will vary depending on site-specific characteristics such as geology, soil properties, and topography, which may not have been adequately accounted for in the regional hazard analysis. Although this variance is represented to some degree by the recorded ground motions that form the basis of the hazard model used to produce Figures 3.1, 3.2, and 3.3, extreme deviations can occur. More sophisticated methods that take into account other factors that may be present at the site (site amplification, basin effects, near source effects, etc.) should be employed as warranted. The decision to use the SPPV method with ground motions derived from Figures 3.1, 3.2, or 3.3 should be based on careful consideration of the above limitations, the geotechnical and seismological aspects of the project setting, and the "importance" or sensitivity of the proposed building with regard to occupant safety.

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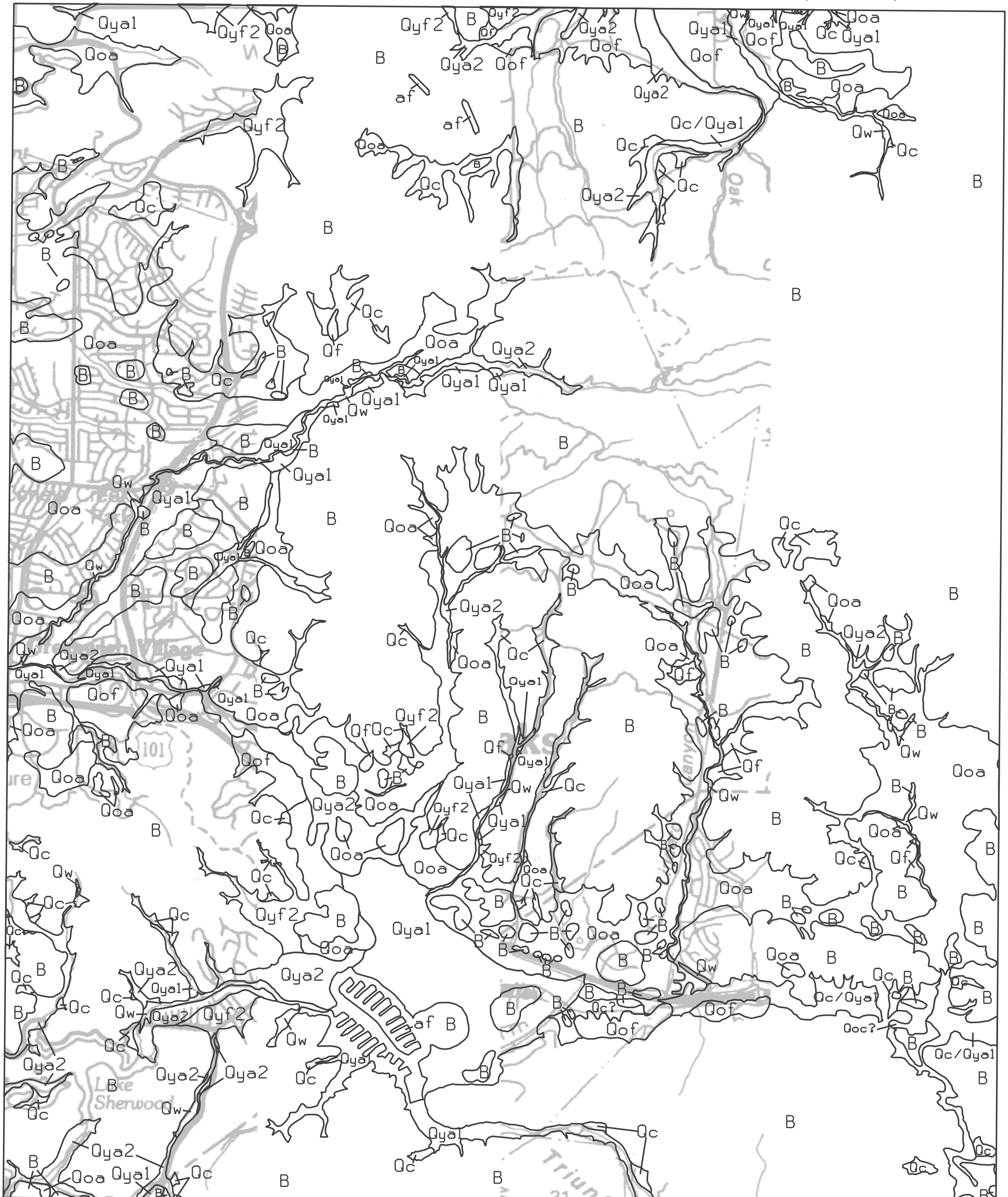


Base map enlarged from U.S.G.S. 30 x 60–minute series

Geologic mapping modified from William Lettis & Associates, 1999

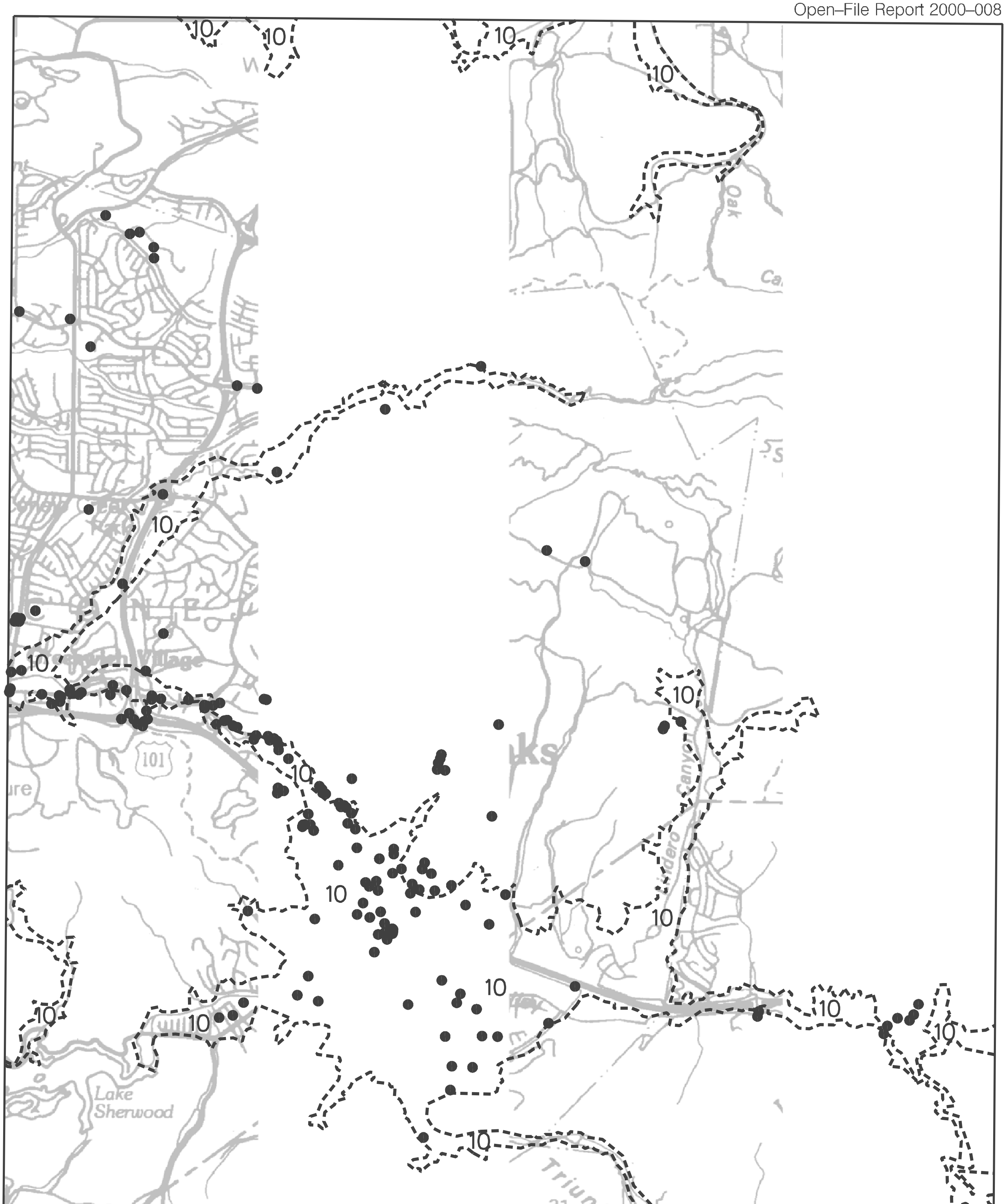
Plate 1.1 Quaternary Geologic Map of the Thousand Oaks Quadrangle.

See Geologic Conditions section in report for descriptions of the units.

B = Pre–Quaternary bedrock.

ONE MILE

Scale



Base map enlarged from U.S.G.S. 30 x 60–minute series

Plate 1.2 Historically shallow ground–water depths and borehole data points in alluviated valley areas of the Thousand Oaks Quadrangle.

Alluviated Valley

10 Historically shallow ground–water depth where same value occurs over a broad area (in feet)

Borehole Site

ONE MILE

Scale

Base map enlarged from U.S.G.S. 30 x 60–minute series

Plate 2.1 Landslide inventory, Shear Test Sample Locations, and Areas of Significant Grading Thousand Oaks Quadrangle.

shear test sample location

landslide

areas of significant grading

ONE MILE

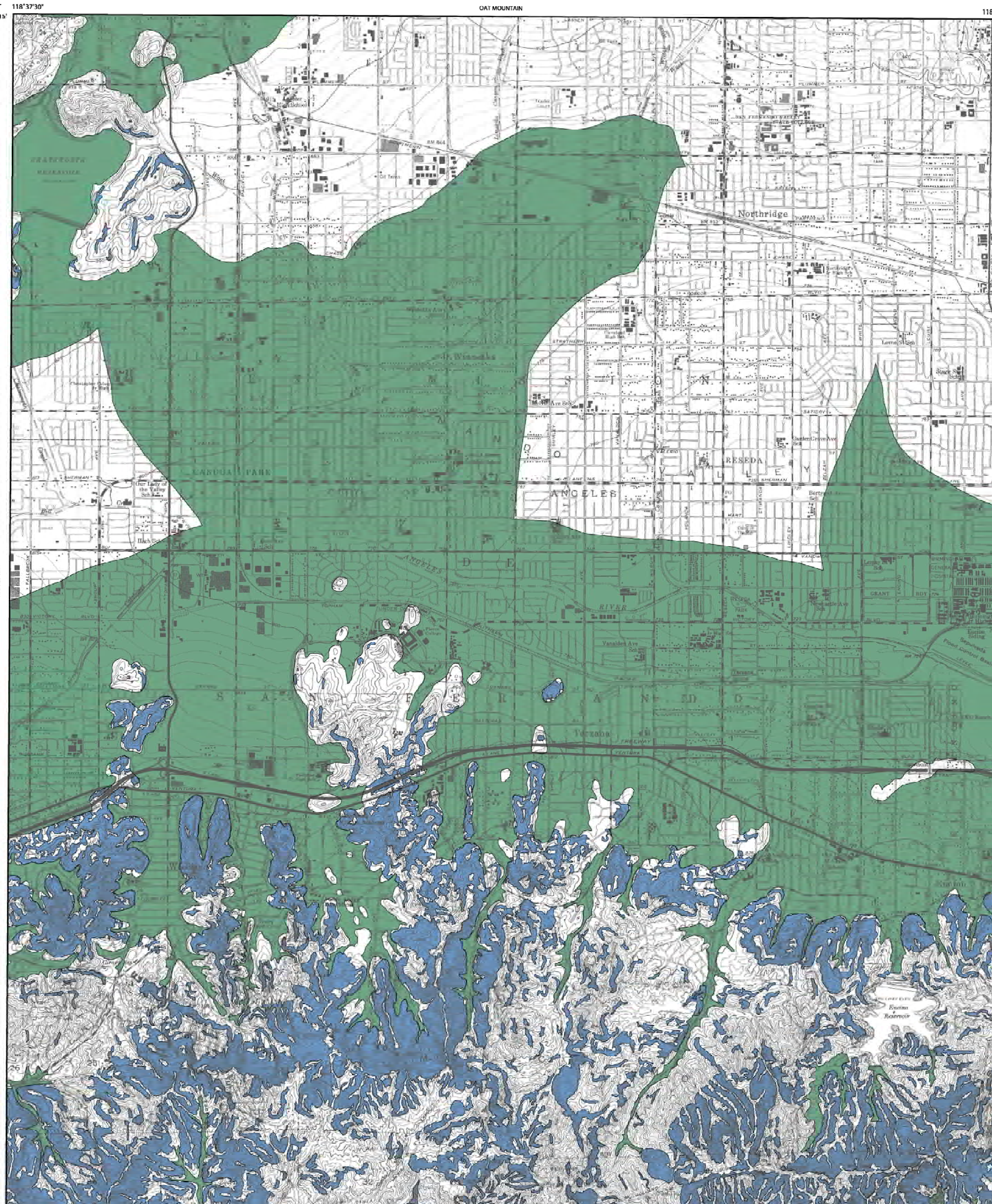
SCALE

Scenario 5 Geotechnical Investigation

DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA-PETE WILSON, GOVERNOR
THE RESOURCES AGENCY-DOUGLAS P. WHEELER, SECRETARY
DEPARTMENT OF CONSERVATION-LAWRENCE J. GOLDZBAND, DIRECTOR

SEISMIC HAZARDS ZONES MAP
Canoga Park Quadrangle



Base Map prepared by U.S. Geological Survey, 1952, photorevised 1967

SCALE 1:24,000

PURPOSE OF MAP

This map will assist cities and counties in fulfilling their responsibilities for protecting the public safety from the effects of earthquake-triggered ground failure as required by the Seismic Hazards Mapping Act (Public Resources Code Sections 2690-2699.6).

For information regarding the scope and recommended methods to be used in conducting the required site investigations, see DMG Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards in California.

For a general description of the Seismic Hazards Mapping Program, the Seismic Hazards Mapping Act and regulations, and related information, please refer to the draft User's Guide (see http://www.consrv.ca.gov/dmg/shezp/userguid.html).

Production of this map was funded by the Federal Emergency Management Agency's Hazard Mitigation Program and the Department of Conservation in cooperation with the Governor's Office of Emergency Services.

IMPORTANT - PLEASE NOTE

1) This map may not show all areas that have the potential for liquefaction, landsliding, strong earthquake ground shaking or other earthquake and geologic hazards. Also, a single earthquake capable of causing liquefaction or triggering landslide failure will not uniformly affect the entire area zoned.

2) Liquefaction zones may also contain areas susceptible to the effects of earthquake-induced landslides. This situation typically exists at or near the toe of existing landslides, downslope from rockfall or debris flow source areas, or adjacent to steep stream banks.

3) This map does not show Alquist-Priolo earthquake fault zones, if any, that may exist in this area. Please refer to the latest official map of earthquake fault zones for disclosures and other actions that are required by the Alquist-Priolo Earthquake Fault Zoning Act. For more information on this subject and and index to available maps, see DMG Special Publication 42.

4) Landslide zones on this map were determined, in part, by adapting methods first developed by the U.S. Geological Survey (USGS). A new generation of landslide hazard maps being prepared by the USGS (Jibson and Harp, in preparation) uses an experimental approach designed to explore new methods to assess earthquake-induced landslide hazards. Although aspects of this new methodology may be incorporated in future seismic hazard zone maps, the experimental USGS maps should not be used as substitutes for these official earthquake-induced landslide zone maps.

5) U.S. Geological Survey base map standards provide that 90 percent of cultural features be located within 40 feet (horizontal accuracy) at the scale of this map. The identification and location of liquefaction and earthquake-induced landslide zones are based on available data. However, the quality of data used is varied. The zone boundaries depicted have been drawn as accurately as possible at this scale.

6) Information on this map is not sufficient to serve as a substitute for the geologic and geotechnical site investigations required under Chapters 7.5 and 7.8 of Division 2 of the Public Resources Code.

7) DISCLAIMER: The State of California and the Department of Conservation make no representations or warranties regarding the accuracy of the data from which these maps were derived. Neither the State nor the Department shall be liable under any circumstances for any direct, indirect, special, incidental or consequential damages with respect to any claim by any user or any third party on account of or arising from the use of this map.

STATE OF CALIFORNIA
SEISMIC HAZARD ZONES

Delineated in compliance with
Chapter 7.8, Division 2 of the California Public Resources Code
(Seismic Hazards Mapping Act)

CANOGA PARK QUADRANGLE

OFFICIAL MAP
Released: February 1, 1998

STATE GEOLOGIST

MAP EXPLANATION

Zones of Required Investigation:

Liquefaction
Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Earthquake-Induced Landslides
Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

DATA AND METHODOLOGY USED TO DEVELOP THIS MAP ARE PRESENTED IN THE FOLLOWING:

Seismic Hazard Evaluation of the Canoga Park 7.5-minute quadrangle, Los Angeles County, California: California Department of Conservation Division of Mines and Geology Open-File Report 97-14.

For additional information on seismic hazards in this map area, the rationale used for zoning, and additional references consulted, refer to DMG's World Wide Web site (http://www.consrv.ca.gov/dmg/).

SEISMIC HAZARD ZONE REPORT 07

SEISMIC HAZARD ZONE REPORT FOR THE CANOGA PARK 7.5-MINUTE QUADRANGLE, LOS ANGELES COUNTY, CALIFORNIA

1997

DEPARTMENT OF CONSERVATION
Division of Mines and Geology

DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, *STATE GEOLOGIST*

SEISMIC HAZARD ZONE REPORT 07

SEISMIC HAZARD ZONE REPORT FOR THE CANOGA PARK 7.5-MINUTE QUADRANGLE, LOS ANGELES COUNTY, CALIFORNIA

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List of Revisions – Canoga Park SHZR 07	
2001	Text updated
6/28/05	BPS address corrected, web links updated, Figure 3.5 added
10/10/05	Bay Area Regional Office and Southern California Regional Office addresses updated

CONTENTS

ILLUSTRATIONS

EXECUTIVE SUMMARY

This report summarizes the methods and sources of information used to prepare the Seismic Hazard Zone Map for the Canoga Park 7.5-minute Quadrangle, Los Angeles County, California. The map displays the boundaries of Zones of Required Investigation for liquefaction and earthquake-induced landslides over an area of approximately 62 square miles at a scale of 1 inch = 2,000 feet.

The Canoga Park Quadrangle is in central San Fernando Valley, about 20 miles northwest of the Los Angeles Civic Center. All or parts of the Los Angeles City communities of Reseda, Tarzana, Encino, Canoga Park, Woodland Hills, and Northridge are within the quadrangle. The northern half of the quadrangle includes part of the San Fernando Valley, part of the Simi Hills and part of the Northridge Hills. The southern half includes terrain of the Santa Monica Mountains, the crest of which lies near the southern boundary, and the Chalk Hills, which are bisected by the Ventura Freeway (U.S. 101). Residential and commercial development is concentrated in the flat-lying valley areas. Hillside residential development continues at present. Other land uses include golf courses, Sepulveda Dam Flood Control and Recreation Area, State parkland, and reservoirs. Encino Reservoir is located in the southeast corner, and Chatsworth Reservoir (now dry) is located in the northwestern part of the quadrangle.

The map is prepared by employing geographic information system (GIS) technology, which allows the manipulation of three-dimensional data. Information considered includes topography, surface and subsurface geology, borehole data, historical ground-water levels, existing landslide features, slope gradient, rock-strength measurements, geologic structure, and probabilistic earthquake shaking estimates. The shaking inputs are based upon probabilistic seismic hazard maps that depict peak ground acceleration, mode magnitude, and mode distance with a 10% probability of exceedance in 50 years.

In the Canoga Park Quadrangle the liquefaction zone is widespread within the southern San Fernando Valley, especially within about one mile of the Los Angeles River. The part of the zone that extends northeastward into Northridge is related to young, loose alluvial sediments and a shallow water table. Liquefaction-related effects were observed in the quadrangle from the 1994 Northridge earthquake. The presence of rocks that are highly susceptible to landsliding and deep dissection of the hillsides on the northern slope of the Santa Monica Mountains contribute to an earthquake-induced landslide zone that covers about 12 percent of the quadrangle. However, except for areas within the Simi Hills and Chalk Hills approximately 50 percent of the upland terrain is within the zone.

How to view or obtain the map

Seismic Hazard Zone Maps, Seismic Hazard Zone Reports and additional information on seismic hazard zone mapping in California are available on the Division of Mines and Geology's Internet page: http://www.conservation.ca.gov/CGS/index.htm

Paper copies of Official Seismic Hazard Zone Maps, released by DMG, which depict zones of required investigation for liquefaction and/or earthquake-induced landslides, are available for purchase from:

BPS Reprographic Services
945 Bryant Street
San Francisco, California 94105
(415) 512-6550

Seismic Hazard Zone Reports (SHZR) summarize the development of the hazard zone map for each area and contain background documentation for use by site investigators and local government reviewers. These reports are available for reference at DMG offices in Sacramento, San Francisco, and Los Angeles. **NOTE: The reports are not available through BPS Reprographic Services.**

INTRODUCTION

The Seismic Hazards Mapping Act (the Act) of 1990 (Public Resources Code, Chapter 7.8, Division 2) directs the California Department of Conservation (DOC), Division of Mines and Geology (DMG) to delineate seismic hazard zones. The purpose of the Act is to reduce the threat to public health and safety and to minimize the loss of life and property by identifying and mitigating seismic hazards. Cities, counties, and state agencies are directed to use the seismic hazard zone maps in their land-use planning and permitting processes. They must withhold development permits for a site within a zone until the geologic and soil conditions of the project site are investigated and appropriate mitigation measures, if any, are incorporated into development plans. The Act also requires sellers (and their agents) of real property within a mapped hazard zone to disclose at the time of sale that the property lies within such a zone. Evaluation and mitigation of seismic hazards are to be conducted under guidelines established by the California State Mining and Geology Board (DOC, 1997; also available on the Internet at http://gmw.consrv.ca.gov/shmp/webdocs/sp117.pdf).

The Act also directs SMGB to appoint and consult with the Seismic Hazards Mapping Act Advisory Committee (SHMAAC) in developing criteria for the preparation of the seismic hazard zone maps. SHMAAC consists of geologists, seismologists, civil and structural engineers, representatives of city and county governments, the state insurance commissioner and the insurance industry. In 1991 SMGB adopted initial criteria for delineating seismic hazard zones to promote uniform and effective statewide implementation of the Act. These initial criteria provide detailed standards for mapping regional liquefaction hazards. They also directed DMG to develop a set of probabilistic seismic maps for California and to research methods that might be appropriate for mapping earthquake-induced landslide hazards.

In 1996, working groups established by SHMAAC reviewed the prototype maps and the techniques used to create them. The reviews resulted in recommendations that 1) the process for zoning liquefaction hazards remain unchanged and 2) earthquake-induced landslide zones be delineated using a modified Newmark analysis.

This Seismic Hazard Zone Report summarizes the development of the hazard zone map. The process of zoning for liquefaction uses a combination of Quaternary geologic mapping, historical ground-water information, and subsurface geotechnical data. The process for zoning earthquake-induced landslides incorporates earthquake loading, existing landslide features, slope gradient, rock strength, and geologic structure. Probabilistic seismic hazard maps, which are the underpinning for delineating seismic hazard zones, have been prepared for peak ground acceleration, mode magnitude, and mode distance with a 10% probability of exceedance in 50 years (Petersen and others, 1996) in accordance with the mapping criteria.

This report summarizes seismic hazard zone mapping for potentially liquefiable soils and earthquake-induced landslides in the Canoga Park 7.5-minute Quadrangle.

SECTION 1
LIQUEFACTION EVALUATION REPORT

Liquefaction Zones in the Canoga Park 7.5-Minute Quadrangle, Los Angeles County, California

By
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Division of Mines and Geology

PURPOSE

The Seismic Hazards Mapping Act (the Act) of 1990 (Public Resources Code, Chapter 7.8, Division 2) directs the California Department of Conservation (DOC), Division of Mines and Geology (DMG) to delineate Seismic Hazard Zones. The purpose of the Act is to reduce the threat to public health and safety and to minimize the loss of life and property by identifying and mitigating seismic hazards. Cities, counties, and state agencies are directed to use seismic hazard zone maps developed by DMG in their land-use planning and permitting processes. The Act requires that site-specific geotechnical investigations be performed prior to permitting most urban development projects within seismic hazard zones. Evaluation and mitigation of seismic hazards are to be conducted under guidelines adopted by the California State Mining and Geology Board (DOC, 1997; also available on the Internet at http://gmw.consrv.ca.gov/shmp/webdocs/sp117.pdf).

This section of the evaluation report summarizes seismic hazard zone mapping for potentially liquefiable soils in the Canoga Park 7.5-minute Quadrangle. This section, along with Section 2 (addressing earthquake-induced landslides), and Section 3 (addressing potential ground shaking), form a report that is one of a series that summarizes production of similar seismic hazard zone maps within the state (Smith, 1996). Additional information on seismic hazards zone mapping in California is on DMG's Internet web page: http://www.conservation.ca.gov/CGS/index.htm

BACKGROUND

Liquefaction-induced ground failure historically has been a major cause of earthquake damage in southern California. During the 1971 San Fernando and 1994 Northridge earthquakes, significant damage to roads, utility pipelines, buildings, and other structures in the Los Angeles area was caused by liquefaction-induced ground displacement.

Localities most susceptible to liquefaction-induced damage are underlain by loose, water-saturated, granular sediment within 40 feet of the ground surface. These geological and ground-water conditions exist in parts of southern California, most notably in some densely populated valley regions and alluviated floodplains. In addition, the potential for strong earthquake ground shaking is high because of the many nearby active faults. The combination of these factors constitutes a significant seismic hazard in the southern California region in general, including areas in the Canoga Park Quadrangle.

METHODS SUMMARY

Characterization of liquefaction hazard presented in this report requires preparation of maps that delineate areas underlain by potentially liquefiable sediment. The following were collected or generated for this evaluation:

- Existing geologic maps were used to provide an accurate representation of the spatial distribution of Quaternary deposits in the study area. Geologic units that generally are susceptible to liquefaction include late Quaternary alluvial and fluvial sedimentary deposits and artificial fill

- Construction of shallow ground-water maps showing the historically highest known ground-water levels

- Quantitative analysis of geotechnical data to evaluate liquefaction potential of deposits

- Information on potential ground shaking intensity based on DMG probabilistic shaking maps

The data collected for this evaluation were processed into a series of geographic information system (GIS) layers using commercially available software. The liquefaction zone map was derived from a synthesis of these data and according to criteria adopted by the State Mining and Geology Board (DOC, 2000).

SCOPE AND LIMITATIONS

Evaluation for potentially liquefiable soils generally is confined to areas covered by Quaternary (less than about 1.6 million years) sedimentary deposits. Such areas within the Canoga Park Quadrangle consist mainly of alluviated valleys, floodplains, and canyon regions. DMG's liquefaction hazard evaluations are based on information on earthquake ground shaking, surface and subsurface lithology, geotechnical soil properties, and ground-water depth, which is gathered from various sources. Although selection of data used in this evaluation was rigorous, the quality of the data used varies. The State of California and the Department of Conservation make no representations or warranties regarding the accuracy of the data obtained from outside sources.

Liquefaction zone maps are intended to prompt more detailed, site-specific geotechnical investigations, as required by the Act. As such, liquefaction zone maps identify areas where the potential for liquefaction is relatively high. They do not predict the amount or direction of liquefaction-related ground displacements, or the amount of damage to facilities that may result from liquefaction. Factors that control liquefaction-induced ground failure are the extent, depth, density, and thickness of liquefiable materials, depth to ground water, rate of drainage, slope gradient, proximity to free faces, and intensity and duration of ground shaking. These factors must be evaluated on a site-specific basis to assess the potential for ground failure at any given project site.

Information developed in the study is presented in two parts: physiographic, geologic, and hydrologic conditions in PART I, and liquefaction and zoning evaluations in PART II.

PART I

PHYSIOGRAPHY

Study Area Location and Physiography

The Canoga Park Quadrangle covers an area of about 62 square miles in western Los Angeles County. The center of the quadrangle lies almost 20 miles northwest of the Los Angeles Civic Center. Most of the quadrangle lies within the San Fernando Valley, although, south of U.S. Highway 101 (Ventura Freeway), the northern slopes of the Santa Monica Mountains rise toward the mountain crest, which nearly coincides with the southern border of the area.

The San Fernando Valley is an east-trending structural trough within the Transverse Ranges geologic province of southern California. The mountains that bound it to the north and south are actively deforming anticlinal ranges bounded on their south sides by thrust faults. As these ranges have risen and been deformed, the San Fernando Valley has subsided and filled with sediment.

The western portion of the valley, including most of the Canoga Park Quadrangle has received sediment from small drainage courses originating in the Santa Monica Mountains, Simi Hills and Santa Susana Mountains. These small streams have deposited their sediment in the form of channel deposits, alluvial fans and floodplain deposits in the valley. Composition of these deposits is dependent on the source areas of the streams. Streams with source areas dominated by Modelo Formation shale tend to deposit clayey alluvium while those with sources in Saugus, Chatsworth, or Topanga formations tend to deposit silty or sandy alluvium.

The eastern portion of the valley, including much of the eastern part of the Canoga Park Quadrangle, has received sediment from Pacoima and Tujunga washes. These washes are associated with very large river systems that originate in the high, steep, crystalline bedrock terrain of the San Gabriel Mountains. These large river systems have deposited a broad, composite alluvial fan consisting of sand, silt and gravel, which covers much of the adjacent Van Nuys Quadrangle.

GEOLOGY

Surficial Geology

Geologic units that generally are susceptible to liquefaction include late Quaternary alluvial and fluvial sedimentary deposits and artificial fill. Late Quaternary geologic units in the San Fernando Valley area were completely re-mapped for this study and a concurrent study by engineering geologist Chris Hitchcock of William Lettis and Associates (Hitchcock and Wills, 1998; 2000). Lettis and Associates received a grant from the National Science Foundation (NSF) to study the activity of the Northridge Hills uplift. As part of the research for this study, Hitchcock mapped Quaternary surficial units by interpreting of their geomorphic expression on aerial photographs and topographic maps. The primary source for this work was 1938 aerial photographs taken by the U.S. Department of Agriculture (USDA). His interpretations were checked and extended for this study using 1952 USDA aerial photos, 1920's topographic maps and subsurface data. The resulting map (Hitchcock and Wills, 2000) represents a cooperative effort to depict the Quaternary geology of the San Fernando Valley combining surficial geomorphic mapping and information about subsurface soil engineering properties. The portion of this map that covers the Canoga Park Quadrangle is reproduced as Plate1.1.

For the Quaternary geologic map for the Canoga Park Quadrangle, geologic maps prepared by Tinsley and others (1985), Yerkes and Campbell (1993), and Dibblee (1992) were referred to. We began with the map of Yerkes and Campbell (1993) as a file in the DMG Geographic Information System. The Quaternary geology shown by Yerkes and Campbell (1993) was compiled from Tinsley and others (1985). For this study, we did not review or revise the mapping of bedrock units by Yerkes and Campbell (1993), except at the contacts between bedrock and Quaternary units. Within the Quaternary units, mapping by Hitchcock (and for this study) was used to refine and substantially revise the mapping of Tinsley and others (1985). For this map, geologic units were defined based on the geomorphic expression of Quaternary units (based on aerial photographs and historic topographic maps) and subsurface characteristics of those units (based on boreholes). The nomenclature of the Southern California Areal Mapping Project (SCAMP) (Morton and Kennedy, 1989) was applied to all Quaternary units (Table 1.1).

	Alluvial fan deposits	**alluvial valley deposits**	
Active	Qf- active fan	Qa- active depositional basin	
	Qw- active wash		Holocene?
Young	Qyf2	Qyt	
	Qyf1		
Old	Qof2	Qt	
	Qof1		Pleistocene?
Very old	Qvof2	Qvoa2*	
		Qvoa1*	

*may have been alluvial fan, depositional form not preserved

Table 1.1. Units of the Southern California Areal Mapping Project (SCAMP) Nomenclature Used in the San Fernando Valley.

The Quaternary geologic map (Plate 1.1) shows that the Canoga Park Quadrangle is occupied by an alluvial basin deposit, surrounded by alluvial fans, which are, in turn, surrounded by mountains (off the map to the west north and east). This basin is part of an east-west trending structural trough that has been filled from the north and south. The Los Angeles River, which flows from west to east across the basin, has contributed very little to the sedimentation of the basin. The major sources of the sediment that fills the San Fernando Valley have been the drainage systems that culminate in Tujunga and Pacoima washes, both of which receive sediment from large regions in the San Gabriel Mountains. These river systems begin in high, rugged mountains composed of crystalline rocks. Periodic torrential rainfall and associated flooding characterize the drainage regimes of these washes. Sedimentation in the San Fernando Valley has formed a large alluvial fan composed primarily of sand, silt, and gravel, reflecting the crystalline rocks of the source area. This alluvial fan extends from its head on the San Fernando and Sunland quadrangles, across most of the Van Nuys and Burbank quadrangles (northeast and east of the Canoga Park Quadrangle). Only the western fringe of this alluvial fan is on the Canoga Park Quadrangle.

The Pacoima/Tujunga alluvial fan on the Van Nuys and Canoga Park quadrangles can be subdivided based on relative ages of different surfaces. The oldest of these surfaces, Qof2, on the western Van Nuys and eastern Canoga Park quadrangles appears to be cut off from its upstream source area by uplift of the Northridge Hills. Qof2 appears to form a fan within the larger fan with its apex near the Bull Creek gap in the Northridge Hills (in the northwestern corner of the Van Nuys Quadrangle).

This fan surface may have been abandoned when continuing uplift of the Northridge Hills deflected the Pacoima Wash (San Fernando and Van Nuys quadrangles) drainage to the east. Although this surface is older than any other part of the Pacoima/Tujunga fan, it probably formed in early to mid Holocene time.

Parts of the San Fernando Valley west of the Pacoima/Tujunga fan have been filled by sediments transported by much smaller steams, which have sources in the lower, less rugged Santa Susana Mountains, Santa Monica Mountains, and Simi Hills. These streams have built alluvial fans out into the valley but the fans have not completely covered the valley, as has the Pacoima/Tujunga fan. Deposition of these fans has also been altered and interrupted by tectonism, particularly along the Northridge Hills.

The oldest alluvial units in the San Fernando Valley are found within the Northridge Hills and on the south flank of the Santa Susana Mountains. The Saugus Formation, a Plio-Pleistocene alluvial unit makes up much of the south flank of the Santa Susana Mountains and is exposed in the core of anticlinal hills along the Northridge Hills uplift.

Overlying Saugus Formation in the Northridge Hills are very old alluvial deposits (Qvoa1, Qvoa2 and Qvof2). These deposits are uplifted, deformed, have reddish soils and are typically dense to very dense.

Overlying very old alluvial deposits in the Northridge Hills are deposits that formed as alluvial fans from the Santa Susana Mountains. These deposits are composed of sands, silts and gravels and form recognizable alluvial fans. These fan surfaces are no longer active because continuing deformation has lifted them out of the area of deposition.

Along the front of the Santa Susana Mountains, all major streams are incised into the Qof1 surface. At the Northridge Hills, the largest stream, Limekiln Wash, is incised completely through the hills, leaving remnants of the Qof1 surface as terraces. Smaller stream courses, especially Wilbur Wash and Aliso Wash, have apparently been blocked by the Northridge Hills, causing deposition of younger alluvium on top of Qof1.

The Qof1 surface re-emerges from beneath these younger sediments in the Northridge Hills. It is warped over the hills and buried by younger sediments also on the south side.

The streams that cross the Northridge Hills, as well as others from the south and west, have built alluvial fans into the main San Fernando Valley basin south of the hills. These alluvial fans can be subdivided into young (Qyf1 and Qyf2) and active (Qf) fan deposits on the basis of geomorphology.

The alluvial fans from all sides of the valley interfinger with an alluvial basin or flood plain deposit (Qa) in the Canoga Park-Reseda area. This deposit is dominantly clay with some silt and sand layers. In contrast to the alluvial fan deposits, layers in this alluvial basin deposit can be easily correlated between wells, in one case for over a mile.

The alluvial basin deposit occurs just west of the Pacoima/Tujunga fan deposits, suggesting that deposition on that major fan has partially blocked the west-to-east surficial drainage. The smaller streams have not been able to deposit enough sediment to maintain a continuous eastward drainage gradient and the low gradient has resulted in a marsh or low-energy stream deposit on the central and eastern Canoga Park Quadrangle.

This blockage of the eastward drainage in the valley appears to occur again farther to the west. The youngest fan of Browns Canyon wash from the north nearly meets the youngest fan of Arroyo Calabasas from the southwest. West of these fans, the small streams from the Simi Hills have not been able to maintain their drainage gradient and a clayey basin deposit (Qa) has formed.

Historical flood plain deposits that formed within the Sepulveda Flood Control Basin are also mapped as active alluvial basin deposits (Qa).

ENGINEERING GEOLOGY

The geologic units described above and listed in Table 1.2 were primarily mapped from their surface expression, especially geomorphology as shown on aerial photos and old topographic maps. The geomorphic mapping was compared with the subsurface properties described in over 850 borehole logs in the study area. Subsurface data used for this study includes the database compiled by John Tinsley for previous liquefaction studies (Tinsley and Fumal, 1985; Tinsley and others, 1985), a database of shear wave velocity measurements originally compiled by Walter Silva (Wills and Silva, 1996), and additional data collected for this study. Subsurface data were collected for this study at Caltrans, the California Department of Water Resources, DMG files of seismic reports for hospital and school sites, the Regional Water Quality Control Board and from Law Crandall, Inc., Leighton and Associates, Inc., and Woodward-Clyde Consultants. In general, the data gathered for geotechnical studies appear to be complete and consistent. Data from environmental geology reports filed with the Water Quality Control Board are well distributed areally and provide reliable data on water levels, but geotechnical data, particularly SPT blow counts, are sometimes less reliable, due to non-standard equipment and incomplete reporting of procedures. Water-well logs from the Department of Water Resources tend to have very sketchy lithologic descriptions and generally unreliable reports of shallow, unconfined water levels. Apparently, water-well drillers may note the level of “productive water,” ignoring shallower perched water or water in less permeable layers.

Standard Penetration Test (SPT) data provide a standardized measure of the penetration resistance of a geologic deposit and commonly are used as an index of density. Many geotechnical investigations record SPT data, including the number of blows by a 140-pound drop weight required to drive a sampler of specific dimensions one foot into the soil. Recorded blow counts for non-SPT geotechnical sampling, where the sampler diameter, hammer weight or drop distance differ from those specified for an SPT (ASTM D1586), were converted to SPT-equivalent blow count values and entered into the DMG GIS. The actual and converted SPT blow counts were normalized to a common reference effective overburden pressure of one atmosphere (approximately one ton per square foot) and a hammer efficiency of 60% using a method described by Seed and Idriss (1982) and Seed and others (1985). This normalized blow count is referred to as $(N_1)_{60}$.

Data from previous databases and additional borehole logs were entered into the DMG GIS database. Locations of all exploratory boreholes considered in this investigation are shown on Plate 1.2. Construction of cross sections from the borehole logs, using the GIS, enabled the correlation of soil types from one borehole to another and the outlining of areas of similar soils.

In most cases, the subsurface data allow mapping of different alluvial fans. Different generations of alluvium on the same fan, which are very apparent from the geomorphology, are not distinguishable from the subsurface data.

The subsurface data were particularly valuable in mapping the alluvial basin or flood plain deposits (Qa). On previous maps (Tinsley and Fumal, 1985), these deposits had been mapped as part of the adjoining alluvial fans. Geomorphically, they appear to be the lower parts of alluvial fans. In the subsurface, however, the alluvial fan deposits are composed of layers of silt, silty sand and clay, which are not easily correlatable between boreholes. The flood plain deposits, in contrast, are composed mainly of clay and thin silt or sand beds that can be easily correlated between boreholes, in one case for over a mile. Because the basin deposits could be most easily distinguished from the subsurface data the areal extent of these deposits was mapped from the subsurface data.

Descriptions of characteristics of geologic units recorded on the borehole logs are given below. These descriptions are generalized but give the most commonly encountered characteristics of the unit (see Table 1.2).

Saugus Formation (Qs)

The Plio-Pleistocene Saugus Formation is an alluvial unit, which is often very difficult to distinguish from younger overlying alluvium on logs of boreholes. In the few boreholes where it is certain that Saugus Formation was encountered, Saugus Formation is described as "sandstone." In others, descriptions of dense or very dense sand may indicate the presence of Saugus Formation but could just as well reflect old or very old alluvium.

Very old alluvium (Qvoa1)

Very old alluvium, mapped in the Northridge Hills, is represented in the subsurface data by several boreholes in unit Qvoa1. The material in these boreholes is dense to very dense silt and very stiff to hard clay with minor dense sand.

Older alluvium (Qof1, Qof2)

Two major older alluvial units were mapped in the study area. Older alluvium is distinguished from younger alluvium by position (uplifted), is usually incised by younger drainage courses, and by displaying relatively even tonal patterns on pre-development aerial photographs. Younger alluvium, in contrast, typically has a braided stream tonal pattern even when the stream channels have no geomorphic expression. Qof1 consists of small alluvial fans from the Santa Susana Mountains that have been warped over the Northridge Hills. Qof2 is a portion of the large Pacoima/Tujunga fan that has been cut off from its source by uplift. These units are probably slightly different in age, because Qof2 probably overlies Qof1 on the south side of the Northridge Hills. The main difference between them is due to the difference in their source areas, which yields different subsurface characteristics.

Qof1 in the Northridge Hills consists of silt sand and sandy silt with lesser amounts of clay. Colors of sandy units are described as light brown or grayish brown, suggesting that they are relatively young and little soil formation has taken place. The granular deposits are loose to moderately dense, based on few SPT blow counts.

Younger alluvium (Qyf1, Qyf2, Qyt, Qf, Qw)

Within an alluvial fan, the different generations of younger alluvium can be distinguished by their geomorphic relationships. In the subsurface, it is not possible to distinguish among the generations of an alluvial fan. There may simply be too little difference in age among the various units, which probably range in age from mid-Holocene to historic, for any differences in density or cementation to have formed. In addition, since no geotechnical data were obtained from locally developed, thin, veneer-like, young terrace deposits adjacent to watercourses (Qyt), this unit is not included in Table 1.2.

On the other hand, differences in source area can readily be distinguished from the subsurface data. Accordingly, the following descriptions are arranged by alluvial fan, beginning in the northeast and proceeding counterclockwise around the basin.

Fans from the Santa Susana Mountains

The fans of Bull, Aliso, Wilbur, Limekiln and Browns canyons are mostly composed of silt, silty sand and clay. This is finer-grained material than found in the Pacoima/Tujunga fan to the east and it reflects source areas in the Santa Susana Mountains. These fans are also smaller and have been disrupted by uplift of the Northridge Hills. Several of these fans are discussed in more detail below.

Bull Canyon

The most recent fan of Bull Canyon is along the border between the Canoga Park and Van Nuys quadrangles, on the south side of the Northridge Hills. Bull Canyon Creek appears to be underfit for this gap, which is probably related to an older branch of the Pacoima/Tujunga fan. The Bull Canyon fan also overlies the older Pacoima/Tujunga fan and appears to be at least partly reworked from material that originated in the Pacoima/Tujunga fan. Although the Bull Canyon fan is poorly represented in the subsurface data, the material recorded is silt and silty sand, which is indistinguishable from the underlying Qof2.

Limekiln Canyon

Limekiln Canyon wash has been able to maintain an incised channel through the Northridge Hills into the main San Fernando basin south of the hills. This is probably due to its larger drainage area (about 3 square miles) and associated erosive power. The apex of the Limekiln Canyon fan is on the south side of the Northridge Hills, from there it extends onto the floor of the valley. The fan is formed of layers of clay, silt, and silty sand.

Browns Canyon

Browns Canyon Wash has the largest drainage basin of the streams with source areas in the Santa Susana Mountains (about 12 square miles), but emerges from the mountains in the complex northwestern corner of the valley. Deposits of Browns Canyon are silty sand, silt and clay. The sands are loose to moderately dense, based on SPT blow counts. This alluvium has filled the Chatsworth basin, which is separated from the main San Fernando basin by the Chatsworth fault. Browns Canyon alluvium then overflowed the Chatsworth basin and built an alluvial fan south of the Northridge Hills onto the floor of the San Fernando Valley. The main alluvial fan has its apex where the trend of the main Northridge Hills uplift crosses Browns Canyon wash, suggesting tectonic control of the young sedimentation. The apex of active fan, however, is once again well south of the main fan apex suggesting southward tilting of the whole San Fernando basin.

Fans from the Santa Monica Mountains

Arroyo Calabasas

Arroyo Calabasas has a drainage basin of about 5 square miles in the Santa Monica Mountains and the southernmost Simi Hills. The apex of the fan is at the southwestern corner of the San Fernando Valley. The arroyo has incised the upper portion of the fan and deposited the youngest material in a fan with its apex northeastward toward the center of the valley. If this represents tilting to the northeast, it may be an indication of tightening of the San Fernando syncline.

Arroyo Calabasas fan consists of clay and silt with beds of sand and silty sand. The sand layers are generally described as medium to coarse sand and are sometimes “pebbly.” SPT field N values of granular deposits are typically between 10 and 20 blows per foot

(BPF). The young Arroyo Calabasas fan appears to be a thin deposit, logs from some boreholes describe a reddish brown (or "gray-orange") dense to very dense sand with gravel at 15 to 25 feet below the surface.

Fans from small drainage basins in the Santa Monica Mountains

The fans of many small streams originating in the Santa Monica Mountains have merged to form a continuous alluvial apron on the south side of the San Fernando Valley. Generally, these small fans have their apices at the mountain front and extend northward toward the Los Angeles River. Fewer generations of fan deposits are distinguished in these small fans, possibly indicating no major changes in slope or shape of the valley while they were being deposited.

Materials in the fans along the Santa Monica Mountain front are variable, with some drainage courses having more sand than others. Generally, however, these fan deposits consist of clay and silt with sand layers. Granular deposits are medium dense, fine- to medium-grained sand and usually silty.

One exception to the lack of tectonic disruption of these fans may occur at Caballero Creek. A ridge of older alluvium, with a core of Modelo Formation bedrock, extends to the northeast from the mouth of Caballero Creek to the Sepulveda Flood Control Basin. This ridge appears to be partly buried by young alluvial fans from the Santa Monica Mountains (Qyf2) but locally disrupts drainage and possibly ground-water flow, leading to a marsh depicted on the 1926 edition of the U.S. Geological Survey Van Nuys 6-minute Quadrangle.

Geologic Map Unit	Material Type	Consistency	Liquefaction Susceptibility
Qa, alluvial basin	clay, silty clay, some sand	soft/loose	low, locally high
Qw, stream channels	sandy, silty sand	loose-moderately dense	high
Qf, active alluvial fans	silty sand, sand, minor clay	loose-moderately dense	high
Qyf2, younger alluvial fans	silty sand, sand, minor clay	loose-moderately dense	high
Qyf1, young alluvial fan	silty sand, sand, minor clay	loose-moderately dense	high
Qof2, older alluvial fan	silt & silty sand	loose-dense	high
Qof1, older alluvial fan	sand & gravel	dense	low
Qvoa1, very old alluvium	clay-silty sand	dense-very dense	low

Table 1.2. General Geotechnical Characteristics and Liquefaction Susceptibility of Younger Quaternary Units.

GROUND-WATER CONDITIONS

Liquefaction hazard may exist in areas where depth to ground water is 40 feet or less. DMG uses the highest known ground-water levels because water levels during an earthquake cannot be anticipated because of the unpredictable fluctuations caused by natural processes and human activities. A historical-high ground-water map differs from most ground-water maps, which show the actual water table at a particular time. Plate 1.2 depicts a hypothetical ground-water table within alluviated areas.

Ground-water conditions were investigated in the Canoga Park Quadrangle to evaluate the depth to saturated materials. Saturated conditions reduce the effective normal stress, thereby increasing the likelihood of earthquake-induced liquefaction (Youd, 1973). The evaluation was based on first-encountered water noted in geotechnical borehole logs. The depths to first-encountered unconfined ground water were plotted onto a map of the project area to constrain the estimate of historically shallowest ground water. Water depths from boreholes known to penetrate confined aquifers were not utilized.

The San Fernando Valley ground-water basin is a major source of domestic water for the City of Los Angeles and, as a result, has been extensively studied. The legal rights to water in the ground within the San Fernando Valley were the subject of a lawsuit by the City of Los Angeles against the City of San Fernando and other operators of water wells in the basin. The "Report of Referee" (California State Water Rights Board, 1962) contains information on the geology, soils and ground-water levels of the San Fernando Valley.

The Report of Referee shows that ground water reached its highest levels in 1944, before excessive pumping caused drawdowns throughout the basin. Management of the ground-water resources led to stabilizing of ground-water elevations in the 1960's and, in some cases, rise of ground-water elevations in the 1970's and 1980's to levels approaching those of 1944. Wells monitored by the Upper Los Angeles River Watermaster (Blevins, 1995) show that in the western San Fernando Valley, including the Canoga Park Quadrangle, water levels have not recovered to the levels of the 1940's.

In order to consider the historically highest ground-water level in liquefaction analysis, the 1944 ground-water elevation contours (California State Water Rights Board 1962, Plate 29) were digitized. A three-dimensional model was created from the digitized contours giving a ground-water elevation at any point on a grid. The ground-water elevation values in this grid were then subtracted from the surface elevation values from the USGS Digital Elevation Model (DEM) for the Canoga Park Quadrangle. The difference between the surface elevation and the ground-water elevation is the ground-water depth. Subtracting the ground-water depth grid from the DEM results in a grid of ground-water depth values at any point where the grids overlapped.

The resulting grid of ground-water depth values shows several artifacts of the differences between the sources of ground-water elevation data and surface elevation data. The ground-water elevations were interpreted from relatively few measurements in water wells. The USGS DEM is a much more detailed depiction of surface elevation; it also shows man-made features such as excavations and fills that have changed the surface elevations. Most of these surface changes occurred after the ground-water levels were measured in 1945. The ground-water depth contours were smoothed and obvious artifacts removed to create the final ground-water depth map, which was digitized and used for the liquefaction analysis (Plate 1.2).

In general, the final ground-water depth map shows shallow ground water along the Los Angeles River in the southern portion of the San Fernando Valley and a broad area of shallow ground water in the Reseda-Canoga Park area. Both of these areas were recognized as areas of shallow ground water in the Report of Referee (1962). Ground-water depth maps for the Reseda-Canoga Park area, prepared in 1950 for the years 1948 and 1949, show similar conditions, as well as being the only place where a report of artesian conditions was found during the present study (Donnan and others, 1950).

Shallow ground water is also shown in the Chatsworth sub-basin, where ground water is apparently ponded north of the Chatsworth fault. This fault is recognized mainly as a ground-water barrier and is poorly expressed at the surface.

The 1945 ground-water depths were checked against the water levels measured in boreholes compiled for this study. Measured ground-water levels from the 1970's, 80's and early 90's tend to be 10 to 20 feet deeper than the 1945 water level, but show the same pattern of shallow ground water in the center of the basin and deeper ground water to the north and (to a lesser extent) the south.

The 1945 ground-water contours were only prepared for the San Fernando Valley. For Canyons in the Santa Monica Mountains we compiled ground-water levels from geotechnical borehole logs. Ground water is shown to be relatively shallow in all canyons in the Santa Monica Mountains, where records were obtained. In general, it appears that relatively shallow and impermeable bedrock underlying the canyon alluvium helps to maintain a shallow water table.

PART II

LIQUEFACTION POTENTIAL

Liquefaction may occur in water-saturated sediment during moderate to great earthquakes. Liquefied sediment loses strength and may fail, causing damage to buildings, bridges, and other structures. Many methods for mapping liquefaction hazard have been proposed. Youd (1991) highlights the principal developments and notes some of the widely used criteria. Youd and Perkins (1978) demonstrate the use of geologic criteria as a qualitative characterization of liquefaction susceptibility and introduce the mapping technique of combining a liquefaction susceptibility map and a liquefaction opportunity map to produce a liquefaction potential map. Liquefaction susceptibility is a function of the capacity of sediment to resist liquefaction. Liquefaction opportunity is a function of the potential seismic ground shaking intensity.

The method applied in this study for evaluating liquefaction potential is similar to that of Tinsley and others (1985). Tinsley and others (1985) applied a combination of the techniques used by Seed and others (1983) and Youd and Perkins (1978) for their mapping of liquefaction hazards in the Los Angeles region. This method combines geotechnical analyses, geologic and hydrologic mapping, and probabilistic earthquake shaking estimates, but follows criteria adopted by the State Mining and Geology Board (DOC, 2000).

LIQUEFACTION SUSCEPTIBILITY

Liquefaction susceptibility reflects the relative resistance of a soil to loss of strength when subjected to ground shaking. Physical properties of soil such as sediment grain-size distribution, compaction, cementation, saturation, and depth govern the degree of resistance to liquefaction. Some of these properties can be correlated to a sediment's geologic age and environment of deposition. With increasing age, relative density may increase through cementation of the particles or compaction caused by the weight of the overlying sediment. Grain-size characteristics of a soil also influence susceptibility to liquefaction. Sand is more susceptible than silt or gravel, although silt of low plasticity is treated as liquefiable in this investigation. Cohesive soils generally are not considered susceptible to liquefaction. Such soils may be vulnerable to strength loss with remolding and represent a hazard that is not addressed in this investigation. Soil characteristics and processes that result in higher measured penetration resistances generally indicate lower liquefaction susceptibility. Thus, blow count and cone penetrometer values are useful indicators of liquefaction susceptibility.

Saturation is required for liquefaction, and the liquefaction susceptibility of a soil varies with the depth to ground water. Very shallow ground water increases the susceptibility to liquefaction (soil is more likely to liquefy). Soils that lack resistance (susceptible soils) typically are saturated, loose and sandy. Soils resistant to liquefaction include all soil types that are dry, cohesive, or sufficiently dense.

DMG's map inventory of areas containing soils susceptible to liquefaction begins with evaluation of geologic maps and historical occurrences, cross-sections, geotechnical test data, geomorphology, and ground-water hydrology. Soil properties and soil conditions such as type, age, texture, color, and consistency, along with historical depths to ground water are used to identify, characterize, and correlate susceptible soils. Because Quaternary geologic mapping is based on similar soil observations, liquefaction susceptibility maps typically are similar to Quaternary geologic maps. The susceptibility of the younger Quaternary geologic units in the Canoga Park Quadrangle to liquefaction is outlined below and summarized in Table 1.2.

Very old alluvium (Qvoa1)

Very old alluvium consists of dense to very dense silt and clay deposits in an area of deep groundwater. Liquefaction susceptibility of this unit is low.

Old alluvium (Qof1, Qof2)

Old alluvium on the Canoga Park Quadrangle consists of loose to moderately dense silt and silty sand. Qof1 is found only in the Northridge Hills, where ground water is deep, so it has a low liquefaction susceptibility. Qof2 extends onto the floor of the valley south of the Northridge Hills. In the southern part of area underlain by this unit, ground water is shallower than 40 feet. Those portions with shallow ground water have a high liquefaction susceptibility.

Young alluvium (Qyf1, Qyf2, Qf, Qw)

Younger alluvium on the Canoga Park Quadrangle consists of silty sand with sand, silt and clay. Most boreholes in these units contain loose to moderately dense sand or silty sand. Where ground water is within 40 feet of the surface liquefaction susceptibility of these units is high.

Alluvial basin deposits (Qa)

Alluvial basin deposits consist of clay with minor interbeds of silty sand and silt. Most of this unit is within an area of shallow ground water. Despite the shallow ground water, the clay deposits are non-liquefiable. Sand and silt layers are concentrated in the southern part of this unit within 2000 feet of the Los Angeles River. These layers may represent either interbeds of fan deposits from the Santa Monica Mountains or basin deposits reworked (winnowed) by the Los Angeles River. Because of these granular deposits the liquefaction susceptibility in the southern 2000 feet of the alluvial basin deposits is considered high.

The alluvial basin deposit on the western edge of the quadrangle is more uniformly clay. Due to the absence of layers of granular materials this unit is considered to have low liquefaction susceptibility.

The deposits formed in historic times behind Sepulveda Dam are similar to the other basin deposits and are mapped as Qa, but these deposits are too thin to affect the liquefaction susceptibility of the area. This area has high liquefaction susceptibility reflecting susceptibility of the underlying alluvium (Qof2 and Qyf2).

LIQUEFACTION OPPORTUNITY

Liquefaction opportunity is a measure, expressed in probabilistic terms, of the potential for strong ground shaking. Analyses of in-situ liquefaction resistance require assessment of liquefaction opportunity. The minimum level of seismic excitation to be used for such purposes is the level of peak ground acceleration (PGA) with a 10% probability of exceedance over a 50-year period (DOC, 2000). The earthquake magnitude used in DMG's analysis is the magnitude that contributes most to the calculated PGA for an area.

For the Canoga Park Quadrangle, a peak acceleration of 0.60g resulting from an earthquake of magnitude 6.5 was used for liquefaction analyses. The PGA and magnitude values were based on de-aggregation of the probabilistic hazard at the 10% in 50-year hazard level (Petersen and others, 1996; Cramer and Petersen, 1996). See the ground motion portion (Section 3) of this report for further details.

Quantitative Liquefaction Analysis

DMG performs quantitative analysis of geotechnical data to evaluate liquefaction potential using the Seed Simplified Procedure (Seed and Idriss, 1971; Seed and others, 1983; Seed and others, 1985; National Research Council, 1985; Seed and Harder, 1990; Youd and Idriss, 1997). This procedure calculates soil resistance to liquefaction, expressed in terms of cyclic resistance ratio (CRR) based on standard penetration test (SPT) results, ground-water level, soil density, moisture content, soil type, and sample depth. CRR values are then compared to calculated earthquake-generated shear stresses expressed in terms of cyclic stress ratio (CSR). The factor of safety (FS) relative to liquefaction is: FS=CRR/CSR. FS, therefore, is a quantitative measure of liquefaction potential. DMG uses a factor of safety of 1.0 or less, where CSR equals or exceeds CRR, to indicate the presence of potentially liquefiable soil. While an FS of 1.0 is considered the “trigger” for liquefaction, for a site specific analysis an FS of as much as 1.5 may be appropriate depending on the vulnerability of the site related structures. For a regional assessment DMG normally has a range of FS that results from the liquefaction analyses. The DMG liquefaction analysis program calculates an FS at each sample that has blow counts. The lowest FS in each borehole is used for that location. These FS vary in reliability according to the quality of the geotechnical data. These FS as well as other considerations such as slope, free face conditions, and thickness and depth of potentially liquefiable soil are evaluated in order to construct liquefaction potential maps, which then directly translate to zones of required investigation.

Of the over 850 geotechnical borehole logs reviewed in this study (Plate 1.2), fewer than 150 include blow-count data from SPT’s or from penetration tests that allow reasonable blow count translations to SPT-equivalent values. Non-SPT values, such as those resulting from the use of 2-inch or 2 1/2-inch inside diameter ring samplers, were translated to SPT-equivalent values if reasonable factors could be used in conversion calculations. The reliability of the SPT-equivalent values varies. Therefore, they are weighted and used in a more qualitative manner. Few borehole logs, however, include all of the information (soil density, moisture content, sieve analysis, etc) required for an ideal Seed Simplified Analysis. For boreholes having acceptable penetration tests, liquefaction analysis is performed using logged density, moisture, and sieve test values or using average test values of similar materials.

LIQUEFACTION ZONES

Criteria for Zoning

Areas underlain by materials susceptible to liquefaction during an earthquake were included in liquefaction zones using criteria developed by the Seismic Hazards Mapping Act Advisory Committee and adopted by the California State Mining and Geology Board (DOC, 2000). Under those guideline criteria, liquefaction zones are areas meeting one or more of the following:

1. Areas known to have experienced liquefaction during historical earthquakes

2. All areas of uncompacted artificial fill containing liquefaction-susceptible material that are saturated, nearly saturated, or may be expected to become saturated

3. Areas where sufficient existing geotechnical data and analyses indicate that the soils are potentially liquefiable

4. Areas where existing geotechnical data are insufficient

In areas of limited or no geotechnical data, susceptibility zones may be identified by geologic criteria as follows:

a) Areas containing soil deposits of late Holocene age (current river channels and their historic floodplains, marshes and estuaries), where the M7.5-weighted peak acceleration that has a 10% probability of being exceeded in 50 years is greater than or equal to 0.10 g and the water table is less than 40 feet below the ground surface; or

b) Areas containing soil deposits of Holocene age (less than 11,000 years), where the M7.5-weighted peak acceleration that has a 10% probability of being exceeded in 50 years is greater than or equal to 0.20 g and the historical high water table is less than or equal to 30 feet below the ground surface; or

c) Areas containing soil deposits of latest Pleistocene age (11,000 to 15,000 years), where the M7.5-weighted peak acceleration that has a 10% probability of being exceeded in 50 years is greater than or equal to 0.30 g and the historical high water table is less than or equal to 20 feet below the ground surface.

Application of SMGB criteria to liquefaction zoning in the Canoga Park Quadrangle is summarized below.

Areas of Past Liquefaction

After the Northridge earthquake, ground cracking showing downslope movement, suggestive of lateral spreading, was recorded in the Northridge area, between Tampa and Vanalden avenues just south of Parthenia Street (locality 1, Plate 1.1). A rupture zone trending N20°W, across Napa Street, showed right-lateral offset. The cracks were followed to the north, where their trend became easterly and the sense of offset changed to extensional. The zone of cracks suggests a lateral spread that moved a few centimeters to the southeast (Hart and others, 1995). A N 45 E-trending zone of cracks to the southwest at the intersection of Malden Street and Beckford Avenue formed a graben 4 inches deep and extending for 250-320 feet. Subsurface conditions at this location were investigated by Holzer and others (1996; 1999), who found that sediments in this area are Holocene clayey silts overlying Pleistocene silty sand. Holzer and others (1996; 1999) suggest that shear failure in parts of the Holocene clay may have occurred during the mainshock. Collapse of very soft clayey silt may have contributed to the ground deformation at this location, particularly in the most prominent graben at Malden Street, but the overall downslope movement suggests lateral spreading. Although Holzer and others (1996; 1999) did not find liquefiable sediments at the Malden Street site, there are Holocene interbedded sands and silty sands nearby, particularly to the north and west where the Holocene alluvial basin deposits grade into the adjacent alluvial fans. At a site just northwest of the intersection of Parthenia Street and Tampa Avenue, three of four boreholes collected for this study encountered saturated, Holocene interbedded sands and silty sands. Although clear evidence of liquefaction is lacking, there is evidence of lateral spreading, and liquefiable sediments in the area.

Deformation in this zone was also investigated by Cruikshank and others (1996) who examined surface survey records. They documented a zone of extension trending northeasterly and a parallel zone of compression downslope. Cruikshank and others (1996) show that the deformation in this zone is consistent with shallow blind-thrust faulting, but provide no corroborating evidence that a fault exists. They apparently did not consider the possibility that deformation could be due to shallow downslope movement.

Other zones of cracking in the Northridge and Reseda areas, described by Hart and others (1995), show settlement and offset of pavements, curbs and floor slabs. One locality at Roscoe Boulevard, west of Winnetka Avenue (locality 2, Plate 1.1), suggests "possible incipient lateral spreading" according to Hart and others (1995).

Another zone of ground cracking at Wynne Avenue in Northridge was investigated by Holzer and others (1996; 1999). Damage at that location (locality 3, Plate 1.1) was apparently localized above a silty sand lens within the clayey basin deposits. This locality, however, also corresponds to a step in the contact between relatively compact Pleistocene deposits and soft Holocene deposits. Average SPT blow counts in the silty sand lenses were 20 and 22, yielding factors of safety against liquefaction of less than one, so liquefaction appears likely and could also have caused this ground deformation. The silty sand lens that appears to have been most likely to liquefy, however, is less than 50 m wide from north to south and the other silty sand layer becomes more silty south of the area of failure.

Artificial Fills

In the Canoga Park Quadrangle the only areas of artificial fill large enough to show at the scale of the map are engineered fill for dams and freeways. Generally, the engineered fills are too thin to have an impact on liquefaction hazard and so were not investigated.

Areas with Sufficient Existing Geotechnical Data

The dense consistency of the very old alluvium exposed in the Northridge Hills (Qvoa1) and deep ground water encountered in boreholes that penetrate it indicate a low susceptibility to liquefaction. Accordingly, this geologic unit has not been included in a liquefaction zone in this area.

Older alluvial fans from the Santa Susana Mountains (Qof1) are also generally dense and are located in an area of low groundwater. They are not included in a liquefaction zone.

Older alluvial fan deposits (Qof2) in the eastern part of the Canoga Park Quadrangle are generally silt and silty sand of loose to moderately dense consistency. Such material properties lead to moderate to high liquefaction susceptibility under conditions characterized by the projected earthquake shaking. Although all of this unit does not have high susceptibility, it is not possible to map subunits of moderate and high susceptibility separately. The ground-water table becomes deeper toward the north and the northern portions of this unit do not have ground water within 40 feet of the surface. All younger alluvium, where ground water has been identified less than 40 feet from the surface, is included within a liquefaction zone.

Younger alluvial deposits (Qyf1, Qyf2, Qyt Qw) of the alluvial fans from all sides of the valley contain layers of loose to moderately dense sand or silty sand. Although these units are largely composed of silt and clay, sand layers occur in nearly all boreholes. Such sand layers generally have a factor of safety against liquefaction of less than one in the anticipated earthquake shaking. The low factors of safety indicate generally high liquefaction susceptibility for these units. Ground water becomes deeper to the north, however, so the northern portions of these units have not had recorded ground water within 40 feet of the surface. All younger alluvial fan deposits and stream channel deposits where ground water has been recorded as less than 40 feet from the surface have been included in a liquefaction zone.

Alluvial Basin deposits (Qa) are composed dominantly of clay and silty clay, with few interbeds of sand and silty sand. The clayey deposits have a low liquefaction susceptibility. Within the large alluvial basin deposit in the Reseda-Canoga Park area, sand layers become more common near the Los Angeles River. These sand layers suggest interfingering of basin deposits with alluvial fan deposits from the south or reworking of the material by the Los Angeles River. In any case, factors of safety against liquefaction are less than one for the anticipated ground motion. Those parts of the basin deposits where sandy layers are found have a moderate to high liquefaction susceptibility. For this reason, an area within 3000 feet of the southern boundary and an area within 1000 feet of the northwestern boundary of the alluvial basin deposit are included within liquefaction zones. Liquefaction is possible in minor, thin, discontinuous layers within the remainder of the alluvial basin deposit. Liquefaction of an isolated sandy layer may have caused surface damage at Wynne Avenue in Northridge during the 1994 Northridge Earthquake. Despite this instance of surface damage, the potential for liquefaction is low and confined to small deposits of sandy material that cannot be mapped from the surface. The central and eastern parts of the alluvial basin deposits are not included in a liquefaction zone. The western alluvial basin deposit, on the border of the Canoga Park Quadrangle and the adjacent Calabasas Quadrangle, does not have the sandy layers. The liquefaction susceptibility of this unit is low and it is not included in a liquefaction zone.

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SECTION 2
EARTHQUAKE-INDUCED LANDSLIDE EVALUATION REPORT

Earthquake-Induced Landslide Zones in the Canoga Park 7.5-Minute Quadrangle, Los Angeles County, California

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PURPOSE

The Seismic Hazards Mapping Act (the Act) of 1990 (Public Resources Code, Chapter 7.8, Division 2) directs the California Department of Conservation (DOC), Division of Mines and Geology (DMG) to delineate Seismic Hazard Zones. The purpose of the Act is to reduce the threat to public health and safety and to minimize the loss of life and property by identifying and mitigating seismic hazards. Cities, counties, and state agencies are directed to use seismic hazard zone maps prepared by DMG in their land-use planning and permitting processes. The Act requires that site-specific geotechnical investigations be performed prior to permitting most urban development projects within the hazard zones. Evaluation and mitigation of seismic hazards are to be conducted under guidelines established by the California State Mining and Geology Board (DOC, 1997; also available on the Internet at http://gmw.consrv.ca.gov/shmp/webdocs/sp117.pdf).

This section of the evaluation report summarizes seismic hazard zone mapping for earthquake-induced landslides in the Canoga Park 7.5-minute Quadrangle. This section, along with Section 1 (addressing liquefaction), and Section 3 (addressing earthquake shaking), form a report that is one of a series that summarizes the preparation of seismic hazard zone maps within the state (Smith, 1996). Additional information on seismic hazard zone mapping in California can be accessed on DMG's Internet web page: http://www.conservation.ca.gov/CGS/index.htm

BACKGROUND

Landslides triggered by earthquakes historically have been a significant cause of earthquake damage. In California, large earthquakes such as the 1971 San Fernando, 1989 Loma Prieta, and 1994 Northridge earthquakes triggered landslides that were responsible for destroying or damaging numerous structures, blocking major transportation corridors, and damaging life-line infrastructure. Areas that are most susceptible to earthquake-induced landslides are steep slopes in poorly cemented or highly fractured rocks, areas underlain by loose, weak soils, and areas on or adjacent to existing landslide deposits. These geologic and terrain conditions exist in many parts of California, including numerous hillside areas that have already been developed or are likely to be developed in the future. The opportunity for strong earthquake ground shaking is high in many parts of California because of the presence of numerous active faults. The combination of these factors constitutes a significant seismic hazard throughout much of California, including the hillside areas of the Canoga Park Quadrangle.

METHODS SUMMARY

The mapping of earthquake-induced landslide hazard zones presented in this report is based on the best available terrain, geologic, geotechnical, and seismological data. If unavailable or significantly outdated, new forms of these data were compiled or generated specifically for this project. The following were collected or generated for this evaluation:

- Digital terrain data were used to provide an up-to-date representation of slope gradient and slope aspect in the study area

- Geologic mapping was used to provide an accurate representation of the spatial distribution of geologic materials in the study area. In addition, a map of existing landslides, whether triggered by earthquakes or not, was prepared

- Geotechnical laboratory test data were collected and statistically analyzed to quantitatively characterize the strength properties and dynamic slope stability of geologic materials in the study area

- Seismological data in the form of DMG probabilistic shaking maps and catalogs of strong-motion records were used to characterize future earthquake shaking within the mapped area

The data collected for this evaluation were processed into a series of GIS layers using commercially available software. A slope stability analysis was performed using the Newmark method of analysis (Newmark, 1965), resulting in a map of landslide hazard potential. The earthquake-induced landslide hazard zone was derived from the landslide hazard potential map according to criteria developed in a DMG pilot study (McCrink and Real, 1996) and adopted by the State Mining and Geology Board (DOC, 2000).

SCOPE AND LIMITATIONS

The methodology used to make this map is based on earthquake ground-shaking estimates, geologic material-strength characteristics and slope gradient. These data are gathered from a variety of outside sources. Although the selection of data used in this evaluation was rigorous, the quality of the data is variable. The State of California and the Department of Conservation make no representations or warranties regarding the accuracy of the data gathered from outside sources.

Earthquake-induced landslide zone maps are intended to prompt more detailed, site-specific geotechnical investigations as required by the Act. As such, these zone maps identify areas where the potential for earthquake-induced landslides is relatively high. Due to limitations in methodology, it should be noted that these zone maps do not necessarily capture all potential earthquake-induced landslide hazards. Earthquake-induced ground failures that are not addressed by this map include those associated with ridge-top spreading and shattered ridges. It should also be noted that no attempt has been made to map potential run-out areas of triggered landslides. It is possible that such run-out areas may extend beyond the zone boundaries. The potential for ground failure resulting from liquefaction-induced lateral spreading of alluvial materials, considered by some to be a form of landsliding, is not specifically addressed by the earthquake-induced landslide zone or this report. See Section 1, Liquefaction Evaluation Report for the Canoga Park Quadrangle, for more information on the delineation of liquefaction zones.

The remainder of this report describes in more detail the mapping data and processes used to prepare the earthquake-induced landslide zone map for the Canoga Park Quadrangle. The information is presented in two parts. Part I covers physiographic, geologic and engineering geologic conditions in the study area. Part II covers the preparation of landslide hazard potential and landslide zone maps.

PART I

PHYSIOGRAPHY

Study Area Location and Physiography

The Canoga Park Quadrangle covers approximately 62 square miles of Los Angeles County in the central San Fernando Valley, about 20 miles northwest of the Los Angeles Civic Center. The map includes the Los Angeles City communities of Reseda, Tarzana, Encino, Canoga Park, Woodland Hills, and Northridge. The northern half of the quadrangle includes gently sloping to flat-lying terrain of the San Fernando Valley, hilly areas that form the eastern edge of the Simi Hills near Chatsworth Reservoir in the northwest corner, and low hills in the northeast corner that mark the southeastern end of the Northridge Hills. The southern half of the quadrangle is characterized by hilly and mountainous terrain of the Santa Monica Mountains and gentle to moderate slopes and numerous small knobs in the Chalk Hills, which are bisected by the Ventura Freeway. The crest of the west-trending Santa Monica Mountain range lies near the southern border of the quadrangle. Within the map area, several large north-trending canyons extend from the range crest to the valley floor. Access to the hilly areas is provided by residential streets, dirt roads, and State Highway 27 (Topanga Canyon Boulevard).

Residential and commercial development is concentrated in the flat-lying valley area. Hillside residential development began after World War II and continues at present. Several large residential developments, characterized by mass grading, are under construction. Other land uses include golf courses, Sepulveda Dam Flood Control and Recreation Area, State parkland, and reservoirs. Encino Reservoir is located in the southeast corner, and Chatsworth Reservoir (now dry), is located in the northwest part of the quadrangle.

Digital Terrain Data

The calculation of slope gradient is an essential part of the evaluation of slope stability under earthquake conditions. An accurate slope gradient calculation begins with an up-to-date map representation of the earth’s surface. Within the Canoga Park Quadrangle, a Level 2 digital elevation model (DEM) was obtained from the USGS (U.S. Geological Survey, 1993). This DEM, which was prepared from the 7.5-minute quadrangle topographic contours that are based on 1927 aerial photography, has a 10-meter horizontal resolution and a 7.5-meter vertical accuracy.

To update the terrain data, areas that have recently undergone large-scale grading in the hilly portions of the Canoga Park Quadrangle, essentially the Santa Monica Mountains, were identified (see Plate 2.1). Terrain data for these areas were obtained from an airborne interferometric radar (TOPSAR) DEM flown and processed in August 1994 by NASA’s Jet Propulsion Laboratory (JPL), and processed by Calgis, Inc. (GeoSAR Consortium, 1995; 1996). The terrain data were also smoothed and filtered prior to analysis. This corrected terrain data was digitally merged with the USGS DEM.

A slope map was made from the DEM using a third-order, finite difference, center-weighted algorithm (Horn, 1981). The DEM was also used to make a slope aspect map. The manner in which the slope and aspect maps were used to prepare the zone map will be described in subsequent sections of this report.

GEOLOGY

Bedrock and Surficial Geology

For the Canoga Park Quadrangle, a recently compiled geologic map was obtained from the U.S. Geological Survey (USGS) in digital form (Yerkes and Campbell, 1993). In the field, observations were made of exposures, aspects of weathering, and general surface expression of the geologic units. In addition, the relation of the various geologic units to development and abundance of landslides was noted.

The oldest geologic unit mapped in the Canoga Park Quadrangle is the Jurassic Santa Monica Slate (Yerkes and Campbell map symbols Jsm and Jsms), which is exposed in the southeast corner of the quadrangle. Locally, it consists of intensely jointed and fractured slate and phyllite with well-developed slaty cleavage and a thick weathered zone characterized by angular chips and thin slabs of slate surrounded by clay. The spotted slate (Jsms) contains abundant crystals of cordierite believed to have formed as a result of contact metamorphism of the Santa Monica Slate by granitic intrusions. Cretaceous granite, quartz diorite, and granodiorite are exposed in the southeast, near Encino Reservoir (Kgr). Locally, at the surface, the granitic rocks are soft and crumbly due to weathering.

Overlying the Jurassic slate is a sequence of Upper Cretaceous marine clastic rocks of the Tuna Canyon Formation (massive pebble conglomerate, sandstone, and thin-bedded shale; Ktc) and Trabuco Formation (cobble conglomerate and soft, red, clayey sandstone; Kt). The Upper Cretaceous Chatsworth Formation (Kc) is mapped in the northwest corner of the quadrangle and consists of massive, thick-bedded marine sandstone and conglomerate interbedded with siltstone and mudstone. The Chatsworth Formation is overlain by unnamed Paleocene and/or Eocene strata (conglomerate and coarse-grained sandstone; Tss), which may be equivalent to the Simi Conglomerate or Santa Susana Formation in the Simi Valley area.

Other Tertiary bedrock formations include the upper Eocene to lower Miocene Sespe Formation (nonmarine sandstone, mudstone and conglomerate; Ts) and middle MioceneTopanga Group (interbedded conglomerate, massive sandstone, concretionary shale and siltstone, and basaltic or andesitic breccia; Tt, Ttc, Ttcc, and Tcob). Basaltic and diabasic volcanic rocks (Ti) intrude middle Miocene and older strata. The upper Miocene Modelo Formation is the most widely exposed bedrock unit in the quadrangle and is composed of interbedded deep marine clay shale, siltstone, and sandstone (Tm), diatomaceous shale and siltstone (Tmd), and massive, fine- to coarse-grained sandstone (Tms). Bedding in the Modelo Formation typically dips in the same direction as the slopes in the area (northward), creating slope-stability problems.

Plio-Pleistocene bedrock units in the area include the Pico and Saugus formations. The Pico Formation (QTp) locally consists of marine fossiliferous siltstone and soft, friable sandstone. In the northeast corner of the quadrangle, nonmarine sandstone, conglomerate and siltstone of the upper Saugus Formation (Qs) are exposed in the Northridge Hills. This unit is characterized by coarse clastic beds composed of angular fragments of porcelaneous shale and sandstone in a silty matrix cemented by caliche, separated by beds of massive siltstone.

Quaternary surficial deposits cover the floor and margins of the San Fernando Valley and extend southward up into the canyons in the Santa Monica Mountains. They generally consist of older and younger alluvial fan and basin deposits of upper Pleistocene and Holocene age (Qa, Qf, Qof1, Qof2, Qt, Qvoa1, Qw, Qyf1, Qyf2, and Qyt). Unconsolidated silt- and clayey silt deposits (res) are mapped in the dry bed of Chatsworth Reservoir. Modern man-made (artificial) fills (af) are also mapped in some areas. Landslides (Qls and Qls?) are widespread in the Canoga Park Quadrangle, occurring primarily on dip slopes in the Modelo Formation. A more detailed discussion of the Quaternary deposits in the Canoga Park Quadrangle can be found in Section 1.

Landslide Inventory

As a part of the geologic data compilation, an inventory of existing landslides in the Canoga Park Quadrangle was prepared (Irvine, unpublished) by combining field observations, analysis of aerial photos (NASA,1994 a and 1994 b; and USDA, 1952/53; see Air Photos in References), and interpretation of landforms on current and older topographic maps. Also consulted during the mapping process were previous maps and reports that contain geologic and landslide data (Byer, 1987; Dibblee, 1992; Harp and Jibson, 1995; Hoots, 1930; Los Angeles Dept. of Public Works, 1963; Weber and others, 1979; Weber and Wills, 1983; Weber and Frasse, 1984; and Yerkes and Campbell, 1993). Landslides were mapped and digitized at a scale of 1:24,000. For each landslide included on the map a number of characteristics (attributes) were compiled. These characteristics include the confidence of interpretation (definite, probable and questionable) and other properties, such as activity, thickness, and associated geologic unit(s). Landslides rated as definite and probable were carried into the slope stability analysis. Landslides rated as questionable were not carried into the slope stability analysis due to the uncertainty of their existence. All landslides on the digital geologic map (Yerkes and Campbell, 1993) were verified or re-mapped during preparation of the inventory map. To keep the landslide inventory of consistent quality, all landslides originally depicted on the digitized geologic map were deleted, and only those included in the DMG inventory were incorporated into the hazard-evaluation process. A version of this landslide inventory is included with Plate 2.1.

ENGINEERING GEOLOGY

Geologic Material Strength

To evaluate the stability of geologic materials under earthquake conditions, the geologic map units described above were ranked and grouped on the basis of their shear strength. Generally, the primary source for rock shear-strength measurements is geotechnical reports prepared by consultants on file with local government permitting departments. Shear-strength data for the rock units identified on the Canoga Park Quadrangle geologic map were obtained from the City of Los Angeles, Department of Public Works (see Appendix A). The locations of rock and soil samples taken for shear testing by consultants are shown on Plate 2.1. When available, shear tests from adjacent quadrangles were used to augment data for geologic formations that had little or no shear test information.

Shear strength data gathered from the above sources were compiled for each geologic map unit. Geologic units were grouped on the basis of average angle of internal friction (average phi) and lithologic character. Average (mean and median) phi values for each geologic map unit and corresponding strength group are summarized in Table 2.1. For most of the geologic strength groups in the map area, a single shear strength value was assigned and used in our slope stability analysis. A geologic material strength map was made based on the groupings presented in Tables 2.1 and 2.2, and this map provides a spatial representation of material strength for use in the slope stability analysis.

CANOGA PARK QUADRANGLE
SHEAR STRENGTH GROUPINGS

	Formation Name	Number Tests	Mean/Median Phi	Mean/Median (Group phi) (deg)	Group Mean/Median C (psf)	No Data: Similar Geologic Strength	Phi Values Used in Stability Analysis
GROUP 1	Tep	2	46/46	39.3 / 34	532/350	Kgr, Kt, Ktc, Ti	39
	Kc	2	32.5/32.5			Ttc, Ttcc, Tcob	
GROUP 2	Jsm	4	32.9/32.0	32.9/32.0	521/500	Jsms, Ts	32
GROUP 3	Qay2	25	31.5/31			af, Qf, Qfy2, Qof1	
	Qa	27	27.9/27			Qof2, Qs, QTp, Qt	
	Tms	14	28.2/29.5	29.0/29.0	326/200	Qu, Qvoa1, Qyf1	29
	Tt	1	30/30			Qyf2,Qw, Qyt	
GROUP 4	Tm	15	25.1/26	25.1/26	321/240		25
GROUP 5	Tmd	25	19.9/19	19.9/19	344/300		20
GROUP 6	Qls	-	-	-	-		10

abc = adverse bedding condition, fine-grained material strength
fbc = favorable bedding condition, coarse-grained material strength

Table 2.1. Summary of the Shear Strength Statistics for the Canoga Park Quadrangle.

SHEAR STRENGTH GROUPS
FOR THE CANOGA PARK QUADRANGLE

GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6
Kc	Jsm	af	Tm	Tmd	Qls
Kgr	Jsms	Qa			
Kt	Ts	Qf			
Ktc		Qfy2			
Ttc		Qof1,2			
Ttcc		Qs			
Tcob		Qt			
Tss		QTp			
Ti		Qu			
		Qvoa1			
		Qw			
		Qyf1,2			
		Qyt			
		Tms			
		Tt			
		Ttc			

Table 2.2. Summary of the Shear Strength Groups for the Canoga Park Quadrangle.

Adverse Bedding Conditions

Adverse bedding conditions are an important consideration in slope stability analyses. Adverse bedding conditions occur where the dip direction of bedded sedimentary rocks is roughly the same as the slope aspect, and where the dip magnitude is less than the slope gradient. Under these conditions, landslides can slip along bedding surfaces due to a lack of lateral support.

To account for adverse bedding in our slope stability evaluation, we used geologic structural data in combination with digital terrain data to identify areas with potentially adverse bedding, using methods similar to those of Brabb (1983). The structural data, derived from the geologic map database, was used to categorize areas of common bedding dip direction and magnitude. The dip direction was then compared to the slope aspect and, if the same, the dip magnitude and slope gradient categories were compared. If the dip magnitude was less than or equal to the slope gradient category but greater than 25% (4:1 slope), the area was marked as a potential adverse bedding area.

The formations, which contain interbedded sandstone and shale, were subdivided based on shear strength differences between coarse-grained (higher strength) and fine-grained (lower strength) lithologies. Shear strength values for the fine- and coarse-grained lithologies were then applied to areas of favorable and adverse bedding orientation, which were determined from structural and terrain data as discussed above. It was assumed that coarse-grained material (higher strength) dominates where bedding dips into a slope (favorable bedding) while fine-grained (lower strength) material dominates where bedding dips out of a slope (adverse bedding). The geologic material strength map was modified by assigning the lower, fine-grained shear strength values to areas where potential adverse bedding conditions were identified. The favorable and adverse bedding shear strength parameters for the formations are included in Table 2.1.

Existing Landslides

The strength characteristics of existing landslides (Qls) must be based on tests of the materials along the landslide slip surface. Ideally, shear tests of slip surfaces formed in each mapped geologic unit would be used. However, this amount of information is rarely available, and for the preparation of the earthquake-induced landslide zone map it has been assumed that all landslides within the quadrangle have the same slip surface strength parameters. We collect and use primarily "residual" strength parameters from laboratory tests of slip surface materials tested in direct shear or ring shear test equipment. Back-calculated strength parameters, if the calculations appear to have been performed appropriately, have also been used.

PART II

EARTHQUAKE-INDUCED LANDSLIDE HAZARD POTENTIAL

Design Strong-Motion Record

To evaluate earthquake-induced landslide hazard potential in the study area, a method of dynamic slope stability analysis developed by Newmark (1965) was used. The Newmark method analyzes dynamic slope stability by calculating the cumulative down-slope displacement for a given earthquake strong-motion time history. As implemented for the preparation of earthquake-induced landslide zones, the Newmark method necessitates the selection of a design earthquake strong-motion record to provide the "ground shaking opportunity." For the Canoga Park Quadrangle, selection of a strong motion record was based on an estimation of probabilistic ground motion parameters for modal magnitude, modal distance, and peak ground acceleration (PGA). The parameters were estimated from maps prepared by DMG for a 10% probability of being exceeded in 50 years (Petersen and others, 1996). The parameters used in the record selection are:

Modal Magnitude:	6.6 to 7.1
Modal Distance:	5 to 16 km
PGA:	0.42 to 0.7 g

The strong-motion record selected for the slope stability analysis in the Canoga Park Quadrangle was the Channel 3 (N35°E horizontal component) University of Southern California Station # 14 recording from the magnitude 6.7 Northridge Earthquake (Trifunac and others, 1994). This record had a source to recording site distance of 8.5 km and a peak ground acceleration (PGA) of 0.59 g. The selected strong-motion record was not scaled or otherwise modified prior to its use in the analysis.

Displacement Calculation

The design strong-motion record was used to develop a relationship between landslide displacement and yield acceleration (a_y), defined as the earthquake horizontal ground acceleration above which landslide displacements take place. This relationship was prepared by integrating the design strong-motion record twice for a given acceleration value to find the corresponding displacement, and the process was repeated for a range of acceleration values (Jibson, 1993). The resulting curve in Figure 2.1 represents the full spectrum of displacements that can be expected for the design strong-motion record.

This curve provides the required link between anticipated earthquake shaking and estimates of displacement for different combinations of geologic materials and slope gradient, as described in the Slope Stability Analysis section below.

The amount of displacement predicted by the Newmark analysis provides an indication of the relative amount of damage that could be caused by earthquake-induced landsliding. Displacements of 30, 15 and 5 cm were used as criteria for rating levels of earthquake-induced landslide hazard potential based on the work of Youd (1980), Wilson and Keefer (1983), and a DMG pilot study for earthquake-induced landslides (McCrink and Real, 1996). Applied to the curve in Figure 2.1, these displacements correspond to yield accelerations of 0.076, 1.29 and 0.232 g. Because these yield acceleration values are derived from the design strong-motion record, they represent the ground shaking opportunity thresholds that are significant in the Canoga Park Quadrangle.

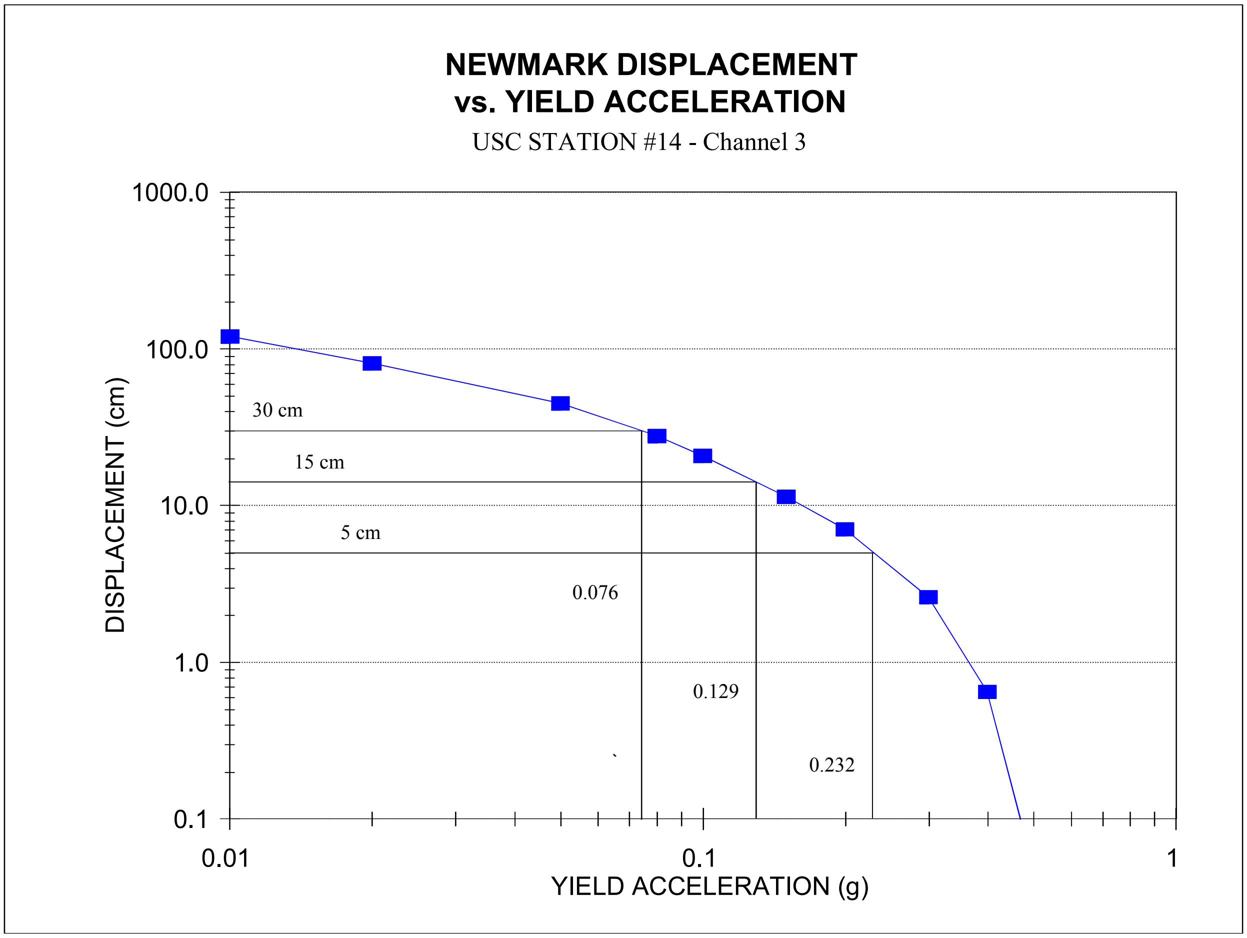

Figure 2.1. Yield Acceleration vs. Newmark Displacement for the USC Station # 14 Strong-Motion Record from the 17 January 1994 Northridge, California Earthquake.

Slope Stability Analysis

A slope stability analysis was performed for each geologic material strength group at slope increments of 1 degree. An infinite-slope failure model under unsaturated slope conditions was assumed. A factor of safety was calculated first, followed by the calculation of yield acceleration from Newmark's equation:

$$a_y = (FS - 1)g \sin \alpha$$

where FS is the Factor of Safety, g is the acceleration due to gravity, and α is the direction of movement of the slide mass, in degrees measured from the horizontal, when displacement is initiated (Newmark, 1965). For an infinite slope failure α is the same as the slope angle.

The yield accelerations resulting from Newmark's equations represent the susceptibility to earthquake-induced failure of each geologic material strength group for a range of slope gradients. Based on the relationship between yield acceleration and Newmark displacement shown in Figure 2.1, hazard potentials were assigned as follows:

1. If the calculated yield acceleration was less than 0.076g, Newmark displacement greater than 30 cm is indicated, and a HIGH hazard potential was assigned (H on Table 2.3)

2. If the calculated yield acceleration fell between 0.076g and 0.129g, Newmark displacement between 15 cm and 30 cm is indicated, and a MODERATE hazard potential was assigned (M on Table 2.3)

3. If the calculated yield acceleration fell between 0.129g and 0.232g, Newmark displacement between 5 cm and 15 cm is indicated, and a LOW hazard potential was assigned (L on Table 2.3)

4. If the calculated yield acceleration was greater than 0.232g, Newmark displacement of less than 5 cm is indicated, and a VERY LOW potential was assigned (VL on Table 2.3)

Table 2.3 summarizes the results of the stability analyses. The earthquake-induced landslide hazard potential map was prepared by combining the geologic material-strength map and the slope map according to this table.

CANOGA PARK QUADRANGLE HAZARD POTENTIAL MATRIX

Geologic Material Group	MEAN PHI	SLOPE CATEGORY (% SLOPE) I 0-13	II 14-22	III 23-27	IV 28-31	V 32-37	VI 38-47	VII 48-54	VIII 55-66	IX 67-72	X >72 percent
1	39	VL	VL	VL	VL	VL	VL	VL	L	M	H
2	32	VL	VL	VL	VL	VL	L	L	H	H	H
3	29	VL	VL	VL	VL	L	L	H	H	H	H
4	25	VL	VL	L	L	L	M	H	H	H	H
5	20	VL	L	M	H	H	H	H	H	H	H

Table 2.3. Hazard Potential Matrix for Earthquake-Induced Landslides in the Canoga Park Quadrangle. Shaded area indicates hazard potential levels included within the hazard zone. H = High, M = Moderate, L = Low, VL = Very Low.

EARTHQUAKE-INDUCED LANDSLIDE HAZARD ZONE

Criteria for Zoning

Earthquake-induced landslide zones were delineated using criteria adopted by the California State Mining and Geology Board (DOC, 2000). Under these criteria, earthquake-induced landslide hazard zones are defined as areas that meet one or both of the following conditions:

1. Areas that have been identified as having experienced landslide movement in the past, including all mappable landslide deposits and source areas as well as any landslide that is known to have been triggered by historic earthquake activity.

2. Areas where the geologic and geotechnical data and analyses indicate that the earth materials may be susceptible to earthquake-induced slope failure.

These conditions are discussed in further detail in the following sections.

Existing Landslides

Existing landslides typically consist of disrupted soils and rock materials that are generally weaker than adjacent undisturbed rock and soil materials. Previous studies indicate that existing landslides can be reactivated by earthquake movements (Keefer, 1984). Earthquake-triggered movement of existing landslides is most pronounced in steep head scarp areas and at the toe of existing landslide deposits. Although reactivation of deep-seated landslide deposits is less common (Keefer, 1984), a significant number of deep-seated landslide movements have occurred during, or soon after, several recent earthquakes. Based on these observations, all existing landslides with a definite or probable confidence rating are included within the earthquake-induced landslide hazard zone.

No earthquake-triggered landslides had been identified in the Canoga Park Quadrangle prior to the Northridge earthquake. The Northridge earthquake caused a number of relatively small, shallow slope failures in the Canoga Park Quadrangle (Harp and Jibson, 1995). Landslides attributed to the Northridge earthquake covered approximately 40 acres of land in the quadrangle, which is less than 1/2 of 1 percent of the total area covered by the map. Of the area covered by these Northridge earthquake landslides, 76% falls within the area of the hazard zone based on a computer comparison of the zone map and the Harp and Jibson (1995) inventory.

Geologic and Geotechnical Analysis

Based on the conclusions of a pilot study performed by DMG (McCrink and Real, 1996), it has been concluded that earthquake-induced landslide hazard zones should encompass all areas that have a High, Moderate or Low level of hazard potential (see Table 2.3). This would include all areas where the analyses indicate earthquake displacements of 5 centimeters or greater. Areas with a Very Low hazard potential, indicating less than 5 centimeters displacement, are excluded from the zone.

As summarized in Table 2.3, all areas characterized by the following geologic strength group and slope gradient conditions are included in the earthquake-induced landslide hazard zone:

1. Geologic Strength Group 6 is included for all slope gradient categories. (Note: Geologic Strength Group 6 includes all mappable landslides with a definite or probable confidence rating).

2. Geologic Strength Group 5 is included for all slopes steeper than 14 percent.

3. Geologic Strength Group 4 is included for all slopes steeper than 23 percent.

4. Geologic Strength Group 3 is included for all slopes steeper than 32 percent.

5. Geologic Strength Group 2 is included for all slopes greater than 38 percent.

6. Geologic Strength Group 1 is included for all slopes greater than 55 percent.

This results in approximately 12 percent of the quadrangle lying within the earthquake-induced landslide hazard zone for the Canoga Park Quadrangle.

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APPENDIX A
SOURCE OF ROCK STRENGTH DATA

SOURCE	NUMBER OF TESTS SELECTED
City of Los Angeles, Department of Public Works Material Engineering Division	**115**
Total number of shear tests used to characterize the units in the Canoga Park Quadrangle	**115**

SECTION 3
GROUND SHAKING EVALUATION REPORT

Potential Ground Shaking in the Canoga Park 7.5-Minute Quadrangle, Los Angeles County, California

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PURPOSE

The Seismic Hazards Mapping Act (the Act) of 1990 (Public Resources Code, Chapter 7.8, Division 2) directs the California Department of Conservation (DOC), Division of Mines and Geology (DMG) to delineate Seismic Hazard Zones. The purpose of the Act is to reduce the threat to public health and safety and to minimize the loss of life and property by identifying and mitigating seismic hazards. Cities, counties, and state agencies are directed to use the Seismic Hazard Zone Maps in their land-use planning and permitting processes. The Act requires that site-specific geotechnical investigations be performed prior to permitting most urban development projects within the hazard zones. Evaluation and mitigation of seismic hazards are to be conducted under guidelines established by the California State Mining and Geology Board (DOC, 1997; also available on the Internet at http://gmw.consrv.ca.gov/shmp/webdocs/sp117.pdf).

This section of the evaluation report summarizes the ground motions used to evaluate liquefaction and earthquake-induced landslide potential for zoning purposes. Included are ground motion and related maps, a brief overview on how these maps were prepared, precautionary notes concerning their use, and related references. The maps provided herein are presented at a scale of approximately 1:150,000 (scale bar provided on maps), and show the full 7.5-minute quadrangle and portions of the adjacent eight quadrangles. They can be used to assist in the specification of earthquake loading conditions ***for the analysis of ground failure*** according to the "Simple Prescribed Parameter Value" method (SPPV) described in the site investigation guidelines (California Department of Conservation, 1997). Alternatively, they can be used as a basis for comparing levels of ground motion determined by other methods with the statewide standard.

This section and Sections 1 and 2 (addressing liquefaction and earthquake-induced landslide hazards) constitute a report series that summarizes development of seismic hazard zone maps in the state. Additional information on seismic hazard zone mapping in California can be accessed on DMG's Internet homepage: http://www.conservation.ca.gov/CGS/index.htm

EARTHQUAKE HAZARD MODEL

The estimated ground shaking is derived from the statewide probabilistic seismic hazard evaluation released cooperatively by the California Department of Conservation, Division of Mines and Geology, and the U.S. Geological Survey (Petersen and others, 1996). That report documents an extensive 3-year effort to obtain consensus within the scientific community regarding fault parameters that characterize the seismic hazard in California. Fault sources included in the model were evaluated for long-term slip rate, maximum earthquake magnitude, and rupture geometry. These fault parameters, along with historical seismicity, were used to estimate return times of moderate to large earthquakes that contribute to the hazard.

The ground shaking levels are estimated for each of the sources included in the seismic source model using attenuation relations that relate earthquake shaking with magnitude, distance from the earthquake, and type of fault rupture (strike-slip, reverse, normal, or subduction). The published hazard evaluation of Petersen and others (1996) only considers uniform firm-rock site conditions. In this report, however, we extend the hazard analysis to include the hazard of exceeding peak horizontal ground acceleration (PGA) at 10% probability of exceedance in 50 years on spatially uniform conditions of rock, soft rock, and alluvium. These soil and rock conditions approximately correspond to site categories defined in Chapter 16 of the Uniform Building Code (ICBO, 1997), which are commonly found in California. We use the attenuation relations of Boore and others (1997), Campbell (1997), Sadigh and others (1997), and Youngs and others (1997) to calculate the ground motions.

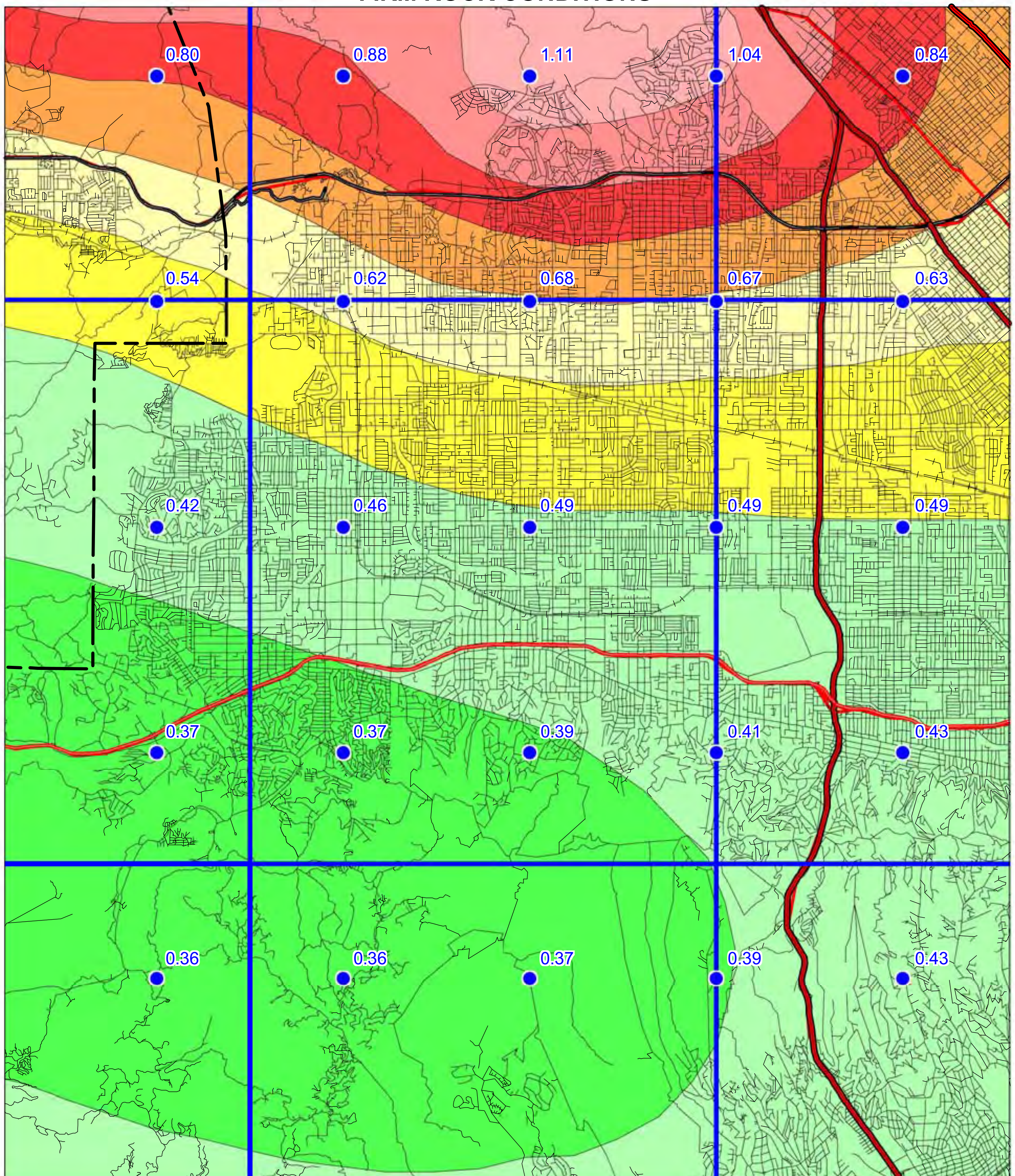
The seismic hazard maps for ground shaking are produced by calculating the hazard at sites separated by about 5 km. Figures 3.1 through 3.3 show the hazard for PGA at 10% probability of exceedance in 50 years assuming the entire map area is firm rock, soft rock, or alluvial site conditions respectively. The sites where the hazard is calculated are represented as dots and ground motion contours as shaded regions. The quadrangle of interest is outlined by bold lines and centered on the map. Portions of the eight adjacent

CANOGA PARK 7.5 MINUTE QUADRANGLE AND PORTIONS OF ADJACENT QUADRANGLES

10% EXCEEDANCE IN 50 YEARS PEAK GROUND ACCELERATION (g)

1998

FIRM ROCK CONDITIONS



Base map modified from MapInfo StreetWorks ©1998 MapInfo Corporation

0 2.5 5
Kilometers

Department of Conservation
Division of Mines and Geology

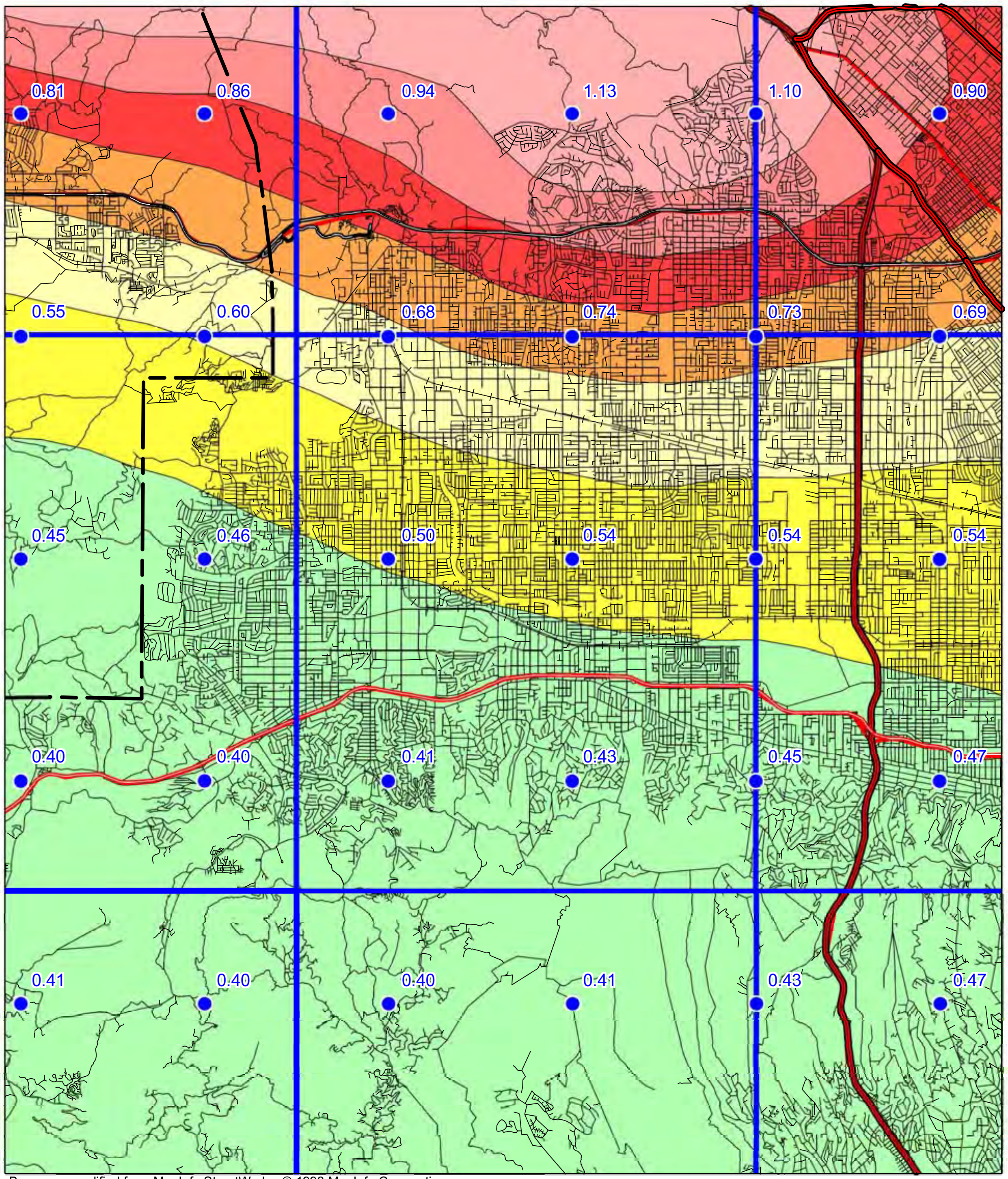
Figure 3.1

CANOGA PARK 7.5 MINUTE QUADRANGLE AND PORTIONS OF ADJACENT QUADRANGLES

10% EXCEEDANCE IN 50 YEARS PEAK GROUND ACCELERATION (g)

1998

SOFT ROCK CONDITIONS



0 2.5 5
Kilometers

Department of Conservation
Division of Mines and Geology

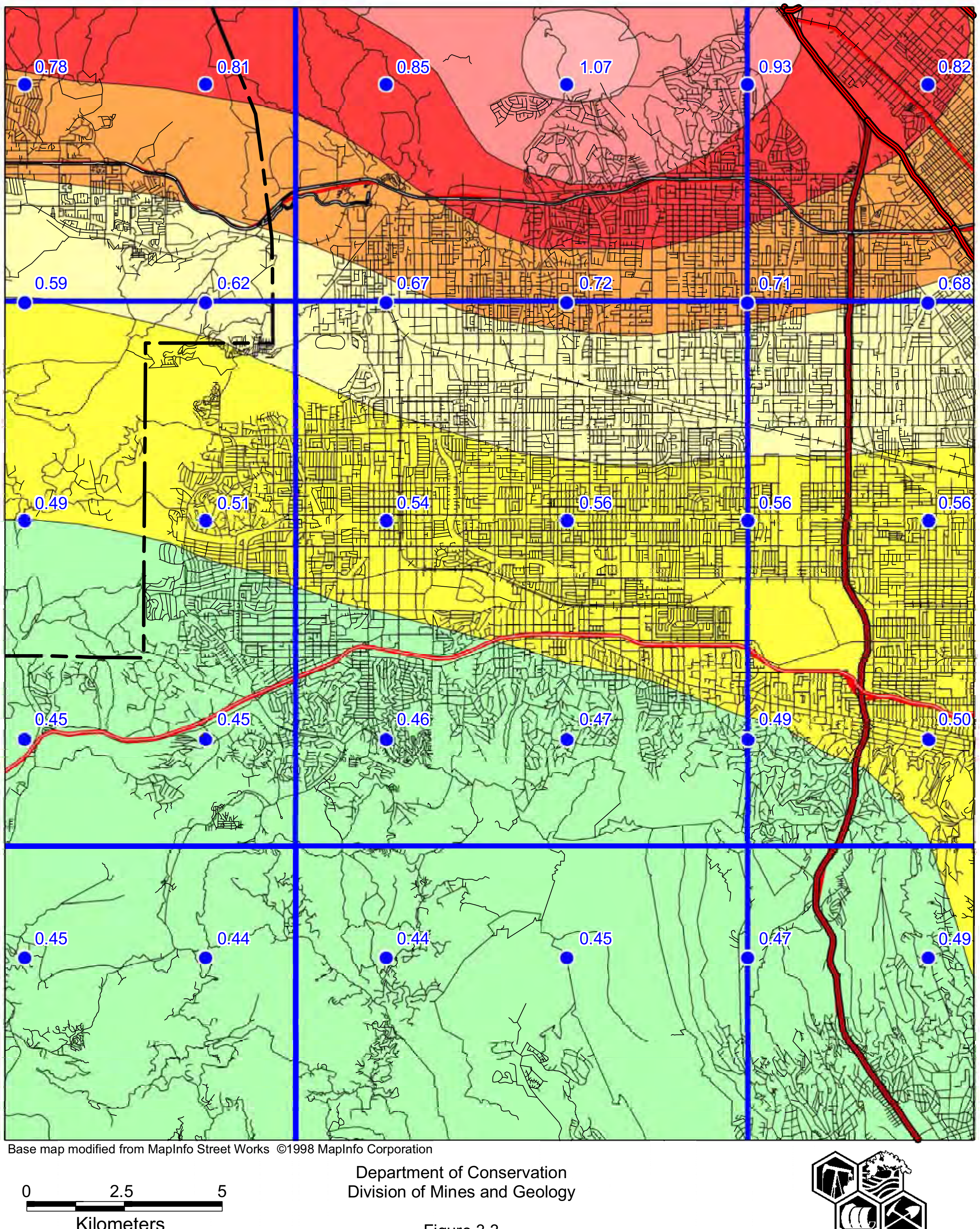
Figure 3.2

CANOGA PARK 7.5 MINUTE QUADRANGLE AND PORTIONS OF ADJACENT QUADRANGLES

10% EXCEEDANCE IN 50 YEARS PEAK GROUND ACCELERATION (g)

1998

ALLUVIUM CONDITIONS



Department of Conservation
Division of Mines and Geology

Figure 3.3

quadrangles are also shown so that the trends in the ground motion may be more apparent. We recommend estimating ground motion values by selecting the map that matches the actual site conditions, and interpolating from the calculated values of PGA rather than the contours, since the points are more accurate.

APPLICATIONS FOR LIQUEFACTION AND LANDSLIDE HAZARD ASSESSMENTS

Deaggregation of the seismic hazard identifies the contribution of each of the earthquakes (various magnitudes and distances) in the model to the ground motion hazard for a particular exposure period (see Cramer and Petersen, 1996). The map in Figure 3.4 identifies the magnitude and the distance (value in parentheses) of the earthquake that contributes most to the hazard at 10% probability of exceedance in 50 years on alluvial site conditions (*predominant earthquake*). This information gives a rationale for selecting a seismic record or ground motion level in evaluating ground failure. However, it is important to keep in mind that more than one earthquake may contribute significantly to the hazard at a site, and those events can have markedly different magnitudes and distances. For liquefaction hazard the predominant earthquake magnitude from Figure 3.4 and PGA from Figure 3.3 (alluvium conditions) can be used with the Youd and Idriss (1997) approach to estimate cyclic stress ratio demand. For landslide hazard the predominant earthquake magnitude and distance can be used to select a seismic record that is consistent with the hazard for calculating the Newmark displacement (Wilson and Keefer, 1983). When selecting the predominant earthquake magnitude and distance, it is advisable to consider the range of values in the vicinity of the site and perform the ground failure analysis accordingly. This would yield a range in ground failure hazard from which recommendations appropriate to the specific project can be made. Grid values for predominant earthquake magnitude and distance should **not** be interpolated at the site location, because these parameters are not continuous functions.

A preferred method of using the probabilistic seismic hazard model and the "simplified Seed-Idriss method" of assessing liquefaction hazard is to apply magnitude scaling probabilistically while calculating peak ground acceleration for alluvium. The result is a "magnitude-weighted" ground motion (liquefaction opportunity) map that can be used directly in the calculation of the cyclic stress ratio threshold for liquefaction and for estimating the factor of safety against liquefaction (Youd and Idriss, 1997). This can provide a better estimate of liquefaction hazard than use of predominate magnitude described above, because all magnitudes contributing to the estimate are used to weight the probabilistic calculation of peak ground acceleration (Real and others, 2000). Thus, large distant earthquakes that occur less frequently but contribute *more* to the liquefaction hazard are appropriately accounted for.

Figure 3.5 shows the magnitude-weighted alluvial PGA based on Idriss' weighting function (Youd and Idriss, 1997). It is important to note that the values obtained from this map are pseudo-accelerations and should be used in the formula for factor of safety without any magnitude-scaling (a factor of 1) applied.

CANOGA PARK 7.5 MINUTE QUADRANGLE AND PORTIONS OF ADJACENT QUADRANGLES

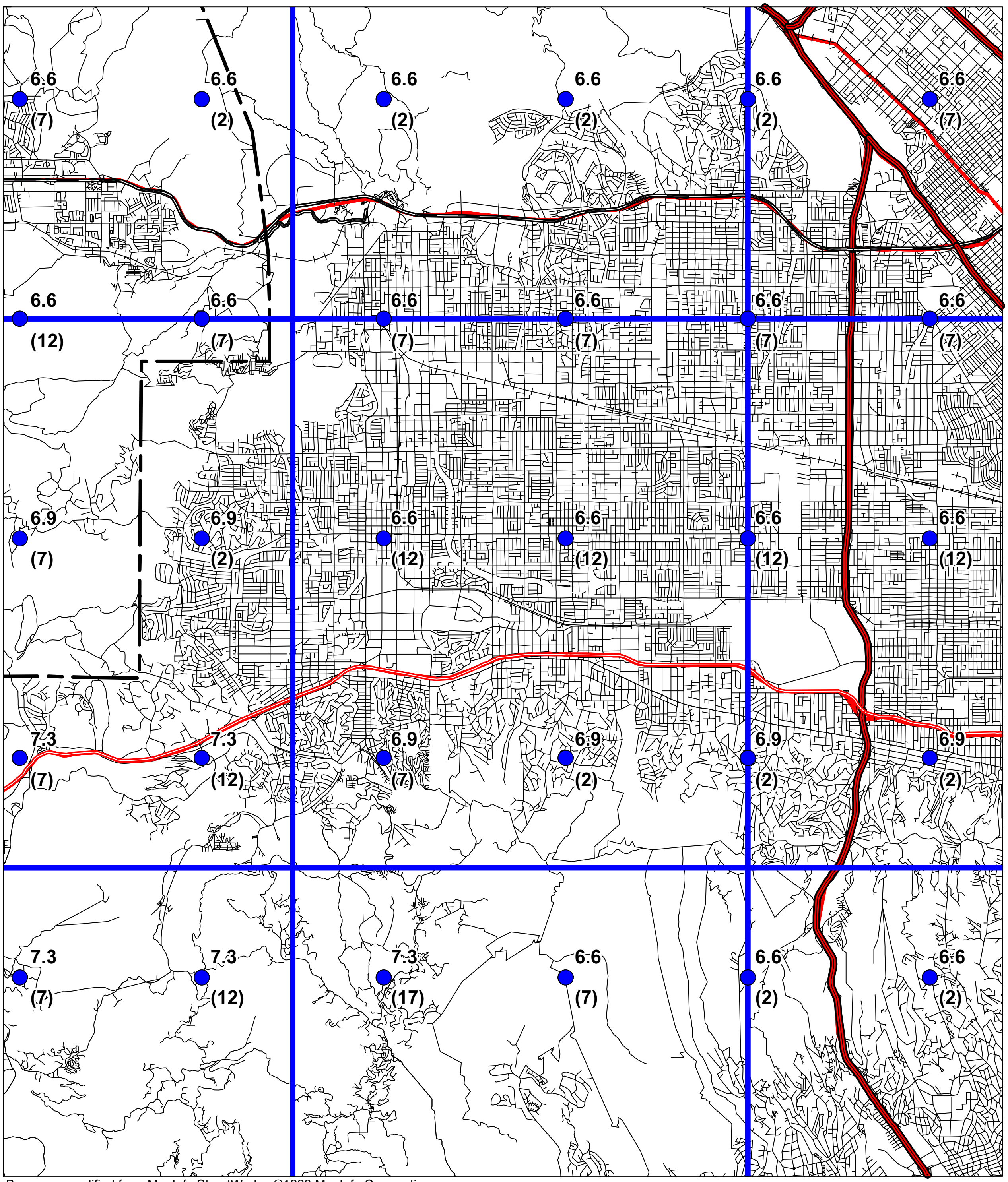
10% EXCEEDANCE IN 50 YEARS PEAK GROUND ACCELERATION

1998

PREDOMINANT EARTHQUAKE

Magnitude (Mw)

(Distance (km))



0 2.5 5
Kilometers

Department of Conservation
Division of Mines and Geology

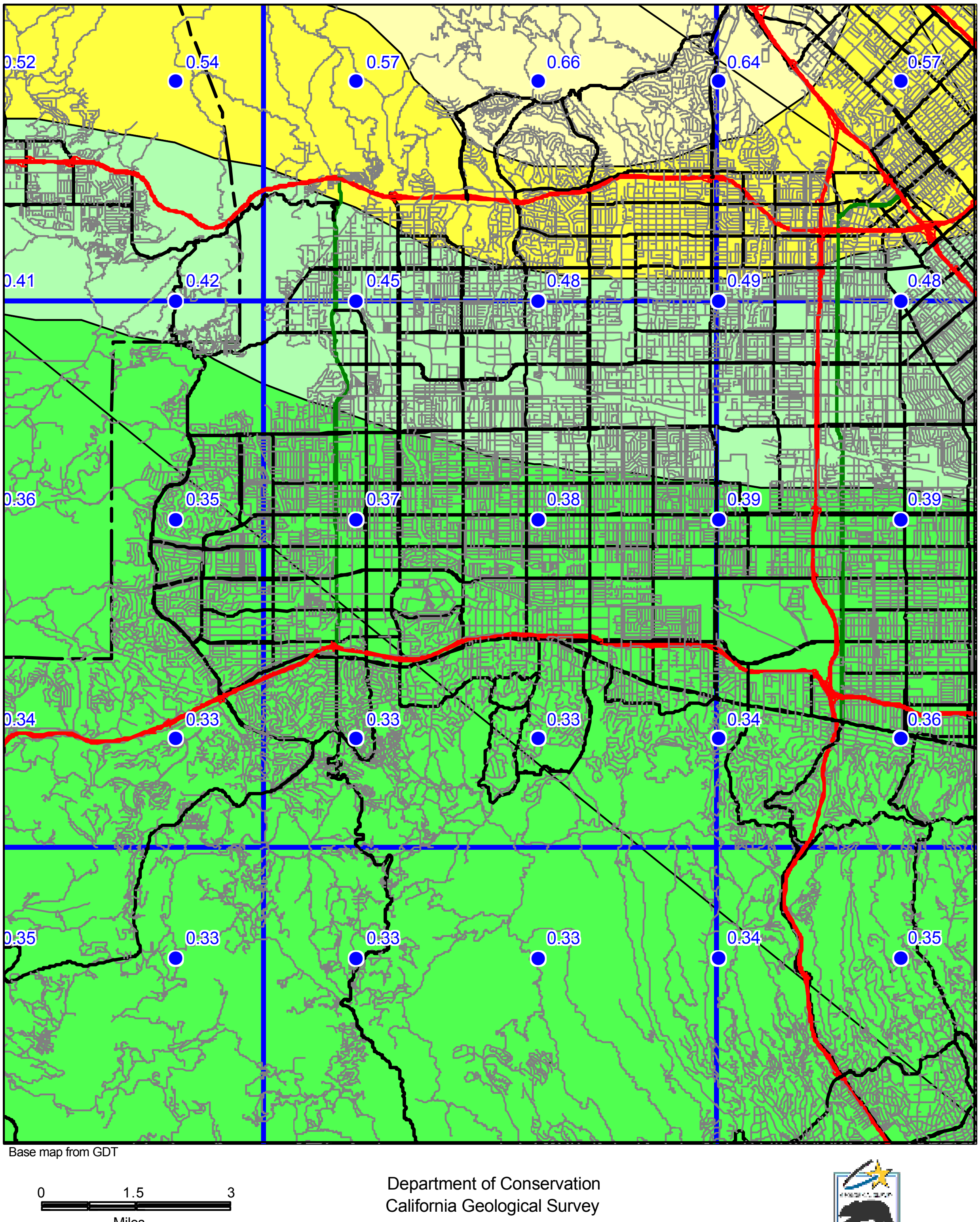
Figure 3.4

CANOGA PARK 7.5-MINUTE QUADRANGLE AND PORTIONS OF ADJACENT QUADRANGLES

10% EXCEEDANCE IN 50 YEARS MAGNITUDE-WEIGHTED PSEUDO-PEAK ACCELERATION (g) FOR ALLUVIUM

1998

LIQUEFACTION OPPORTUNITY



Department of Conservation
California Geological Survey

Figure 3.5

USE AND LIMITATIONS

The statewide map of seismic hazard has been developed using regional information and is ***not appropriate for site specific structural design applications***. Use of the ground motion maps prepared at larger scale is limited to estimating earthquake loading conditions for preliminary assessment of ground failure at a specific location. We recommend consideration of site-specific analyses before deciding on the sole use of these maps for several reasons.

1. The seismogenic sources used to generate the peak ground accelerations were digitized from the 1:750,000-scale fault activity map of Jennings (1994). Uncertainties in fault location are estimated to be about 1 to 2 kilometers (Petersen and others, 1996). Therefore, differences in the location of calculated hazard values may also differ by a similar amount. At a specific location, however, the log-linear attenuation of ground motion with distance renders hazard estimates less sensitive to uncertainties in source location.

2. The hazard was calculated on a grid at sites separated by about 5 km (0.05 degrees). Therefore, the calculated hazard may be located a couple kilometers away from the site. We have provided shaded contours on the maps to indicate regional trends of the hazard model. However, the contours only show regional trends that may not be apparent from points on a single map. Differences of up to 2 km have been observed between contours and individual ground acceleration values. *We recommend that the user interpolate PGA between the grid point values rather than simply using the shaded contours*.

3. Uncertainties in the hazard values have been estimated to be about +/- 50% of the ground motion value at two standard deviations (Cramer and others, 1996).

4. Not all active faults in California are included in this model. For example, faults that do not have documented slip rates are not included in the source model. Scientific research may identify active faults that have not been previously recognized. Therefore, future versions of the hazard model may include other faults and omit faults that are currently considered.

5. A map of the predominant earthquake magnitude and distance is provided from the deaggregation of the probabilistic seismic hazard model. However, it is important to recognize that a site may have more than one earthquake that contributes significantly to the hazard. Therefore, in some cases earthquakes other than the predominant earthquake should also be considered.

Because of its simplicity, it is likely that the SPPV method (DOC, 1997) will be widely used to estimate earthquake shaking loading conditions for the evaluation of ground failure hazards. It should be kept in mind that ground motions at a given distance from an earthquake will vary depending on site-specific characteristics such as geology, soil properties, and topography, which may not have been adequately accounted for in the regional hazard analysis. Although this variance is represented to some degree by the recorded ground motions that form the basis of the hazard model used to produce Figures 3.1, 3.2, and 3.3, extreme deviations can occur. More sophisticated methods that take into account other factors that may be present at the site (site amplification, basin effects, near source effects, etc.) should be employed as warranted. The decision to use the SPPV method with ground motions derived from Figures 3.1, 3.2, or 3.3 should be based on careful consideration of the above limitations, the geotechnical and seismological aspects of the project setting, and the "importance" or sensitivity of the proposed building with regard to occupant safety.

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118°37'30"

Open-File Report 97-14

34°15'

34°07'30"

Base map enlarged from U.S.G.S. 30 x 60-minute series

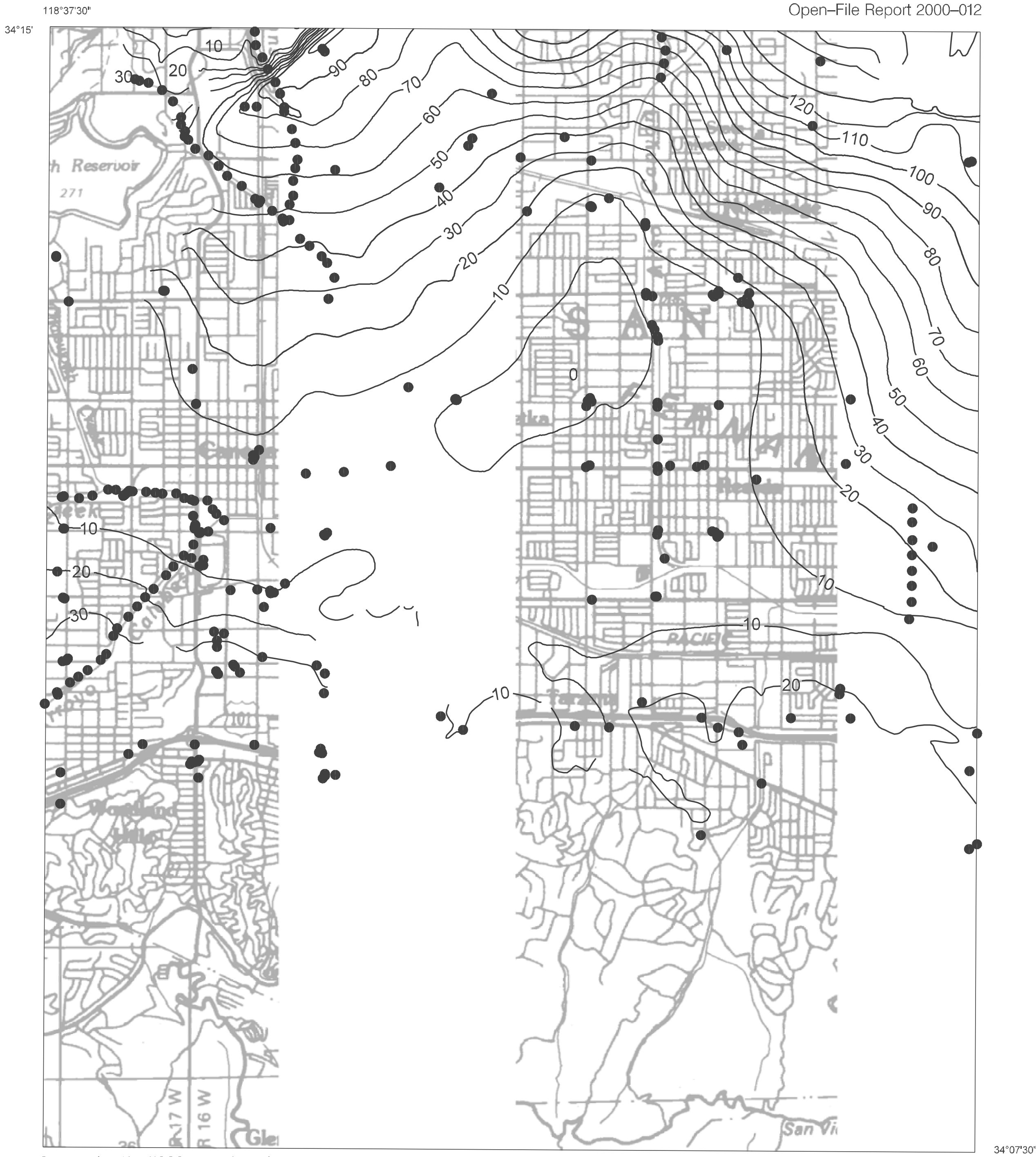
118°30'

B = Pre-Quaternary bedrock
See "Bedrock and Surficial Geology" in Section 1 of the report for descriptions of units.

ONE MILE

SCALE

Plate 1.1 Quaternary Geologic Map of the Canoga Park 7.5-minute Quadrangle, California



Base map enlarged from U.S.G.S. 30 x 60–minute series

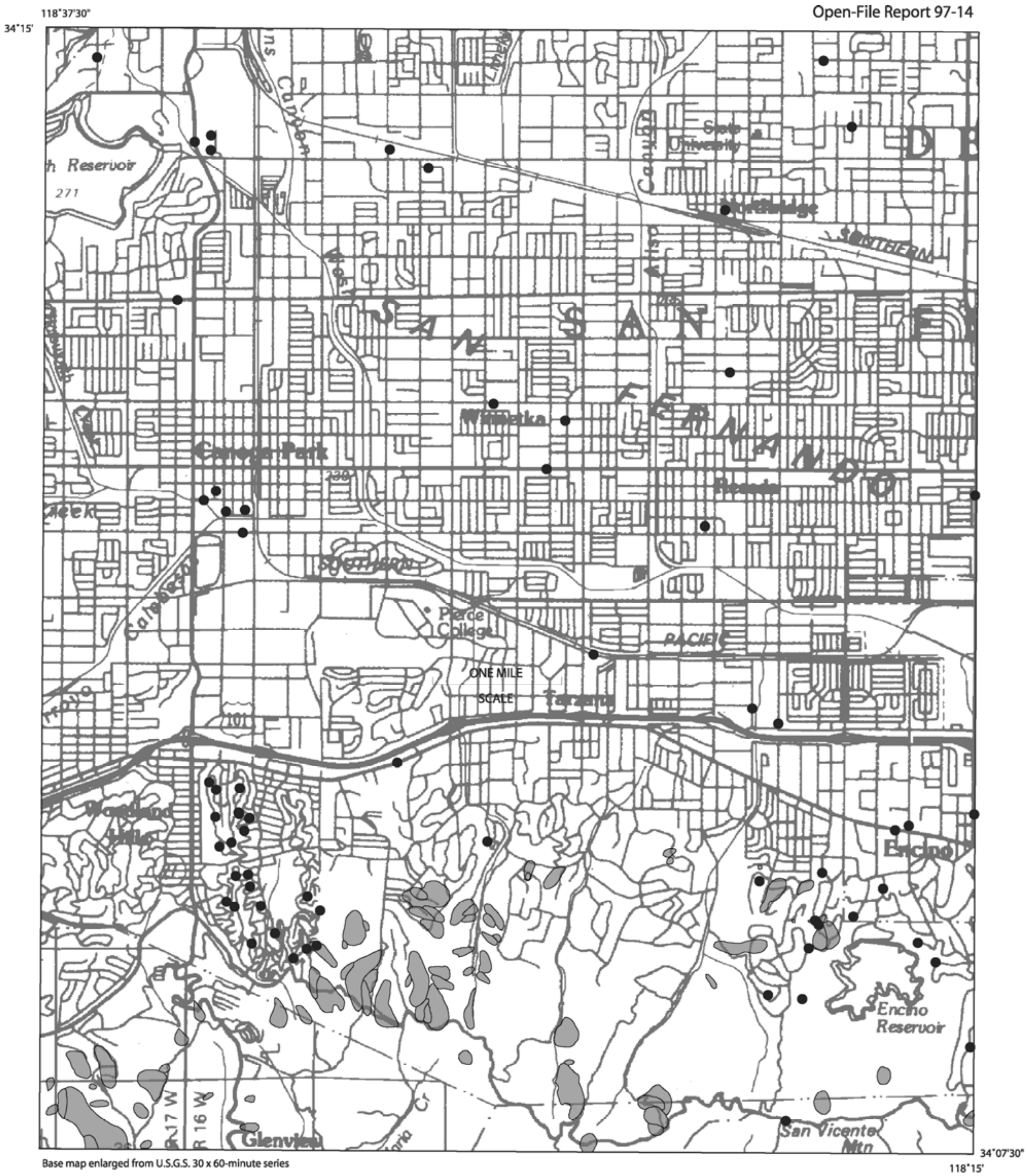
Plate 1.2 Historically highest ground water contours and borehole locations,Canoga Park 7.5–minute Quadrangle, California.

● Borehole Site

30 Depth to ground water in feet

ONE MILE

SCALE



Base map enlarged from U.S.G.S. 30 x 60-minute series

Plate 2.1 Landslide inventory, shear test sample locations, Canoga Park Quadrangle, California.

● Shear test sample location — Landslide

ONE MILE
SCALE
N

Appendix H –
Costs

Scenario 4

LVMWD BODR - Scenario 4

Capital Cost Summary

Item Number	Description	Quantity	Unit Price	Total Cost
1	AWT Plant	-	Lump Sum	$46,721,000.00
2	AWT Inlet Pipeline	4,000 LF of 24"	365	$1,460,000.00
3	AWT Outlet Pipeline	20,000 LF of 20"	320	$6,400,000.00
4	Brine Line	60,000 LF of 8 "	175	$10,500,000.00
6	Mixing System	-	Lump Sum	$1,000,000.00
7	Land Acquisition	-	Lump Sum	$2,000,000.00
	Subtotal			$68,081,000.00
	Contigency (25%)	25%		$17,020,250.00
	Engineering and Admin (15%)	15%		$10,212,150.00
	Total Construction Cost			**$95,313,400.00**

LVMWD BODR - Scenario 4

O&M Cost Summary

Item Number	Description	Quantity (AF)	Unit Price ($/AF)	Total Cost
1	RWPS West Pump Station	3102.0	$25	$77,550
2	AWT	2637	$665	$1,753,605
4	Mixing System	9500	$25	$237,500
5	Westlake WTP	498	$150	$74,700
5	Brine Discharge Fee	465.0	$500	$232,500
6	Brine Discharge Facility	1	$45,000	$45,000
	Subtotal			$2,420,855
	Contigency	10%		$242,085.50
	Total O&M Cost			**$2,662,941**
	Imported Water Savings	**2637**	-$900	**-$2,373,300**
	Net O&M Cost			$289,641

LVMWD BODR - Scenario 4 AWT

Capital Cost Summary

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Treatment Process Equipment					
- Microfiltration/Ultrafiltration Racks	5	EA	$ 754,000	$ 3,770,000	Vendor quote - H_2O Innovation - scaled
- Reverse Osmosis Skids	3	EA	$ 1,330,000	$ 3,990,000	Vendor quote - H_2O Innovation
- UV-AOP Reactors	2	EA	$ 405,000	$ 810,000	Vendor quote - Trojan
- Carbon Dioxide	1	EA	$ 150,000	$ 150,000	Vendor quote - BlueInGreen
- Lime Feed	1	LS	$ 860,000	$ 860,000	Vendor quote - Merrick Industries
- Chemical Feed Systems	1	LS	$ 1,830,928	$ 1,830,927.84	Estimate (See 'Chemical capital.xls')
Subtotal: Process Equipment Costs				**$ 11,410,928**	
Plant Integration					
- Process Equipment Installation	40%			$ 4,564,371	Assumed allowance
- Earthwork and Site Improvements	20%			$ 2,282,186	Assumed allowance
- Valves, Piping, and Appurtenances	20%			$ 2,282,186	Assumed allowance
- Electrical, Instrumentation, and Controls	30%			$ 3,423,278	Assumed allowance
Subtotal: Plant Integration				**$ 12,552,021**	
Pumping and Storage					
- MF Feed Pumps	0	EA	$ -	$ -	Assume influent pipeline pressure is sufficient
- Break Tanks - 3	1	EA	$ 498,000	$ 498,000	Vendor quote - Pacific Tank Solution
- Effluent Pumps	4	EA	$ 45,000	$ 180,000	Vendor quote - Flo-Systems
- Installation Allowance	40%			$ 271,200	Assumed allowance
Subtotal: Pumping and Storage				**$ 949,200**	
Plant Building					
- Poured Concrete Foundation	25400	SF	$ 78	$ 1,981,200	Cost per square foot from RMWTP
- Prefabricated Building	25400	SF	$ 56	$ 1,422,400	Cost per square foot from RMWTP
Subtotal: Plant Building				**$ 3,403,600**	
Total Project Cost					
Subtotal: Total Direct Cost				**$ 28,315,748**	
- Contractor Overhead and Profit	15%			$ 4,247,362	Assumed allowance
- Scope and Estimating Contingency	30%			$ 8,494,725	Assumed allowance
- Engineering and Administrative Cost	20%			$ 5,663,150	Assumed allowance
Total: Capital Cost Estimate				**$ 46,721,000**	

LVMWD BODR - Scenario 4 AWT

O&M Cost Summary

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Power Costs					
- Microfiltration/Ultrafiltration Racks	182000	kWh/Yr	$ 0.13	$ 23,700	Based on avg flow 5 mgd when operating, plant operates 6 mo/year
- Reverse Osmosis Skids	946000	kWh/Yr	$ 0.13	$ 123,000	Based on avg flow 5 mgd when operating, plant operates 6 mo/year
- UV-AOP Reactors	266000	kWh/Yr	$ 0.13	$ 34,600	Based on avg flow 5 mgd when operating, plant operates 6 mo/year
- Lime and Carbon Dioxide Feed	42000	kWh/Yr	$ 0.13	$ 5,500	Based on avg flow 5 mgd when operating, plant operates 6 mo/year
- Effluent PS	785000	kWh/Yr	$ 0.13	$ 102,100	Based on avg flow 5 mgd when operating, plant operates 6 mo/year
- Miscellaneous Equipment	11000	kWh/Yr	$ 0.13	$ 1,400	Based on PureWater Program 10% design cost estimate
- Buildings	1108000	kWh/Yr	$ 0.13	$ 144,000	Based on 6 months/year equipment operation
Subtotal: Power Costs				**$ 434,300**	
Chemical Costs					
- Microfiltration/Ultrafiltration Pretreatment & Cleaning	183	Days/Yr	$ 234	$ 42,700	Based on PureWater Program 10% design cost estimate
- Reverse Osmosis Pretreatment & Cleaning	183	Days/Yr	$ 411	$ 75,000	Based on PureWater Program 10% design cost estimate
- UV-AOP Oxidant Addition	183	Days/Yr	$ 365	$ 66,600	Based on using hydrogen peroxide, 10 mg/L dose
- Post-Treatment & Chlorination	183	Days/Yr	$ 496	$ 90,500	Based on PureWater Program 10% design cost estimate, and using $130/ton for CO2 (with 0.5 ton/day consumed)
- Long Term Storage of Membranes	182	Days/Yr	$ 10	$ 1,900	
Subtotal: Chemical Costs				**$ 276,700**	
Maintenance & Replacement of Consumables					
- Microfiltration/Ultrafiltration Modules	183	Days/Yr	$ 347	$ 63,400	Based on PureWater Program 10% design cost estimate
- Reverse Osmosis Cartridge Filters & Membranes	183	Days/Yr	$ 525	$ 95,800	Based on PureWater Program 10% design cost estimate
- UV Lamps & Ballasts	183	Days/Yr	$ 150	$ 27,400	Based on lamp life for Trojan UVPhox
Subtotal: Consumables Costs				**$ 186,600**	
- Maintenance Costs	2%			$ 228,200	2% of equipment cost, assumed allowance
Subtotal: Maintenance Costs				**$ 228,200**	
Labor Costs					
- Labor Costs for AWTP	6240	Hrs/Yr	$ 75	$ 468,000	Assumed equivalent of 6 full time employees, annually
Subtotal: Labor Costs				**$ 468,000**	
Total Project Cost					
Subtotal: Total Direct Cost				**$ 1,593,800**	
- Scope and Estimating Contingency	10%			$ 159,400	Assumed allowance
Total: Annual O&M Cost Estimate				**$ 1,753,000**	

LVMWD BODR - Scenario 4 AWT
Labor Cost Summary

	Avg. hourly rate (incl. burden)	Work hours per year	# of employees	Labor cost per year
AWT Staff during operation	$ 75	2080	3	$ 468,000
AWT Staff during shutdown	$ 75	1040	0	$ -

LVMWD BODR - Scenario 4 AWT

Equipment Information Calculating AWT Power Costs

Note: Anything highlighted in red is based on Pure Water go-by

Online Factor (over 12 months annually) 42%

Major Pumping	Quantity Available	Quantity Online	Pump Efficiency	Motor Efficiency	VFD Efficiency	Average Flow (gpm)	Average Suction Pressure (psi)	Average Discharge Pressure (psi)	Average Head (psi)	Maximum Motor Power (hp) (from MWH)	Average Motor Power (hp)	Average Motor Input (kW)	Average Annual Online Factor (if online 365 days/yr)	Average Power Consumption (kW)	Average Annual Energy Requirement (kWh)	Power requirement (kVA) (from MWH)
MF/UF System																
MF/UF Backwash Pumps	2	1	80%	95%	97%	1,960			26.0	50	37.1	30.0	11%	3.3	28,712	
MF/UF CIP Recirculation Pumps	2	1	80%	95%	97%	650			25.0	15	11.9	9.6	8%	0.8	6,632	
													Subtotal	4.0	**35,343**	
RO System																
RO Transfer Pumps	4	3	80%	95%	97%	1122			12	100	9.8	7.9	95%	22.6	198,292	
Production RO Feed Pumps	4	3	80%	95%	97%	1122			120	600	98.1	79.4	95%	226.4	1,982,921	
Recovery RO Feed Pumps	4	3	80%	95%	97%	280			20	100	4.1	3.3	95%	9.4	82,622	
													Subtotal	**258**	**2,263,835**	
Post-Treatment System																
Lime Slurry Pump	4	2														20
													Subtotal	0.0	-	
Effluent Pumps																
Effluent Pumps	4	3	80%	95%	97%	1122			108.3188908	100	88.6	71.7	100%	215.1	1,884,104	
											Major Pumping Annual Power Requirement				4,183,282	

LVMWD BODR - Scenario 4 AWT
Equipment Information Calculating AWT
Power Costs (cont.)

System	Energy per year, assuming full time operation (kWh)	Energy per year, given partial operation (KWh)	Power Cost	
MF/UF	436,444	182,000.00	$ 23,660	$ 24,000
RO	2,270,405	946,000.00	$ 122,980	$ 123,000
UV	638,604	266,000.00	$ 34,580	$ 35,000
Post Treatment	100,740	42,000.00	$ 5,460	$ 5,000
Effluent PS	1,884,104	785,000.00	$ 102,050	$ 102,000
Chemical feed pumps	26,938	11,000.00	$ 1,430	$ 1,000
Buildings	1,108,000	1,108,000	$ 144,040	$ 144,000
Total annual power cost	**6,465,234**		**$ 434,200**	**$ 434,000**

LVMWD BODR - Scenario 4 AWT

Equipment Information Calculating AWT Power Costs (cont.)

Other Power Demands	Quantity Available	Quantity Online	Max Power Consumption (kW) (from MWH)	Average Power Consumption (kW)	Total Average Power Consumption (kW)	Average Annual Online Factor	Average Annual Energy Requirement (kWh)	
MF/UF System								
MF/UF CIP Tank Heater	2	2	80	80	160	22%	306,600	
MF/UF Air Scour Blowers	2	1	59.7	59.7	59.7	11%	57,051	
MF/UF Compressor	2	2		2.25	4.5	95%	37,449	MF/UF Power
						Subtotal	**401,100**	$ 52,143
RO System								
RO CIP Tank Heater	2	1	100	100	100	1%	6,570	
						Subtotal	**6,570**	
AOP System[1]								
UV Reactors (Calgon Sentinel 24)	1	1	90	81	81	90%	638,604	See MJA's UV_AOP Comparison spreadsheet
						.	**638,604**	
Post-Treatment System								
Decarb Blowers	8	4	5.6	5.6	22.4	100%		Seems like decarb are out for now
Lime Addition System - Lime Feeder - Slaker - Aging Tank Mixer - Grit Classifier (only 1 for system) - Heater Silo	2	1	11.5	11.5	11.5	100%	100,740	Water quality stable. Silos contimuously on-line.
CO2 Addition System	1	1			0			CO2 addition: will provide loading once quote provided (upcoming week)
						Subtotal	**100,740**	
Building HVAC Systems								
Control Room & Restroom/Locker Room	1	1	24	24	24	100%	210,240	
Process Building Area	1	1	30	30	15	100%	131,400	
Electrical Room	1	1	175	175	175	50%	766,500	
						Subtotal	**1,108,140**	
Building HVAC Systems								
O&M Building HVAC	1	1	235	235	235	60%	1,235,160	
North City Pump Station	1	1	15	15	15	100%	131,400	
MF Building HVAC	1	1	32	32	32	100%	280,320	
RO Building HVAC	1	1	92.5	92.5	92.5	100%	810,300	
UV-AOP Building HVAC	1	1	4.5	4.5	4.5	100%	39,420	
UV-AOP Electrical Room	1	1	22	22	22	60%	115,632	
Electrical Building HVAC	1	1	245	245	245	60%	1,287,720	
RO Electrical Building HVAC	1	1	128	128	128	60%	672,768	
MF Electrical Building HVAC	1	1	77	77	77	60%	404,712	
						Subtotal	**4,977,432**	
Chemical feed pumps								
Sodium Bisulfite MF Transfer	2	1	0.373	0.373	0.373	5%	163	
Sodium Bisulfite MF CIP Feed	2	1	0.373	0.373	0.373	10%	327	
Ammonium Hydroxide MF Influent Pump	1	1	0.249	0.249	0.249	100%	2,181	
Sodium Hypochlorite Chlorination	1	1	0.373	0.373	0.373	100%	3,267	
Sodium Hypochlorite UV Influent Chlorination	1	1	0.373	0.373	0.5	100%	4,380	
Sodium Hypochlorite Residual	1	1	0.373	0.373	0.373	100%	3,267	
Sodium Hypochlorite MF Transfer	1	1	0.373	0.373	0.373	5%	163	
Sodium Hypochlorite MF CIP Feed	4	2	0.373	0.373	0.746	10%	653	
Antiscalant Stages 1 & 2	1	1	0.249	0.249	0.249	100%	2,181	
Antiscalant Stage 3	1	1	0.249	0.249	0.249	100%	2,181	
Sulfuric Acid Stages 1 and 2	1	1	0.373	0.373	0.373	100%	3,267	
Sulfuric Acid Stage 3	1	1	0.249	0.249	0.249	100%	2,181	
Sulfuric Acid Transfer	1	1	0.373	0.373	0.373	5%	163	
Sulfuric Acid MF CIP Feed	2	1	0.373	0.373	0.373	10%	327	
Citric Acid MF Transfer	3	2	0.249	0.249	0.498	5%	218	
Citric Acid MF CIP Feed	2	1	0.249	0.249	0.249	10%	218	
Citric Acid RO Transfer	1	1	0.373	0.373	0.373	5%	163	
Citric Acid RO CIP Feed	2	1	0.373	0.373	0.373	10%	327	
Sodium Hydroxide MF Transfer	1	1	0.373	0.373	0.373	5%	163	
Sodium Hydroxide MF CIP Feed	2	1	0.373	0.373	0.373	10%	327	
Sodium Hydroxide RO Transfer	1	1	0.373	0.373	0.373	5%	163	
Sodium Hydroxide RO CIP Feed	2	1	0.373	0.373	0.373	10%	327	
Sump Pumps	7	0	0.746	0.746	0.746	5%	327	
						Subtotal	**26,938**	
				Other Annual Power Demand Requirements			**6,151,384**	

Major Pumping Annual Energy Requirement	4,183,282	kWh
Other Annual Energy Demand Requirements	6,151,384	kWh
Total Annual Energy Requirement	10,334,666	kWh
Energy price	0.13	$/kWh
Total Annual Energy Cost	$ 1,343,507	

Notes:

1. Assume Wedeco reactor given this requires the most power of the large diameter LPHO technology.

LVMWD BODR - Scenario 4 AWT

AWT Consumables Costs

Note: Anything highlighted in red has not been updated from the Pure Water go-by

Online Factor (when in operation) 83%

MF/UF system (Pall)

Modules/rack	Total racks	Total modules	Cost per element	Cost of complete replacement	Sales tax	Cost of complete replacement plus 9% sales tax	Module life (yr)	Online factor (when in operation)	Time to replacement (yr) -	**Prorated annual replacement cost**	
155	3	465	$ 3,000	$ 1,395,000	9.0%	$ 1,520,550	10	83%	12	**$ 126,712.50**	$ 127,000

RO system - Stages 1 and 2

Elements per Vessel	Stage 1 vessels/train	Stage 2 vessels/train	Total vessels per Train	Total train	Total Stage 1/2 elements	Cost per element	Cost of complete replacement	Sales tax	Cost of complete replacement plus 9% sales tax	Element life (yr)	Online factor (when in operation)	Time to replacement (yr) -	Prorated annual replacement cost	
6	42	21	63	3	1134	$ 500	$ 567,000	9.0%	$ 618,030	5	83%	6	$ 103,005.00	$ 103,000

RO system - Stage 3

Elements per Vessel	Stage 1 vessels/train	Total train	Total Stage 1/2 elements	Cost per element	Cost of complete replacement	Sales tax	Cost of complete replacement plus 9% sales tax	Element life (yr)	Online factor (when in operation)	Time to replacement (yr) -	Prorated annual replacement cost	
6	10	3	180	$ 500	$ 90,000	9.0%	$ 98,100	1	83%	1.2	$ 81,750	$ 82,000

RO system - Cartridge Filters

Scaled replacement costs from Pure Water based on flow

Flow scaling factor	scaled annual replacement cost	Online factor (when in operation)	actual annual replacement cost (after online factor adjustment)
0.142517815	$ 8,266.03	83%	$ 6,888.36
Total Annual RO Replacement Cost		**$ 191,643**	$ 192,000

LVMWD BODR - Scenario 4 AWT

AWT Consumables Costs

RO system - Cartridge Filters - NOT USED

Online Factor (when in

Filters per Vessel	Vessels	Total filters	Cost per filter	Cost of complete replacement	Sales tax	Cost of complete replacement plus 9% sales tax	Filter life (yr)	Annual replacement cost	
176	9	1584	$ 16.76	$ 26,548	9.0%	$ 28,937	0.500	$ 57,874	$ 58,000

Total Annual RO Replacement Cost	**$ 242,629**	$ 243,000	20	gpm/filter
			28800	gpd

AOP

Vendor	Calgon Carbon	Trojan UVPhox	Trojan UVTorrent	Wedeco K143		
Lamp life (hrs)	5000	12000	15000	14000		
Annual replacement per lamp	1.75	0.73	0.58	0.63	annual lamp replacement from MWH	
Total annual lamps to replace	39	1262	169	256		
Cost per lamp	$ 726	$ 250	$ 680	$ 315		
Annual lamp replacement cost	$ 28,314	$ 315,500	$ 114,920	$ 80,640		
Sales tax	9.0%	9.0%	9.0%	9.0%		
Annual replacement cost plus sales tax	$ 30,862	$ 343,895	$ 125,263	$ 87,898		
Total number of lamps	22	1728	291	406		
Total number of ballasts	22	864	145.5	203		
Annual replacement per ballast	0.067	0.2	0.1	0.2		
Total annual ballasts to replace	2	173	15	41		
Cost per ballast	$ 5,800	$ 574	$ 1,200	$ 620		
Annual lamp replacement cost	$ 11,600	$ 99,302	$ 18,000	$ 25,420		
Sales tax	9.0%	9.0%	9.0%	9.0%		
Annual replacement cost plus sales tax	$ 12,644	$ 108,239	$ 19,620	$ 27,708	Average Lamp and Ballast Replacement Cost (UVTorrent & Wedeco)	
Total lamp & ballast replacement cost	**$ 43,506**	**$ 452,134**	**$ 144,883**	**$ 115,605**	**$ 130,244**	$ 130,000

LVMWD BODR - Scenario 4 AWT

Chemical O&M Costs for Long-Term Shutdown

Operational Scheme Variables

Annual shutdown duration	6	months	assumed period of AWT shutdown

Chemical Information

parameter	value	unit	notes
concentration of SBS	38	% w/w	
specific gravity of 38% SBS	1.34		
unit price of SBS	1.79	$/gal	unit cost used for Pure Water from Brenntag

MF/UF system

parameter	value	unit	notes
sodium bisulfite concentration	1000	mg/L	per email from H2O innovation
volume per module	13.43	gal	per Toray/H2O Innovation proposal from Pure Water, inc
modules per rack	70		per quote from H2O Innovation
# of racks	4		per quote from H2O Innovation
allowance for piping	20	%	allowance for drain/recirc piping
volume solution	4512.48	gal	
storage duration	6	months	assumed period of AWT shutdown
refresh frequency	1	/month	
total chemical usage (mass)	37.6	lb	
total SBS solution usage (mass)	99.0	lb	
total SBS solution usage (gal)	8.9	gal	
total cost	$ 15.86		

MF/UF system

parameter	value	unit	notes
sodium bisulfite concentration	1000	mg/L	per email from H2O innovation
volume per element	9	gal	per H2O innovation CIP guide
elements per vessel	7		per quote from H2O Innovation
# of vessels	61		per quote from H2O Innovation
# of trains	3		per quote from H2O Innovation
allowance for piping	20	%	allowance for drain/recirc piping
volume solution	13834.8	gal	
storage duration	6	months	assumed period of AWT shutdown
refresh frequency	1	/month	
total chemical usage (mass)	115.4	lb	
total SBS solution usage (mass)	1302.0	lb	
total SBS solution usage (gal)	116.5	gal	
total cost	$ 1,848.08		

Total

daily cost	$ 10.24

LVMWD BODR - Scenario 4
30 Year Cost Analysis

Description	Value		Year				
Number of Years Analysis	30		1	2	3	4	5
Capital	0.02		$ 95,313,400				
Fixed O&M	0.02		$ 1,369,505.5	$ 1,396,895.6	$ 1,424,833.5	$ 1,453,330.2	$ 1,482,396.8
Variable O&M	0.02		$ 1,293,435.0	$ 1,319,303.7	$ 1,345,689.8	$ 1,372,603.6	$ 1,400,055.6
Growth	0.02		$ -	$ 44,539.6	$ 90,860.9	$ 139,017.1	$ 189,063.3
W Savings	0.07		$ (2,373,300)	$ (2,625,162.08)	$ (2,900,655.67)	$ (3,201,855.08)	$ (3,531,009.18)
Annual Cost			$ 289,641	$ 135,577	$ (39,272)	$ (236,904)	$ (459,493)
P/F	0.05		$ 289,641	$ 129,121	$ (35,620)	$ (204,647)	$ (378,026)

Present Value of O&M **$ (80,684,644)**

Net PW **$ 14,628,756**

*For brevity, only first 5 years of 30 Year Analysis are shown. Calculations are carried through for 30 years.

LVMWD BODR - Scenario 4
30 Year Cost Analysis

	O&M			
Number	**Description**	**Quantity (AF)**	**Unit Price ($/AF)**	**Cost**
1	RWPS West Pump Station	3102.0	$25	$77,550
2	AWT - fixed	2637	$365	$962,505
	AWT - variable	2637	$300	$791,100
3	Mixing System	9500	$25	$237,500
4	Westlake WTP	498	$150	$74,700
5	Brine Discharge Fee	465.00	$500	$232,500
6	Brine Discharge Facilities - Fixed	1	$45,000	$45,000
	Subtotal Fixed			$1,245,005
	Contingency		10%	$124,501
	Total Fixed			**$1,369,506**
	Subtotal Variable			$1,175,850
	Contingency		10%	$117,585.00
	Total Variable			**$1,293,435.00**
	Total Fixed + Variable			$2,662,941
	Variable O&M Unit Cost			$ 490.49
	Annual Growth			89.03
	Annual Cost Due to Growth (Year 1 $)			$ 43,666.31
	Imported Water Savings			
Number	**Description**	**Quantity**	**Unit Price ($/AF)**	**Cost**
1	Imported Water Savings	2637	($900)	**($2,373,300)**
			Net O&M	**$289,641**

Notes:

1. AWT fixed costs are those that would not change significantly with increase water - namely labor & maintenance
2. AWT - variable represents costs that would increase with larger volume of water, namely energy and chemicals
3. Growth represents the change in storage (AF) per year
4. Variable O&M Uni cost is calculated by Total Variable / Quantity
5. Annual increase in costs due to growth = Variable O&M Unit Cost x Quantity of storage changing per year

LVMWD BODR - Scenario 4
30 Year Cost Analysis

With Imported Savings

Capital Cost	$	95,313,400
Total Annual Cost	$	4,545,376
Total AF Produced		2637
Unit Cost per AF	**$**	**1,723.69**

Annualized Capital Cost	$	4,255,735.90

Scenario 5

LVMWD BODR - Scenario 5

Capital Costs

Wells Alignment

Item Number	Description	Quantity	Unit Price	Total Cost
1	RWPS East Pump Station Upgrade	2 x 500 HP	$4,000/HP	$4,000,000.00
2	Standard PressurePipeline	52,400 ft. of 24"	$450/LF	$23,580,000.00
	High Pressure Pipeline	27,500 ft of 24"	$500/LF	$13,750,000.00
3	Pump Station at Encino Reservoir	5 x 500 HP	$6,000/HP	$15,000,000.00
4	Strainers and Chlorination System		Lump Sum	$1,000,000.00
6	Mixing System	-	Lump Sum	$500,000.00
	Subtotal			$57,830,000.00
	Contingency	25%		$14,457,500.00
	Engineering and Admin	15%		$8,674,500.00
	Total Construction Cost			$80,962,000.00

Mulholland Alignment

Item Number	Description	Quantity	Unit Price	Total Cost
1	RWPS East Pump Station Upgrade	1 x 500 HP	$4,000/HP	$4,000,000.00
2	Pipeline	28,300 ft. of 24"	$450/LF	$12,735,000.00
	High Pressure Pipeline	52,500 of 24"	$500/LF	$26,250,000.00
3	Pump Station on Mulholland	4x300 HP	$6,000/HP	$7,200,000.00
4	Tank on Mulholland	1 x 1 MG	$1,000,000/MG	$3,000,000.00
5	Pump Station at Encino Reservoir	6x500 HP	$6,000/HP	$18,000,000.00
	Regeneration at Encino Reservoir	LS	LS	$1,500,000.00
6	Strainers and Chlorination System		Lump Sum	$1,000,000.00
8	Mixing System	-	Lump Sum	$500,000.00
	Land Acquisition	LS	LS	$1,000,000.00
	Subtotal			$75,185,000.00
	Contingency (25%)			$18,796,250.00
	Engineering and Admin (10%)			$7,518,500.00
	Total Construction Cost			$101,499,750.00

LVMWD BODR - Scenario 5

O&M Costs

Wells Alignment

Item Number	Description	Quantity (AF)	Unit Price ($/AF)	Total Cost
1	RWPS East Pump Station	3102	$105	$325,710
2	Treatment	2702	$60	$162,120
3	Mixing System	6000	$25	$150,000
4	Encino Pump Station	2702	$70	$189,140
	Subtotal			$826,970
	Contigency	10%		$82,697.00
	Total O&M Cost			$909,667
	Unbalanced Exchange*			$0
	Additional RW Sales			-$453,475
	Net O&M Cost			$456,192

Mulholland Alignment

Item Number	Description	Quantity (AF)	Unit Price ($/AF)	Total Cost
1	RWPS East Pump Station	3103.75	$105	$325,894
2	Treatment	2703.75	$60	$162,225
3	Mixing System	6000	$25	$150,000
4	Encino Pump Station	2700	$110	$297,000
5	Mulholland Pump Station	2400	$70	$168,000
	Energy Recovery			-$111,750
	Subtotal			$991,369
	Contigency (10%)			$99,137
	Total O&M Cost			$1,090,506
	Unbalanced Exchange*			$0
	Net O&M Cost			$1,090,506

	Imported Water Savings			
Number	**Description**	**Quantity**	**Unit Price ($/AF)**	**Cost**
1	Imported Water Savings	289	($900)	($260,100)
			Total Imported Water Savings	($260,100)

LVMWD BODR - Scenario 5

30 Year Cost Analysis

Description	Value		Year				
Number of Years Analysis	30		1	2	3	4	5
Capital	0.02		$ 80,962,000				
Fixed O&M	0.02		$ 165,000	$ 168,300.00	$ 171,666.00	$ 175,099.32	$ 178,601.31
Variable O&M	0.02		$ 744,667	$ 759,560.34	$ 774,751.55	$ 790,246.58	$ 806,051.51
Growth RES	0.02		0	$15,264.25	$30,833.78	$46,714.71	$62,913.25
Growth EAST PS	0.02		0	$12,328.82	$25,150.79	$38,480.70	$52,333.75
RWPS West - Growth O&M	0.02		0	$1,693.20	$3,454.13	$5,284.82	$7,187.35
Imported W Savings*	0.07		$ (258,300)	$ (276,381)	$ (295,728)	$ (316,429)	$ (338,579)
Additional RW Sales - golf courses	0.07		$ (453,475)	$ (485,218)	$ (519,184)	$ (555,526)	$ (594,413)
Additional RW Sales	0.07		$ -	$ (30,195)	$ (64,618)	$ (103,712)	$ (147,963)
Annual Cost			$ 197,892	$ 165,352	$ 126,327	$ 80,159	$ 26,133
P/F	0.05		$ 197,892	$ 157,478	$ 114,582	$ 69,244	$ 21,499

Present Value of O&M **$ (21,243,337)**

Net PW **$ 59,718,663**

*For brevity, only first 5 years of 30 Year Analysis are shown. Calculations are carried through for 30 years.

LVMWD BODR - Scenario 5

30 Year Cost Analysis (cont.)

	O&M			
Number	**Description**	**Quantity (AF)**	**Unit Price ($/AF)**	**Cost**
1	RWPS East Pump Station	3102	$105	$325,710
2	Treatment	2702	$60	$162,120
3	Mixing System	6000	$25	$150,000
4	Encino Pump Station	2702	$70	$189,140
5	RWPS West Pump Station	66.4	$25	
	Subtotal O&M Fixed			$150,000
	Contingency		10%	$15,000
	Total O&M Fixed			**$165,000**
	O&M Variable - East PS			$325,710
	Contingency East PS		10%	$32,571.00
	Subtotal O&M Variable East PS			**$358,281**
	Annual Growth (AF) for East PS			104.65
	Additional Unit Cost for East PS			$115.50
	Total Additional Cost for East PS			$12,087.08
	O&M Variable - RES			$351,260
	Contingency		10%	$35,126.00
	Subtotal O&M Variable - RES			**$386,386**
	Annual Growth (AF) for RES			104.65
	Additional Unit Cost for RES			$ 143.00
	Total Additional Cost for RES			$ 14,964.95
	Est. Total Variable O&M			$744,667
	Est. Total O&M			**$909,667**

	Savings			
Number	**Description**	**Quantity**	**Unit Price ($/AF)**	**Cost**
1	Imported Water Savings	287	($900)	($258,300)
2	Additional RW Sales	66.4	$ (425)	$ (28,220)
3	Additional RW Sales - Golf Course	1067	$ (425)	$ (453,475)
			Total Savings	($286,520)
	Net O&M			$623,147

Notes:

1. Growth in O&M for RWPS West Pump Station mirrors growth in Additional RW Sales
2. Imported Water Savings - based on assumption of 1,700 AF @ unit price of $900/AF. Assume MWD imported water rates will increase 5% (not including interest)
3. Growth for Scenario 5 has been divided in growth for the reservoir and additional usage of East PS
4. Additional RW Sales total RW sales quantity in 2035 Spanned over a quantity of 20 years to get annual growth amount

LVMWD BODR - Scenario 5
30 Year Cost Analysis (cont.)

Capital Cost	$	80,962,000
Total Annual Cost	$	3,812,839
Total AF Produced		2702
Unit Cost per AF	**$**	**1,411.12**

Annualized Capital Cost	$	3,614,947.01

Appendix I –

Interagency Meeting Notes

Meetings with LADWP

Agenda

Project: Recycled Water Seasonal Storage, Basis of Design Meeting with Los Angeles Department of Water and Power

Purpose: Interagency Coordination – Scenario 5 Recycled Water Storage at Encino Reservoir

Date and Time: January 11, 2016
9:30am

Location: 433 E. Temple Street Los Angeles, CA 90012

Discussion Items:

1. **Scenario Summary**
2. **Facilities Map**
3. **Scope of Work**
4. **Reservoir Operations**
5. **Emergency Operations**
6. **Treatment (Screening, filtration, mixing, and/or aeration)**
7. **Pumping**
8. **Connection with LASan Sewer**

Scope of Work:

1. **Reuse Studies for Encino Reservoir Option:** MWH will conduct the following studies to determine the viability of the Encino Reservoir Options
   a. Reservoir Operation Modeling

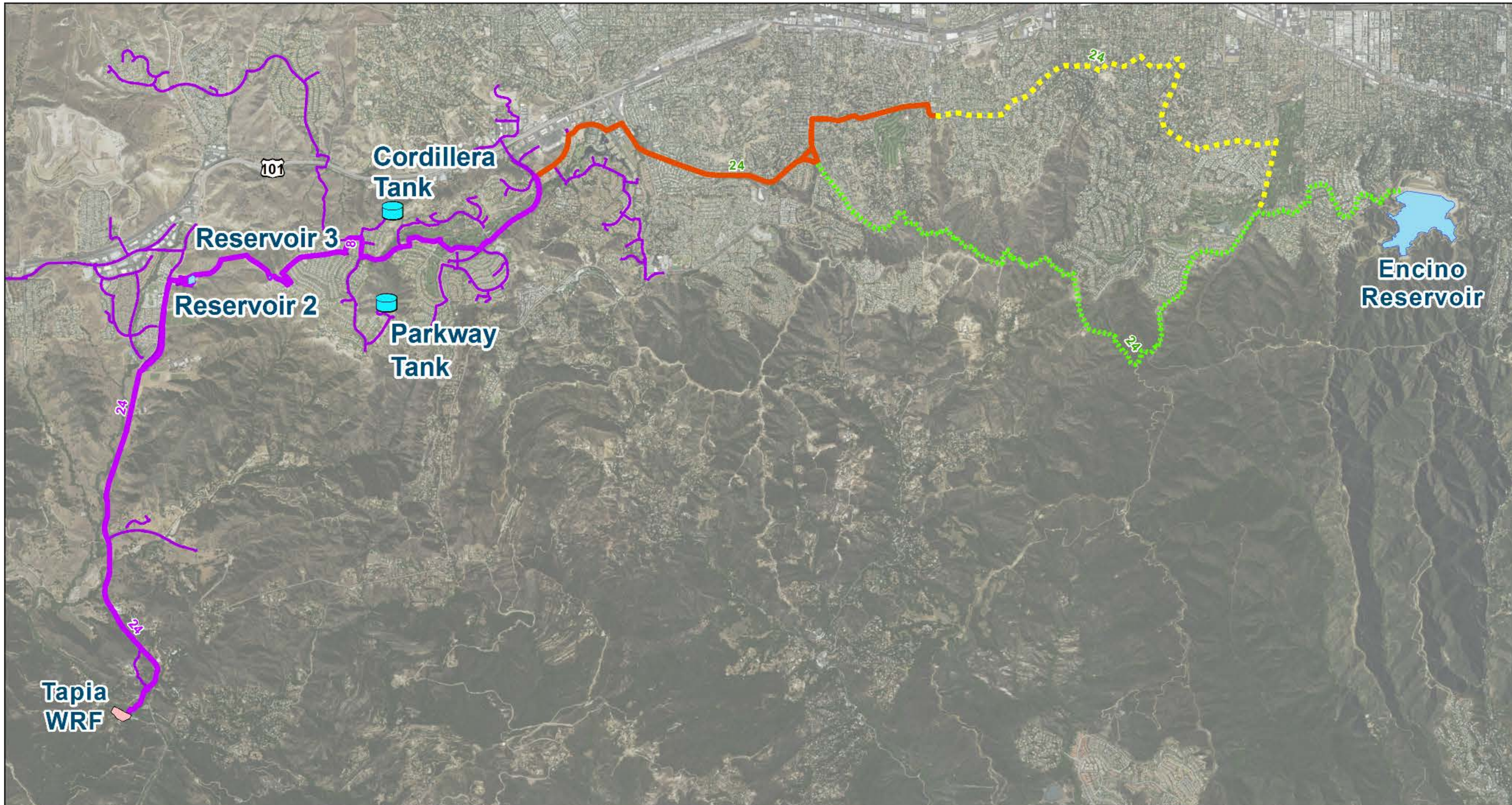
      MWH will develop an operations model of Encino Reservoir to evaluate changes in storage conditions under the proposed seasonal storage conditions.

      i. MWH will develop an Operations Model using the GoldSim simulation platform. GoldSim is a general purpose operations simulation platform with extensions specifically designed to simulate water resource systems. Based on initial evaluation of existing data, the Model will run on a daily time step, and produce time-series outputs of inflow, outflow, storage, and relevant operational parameters.
      ii. MWH will use the information collected to develop, test, and verify the Operations Model. The model is anticipated to run over a three year analysis period using available historical data on reservoir operations, local inflow, and recycled water supply and demand.
      iii. MWH will also develop a water quality model of Encino Reservoir to support evaluation of changes in concentrations of water quality constituents. This modeling effort will evaluate two primary water quality constituents: TDS and temperature. A completely mixed one-dimensional model will be developed and used to investigate stratification impacts on water quality in each reservoir.

   b. Water quality and sampling plan update Recycled water quality data will be sorted and summarized to determine if there are any data gaps in information needed to comply with regulatory or operational requirements. If gaps are identified, an updated sampling plan will be prepared, including an estimate of additional sampling and analytical costs.
   c. Verify Flowrates
      i. MWH will analyze the supply and demand data to determine minimum, average and maximum flow rates through the pipes, tanks, pump stations, or other facilities. The results of this work will be used in conjunction with the Reservoir Operations Model and confirm that facilities are sized properly to operate over the full range of anticipated conditions. MWH will coordinate with RMC engineers on recycled water conveyance.

d. Encino Reservoir Management The management of Encino Reservoir will be investigated regarding the issues below.

   i. The impacts of water quality changes and potential mitigation measures to maintain and/or improve water quality (i.e. appearance and odor) and mitigate potential problems with reservoir turnover, excessive algal growth, and anaerobic conditions that can result in odors and/or fish mortality. Also, vector control methods will be examined.
   ii. Requirements for any additional treatment required to maintain water quality during storage (i.e. supplemental mixing or aeration) or to re-treat the water prior to introduction back into the recycled water system, including schematic diagrams and design criteria, if needed.
   iii. Evaluate Reservoir catchment area, expected storm flow volumes, and management of storm flows.
   iv. Changes to the emergency supply potential for LADWP, due to the storage of recycled water.



Key to Features

- Woodland Hills WRP
- New RW Alternative 1
- New Alternative 2
- Existing RW Pipe
- Recycled Water Tanks
- Reservoir
- Treatment

N

0 1 2 Miles

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Date: October 29, 2015

LVMWD Recycled Water Basis of Design Scenario 5

MWH

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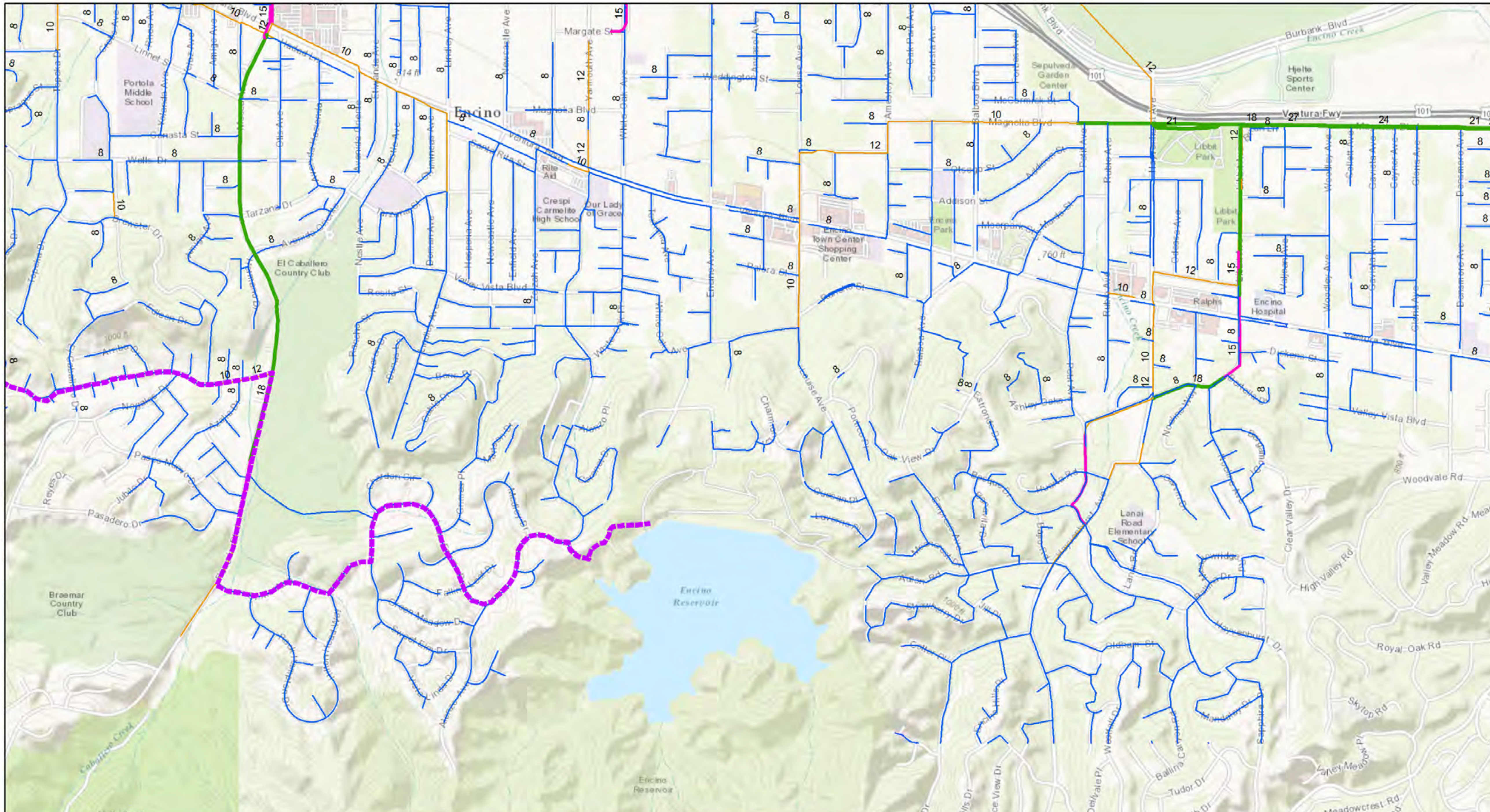

Key to Features

Encino Reservoir Extension

LA Sanitation Gravity Mains

- 0.0 - 9.0
- 9.0 - 12.0
- 12.0 - 15.0
- 15.0 - 30.0
- 30.0 - 108.0

N

0 700 1,400 2,800 Feet

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Date: December 2015

Potential Recycled Water Tie-In Locations for Scenario 5

MWH

Figure 1

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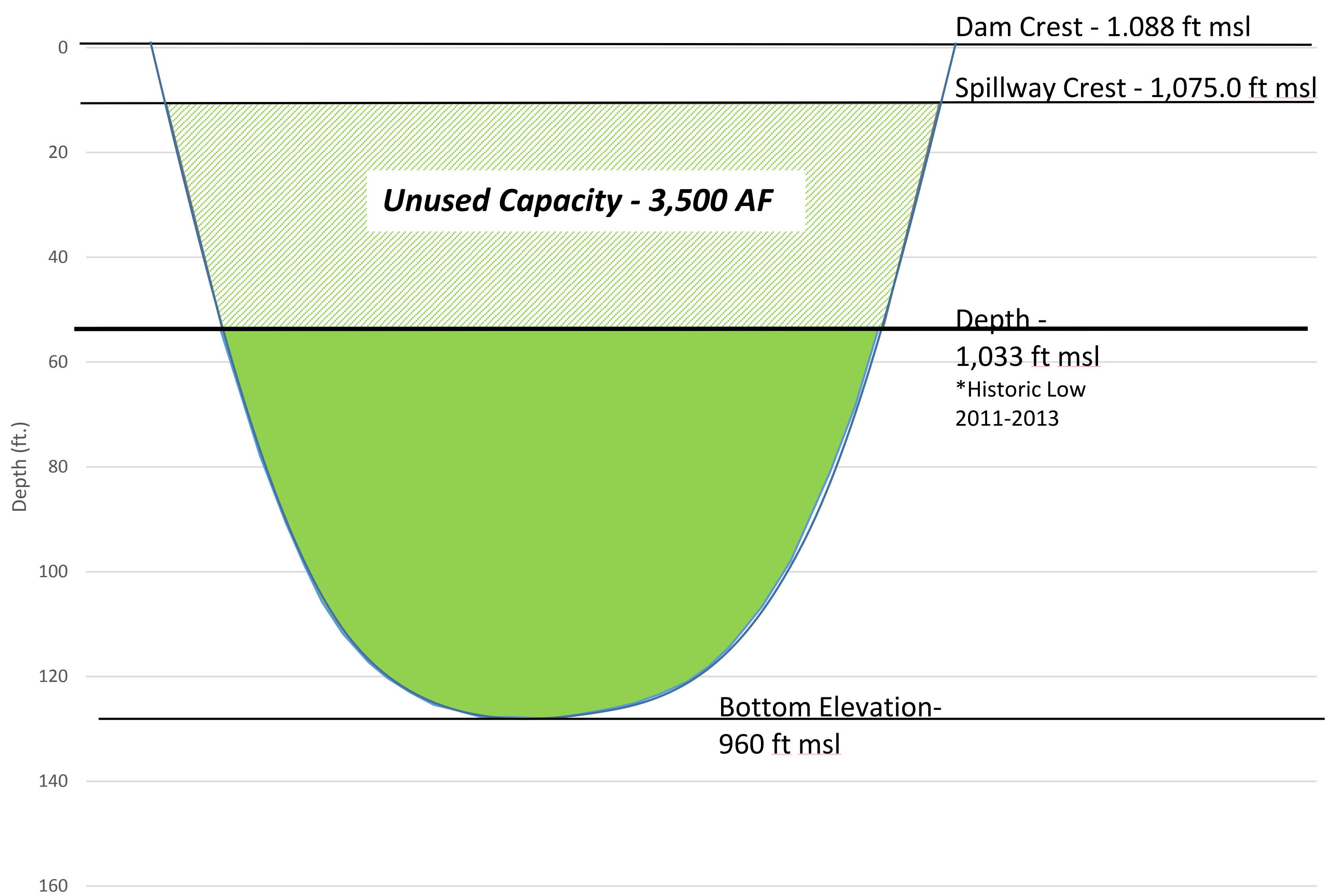
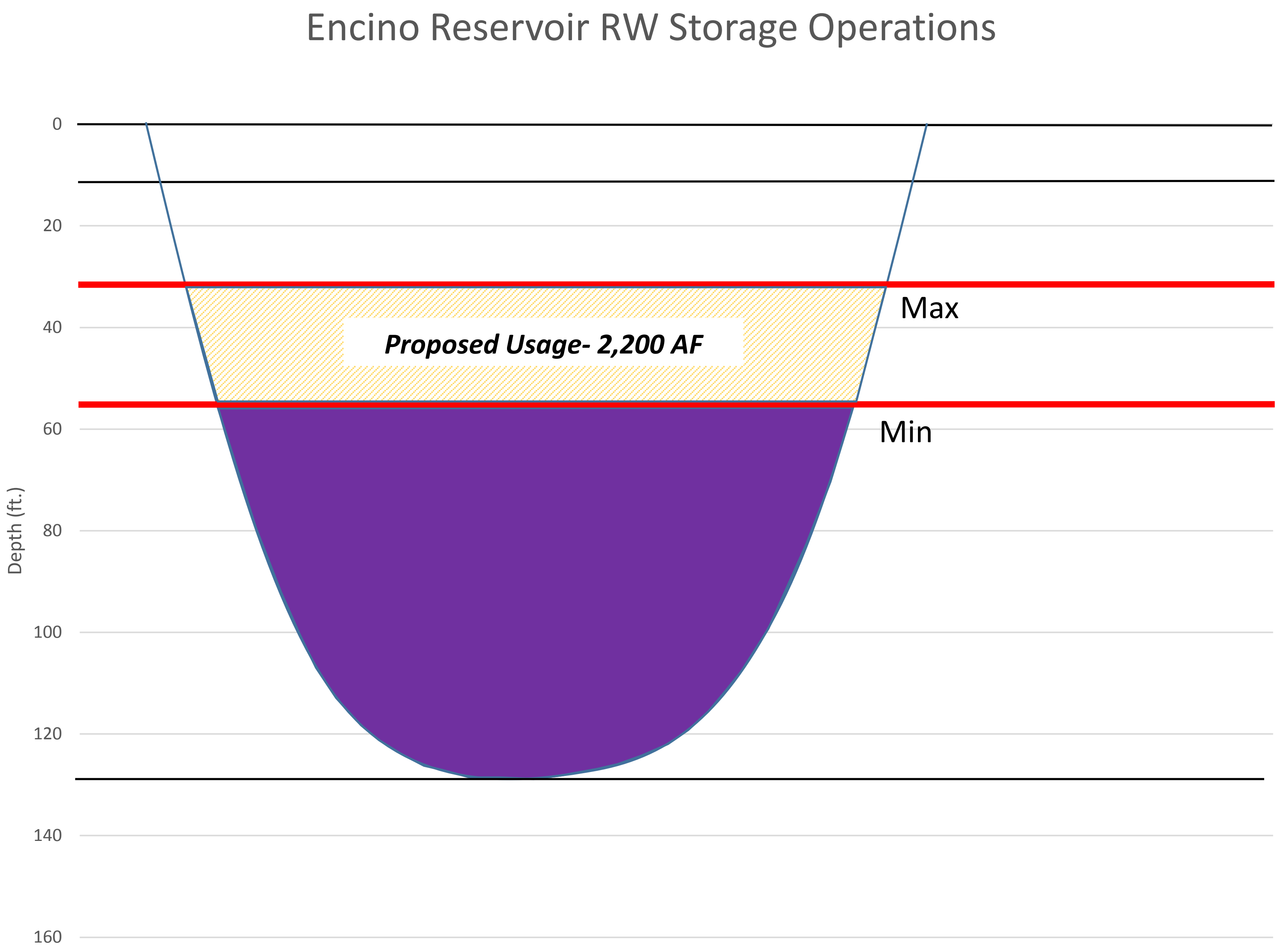
Encino Reservoir Historical Operation




Encino Reservoir RW Storage Operations
Depth (ft.)
0
20
40
60
80
100
120
140
160
Max
Min
Proposed Usage- 2,200 AF

MEETING NOTES

Meeting Location:	433 E. Temple Street Los Angeles, CA
Meeting Date:	January 11, 2016
Meeting Time:	9:30am-10:30am
Meeting Topic:	Recycled Water Seasonal Storage, Basis of Design

Attendees:

Person	Organization
Dave Lippman	Las Virgenes MWD
David Pedersen	Las Virgenes MWD
Mario Acevedo	LADWP
Aimee Jung	LADWP
Yoshi Tsunehara	LADWP
Bill Van Wagoner	LADWP
Jim Borchardt	MWH
Oliver Slosser	MWH
Areeba Syed	MWH

1. **Scenario Summary**
    - Woodland Hills Water Recycling Project Mitigated Negative Declaration (MND) has been completed
    - Pipeline size for Woodland Hills project will be determined by results of the Basis of Design Report (BODR)
    - LVMWD will know the size of the pipeline by March

2. **Reservoir Operations**
    - MWH would like to confirm if the reservoir is being filled with the 30” Reservoir Fill Pipeline
    - The project will go to bid in the June/July timeframe (2016), with construction beginning in the October timeframe.
    - LADWP will need to sit down with Operations staff to confirm reservoir operations
    - Encino’s existing strainers and chlorination would like to be used
    - Encino’s MF facility is not currently in use
    - The reservoir is currently filled to about half of its total volume
    - Scenario 5 is not intended to fill the reservoir to its total volume
    - An emergency(?) drain or a drain to Tillman was discussed
    - LVMWD is still required to discharge to Malibu if the flow is below 2 cfs
        - o The quality of water required when discharging to Malibu Creek is still undergoing discussion with RWQCB
    - LADWP expressed interest in being able to drain the reservoir into the LA River in the case of an extremely wet year
    - DSOD Seismic study will be required if a certain reservoir level is reached
        - o MWH is uncertain what level will trigger a seismic study
        - o The reservoir’s minimum level can be drawn down more but that may increase pumping costs

3. **Emergency Operations**
   - LADWP needs to confirm if the reservoir would be used in an emergency situation with Operations staff
   - Assuming that using Encino as a recycled water reservoir effectively eliminates its use as emergency storage
   - New headworks tanks were proposed as an alternative to alleviate the emergency storage
     - It was determined that the new headworks tanks do not have enough storage capacity to be used as emergency storage

4. **Treatment**
   - MWH has researched possible vector control
     - o LADWP is not currently experiencing any vector control issues at Encino
     - o MWH has talked to Irvine Ranch Water District about vector control in their recycling water reservoir – algae was avoided by creating mixing through blowers
     - o Oxygen-mixing could also be used
   - LADWP asked if sending recycled water down the spillway would create a smell
     - Alternatives of running the pipe below water level or using the existing 30" pipeline near the spillway were discussed
   - LADWP asked if there would be a significant changes in water quality
     - MWH confirmed that there would not be significant changes in water quality

5. **Pumping**
   - MWH discussed utilizing the existing pump station or building a new one
   - LADWP mentioned there would be significant public resistance against building a new pump station on the existing grounds
     - Homes adjacent to Encino Reservoir objected the most about visual appearances of facilities (not homes above Encino Reservoir)
   - MWH noted that the max amount of water that will be moved is approximately 6 mgd (equivalent to the facility's capacity)

6. **Connection with LASan Sewer**
   - A possible connection to the LASan Sewer was discussed

7. **Cost**
   - LADWP expressed that the initial costs seemed too low
     - o LADWP mentioned that the current North Hollywood RW construction costs have been off by 50-100%
     - o LADWP agreed to provide the bid for this current project in order to provide a more realistic representation of actual construction costs

8. **Action Items**
   - MWH will meet with LASan to discuss connection to sewer lines
   - LADWP will set up a meeting with Operations staff and will try to coordinate a tour of Encino Reservoir's facilities

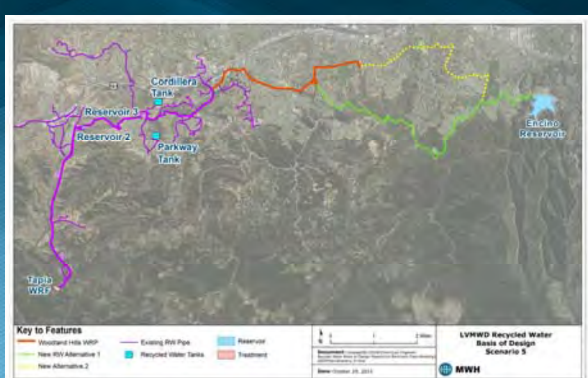
Encino Reservoir
Recycled Water Concept

January 20, 2016

Agenda

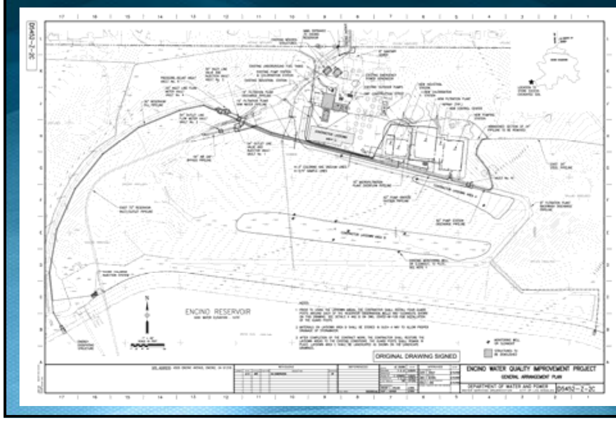
- Facilities Map
- Emergency Operations
- Treatment
- Reservoir Operations
- Connection with LASan Sewer

LVMWD BASIS OF DESIGN SCENARIO 5

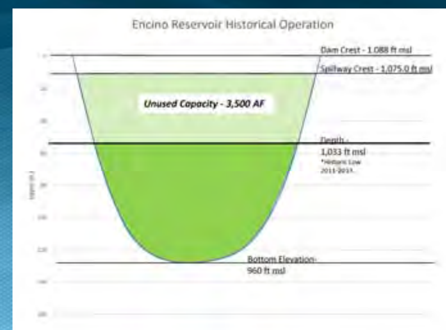


RESERVOIR FACILITIES

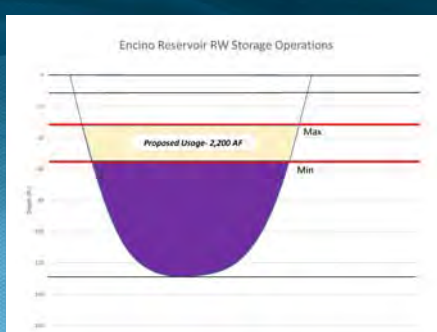
RESERVOIR FACILITIES



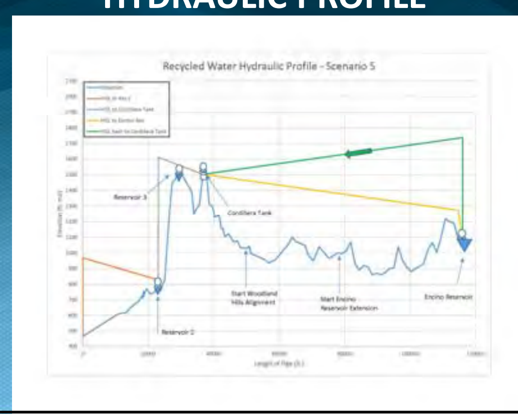
RESERVOIR OPERATIONS



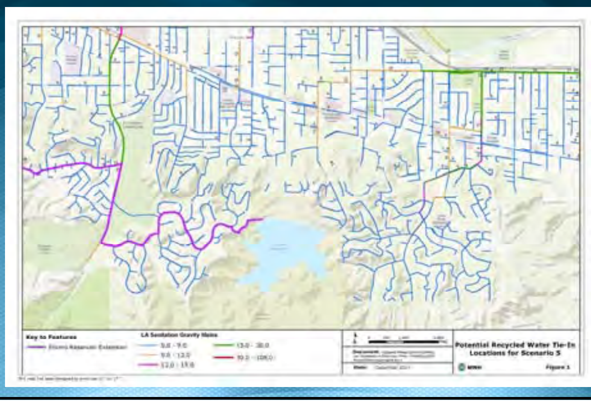
RESERVOIR OPERATIONS



HYDRAULIC PROFILE



POTENTIAL RW TIE-IN LOCATIONS



Encino Reservoir Recycled Water Concept

January 21, 2016

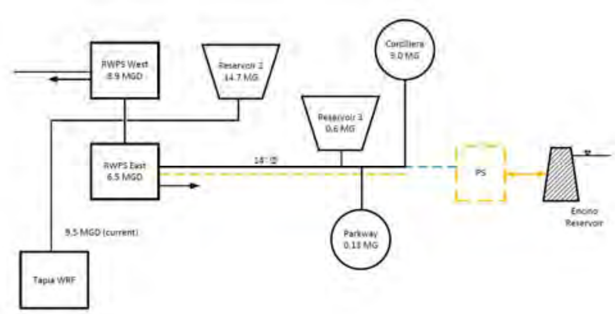
Agenda

1. Introduction
2. LADWP: Overview of season storage concept for Las Virgenes and LADWP
3. MWH: Operational questions
   a. Facilities map
   b. Scope of Work
   c. Reservoir Operations
      I. Can existing 30" or 74" pipelines be tapped and used for RW?
      II. Are there other nearby pipelines that could be downsized if the reservoir is no longer part of the potable system?
      III. Blowoff?
   d. Emergency Operations
      I. How critical is Encino Reservoir as emergency storage?
   e. Treatment
      I. Repurpose MF plant to maintain RW quality in the reservoir?
   f. Pumping
      I. Can the emergency water pump station be repurposed?
   g. Connection with LASAN Sewer
   h. Other
4. Discussion
5. Action Items

2. LADWP

Overview of Seasonal Storage Concept for Las Virgenes and LADWP

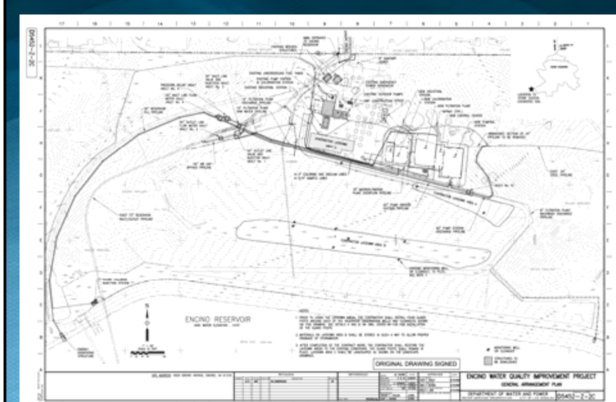
3. FACILITIES MAP



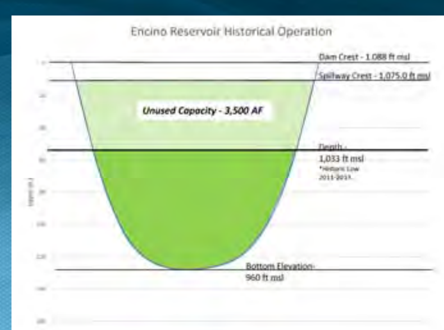
3. FACILITIES MAP

3. RESERVOIR OPERATIONS

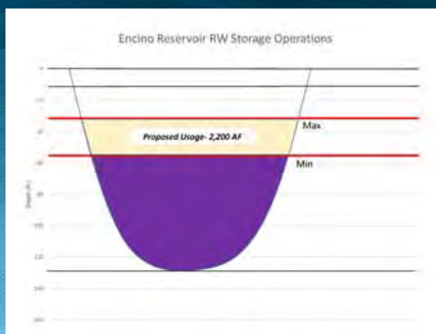
3. RESERVOIR OPERATIONS



3.RESERVOIR OPERATIONS



3.RESERVOIR OPERATIONS



3. EMERGENCY OPERATIONS

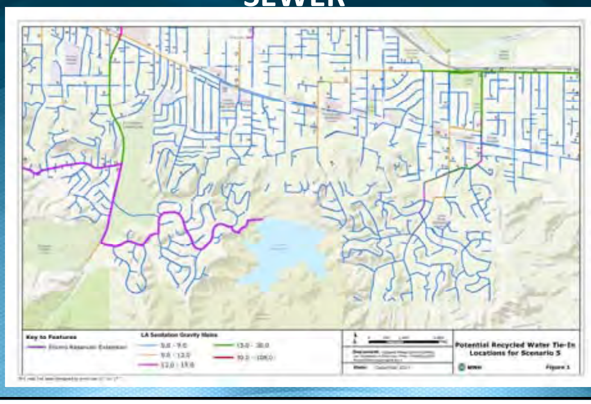
I. How critical is Encino Reservoir as emergency storage?

3. TREATMENT

I. Repurpose MF Plant to maintain RW quality in the reservoir?

3. PUMPING

3. CONNECTION WITH LASAN SEWER

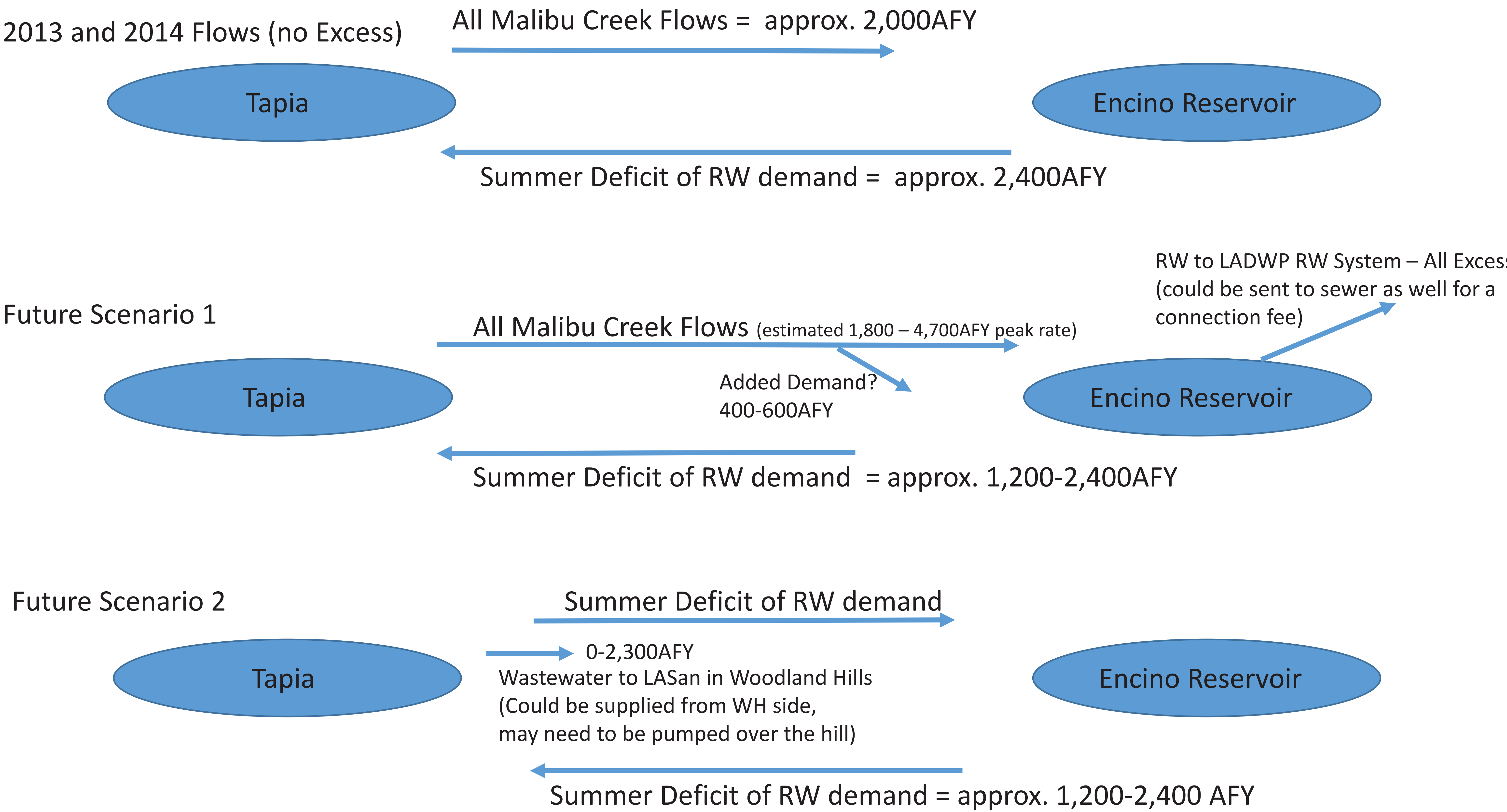


3. OTHER

I. Seismic Stability Study
II. Community Concerns

4. DISCUSSION

5. ACTION ITEMS


2013 and 2014 Flows (no Excess)
All Malibu Creek Flows = approx. 2,000AFY
Tapia
Encino Reservoir
Summer Deficit of RW demand = approx. 2,400AFY
Future Scenario 1
RW to LADWP RW System – All Excess (could be sent to sewer as well for a connection fee)
All Malibu Creek Flows (estimated 1,800 – 4,700AFY peak rate)
Tapia
Added Demand? 400-600AFY
Encino Reservoir
Summer Deficit of RW demand = approx. 1,200-2,400AFY
Future Scenario 2
Summer Deficit of RW demand
0-2,300AFY
Wastewater to LASan in Woodland Hills
(Could be supplied from WH side,
may need to be pumped over the hill)
Tapia
Encino Reservoir
Summer Deficit of RW demand = approx. 1,200-2,400 AFY

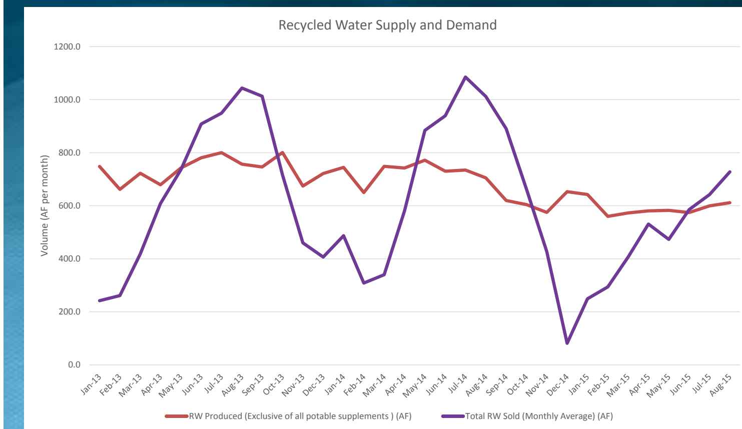
Meetings with DDW

Recycled Water
Basis of Design Report

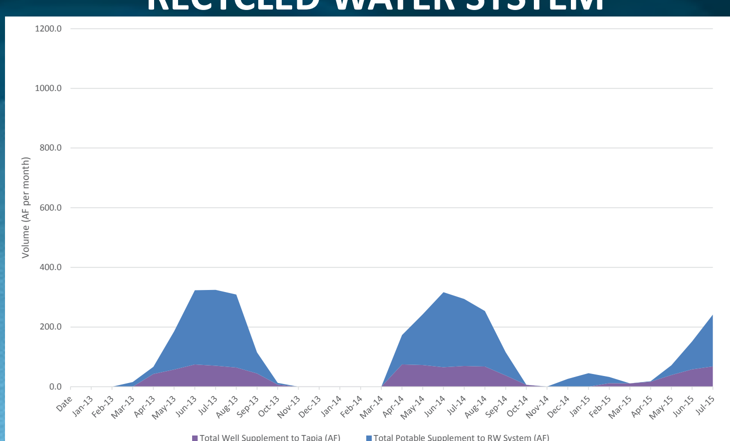
Division of Drinking Water Briefing – April 19, 2016

MWH

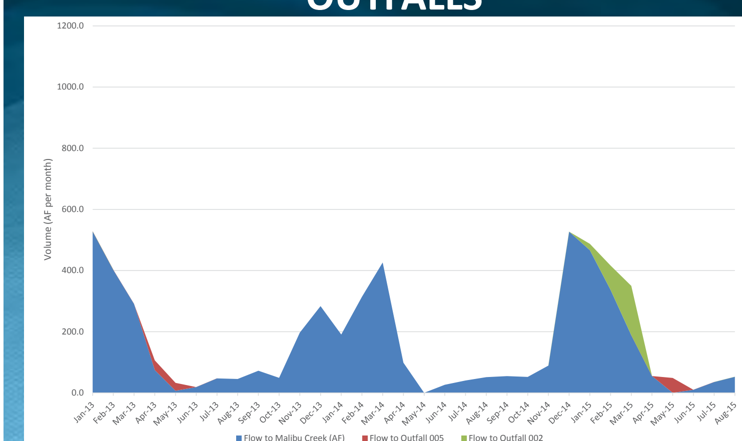
RECYCLED WATER SUPPLY AND DEMAND



POTABLE SUPPLEMENT TO RECYCLED WATER SYSTEM



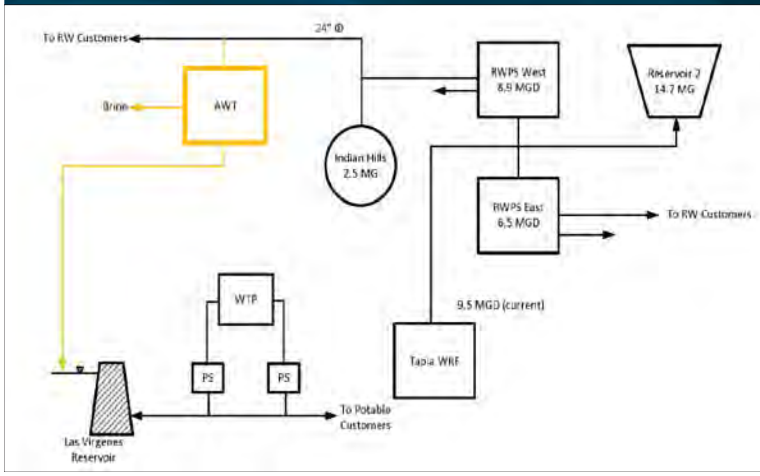
RECYCLED WATER DISCHARGE TO OUTFALLS



JPA Board Selected Two Options to Address Supply/Demand Imbalance

1. Surface Water Augmentation using Las Virgenes Reservoir (Scenario 4)
2. Seasonal Recycled Water Storage in Encino Reservoir (Scenario 5)

Scenario 4 -Schematic



Scenario 4 – Proposed Facilities

- New facilities include:
  - AWT Plant
  - New conveyance pipeline
  - Brine pipeline
    - Pumped directly to Salinity Management Pipeline (requires 11 mi of pipeline)

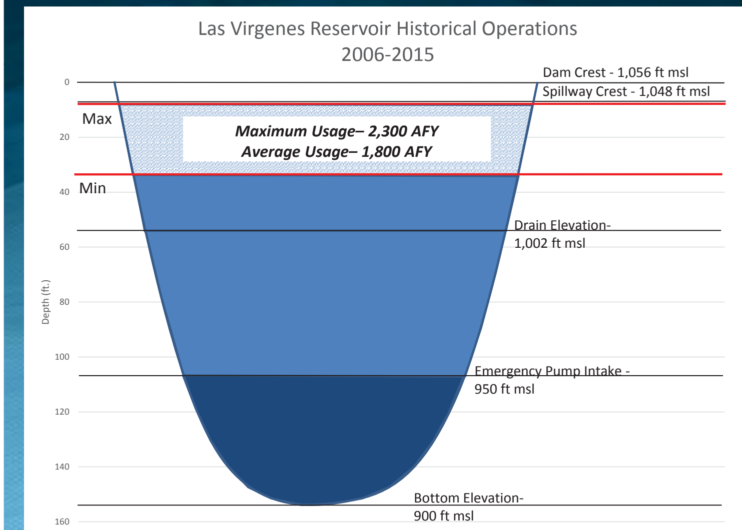
OR

- Pumped to Hill Canyon Wastewater Treatment Plant for discharge (requires 4 miles of pipeline)

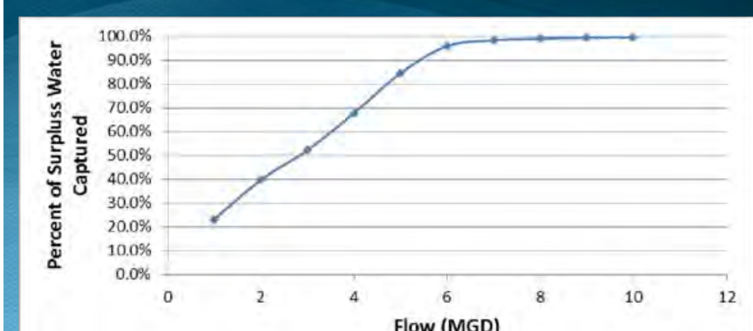
Scenario 4 –New Facilities

Scenario 4 – Reservoir Operations (Draft – No Growth)

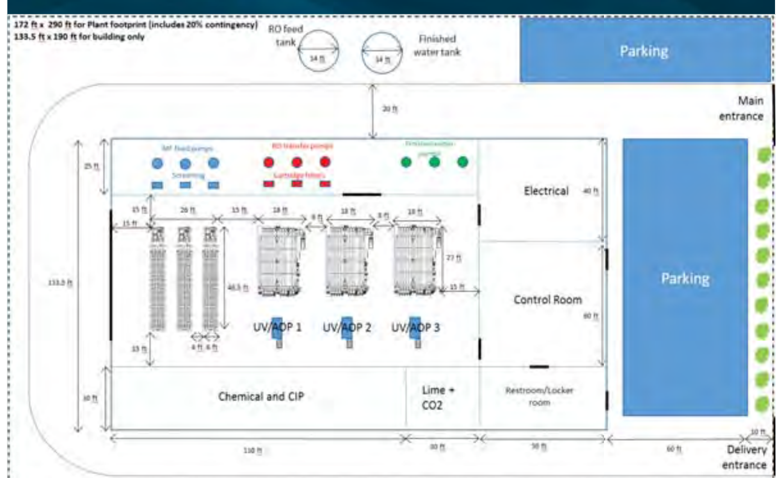
Year	Net RW Available for Storage (AF)
1997-1998	2392.38
1998-1999	2624.11
1999-2000	2920.47
2000-2001	3117.83
2001-2002	2674.31
2002-2003	2500.24
2003-2004	2158.17
2004-2005	2422.01
2005-2006	2531.30
2006-2007	2258.06
2007-2008	2567.30
2008-2009	1338.83
2009-2010	2098.71
2010-2011	2181.58
2011-2012	1695.43
2012-2013	1688.14
2013-2014	1867.10
Minimum	1338.83
Average	2296.23



Scenario 4 – AWT Capture Rate



Scenario 4 – AWT Facility Layout



Scenario 4 – Interagency Coordination

- State of California:
  - Department of Transportation (CalTrans) - encroachment permit for crossing Highway 101 for effluent pipeline or brine pipeline
  - Division of Drinking Water (DDW) – Lead agency in approving Scenario 4
  - Regional Water Quality Control Board (RWQCB) – final approval over NPDES discharge permit

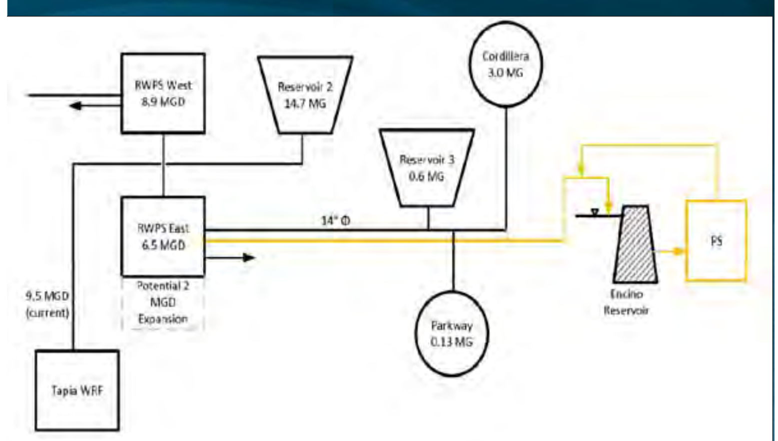
Scenario 4 – Interagency Coordination

- Local Agencies:
  - City of Westlake Village -encroachment permit for pipelines to reach Las Virgenes Reservoir
  - City of Thousand Oaks – discharge of brine to the City's wastewater collection system and treatment of brine at Hill Canyon WRF
  - Camrosa Water District – City of TO has existing agreement with Camrosa Water District for use of Hill Canyon WRF effluent
  - Calleguas Municipal Water District – owns and manages the Salinity Management Pipeline (SMP)

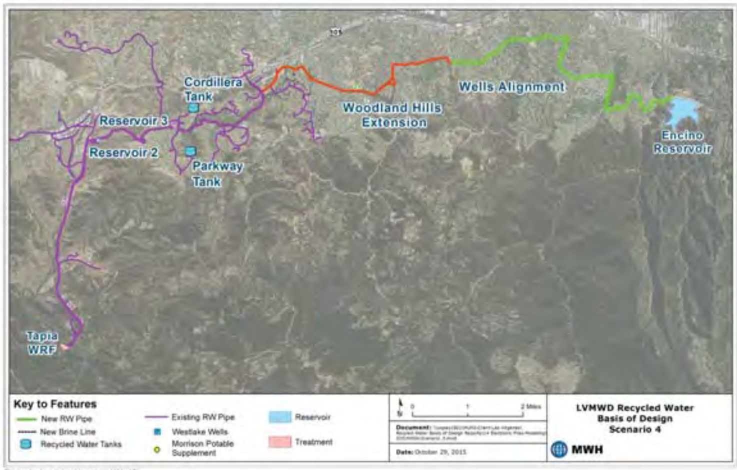
Scenario 5 – Proposed Facilities

- New Facilities include:
  - Wells Alignment (or Mulholland Alignment)
  - Pump Station at Encino Reservoir
  - Mixing system
  - Strainers and chlorination equipment
  - Expansion of RWPS East
  - Facilities required for discharge of excess water (To be determined)

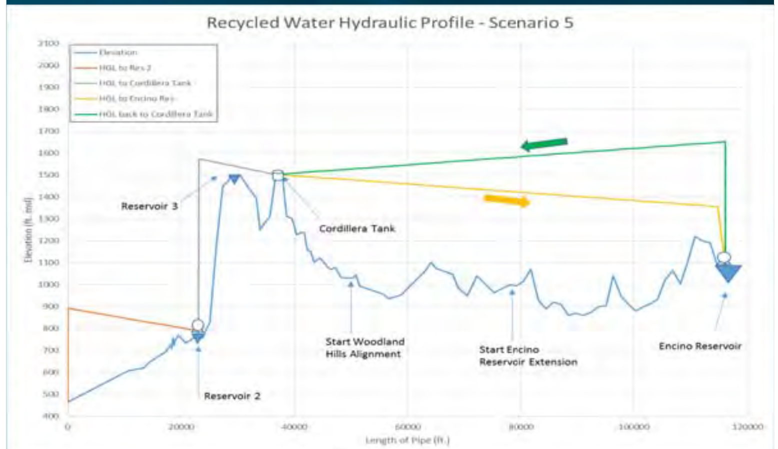
Scenario 5 - Schematic



Scenario 5 – Proposed Facilities



Scenario 5 – Wells Alignment Hydraulic Profile



Meetings with LASAN

Agenda

Project: Recycled Water Seasonal Storage, Basis of Design Meeting with Los Angeles Sanitation

Purpose: Interagency Coordination – Scenario 5 Recycled Water Storage at Encino Reservoir

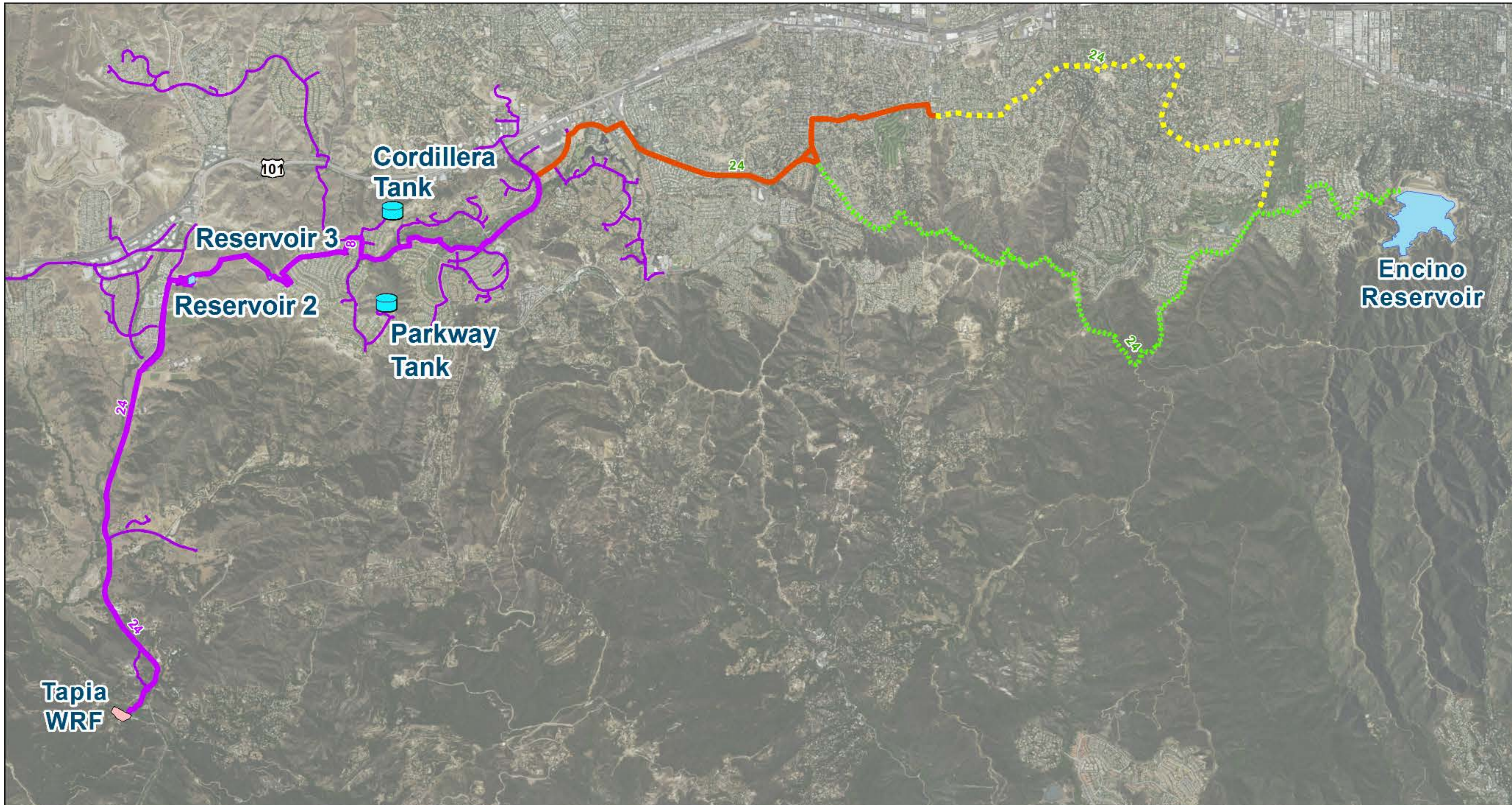
Date and Time: January 12, 2016 1:00pm

Location: Tillman Water Reclamation Plant

6100 Woodley Ave Van Nuys, CA 91406

Discussion Items:

1. **Scenario Summary**
2. **Facilities Map**
3. **Emergency Operations**
4. **Treatment (Screening, filtration, mixing, and/or aeration)**
5. **Current Connections to LASan from Encino Reservoir**
6. **Connection with LASan Sewer**
7. **Treatment at Tillman WRP**



Key to Features

- Woodland Hills WRP
- New RW Alternative 1
- New Alternative 2
- Existing RW Pipe
- Recycled Water Tanks
- Reservoir
- Treatment

N

0 1 2 Miles

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Date: October 29, 2015

LVMWD Recycled Water Basis of Design Scenario 5

MWH

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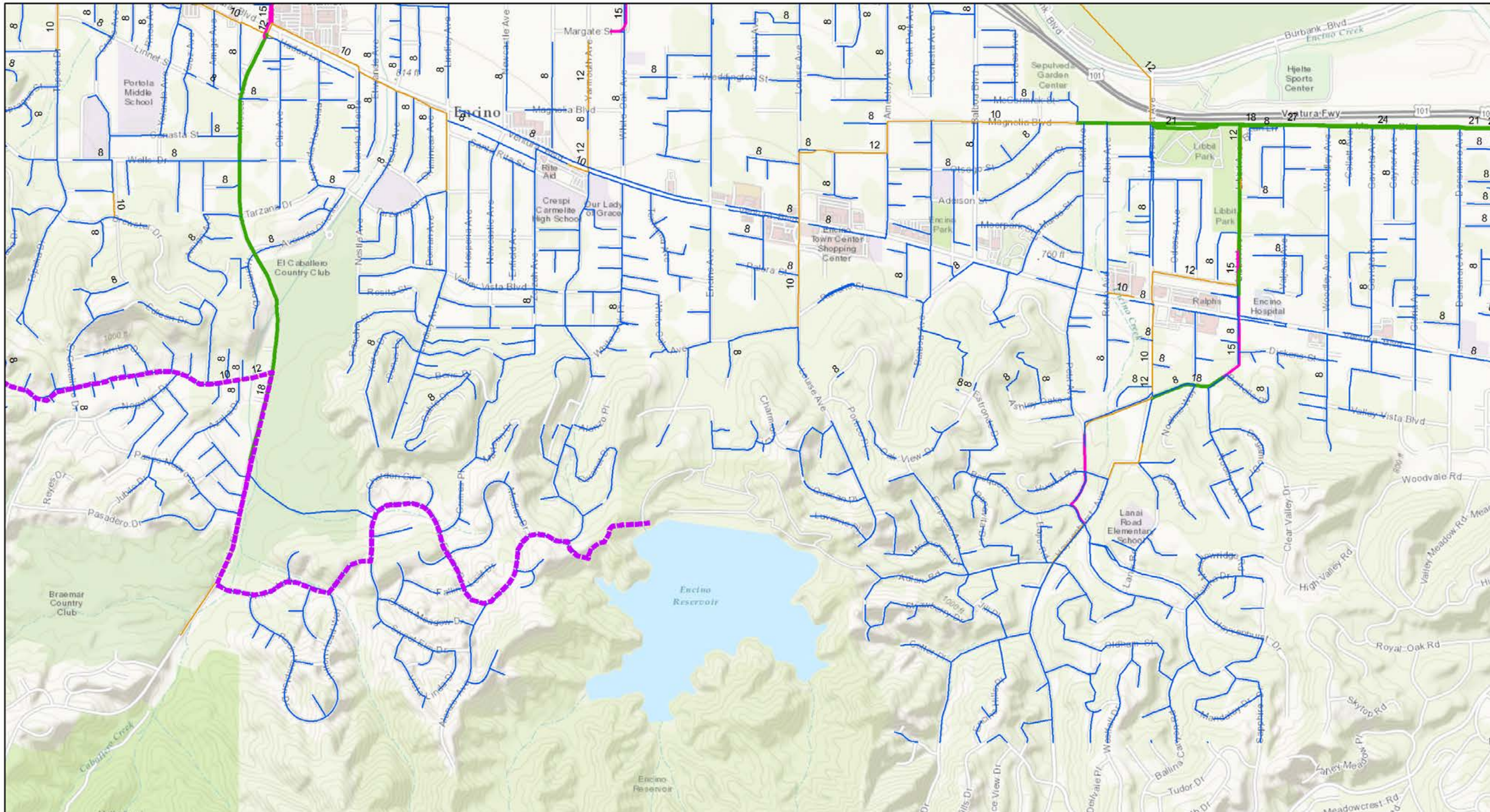

Key to Features

Encino Reservoir Extension

LA Sanitation Gravity Mains

- 0.0 - 9.0
- 9.0 - 12.0
- 12.0 - 15.0
- 15.0 - 30.0
- 30.0 - 108.0

N

0 700 1,400 2,800 Feet

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Date: December 2015

Potential Recycled Water Tie-In Locations for Scenario 5

MWH

Figure 1

This map has been designed to print size 11'' by 17''.

Meetings with Thousand Oaks

Agenda

Project: Recycled Water Seasonal Storage, Basis of Design Meeting #2 with City of Thousand Oaks

Purpose: Interagency Coordination – Scenario 4 IPR At Las Virgenes Reservoir

Date and Time: January 7, 2016
9:00am

Location: Thousand Oaks City Hall, Public Works. 2100 E Thousand Oaks Blvd, Thousand Oaks, CA 91362

Discussion Items:

1. **Facilities Map**

2. **Brine line location and tie-in**

3. **Brine Quality and treatment at Hill Canyon WRF**

4. **Water Quality Compliance with Conejo Creek NPDES and SMP**

5. **Camrosa WD Agreement**

6. **Potential Costs for Estimating (e.g. connection fee, treatment fee, etc.)**

Meeting Notes

Project:	Recycled Water Seasonal Storage, Basis of Design Meeting with City of Thousand Oaks
Purpose:	Interagency Coordination – Scenario 4 IPR At Las Virgenes Reservoir
Date and Time:	October 20, 2015 01:30 – 3:00pm
	Job No: 10507990
Location:	Thousand Oaks City Hall, Public Works. 2100 E Thousand Oaks Blvd, Thousand Oaks, CA 91362
Attendees:	Jay Spurgin, City of Thousand Oaks David Lippman, LVMWD James Borchardt, MWH Oliver Slosser, MWH

- LVMWD and MWH met with City of Thousand Oaks (City) to discuss the possibility of sending brine from a proposed advanced water treatment (AWT) plant to the City's sewer system.
- The City has future plans to pump and treat groundwater (GW) for use as recycled and potable water, with discharge of any generated brine to their sewer system.
- The City has an existing contract with the Camrosa Water District (Camrosa) for purchase of Hill Canyon WWTP effluent recharge in the Santa Rosa Basin. Camrosa also has plans to build a future GW desalting facility.
- The City is below their TMDL limits for the outfall of HCWTP and will not need to necessarily perform additional treatment to added brine from GW desalting in order to discharge.
- The City has seen wastewater flows drop from approximately 11 MGD to 8 MGD in recent years, due to conservation and drought. Lining projects initiated by the City have also helped decrease the amount of infiltration and inflow. Because of this lower overall flow in the City, it may be more difficult for the City to treat any additional flow with high total dissolved solids (TDS). Dilution may be a concern if LVMWD were to introduce brine to the collection system.

- The City requested that LVMWD quantify the impacts to the City's effluent from any plan to add brine from an AWT plant.
- MWH will review the TMDL and Permit for HCWTP to verify the ability of sending additional brine to the collection system with current treatment processes
- The City advised that the permit for HCWTP varies seasonally and MWH should ensure compliance for all seasons.
- The City and LVMWD would need to negotiate ownership of the water (brine) once it is discharged into the City's collection system
- MWH will review the City's collection system maps and model to identify a potential location of tie in from the AWT plant. MWH will also review the City's design criteria for any proposed tie in
- The City advised that atlas maps of the collection system are available from the City's website
- City advised that any new tie in would require a new metering station, and costs incurred for the brine discharge may include a wastewater charge, connection fee, and surcharge for retreatment at Hill Canyon.
- MWH will also review discharge limits to Salinity Management Pipeline (SMP) and ensure that added flow from LVMWD brine would not violate any of the contaminant limits for the SMP.

Meeting Notes

Project: Recycled Water Seasonal Storage, Basis of Design Meeting with City of Thousand Oaks

Purpose: Interagency Coordination – Scenario 4 IPR At Las Virgenes Reservoir

Date and Time: January 7, 2016 09:00 – 10:30pm

Job No: 10507990

Location: Thousand Oaks City Hall, Public Works. 2100 E Thousand Oaks Blvd, Thousand Oaks, CA 91362

Attendees:

Jay Spurgin, City of Thousand Oaks
David Pedersen, LVMWD
David Lippman, LVMWD
James Borchardt, MWH
Sarah Munger, MWH
Oliver Slosser, MWH

- Next Workshop is planned for January 27th at 5:00pm

Brine Line and Pipeline Alignments:

- Three Springs Community may be a difficult alignment logistically, MWH will look at other alignments from the AWT plant to Las Virgenes Reservoir
- MWH will run hydraulic calculations to confirm the ability of 18 inch line to accept brine flows
- MWH is talking to City of Thousand Oaks for flow monitoring information along the line with brine flows, additional flow monitoring may be required to confirm loading
- City of Thousand Oaks provided design criteria for d/D requirements of collection system
- City of Thousand Oaks communicated that quality issues such as sulfides have been addressed in their system for the most part.

Treatment and Permitting

- MWH will confirm the expected BOD of the brine
- City of Thousand Oaks communicated that the main driver for quality at the Hill Canyon Wastewater Treatment Plant (HCWWTP) is Chloride concentration

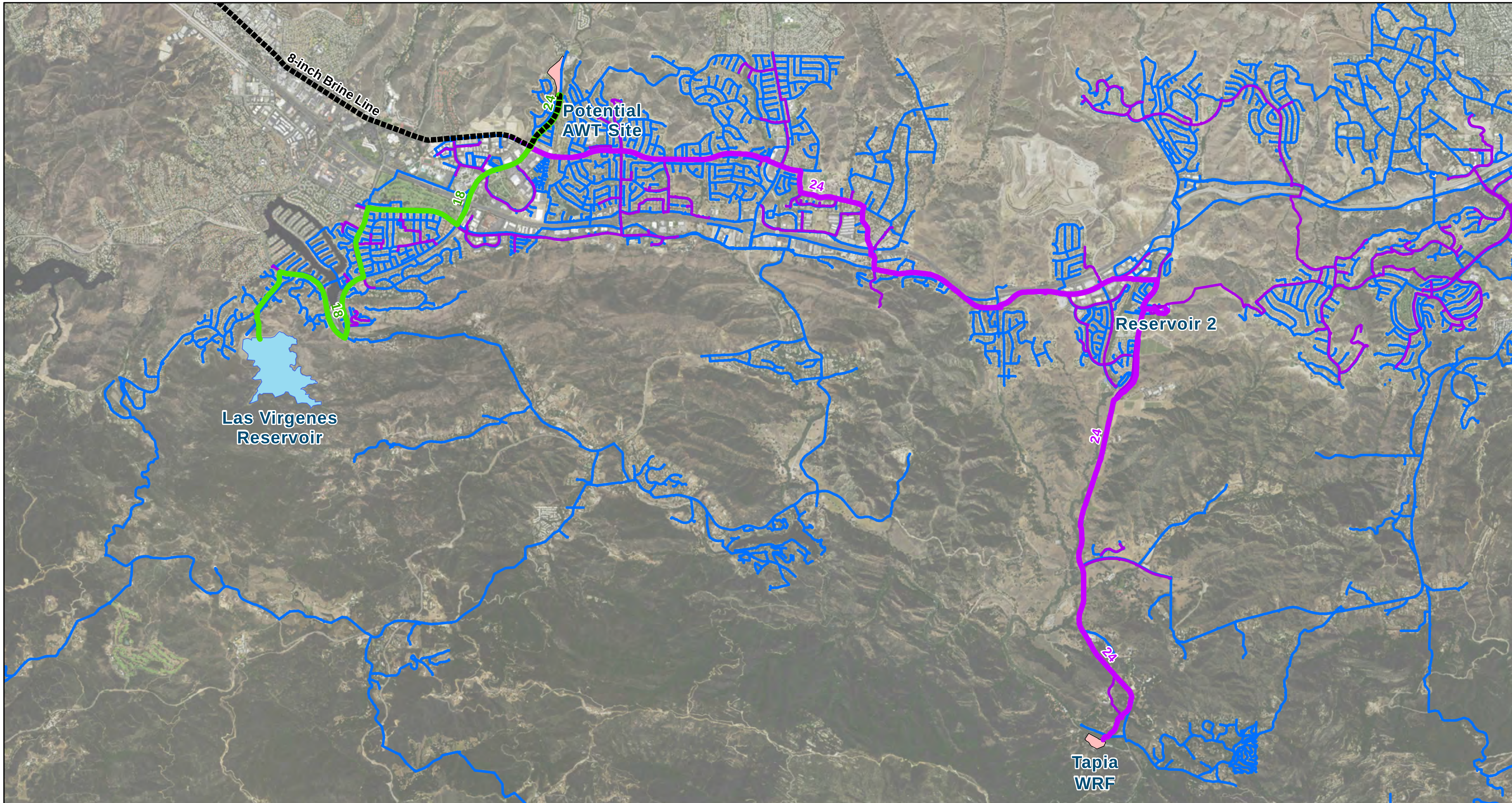
- MWH will review the NPDES permit to confirm monitoring requirements and wet weather versus dry weather requirements for discharge
- MWH will discuss monitoring practices with City of Thousand Oaks staff
- Thousand Oaks communicated that they are looking into desalting of wells in their service area and the effects of sending brine to the HCWWTP. City advised that the draft report is being presented to the City Council this month.
- City of Thousand Oaks requested MWH review the Salts TMDL which is the driver for the HCWWTP limits
- City of Thousand Oaks requested MWH review the hydrograph for the monitoring station for 2005 and 1998 (El Nino effects)

Camrosa Agreement

- City of Thousand Oaks advised that the agreement with Camrosa Water District has a meet and confer clause and that any changes to the effluent of HCWWTP would need to be discussed with them
- City of Thousand Oaks advised that there may be plans to hard pipe effluent flows to Camrosa in the future
- Plans to do groundwater infiltration at nearby pepper farm with Conejo Creek water have also been discussed

Costs

- City of Thousand Oaks communicated that cost for brine disposal could be under a unique agreement similar to those between the City and Amgen, and fall outside the traditional Municipal and Industrial rates which are based on amount of fixtures
- City of Thousand Oaks communicated that there may also have to be considerations of costs based on brine contaminate concentration (strength) which are not currently part of the fee schedule
- City of Thousand Oaks expressed interest in a par6tnership and water sharing structure when setting up agreement.



Key to Features

- New RW Pipe
- New Brine Line
- Existing RW Pipe
- Existing PW Pipe
- Reservoir
- Treatment

N

0 1 2 Miles

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Date: October 23, 2015

LVMWD Recycled Water
Basis of Design
Scenario 4

MWH

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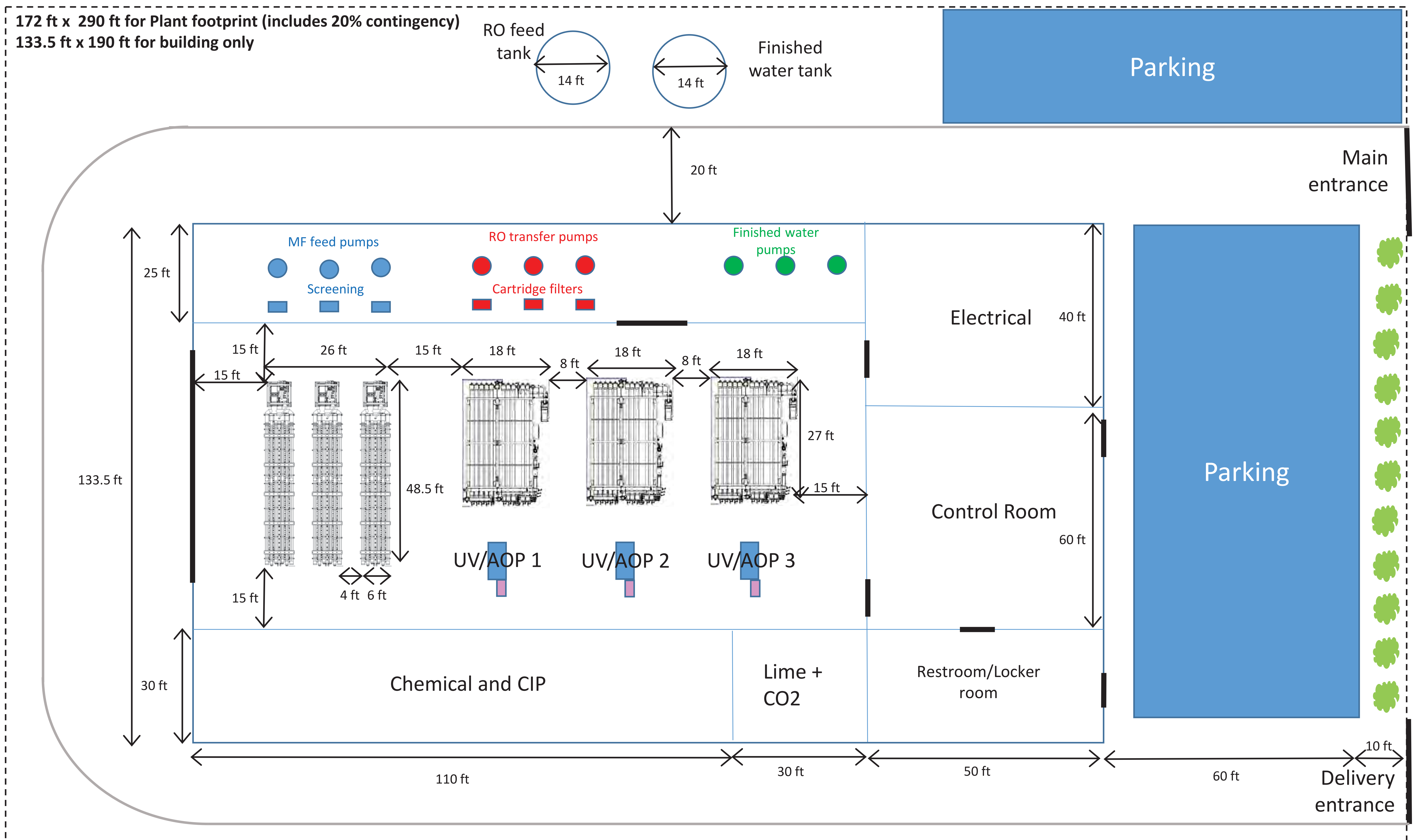
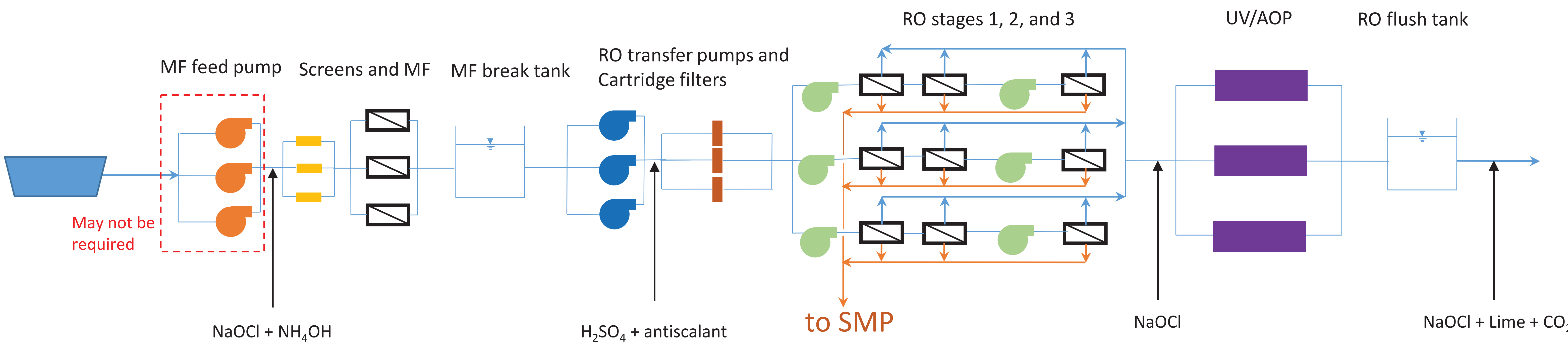


172 ft x 290 ft for Plant footprint (includes 20% contingency)
133.5 ft x 190 ft for building only
RO feed tank
14 ft
14 ft
Finished water tank
Parking
20 ft
Main entrance
MF feed pumps
RO transfer pumps
Finished water pumps
Screening
Cartridge filters
Electrical
40 ft
25 ft
133.5 ft
15 ft
26 ft
15 ft
18 ft
8 ft
18 ft
8 ft
18 ft
15 ft
27 ft
48.5 ft
15 ft
Control Room
60 ft
Parking
UV/AOP 1
UV/AOP 2
UV/AOP 3
15 ft
4 ft
6 ft
30 ft
Chemical and CIP
Lime + CO2
Restroom/Locker room
110 ft
30 ft
50 ft
60 ft
10 ft
Delivery entrance



MF feed pump
Screens and MF
MF break tank
RO transfer pumps and Cartridge filters
RO stages 1, 2, and 3
UV/AOP
RO flush tank
May not be required
NaOCl + NH_4OH
H_2SO_4 + antiscalant
to SMP
NaOCl
NaOCl + Lime + CO_2

Key to Features

- Advanced Water Treatment Plant Layout
- Potential AWTP Site Area

N

0 | 0.025 | 0.05 Miles

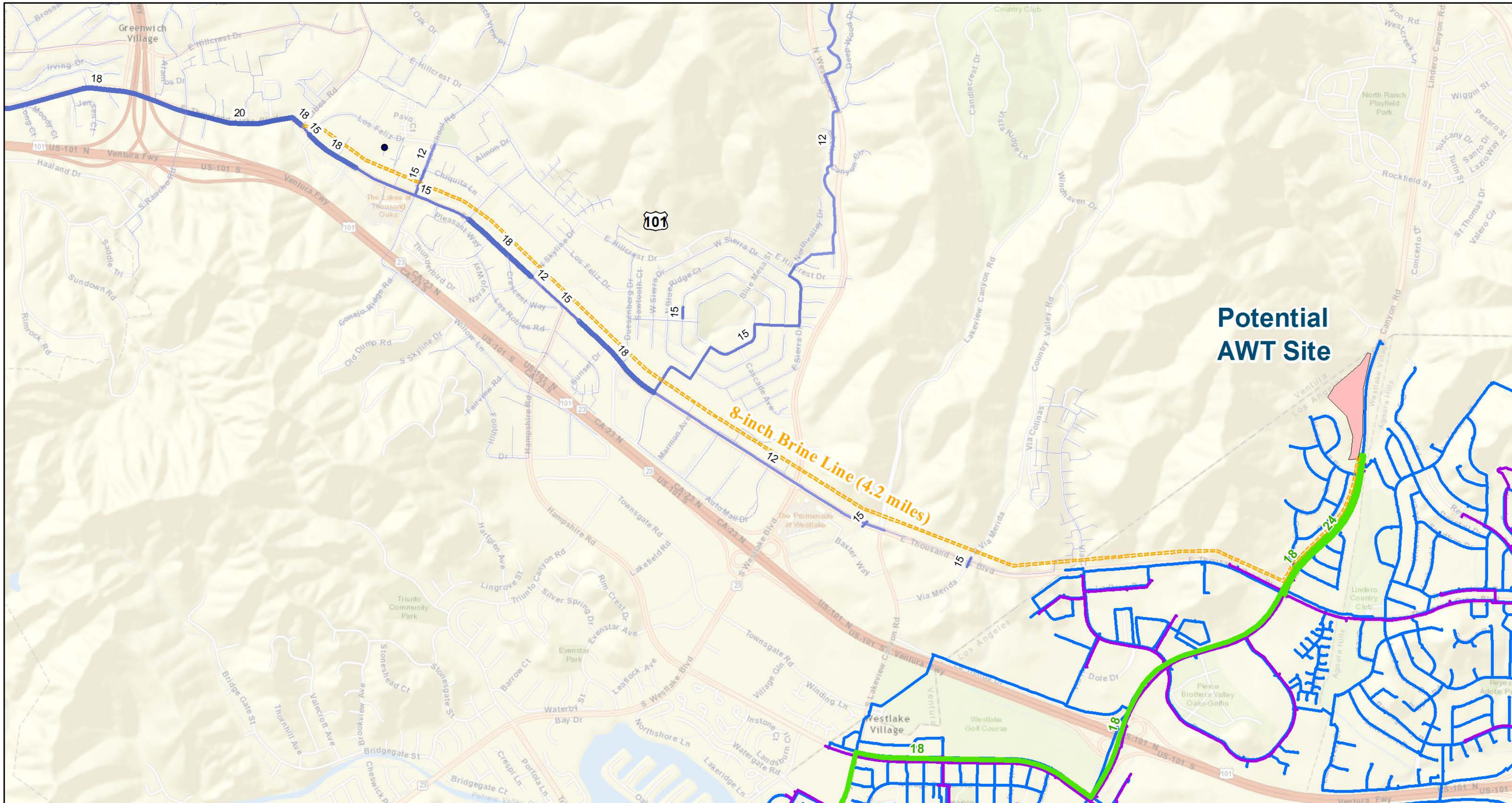
Document: \\Uspas1S01\MUNI\Client\Las Virgenes\Recyled Water Basis of Design Reports\14 Electronic Files-Modeling\GIS\MXDs\LV AWTP Site Layout.mxd

Date: December 9, 2015

Scenario 4
Potential AWTP Site Layout

MWH

This map has been designed to print size 11'' by 17''.



Key to Features

- New RW Pipe
- New Brine Line
- Recycled Water Tanks
- Existing RW Pipe
- Westlake Wells
- Morrison Potable Supplement
- Thousand Oaks Sewer Collection Line (dia. labelled)
- Treatment

N 0 0.375 0.75 Miles

Document: \\Uspas1S01\MUNI\Client\Las Virgenes\Recyled Water Basis of Design Reports\14 Electronic Files-Modeling\GIS\MXDs\Scenario_5.mxd

Date: October 29, 2015

LVMWD Recycled Water Basis of Design Potential Brine Line Tie-In

MWH

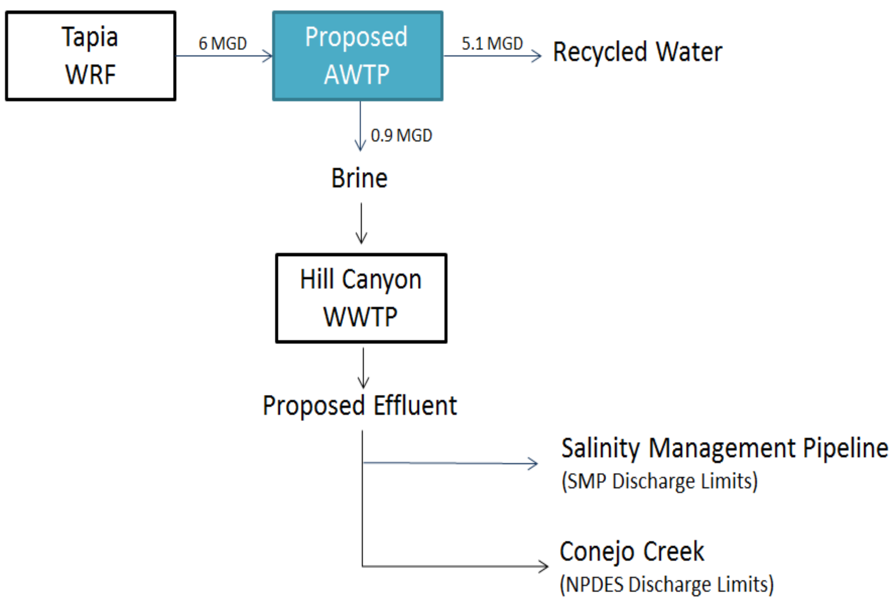
This map has been designed to print size 11'' by 17''.

AWTP Design Parameters

Plant Capacity: 6 MGD

RO Recovery: 85%

AWTP Flow Diagram



SMP Discharge Limits*

Proposed Effluent meets all SMP Discharge Limits.

NPDES Discharge Limits*

Proposed Effluent exceeds the following NPDES Discharge Limits:

Contaminant	Exceedance over NPDES Limit	Response
Bis(2-Ethylhexyl) Phthalate	26 > 4 µg/L	Potential for oxidation in the AWTP. To be confirmed.
Cyanide	7 > 4 µg/L	Potential for oxidation in the AWTP. To be confirmed.
Chloride (wet weather)	240 (dry) > 150 mg/L (wet)	Due to lack of wet-weather samples, dry-weather water quality data was compared to the wet-weather NPDES limit. Although the dry-weather data meets the dry-weather limits, the dry-weather data exceeds the wet-weather limits. Wet-weather samples are needed.
Sulfate (wet weather)	303 (dry) > 250 mg/L (wet)	
TDS (wet weather)	1152 (dry) > 850 mg/L (wet)	

*Compliance with discharge limits was only verified for contaminants where water quality data from both Tapia WRF and Hill Canyon WWTP were available.

Proposed Effluent vs. SMP Limits

Parameter	Units	Proposed Effluent Concentrations		OK? Is Max > Limit?	Most Stringent SMP Limit	Comment:
		Average	Max			
Ammonia (as N)	µg/L	1,508	2,236	Y	440,000	
Arsenic (Total Recoverable)	µg/L	--	4	Y	5,600	
Bis(2-Ethylhexyl)Phthalate	µg/L	--	26	Y	260	
BOD (5-day @ 20° C)	mg/L	8	10	Y	45	
Cadmium (Total Recoverable)	µg/L	--	1	Y	730	
Chlorodibromomethane	µg/L	--	10	Y	630	
Chloroform	µg/L	--	45	Y	9,500	
Copper (Total Recoverable)	µg/L	4	13	Y	2,000	
Cyanide	µg/L	--	7	Y	730	
Dichlorobromomethane	µg/L	--	43	Y	450	
Nickel (Total Recoverable)	µg/L	5	6	Y	3,700	
Selenium (Total Recoverable)	µg/L	--	1	Y	11,000	
Total Suspended Solids	mg/L	2	6	Y	60	
Turbidity	NTU		0.7	Y	225	Assumes 90% removal of turbidity from brine at HCWWTP.
Zinc (Total Recoverable)	µg/L	--	71	Y	14,000	

Color Code:

Water Quality Data in compliance with most stringent standard

Proposed Effluent vs. NPDES Standards

Parameter	Units	Proposed Effluent Concentrations: Average	Proposed Effluent Concentrations: Max	OK? Is Max > Limit?	Most Stringent NPDES Limit	Comment:
Ammonia (as N)	µg/L	1,508	2,236	Y	3,100	
Arsenic (Total Recoverable)	µg/L	--	4	Y	370	
BOD (5-day @ 20° C)	mg/L	8	10	Y	20	
Cadmium (Total Recoverable)	µg/L	--	1	Y	73	
Chlorodibromomethane	µg/L	--	10	Y	630	
Chloroform	µg/L	--	45	Y	9,500	
Copper (Total Recoverable)	µg/L	4	13	Y	28	
Dichlorobromomethane	µg/L	--	43	Y	450	
Nickel (Total Recoverable)	µg/L	5	6	Y	153	
Selenium (Total Recoverable)	µg/L	--	1	Y	1,100	
Total Suspended Solids	mg/L	2	6	Y	15	
Turbidity	NTU		0.7	Y	2	Assumes 90% removal of turbidity from brine at HCWWTP.
Zinc (Total Recoverable)	µg/L	--	71	Y	880	
Boron	mg/L	0.69	0.72	Y	1.0	
Chloride- Dry weather	lbs/day	16,094	16,879	Y	17,500	
Sulfate - Dry weather	lbs/day	16,483	21,145	Y	29,200	
TDS - Dry weather	lbs/day	81,973	90,458	Y	99,250	
[Nitrate + Nitrite] (as N)	mg/L	--	8	Y	9	Assumes 80% removal of Total Nitrogen from brine at HCWWTP.
Bis(2-Ethylhexyl)Phthalate	µg/L	--	26	N	4	Potential for oxidation in the AWTP. To be confirmed.
Cyanide	µg/L	--	7	N	4	Potential for oxidation in the AWTP. To be confirmed.
Chloride - Wet weather	mg/L	230*	240*	N	150	*Due to lack of wet-weather samples, dry-weather water quality data was compared to the wet-weather standard. Although the dry-weather data meets the dry-weather standards, the dry-weather data exceeds the wet-weather standards. Wet-weather samples are needed.
Sulfate - Wet weather	mg/L	247*	303*	N	250	
TDS - Wet weather	mg/L	1,050*	1,152*	N	850	

Color Code:

Water Quality Data in compliance with most stringest standard

Water Quality Data approaching standard limit

Water Quality data exceeds standard

Agreement Between the City of Thousand Oaks and the Camrosa Water District for the Beneficial Use of Water Pursuant to State Water Resources Control Board Water Right Decision 1638

This Agreement is entered into this 28 the day of May, 2013 by and between the City of Thousand Oaks, a California general law city (hereinafter referred to as "***City***"); and the Camrosa Water District, a county water district organized under the County Water District Law of the State of California (hereinafter referred to as "***Camrosa***").

RECITALS

A. The City and Camrosa have a common interest in maximizing the beneficial use of waters available for appropriation as described in the State Water Resources Control Board Water Right Decision 1638 and corresponding Water Right Permit 20952 issued by the State Water Resources Control Board to the City (hereinafter referred to as "***City Water Rights***").

B. The City and Camrosa have cooperated in harmonizing the legal, institutional, financial, and operational aspects of their joint relationships to maximize the use of water made available under the City Water Rights.

C. The City and Camrosa acknowledge that cooperatively they can most effectively maximize the beneficial use of the water available under the City Water Rights.

D. In anticipation of the State Water Resources Control Board's Water Right Decision 1638 and based on the City's original Water Right application, first the City and the Calleguas Municipal Water District ("***Calleguas***"), and then Calleguas and Camrosa, executed agreements to cooperate in the appropriation of water pursuant to the pending water right decision. Subsequent to the State Water Resources Control Board's Water Right Decision 1638, but prior to appropriation of water under Water Right Permit 20952, the City and Calleguas renegotiated their previous agreement incorporating portions of Water Right Decision 1638 and portions of the City's original water right application. Camrosa and Calleguas continued to operate under their previous agreement.

E. With Camrosa's assumption of full operation of the physical facilities necessary to appropriate the water pursuant to the City Water Rights, and the recoupment of Calleguas' capital investment in said facilities, the City, Calleguas and Camrosa have proven amenable to Calleguas ceding any and all control over or participation in the operation and management of said facilities, as outlined in any previous agreement pertaining thereto, and the City and Camrosa desire to re-establish and consolidate the terms of their contractual relationship consistent with the City Water Rights and the parties' relative roles in developing the City Water Rights.

F. In re-establishing the terms under this Agreement, the parties wish to make this Agreement substantially cost or revenue neutral to all parties as compared to the terms of the previous agreements. This Agreement shall be interpreted consistent with this purpose.

G. The parties acknowledge that through their cooperation to maximize the beneficial use of the waters available for appropriation under the City Water Rights, they have developed a water resource with regional significance.

NOW, THEREFORE, IT IS AGREED as follows:

1. <u>Definitions</u>

For the purposes of this Agreement, the following definitions shall apply:

a. "***City Measurement Station***" shall refer to the flume and measurement apparatus placed by the City below the confluence of the north and south forks of the Arroyo Conejo to measure the combined flows from the Hill Canyon Wastewater Treatment Plant and water flowing downstream from the forks of the Arroyo Conejo. This facility is owned and operated by the City.

b. "***Camrosa Diversion***" shall refer to the Conejo Creek Diversion structure located downstream and adjacent to the U.S. Highway 101 bridge over Conejo Creek and designated by Decision 1638 as the point of diversion for water appropriated pursuant to any water right or license pursuant to Water Right Decision 1638. This facility is owned and operated by Camrosa.

c. "***PVCWD Pipeline***" shall refer to the pipelines constructed by Camrosa and Calleguas which extend from the Camrosa Storage Ponds pump station to the point of connection to the intersection of Laguna Road and Las Posas Road. This pipeline is owned and operated by Camrosa.

d. "***Camrosa Storage Ponds***" shall refer to Camrosa's ponds located east of Conejo Creek and adjacent to Old Dairy Road.

e. "***Camrosa/Pleasant Valley Metering Stations***" shall refer to the water metering station where water is metered for delivery into the Pleasant Valley County Water District's (PVCWD) irrigation water distribution system and any other meters connected to the Camrosa pipeline delivering water to the service area of PVCWD. These facilities are owned and operated by Camrosa.

f. "***CFS***" shall mean cubic feet per second, a measurement of flowing water, which on a continuous basis equates to 724 acre feet per year, or 0.646 million gallons per day.

g. "***City Water Rights***" shall refer to the City's Water Right Permit 20952 issued by the State Water Resources Control Board pursuant to Water Right Decision 1638, and any subsequent license granted by the State Water Resources Control Board relating to the same.

2. Cooperation and Diligence in Perfecting Water Right License and Sharing Records

The parties agree to cooperate and exercise due diligence in meeting the requirements of the City Water Rights as specified below: (See Exhibit A for Calendar of routine actions required by the City's Water Rights and this Agreement)

a. The City shall be responsible for submitting such documentation to the State Water Resources Control Board as required to comply with Water Right Permit 20952, including without limitation Section 6 regarding complete application of water authorized by said Permit by December 31, 2025 or any extension granted thereto. In the event that the parties concur that additional water could be applied to beneficial use within the quantities limited by Water Right Permit 20952, Section 5; the City shall be responsible for petitioning the State Water Resources Control Board for an extension for a reasonable amount of time to put the full quantity of water provided by Water Right Permit 20952 to beneficial use.

b. The City shall be responsible for submitting annual progress reports to the State Water Resources Control Board to comply with Water Right Permit 20952, Sections 15 and 16. The City shall provide copies of said progress reports to Camrosa.

c. Camrosa shall keep metered records of dates of diversion, quantity of water diverted, and records documenting the bypass flow as required by Water Right Permit 20952, Sections 15 and 16, regarding quantification of flows. Such records shall be made available to the City for use in submitting its annual progress report above or as necessary to document water use under Water Right Permit 20952.

d. Camrosa shall be responsible for submitting to the State Water Resources Control Board all reports documenting compliance with Water Right Permit 20952, Section 12, regarding water use efficiency and conservation. Camrosa shall provide copies of said reports to the City.

e. The parties agree to share and provide the documents and information specified on Exhibit A attached to this Agreement and such other documents and information as the parties deem reasonably necessary to maximize the water available under Water Right Permit 20952. It is the obligation of the City to timely advise Camrosa in writing of any such documents and information which are not specifically required in this Agreement.

3. Basis for Water Available for Sale

The City Water Rights provide the basis for the water available for sale by the City. Under Decision 1638, the quantity of water that the parties may put to beneficial use is described in terms of streamflow available at the Camrosa Diversion. That streamflow is quantified as:

Effluent discharged from the Hill Canyon Wastewater Treatment Plant

minus 2.0 CFS to account for channel losses en route to the point of diversion

minus 2.0 CFS dedicated by City to protect instream environmental resources

plus 4.0 CFS when the total streamflow at the Camrosa Diversion is greater than the sum of the effluent discharged from the Hill Canyon Treatment Plant plus the required downstream bypass of 6.0 CFS

minus 0.82 CFS to satisfy downstream Water Right License #12598, up to 306 acre feet per year.

As a practical matter, given the technical constraints in the continuous measurement and reconciliation of real-time flows, and various complicating factors, the parties agree that a reasonable and rational translation of Water Right Decision 1638's quantification of the City's Water Rights for the purposes of this Agreement is described in Section 4. Notwithstanding the foregoing, the City acknowledges and agrees that the City is ultimately responsible for maintaining the City's Water Rights including compliance with Water Right Decision 1638.

4. Quantification of Water Available for Sale

For the purposes of this Agreement, the parties agree that the water available for sale shall be determined annually and quantified as follows:

Twelve times the average monthly streamflow recorded at the City Measurement Station for the months of June, July, and August of the preceding year

minus 1448 acre feet to account for 2.0 CFS channel losses between the City Measurement Station and the Camrosa Diversion *minus* 4344 acre feet to account for 6.0 CFS bypass downstream from the Camrosa Diversion

minus 306 acre feet to account for Water Right License #12598 downstream from the Camrosa Diversion (see Exhibit B for example calculation of water available).

5. Availability of Water and Purchase Commitments Among the Parties

   a. The City agrees to make available to Camrosa the total quantity of water available for sale as quantified in Section 4. Camrosa agrees to purchase from the City all such water made available to Camrosa under this Agreement for the price determined under Section 6 of this Agreement.

   b. Camrosa agrees to make the 6.0 CFS bypass releases downstream of the Camrosa Diversion as quantified in Section 4.

   c. Pursuant to Water Right Decision 1638, all water made available under this Agreement is limited to use within the boundaries of Camrosa and within the boundaries of the PVCWD.

6. Cost for Water Made Available

   a. The unit price per acre foot of water covered under this Agreement upon the Effective Date of this Agreement is $104.89 per acre foot.

   b. On September 1st of each year, the parties agree to adjust the unit price per acre foot of water as described in subsections c and d below.

   c. The adjusted unit price per acre foot of water shall be determined by adjusting the previous year's unit price per acre foot of water by the annual percentage change from the preceding July to July period in the Consumer Price Index (Los Angeles-Riverside-Orange County, All Urban Consumers) as published by the U.S. Bureau of Labor Statistics (See Exhibit B for sample calculation). Notwithstanding the foregoing, in no event shall the adjusted unit price be more than 107% of the previous year's unit price and in no event shall the adjusted unit price be less than 93% of the previous year's unit price.

   d. The adjusted unit price so determined shall then be the amount per acre foot applied to the water available for sale, as quantified pursuant to Section 4, until the next September adjustment.

7. Costs Related to the Operation and Maintenance of Facilities (See Exhibit C for map of facilities).

a. The City agrees to operate and maintain the City Measurement Station at its sole expense.

b. Camrosa agrees to operate and maintain the Camrosa Diversion, Camrosa Storage Ponds, and the related pump station at the Camrosa Storage Ponds at its sole expense.

c. Camrosa agrees to operate and maintain the PVCWD Pipeline. Routine maintenance of this pipeline will be at Camrosa's sole expense and shall include routine inspection and surveillance of pipeline right-of-way, valves, and other appurtenances and first response to reported emergencies.

8. Water Quality and Quantity Limitation

a. The parties acknowledge that the City cannot guarantee to Camrosa the quality of water downstream of the City Measurement Station. Camrosa agrees to hold the City harmless from any and all claims, lawsuits, demands, judgments or other liability arising out of, directly or indirectly, the use of the water delivered under this Agreement, including but not limited to impurities, pollution, or chemicals which may be introduced downstream of the City Measurement Station into the water made available under this Agreement.

b. The City agrees to exercise its best efforts to comply with the requirements of its National Pollution Discharge Elimination Permit (hereinafter referred to as "***NPDES Permit***") as well as all other applicable Federal, State and County statutes, laws and ordinances regarding the City's discharge of effluent to Conejo Creek and surface waters constituting water made available by the City under this Agreement.

c. In the event that the City cannot treat its effluent substantially to the standards in applicable NPDES Permit or other applicable Federal, State, or County regulation, or in the event that the City is aware of a sewage spill or any other hazardous material introduced into the City's drainage system that would impair the quality of water subject to this Agreement, the City will immediately notify Camrosa by telephone. In particular, in the event that any substance listed pursuant to Public Health and Safety Code Section 25249.8 is discharged, the City shall immediately notify Camrosa by telephone. Camrosa shall provide the City at all times a current listing of emergency telephone numbers. The City will further notify by telephone Camrosa when water made available under this Agreement is no longer impaired and available for beneficial reuse.

d. Quantification of water impaired for reuse: Where water made available by the City at the City Measurement Station is rendered unusable for beneficial reuse due to failure to meet its NPDES Permit standards, hazardous materials spills, or standards in its municipal storm water permit, such water will be quantified by the City per day for every day or portion of any day when water is impaired for reuse and a pro-rated credit shall be applied to Camrosa for the cost of water as quantified in Section 6.

e. The parties recognize that certain actions by agencies with statutory authority to regulate the water governed by this Agreement may jeopardize the ability of the parties to place the City Water Rights to beneficial use. Examples of these actions include, but are not limited to: modification of the City Water Rights, new regulation on the use of surface water, or implementation of Clean Water Act standards limiting the beneficial uses of such water or requiring additional treatment facilities. Either party may, upon written notice of such action to the other parties, request consultation among the parties to negotiate such amendments to this Agreement as may be necessary to continue to maximize the beneficial use of water available to the parties under the City Water Rights. To the extent that any action by others limits the ability of the parties to place the City Water Rights to beneficial use, the provisions for payment under this Agreement, to the extent of such limitation, shall be suspended pending renegotiation of this Agreement.

f. The parties recognize that certain other conditions could substantially affect the balance of obligation and benefit among the parties such that the individual interests of one or more of the parties would no longer be rationally related to continued cooperation in maximizing the beneficial use of the water under the terms of this Agreement. Examples of these conditions include, but are not limited to: the inability of either party to deliver water due to distribution or treatment system failure, regulatory changes, or water quality degradation to the point that it is no longer acceptable to the customer base. In response to such changed conditions, either party may upon written notice of such action to the other party request consultation among the parties to negotiate such amendments to this Agreement as may be necessary to continue to maximize the beneficial use of water available to the parties under the City Water Rights. To the extent that any action by others limits the ability of the parties to place the City Water Rights to beneficial use, the provisions for payment of such water under this Agreement shall be suspended pending renegotiation of this Agreement.

9. Schedule for Payments

a. City shall bill Camrosa no later than October 1st for payment due for the period twelve months preceding measured from September 1st through August 31st. Payments shall be made to the City by Camrosa on or about November 15 of each year during the term of this Agreement. Payment for the last year (or any partial year) of this Agreement will be based upon the number of full months the water was made available by the City during the last year of the term of this Agreement.

10. Term of the Agreement

The term of this Agreement is forty (40) years from the Effective Date of this Agreement. The parties, by mutual consent, may extend the term of the Agreement for additional five-year periods.

11. Cooperation and Exchange of Information

The parties agree to cooperate, exchange information, and provide the availability of records necessary for the maintenance of the City Water Rights, administration of this Agreement, and operation of associated facilities.

12. Conservation Credits

From the Effective Date of this Agreement, Camrosa agrees to use reasonable efforts to secure conservation credits from the Fox Canyon Groundwater Management Agency for waters delivered by the project which offset the need to extract groundwater from the aquifers within the Fox Canyon Groundwater Management Agency. Camrosa agrees that one-half of the accumulated credits will be made available to the City.

13. Deliveries to PVCWD

Camrosa agrees to use reasonable diligence in providing surplus water, not needed by Camrosa, to the PVCWD.

14. Assignment

The parties agree that this Agreement may not be assigned without the written consent of all of the non-assigning parties.

15. Waiver: Remedies Cumulative

Failure by a party to insist upon the strict performance of any of the provisions of this Agreement by another party, irrespective of the length of time for which such failure continues, shall not constitute a waiver of such parties' rights to demand strict compliance by such other party in the future. No waiver by a party of a default or breach by another party or parties shall be effective or binding upon such party unless made in writing by such party, and no such waiver shall be implied from any omission by a party to take any action with respect to such default or breach. No express written waiver of a specified default or breach shall affect any other default or breach, or cover any other period of time, other than any default or breach and/or period of time specified. All of the remedies permitted or available to a party under this Agreement, or at law or in equity, shall be cumulative and alternative, and invocation of any such right or remedy shall not constitute a waiver or election of remedies with respect to any other permitted or available right or remedy.

16. Construction of Language of Agreement

The provisions of this Agreement shall be construed as a whole according to its common meaning and purpose of providing a public benefit and not strictly for or against any party. It shall be construed consistent with the provisions hereof, in order to achieve the objectives and purposes of the parties. Wherever required by the context, the singular shall include the plural and vice versa, and the masculine gender shall include the feminine or neutral genders or vice versa.

17. Mitigation of Damages

In all situations arising out of this Agreement, the parties shall attempt to avoid and minimize the damages resulting from the conduct of the other parties.

18. Governing Law

This Agreement, and the rights and obligations of the parties, shall be governed and interpreted in accordance with the laws of the State of California.

19. Captions

The captions or headings in the Agreement are for convenience only and in no other way define, limit or describe the scope or intent of any provision or section of the Agreement.

20. Authorization

Each party represents and warrants to the other that the execution, delivery, election to participate in, and performance of this Agreement (i) are within its powers, (ii) has been duly authorized by all necessary actions on its behalf and all necessary consents or approvals have been obtained and are in full force and effect; and (iii) binds said party and its respective administrators, officers, directors, agents, employees, successors, assigns, principals, joint ventures, insurance carriers, and any others who may claim through it under this Agreement.

21. Entire Agreement Between Parties

This Agreement supersedes any other agreements, either oral or in writing, between or among any of the parties hereto with respect to the beneficial use of water available for appropriation pursuant to State Water Resources Control Board Water Right Decision 1638, and contains all of the covenants and agreements between the parties with respect thereto. Any modifications of this Agreement will be effective only if it is in writing and signed by all of the parties to this Agreement.

22. Partial Invalidity

If any provision in this Agreement is held by a court of competent jurisdiction to be invalid, void, or unenforceable, the remaining provisions will nevertheless continue in full force without being impaired or invalidated in any way. To the extent permissible the illegal or invalid provision shall be modified, amended, or construed to make it legal or valid and carry out the purposes of the parties hereto.

23. Relationship of the Parties

The relationship of the parties to this Agreement shall be that of independent contractors and in no event shall any party be considered a partner, officer, agent, servant or employee of any other party. Without limiting the foregoing, each party agrees to be solely responsible for any workers compensation, withholding taxes, unemployment insurance and any other employer obligations associated with the described work or obligations assigned to them under this Agreement.

24. Notices

Any notice required to be given hereunder shall be deemed to have been given by depositing said notice in the United States mail, postage prepaid, and addressed as follows:

To City:	City of Thousand Oaks Attn: Public Works Director 2100 Thousand Oaks Boulevard Thousand Oaks, CA 91362
To Camrosa:	Camrosa Water District Attn: General Manager 7385 Santa Rosa Road Camarillo, CA 93012

25. Effective Date.

This Agreement shall take effect on September 1, 2013, provided the following events have taken place (the "***Effective Date***"):

a. Upon due approval of this Agreement as required by its governing documents and applicable law, City shall execute this Agreement and deliver a duly executed original to Camrosa; and

b. Upon due approval of this Agreement as required by its governing documents and applicable law, Camrosa shall execute this Agreement and deliver a duly executed original to City; and

c. Upon receipt by Camrosa and City of (1) the Thousand Oaks – Calleguas Termination Agreement duly executed by City and Calleguas, and (2) the Camrosa – Calleguas Termination Agreement duly executed by Camrosa and Calleguas.

IN WITNESS WHEREOF, the parties have executed this Agreement as of the Effective Date in Ventura County, California.

Dated: 6/5, 2013

CAMROSA WATER DISTRICT

By: Tony Stafford

Tony Stafford, General Manager

Dated: May 28, 2013

CITY OF THOUSAND OAKS

By: Claudia Bill-de la Peña, Mayor

ATTEST:

for Linda D. Lawrence, City Clerk

APPROVED AS TO ADMINISTRATION:

for
Scott Mitnick, City Manager

APPROVED AS TO FORM:
Office of the City Attorney

Christopher G. Norman, Assistant City Attorney

Appendix J –

Environmental Investigation

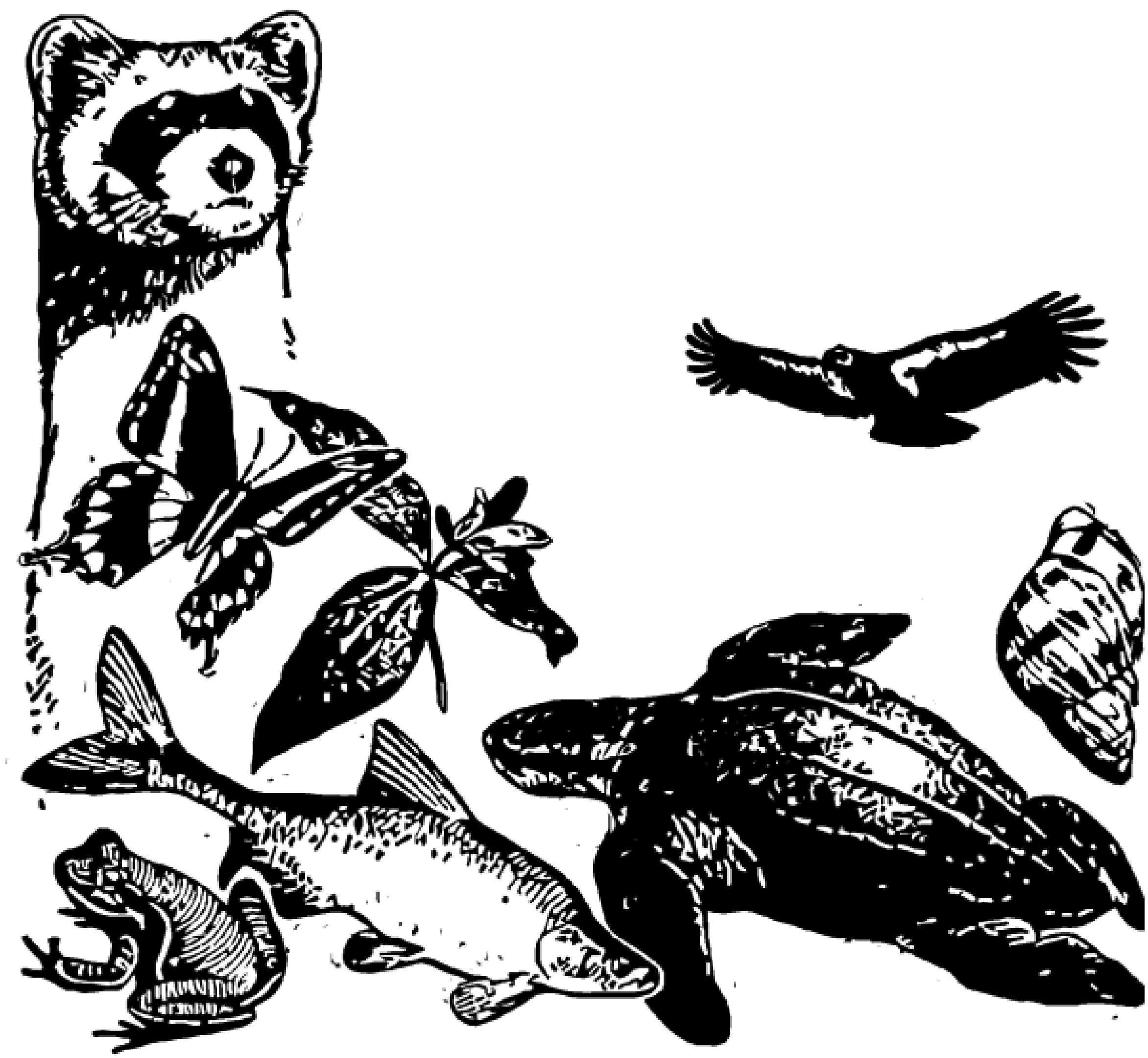
Potential Site #3

U.S. Fish & Wildlife Service

IPaC Trust Resource Report

Generated February 10, 2016 12:47 PM MST, IPaC v2.3.2

This report is for informational purposes only and should not be used for planning or analyzing project level impacts. For project reviews that require U.S. Fish & Wildlife Service review or concurrence, please return to the IPaC website and request an official species list from the Regulatory Documents page.



IPaC - Information for Planning and Conservation (http://ecos.fws.gov/ipac/): A project planning tool to help streamline the U.S. Fish & Wildlife Service environmental review process.

US Fish & Wildlife Service

IPaC Trust Resource Report

LOCATION

Los Angeles County, California

IPAC LINK

http://ecos.fws.gov/ipac/project/
BRHCF-A6YXZ-BSHOV-WEBZU-D7H3GA

U.S. Fish & Wildlife Contact Information

Trust resources in this location are managed by:

Ventura Fish And Wildlife Office
2493 Portola Road, Suite B
Ventura, CA 93003-7726
(805) 644-1766

Endangered Species

Proposed, candidate, threatened, and endangered species are managed by the Endangered Species Program of the U.S. Fish & Wildlife Service.

This USFWS trust resource report is for informational purposes only and should not be used for planning or analyzing project level impacts.

For project evaluations that require FWS concurrence/review, please return to the IPaC website and request an official species list from the Regulatory Documents section.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency.

A letter from the local office and a species list which fulfills this requirement can only be obtained by requesting an official species list from the Regulatory Documents section in IPaC.

The list of species below are those that may occur or could potentially be affected by activities in this location:

Amphibians

California Red-legged Frog Rana draytonii — Threatened

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=D02D

Birds

Coastal California Gnatcatcher Polioptila californica californica — Threatened

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B08X

Least Bell's Vireo Vireo bellii pusillus — Endangered

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B067

Southwestern Willow Flycatcher Empidonax traillii extimus — Endangered

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B094

Crustaceans

Riverside Fairy Shrimp Streptocephalus woottoni

Endangered

CRITICAL HABITAT

There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=K03F

Vernal Pool Fairy Shrimp Branchinecta lynchi

Threatened

CRITICAL HABITAT

There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=K03G

Flowering Plants

Braunton's Milk-vetch Astragalus brauntonii — Endangered

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q05E

California Orcutt Grass Orcuttia californica — Endangered

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q1ZO

Conejo Dudleya Dudleya abramsii ssp. parva — Threatened

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q0O7

Gambel's Watercress Rorippa gambellii — Endangered

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q38L

Lyon's Pentachaeta Pentachaeta lyonii — Endangered

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q1EA

Marsh Sandwort Arenaria paludicola — Endangered

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q25H

San Fernando Valley Spineflower Chorizanthe parryi var. fernandina — Candidate

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q0EZ

Santa Monica Mountains Dudleyea Dudleya cymosa ssp. ovatifolia — Threatened

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q3AK

Spreading Navarretia Navarretia fossalis — Threatened

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q2E7

Verity's Dudleya Dudleya verityi Threatened

CRITICAL HABITAT

No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q2OM

Critical Habitats

There are no critical habitats in this location

Migratory Birds

Birds are protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

Any activity which results in the take of migratory birds or eagles is prohibited unless authorized by the U.S. Fish and Wildlife Service (1). There are no provisions for allowing the take of migratory birds that are unintentionally killed or injured.

Any person or organization who plans or conducts activities that may result in the take of migratory birds is responsible for complying with the appropriate regulations and implementing appropriate conservation measures.

Additional information can be found using the following links:

- Birds of Conservation Concern
  http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Conservation measures for birds
  http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Year-round bird occurrence data
  http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/akn-histogram-tools.php

The following species of migratory birds could potentially be affected by activities in this location:

Allen's Hummingbird Selasphorus sasin — Bird of conservation concern
Season: Breeding
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0LI

Bald Eagle Haliaeetus leucocephalus — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B008

Bell's Vireo Vireo bellii — Bird of conservation concern
Season: Breeding
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JX

Black Oystercatcher Haematopus bachmani — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0KJ

Brewer's Sparrow Spizella breweri — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HA

Burrowing Owl Athene cunicularia — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0NC

Cactus Wren Campylorhynchus brunneicapillus — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0FZ

Costa's Hummingbird Calypte costae — Bird of conservation concern
Season: Breeding
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JE

Fox Sparrow Passerella iliaca — Bird of conservation concern
Season: Wintering

Least Bittern Ixobrychus exilis — Bird of conservation concern
Year-round

Lesser Yellowlegs Tringa flavipes — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0MD

Lewis's Woodpecker Melanerpes lewis — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HQ

Long-billed Curlew Numenius americanus — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B06S

Marbled Godwit Limosa fedoa — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JL

Nuttall's Woodpecker Picoides nuttallii — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HT

Oak Titmouse Baeolophus inornatus — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0MJ

Olive-sided Flycatcher Contopus cooperi — Bird of conservation concern
Season: Breeding
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0AN

Peregrine Falcon Falco peregrinus — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0FU

Red-crowned Parrot Amazona viridigenalis — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0GO

Rufous-crowned Sparrow Aimophila ruficeps — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0MX

Short-billed Dowitcher Limnodromus griseus — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JK

Short-eared Owl Asio flammeus — Bird of conservation concern

Season: Wintering

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HD

Snowy Plover Charadrius alexandrinus — Bird of conservation concern

Season: Breeding

Western Grebe aechmophorus occidentalis — Bird of conservation concern

Season: Wintering

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0EA

Whimbrel Numenius phaeopus — Bird of conservation concern

Season: Wintering

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JN

Yellow Warbler dendroica petechia ssp. brewsteri — Bird of conservation concern

Season: Breeding

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0EN

Red Knot Calidris canutus ssp. roselaari — Bird of conservation concern

Season: Wintering

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0G6

Refuges

Any activity proposed on National Wildlife Refuge lands must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

Refuge data is unavailable at this time.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal Statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

DATA LIMITATIONS

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

DATA EXCLUSIONS

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

DATA PRECAUTIONS

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

There are no wetlands in this location

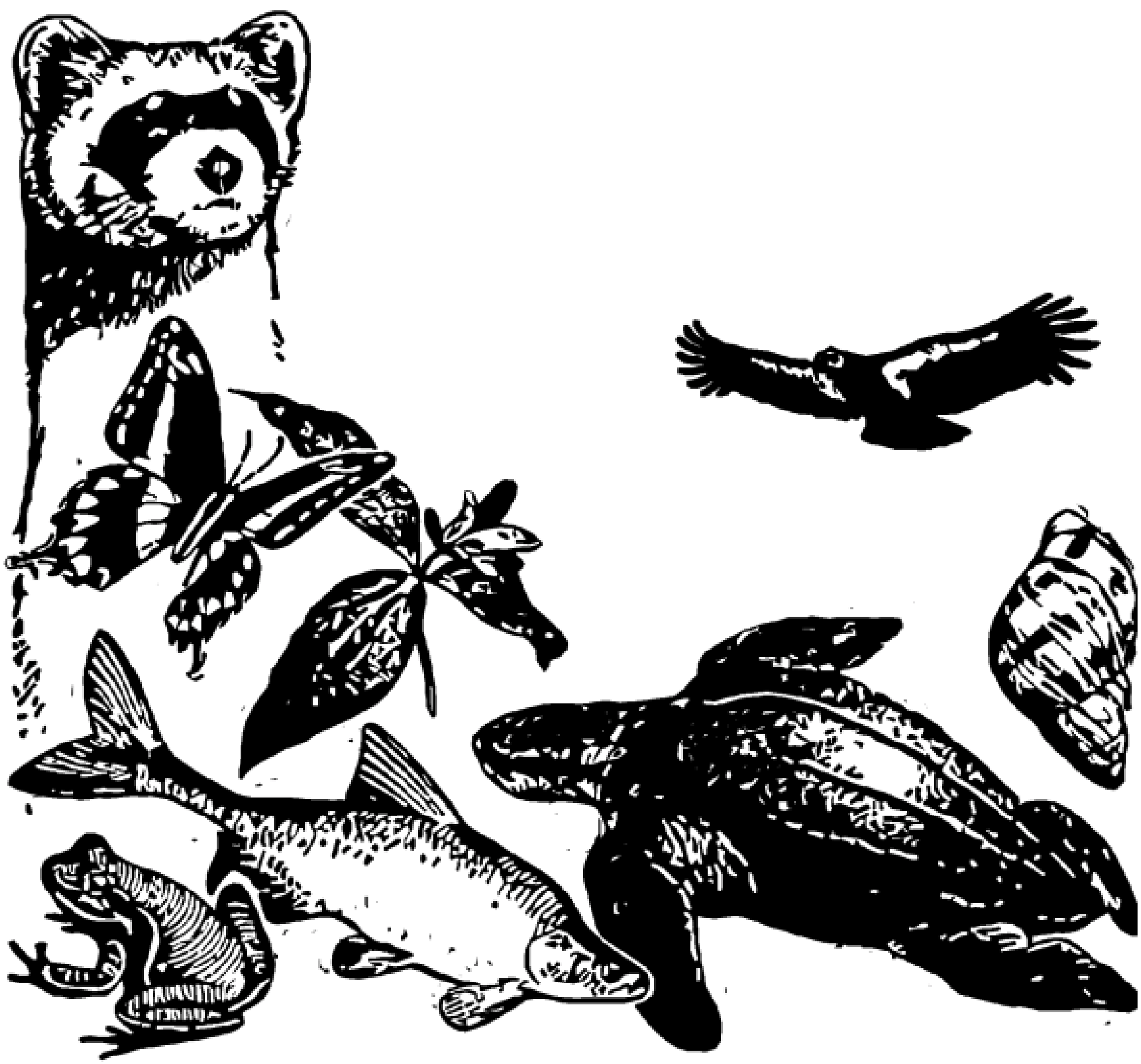
Potential Site #7

U.S. Fish & Wildlife Service

IPaC Trust Resource Report

Generated February 10, 2016 12:45 PM MST, IPaC v2.3.2

This report is for informational purposes only and should not be used for planning or analyzing project level impacts. For project reviews that require U.S. Fish & Wildlife Service review or concurrence, please return to the IPaC website and request an official species list from the Regulatory Documents page.



IPaC - Information for Planning and Conservation (http://ecos.fws.gov/ipac/): A project planning tool to help streamline the U.S. Fish & Wildlife Service environmental review process.

US Fish & Wildlife Service

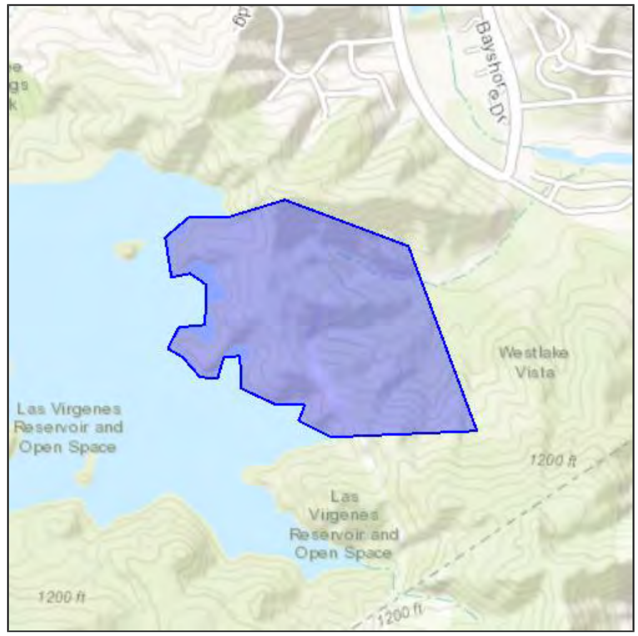
IPaC Trust Resource Report

LOCATION

Los Angeles County, California

IPAC LINK

http://ecos.fws.gov/ipac/project/M6VAC-JRBVB-DGLI5-HPONN-VBIWPQ



U.S. Fish & Wildlife Contact Information

Trust resources in this location are managed by:

Ventura Fish And Wildlife Office
2493 Portola Road, Suite B
Ventura, CA 93003-7726
(805) 644-1766

Endangered Species

Proposed, candidate, threatened, and endangered species are managed by the Endangered Species Program of the U.S. Fish & Wildlife Service.

This USFWS trust resource report is for informational purposes only and should not be used for planning or analyzing project level impacts.

For project evaluations that require FWS concurrence/review, please return to the IPaC website and request an official species list from the Regulatory Documents section.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency.

A letter from the local office and a species list which fulfills this requirement can only be obtained by requesting an official species list from the Regulatory Documents section in IPaC.

The list of species below are those that may occur or could potentially be affected by activities in this location:

Amphibians

California Red-legged Frog Rana draytonii — Threatened

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=D02D

Birds

Coastal California Gnatcatcher Polioptila californica californica — Threatened

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B08X

Least Bell's Vireo Vireo bellii pusillus — Endangered

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B067

Southwestern Willow Flycatcher Empidonax traillii extimus — Endangered

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B094

Crustaceans

Riverside Fairy Shrimp Streptocephalus woottoni — Endangered

CRITICAL HABITAT

There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=K03F

Vernal Pool Fairy Shrimp Branchinecta lynchi — Threatened

CRITICAL HABITAT

There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=K03G

Flowering Plants

Braunton's Milk-vetch Astragalus brauntonii — Endangered

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q05E

California Orcutt Grass Orcuttia californica — Endangered

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q1ZO

Conejo Dudleya Dudleya abramsii ssp. parva — Threatened

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q0O7

Gambel's Watercress Rorippa gambellii — Endangered

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q38L

Lyon's Pentachaeta Pentachaeta lyonii — Endangered

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q1EA

Marsh Sandwort Arenaria paludicola — Endangered

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q25H

San Fernando Valley Spineflower Chorizanthe parryi var. fernandina — Candidate

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q0EZ

Santa Monica Mountains Dudleyea Dudleya cymosa ssp. ovatifolia — Threatened

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q3AK

Spreading Navarretia Navarretia fossalis — Threatened

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q2E7

Verity's Dudleya Dudleya verityi Threatened

CRITICAL HABITAT

No critical habitat has been designated for this species.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q2OM

Critical Habitats

This location overlaps all or part of the critical habitat for the following species:

Lyon's Pentachaeta Critical Habitat Final designated

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q1EA#crithab

Migratory Birds

Birds are protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

Any activity which results in the take of migratory birds or eagles is prohibited unless authorized by the U.S. Fish and Wildlife Service (1). There are no provisions for allowing the take of migratory birds that are unintentionally killed or injured.

Any person or organization who plans or conducts activities that may result in the take of migratory birds is responsible for complying with the appropriate regulations and implementing appropriate conservation measures.

Additional information can be found using the following links:

- Birds of Conservation Concern
  http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Conservation measures for birds
  http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Year-round bird occurrence data
  http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/akn-histogram-tools.php

The following species of migratory birds could potentially be affected by activities in this location:

Allen's Hummingbird Selasphorus sasin — Bird of conservation concern
Season: Breeding
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0LI

Bald Eagle Haliaeetus leucocephalus — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B008

Bell's Vireo Vireo bellii — Bird of conservation concern
Season: Breeding
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JX

Black Oystercatcher Haematopus bachmani — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0KJ

Black Skimmer Rynchops niger — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0EO

Brewer's Sparrow Spizella breweri — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HA

Burrowing Owl Athene cunicularia — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0NC

Cactus Wren Campylorhynchus brunneicapillus — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0FZ

Costa's Hummingbird Calypte costae — Bird of conservation concern
Season: Breeding
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JE

Fox Sparrow Passerella iliaca — Bird of conservation concern
Season: Wintering

Least Bittern Ixobrychus exilis — Bird of conservation concern
Year-round

Lesser Yellowlegs Tringa flavipes — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0MD

Lewis's Woodpecker Melanerpes lewis — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HQ

Long-billed Curlew Numenius americanus — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B06S

Marbled Godwit Limosa fedoa — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JL

Nuttall's Woodpecker Picoides nuttallii — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HT

Oak Titmouse Baeolophus inornatus — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0MJ

Olive-sided Flycatcher Contopus cooperi — Bird of conservation concern
Season: Breeding
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0AN

Peregrine Falcon Falco peregrinus — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0FU

Red-crowned Parrot Amazona viridigenalis — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0GO

Rufous-crowned Sparrow Aimophila ruficeps — Bird of conservation concern
Year-round
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0MX

Short-billed Dowitcher Limnodromus griseus — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JK

Short-eared Owl Asio flammeus — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HD

Snowy Plover Charadrius alexandrinus — Bird of conservation concern
Season: Breeding

Western Grebe aechmophorus occidentalis — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0EA

Whimbrel Numenius phaeopus — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JN

Yellow Warbler dendroica petechia ssp. brewsteri — Bird of conservation concern
Season: Breeding
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0EN

Red Knot Calidris canutus ssp. roselaari — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0G6

Refuges

Any activity proposed on National Wildlife Refuge lands must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

Refuge data is unavailable at this time.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal Statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

DATA LIMITATIONS

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

DATA EXCLUSIONS

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

DATA PRECAUTIONS

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

This location overlaps all or part of the following wetlands:

Lake

L1UBHh 138.0 acres

A full description for each wetland code can be found at the National Wetlands Inventory website: http://107.20.228.18/decoders/wetlands.aspx

Appendix K –
RMC Reports

DRAFT Technical Memorandum

Woodland Hills Water Recycling Project

Subject:	**Woodland Hills Water Recycling Expansion Concept Evaluation**
Prepared For:	Eric Schlageter, P.E., Las Virgenes Municipal Water District
Prepared By:	Miluska Propersi, P.E., RMC
Reviewed by:	Rich Bichette, P.E., RMC Brian Dietrick, P.E., RMC
Date:	December 4, 2015
Reference:	0254-003.08

1 Introduction

RMC Water and Environment (RMC) is under contract with Las Virgenes Municipal Water District (LVMWD) to prepare preliminary design and CEQA documentation for the Woodland Hills Water Recycling Project (WRP). The Woodland Hills WRP will deliver recycled water from the LVMWD recycled water system to customers within the Los Angeles Department of Water and Power (LADWP) service area. Seasonal storage opportunities at Encino Reservoir are also being evaluated as the Woodland Hills Water Recycling Expansion Concept, which would extend the pipeline serving Woodland Hills WRP to Encino Reservoir (Seasonal Storage Extension). The existing LVMWD recycled water system, the Woodland Hills WRP and the Seasonal Storage Extension are shown in **Figure 1-1**.

The purpose of this Technical Memorandum (TM) is to identify a preliminary alignment from the Woodland Hills WRP to Encino Reservoir, identify potential LADWP customers along the alignment, evaluate hydraulic requirements for delivery of water to and from the seasonal storage facility, and develop conceptual-level construction cost estimates for the Seasonal Storage Extension.

This TM is organized in nine sections:

Section 1 – Introduction: Provides an overview of the project and the purpose of this TM.

Section 2 – Seasonal Storage Pipeline Alignment: Evaluates three pipeline alignments from the Woodland Hills WRP to Encino Reservoir.

Section 3 – Non-Potable Customers: Identifies and describes demand characteristics for two additional non-potable customers along the alignment from the Woodland Hills WRP to Encino Reservoir.

Section 4 – Seasonal Storage Delivery and Supply Parameters: Describes the proposed approaches to sizing seasonal storage delivery facilities from the LVMWD system to Encino Reservoir based on available buildout recycled water supply.

Section 5 – LVMWD Recycled Water System Limitations: Evaluates and identifies hydraulic limitations within the existing LVMWD recycled water system for delivering recycled water to seasonal storage.

Section 6 – **Methodology for Hydraulic Modeling:** Describes the methodology and assumptions used to evaluate and size the pipeline from the Woodland Hills WRP to Encino Reservoir.

Section 7 – **Evaluation and Results:** Presents the hydraulic modeling scenarios and results.

Section 8 – Conceptual Level Construction Cost Estimate: Presents the cost estimating basis and conceptual-level construction cost estimates for facilities to deliver recycled water to and from Encino Reservoir.

Section 9 – **Conveyance to Donald C. Tillman Water Reclamation Plant** (**DCTWRP) Evaluation:** Identifies connection points, alignments and costs to convey surplus recycled water from Encino Reservoir to DCTWRP to expand reuse.

Appendix A – Construction Cost Estimates

Figure 1-1: LVMWD Existing Recycled Water System, Woodland Hills WRP and Seasonal Storage Extension

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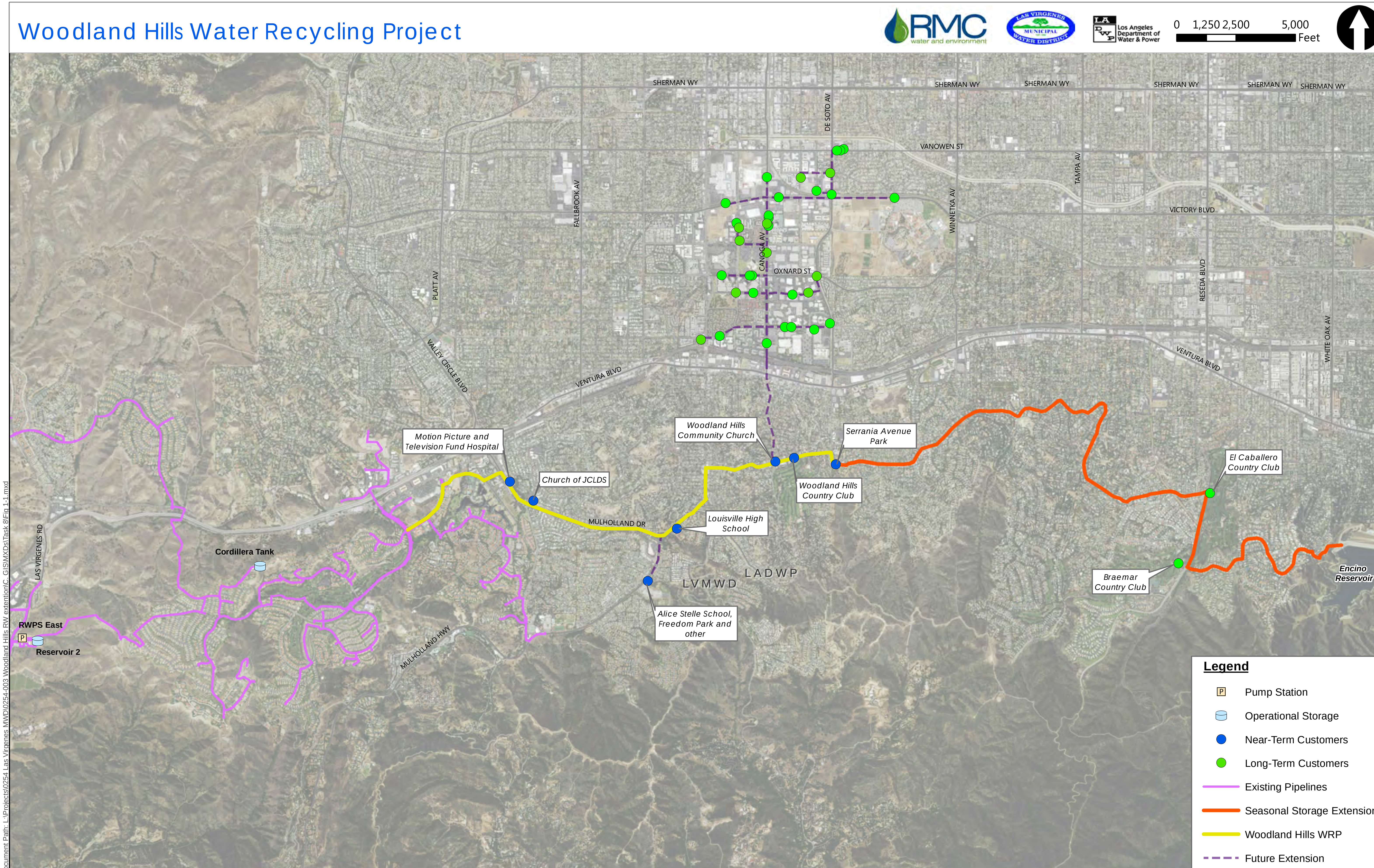

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2 Seasonal Storage Pipeline Alignment

Three pipeline alignments were developed based primarily on the shortest east to west right-of-way corridors from the Woodland Hills WRP pipeline to Encino Reservoir. Utilities congestion, constructability constraints and potential environmental impacts were not considered, and a thorough alignment evaluation should be conducted if the project moves forward.

The three alignment alternatives are described below and are summarized in **Table 2-1**.

- Alignment 1 would extend from the Woodland Hills WRP at the intersection of California State Route 27 and Mulholland Drive and head east on Mulholland Drive. The alignment would continue along Mulholland Drive where it becomes a dirt road, then at Reseda Boulevard, the alignment would head north to Saint Moritz Drive, then east via San Moritz Drive, Elm View, Lake Encino Drive, and Twilight Lane to Encino Reservoir. The alignment is approximately 7.8 miles (41,300 feet) in length.
- Alignment 2 would extend from the Woodland Hills WRP at Serrania Avenue Park and head east on Wells Drive to Vanalden Avenue, then south to Rosita Street, then east to Reseda Boulevard, then south to Saint Moritz Drive, then east via San Moritz Drive, Elm View, Lake Encino Drive and Twilight Lane to Encino Reservoir. This alignment is approximately 6.5 miles (34,600 feet) in length.
- Alignment 3 is similar to Alignment 2, except the pipeline would continue south on Vanalden Avenue past Rosita Street to Caladero Street, then east to Nogales Drive, then north to Pasadero Drive, then east to Reseda Boulevard where it would rejoin Alignment 2 to Encino Reservoir. The alignment is approximately 7.2 miles (37,900 feet) in length.

One potential modification to Alignment 2 is to install the pipeline within an existing Southern California Edison easement between Rosita Street and Reseda Street. This alignment could shorten the length of pipeline, reduce construction costs for roadway repairs within the public right-of-way, and lessen the impact on the public. Longitudinal encroachments within Southern California Edison right-of-way are generally difficult to obtain; therefore, the hydraulics and costs in this TM assume this route is not available.

Table 2-1: Woodland Hills Water Recycling Expansion Concept Alternative Alignments

Alignment No.	Streets	Length		Highest Elevation (ft)
		feet	miles	
1	Mulholland Drive, Reseda Boulevard, Saint Moritz Drive, Elm View, Lake Encino Drive, Twilight Lane	41,300	7.8	1,780
2	Wells Drive, Vanalden Avenue, Rosita Street, Reseda Boulevard, Saint Moritz Drive, Elm View, Lake Encino Drive, Twilight Lane	34,600	6.5	1,060
3	Wells Drive, Vanalden Avenue, Caladero Street, Nogales Drive, Pasadero Drive, Reseda Boulevard, Saint Moritz Drive, Elm View, Lake Encino Drive, Twilight Lane	37,900	7.2	1,140

Note: The total lengths of Alignments 1 and 3 do not include the additional pipelines to serve El Caballero Country Club which are approximately 3,200 and 2,100 feet, respectively.

The three alignments were further evaluated based on elevations along each route. Alignment 1 is not recommended because its highest elevation along the dirt portion of Mulholland Drive is approximately 1,780 feet above mean sea level (MSL) compared to the high water elevation in the Cordillera Tank which is approximately 1,529 feet above MSL. The Cordillera Tank drives the hydraulic grade line to move water from LVMWD to Encino Reservoir. In order to send recycled water to the seasonal storage site via this alignment, intermediate pumping would be required.

The highest elevation along Alignments 2 and 3 is approximately 1,250 feet above MSL on Alonzo Avenue near Avenida Puerto Vallarta. Both options are hydraulically feasible; however, Alternative 2 is hydraulically superior due to shorter overall distance and it does not require an additional pipeline to serve El Caballero Country Club. For these reasons, Alternative 2 was selected to evaluate the Woodland Hills Water Recycling Expansion Concept.

Figure 2-1 shows the three proposed alignments and the recycled water meter locations for the two country clubs.

Figure 2-1: Woodland Hills Water Recycling Expansion Concept Alignment Alternatives to Encino Reservoir

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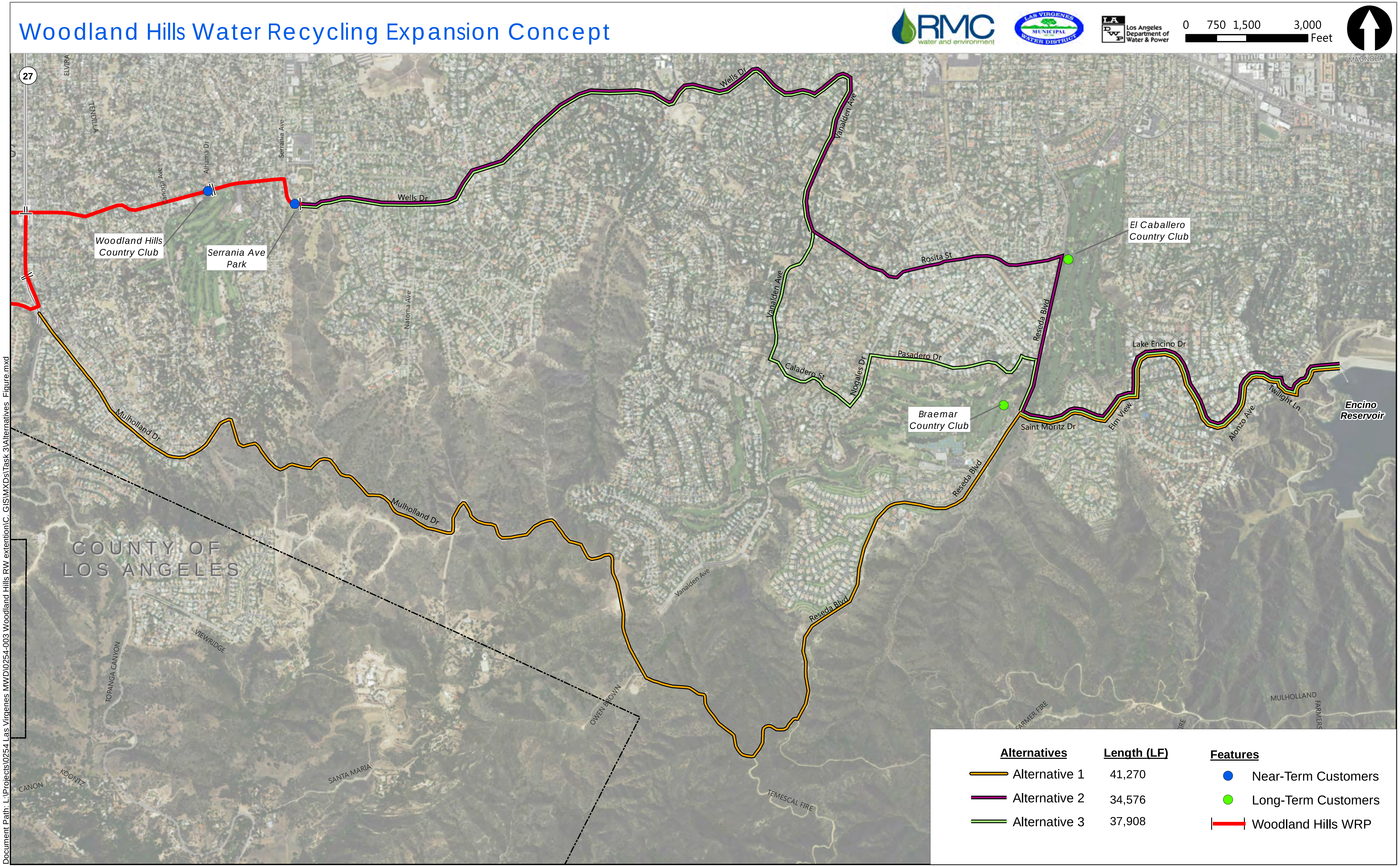

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3 Non-Potable Customers

The Woodland Hills Water Recycling Expansion Concept would serve two non-potable customers along the proposed alignment: El Caballero Country Club and Braemar Country Club. Based on the 2012 LADWP Non-Potable Reuse Master Planning Report (NPRMPR), there are no additional non-potable customers within a half a mile radius of the alignments to Encino Reservoir. There is one customer, Portola Middle School, located approximately 4,000 feet from Alignment 2 that has an estimated recycled water demand of 13 acre-feet per year (AFY). If the project moves forward, this customer may be connected if it is determined to be economically feasible. This customer is not included in the hydraulic evaluation, and its relatively small demand would not impact the pipeline size recommendations.

Customer Conversion TMs were developed for El Caballero Country Club and Braemar Country Club as part of the 2012 LADWP NPRMPR. Based on the site visits and a review of customer demand information, the demand and delivery requirements for these two customers are summarized below and were used in the hydraulic evaluation.

Braemar Country Club

Recycled water demand is estimated to be 300 AFY based on 2006 to 2008 average annual potable water demands. LADWP's monthly meter data from July 2007 and July 2008 indicates that the customer has an estimated peak summer irrigation demand of roughly 670,000 gallons per day (gpd). Irrigation generally occurs over an 8-hour period; however, an existing irrigation storage feature (storage ponds) allows demand to be spread over 14 hours during the day. The customer-specific operational flow rate for the Peak Month demand of 670,000 gpd, spread over 14 hours, is approximately 800 gallons per minute (gpm).

The two onsite storage ponds are used as water storage facilities for the irrigation system. Both storage ponds are located at approximately elevation 1,020-feet and have irrigation pumps that draw water from each pond. Therefore, there are no minimum recycled water pressure requirements for the irrigation system to operate, and a minimum pressure of 40 pounds-per-square-inch (psi) at the customer meter will be assumed for the hydraulic evaluation.

El Caballero Country Club

Recycled water demand is estimated to be 290 AFY based on 2006 to 2008 average annual potable water demands. Based on discussions with the golf course superintendent, the estimated peak summer irrigation demand is 1,500 gpm over a 6-hour irrigation period during the night. This equates to a peak summer month demand of approximately 540,000 gpd.

El Caballero Country Club does not have irrigation storage ponds or an existing onsite booster pump system. The existing ponds are for aesthetic purposes only. LADWP is currently providing approximately 135 psi of water pressure for potable service. Based on the site visit, the minimum pressure to operate the golf course irrigation system is 120 psi at the customer meter, which is what will be assumed for the hydraulic evaluation. **Table 3-1** summarizes the non-potable demands that would be served along the proposed Woodland Hills Water Recycling Expansion Concept alignment.

Table 3-1: Woodland Hills Water Recycling Expansion Concept Non-Potable Demands

Customer	RW Demand (AFY)	Customer Type	Minimum Service Pressure (psi)	MDD (gpd)	Hours/Day of Operation
Braemar Country Club	300	Irrigation-Only	20	670,000	14 hours / day
El Caballero Country Club	290	Irrigation-Only	120	540,000	6 hours / night
Total	**590**				

Source: RMC/CDM Smith. 2012

4 Seasonal Storage Delivery and Supply Parameters

Based on the 2014 LVMWD Recycled Water Master Plan Update (RWMP), the Tapia Water Reclamation Facility (WRF) will be expanded to a capacity of 12 MGD to treat dry weather flows in the future, and dry weather supply at buildout is estimated to be 11 MGD. Estimates of buildout supply have decreased as more land has been set aside for open space and parks and water conservation has reduced per capita usage. Actual buildout supply may be less than the predicted 11 MGD, but for the purposes of sizing the pipeline for seasonal storage, the conservatively high value of 11 MGD will be used. Seasonal storage conveyance facilities were sized for dry weather flow scenarios only. During wet weather flows, LVMWD would continue to discharge, similar to current practices.

Three different delivery approaches for seasonal storage were used to size the pipeline to Encino Reservoir. These approaches have the common assumption that the inflow to the seasonal storage will be delivered over a 24-hour period and at a constant flow rate out of Reservoir 2. For justification of the 24-hour pumping assumption, refer to Section 5. The approaches below are for delivery of water to the seasonal storage facility only, and do not include the summer time balance of return flow from Encino Reservoir to LVMWD, which is further discussed in Section 7.5.

- **Approach 1:** Assumes that all flow from Tapia WRF is sent to seasonal storage at Encino Reservoir with no recycled water demands. This would represent a rainy period when non-potable customers would not require recycled water for irrigation. Tapia WRF is assumed to produce 11 MGD and the pipeline to Encino Reservoir is assumed to deliver approximately 7,640 gpm over a 24-hour period.
- **Approach 2**: Assumes all excess flow from Tapia WRF minus winter recycled water demands will be sent to Encino Reservoir. During the month of December, approximately 820 AF/month of excess recycled water would be available after meeting recycled water demands based on projected buildout supply (11 MGD) and projected buildout demands. Assuming the monthly demands are spread out evenly over 31 days, the pipeline to Encino Reservoir is assumed to deliver approximately 6,000 gpm in December with a constant flow rate over the entire month (24 hours per day, every day).
- **Approach 3:** Assumes the minimum amount of recycled water required to eliminate supplemental potable water supply to LVMWD in the summer would be sent to Encino Reservoir. Over the five summer months at buildout, approximately 940 AFY of potable water is estimated to be required to supplement future demands. To eliminate the need for supplemental potable water supplies, approximately 134 AF/month over seven months (November through May) would need to be delivered from Tapia WRF to Encino Reservoir. Assuming a constant flow rate over the seven

months (i.e., 24 hours per day, every day), approximately 1,010 gpm would be delivered through the pipeline. For this scenario, it was assumed that El Caballero and Braemar Country Club would be served recycled water; therefore, summer non-potable demands would be the driver for determining the pipeline diameter, not seasonal storage delivery.

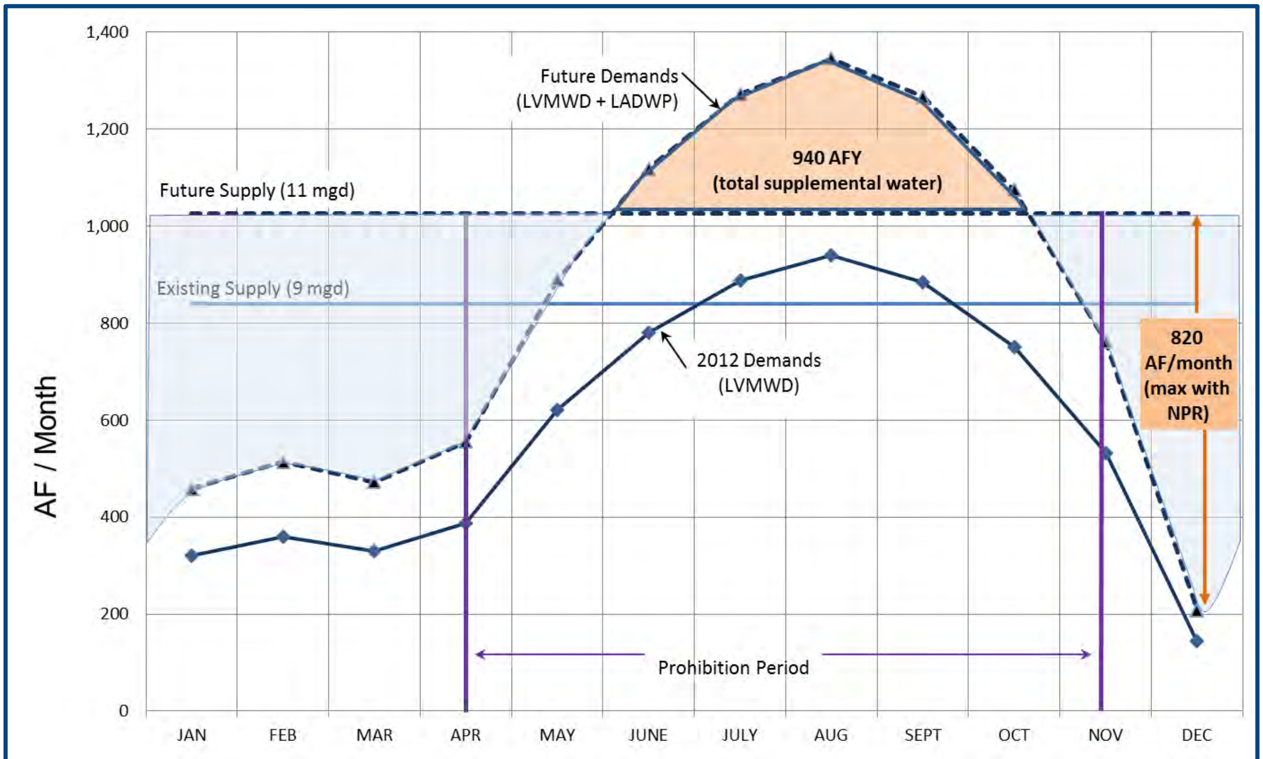
Table 4-1 summarizes the seasonal storage inflows for each approach described above. **Figure 4-1** illustrates the existing and future supplies from Tapia WRF and the existing and projected demands, along with the maximum storage and potable supplement volumes. The three approaches were carried forward into the evaluation scenarios presented in Section 7.

Table 4-1: Approaches for Seasonal Storage Flows from Tapia WRF to Encino Reservoir

Approach	AF/month [1]	MGD	gpm
All Tapia WRF effluent delivered to Encino Reservoir (no non-potable demand)	--	11	7,640
All excess Tapia WRF effluent delivered to Encino Reservoir after accounting for winter non-potable demands	820 (during December)	8.6 [2]	6,000
Minimum Tapia WRF Effluent required to eliminate potable water in the summer delivered to Encino Reservoir	134 (over 7 months)	1.5 [3]	1,010

1. AF/month values were updated based on the revised demands in the Draft Woodland Hills WRP Hydraulic Evaluation and Modeling TM (November 20, 2015).
2. Based on 31 days in December.
3. Based on 30 days during the months from November through May.

Figure 4-1: LVMWD Existing and Future Supply and Demands



5 LVMWD Recycled Water System Limitations

RMC reviewed the existing LVMWD recycled water system configuration between Tapia WRF and Reservoir 2. The objective was to determine if continuous (24-hour) pumping to seasonal storage out of Reservoir 2 using the Recycled Water Pump Station East (RWPS East) is a reasonable assumption. The results of this review are presented in this section.

Tapia WRF Pump Station

The Tapia WRF effluent pump station consists of three pumps [1-900 horsepower (HP), and 2-800 HP]. The three pumps can operate in different combinations (e.g., 1 small, 2 small, 1 small + 1 large, etc.). The small pumps have a capacity of 7 MGD each, and the larger pump has a capacity of 10 MGD. Under existing conditions, up to 16 MGD is delivered from the Tapia WRF pump station to Reservoir 2; and pumping typically occurs between the hours of 9 a.m. and 5 p.m. based on flow records provided by LVMWD.

The hydraulic model used in the 2014 LVMWD RWMP did not include the portion of the system with the Tapia WRF pump station and the pipelines to Reservoir No. 2. The capacity of this part of the system under buildout conditions was determined to have ample pumping and pipeline capacity from Tapia WRF to Reservoir 2. Based on this conclusion from the 2014 LVMWD RWMP, this portion of the system does not require additional evaluation.

Reservoir 2

Reservoir 2 has a storage capacity of 14.7 million gallons. In order to validate whether Reservoir 2 has sufficient buffer capacity to supply recycled water over a 24-hour period without emptying and requiring potable water supplements, RMC developed a spreadsheet model of Reservoir 2 that simulates inflows from the Tapia WRF and outflows to recycled water demands including the proposed seasonal storage flows. The following inflows and outflows were used:

- Inflow from Tapia WRF: Flows from Tapia WRF to Reservoir 2 were assumed to be approximately 23,000 gpm based on 11 MGD (future effluent/supply) over an 8-hour day period (9 a.m. to 5 p.m.). This assumption is based generally on current pumping patterns. Actual pumping times vary based on flow out of the treatment plant to the Tapia WRF pump station, but the variation will not have an effect on the results of this analysis since any inflow from Tapia WRF that is outside the non-potable demand period (see next bullet) is accounted for as a “worst-case” scenario.
- Outflow to Non-Potable Demands: Non-potable demands vary throughout the day for the entire system based on 2014 LVMWD RWMP Figure 5-5, page 48. For a “worst-case” scenario, it was assumed all non-potable demands would occur at night (9 p.m. to 5 a.m.) during a typical irrigation period. In December, the amount of existing and future non-potable demands is estimated to be 210 AF/month (see Figure 4-1), which would be approximately 4,600 gpm over an 8-hour period.
- Outflow to Seasonal Storage: A constant flow of approximately 6,000 gpm over 24 hours (820 AF/month) to Encino Reservoir was assumed. This is consistent with approach 2 described in Section 4.

Figure 5-1 shows the modeled inflows and outflows from Reservoir 2 under these conditions. **Figure 5-2** shows the hourly volume of Reservoir 2 over the simulated 24-hour period. Based on these flows and the analysis, Reservoir 2 has ample storage to deliver recycled water to seasonal storage (Encino Reservoir) over a 24-hour continuous period while also serving winter non-potable demands. There is no cause for concern about the reservoir emptying and requiring non-potable backup supply.

Figure 5-1: Reservoir 2 Simulated Hourly Inflow and Outflow

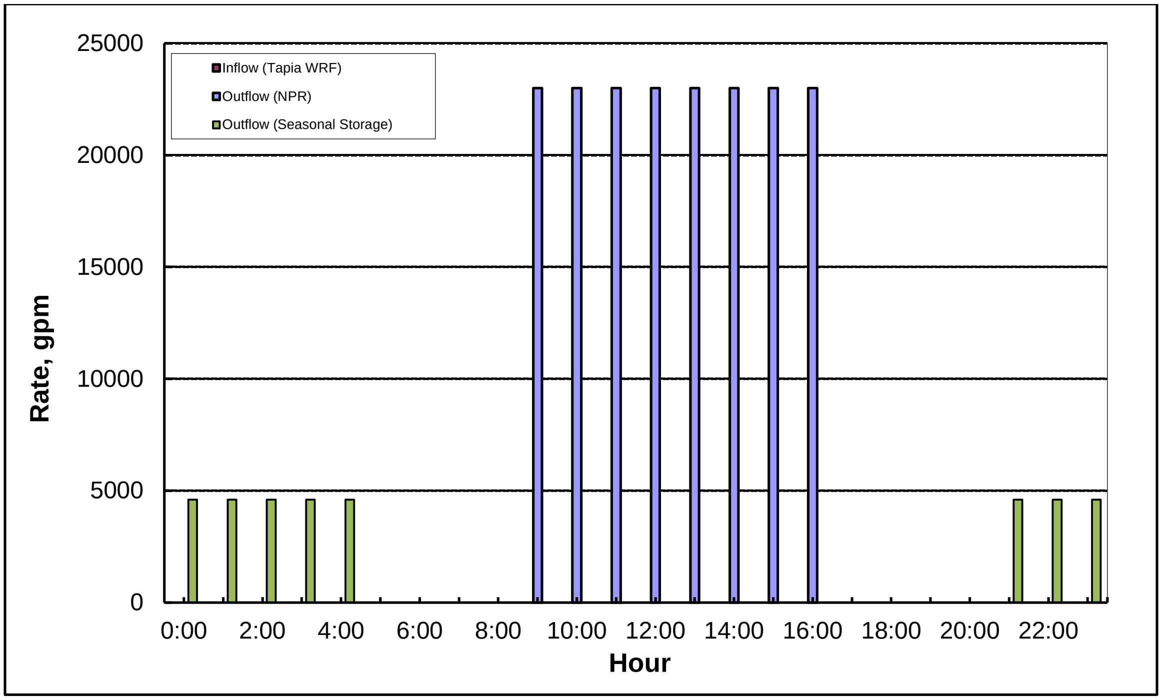
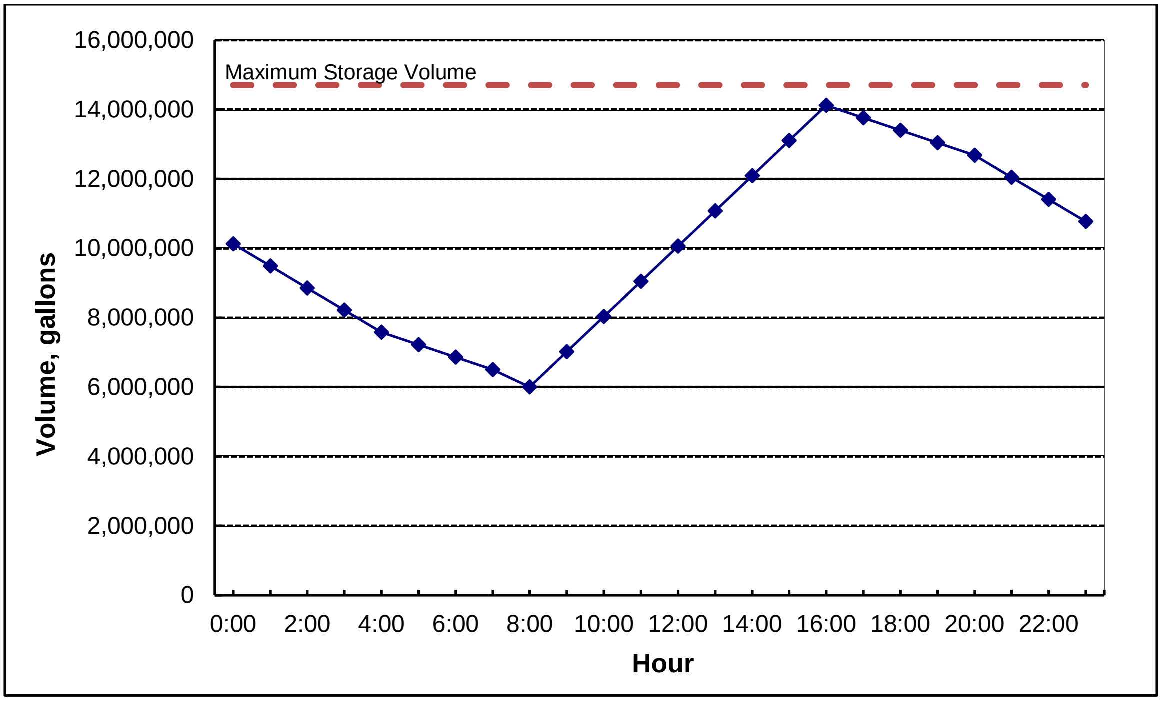


Figure 5-2: Hourly Storage in Reservoir 2



Recycled Water Pump Station East

Currently, the RWPS East has three 500-HP pumps with a total capacity of 4,500 gpm. This pump station serves the eastern service area and would be used to deliver recycled water to seasonal storage at Encino

Reservoir. RWPS East will need to be upgraded to meet the long-term demands of the Woodland Hills WRP and the Woodland Hills Water Recycling Expansion Concept. For approaches 1 and 2 described in Section 4, additional capacity at the RWPS East will be required; and the suction pipelines connecting Reservoir 2 to RWPS East, 16-inch and 14-inch diameter pipelines, will also need to be upsized. From the RWPS East, a new discharge pipeline will be needed to convey the increased flow rate needed for seasonal storage delivery and is further described in Section 7.

6 Methodology for Hydraulic Modeling

This section presents the methodology that was used within the hydraulic model to simulate seasonal flows during winter and summer periods for the proposed Woodland Hills Water Recycling Expansion Concept.

The 2014 LVMWD model was converted from WaterGems to the InfoWater software platform and was used for all hydraulic scenarios. The “S5_Improved” Scenario from the 2014 LVMWD RWMP reflects buildout demands and system conditions and therefore was used to evaluate the seasonal storage scenarios. Prior to performing the evaluation of scenarios, the S5_Improved Scenario from the converted model was compared with the 2014 LVMWD RWMP hydraulic modeling results for verification of a successful conversion. The evaluation of the conversion was conducted in the Draft Woodland Hills WRP Hydraulic Evaluation and Modeling TM (November 20, 2015) and the conversion from WaterGems to the InfoWater platform was determined to be successful.

Similar to the Draft Woodland Hills WRP Hydraulic Evaluation and Modeling TM, the model was simplified to evaluate only the eastern portion of the system (from Reservoir 2 to the LADWP service area). The hydraulic criteria that were used to evaluate and size the Woodland Hills WRP were also used to evaluate and size the proposed Woodland Hills Water Recycling Expansion Concept.

Encino Reservoir

Encino Reservoir was modeled in two different ways depending on the scenario and season:

- For winter scenarios, Encino Reservoir was modeled as a demand node with a 24-hour pattern to simulate flows delivered to the reservoir.
- For summer scenarios, Encino Reservoir was modeled as a supply reservoir with a constant head to supply flows to the LADWP/LVMWD system. Since the Encino Reservoir volume is 3 billion gallons (9,200 AF) and the recycled water volume to be stored is a small fraction of the total reservoir volume, the reservoir water surface elevation should not fluctuate significantly.

Based on the elevation and capacity data provided by LADWP, the Encino Reservoir water elevation ranges from 960 to 1,090 feet. The spillway elevation is at 1,083 feet (10,985 AF) and the 60-inch pipeline spillway is at 1,075 feet (9,631 AF). The reservoir also has six gate outlets ranging in elevation by 25 feet. For the purposes of this evaluation, it was assumed the reservoir is typically half full at an elevation of 1,025 feet (3,237 AF based), equal to the elevation of Gate No. 5. Therefore, the constant head elevation for Encino Reservoir of 1,025 feet was used in the hydraulic model. If actual reservoir elevation varies from this level, pumping head will increase or decrease, but it will not significantly change the overall findings of this evaluation.

Reservoir 2 and RWPS East

In the 2014 LVMWD model, Reservoir No. 2 was modeled as an infinite water source, with water at an elevation of 775 feet based on an average water surface elevation determined from SCADA data. For this evaluation, Reservoir 2 was modeled as a reservoir with constant head. The capacity limitations and capacity increases required at RWPS East to meet the demands were determined for each scenario and are further discussed in Section 7.

7 Evaluation and Results

This section presents the evaluation and results for the five scenarios that were developed.

7.1 Evaluation Scenarios

In addition to the five hydraulic scenarios identified in the Draft Woodland Hills WRP Hydraulic Evaluation and Modeling TM (November 20, 2015), three additional hydraulic modeling scenarios were developed to fully evaluate seasonal storage. The Draft Woodland Hills WRP Hydraulic Evaluation and Modeling TM evaluated scenarios with non-potable reuse delivery only (Scenarios 1 through 3) and scenarios with seasonal storage deliveries in addition to non-potable reuse (Scenarios 4 and 5). Based on the previous hydraulic modeling evaluation, operational storage at Pierce College would not allow for a decrease in the pipeline diameter for the Woodland Hills WRP; and therefore Scenario 5 was eliminated from further consideration.

The goal of looking at seasonal storage in the Draft Woodland Hills WRP Hydraulic Evaluation and Modeling TM was to identify the required diameter of the Woodland Hills WRP to deliver recycled water to seasonal storage. In this hydraulic evaluation, the Scenario 4 pipeline diameter for the Seasonal Storage Extension (downstream of the Woodland Hills WRP) and within LVMWD service area were further refined; and an additional three seasonal storage delivery scenarios were included. The scenarios are summarized in **Table 7-1.**

For all the scenarios, Alignment 2 identified in Section 2 was used for the hydraulic model. Based on the previous evaluation, pressure available for the Pierce College Extension are more than adequate, and a pressure reducing valve (PRV) was identified at Canoga Avenue, north of Dumetz Road. The PRV would stabilize pressures within the Pierce College Extension and maintain them within the hydraulic criteria. Therefore, for this evaluation, only the Woodland Hills WRP and the Seasonal Storage Extension pressures, velocities and headlosses are presented in the results.

Table 7-1: Seasonal Storage Scenarios Description

No.	Scenario Name	Description	Demand Scenario	Outcome
4	Long-Term with no Operational Storage and Seasonal Storage	Maximum seasonal storage delivery plus non-potable winter demands	Winter	Mid-Size pipeline to Encino Reservoir
5 [(1)]	Long-Term with Operational Storage and Seasonal Storage	Maximum seasonal storage delivery plus non-potable winter demands and operational storage near Pierce College	Winter	Mid-Size pipeline to Encino Reservoir
6	Maximum Flow to Seasonal Storage	Maximum seasonal storage delivery with no non-potable winter demands	Winter	Maximum pipeline diameter to Encino Reservoir
7	Minimum Flow to Seasonal Storage	Minimum seasonal storage delivery plus non-potable winter demands	Winter	Minimum pipeline diameter to Encino Reservoir
8	Flow from Seasonal Storage to LVMWD	Delivery from Encino Reservoir to LADWP and LVMWD to serve non-potable summer demands	Summer	Check pipeline diameter for flows back to LVMWD and determine pumping requirements

1. Scenario 5 was removed from further evaluation as operational storage at Pierce College would not provide benefits.

7.2 Scenario 4: Long-Term Woodland Hills WRP with Seasonal Storage

Scenario 4, previously evaluated in the Draft Woodland Hills WRP Hydraulic Evaluation and Modeling TM, would connect eight near-term and 36 long-term customers[1], including Braemar Country Club and El Caballero Country Club, with the pipeline extensions to Pierce College and to Encino Reservoir. Scenario 4 would deliver winter PHD to non-potable customers and deliver 6,000 gpm of recycled water to Encino Reservoir for seasonal storage. The purpose of this scenario is to determine the mid-size pipeline diameter to Encino Reservoir.

Scenario 4 was optimized by progressively reducing pipeline diameters in the model while maintaining the minimum level of service required at connections and positive pressures at high elevation nodes. Due to a high elevation node at the intersection of Alonzo Avenue and Avenida Puerto Vallarta, a 24-inch diameter pipeline had to be used from the Woodland Hills WRP to El Caballero Country Club to ensure a positive pressure. Downstream of El Caballero Country Club, the pipeline diameter could be reduced from a 24-inch diameter to 20-inch diameter pipeline.

[1] The near-term customers are served by the Woodland Hills WRP and the long-term customers are served by the Pierce College and Seasonal Storage extensions. Specific customer information is located in Draft Woodland Hills WRP Hydraulic Evaluation and Modeling TM (November 20, 2015)

Scenario 4 pipeline diameters are shown in **Figure 7-1.** Facilities required for this scenario would include:

- 13,700 linear feet (LF) of 20-inch diameter pipeline (from Park Granada between Parkway Calabasas and Park Capri and from El Caballero Country Club to Encino Reservoir)
- 66,700 LF of 24-inch diameter pipeline (from the RWPS East to Parkway Calabasas and from El Caballero Country Club to Encino Reservoir).
- Upsizing the existing 14-inch and 16-inch diameter suction pipelines connecting Reservoir 2 to the RWPS East.
- An additional 2,800 gpm of pumping capacity at the RWPS East to meet system demands and deliver winter flows to Encino Reservoir.

Pressures for the demand nodes in both the Woodland Hills WRP and Seasonal Storage Extension are shown in **Figure 7-2**; all customers would receive the required level of service. Customer pressures along the Woodland Hills WRP would fluctuate from 170 to 230 psi, except for Alice Stelle School/Freedom Park where pressures would be approximately 120 psi. Due to the high pressures (over 130 psi), nine individual PRVs would be needed for the customer sites, including Braemar and El Caballero Country Clubs along the Seasonal Storage Extension. Customers that would require PRVs are indicated in red font in **Table 7-2**. Pressures at the high elevation point and Encino Reservoir range from 20 to 30 psi and 80 to 90 psi, respectively. If the pipeline from the Woodland Hills WRP to El Caballero Country Club was reduced from a 24-inch diameter to a 20-inch diameter, the pressures at the high point would be negative.

Velocities and headlosses for the Woodland Hills WRP and the Seasonal Storage Extension pipelines are shown in **Figure 7-3** and **Figure 7-4**, respectively, and they meet the hydraulic criteria (velocities are less than 8 feet per second [fps] and headlosses per 1,000 feet are less than 10 feet).

Figure 7-1: Scenario 4 DIameter, Pipeline and Nodel Model IDs

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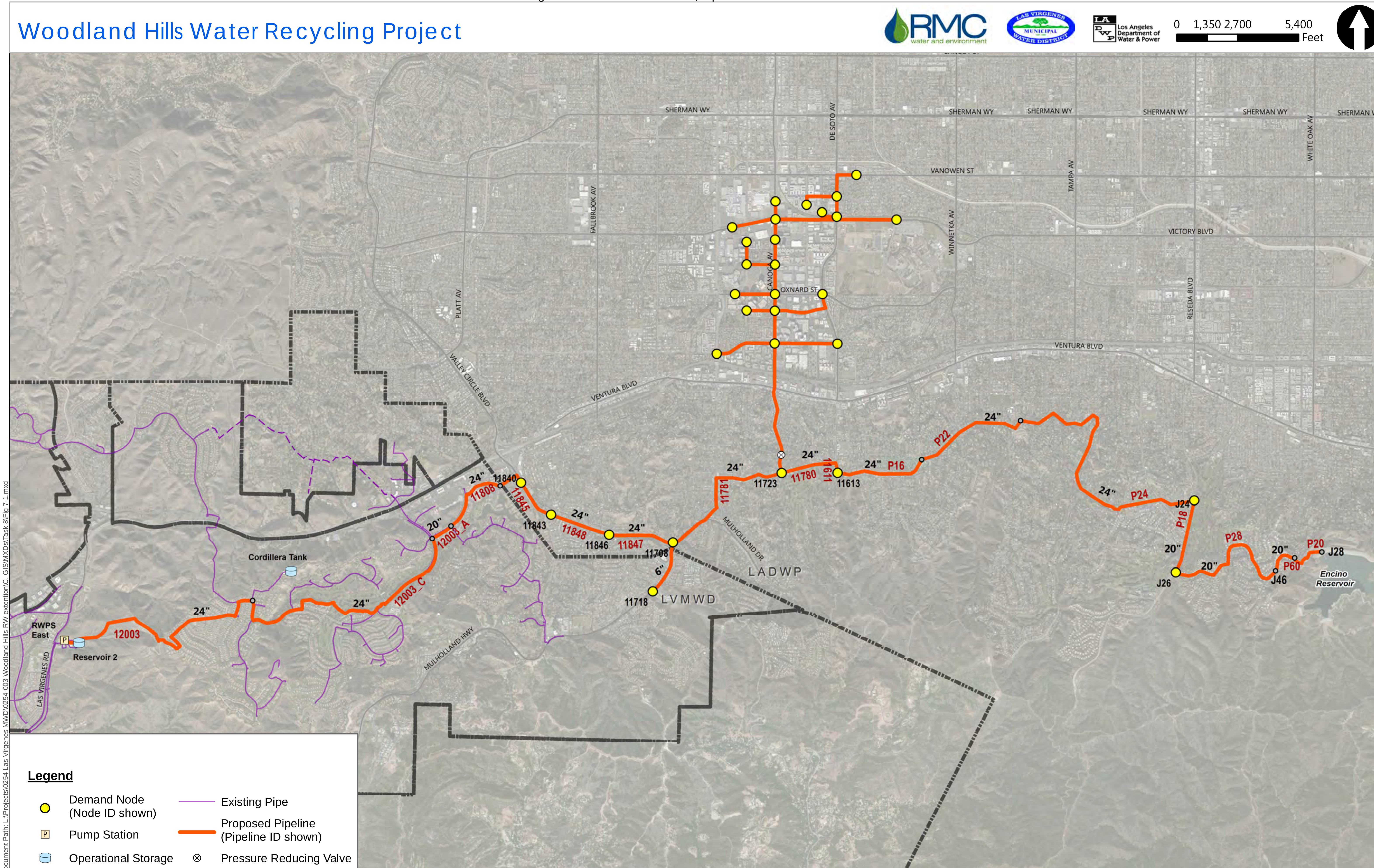


Table 7-2: Scenario 4 Customer Pressures

ID	Customer	Max. Value (psi)	Min. Value (psi)	Average (psi)	Desired Min. (psi)	Desried Max. (psi)
11613	Serrania Avenue Park	192	184	188	70	130
11708	Louisville High School	179	173	176	40	130
11718	Alice Stelle School, Freedom Park & Other	123	116	120	40	130
11723	Woodland Hills Country Club and Woodland Hills Community Church	206	198	202	100	130
11840	Motion Picture and Television Fund Hospital	233	228	231	90	130
11843	Church of JCLDS	225	219	222	40	130
11846	Mulholland Drive Medians	184	178	181	40	130
J24	El Caballero Country Club	220	209	214	120	130
J26	Braemar Country Club	179	168	173	20	130

Note: Customers that would require PRVs are indicated in red font.

Figure 7-2: Scenario 4 Customer Pressures

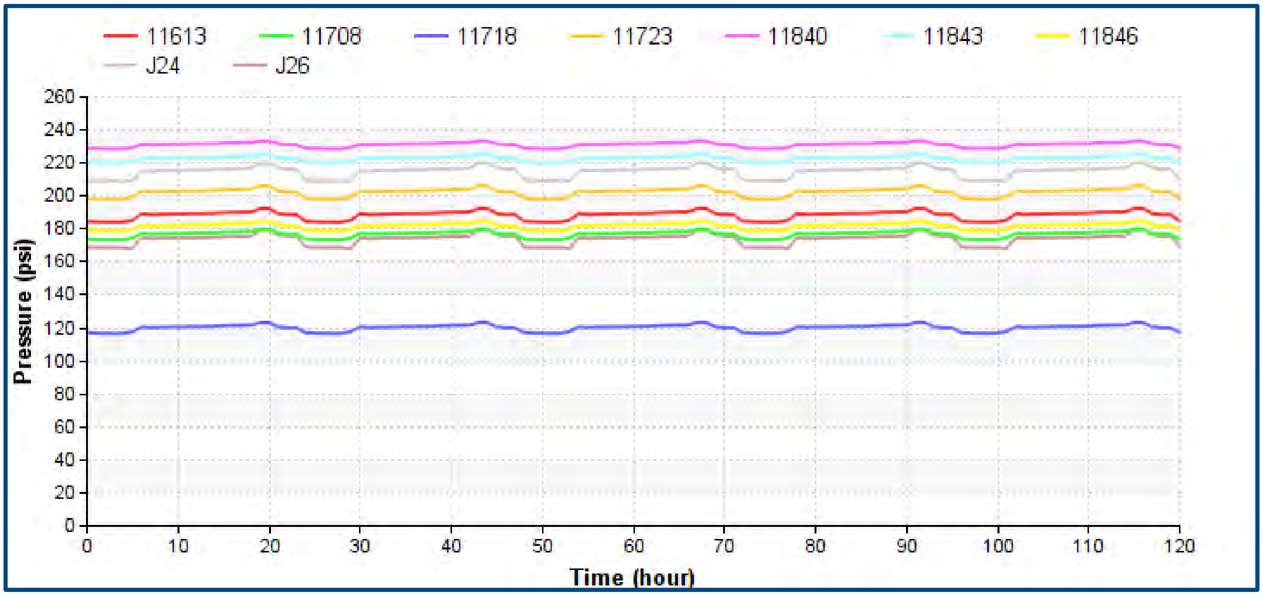


Figure 7-3: Scenario 4 Velocities

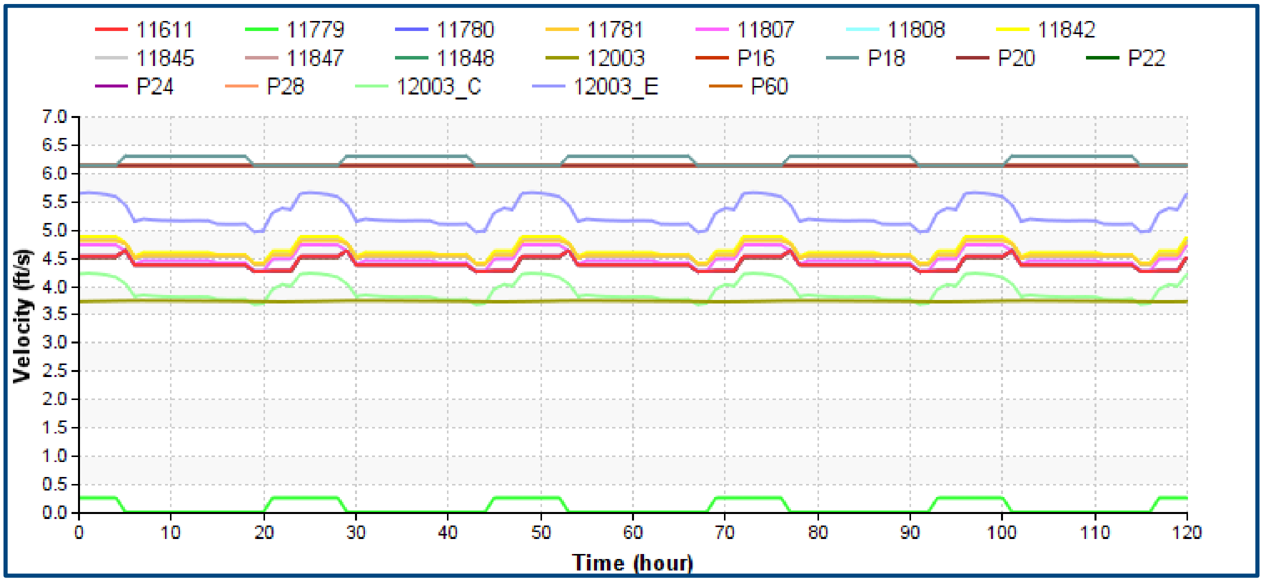
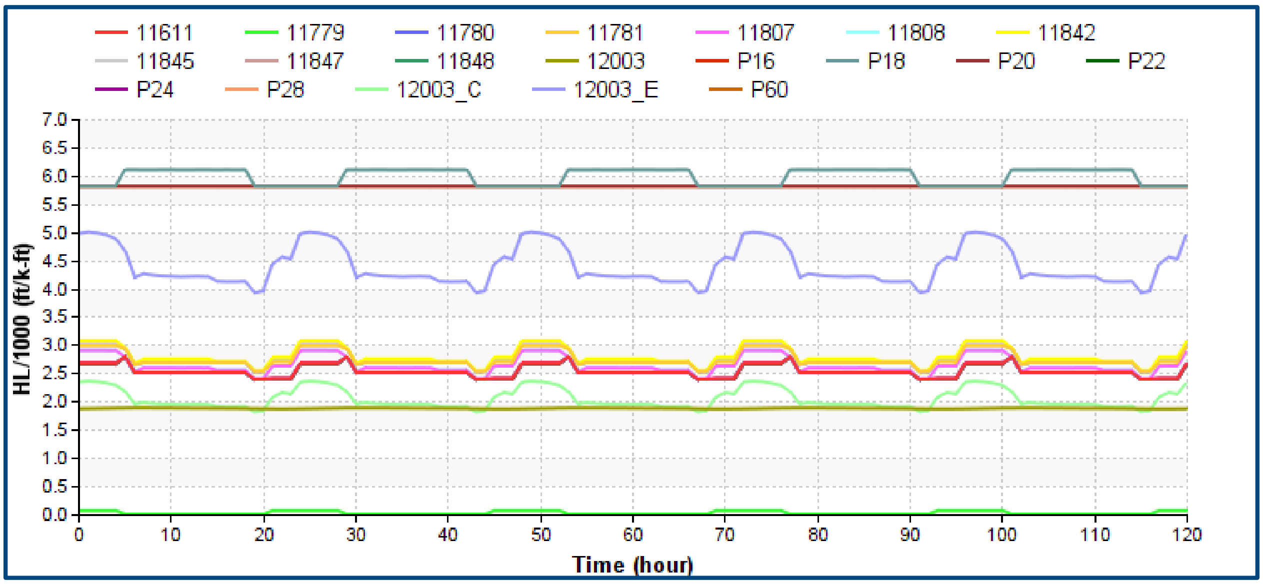


Figure 7-4: Scenario 4 Headlosses



7.3 Scenario 6: Maximum Flow to Seasonal Storage

Scenario 6 would deliver 100 percent of future dry weather flow from Tapia WRF to seasonal storage at Encino Reservoir (11 MGD, 7,640 gpm). This scenario would simulate potential conditions during an extended heavy rain event when no customers are using recycled water for irrigation. The wet weather flows would continue to be discharged into Malibu Creek. All the demands in the LVMWD and LADWP service areas were removed. The purpose of this scenario is to determine the maximum pipeline diameter to Encino Reservoir.

Scenario 6 pipeline diameters are shown in **Figure 7-6.** Facilities required for this scenario would include:

- 1,000 LF of 20-inch diameter pipeline on Park Granada (from Parkway Calabasas to Park Capri)
- 79,400 LF of 24-inch diameter pipeline from the RWPS East to Parkway Calabasas and from Park Capri to Encino Reservoir.
- Upsizing the existing 14-inch and 16-inch diameter suction pipelines connecting Reservoir 2 to the RWPS East.
- An additional 3,800 gpm of pumping capacity would be required at the RWPS East to deliver maximum flows to the Encino Reservoir.

Although there are no demands assumed, pressures for the demand nodes in both the near-term Woodland Hills WRP and Seasonal Storage Extension are shown in **Figure 7-6**. Nine individual PRVs will be needed at each customer site in case one or more customers uses recycled water. Customer pressures along the near-term Woodland Hills WRP would range from 175 to 225 psi, except for Alice Stelle School/Freedom Park where pressures would be approximately 110 psi. Pressures at the high elevation point (intersection of Alonzo Avenue and Avenida Puerto Vallarta) and Encino Reservoir are 12 and 72 psi, respectively.

Velocities and headlosses for the Woodland Hills WRP and Seasonal Storage Extension pipelines are shown in **Figure 7-7** and **Figure 7-8**, respectively, and they meet the hydraulic criteria.

Figure 7-5: Scenario 6 Diameter, Pipeline and Nodel Model IDs

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Woodland Hills Water Recycling Project

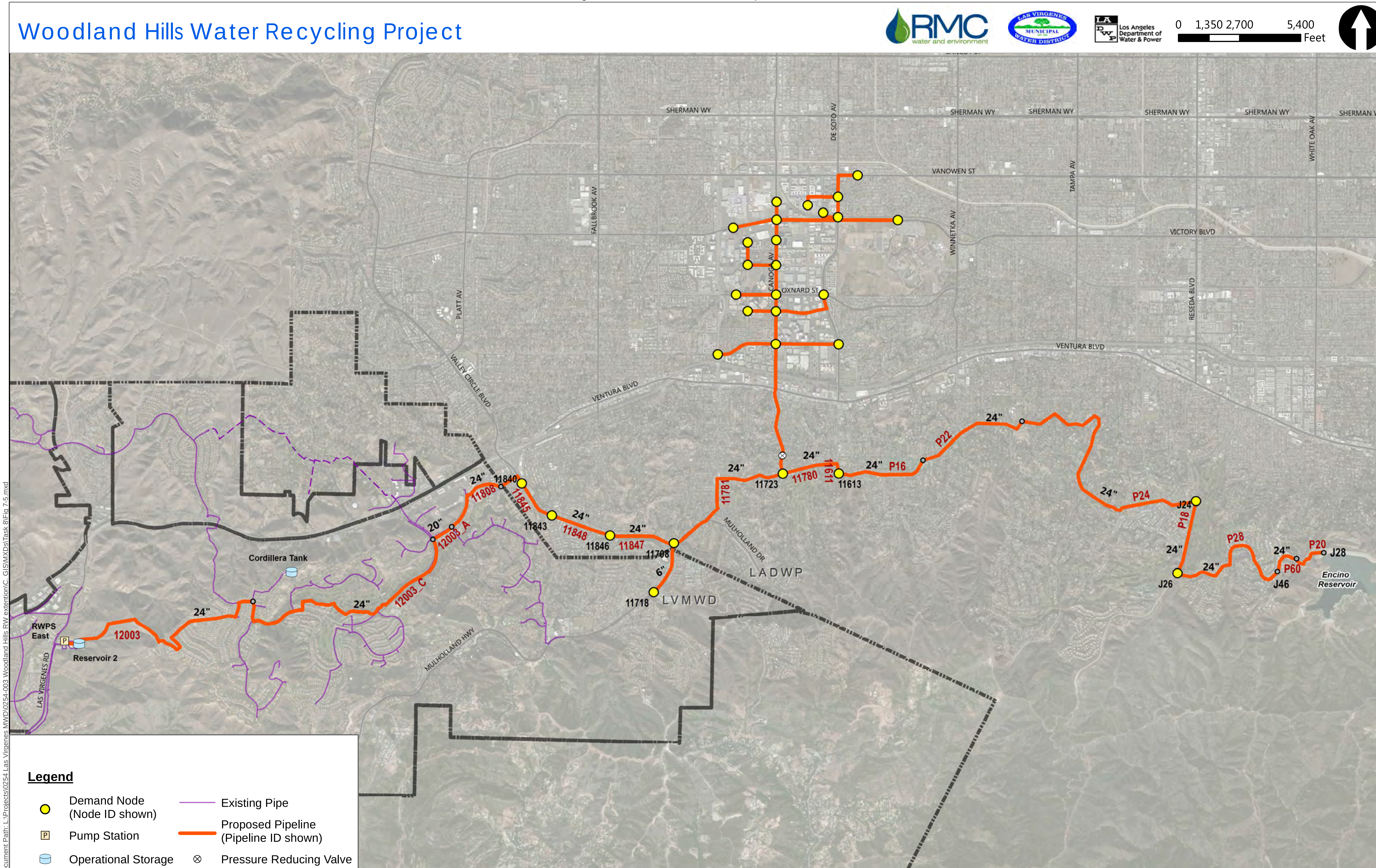

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Table 7-3: Scenario 6 Customer Pressures

ID	Customer	Max. Value (psi)	Min. Value (psi)	Average (psi)	Desired Min. (psi)	Desried Max. (psi)
11613	Serrania Avenue Park	175	175	175	70	130
11708	Louisville High School	168	168	168	40	130
11718	Alice Stelle School, Freedom Park & Other	112	111	111	40	130
11723	Woodland Hills Country Club and Woodland Hills Community Church	191	191	191	100	130
11840	Motion Picture and Television Fund Hospital	226	226	226	90	130
11843	Church of JCLDS	216	216	216	40	130
11846	Mulholland Drive Medians	174	174	174	40	130
J24	El Caballero Country Club	190	190	190	120	130
J26	Braemar Country Club	153	152	152	20	130

Note: Customers that would require PRVs are indicated in red font.

Figure 7-6: Scenario 6 Customer Pressures

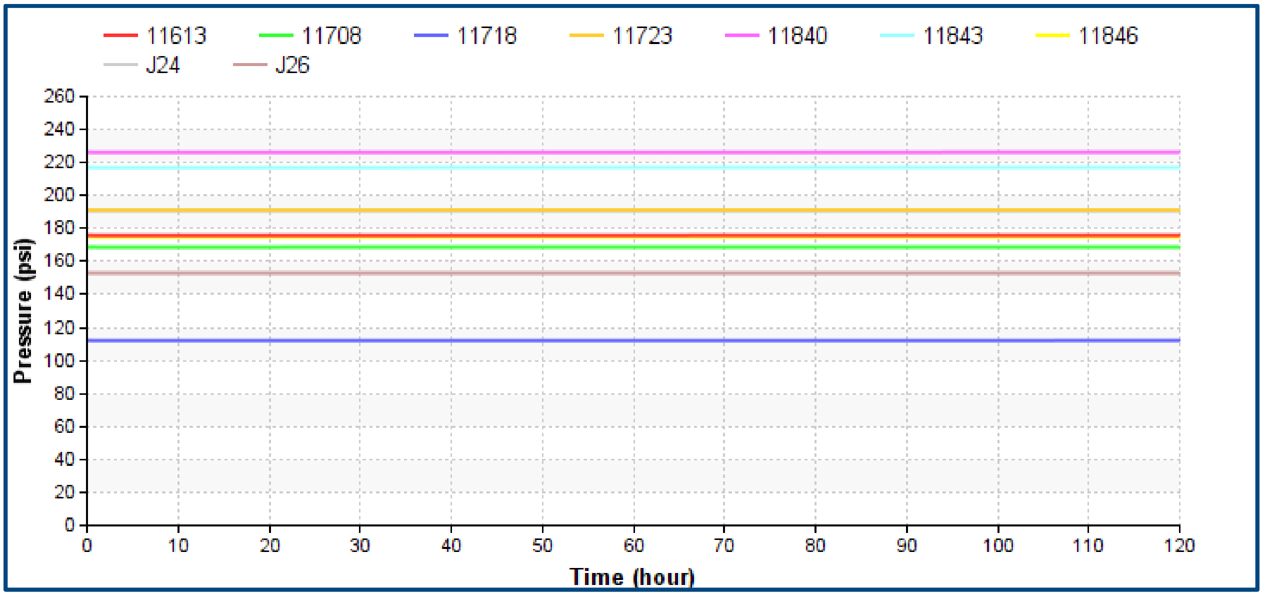


Figure 7-7: Scenario 6 Velocities

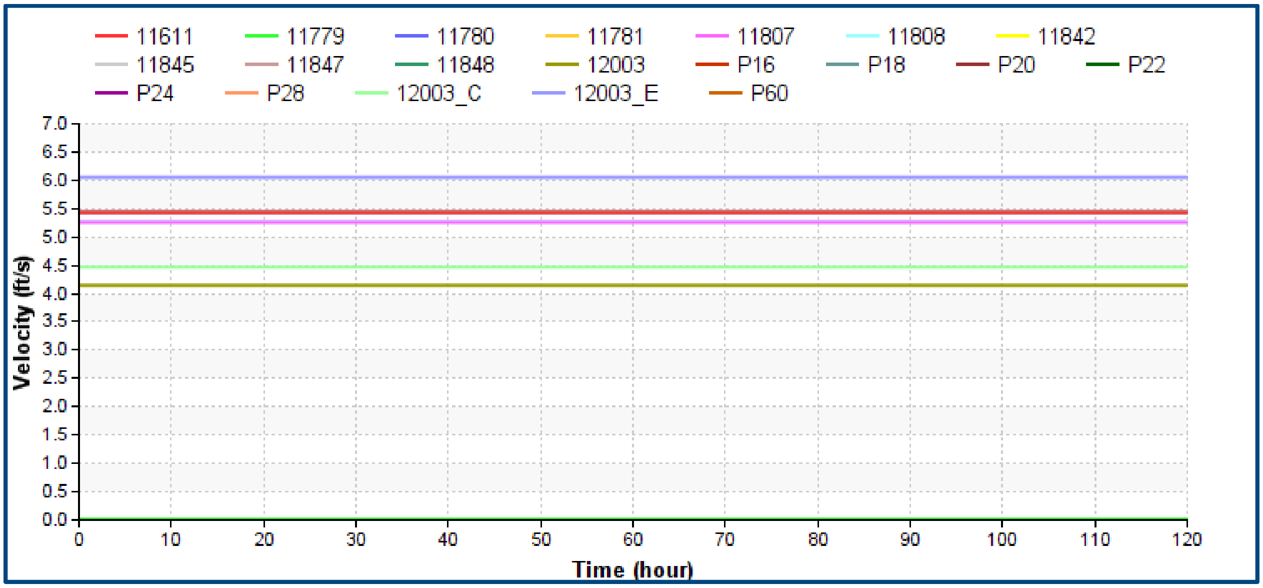
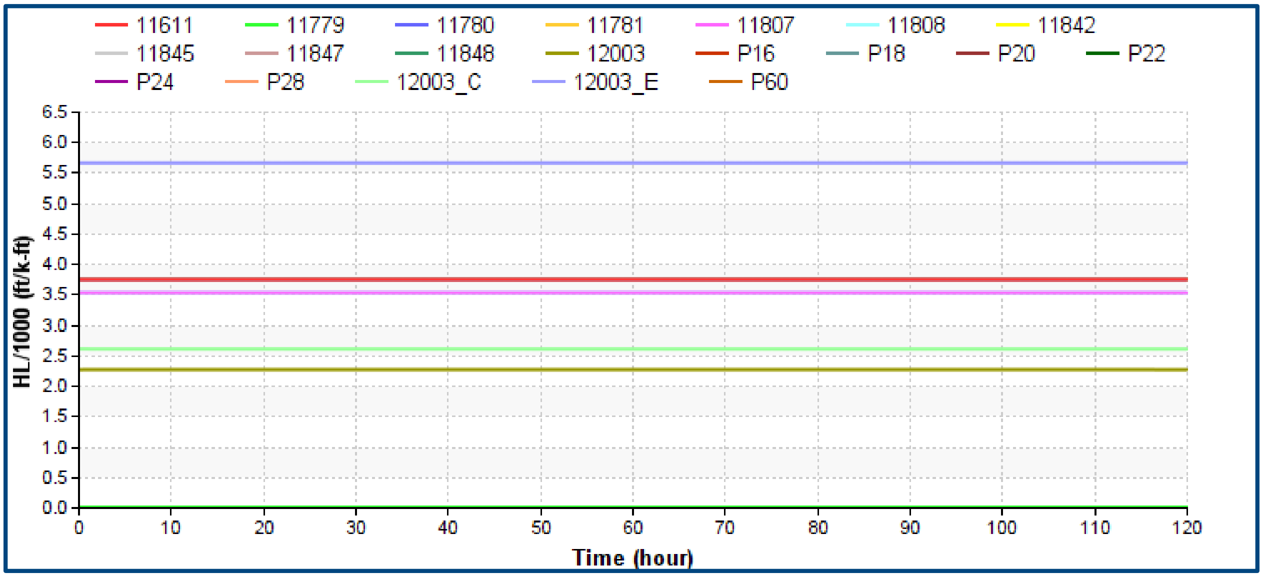


Figure 7-8: Scenario 6 Headlosses



7.4 Scenario 7: Minimum Flow to Seasonal Storage

Scenario 7 would deliver winter PHD to non-potable customers and deliver 1,010 gpm to Encino Reservoir over seven months. This flow rate would supply the amount needed to eliminate potable water supplements in the summer in LVMWD's service area. The purpose of this scenario is to determine the minimum pipeline diameter to Encino Reservoir.

Scenario 7 pipeline diameters are shown in **Figure 7-9**. Facilities required for this scenario would include:

- 44,800 LF of 16-inch diameter pipeline (RWPS East to Park Calabasas and from Park Capri to Serrania Park Granada)

- 36,600 LF of 12-inch diameter pipeline (from Serrania Park to Encino Reservoir).
- The suction pipelines connecting Reservoir 2 to the RWPS East do not need to be upsized and no additional pump capacity is needed at the RWPS East.

Pressures for the demand nodes in both the Woodland Hills WRP and Seasonal Storage Extension are shown in **Figure 7-10**; all customers will receive the minimum level of service. Customer pressures along the Woodland Hills WRP would fluctuate from 180 to 250 psi, except for Alice Stelle School/Freedom Park where pressures would be approximately 135 psi. Due to the high pressures, nine individual PRVs will be needed for the customer sites, including Braemar and El Caballero country clubs. Customers that would require PRVs are indicated in red font in **Table 7-4**. Pressures at the high elevation point (intersection of Alonzo Avenue and Avenida Puerto Vallarta) and Encino Reservoir range from 20 to 70 psi and 80 to 135 psi, respectively.

Velocities and headlosses for the Woodland Hills WRP and Seasonal Storage Extension pipelines are shown in **Figure 7-11** and **Figure 7-12**, respectively, and they meet the hydraulic criteria.

Figure 7-9: Scenario 7 Diameter, Pipeline and Node Model IDs

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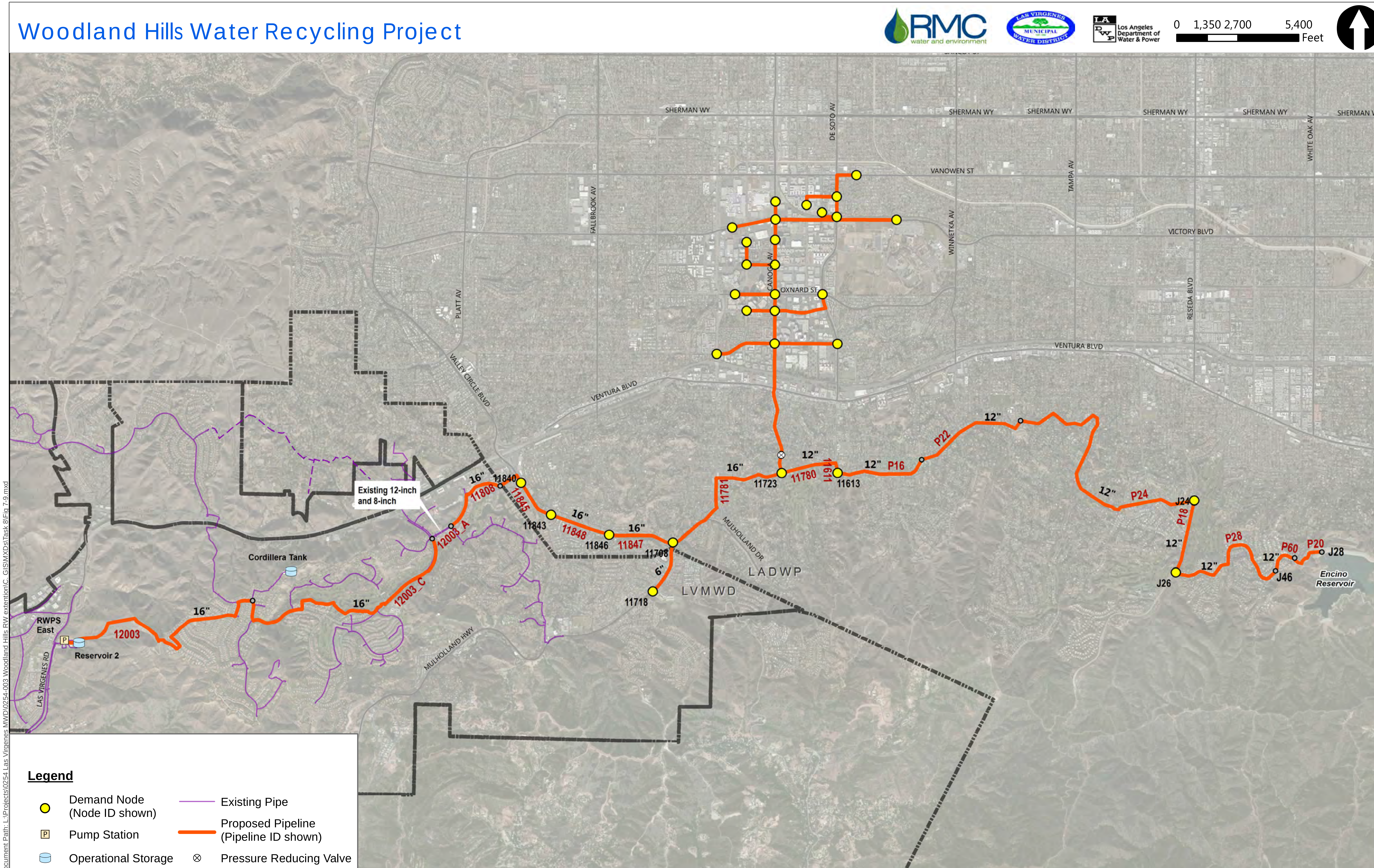

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Table 7-4: Scenario 7 Customer Pressures

ID	Customer	Max. Value (psi)	Min. Value (psi)	Average (psi)	Desired Min. (psi)	Desried Max. (psi)
11613	Serrania Avenue Park	218	193	207	70	130
11708	Louisville High School	201	181	192	40	130
11718	Alice Stelle School, Freedom Park & Other	144	125	135	40	130
11723	Woodland Hills Country Club and Woodland Hills Community Church	232	210	222	100	130
11840	Motion Picture and Television Fund Hospital	249	233	242	90	130
11843	Church of JCLDS	242	225	234	40	130
11846	Mulholland Drive Medians	204	185	195	40	130
J24	El Caballero Country Club	244	194	223	120	130
J26	Braemar Country Club	208	157	187	20	130

Note: Customers that would require PRVs are indicated in red font.

Figure 7-10: Scenario 7 Customer Pressures

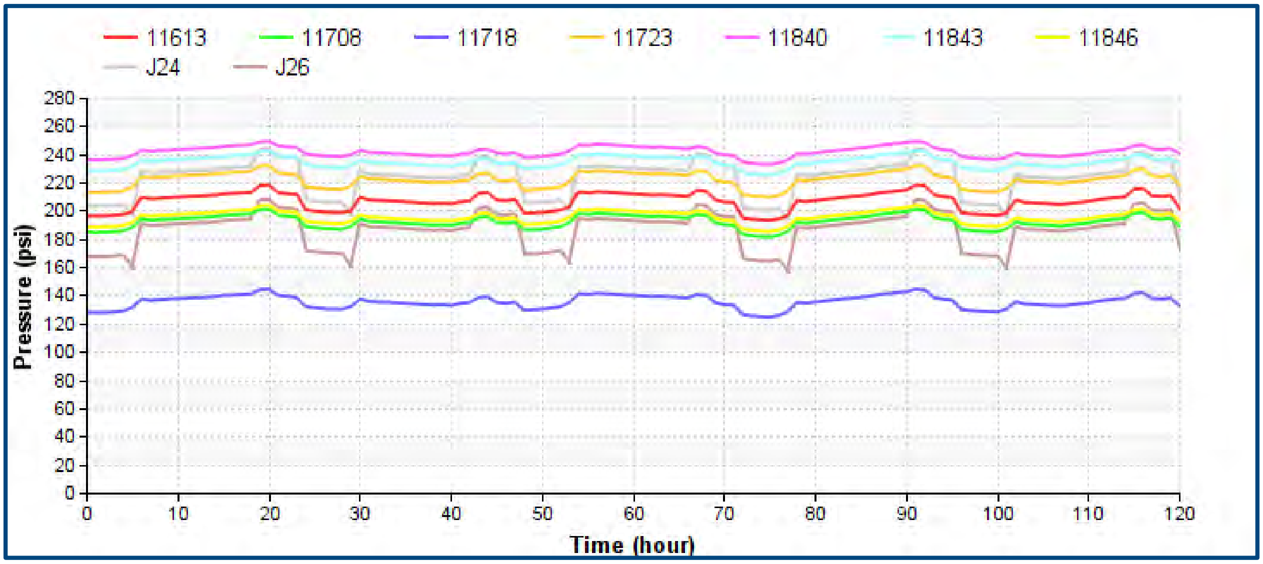


Figure 7-11: Scenario 7 Velocities

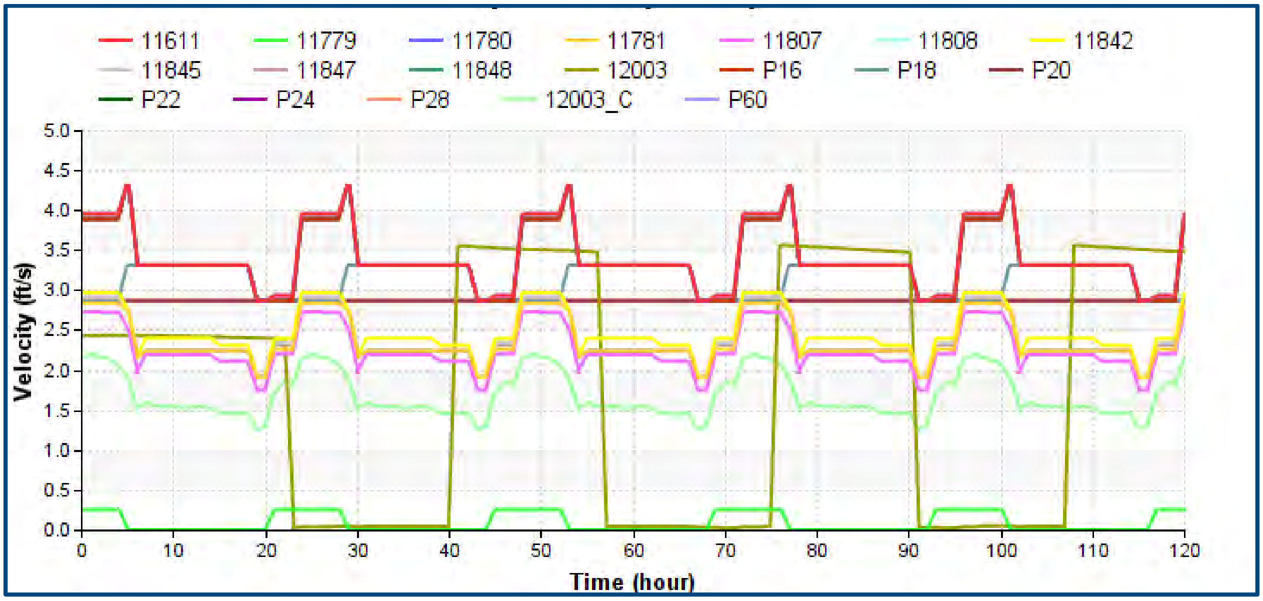
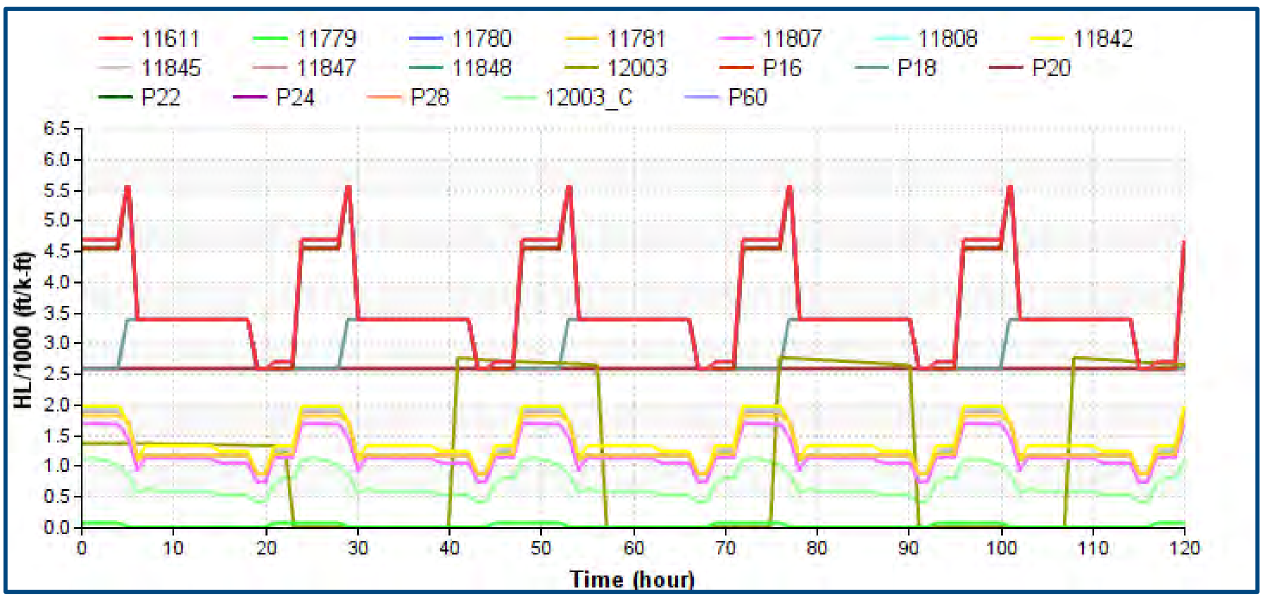


Figure 7-12: Scenario 7 Headlosses



7.5 Scenario 8: Flow from Seasonal Storage to LVMWD

Scenario 8 would deliver summer PHD to LVMWD/LADWP non-potable customers from Encino Reservoir to offset the need for LVMWD supplemental potable water. The purpose of this scenario is to check the required pipeline diameter for flows back to LVMWD and determine pumping requirements at Encino Reservoir.

Based on August buildout demands (LVMWD and LADWP), approximately 1,350 AF/month of recycled water would be required; however, Tapia WRF can only provide 1,030 AF/month (Figure 4-1). To eliminate supplemental potable water, 320 AF/month in August would need to be delivered from Encino Reservoir to the LVMWD/LADWP service area. Assuming a constant flow rate over the month (24 hours per day, 31 days), approximately 2,330 gpm would need to be supplied from Encino Reservoir.

This scenario would serve summer PHD to the LADWP and eastern LVMWD service area. This allows additional flows from Reservoir 2 to serve the western service area, offsetting supplement potable water in the LVMWD service area. During the summer period, additional flows in Malibu Creek for Steelhead trout are needed (approximately 100-200 AFY); however, the flows for habitat protection are relatively small and will not be considered in the seasonal storage evaluation.

The same pipeline diameters identified in Scenario 4 were assumed for this scenario (shown in **Figure 7-13**). A pump station with 2,330 gpm of pumping capacity and total dynamic head of 540 feet would be needed at Encino Reservoir to lift recycled water to serve customers within the Woodland Hills WRP and Seasonal Storage and Pierce College extensions.

Pressures for the demand nodes in both the Woodland Hills WRP and Seasonal Storage Extension are shown in **Figure 7-14**; all customers will receive the required level of service. Customer pressures along the Woodland Hills WRP would fluctuate from 135 to 260 psi, including Alice Stelle School/Freedom Park, as shown in **Table 7-5**. Due to the high pressures along the Seasonal Storage Extension and the Woodland Hills WRP, nine individual PRVs will be needed at each customer site. Customers that would require PRVs are indicated in red font. Encino Reservoir and the high elevation point (intersection of Alonzo Avenue and Avenida Puerto Vallarta) have pressures over 20 psi.

Velocities and headlosses for the near- and long-term Woodland Hills WRP pipelines are shown in **Figure 7-15** and **Figure 7-16**, respectively, and they meet the hydraulic criteria.

Figure 7-13: Scenario 8 Diameter, Pipeline and Node Model IDs

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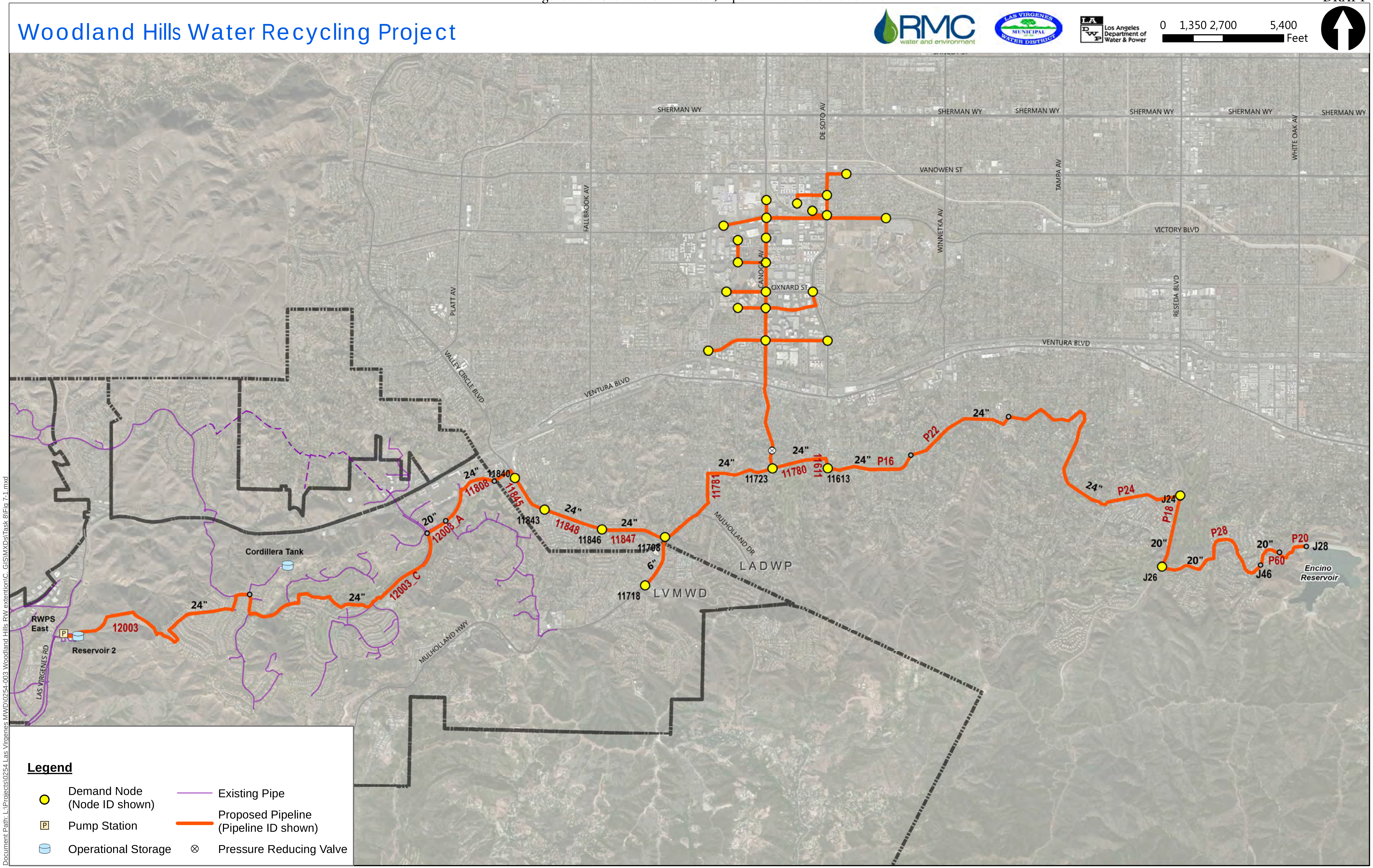


Table 7-5: Scenario 8 Customer Pressures

ID	Customer	Max. Value (psi)	Min. Value (psi)	Average (psi)	Desired Min. (psi)	Desried Max. (psi)
11613	Serrania Avenue Park	258	217	229	70	130
11708	Louisville High School	234	194	206	40	130
11718	Alice Stelle School, Freedom Park & Other	178	136	149	40	130
11723	Woodland Hills Country Club and Woodland Hills Community Church	268	227	240	100	130
11840	Motion Picture and Television Fund Hospital	280	239	251	90	130
11843	Church of JCLDS	274	233	245	40	130
11846	Mulholland Drive Medians	236	195	208	40	130
J24	El Caballero Country Club	309	270	282	120	130
J26	Braemar Country Club	278	239	251	20	130

Note: Customers that would require PRVs are indicated in red font.

Figure 7-14: Scenario 8 Customer Pressures

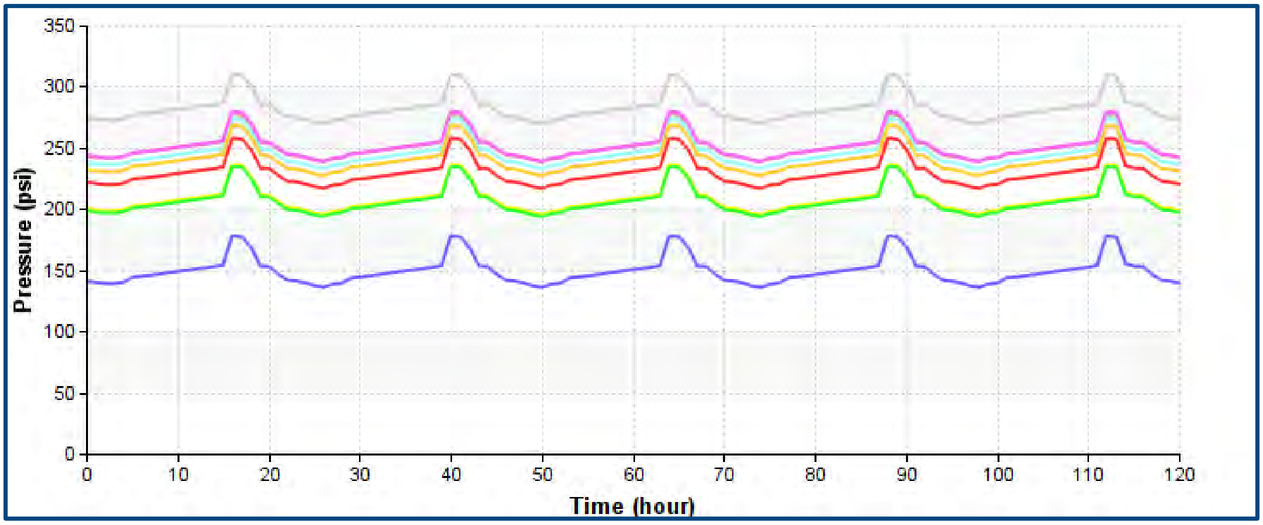


Figure 7-15: Scenario 8 Velocities

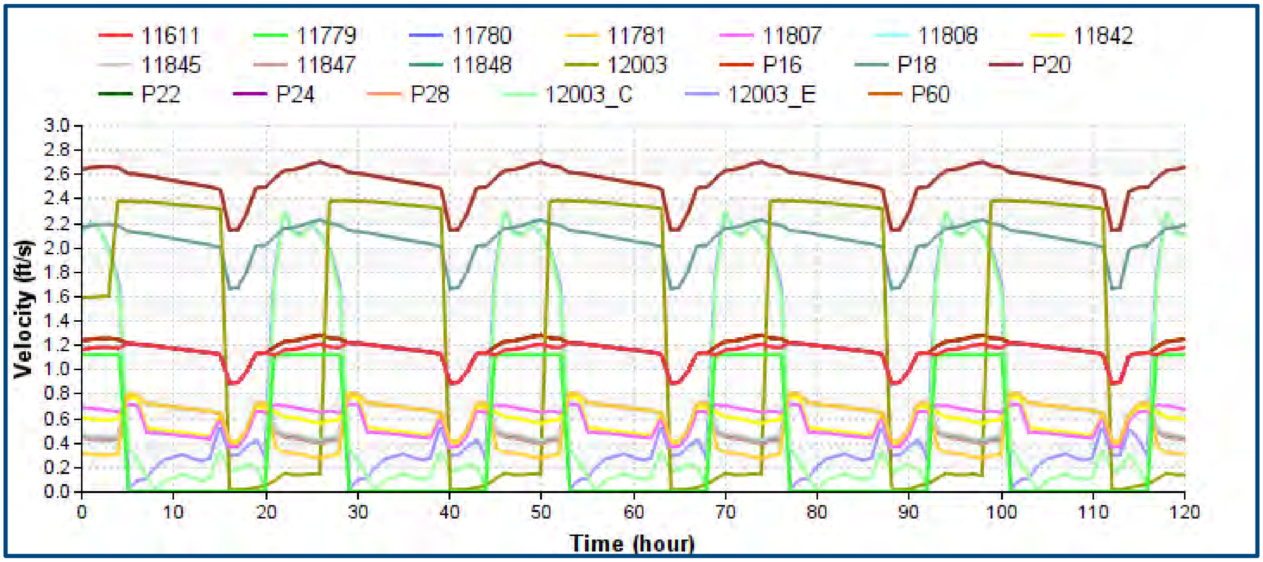
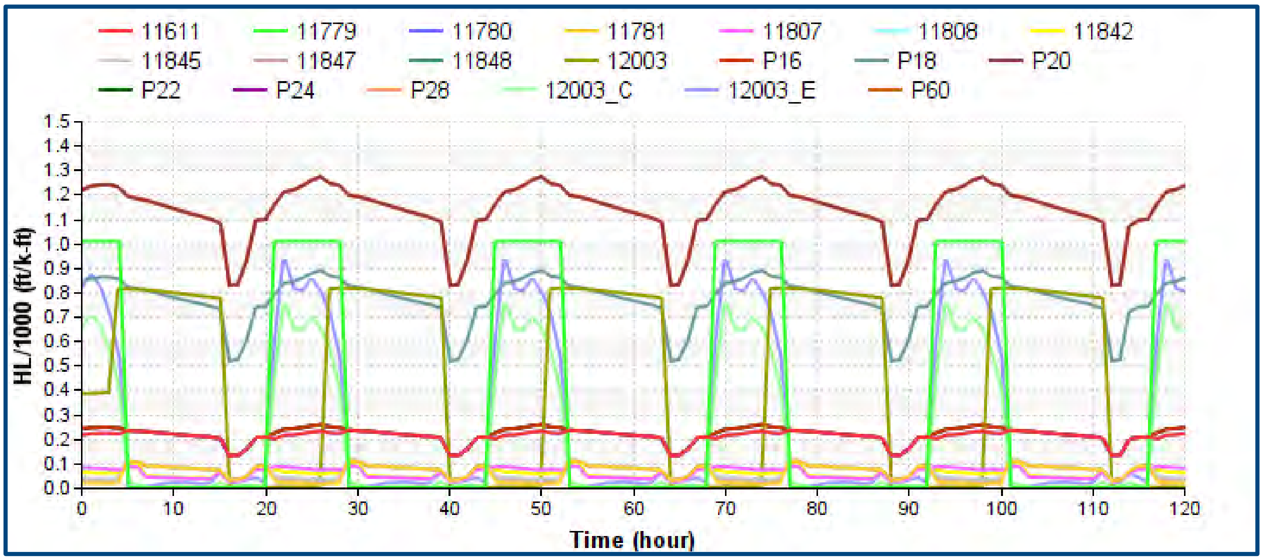


Figure 7-16: Scenario 8 Headlosses



7.6 Summary of Results

Based on the hydraulic evaluation, recommended pipeline diameters varied for each scenario. **Table 7-6** summarizes the lengths and diameters for each scenario, and **Figure 7-17** indicates the locations of each reach. Scenario 5 was eliminated from consideration and is not presented.

Table 7-6: Summary of Pipeline Diameter Recommendations by Scenario and Reach

Reach	1	2	3	4	5
Location	From RWPS East to Park Granada	Park Granada from Parkway Calabasas to Park Capri	Woodland Hills WRP (Park Capri to WHCC)	From WHCC Park to El Caballero Country Club	From El Caballero Country Club to Encino Reservoir
Length (LF)	23,000	1,000	19,600	24,100	12,700
Scenario 4 Diameter	24-inch	20-inch	24-inch	24-inch	20-inch
Scenario 6 Diameter	24-inch	20-inch	24-inch	24-inch	24-inch
Scenario 7 Diameter	16-inch	Existing 12-inch and 8-inch	16-inch	12-inch	12-inch
Scenario 8 Diameter (1)	24-inch	20-inch	24-inch	24-inch	20-inch

1. Same pipelines as Scenario 4 were used to determine the pressures along the Woodland Hills WRP.

Figure 7-17: Woodland Hills WRP Pipeline Reaches

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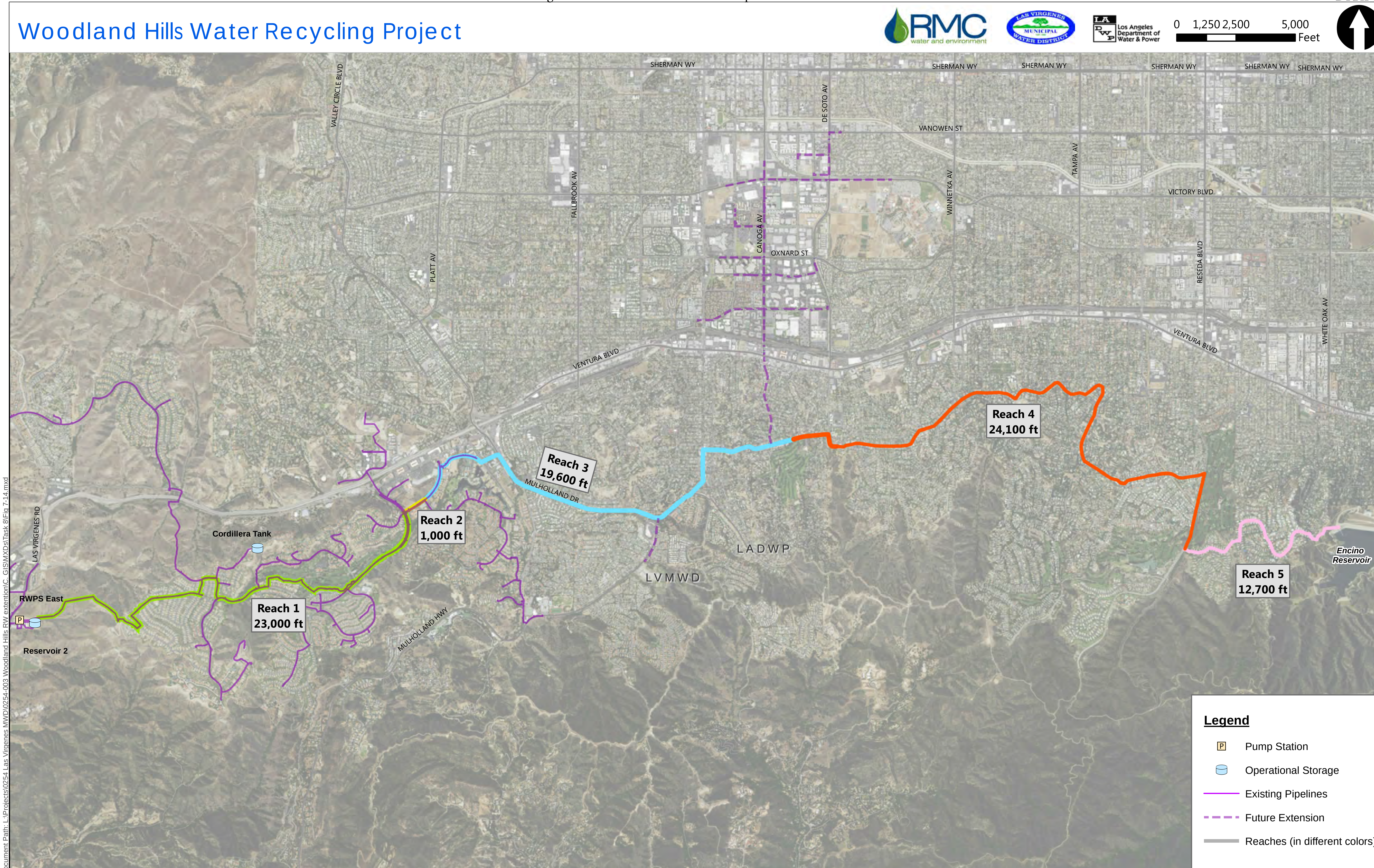

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8 Conceptual Level Construction Cost Estimates

This section presents the unit costs and the conceptual level construction cost estimates for facilities required to deliver recycled water to and from Encino Reservoir.

8.1 Construction Basis and Unit Costs

Conceptual level construction cost estimates were developed to assess the budgetary impact of delivering and serving recycled water from the Encino Reservoir. The same unit costs described in the Draft Woodland Hills WRP Alignment Evaluation TM (October 6, 2015) were used to develop construction cost estimates for Scenario 4. The unit cost estimates are based on bid tabulations for recent pipeline projects of similar size and scope, including those provided by LVMWD. Costs are intended to provide a budgetary estimate and at this stage are considered Class 4 estimates in accordance with AACE International Publication 56R-08 Cost Estimate Classification System. These estimates apply to projects with 1% to 15% definition and have an expected accuracy range of -20% to +30%. Costs presented are for construction only and do not include other capital costs such as easement acquisition, engineering, construction management, administration, legal, permitting and environmental mitigation costs.

Costs are benchmarked to the Engineering News Record Construction Cost Index (ENRCCI) for the Los Angeles area for October 2015 (ENRCCI LA = 11,628.27). Where historic unit cost data have been applied, those unit costs have been escalated to October 2015 dollars using the index.

Pipeline Unit Costs

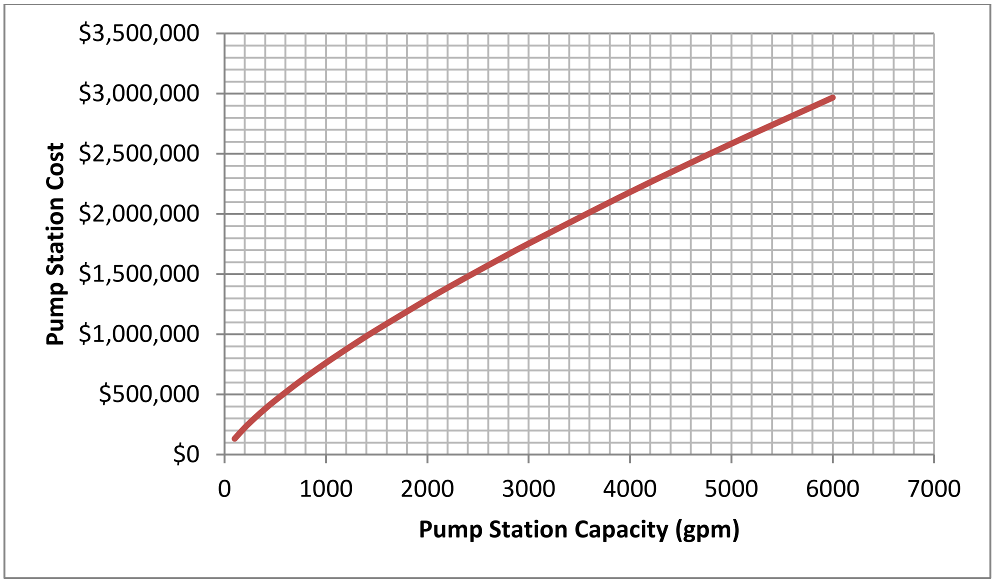
Pipeline costs are based on $16 per inch per lineal foot. Pipeline costs include pipeline materials and installation, standard trench repair (t-patch), isolation valves, air valves, blowoffs, traffic control, field engineering, mobilization and demobilization, and all other costs for typical pipeline construction not included as additional line items and described below.

Within the Woodland Hills WRP alignment, additional construction costs were added for creek crossings assuming trenchless installation that were already identified in the Draft Woodland Hills WRP Alignment Evaluation TM. Trenchless costs include costs for pits and casing installation using jack and bore techniques. Jacking and receiving pit costs are estimated at $100,000 and $50,000 respectively. A 30-inch diameter casing pipe is assumed for 16-inch mainlines and a 36-inch diameter casing pipe is assumed for 24-inch mainlines. Costs for casing installation, annular space grouting, tunneling subcontractor mobilization and field engineering are estimated at $40/in/LF or $1,200 and $1,440 per lineal foot for a 30 and 36-inch casing, respectively.

Pump Station Unit Costs

A cost curve was developed using the construction cost curves from Pumping Station Design (Sank et al, 1989) and adjusted to October 2015 dollars. The cost curve is based on the flow rate of the pump station and is shown in **Figure 8-1**.

Figure 8-1: Pump Station Cost Curve



Connection to Encino Reservoir

An allowance of $500,000 has been applied based on the anticipated requirements of this component, including a flowmeter, valve vault, flow control/pressure sustaining valve, associated electrical and controls, and discharge structure. Some existing onsite piping and facilities could potentially be used, but this could not be determined based on the information available during this evaluation.

Construction Contingency

A 25 percent factor has been applied to the construction cost subtotal to cover unknown conditions and preliminary project definition.

8.2 Seasonal Storage Facility Cost Estimates

Construction cost estimates were developed to deliver and supply recycled water from Encino Reservoir, using the facilities defined in Scenarios 4 and 8. Scenario 4 includes facilities to delivery maximum seasonal storage delivery plus serve winter non-potable demands and Scenario 8 includes facilities to serve summer non-potable demands, offsetting supplemental potable water. **Table 8-1** summarizes the construction costs developed to implement Scenarios 4 and 8. Approximately $43.6 million would be needed to supply and deliver recycled water to and from Encino Reservoir. Costs do not include facilities required for operational needs at the reservoir, which may be required to maintain reservoir water quality, such as treatment, aeration or mixing. Detailed costs are located in **Appendix A**.

Table 8-1: Scenario 4 and 8 Construction Costs Estimate

Item	Total Cost
Woodland Hills WRP (12- and 16-inch) [1]	$ 5,690,000
Upsizing Woodland Hills WRP (24-inch) [1]	$ 4,021,000
Seasonal Storage Extension [2]	$ 21,530,000
RWPS East	$ 1,665,000
Pump Station at Encino Reservoir	$ 1,448,000
Encino Reservoir Connection Allowance	$ 500,000
Construction Cost	**$ 34,854,000**
Contingency (25%)	$ 8,714,000
Total Construction Cost	**$ 43,568,000**

1. Does not include lateral to Alice Stelle/Freedom Park.
2. Cost includes seasonal storage pipeline from Woodland Hills WRP to Encino Reservoir, RWPS East suction pipelines and 24-inch pipeline from RWPS East to the beginning of the Woodland Hills WRP.

If maximum flows are sent to Encino Reservoir (Scenario 6), the construction costs would be higher as a 24-inch diameter would be needed from El Caballero County Club to Encino Reservoir and a larger pump would be needed at the RWPS East.

If minimum flows are sent to Encino Reservoir (Scenario 7), the construction costs would be lower since a smaller diameter pipeline from Woodland Hills Country Club to Encino Reservoir could be used. The summer PHD flows from Encino Reservoir would govern the pipeline diameter size from Encino Reservoir to Woodland Hills Country Club.

9 Conveyance to DCTWRP Evaluation

If all the remaining recycled water flow from Tapia WRP is sent to Encino Reservoir, there will be a surplus of flow in Encino Reservoir, even after Encino Reservoir supplies the summer demands to offset potable water. In order to reuse the additional volume, options to deliver the excess recycled water to Donald C. Tillman Water Reclamation Plant (DCTWRP) for reuse by LADWP were further evaluated.

Conceptual alignments and cost estimates to connect the Encino Reservoir to DCTWRP directly and indirectly, utilizing the existing sewer system, were developed. For the direct connection, one preliminary alignment with one point of connection to DCTWRP was identified. For the indirect connection, three preliminary alignments from Encino Reservoir were identified: two potential connection points on the City of Los Angeles sewer system and one connection to LADWP’s existing recycled water system.

9.1 Additional Flow from Encino Reservoir

Table 9-1 presents a summary of annual demand and supply, including LADWP demands. The summary indicates that a potential surplus of 2,360 AFY will be available once the plant is producing 11 MGD. The 2,360 AFY is the surplus recycled water that could potentially be conveyed to DCTWRP.

Table 9-1: Summary of LVMWD Recycled Water Supply and Demand

Agency	Existing Demand (AFY)	Incremental Future Demand (AFY)	Total Future Demand (AFY)	Notes
LVMWD	6,940	1,290	8,230	Existing and future demands are from the LVMWD 2014 RWMP, not including near-term and long-term LADWP demands to be served by the Woodland Hills WRP. Future demands include Alice Stelle School/Freedom Park.
LADWP (WHCC and Pierce College)	0	1,120	1,120	Includes near-term and long-term demands from the Woodland Hills WRP, except for Alice Stelle School/Freedom Park.
LADWP (Potential Customers along seasonal storage pipeline route)	0	590	590	Braemar Country Club and El Caballero Country Club, once connected to Encino Reservoir
Total	**6,940**	**3,000**	**9,940**	
Supply	10,100		12,300	
Surplus	**3,160**		**2,360**	Surplus flow available

Notes:

1. WHCC: Woodland Hills Country Club
2. AFY values were updated based on the revised demands in the Draft Woodland Hills WRP Hydraulic Evaluation and Modeling TM (November 20, 2015).

It was assumed the flows would be conveyed from Encino Reservoir to DCTWRP over six months during winter, when demands are low and Encino Reservoir is filling. Flows were assumed to be conveyed over 24-hours. Hydraulic modeling was not performed for this analysis, but it was determined that approximately a 16-inch diameter pipeline would be needed to convey flows from Encino Reservoir to DCTWRP, directly or indirectly assuming a maximum velocity of 5 feet per second at full pipe flow. If flows to DCTWRP are limited to a shorter duration, the diameter pipeline to DCTWRP may need to be increased. Depending on flows within the existing sewer mainline

Based on the elevations at Encino Reservoir (approximately 1,050 feet) and at DCTWRP (710 feet), flow from Encino Reservoir could be gravity fed to DCTWRP.

9.2 Alignments

Four potential pipeline alignments were developed based on the shortest east to west right-of-way corridors from Encino Reservoir to four connection points: DCTWRP, two sewer connections and one recycled water connection. The alignments did not consider utilities and other constructability constraints were not considered, nor environmental impacts; a detailed alignment evaluation will need to be conducted if the project moves forward.

Large sewer pipelines, 18-inch diameter or greater, near Encino Reservoir were identified as potential connection points. However, a sewer hydraulic analysis would need to be conducted to determine if capacity in those main sewer pipelines is available.

The four alignments to the connection points are described below and are summarized in **Table 9-2**.

- **Connection to DCTWRP**: This alignment would extend east from the Encino Reservoir on Adlon Road, head north on Hayenhurst Avenue and then head east on Burbank Avenue until Woodley Avenue. At Woodley Avenue, the alignment would head north and connect to DCTWRP. The alignment is approximately 4.4 miles (23,400 feet) and involves crossing Highway 101 and the Los Angeles River.
- **Connection to Sewer Point No. 1**: This alignment would extend east from the Encino Reservoir on Adlon Road and head north on Hayenhurst Avenue. At the intersection of Hayenhurst Avenue and Magnolia Boulevard, the alignment would connect to an existing 21-inch diameter sewer pipeline. This alignment is approximately 2.1 miles (11,000 feet) and does not involve crossing Highway 101 and the Los Angeles River.
- **Connection to Sewer Point No. 2:** This alignment would extend east from the Encino Reservoir on Adlon Road, head north on Hayenhurst Avenue and east on Libbi Avenue. At the intersection of Libbi Avenue and Noeline Avenue, the alignment would connect to an existing 15-inch diameter sewer pipeline. The alignment is approximately 1.5 miles (7,700 feet) and does not involve crossing Highway 101 and the Los Angeles River.
- **Connection to Existing Recycled Water System:** This alignment would extend east from the Encino Reservoir on Adlon Road, head north on Hayenhurst Avenue and then go through Balboa Golf Course to connect to the existing 30-inch diameter recycled water pipeline. The alignment is approximately 2.7 miles (14,000 feet) and involves crossing only Highway 101.

Table 9-2: Summary of Connection Alignments from Encino Reservoir

<table>
<tr><th>Connection Name</th><th>Location</th><th>Length (ft)</th><th>Considerations</th></tr>
<tr><td>DCTWRP</td><td>DCTWRP Headworks on Woodley Ave</td><td>23,400</td><td>LA River crossing
Hwy 101 crossing
Residential area</td></tr>
<tr><td>Sewer Connection 1</td><td>21” existing sewer located at the intersection of Hayenhurst Avenue and Magnolia Boulevard</td><td>10,990</td><td rowspan="2">Residential area</td></tr>
<tr><td>Sewer Connection 2</td><td>15” existing sewer located at the intersection of Libbi Avenue and Noeline Avenue</td><td>7,680</td></tr>
<tr><td>Existing RW Pipeline</td><td>30” existing RW Line located on Balboa Golf Course</td><td>14,000</td><td>Hwy 101 crossing
Residential area</td></tr>
</table>

For all four proposed connections, the alignments would pass through residential areas, near Encino Reservoir. Some roads may be privately-owned. Since Burbank Boulevard passes under Highway 101 and above the Los Angeles River, trenchless technology may not be needed for these crossing; however, further investigation would be needed.

Figure 9-1: Alignments from Encino Reservoir to DCTWRP, Sewer and Recycled Water Connection Points

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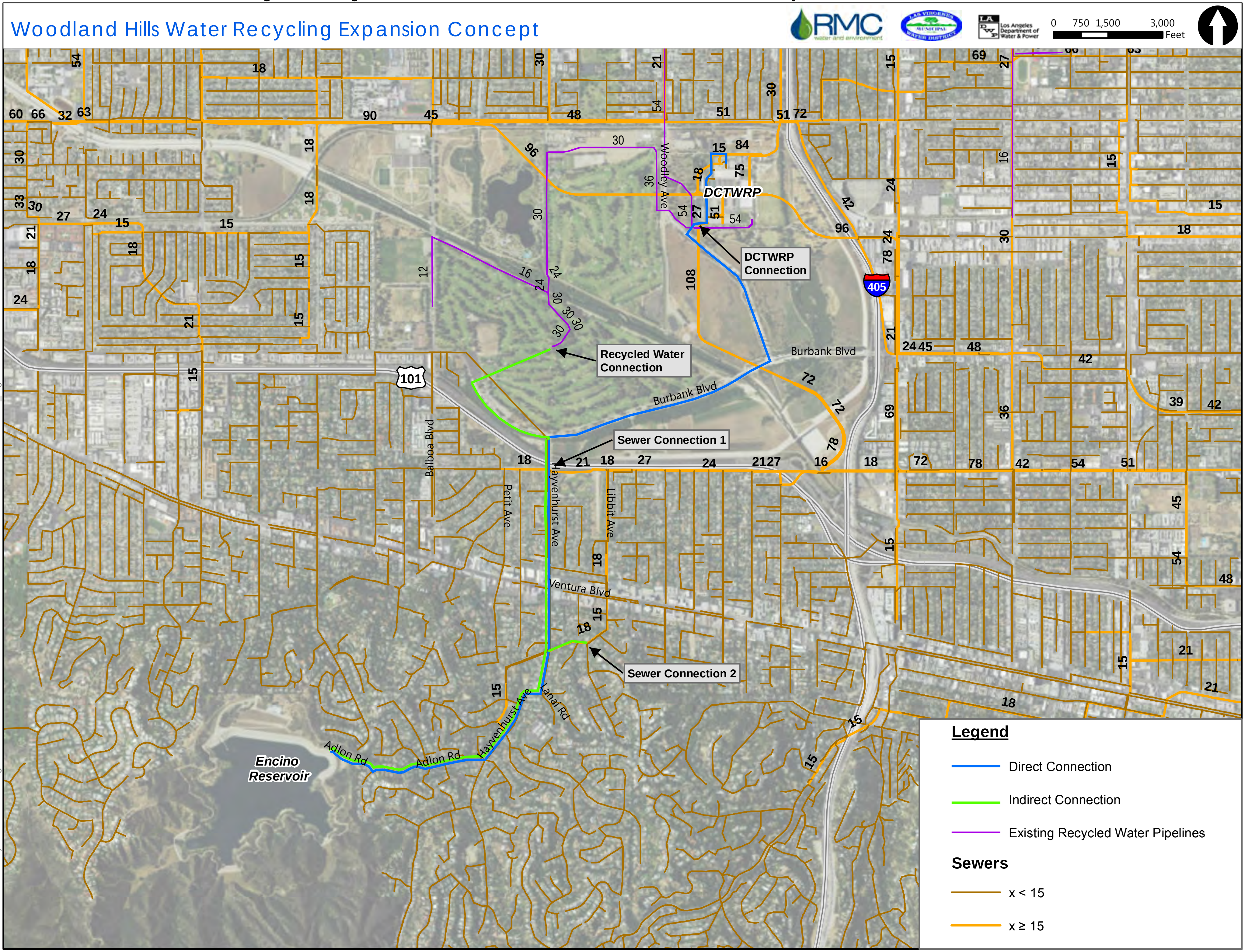

9.3 Conceptual Costs

For the four alignments, conceptual costs were developed based on the cost criteria presented in Section 8. **Table 9-3** provides estimated construction costs for each connection alternative. Pumping requirements, if a pressure connection is made to the existing recycled water system, is not included.

Table 9-3: Alternatives Comparison

Connection	Alternative			
	DCTWRP	Sewer Connection 1	Sewer Connection 2	RW Pipeline
16-inch Pipeline	$5,990,000	$2,813,000	$1,966,000	$3,584,000
Connection Facilities	$500,000	$500,000	$500,000	$500,000
Construction Cost	**$6,490,000**	**$3,313,000**	**$2,466,000**	**$4,084,000**
Contingency (25%)	$1,622,500	$828,250	$616,500	$1,021,000
Total Construction Cost	**$8,112,500**	**$4,141,250**	**$3,082,500**	**$5,105,000**

Based on the estimates, connecting to the existing sewer pipeline is potentially the lowest cost alternative. By connecting to the existing recycled water pipeline, more recycled water would be directly available to LADWP and the water would not have to be re-treated at DCTWRP. The alternative to connect directly to DCTWRP is the most expensive alternative. Further evaluation will be needed to assess the connection points and feasibility.

References

AECOM. 2011. Woodland Hills Country Club Recycled Water Service Study. January 2011.

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LVMWD. 2014. Recycled Water Master Plan Update 2014. Prepared by Kennedy/Jenks Consultants and HDR for LVMWD, Triunfo Sanitation District, and Calleguas Municipal Water District. June 2014.

RMC/CDM Smith. 2012. LADWP and City of Los Angeles Department of Public Works Non-Potable Reuse Master Planning Report. March 2012.

RMC. 2015. Draft Woodland Hills WRP Hydraulic Evaluation Technical Memorandum (November 20, 2015)

RMC. 2015. Draft Woodland Hills WRP Alignment Evaluation Technical Memorandum (October 6, 2015)

Sanks, Robert 1989. Pumping Station Design, August 1989

Appendix A – Construction Cost Estimates

Project: Woodland Hills WRP

Woodland Hills WRP (16 & 12-inch)

Estimate Type: Conceptual Construction Cost

Date:	December 2, 2015
Project No:	0254-003.08
Prepared by:	M. Propersi
Checked by:	R. Sharafi
Check Date:	December 4, 2015

Item	Quantity	Unit	Unit Cost	Total Cost
Park Granada (Parkway Calabasas to Park Capri)				
16" RW Pipeline	0	LF	$ 256	$ -
Park Granada (Park Capri to Park Sorrento)				
16" RW Pipeline	1,500	LF	$ 256	$ 384,000
Park Sorrento (Park Granada to Private Road at Motion Picture Hospital)				
16" RW Pipeline	2,000	LF	$ 256	$ 512,000
Trenchless Installation at Arroyo Calabasas				
30" Steel Casing	200	LF	$ 1,200	$ 240,000
Receiving Pit	1	LS	$ 50,000	$ 50,000
Jacking Pit	1	LS	$ 100,000	$ 100,000
Motion Picture Hospital (Park Sorrento to Mulholland Dr)				
16" RW Pipeline	800	LF	$ 256	$ 205,000
Mulholland Dr (Ag Area to Valmar Rd)				
16" RW Pipeline	1,800	LF	$ 256	$ 461,000
Trenchless Installation at Creek				
30" Steel Casing	300	LF	$ 1,200	$ 360,000
Receiving Pit	1	LS	$ 50,000	$ 50,000
Jacking Pit	1	LS	$ 100,000	$ 100,000
Mulholland Dr (Valmar Rd to Flamingo St)				
16" RW Pipeline	3,300	LF	$ 256	$ 845,000
Mulholland Dr (Flamingo St to San Feliciano Dr)				
16" RW Pipeline	1,700	LF	$ 256	$ 435,000
Mulholland Dr (San Feliciano Dr to Mulholland Hwy)				
16" RW Pipeline	800	LF	$ 256	$ 205,000
Mulholland Dr (Mulholland Hwy to East of Alizondo Dr)				
12" RW Pipeline	1,700	LF	$ 192	$ 326,000
Mulholland Dr (East of Alizondo Dr to State Hwy 27 through Mulholland Way)				
12" RW Pipeline	800	LF	$ 192	$ 154,000
State Hwy 27 (Mulholland Dr to Dumetz Rd)				
12" RW Pipeline	1,300	LF	$ 192	$ 250,000
Dumetz Rd (State Hwy 27 to Alhama Dr)				
12" RW Pipeline	3,900	LF	$ 192	$ 749,000
Dumetz Rd (Alhama Dr to Serrania Ave)				
6" RW Pipeline	1,500	LF	$ 120	$ 180,000
Wells Dr (Serrania Ave to Serrania Ave Park)				
6" RW Pipeline	700	LF	$ 120	$ 84,000
		CONSTRUCTION COST SUBTOTAL		**$ 5,690,000**
		CONTINGENCY	25%	$ 1,422,500
		TOTAL CONSTRUCTION COST		**$ 7,112,500**

RMC water and environment

Project: Woodland Hills WRP

Upsizing Woodland Hills WRP (24-inch)

Estimate Type: Conceptual Construction Cost

Date:	December 2, 2015
Project No:	0254-003.08
Prepared by:	M. Propersi
Checked by:	R. Sharafi
Check Date:	December 3, 2015

Item	Quantity	Unit	Unit Cost	Total Cost
Park Granada (Parkway Calabasas to Park Capri)				
20" RW Pipeline	1,000	LF	$ 320	$ 320,000
Park Granada (Park Capri to Park Sorrento)				
24" RW Pipeline	1,500	LF	$ 384	$ 576,000
Park Sorrento (Park Granada to Private Road at Motion Picture Hospital)				
24" RW Pipeline	2,000	LF	$ 384	$ 768,000
Trenchless Installation at Arroyo Calabasas				
36" Steel Casing	200	LF	$ 1,440	$ 288,000
Receiving Pit	1	LS	$ 50,000	$ 50,000
Jacking Pit	1	LS	$ 100,000	$ 100,000
Motion Picture Hospital (Park Sorrento to Mulholland Dr)				
24" RW Pipeline	800	LF	$ 384	$ 307,000
Mulholland Dr (Ag Area to Valmar Rd)				
24" RW Pipeline	1,800	LF	$ 384	$ 691,000
Trenchless Installation at Creek				
36" Steel Casing	300	LF	$ 1,440	$ 432,000
Receiving Pit	1	LS	$ 50,000	$ 50,000
Jacking Pit	1	LS	$ 100,000	$ 100,000
Mulholland Dr (Valmar Rd to Flamingo St)				
24" RW Pipeline	3,300	LF	$ 384	$ 1,267,000
Mulholland Dr (Flamingo St to San Feliciano Dr)				
24" RW Pipeline	1,700	LF	$ 384	$ 653,000
Mulholland Dr (San Feliciano Dr to East of Alizondo Dr)				
24" RW Pipeline	2,500	LF	$ 384	$ 960,000
Mulholland Dr (East of Alizondo Dr to State Hwy 27 through Mulholland Way)				
24" RW Pipeline	800	LF	$ 384	$ 307,000
State Hwy 27 (Mulholland Dr to Dumetz Rd)				
24" RW Pipeline	1,300	LF	$ 384	$ 499,000
Dumetz Rd (State Hwy 27 to Alhama Dr)				
24" RW Pipeline	3,900	LF	$ 384	$ 1,498,000
Dumetz Rd (Alhama Dr to Serrania Ave)				
24" RW Pipeline	1,500	LF	$ 384	$ 576,000
Wells Dr (Serrania Ave to Serrania Ave Park)				
24" RW Pipeline	700	LF	$ 384	$ 269,000
		CONSTRUCTION COST SUBTOTAL		**$ 9,711,000**
		CONTINGENCY	25%	$ 2,427,750
		TOTAL CONSTRUCTION COST		**$ 12,138,750**

RMC water and environment

Project: Woodland Hills WRP

Seasonal Storage Alignment

Estimate Type: Conceptual Construction Cost

Date:	December 1, 2015
Project No:	0254-003.08
Prepared by:	M. Propersi
Checked by:	R. Sharafi
Check Date:	December 3, 2015

Item	Quantity	Unit	Unit Cost	Total Cost
Serrania Ave Park to El Caballero CC				
24" RW Pipeline	21,900	LF	$ 384	$ 8,410,000
El Caballero CC to Encino Reservoir				
20" RW Pipeline	12,700	LF	$ 320	$ 4,064,000
RWPS East to Park Granada				
24" RW Pipeline	23,000	LF	$ 384	$ 8,832,000
RWPS East Suction Pipelines				
20" RW Pipeline	700	LF	$ 320	$ 224,000
Additional Pump at RWPS East				
2,800 gpm				$ 1,665,000
Pump at Encino Reservoir				
2,330 gpm				$ 1,448,000
Connection to Encino Reservoir Allowance				$ 500,000
		CONSTRUCTION COST SUBTOTAL		**$ 25,143,000**
		CONTINGENCY	25%	$ 6,285,750
		TOTAL CONSTRUCTION COST		**$ 31,428,750**

Appendix L –
Stakeholder Involvement

STAKEHOLDER ORGANIZATIONS

Representatives of the following organizations actively participated in the stakeholder process:

- Senator Fran Pavley's Office
- Supervisor Sheila Kuehl's Office
- Heal the Bay
- Los Angeles Waterkeeper
- National Park Service
- California State Parks
- City of Calabasas
- City of Thousand Oaks
- Malibu Creek MS4 Watershed Management Committee
- Mountains Restoration Trust
- Santa Monica Mountains Conservancy
- Resource Conservation District of the Santa Monica Mountains
- Santa Monica Mountains Fund
- Los Angeles Department of Water and Power
- Calleguas Municipal Water District
- Camrosa Water District
- Metropolitan Water District of Southern California

Workshop #1

Workshop 1 - Agenda

Time	Item
5:00- 5:30	JPA Board of Directors Meeting
5:30- 5:45	Break/ Light dinner
5:45-5:50	Introduction to Workshop, by General Manager Dave Pedersen
5:50 – 6:10	Workshop Overview, presented by Dr. Steve Weber
6:10 – 6:45	Scenario 4 and 5 Overview, presented by James Borchardt, Sarah Munger, and Oliver Slosser
6:45-7:15	Break
7:15-8:00	PESTLE, by Dr. Steve Weber and James Borchardt
8:00 – 8:15	Closing and Next Steps, presented by Dave Pedersen

Recycled Water Basis of Design Reports

…Reorientation

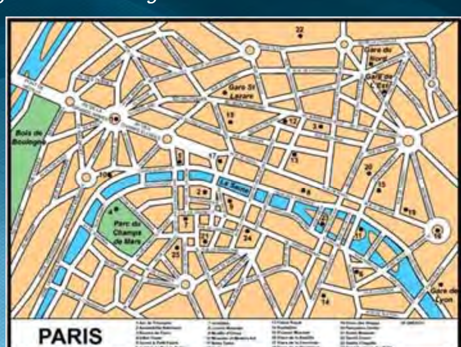
Recycled Water Basis of Design Reports

A facilitated exercise in project definition and risk evaluation

There are a wide variety of paths to choose from…

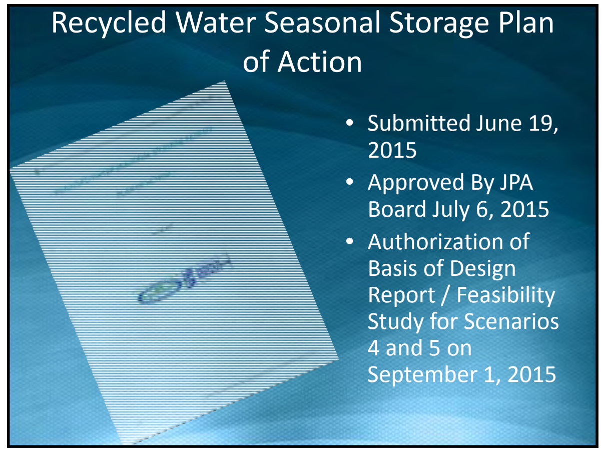
…the correct path for your project may not always be the obvious one.

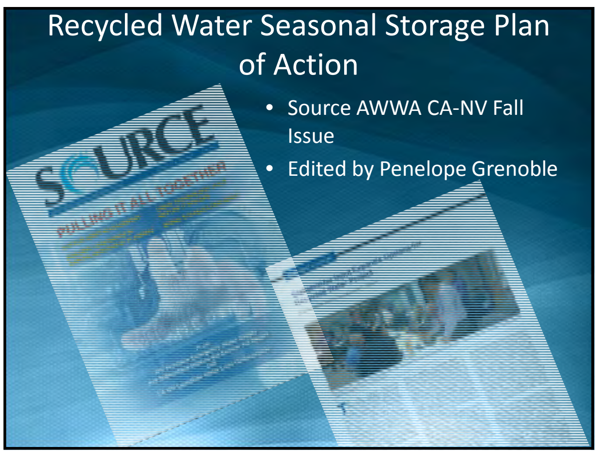
There are many ways to navigate your way through the challenges

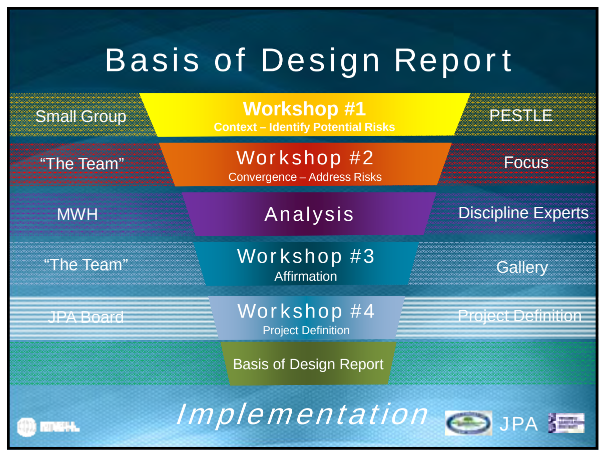


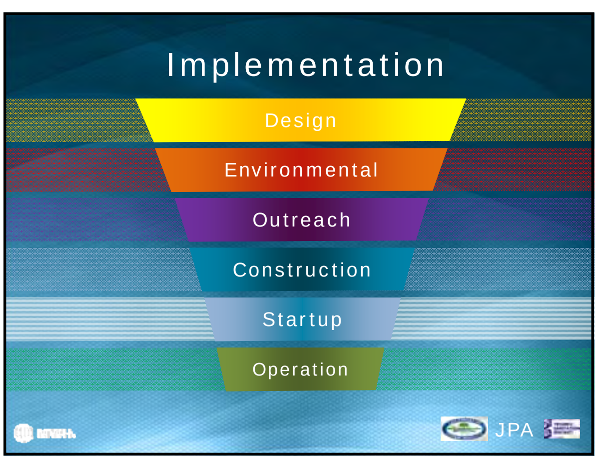
Scenario 4 and 5
A fork in the road…

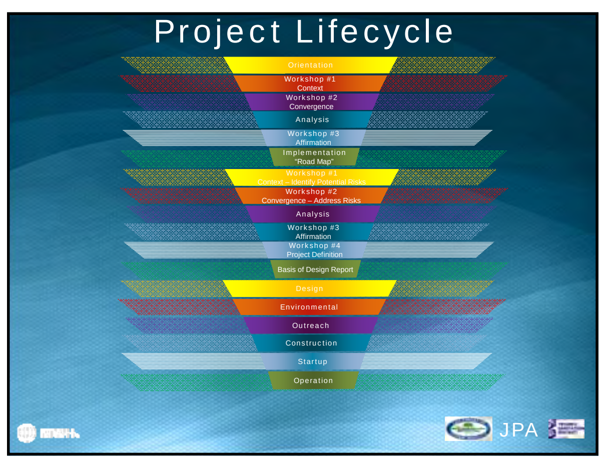

Plan of Action
Individual
Orientation
Interviews
Small Group
Workshop #1
Context
PESTLE
"The Team"
Workshop #2
Convergence
BPAT
MWH
Analysis
"The Team"
Workshop #3
Affirmation
Elements of the Roadmap
Road Map
GO TIME
JPA


Recycled Water Seasonal Storage Plan of Action
• Submitted June 19, 2015
• Approved By JPA Board July 6, 2015
• Authorization of Basis of Design Report / Feasibility Study for Scenarios 4 and 5 on September 1, 2015


Recycled Water Seasonal Storage Plan of Action
• Source AWWA CA-NV Fall Issue
• Edited by Penelope Grenoble
SOURCE
PULLING IT ALL TOGETHER

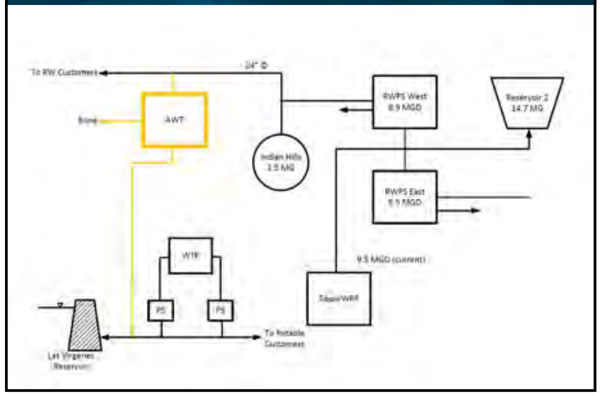

Basis of Design Report
Small Group
Workshop #1
Context – Identify Potential Risks
PESTLE
"The Team"
Workshop #2
Convergence – Address Risks
Focus
MWH
Analysis
Discipline Experts
"The Team"
Workshop #3
Affirmation
Gallery
JPA Board
Workshop #4
Project Definition
Project Definition
Basis of Design Report
Implementation
JPA


Implementation
Design
Environmental
Outreach
Construction
Startup
Operation
JPA


Project Lifecycle
Orientation
Workshop #1
Context
Workshop #2
Convergence
Analysis
Workshop #3
Affirmation
Implementation
"Road Map"
Workshop #1
Context – Identify Potential Risks
Workshop #2
Convergence – Address Risks
Analysis
Workshop #3
Affirmation
Workshop #4
Project Definition
Basis of Design Report
Design
Environmental
Outreach
Construction
Startup
Operation
JPA

SCENARIO 4 AND 5 OVERVIEW

SCENARIO 4 SCHEMATIC

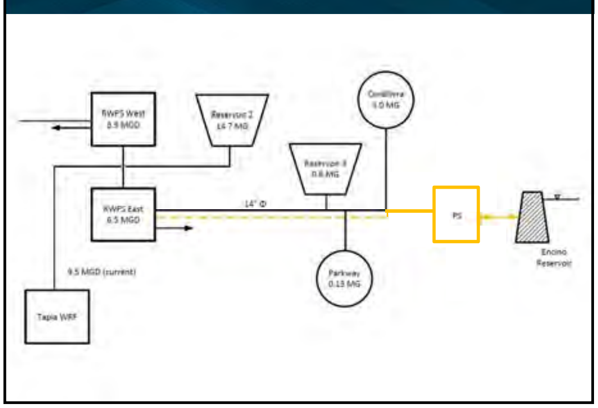


SCENARIO 4

SCENARIO 4 - SUMMARY

- Supported by existing facilities
- Potential sites for treatment plant
- New pipelines in congested areas
- Inter-agency Meetings:
  - Division of Safety of Dams (DSOD)
  - Division of Drinking Water (DDW)
  - Calleguas MWD
  - City of Thousand Oaks
  - RWQCB

SCENARIO 5 SCHEMATIC

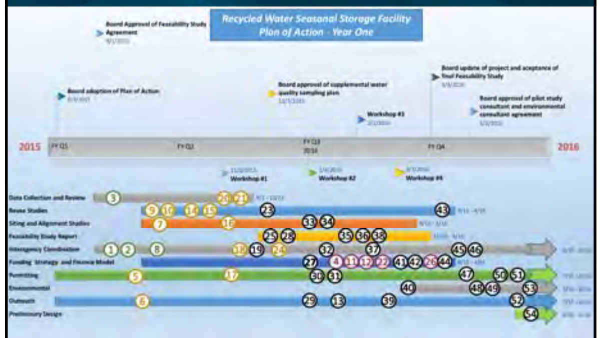


SCENARIO 5

SCENARIO 5 - SUMMARY

- Existing facilities may require expansion
- Potential sites for pumping station
- New pipelines in congested areas
- Interagency Meetings:
  - Division of Safety of Dams (DSOD)
  - Division of Drinking Water (DDW)
  - Los Angeles DWP
  - RWQCB

UPDATED PROJECT TIMELINE



ACTIVITY SHEET COMPLETED

Item	Action
	Fiscal Quarter 1, FY 2015-2016
B1	**Board adoption of the Plan of Action**
1	Initiate exploratory meetings with Metropolitan
2	Initiate exploratory meetings with LADWP
3	Negotiate agreement for Basis of Design Report (BODR)
B2	**Board approval of BODR agreement**
8	Initiate exploratory meetings with Division of Drinking Water (DDW)

ACTIVITY SHEET IN PROGRESS (PT. 1)

Item	Action
	Fiscal Quarter 1, FY 2015-2016
5	On-going negotiation with RWQCB for TWRF discharge permit
6	Prepare draft engagement plan for Stakeholders
7	Initiate pipeline alignment and hydraulic studies
9	Initiate RW operational storage study at Las Virgenes Reservoir
10	Initiate RW operational storage study at Encino Reservoir

IN PROGRESS (PT. 2)

Item	Action
	Fiscal Quarter 2, FY 2015-2016
14	Prepare summary of water quality data and supplemental sampling plan
15	Prepare supply and demand summary for facility sizing
16	Identify potential sites for new pump stations, tanks, and/or treatment facilities
17	On-going negotiation with RWQCB for TWRF discharge permit, including reservoirs
18	Initiate discussions with Calleguas MWD on use of brine line and RW supply
20	Conduct literature search of operational issues for recycled water storage facilities
21	Review source water control plans and identify issues in the collection system
24	On-going meetings with LADWP

ACTIVITY SHEET PENDING

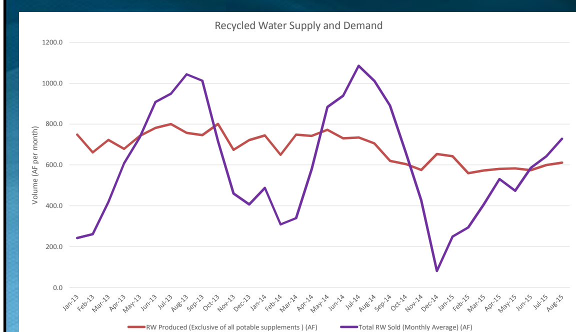
Item	Action
	Fiscal Quarter 1, FY 2015-2016
4	Prepare RFP for selection of funding consultant
11	Identify modifications to Integrated Regional Water Management Plan (IRWMP)
12	Select and negotiate agreement with funding consultant
13	Prepare draft public outreach program for project, including NGO engagement
	Fiscal Quarter 2, FY 2015-2016
B3	**Board update of project, and approval of funding consultant agreement**
22	Prepare Prop 1 funding strategies and schedules for Chapters 5, 6, 7, 8, and 9
26	Prepare preliminary project descriptions for coordination with funding efforts

UPDATED PROJECT TIMELINE

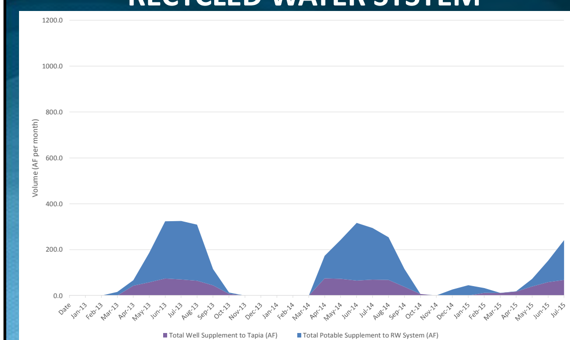
DATA COLLECTION ACTIVITY TABLE

Source	Item
CMWD	Calleguas Municipal Water District record drawings and Hydraulic Model for brine line configurations
LADWP	LADWP piping system drawings in the vicinity of and connecting to Encino Reservoir
	Inflow and Outflow of Encino Reservoir
	Estimated Seepage for Encino Reservoir
	Area-storage-Elevation data for Encino Reservoir
	Reservoir bathymetry for Encino Reservoir
	Treatment Plant Schematics
	Dam Performance Data -Latest DOSD Evaluation
LVMWD	GIS Files for JPA Potable Water, Recycled Water and Wastewater Collection Systems
	Hydraulic Models for JPA Potable Water, Recycled Water and Wastewater Collection Systems
	Recycled Water Quality Records
	Key water quality parameters for Las Virgenes Reservoir
	Inflow and Outflow of Las Virgenes Reservoir
	Estimated Seepage and Evaporation for Las Virgenes Reservoir
	Evaporation Losses for Las Virgenes Reservoir
	Vertical Profile data for Las Virgenes Reservoir
	Area-storage-Elevation data for Las Virgenes Reservoir
	Dam Facilities on Las Virgenes Reservoir
	Source Control Program for the sewer collection system
	Potable Supplement
	Well Operation
	RMC Technical Memorandum - Woodland Hills Water Recycling Expansion Concept – Concept Development

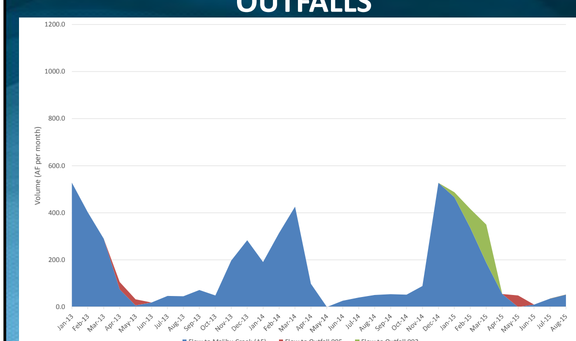
RECYCLED WATER SUPPLY AND DEMAND

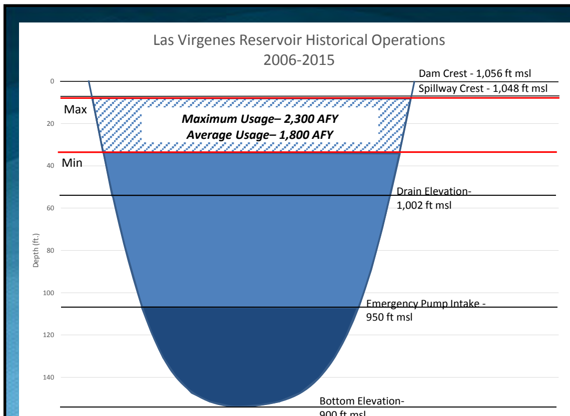


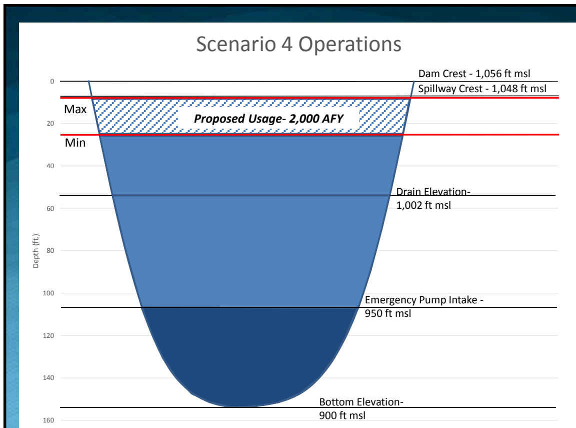
POTABLE SUPPLEMENT TO RECYCLED WATER SYSTEM

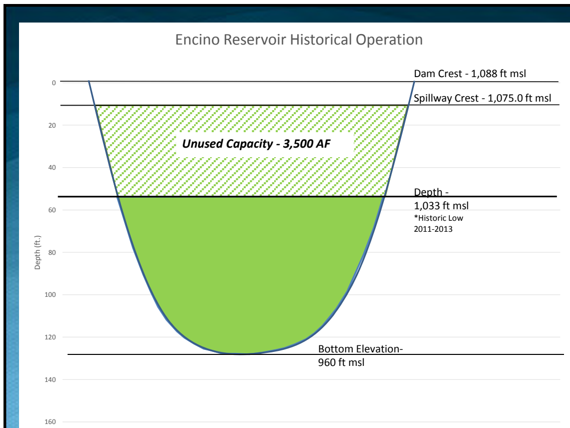


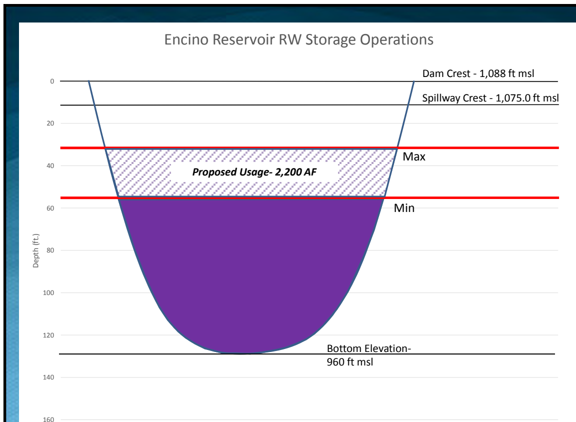
RECYCLED WATER DISCHARGE TO OUTFALLS











WTP effluent water quality summary

	Average	Max
Ammonia (mg/L as N)	0.1	0.4
BOD (mg/L)	0.1	4.6
Nitrate + Nitrite (mg/L as N)	6.6	9.9
Phosphates (mg/L as P)	2.3	3.4
Sulfate (mg/L)	192	281
TSS (mg/L)	1.7	9.9
TDS (mg/L)	750	912

Good water quality due to source control program and effective WWTP performance

Potential Impacts on Encino Reservoir

- Algae bloom in reservoir due to phosphate and nitrogen in Title 22 water:
  - May need additional treatment processes at the reservoir effluent for Algae (filtration)
  - May need mixing and additional aeration in reservoir
- In addition, screening may be required for debris.

Impacts on Las Virgenes Reservoir

- May need supplemental mixing in reservoir to ensure uniform water quality
- Advanced Treatment Plant:
  - TDS is relatively low, and power costs for membranes will be less than typical membrane plant
  - Phosphate levels will require slightly higher doses of antiscalant and acid to prevent scaling
  - Nitrogen is low, so no need for additional N-removal system

BREAK

PESTLE EXERCISE

LVMWD – Truinfo JPA
Workshop
November 2, 2015

MWH has completed data collection, and is developing preliminary design concepts for both of the two scenarios that were selected during the previous JPA Workshops in an effort to complete a Basis of Design.

A key activity is to fully understand the associated elements of risk.

LVMWD – Truinfo JPA
Workshop
November 2, 2015

Exercise Questions:

1. What are the elements of risk associated with Scenario 4?

2. What are the elements of risk associated with Scenario 5?

The outcome of this exercise will be used to ensure that the study will prepare a mitigation strategy for all the identified risks associated with each scenario.

Political
Economic
Social
Technical
Legal
Environmental

PESTLE EXERCISE

NEXT STEPS:

Tentative Schedule

Workshop	Date
Workshop #2	January 2016
Workshop #3	February
Workshop #4	March

Questions / Comments / Adjourn

SIGN-IN

WORKSHOP
PLAN OF ACTION FOR SEASONAL STORAGE OF RECYCLED WATER
NOVEMBER 2, 2015 AT 5:30 PM

Printed Name Below:	*Sign-In Below:*
Bellomo, Joe	
Chisum, John	
De La Cruz, Calvin	
Grenoble, Penelope	
Kampalath, Rita	
Mokhtari, Ray	attended
Russell, Dusty	
Sharpton, Debbie	
Spurgin, Jay	
Stevens, Clark	
Tsunehara, Yoshiko	
Washburn, Dennis	Dennis S Washburn
Caspary, Charlie	
Lewitt, Jay	
Peterson, Glen	
Polan, Len	
Renger, Lee	Lee Renger
Iceland, Steve	

SIGN-IN

WORKSHOP
PLAN OF ACTION FOR SEASONAL STORAGE OF RECYCLED WATER
NOVEMBER 2, 2015 AT 5:30 PM

Printed Name Below:	*Sign-In Below:*
McReynolds, Mike	Mike McReynolds
Orkney, Janna	[signature]
Paule, Mike	[signature]
Wall, James	[signature]
Pedersen, Dave	[signature]
Lemieux, Wayne	[signature]
Lemieux, Keith	[signature]
Patterson, Don	attended
Lippman, David	[signature]
Reyes, Carlos	attended
Guzman, Josie	attended
Miller, Larry	[signature]
Zhao, John	[signature]
Bigilen, Stephen	[signature]
Norris, Mark	[signature]
Mathews, John	[signature]
Weber, Steve	[signature]

Jim Borchardt	
Oliver Slosser	
Jeff Reinhardt	
Brett Dingman	
Areeba Syed	
Sarah Manger	
Ray Mokhtari	

Row Labels	Count of Risk Category
AGENCY COORD	17
AWTP COST	2
BRINE	7
CEQA	7
CUSTOMER	1
DEMAND	11
DROUGHT	3
DW STANDARDS	8
EARTHQUAKE	2
ELECTIONS	2
HABITAT	2
IDLE FACILITIES	2
LAND COST	4
LIABILITY	1
NIMBY	26
OPERATIONS	4
PARTNERS	1
POLITICS	6
POWER	4
PROJECT COST	12
REGULATORY	2
SYSTEM COST	1
TECHNOLOGY	4
WASTE OF MONEY	1
WATER QUALITY	10
WATER RIGHTS	5
YUCK	8
ROW/LAND	6
Grand Total	**159**

Row Labels	CAP COST	ENGINEERING	LEGAL	OP COST	OUTREACH	POLITICAL	REGULATORY	Grand Total
Environmental		9		1	3		7	20
Financial	17	5	1	7				30
Legal		1	3		4		9	17
Political	1		4		17	9	4	35
Social	1	6	2		17	1	1	28
Technical		26			2	1		29
Grand Total	**19**	**47**	**10**	**8**	**43**	**11**	**21**	**159**

Row Labels	Sum of Count of Risk Category
FINANCE	20
GM'S	14
MWH	58
OUTREACH	37
PROJECT MANAGER	29
Grand Total	**158**

Number	Risk Category	Risk Description *(opportunity or threat)*	IMPLEMENTATION GROUP (Step One)	IMPLEMENTATION GROUP (Step Two)	Mitigation Strategy	Tactic
1	Environmental	Negative Impact to LV Reservoir Water Quality	ENGINEERING	WATER QUALITY	Regulation, operation methods, monitoring program	
2	Environmental	Contamination of Westlake Res. If RO fails	ENGINEERING	WATER QUALITY	Regulation, operation methods, monitoring program	
3	Environmental	Plant EIR?	REGULATORY	CEQA	Will have to be conducted	Hire environmental sub
4	Environmental	Who wants ATP by them?	OUTREACH	NIMBY	Public outreach, architectural design of plant	Hire outreach firm & architectural firm
5	Environmental	brine discharge, ocean discharge requirements get more stringent	REGULATORY	BRINE	Public outreach, public policy advisor	Hire public policy advisor & outreach firm
6	Environmental	Chemical trucks to Treatment plant (ATP) in neighborhood	OUTREACH	NIMBY	Proximity to freeway, Health & Safety plan, public outreach	Draft Health & Safety plan, siting study
7	Environmental	loss of water to M. Creek	REGULATORY	HABITAT	Coordination with regulatory bodies & operational flexibility	Retaining outfall to Malibu Creek
8	Environmental	comparative annual power requiremnts and GHG impacts	OP COST	POWER	Will be done	Compare annual power requirements & GHG impacts
9	Environmental	Environmental Regulations	REGULATORY	CEQA		0
10	Environmental	Ongoing drought reduces inflow volume available	ENGINEERING	DROUGHT	Sewer mining for sufficient flows, possible regional partnerships	Future flow projection for supply & demand
11	Environmental	Dealing with SMMC, NPS, California DPR, Park Agencies	REGULATORY	AGENCY COORD	Continue stakeholder outreach	Continue workshop schedule
12	Environmental	Regulations	REGULATORY	CEQA		0
13	Environmental	Drought	ENGINEERING	DROUGHT		
14	Environmental	Drop in demand of reclaimed water	ENGINEERING	DROUGHT		
15	Environmental	Algae	ENGINEERING	WATER QUALITY		
16	Environmental	Water quality in Reservoir due to imported water quality/Algae	ENGINEERING	WATER QUALITY		
17	Environmental	One user only (IPR)	ENGINEERING	DEMAND		
18	Environmental	Reservoir Encino sensitivity social and environmental	OUTREACH	NIMBY	Public outreach & EIR	Water quality analysis, public outreach consultant
19	Environmental	Habitat Changes	REGULATORY	HABITAT	Conduct EIR	
20	Environmental	Seismic risk for Encino Reservoir	ENGINEERING	EARTHQUAKE	Coordination with DSOD & LADWP	possible re-intiation of seismic study for Encino Dam, continue inter-agency coordination
21	Legal	Lake Lindero HOA sues to stop ATP	OUTREACH	NIMBY	Multiple site selection, public outreach	
22	Legal	Will regs allow for IPR?	REGULATORY	DW STANDARDS	Continue conversations with DDW	Continue conversations with DDW
23	Legal	SWRCB does not pass IPR regs	REGULATORY	DW STANDARDS	Continue conversations with DDW	Continue conversations with DDW, hire public policy advisor
24	Legal	future surface water treatment rule changes	REGULATORY	DW STANDARDS	Continue conversations with DDW	Continue conversations with DDW, hire public policy advisor
25	Legal	permitting	REGULATORY	CEQA	Continue conversations with DDW	Continue conversations with DDW
26	Legal	DPR regs develop	REGULATORY	DW STANDARDS	Site Selection, plant design	
27	Legal	Regulations	REGULATORY	CEQA		
28	Legal	Need blend water	ENGINEERING	WATER QUALITY		

29	Legal	Ownership of water	LEGAL	WATER RIGHTS	Legal review of water rights	Will address water ownership for scenario 4 & 5 BODR
30	Legal	Contract approvals by other agencies	LEGAL	AGENCY COORD	Continue inter-agency coordination & legal council	Engage legal council
31	Legal	Legal challenge by Nimby folks	OUTREACH	NIMBY	Public outreach, siting selection, forming of legal strategy	Public outreach consultant, engage in legal council
32	Legal	Regulation requirements moving target	REGULATORY	DW STANDARDS		
33	Legal	EIR	REGULATORY	CEQA		
34	Legal	Changes in IPR regulations	REGULATORY	DW STANDARDS		
35	Legal	Challenge from citizens	OUTREACH	NIMBY		
36	Legal	What Liablity does district have for Encino water quality	LEGAL	LIABILITY	Thorough legal review & water rights review	Engage legal for contract formation
37	Legal	Encino HOA sues to stop project	OUTREACH	NIMBY		
38	Financial	Treatment Facility not being used	ENGINEERING	IDLE FACILITIES	Regional partnerships	Engage Thousand Oaks & City of Simi Valley, continue inter-agency coordination
39	Financial	Stranded AWTP with the summer	ENGINEERING	IDLE FACILITIES		
40	Financial	Cost of AWTP	CAP COST	AWTP COST	Cost analysis & projections for future imported water costs, grants & possible funding sources	Cost analysis & projections for future imported water costs, hire funding consultants
41	Financial	Ability to pay for	CAP COST	PROJECT COST		
42	Financial	Property Acquisition	CAP COST	LAND COST	Multiple site selection, identify public owned parcels	Multiple site selection, identify public owned parcels
43	Financial	brine disposal and cost	ENGINEERING	BRINE	Continue Regional partnerships, identify other options for brine disposal	Continue Regional partnerships, identify other options for brine disposal
44	Financial	Rising power costs	OP COST	POWER	Cost analysis & opportunities for energy recovery	Cost analysis & opportunities for energy recovery
45	Financial	Operation challenges with 7mo/yr unused ATP	OP COST	OPERATIONS		
46	Financial	Cost of location of plant	CAP COST	LAND COST		
47	Financial	Land cost/availablitiy	CAP COST	LAND COST		
48	Financial	Cost of Plant and pipes to LV/JPA	CAP COST	AWTP COST	Identify multiple alignments with cost analysis	Identify multiple alignments with cost analysis
49	Financial	Cannot reach agreemnt with TO for brine	ENGINEERING	BRINE	Identify treatment technologies for brine disposal and associated costs, engage regional partners	Identify treatment technologies for brine disposal and associated costs, engage regional partners
50	Financial	Pumping costs	OP COST	OPERATIONS	Identifying multiple alignments with cost analysis	Identifying multiple alignments with cost analysis
51	Financial	Project Funding uncertainty	CAP COST	PROJECT COST		
52	Financial	Ongoing operating cost	OP COST	OPERATIONS		
53	Financial	Too much time on our infrastructure	CAP COST	SYSTEM COST		
54	Financial	Obtaining financing for either project	CAP COST	PROJECT COST		
55	Financial	Time value of Money Resistance costs	CAP COST	PROJECT COST		
56	Financial	Develop budgets for both ASAP - ala "blink" 85% solution	CAP COST	PROJECT COST		
57	Financial	Reduce need for imported water	ENGINEERING	DEMAND		
58	Financial	Need to negotiate both 4&5 so that project is not held over a board	LEGAL	AGENCY COORD		

59	Financial	Impact(s) to average water and sewer bills	OP COST	CUSTOMER		
60	Financial	Initial Cost/funding source	CAP COST	PROJECT COST		
61	Financial	Cost of distribution system (pipeline)	OP COST	OPERATIONS		
62	Financial	O&M Cost control on facilities not owned by District	OP COST	AGENCY COORD	Continue regional partnership & contract negotiation	Continue regional partnership & contract negotiation
63	Financial	Construction costs and mitigation	CAP COST	PROJECT COST		
64	Financial	Cost to Build	CAP COST	PROJECT COST		
65	Financial	Possible much lower cost to build and operate	CAP COST	PROJECT COST	Cost analysis	Cost analysis
66	Financial	No brine line	CAP COST	PROJECT COST		
67	Financial	Does this qualify for Prop 1 money?	CAP COST	PROJECT COST		
68	Political	Drinking Water Standards?	REGULATORY	DW STANDARDS		
69	Political	Treatment facility location	OUTREACH	NIMBY	Multiple site selection, identify public owned parcels	Multiple site selection, identify public owned parcels
70	Political	Siting of ATP big deal	OUTREACH	NIMBY		
71	Political	Lack of political support	OUTREACH	AGENCY COORD	Engage in public outreach & policy advisor, identify political champion	Engage in public outreach & policy advisor, identify political champion
72	Political	Land acquisitions issues associated with 5mgd tank, land use, city of Westlake waiting to give that land for that use	CAP COST	LAND COST		
73	Political	Institutional Agreements (inter-agency)	LEGAL	AGENCY COORD		
74	Political	Three Springs concerns	OUTREACH	NIMBY		
75	Political	Community support	OUTREACH	AGENCY COORD		
76	Political	What if an impacted city objects to project?	OUTREACH	AGENCY COORD		
77	Political	Opposition to pipeline construction	OUTREACH	NIMBY		
78	Political	Timing of getting all the impacted agencies buy-in	OUTREACH	AGENCY COORD	Continue inter-agency coordination, project management & engage contract formation	Continue inter-agency coordination, project management & engage contract formation
79	Political	Changes at EPA 2016-2017	REGULATORY	DW STANDARDS		
80	Political	Change in political leadership	POLITICAL	ELECTIONS	Board action	
81	Political	Public support impacted by wet winter or cost	OUTREACH	DEMAND		
82	Political	Board resolve	POLITICAL	POLITICS		
83	Political	Public perception (operating only a few months per year)	OUTREACH	WASTE OF MONEY		
84	Political	Interagency agreement challenges	LEGAL	AGENCY COORD		
85	Political	Lengthy permitting Process for new facilities	REGULATORY	CEQA	Draft permit timeline & engage DDW early in process	Draft permit timeline & engage DDW early in process
86	Political	Changing political landscape (federal and local)	POLITICAL	ELECTIONS		
87	Political	New Partners	OUTREACH	PARTNERS		
88	Political	Dealing with City Councilmen	POLITICAL	POLITICS		
89	Political	LA City Council not logical but are emotional	POLITICAL	AGENCY COORD		
90	Political	Community concerns (NIMBY)	OUTREACH	NIMBY		
91	Political	DWP red tape	REGULATORY	AGENCY COORD	Continue LADWP coordination	Continue LADWP coordination
92	Political	Pipeline route through expensive neighborhoods	OUTREACH	NIMBY		
93	Political	DWP is so big will we be in bad position in future	POLITICAL	POLITICS		
94	Political	Residents resistance to recycled water in reservoir	OUTREACH	NIMBY		
95	Political	Maybe community opposition (on way to reservoir)	OUTREACH	NIMBY		
96	Political	Pipeline alignments through neighborhoods	OUTREACH	NIMBY		
97	Political	Long term loss of water	LEGAL	WATER RIGHTS		
98	Political	Loss of control over R.W.	LEGAL	WATER RIGHTS		

99	Political	LADWP aligned interest of commitment	OUTREACH	AGENCY COORD		
100	Political	Multiple cities involved	POLITICAL	AGENCY COORD		
101	Political	What chances can we deal on equal footing with LADWP	POLITICAL	POLITICS		
102	Political	Change of mind of LADWP	POLITICAL	POLITICS		
103	Technical	Brine (20 miles of brine line, disposal)	ENGINEERING	BRINE		
104	Technical	Not enough storage for RW to operate and use for ATP	ENGINEERING	DEMAND	Modeling of reservoir, analysis of supply/demandd, review developing IPR regulations, discussions with DDW	Modeling of reservoir, analysis of supply/demandd, review developing IPR regulations, discussions with DDW
105	Technical	RO technology is improving, early use loses potential efficiency	ENGINEERING	TECHNOLOGY	Proper sizing of facilities, review of current treatment technologies	Proper sizing of facilities, review of current treatment technologies
106	Technical	Interagency coordination	OUTREACH	AGENCY COORD		
107	Technical	Advanced treatment able to meet future demand	ENGINEERING	TECHNOLOGY	Analysis of future demands & detailed projections - supply is currently greater than demand	Analysis of future demands & detailed projections
108	Technical	Current Westlake treatment limits for RW	ENGINEERING	WATER QUALITY		
109	Technical	Might better techology be available in 5-10 years	ENGINEERING	TECHNOLOGY	Purchasing schedule	
110	Technical	7 miles and mountain for brine dischage if Thousand Oaks sewers cannot handle brine	ENGINEERING	BRINE	Identify alternatives for brine disposal	Identify alternatives for brine disposal
111	Technical	If plant breaks down can we stay out of creek	ENGINEERING	REGULATORY	Assess seasonality of plant operations (plant would be run in winter, when there is less restrictions on Creek discharge), negotiations with RWQCB for regulations on emergency discharges to Malibu Creek	Assess seasonality of plant operations (plant would be run in winter, when there is less restrictions on Creek discharge), negotiations with RWQCB for regulations on emergency discharges to Malibu Creek
112	Technical	AWTF water too "pure" (may need chemical treatment)	ENGINEERING	WATER QUALITY	Water quality plan for treated water and monitoring plan for LV Reservoir	Water quality plan for treated water and monitoring plan for LV Reservoir
113	Technical	SMP construction may be delayed	ENGINEERING	BRINE	Continue conversations with Calleguas MWD	Continue conversations with Calleguas MWD
114	Technical	Get Malibu Broad Beach to get their $31 million in sand from Rindge	POLITICAL	AGENCY COORD	Unsure of application to scenarios	
115	Technical	Clean and discharge our treated water to MC Watershed	ENGINEERING	REGULATORY	(This is scenario 1 TMDL compliance, high cost, low benefit, already considered by board)	
116	Technical	If drought continues, can we stay out of creek if golf courses and medians don't get water	ENGINEERING	DEMAND	Scenario 4 - demand could be made up in potable system; Scenario 5 - identify additional demand in LADWP service area	
117	Technical	Will we be continually chasing demand to dispose of water	ENGINEERING	DEMAND	Scenario 4 - potable demand always exceeds RW supply; Scenario 5 - large amount of users in LADWP region & possibility for future IPR	
118	Technical	Available use of water in Ventura County stored in Encino Reservoir	ENGINEERING	DEMAND		
119	Technical	Insufficient demand to cycle Encino	ENGINEERING	DEMAND	Identify new demands	
120	Technical	Raw short of RW demand	ENGINEERING	DEMAND	Supplement with potable water would be needed if demand exceeds possible supply (current situation)	
121	Technical	Water quality issues in Encino Res	ENGINEERING	WATER QUALITY		

122	Technical	Where send extra RW from Encino Res?	ENGINEERING	DEMAND		
123	Technical	Pipe Alignment issues (easements, crossings, etc.)	ENGINEERING	ROW/LAND		
124	Technical	Tertiary water quality management	ENGINEERING	WATER QUALITY		
125	Technical	Traffic disruption	OUTREACH	NIMBY	Traffic Plan will be included for any construction	
126	Technical	Rate the degree of difficulty (1-10 scale)	ENGINEERING	TECHNOLOGY		
127	Technical	Encino dam seismic study	ENGINEERING	EARTHQUAKE		
128	Technical	WQ (algae) problem at Encino	ENGINEERING	WATER QUALITY		
129	Technical	Pipeline extension	ENGINEERING	ROW/LAND		
130	Technical	LADWP's Encino OPS	ENGINEERING	ROW/LAND	Will work with LADWP to develop operations plan	
131	Social	Interagency Agreements	REGULATORY	AGENCY COORD	Continue inter-agency coordination & legal council	Continue inter-agency coordination
132	Social	Brine line alignment too many fatal flaws	ENGINEERING	BRINE		
133	Social	Dodge the bullet for a few more years by using Rindge Reservoir	ENGINEERING	DEMAND		
134	Social	Identifying AWT site/Neighborhood impacts	OUTREACH	NIMBY		
135	Social	NIMBY	OUTREACH	NIMBY		
136	Social	Construction through residential neighborhood	OUTREACH	NIMBY		
137	Social	Overhead power lines to AWT plant	OUTREACH	NIMBY		
138	Social	How to allay neighbors fears of a "Sewer Plant" near their homes	OUTREACH	NIMBY		
139	Social	Homeowners Resistance	OUTREACH	NIMBY		
140	Social	Public acceptance of construction activity	OUTREACH	NIMBY	Public outreach & notification of construction schedules, possible town hall meetings, construction plan	
141	Social	Need to keep public involved and supportive	OUTREACH	NIMBY		
142	Social	Alignment resistance	OUTREACH	NIMBY		
143	Social	Brine line to T.O. residents reject	POLITICAL	POLITICS	Alternative disposal of brine	
144	Social	Power for brine line pump station	ENGINEERING	POWER	Identify power needs early & possibility of high output overhead lines	
145	Social	Power for brine line pump station	ENGINEERING	POWER	Identify power needs early & possibility of high output overhead lines	
146	Social	Cost	CAP COST	PROJECT COST	Public outreach & explanation to rate payers of long term savings	
147	Social	Siting membrane facility in WLV	ENGINEERING	ROW/LAND		
148	Social	Where to place treatment plant (algae)	ENGINEERING	ROW/LAND		
149	Technical	Pipes in high traffic areas	ENGINEERING	ROW/LAND	Develop alternative alignment	
150	Social	What is a favorable water exchange with City of LA	LEGAL	WATER RIGHTS	Address during contract negotiations	
151	Social	Loss of resource (LV water)	LEGAL	WATER RIGHTS	Contract negotiation	
152	Social	Acceptace of IPR	OUTREACH	YUCK	Public outreach & education, community leader involvement and stakeholder involvement	
153	Social	Public concern over "Toilet to Tap"	OUTREACH	YUCK		
154	Social	Yuck factor	OUTREACH	YUCK		
155	Social	Public perception/acceptance	OUTREACH	YUCK		
156	Social	Public acceptance of drinking RW	OUTREACH	YUCK	Public outreach	

157	Social	Outreach for IPR use in Las Virgenes Res	OUTREACH	YUCK		
158	Social	Ignorance	OUTREACH	YUCK		
159	Social	residents not wanting recycled water reservoir	OUTREACH	YUCK		

Workshop #2

Recycled Water Basis of Design Reports

January 2016 Workshop

Recycled Water Basis of Design Reports

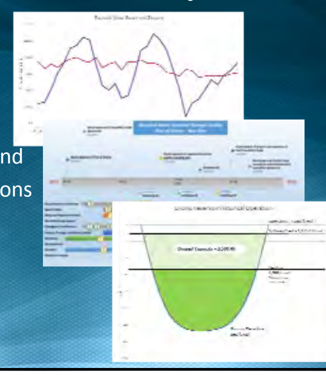
...Scenario Details

January Workshop - Agenda

Time	Item
5:30 – 5:35	Introduction to Workshop, by General Manager Dave Pedersen
5:35 – 5:40	Workshop Agenda, presented by Dr. Steve Weber
5:40 – 5:50	Recap of December Workshop and Discussion of Risks, presented by Steve Weber
5:50 – 6:15	Exercise #1 - Teamwork
6:15 – 6:30	Break/ Light dinner
6:30 – 7:30	Presentation on Scenario 4 and 5 Details, presented by Dr. Steve Weber, James Borchardt, and Oliver Slosser
7:30 – 7:40	Break
7:40 – 8:10	Exercise #2 - Criteria
8:10 – 8:15	Closing and Next Steps, presented by Dave Pedersen

December Workshop

- Project Timeline
- Scenario 4 and 5
  - Overview
  - Supply and Demand
  - Reservoir Operations
  - Water Quality
- PESTLE Exercise
  - Risks



Risk Review

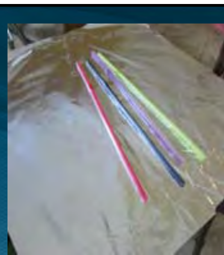
- 159 Risks Identified (PESTLE)
- Each Risk was Categorized and Given an Implementation Group
- Mitigation Strategies Identified for all
- Assigned an Owner

PESTLE Category	Grand Total
Political	35
Economic	30
Social	28
Technical	29
Legal	17
Environmental	20
Grand Total	159

Risk Summary

Category	Risks
NIMBY	26
AGENCY COORD	17
PROJECT COST	12
DEMAND	11
WATER QUALITY	10
DW STANDARDS	8
YUCK	8
BRINE	7
CEQA	7
POLITICS	6
ROW/LAND	6
WATER RIGHTS	5
LAND COST	4
OPERATIONS	4
POWER	4
TECHNOLOGY	4
DROUGHT	3
AWTP COST	2
EARTHQUAKE	2
ELECTIONS	2
HABITAT	2
IDLE FACILITIES	2
REGULATORY	2
CUSTOMER	1
LIABILITY	1
PARTNERS	1
SYSTEM COST	1
WASTE OF MONEY	1
Grand Total	159

Owner	Risks
FINANCE	20
GM/JPA BOARD	14
MWH	58
OUTREACH	37
FACILITY DIRECTOR	30
GRAND TOTAL	**159**



EXERCISE #1

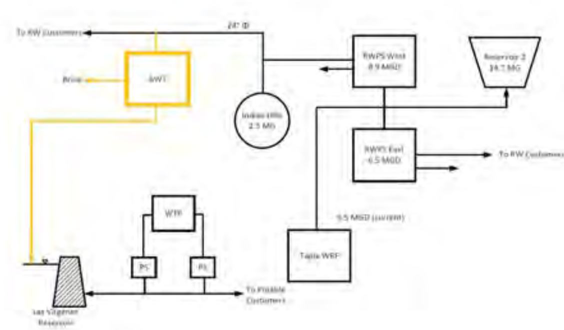
- Team 1 – 59
- Team 2 – 84
- Team 3 – 119
- Team 4 – 65
- Team 5 – DQ

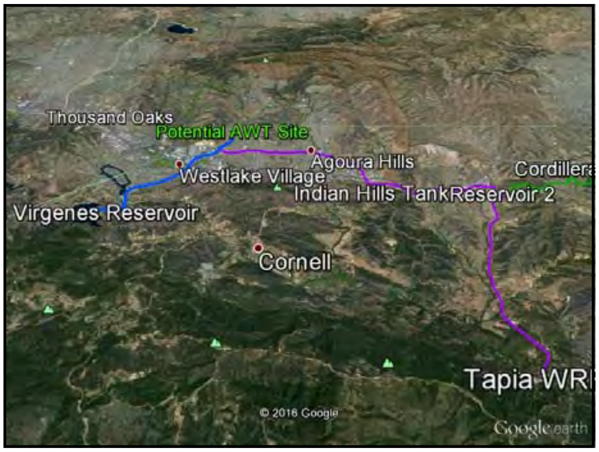
BREAK/ LIGHT DINNER

SCENARIO 4 – INDIRECT POTABLE REUSE USING LAS VIRGENES RESERVOIR

SCENARIO 4

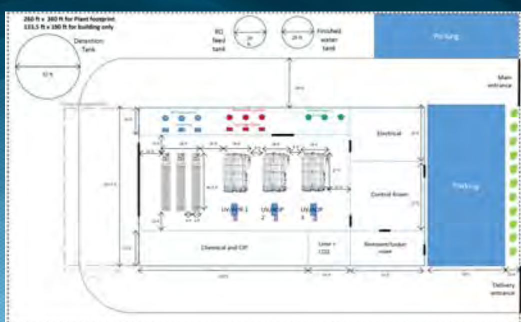
SCENARIO 4 SCHEMATIC





Site Layout

AWT Layout



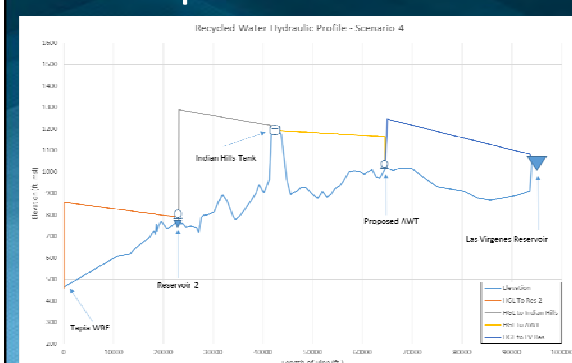
AWT Considerations

- Spare units ensure continuous operation
- In unlikely event of process upset, AWT would be contained onsite until resolved
- AWT would be connected to sewer for recovery of residuals at Tapia WRF

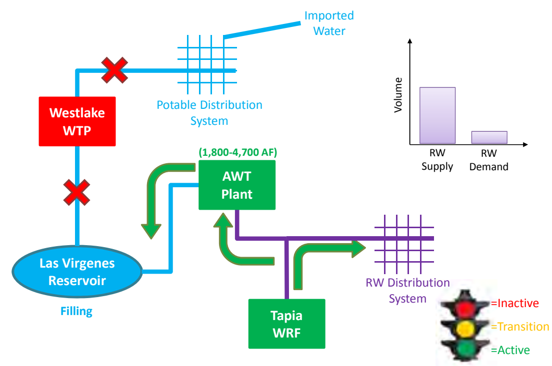
Emergency Operations

- AWT Plant must shut down for 24 hours before serving water from LV Reservoir.
- Storage in potable system would supply customers until water can be drawn from LV Reservoir.
- AWT can be shut down for up to two days using Reservoir 2.
- For longer shutdowns, AWT may be connected to storm drain system so flows could be diverted.

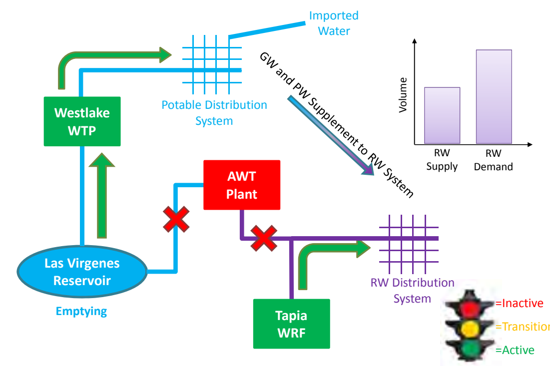
Pump Stations and Tanks



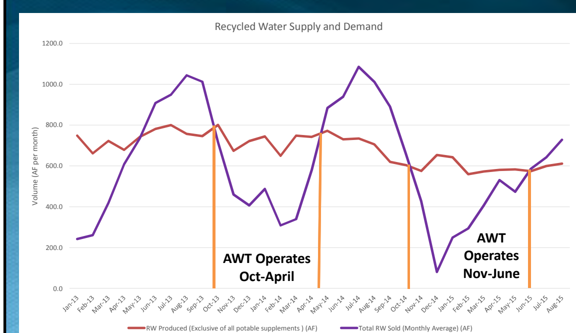
Seasonal Operation Strategy - Winter



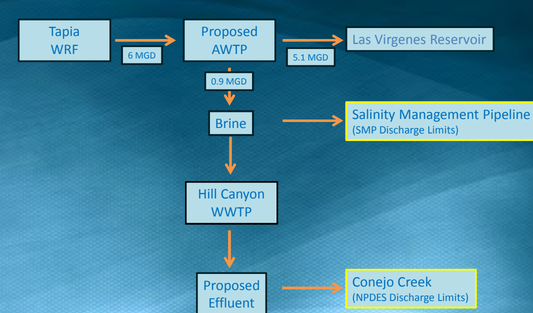
Seasonal Operation Strategy - Summer



RECYCLED WATER SUPPLY AND DEMAND



Brine Flow Diagram



Brine Line Location

Brine Disposal Compliance

- AWTP Design Parameters
  - Plant Capacity: 6 MGD
  - RO Recovery: 85%
  - Brine Line Capacity: 0.9 MGD
- **Compliance**
  - <u>SMP Discharge Limits:</u>
    - Brine quality complies with all SMP Discharge limits
  - <u>NPDES Discharge Limits:</u>
    - Proposed Hill Canyon effluent complies with Conejo Creek NPDES Discharge Limits under historical conditions

Estimated Capital Cost

Item Number	Description	Estimated Total Cost (In Millions)
1	AWT Plant (6 MGD)	$38
2	AWT Inlet Pipeline	$1.1
3	AWT Outlet Pipeline	$6.3
4	Brine Line	$4.0
5	Mixing System	$0.5
	Subtotal	$50
	Contingency (25%)	$13
	Engineering and Admin (15%)	$7.5
	Est. Total Construction Cost	$71

Estimated O&M Cost
(Based on 2014 Flows)

Item Number	Description	Quantity (AF)	Unit Price ($/AF)	Estimated Total Cost (In Thousands)
1	RWPS West Pump Station	2,000	$25	$50
2	AWT	1,700	$900	$1,500
3	Mixing System	9,500	$25	$250
4	Westlake WTP	200	$150	$30
5	Brine Discharge Fee*	300	$1,500	$450
	Subtotal			$2,300
	Contingency (10%)			$230
	Est. Total O&M Cost		$1,500	$2,500
	Imported Water Savings	1,700	$900	($1,500)
	Est. Net O&M Cost			$1,000

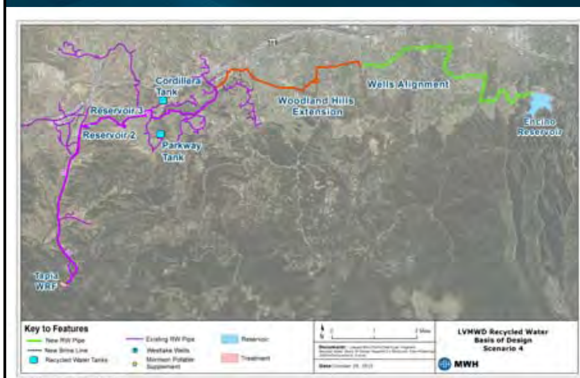
*Based on typical WWTP O&M Costs, to be negotiated with City of Thousand Oaks

Potential Partners

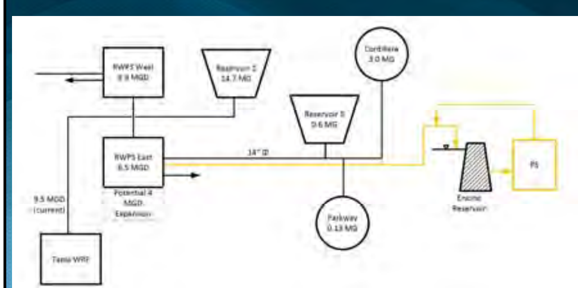
- Scenario 4
  - City of Thousand Oaks
  - Calleguas Water District
  - Camrosa Water District
  - City of Westlake Village
  - Metropolitan Water District of Southern California
  - State of California

SCENARIO 5 – RECYCLED WATER STORAGE USING ENCINO RESERVOIR

SCENARIO 5



SCENARIO 5 SCHEMATIC



Site Physical

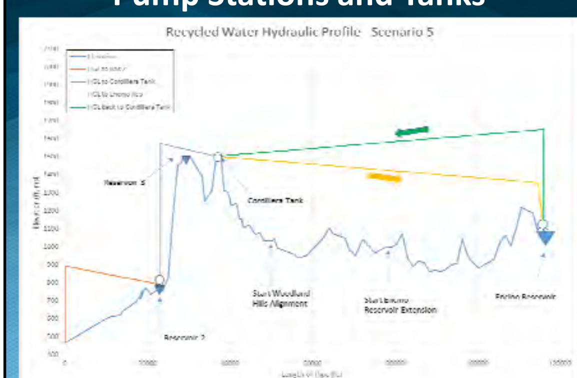
Encino Reservoir Considerations

- Seismic Study of Dam
- Pump Station Construction (Proximity to Neighborhood)
- Vector Control
- Mixing & Aeration

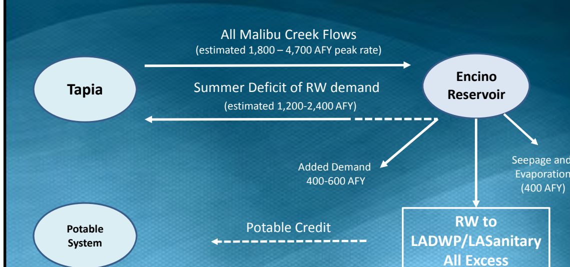
Emergency Operations

- Emergency Storage
- Reservoir Drain to LA River
- Interim connection to LASanitary Sewers in case of pipe break

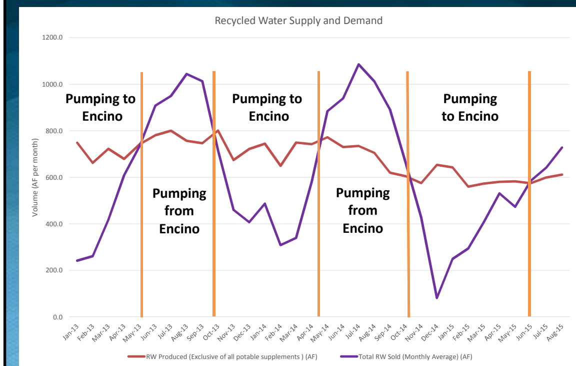
Pump Stations and Tanks



Operation Strategy



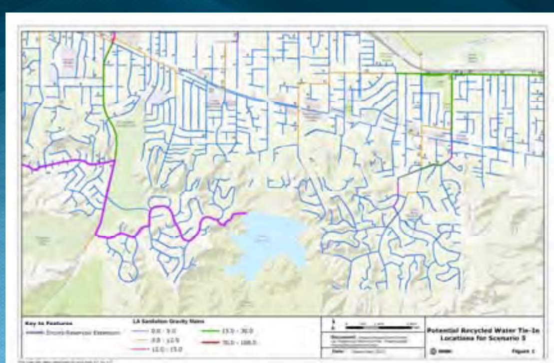
SEASONAL OPERATION STRATEGY



Distribution Options

- LASanitation Sewer Connection in Encino
  - Would allow for discharge of RW to Tillman WWTP for retreatment
- LADWP Recycled Water Tie-in
  - Would allow for JPA to send recycled water directly to LADWP distribution system
- Additional RW Customers
  - Country Clubs and golf courses along new alignment that could be served by JPA

Connection to LASanitation Sewers



Estimated Capital Cost

Item Number	Description	Estimated Total Cost (In Millions)
1	RWPS East Pump Station Upgrade	$4.0
2	Pipeline	$36
3	Pump Station at Encino Reservoir	$10
4	Strainers and Chlorination System	$0.5
5	Mixing System	$0.5
	Subtotal	$51
	Contingency (25%)	$13
	Engineering and Admin (15%)	$7.6
	Est. Total Construction Cost	$72

Estimated O&M Cost

(Based on 2014 Flows)

Item Number	Description	Quantity (AF)	Unit Price ($/AF)	Estimated Total Cost (In Thousands)
1	RWPS East Pump Station	2,000	$105	$210
2	Treatment	1,600	$60	$100
3	Mixing System	6,000	$25	$150
4	Encino Pump Station	1,600	$70	$110
	Subtotal			$570
	Contingency (10%)			$57
	Est. Total O&M Cost			$630

Potential Partners

- Scenario 5
  - LADWP
  - LASanitation
  - Metropolitan Water District of Southern California
  - State of California

EXERCISE: EVALUATION CRITERIA

EVALUATION CRITIERA

1. Lifecycle Cost
2. Environmental Impact
3. Public Acceptance/ Community Impact
4. Water Supply Benefits
5. Regional Partnerships
6. Water Quality
7. System Flexibility
8. Funding Opportunities
9. Regulatory Compliance
10. Emergency Supply
11. Susceptibility to Climate Change
12. Project Schedule
13. Level of Uncertainty
14. Rate Impact

0 — 9

Low Importance — High Importance

EVALUATION CRITIERA

1. Lifecycle Cost

0 — 9

Low Importance — High Importance

EVALUATION CRITIERA

2. Environmental Impact

0 — 9

Low Importance — High Importance

EVALUATION CRITIERA

3. Public Acceptance

0 — 9

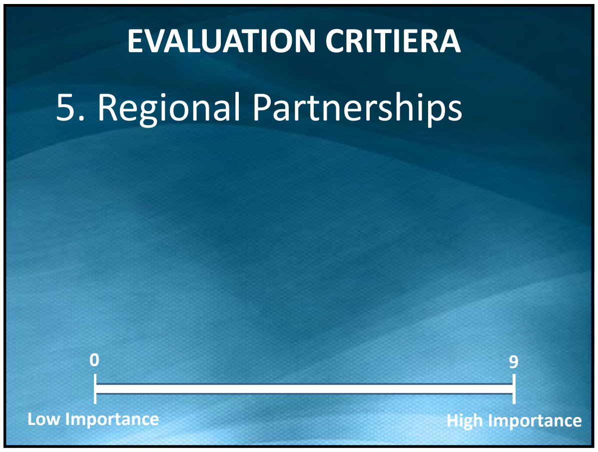
Low Importance — High Importance

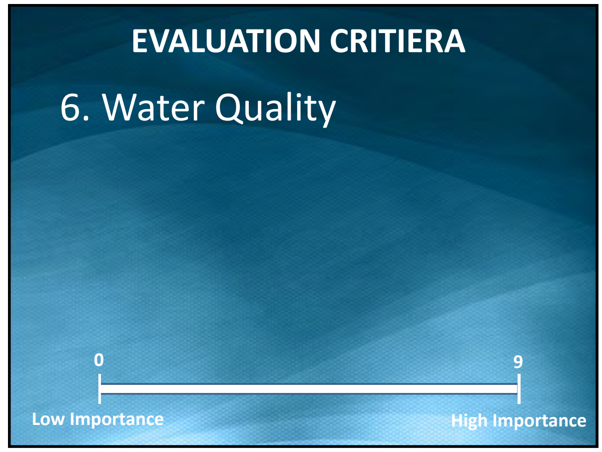
EVALUATION CRITIERA

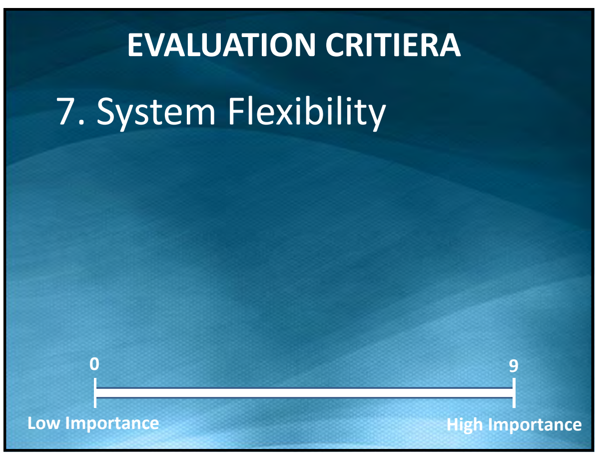
4. Water Supply Benefits

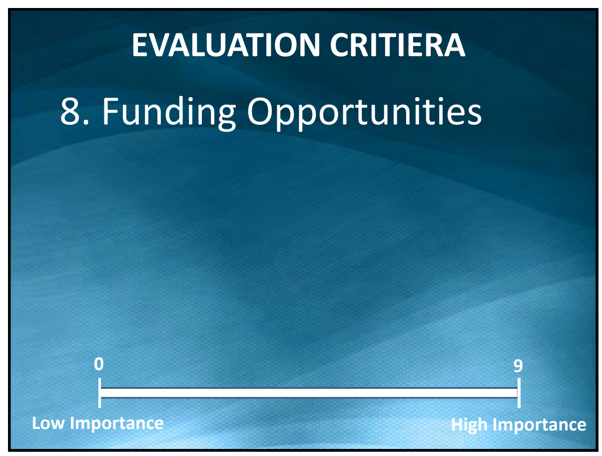
0 — 9

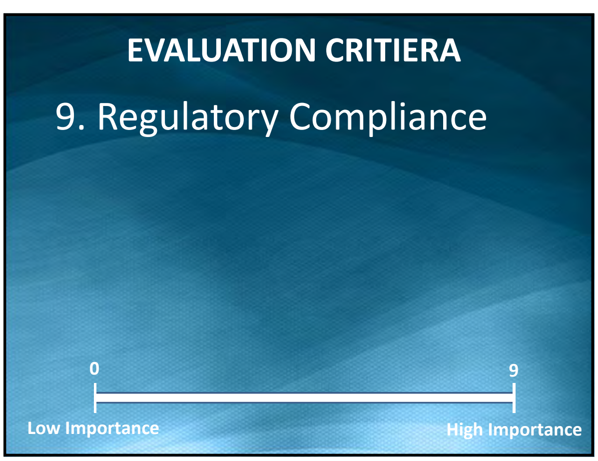
Low Importance — High Importance

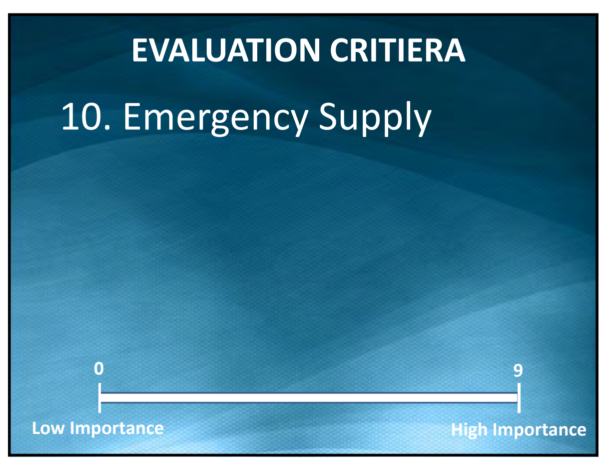

EVALUATION CRITIERA
5. Regional Partnerships
0
9
Low Importance
High Importance


EVALUATION CRITIERA
6. Water Quality
0
9
Low Importance
High Importance


EVALUATION CRITIERA
7. System Flexibility
0
9
Low Importance
High Importance


EVALUATION CRITIERA
8. Funding Opportunities
0
9
Low Importance
High Importance


EVALUATION CRITIERA
9. Regulatory Compliance
0
9
Low Importance
High Importance


EVALUATION CRITIERA
10. Emergency Supply
0
9
Low Importance
High Importance

EVALUATION CRITIERA

11. Susceptibility to Climate Change

0 — 9

Low Importance — High Importance

EVALUATION CRITIERA

12. Project Schedule

0 — 9

Low Importance — High Importance

EVALUATION CRITIERA

13. Level of Uncertainty

0 — 9

Low Importance — High Importance

EVALUATION CRITIERA

14. Rate Impact

0 — 9

Low Importance — High Importance

NEXT STEPS

Questions / Comments / Adjourn

SIGN-IN

WORKSHOP
PLAN OF ACTION FOR SEASONAL STORAGE OF RECYCLED WATER
JANUARY 27 AT 5:30 PM

A - N *SIGN-IN BELOW:*

Acevedo	Mario	*LADWP*	+ attended
Bigilen	Stephen	*Stephens Video*	attended
Borchardt	Jim	*MWH Global*	[signature]
Caspary	Charlie	*LVMWD*	[signature]
~~Dingman~~	Brett	*LVMWD*	
Guzman	Josie	*LVMWD*	Josie Guzman
Iceland	Steve	*TSD*	[signature]
Johnson	Steven	*Heal the Bay*	[signature]
~~Kampalath~~	Rita	*Heal The Bay*	
Lemieux	Keith	*Lemieux-O'Neill*	[signature]
~~Lemieux~~	Wayne	*Lemieux-O'Neill*	
Lemus	Alba	*City of Calabasas*	[signature]
Lewitt	Jay	*LVMWD*	[signature]
Lippman	David	*LVMWD*	[signature]
Mathews	John	*TSD*	[signature]
McCaffrey	Kristine	*Calleguas MWD*	[signature]
McReynolds	Mike	*TSD*	[signature]
Miller	Larry	*LVMWD*	[signature]
Mokhtari	Ray	*Metropolitan Water District*	[signature]
Mulligan	Susan	*Calleguas MWD*	SBM
~~Munger~~	Sarah	*MWH Global*	
Norris	Mark		[signature]

SIGN-IN

WORKSHOP
PLAN OF ACTION FOR SEASONAL STORAGE OF RECYCLED WATER
JANUARY 27 AT 5:30 PM

O - Z

SIGN-IN BELOW:

~~Orkney~~	Janna	*TSD*	
Parks	Greg	*Katz & Associates*	
Patterson	Don	*LVMWD*	
Paule	Mike	*TSD*	
Pedersen	Dave	*LVMWD*	
Peterson	Glen	*LVMWD*	
Polan	Len	*LVMWD*	
Reinhardt	Jeff	*LVMWD*	
Renger	Lee	*LVMWD*	
Reyes	Carlos	*LVMWD*	
Russell	Dusty	*Senator Pavley staff*	
Sharpton	Debbie	*Mountains Restoration Trust*	
Slosser	Oliver	*MWH Global*	
Spurgin	Jay	*City of Thousand Oaks*	
~~Unger~~	Sam	*RWQCB*	
Valdez	Jennifer	*LADWP*	
Wall	James	*TSD*	
Washburn	Dennis	*Calabasas Planning Commissioner*	
Weber	Steve	*MWH Global*	+ attended
~~Zhao~~	John	*LVMWD*	

SIGN-IN

WORKSHOP
PLAN OF ACTION FOR SEASONAL STORAGE OF RECYCLED WATER
JANUARY 27 AT 5:30 PM

O - Z

SIGN-IN BELOW:

Brown	Susan		Susan Brown
Syed	Areeba		ASyed
OMARY	Michael	apd cleanwater technologies.com	MO info@cleanwatertechnologies.net

January 28, 2016

De-brief Seasonal Storage BODR Workshop # 2

Attendance: Dave Pederson, David Lippman, Jeff Reinhardt, Carlos Reyes, Don Patterson, John Zhao, Larry Miller

What was positive about the workshop

- The fly overs
- The stakeholders are sticking with us
- The Board is invested
- The Board and stakeholders are hungry for information

What could we have done better

- Shorten or eliminated the ice breaker exercise
- Improve on the voting system and feed back
- Better time management in describing the two scenarios

General Observations

- Manage the impression of some Board members there is pressure to make a decision
- Understand what it really means to deicide
- Escalate conversation with DWP up to Marty Adams in particular the emergency operation of Encino Reservoir
- Should we survey stakeholders to provide feedback?
- The institutional issues need some attention, i.e. who owns the water going to Encino Reservoir
- Board members have concerns about how either option would be paid for (is it time to hire a financing consultant?)
- Divide risks by alternative in addition to by category & by owner

Specific Observations/Concerns we heard

Scenario 4

- Concerns over siting of the AWT plant, history of the parcel on Lindero
- Can the AWT be sited at LV Reservoir?
- Additional siting options for AWT location
- What is the plant community at current planned AWT Site?
- Is there access to a substation? What is the distance to electric power?
- Concerns with operating LV Reservoir level 4,700 AF every year
- Long term certainty for brine disposal at Hill Canyon, the NPDES permit is renewed every 5 years
- How do we address off spec water and emergency discharge from the AWT
- Operating the AWT facility as an on/off plant (and modulating between MGD ranges)
- How would the idea of treating TO ground water work?

Scenario 5

- Need to look closer at the dirt Mulholland route to avoid neighborhood disruption
- Concerns about the need to do a seismic study for the dam, how long and how much money would this take
- Is the use of Encino Reservoir as an emergency supply kill this option? (Mario was pretty strong about need for it)
- Has any energy recovery been considered with this alternative?
- What is the overall schedule for this alternative?
- Are any of the agency agreements in writing?
- Do we still have the same issue of buying back summer water in this scenario?

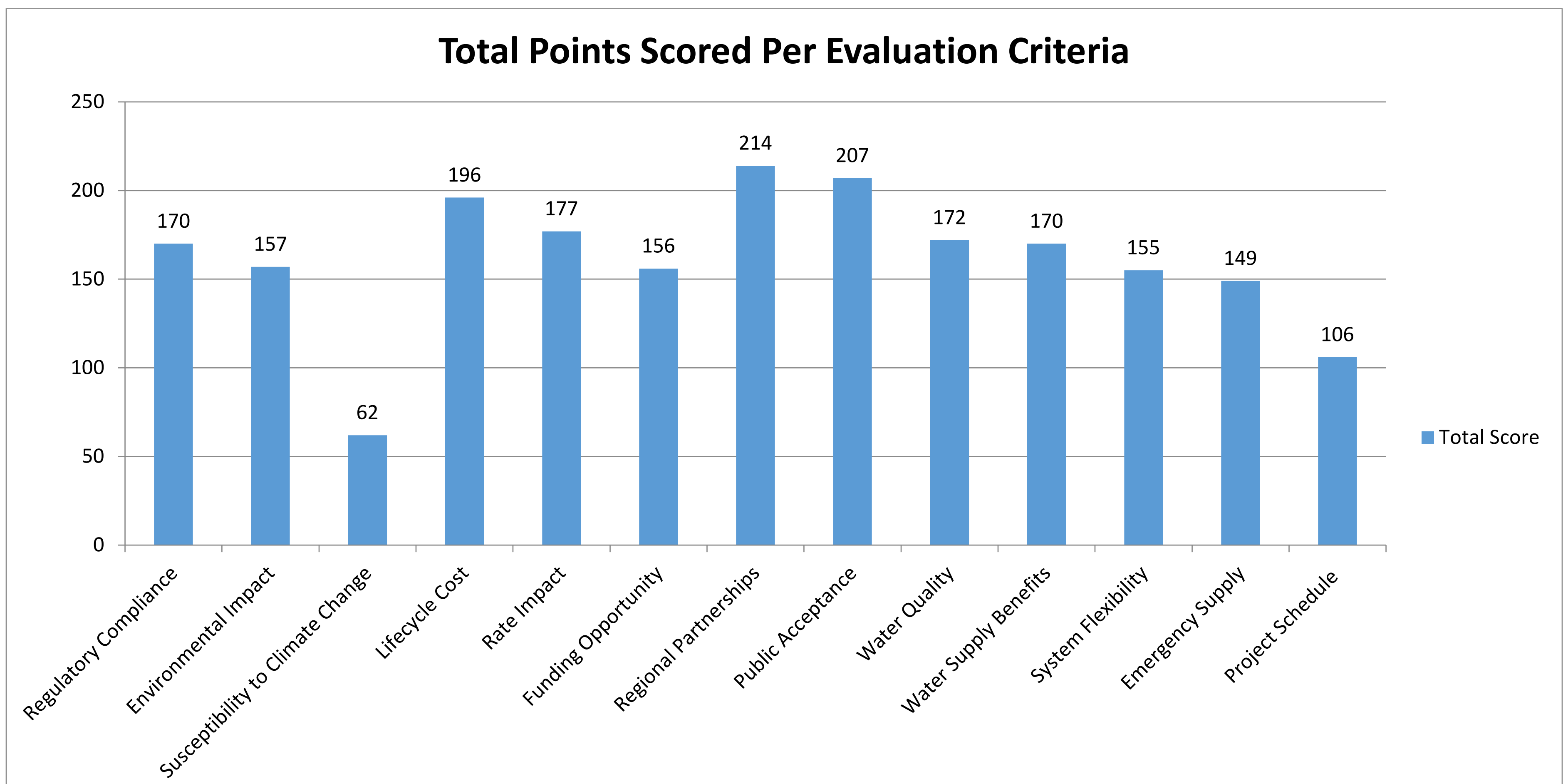
Economics:

- Analysis of a wet year, a dry year, and a normal year for cost estimates
- Scenario 5: Offset for water savings will be applied
- Consider land acquisition costs
- Discuss effect on ratepayers
- Discuss likelihood of getting Prop 1 funding?

What should be next step?

- The consensus of the group was there should be a technical workshop just with the Board. There is a hungry for more detail we were unable to provide at the workshop.

Score	Lifecycle Cost	Environmental Impact	Public Acceptance	Water Supply Benefits	Regional Partnerships	Water Quality	System Flexibility	Funding Opportunity	Regulatory Compliance	Community Impact	Emergency Supply	Susceptibility to Climate Change	Level Uncertainty	Rate Impact	Project Schedule
0	1	1		1				1	1		1	9	2		1
1		1					1	2	1		5	5	2	2	5
2		2		2			3	1	1			4	4		3
3		1	1	2	2	5		1	2		2	3	3	3	2
4		4	2	2	1	4	3	2	2		1	2	1	3	7
5	5	2	2	2		4	6	5	3		3	2	3		3
6	2	5	2	6	1	1	7	2	5		5		1	5	5
7	8	7	5	3	6	4	2	8	2		3	2	4	3	
8	5	1	5	5	6	3	4	6	5		4	1	4	5	2
9	7	4	11	5	12	7	2		6		4		4	7	
Total Score	**196**	**157**	**207**	**170**	**214**	**172**	**155**	**156**	**170**	**0**	**149**	**62**	**140**	**177**	**106**



Workshop #3

MWH

BUILDING A BETTER WORLD

March 7, 2016

Joint Powers Authority
Las Virgenes Municipal Water District
Triunfo Sanitation District

Subject: Board Packet for Board Workshop on March 15, 2016

Dear Board Member,

In preparation for the March 15, 2016 Board Session to discuss the scenarios presented in the Basis of Design Report (BODR) project, LVMWD staff and MWH have prepared the following Board Packet in order to present more detailed information for each scenario. This packet contains an executive summary for Scenario 4 and Scenario 5 based on the work completed to this point by MWH. This packet is meant to serve as a summary of the information garnered thus far to allow the JPA Board an opportunity to review the elements of each scenario and formulate a path forward for the remainder of the project.

In addition to the Board packet contained herein, MWH also collected specific questions raised in the previous workshop for the BODR. The previous workshop (Workshop #2 for the BODR) explored technical details of each scenario and elicited feedback from the JPA Board, LVMWD and TSD staff, and the stakeholders in attendance. From this session, specific questions and concerns were raised by the workshop participants and recorded by MWH staff. These questions are presented below with brief responses from MWH and LVMWD staff. More detailed information on many of these questions can be found in the Board packet and will be presented in the final BODR for Scenario 4 and 5.

Thank you for your attention to this information and please feel free to contact David Lippman (LVMWD) for any further clarification to any of this information prior to the JPA Board Workshop on March 15.

Sincerely,

James Borchardt, PE
MWH
Project Technical Lead

MWH
BUILDING A BETTER WORLD

Questions from previous workshop:

Scenario 4 – Indirect Potable Reuse at Las Virgenes Reservoir

1. What is the history of the parcel on Lindero Canyon Rd. being considered for the AWT site?
   Response: MWH is looking into the parcel at Lindero Canyon Rd. as well as seven other locations as part of Scenario 4 and will present relevant information for the site including ownership, environmental concerns, pros and cons, and site characteristics in a table.

2. Can the AWT be sited at LV Reservoir?
   Response: One of the sites being considered for Scenario 4 is a site at LV Reservoir, either along the south eastern bank, or at a lower elevation at the intersection of Triunfo Canyon Rd. and Lindero Canyon Rd. These will be presented in a table as described in the response to the previous question.

3. Are there additional siting options for AWT plant?
   Response: MWH is looking at a total of eight different locations as possibilities for the AWT plant site, and will present information on these sites including ownership, environmental concerns, pros and cons, and site characteristics in the Board Packet.

4. What is the plant community at current planned AWT Site?
   Response: The site on Lindero Canyon Rd. presented in Workshop #2 showed no sensitive plant species during initial environmental research of the site. The environmental concerns for this site and the other sites being considered are presented in this Board Packet.

5. Is there access to a substation? What is the distance to electric power?
   Response: MWH has calculated the total power needs for the proposed AWT plant and will address electrical availability and cost to provide power to the AWT site in the final BODR.

6. Would the Las Virgenes Reservoir level need to go down by 4,700 AF every year?
   Response: MWH used 4,700 acre feet as the upper limit of storage that may be required based on information available in the Recycled Water Seasonal Storage Project Feasability Study (2012). MWH has conducted an analysis of the storage needs from year to year using 18 years of historical record and will present a preliminary operation strategy for Las Virgenes and/or Encino reservoir based on this analysis. MWH will present the results of this analysis with storage and operational recommendations at the March 15 workshop.

7. What is the long term certainty for brine disposal at Hill Canyon WWTP, the NPDES permit is renewed every 5 years?
   Response: MWH has discussed past and future NPDES permits with staff at City of Thousand Oaks. Changes to the permit are not expected until 2019 at the earliest and in all likelihood would have an extended implementation schedule. According to City of Thousand Oaks staff, the current focus of permit discussions are on contaminants of emerging concern (CECs) and pharmaceuticals, not TDS or chloride. As an alternative to discharging through Hill Canyon WWTP, MWH will discuss discharging brine directly to the Salinity Management Pipeline on Santa Rosa Rd.

300 N Lake Avenue,
Suite 400
Pasadena, CA 91101
TEL 626 796 9141
FAX 626 568 6101
www.mwhglobal.com

8. How is off spec water and emergency discharge from the AWT addressed?
   Response: Short term occurrence of off spec water is expected to be mitigated by on site storage at the AWT and available storage at Reservoir 2. Short term storage would allow operators to fix any issues at the AWT that may span as much as a day or two. Longer term off spec water could be discharged through Tapia's connection to the LA River through Discharge Point 005 until normal operating conditions are restored.

9. Can the AWT facility be operated as an on/off plant (and operated between mgd ranges)?
   Response: Yes, the AWT can be operated as an on/off plant. Shutdowns longer than one day will require special operating procedures. This will require training of the AWT operators to ensure the equipment is shut down, stored, and restarted properly but can be accomplished on a seasonal basis. The treatment processes at the AWT will be able to be run at different discrete flow rates, and stepwise increases or decreases in total flow processed through the plant can be accomplished using the available storage options described in the response to the previous question.

10. How would the idea of treating City of Thousand Oaks groundwater work?
    Response: MWH has confirmed with City of Thousand Oaks that treating groundwater through the AWT is a possibility, and has confirmed that it is technically possible. Any treatment of City of Thousand Oaks groundwater through the AWT would likely involve an en lieu exchange of potable water for the treated well water. Any use of the AWT plant for these purposes would be limited by the minimum of 24 hours required before fill and draw from the Las Virgenes Reservoir.

Scenario 5 – Recycled Water Storage at Encino Reservoir

1. Has MWH looked closer at the dirt Mulholland Rd. route to avoid neighborhood disruption in the City of Encino?
   Response: Yes, MWH has completed an analysis of the two proposed alignments and the results of the analysis are presented in this Board Packet. Initial findings indicate higher costs for additional pumping and storage facilities are associated with the Mulholland alignment.

2. Is there a need to do a seismic study for Encino Dam and what is the cost and schedule for this study?
   Response: Any deficiency with Encino Dam and need for a seismic study should be included in an MOU with LADWP. LVMWD and MWH are in discussions with LADWP to verify necessity for this study and projected costs and schedule should it be required.

3. Does the use of Encino Reservoir as an emergency supply eliminate this option?
   Response: LVMWD staff is meeting with LADWP to discuss emergency operations for Encino Reservoir.

4. Has any energy recovery been considered with this alternative?
   Response: Yes, energy recovery is an option with the Mulholland Rd. alignment and has been shown on the hydraulic grade line presented in the Board Packet. The energy recovered is typically

50% to 60% of the available energy and it is not clear that the reduction in operating costs would justify the increased capital costs.

5. What is the overall schedule for this scenario?
   Response: This Board Packet presents full schedules for both scenarios based on MWH's best judgment of project phases. The schedules have been constructed to reflect consecutive completion of project phases for the purpose of comparing the scenarios.

6. Are any of the agency agreements in writing?
   Response: Coordination and agreements with other agencies have only been discussed verbally and no commitments have been formalized.

7. Is there still a possibility of having to buy potable water during the summer months to augment the recycled water system in this scenario?
   Response: Yes, it is possible that the JPA would have to buy potable water to augment the recycled water system in either option during dry years. It depends on the trend in potable water conservation and if recycled water conservation continues to keep pace. Either option allows for storage of recycled water on a year to year basis.

Financial questions

1. Has MWH done any cost analysis of different supply volumes?
   Response: MWH has done an analysis of 18 years of supply and demand data to quantify the amount of available water for each scenario. This analysis will be used in the cost estimates for each scenario.

2. Is there an offset for water savings that will be applied?
   Response: Yes, there are water savings associated with each scenario that will be reflected in the cost estimates.

3. Will MWH consider land acquisition costs?
   Response: MWH will consider land ownership for each of the selected parcels and will include a land acquisition allowance for new facilities.

4. Discuss effect on ratepayers.
   Response: The Plan of Action identifies the need for a funding and finance consultant once a scenario is selected to consider the effect on ratepayers.

5. Discuss likelihood of getting Prop 1 funding.
   Response: This question would be addressed by a funding consultant, MWH's estimated costs is an initial step in the funding analysis process.

LAS VIRGENES – TRIUNFO
JOINT POWERS AUTHORITY
MINUTES
SPECIAL MEETING

5:30 PM March 15, 2016

PLEDGE OF ALLEGIANCE

The Pledge of Allegiance to the Flag was led by Carlos Reyes.

1. CALL TO ORDER AND ROLL CALL

The meeting was called to order at **5:00 p.m.** by Chair Glen Peterson in the Board Room at Las Virgenes Municipal Water District headquarters at 4232 Las Virgenes Road in Calabasas, California. Josie Guzman, Clerk of the Board, conducted the roll call.

Present:	Directors: Caspary, Iceland, Lewitt, McReynolds, Orkney, Paule, Peterson, Polan, and Renger
Absent:	Director: Wall
Staff:	David Pedersen, General Manager Josie Guzman, Clerk of the Board David Lippman, Director of Facilities and Operations Donald Patterson, Director of Finance and Administration Carlos Reyes, Director of Resource Conservation and Public Outreach Larry Miller, Water System/Facilities Manager John Zhao, Principal Engineer Jeffrey Reinhardt, Public Affairs and Communications Manager Keith Lemieux, District Counsel

Representatives from the following organizations:

Montgomery Watson Harza (James Borchardt, Kyleen Marcella, Oliver Slosser, and Areeba Syed); Triunfo Sanitation District (Mark Norris and John Mathews)

2. APPROVAL OF AGENDA

Director Renger moved to approve the agenda as presented. Motion seconded by Director Polan. Motion carried by the following vote:

AYES: Caspary, Iceland, Lewitt, McReynolds, Orkney, Paule, Polan, Peterson, Renger.
NOES: None
ABSENT: Wall

3. **PUBLIC COMMENTS**

None.

4. **RECYCLED WATER SEASONAL STORAGE PROJECT: BASIS OF DESIGN WORKSHOP NO. 3**

Administering Agent/General Manager David Pedersen provided introductory remarks. He noted there were several technical questions posed at the previous workshop regarding Scenario 4 for indirect potable reuse using Las Virgenes Reservoir, and Scenario 5 for potentially repurposing the Encino Reservoir. He also noted that there was discussion at previous workshops regarding project risks and evaluation criteria in order for the Board to make a project selection or identify a preferred alternative for further study.

James Borchardt, representing Montgomery Watson Harza (MWH), presented a PowerPoint presentation and conducted the workshop. He noted the responses to questions from the previous workshop were included in the agenda packet, and he stated that he and his staff were present to solicit additional questions for Scenarios 4 and 5.

The Board engaged in the workshop and posed questions for further study of Scenarios 4 and 5.

The Board recessed to a break at 6:28 p.m. and reconvened at 6:38 p.m.

The following questions were posed by the Board for further study:

Scenario 5

- What would be the cost in dollars per month for customers?
- Which scenario provides greater water reliability?
- What would be the difference between agencies for recycled water supplement?

Scenario 4

- What would be the cost in dollars per month for customers?
- How will benefits be shared between agencies?
- What infrastructure is needed to connect the agencies?
- Which scenario provides greater water reliability?
- Why is potable water less for Scenario 4 than Scenario 5?
- What is the breakdown for preventative maintenance including operations

and maintenance?

- What are the fixed and variable costs for advanced water treatment, including assumptions on numbers?
- Is it possible to send brine to Pepperdine in the existing recycled water pipeline?
- Are there additional pumping costs for the 11 mile brine discharge line?
- What would be the operational conditions for a seven-day shutdown of imported water?
- What is the capital cost for a campaign to address public perception issues associated with indirect potable reuse?

Mr. Borchardt and JPA staff answered some of the questions based on information collected to-day. However, Mr. Borchardt explained that he and his staff would work on providing answers to the remaining questions and work with JPA staff to schedule another workshop in approximately one month.

5. ADJOURNMENT

Seeing no further business to come before the Board, the meeting was duly adjourned at **7:48 p.m**.

Glen Peterson, Chair

ATTEST:

Michael Paule, Vice Chair

Recycled Water Basis of Design Reports

Board Q&A

Agenda

Time	Item
5:00 – 5:05	Opening Remarks, presented by General Manager Dave Pedersen
5:05 – 5:10	Project Status, presented by James Borchardt
5:10 – 6:00	Questions & Answers, presented by James Borchardt
6:00 – 6:10	Break
6:10 - ?	Questions & Answers, presented by James Borchardt

Scenario 4 Questions

AWT Plant Siting (Questions #1-5)

Scenario 4 – AWT Plant Siting

Q3. Are there additional siting options for AWT plant?

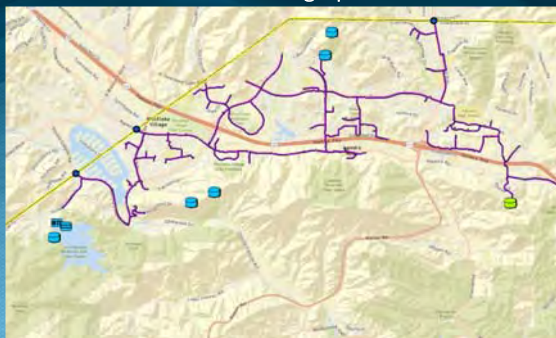
- What makes a good site?
  - 2 acres (minimum)
  - Undeveloped Land
  - Adjacent to:
    - Existing transmission piping
    - Access to sewer
    - Power
    - Thousand Oaks for Brine Line
- No environmental issues
- Good neighbor
- Low Acquisition cost
- Access for construction & operation

Scenario 4 – AWT Plant Siting

Q3. Are there additional siting options for AWT Plant?

Scenario 4 – AWT Plant Siting

Q3. Are there additional siting options for AWT Plant?



Potential Site at Triunfo Canyon Rd & Kanan Rd

Scenario 4 – AWT Plant Siting

Q2. Can AWT be sited at LV Reservoir?

Scenario 4 – AWT Plant Siting

Q1. What is the history of the parcel on Lindero Canyon Rd. being considered for the AWT Site?

- Currently owned by Las Virgenes Unified School District
- Vacant land
- No critical habitats
- Close proximity to power supply

Scenario 4 – AWT Plant Siting

Q3, Q4. What is the plant community at current planned AWT site?

Parcel Name	Owner	Property Class	Pros	Cons
1. Lindero Canyon	Las Virgenes Unified School District	Residential Vacant Land	-No Critical Habitats -Plenty of land for growth -Close to Power Lines	-Close to School
2. Lindero Country Club	Agoura Hills City	Residential Vacant Land	-Close to Power Lines -No Critical Habitats	-Close to School and Residences
3. Triunfo Canyon Road	Mountains Recreation and Conservation Authority	Vacant Land	-Near Reservoir	-Critical Habitat for Lyons Pentachaeta -Small parcel
4. Westlake Golf course	Westlake Golf Course LLC	Golf course	-Near existing utilities -No Critical Habitats	-Decrease Size of Golf course - Expensive land
5. Mortuary	Pierce Brothers	Cemetery/ Mausoleum	-Away from Residential Area -Near existing utilities -No Critical Habitats	-Small Parcel
6. Agoura Road	Agoura Hills Center Properties	Single Family Residence	-Away from Residential Area -No Critical Habitats	-Close to Residences, would require rezoning
7. Las Virgenes Reservoir	Las Virgenes Municipal Water District	Government Owned Property	-Away from Residential Area -Near LV Reservoir	-Critical Habitat for Lyons Pentachaeta
8. S Triunfo Canyon Rd. near Kanan Rd.	---	Residential Vacant Land		-No near outfall -Long brine line -All new piping from Indian Hills Tank

Scenario 4 – AWT Plant Siting

Q5. Is there access to a substation? What is the distance to electric power?

- Service requirement is 1.25 Megawatt
- Requires standard 12.47 kV power service from SCE
- SCE provides step-down transformer
- Once site selection is narrowed, discussion with SCE on power service can begin

AWT Plant Operations (Questions #6-10)

Scenario 4 – AWT Plant Operations

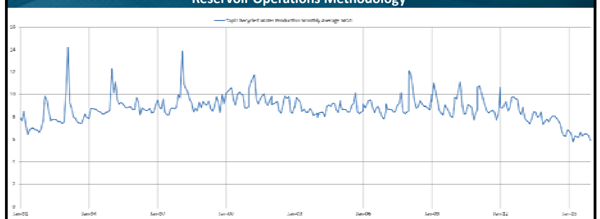
Q6. Methodology for Available Recycled Water for Storage in Las Virgenes Reservoir

- Started with historical daily RW production from Tapia from the past 17 years
- Subtracted average RW demand for the period of 2013-2015 (reflects current conditions)
- Subtracted 15% for brine disposal
- The net result is recycle water available for storage in Las Virgenes Reservoir

Scenario 4 – AWT Plant Operations

Q6. Would Las Virgenes Reservoir level need to go down by 4,700 AF every year?

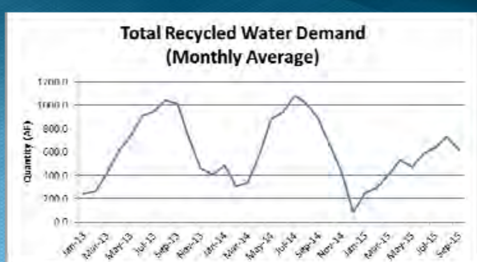
Reservoir Operations Methodology



Historical record of monthly average Tapia Recycled Water Production (in MGD)

Scenario 4 – AWT Plant Operations

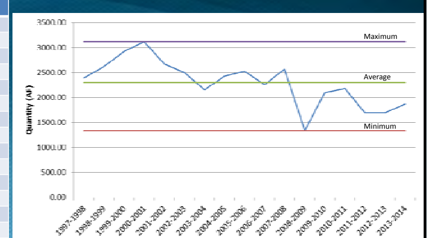
Q6. Would Las Virgenes Reservoir level need to go down by 4,700 AF every year?



Scenario 4 – AWT Plant Operations

Q6. Would the Las Virgenes Reservoir level need to go down by 4,700 AF every year?

Year	Net RW Available for Storage (AF)
1997-1998	2392.38
1998-1999	2624.11
1999-2000	2920.47
2000-2001	3117.83
2001-2002	2674.31
2002-2003	2500.24
2003-2004	2158.17
2004-2005	2422.01
2005-2006	2531.30
2006-2007	2258.06
2007-2008	2567.30
2008-2009	1338.83
2009-2010	2098.71
2010-2011	2181.58
2011-2012	1695.43
2012-2013	1688.14
2013-2014	1867.10
Minimum	1338.83
Average	2296.23



Scenario 4 – AWT Plant Operations

Q6. Would Las Virgenes Reservoir level need to go down by 4,700 AF every year?

- Recycled water available for storage in LV Reservoir
  - Minimum: 1,339 AF
  - Average: 2,296 AF
  - Maximum: 3,117 AF
- Las Virgenes Reservoir would be drawn down by the fall of each year to accommodate the anticipated yield of recycled water in the following winter
- Anticipated yield would likely be developed using trending and statistical analysis
- Greater than anticipated yield could be accommodated with on-off operation of the Westlake Treatment Plant
- Any water not stored would be discharged to the LA River or used on spray fields

Scenario 4 – AWT Plant Operations

Q7. What is the long term certainty for brine disposal at Hill Canyon WWTP?

- No changes until new permit in July 2019 (possibly later)
- New requirements possible for CECs and pharmaceuticals
  - 2014 permit asked for special study
- Currently fighting board on aquatic toxicity limits
- Interim regulations for Chloride and Copper
  - Chloride: measured at 155-169 mg/L; above wet-weather limit of 150 mg/L but within interim permit limit of 189 mg/L
  - Copper: On border of copper limit; ongoing discussions to change basis for copper limit (based on assumption that 100% of flows from HCWWTP go to Pt. Mugu Lagoon; large portion actually recycled through Camrosa)

Scenario 4 – AWT Plant Operations

Q7. What is the long term certainty for brine disposal at Hill Canyon WWTP?

- If after committing to Scenario 4 discharge of brine to Thousand Oaks is not possible, pipeline to connect directly to the SMP would be necessary
- Cost for additional 11 miles would be $11 million ($1 million/mile)
- Calleguas MWD fee to discharge to SMP $750/AF (50% surcharge). 405 AF of estimated brine per year is $300,000 for disposal

Scenario 4 – AWT Plant Operations

Q8. How is off-spec water and emergency discharge from the AWT addressed?

- Short-term occurrence of off-spec water can be mitigated by on-site storage at the AWT Plant and available storage at Reservoir 2
- Longer term occurrences or emergency discharge would be to the LA River via Discharge Point 005 (Calabasas Rd at Park Granada)
  - Total Capacity at Discharge Point 005 is 6 MGD, possible limitations at Arroyo Calabasas storm drain
  - Meets effluent limitations of Discharge Point 005

Scenario 4 – AWT Plant Operations

Q9. Can the AWT facility be operated as an on/off plant (and operated between mgd ranges)?

- Operating the AWT plant as on/off plant should not effect membrane life provided proper shutdown procedures are followed
- Treatment processes at the AWT plant will be able to run at different discrete flow rates and stepwise increases and decreases in total flow processed can be accomplished using on-site storage at the AWT plant or at Reservoir 2
- Partial day operation is also feasible

Scenario 4 – AWT Plant Operations

Q9. AWT Plant Shutdown Requirements

Treatment Process	Steps for Shutdown	Requirements for Long-Term Storage
MF/UF	• Run a CIP cycle • Rinse the system and neutralize the CIP solution • Flush the system again before it comes back online	• Store in a pickling solution of ~1000 mg/L sodium bisulfite in utility water • Replace the solution every few months to maintain pH 3.0-6.0
RO	• Run a CIP cycle • Run a flush cycle to fill the vessels with RO permeate • Flush the system again before it comes back online	• Store in a pickling solution of ~1000 mg/L sodium bisulfite in RO permeate • Replace the solution every few months to maintain pH 3.0-6.0
UV-AOP	• Run a cleaning cycle for the lamp surfaces • Clean again before the system comes back online	• Drain reactors: dry reactors can easily stay offline for months
Chemical Feeds	• Flush concentrated chemical out of all chemical feed lines • Refill the chemical feed lines with chemical stock before they come back online	• Store chemical feed systems with lines full of utility water to prevent precipitation / clogging

Scenario 4 – AWT Plant Operations

Q10. How would the idea of treating City of Thousand Oaks groundwater work?

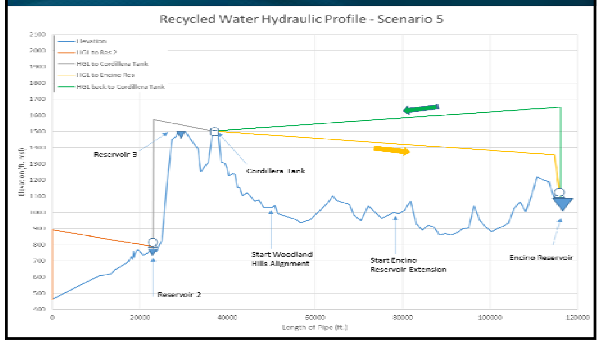
- City of Thousand Oaks has confirmed that treating groundwater through the AWT is a possibility
- This option offers the possibility plant operation in seasons when it would otherwise not be used
- Treatment of City of Thousand Oaks groundwater would reclassify this water as IPR
- Therefore, treatment of groundwater would likely involve an en lieu exchange of potable water

Scenario 5 Questions

Alignment Comparison (Questions #1 & 4)

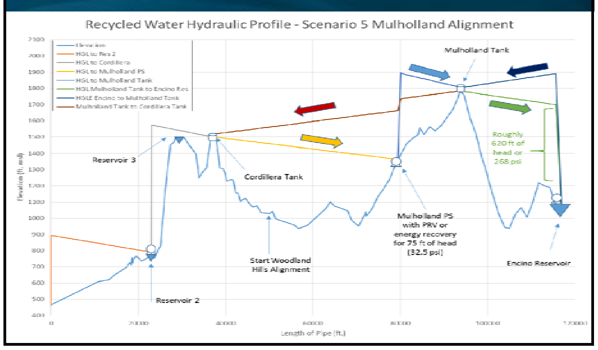
Scenario 5 – Alignment Comparison

Q1. Has MWH looked closer at the dirt Mulholland Rd. route to avoid neighborhood disruption in Encino?



Scenario 5 – Alignment Comparison

Q1. Alternative Alignment



Scenario 5 – Alignment Comparison

Q1. Alignment Comparison

- Total pipe lengths are similar for both alignments
- Mulholland alignment requires more high pressure piping due to greater elevation differences over a longer distance
- Mulholland alignment also requires land acquisition and additional facility costs needed for additional pump station and new storage tank

Scenario 5 – Alignment Comparison

Q1. Alignment Cost Comparison

Item	Unit Price	Wells Alignment		Mulholland Alignment	
		Quantity	Cost	Quantity	Cost
Standard Pressure Pipeline	$450/LF	52,400 LF	$23,580,000	28,300 LF	$12,735,000
High Pressure Pipeline	$500/LF	27,500 LF	$13,750,000	52,500 LF	$26,250,000
Pump Station on Mulholland Rd.	$6,000/HP	--	--	4x300 HP	$7,200,000
Mulholland Tank	Lump Sum	--	--	1 MG	$3,000,000
Pump Station at Encino Reservoir	$6,000/HP	4x300 HP	$7,200,000	4x400 HP	$9,600,000
Regeneration at Encino Reservoir	Lump Sum	--	--	2x400 HP	$1,500,000
Land Acquisition	Lump Sum	--	--	1 acre	$1,000,000
Subtotal		$44,530,000		$61,285,000	
Contingency (25%)		$11,132,500		$15,321,250	
Engineering and Admin (15%)		$6,679,500		$9,192,750	
Total Construction Cost (rounded)		**$62,300,000**		**$85,800,000**	

*Financial savings due to energy recovery are not shown in the above table

Scenario 5 – Alignment Comparison

Q4. Has any energy recovery been considered with this alternative?

- Energy recovery would be possible in the Mulholland alignment
- Energy recovery is typically 50-60% of the available energy and would not likely offset the increased capital costs
- Estimated annual energy savings 745,200 kWh, which would result in an approximate savings of $111,780
- Savings from energy recovery would not make the Mulholland Alignment the financially favorable alternative

Encino Dam
(Questions #2 & 3)

Scenario 5 – Encino Dam

Q2. Is there a need to do a seismic study for Encino Dam and what is the cost and schedule for this study?

- Encino Dam is currently permitted by DSOD, but a seismic study for Encino Dam is still required
- Study was initiated by DWP but is currently on hold
- Estimated costs to complete the seismic study is approximated to be $300,000-$450,000 (not including any recommended mitigation costs)
- Higher reservoir elevations would most likely trigger the need to complete the study

Scenario 5 – Encino Dam

Q3. Does the use of Encino Reservoir as an emergency supply eliminate this option?

- The City of LA Emergency Task Force has noted that Encino Reservoir is currently used for emergency water storage
- LADWP is evaluating options for emergency operations

Additional Questions
(Questions #5-7)

Scenario 5 – Additional Questions

Additional Questions

Q5. Overall schedule for this scenario?

- Schedule is provided in the Board packet

Q6. Are any of the agency agreements in writing?

- Discussions have taken place with agencies to identify any red flags with this scenario and none have been identified to date

Q7. Will buying potable water to supplement the recycled water system during summer months still be needed?

- Additional potable water may need to be purchased as supplement in dry years with high recycled water demand.

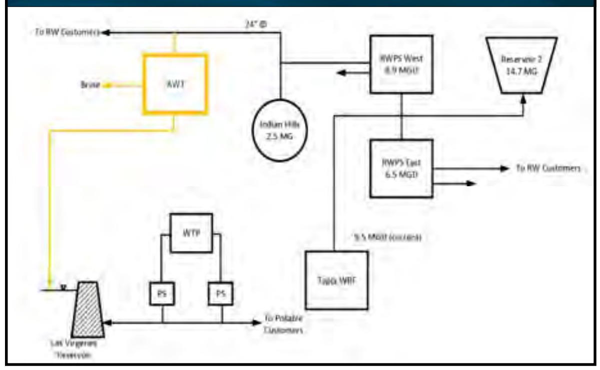
Financial questions will be addressed in the presentation for each respective scenario

SCENARIO 4 OVERVIEW

Scenario 4 -SUMMARY

- Supported by existing facilities
- Potential sites for treatment plant
- New pipelines in congested areas
- Brine disposal agreement required with City of Thousand Oaks
- Inter-agency Coordination:
  - Division of Drinking Water (DDW)
  - Department of Transportation (CalTrans)
  - Regional Water Quality Control Board (RWQCB)
  - City of Westlake Village
  - City of Thousand Oaks
  - Camrosa Water District
  - Calleguas Municipal Water District

Scenario 4 -Schematic



Scenario 4 – New Facilities

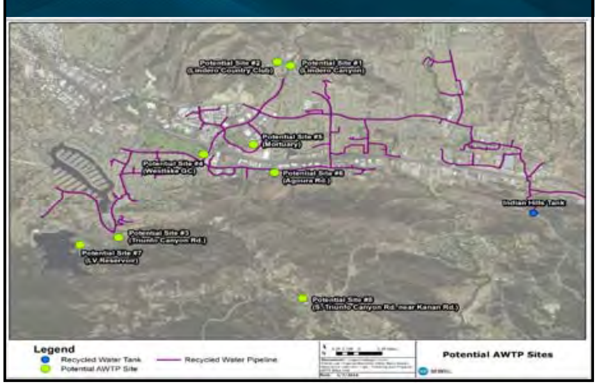
- New facilities include:
  - AWT Plant
  - New conveyance pipeline
  - Brine pipeline
    - Pumped to Hill Canyon Wastewater Treatment Plant for discharge (requires 4 miles of pipeline)

OR

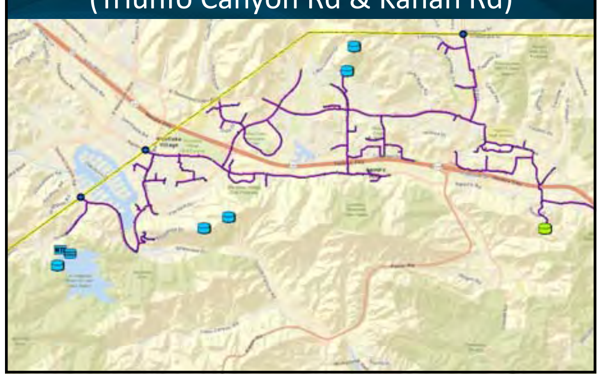
- Pumped directly to Salinity Management Pipeline (requires additional 11 mi of pipeline)

Scenario 4 –New Facilities

Scenario 4 –Potential AWTP Sites



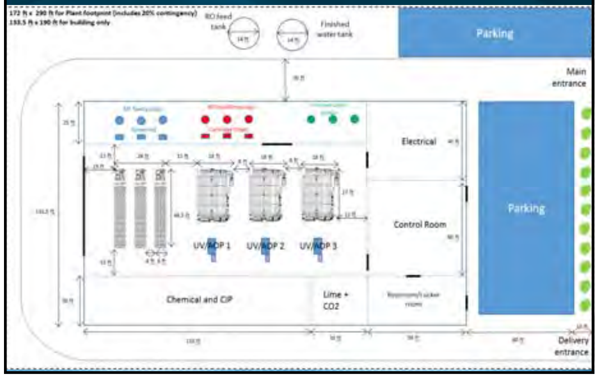
Scenario 4 –Potential Sites (Triunfo Canyon Rd & Kanan Rd)



Scenario 4 –Potential Sites Pro/Con

Parcel Name	Owner	Property Class	Pros	Cons
1. Lindero Canyon	Las Virgenes Unified School District	Residential Vacant Land	-No Critical Habitats -Plenty of land for growth -Close to Power Lines	-Close to School
2. Lindero Country Club	Agoura Hills City	Residential Vacant Land	-Close to Power Lines -No Critical Habitats	-Close to School and Residences
3. Triunfo Canyon Road	Mountains Recreation and Conservation Authority	Vacant Land	-Near Reservoir	-Critical Habitat for Lyons Pentachaeta -Small parcel
4. Westlake Golf course	Westlake Golf Course LLC	Golf course	-Near existing utilities -No Critical Habitats	-Decrease Size of Golf course - Expensive land
5. Mortuary	Pierce Brothers	Cemetery/ Mausoleum	-Away from Residential Area -Near existing utilities -No Critical Habitats	-Small Parcel
6. Agoura Road	Agoura Hills Center Properties	Single Family Residence	-Away from Residential Area -No Critical Habitats	-Close to Residences, would require rezoning
7. Las Virgenes Reservoir	Las Virgenes Municipal Water District	Government Owned Property	-Away from Residential Area -Near LV Reservoir	-Critical Habitat for Lyons Pentachaeta
8. S Triunfo Canyon Rd. near Kanan Rd.	---	Residential Vacant Land		-No near outfall -Long brine line -All new piping from Indian Hills Tank

Scenario 4 – AWT Facility Layout



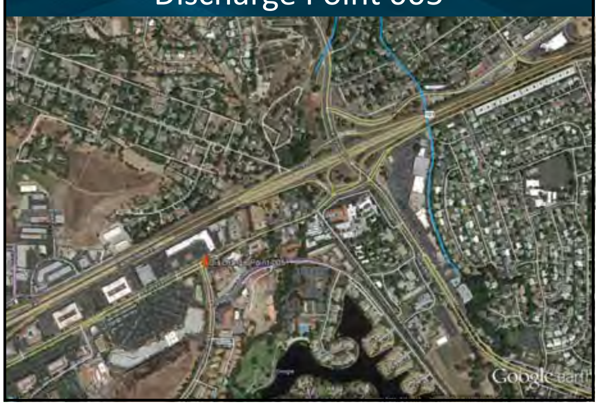
Scenario 4 - NPDES Permit

- No changes until new permit in July 2019 (possibly later)
- New regulations for CECs and pharmaceuticals
  - 2014 permit asked for special study
- Currently challenging Board on aquatic toxicity limits
- Interim regulations for Chloride and Copper
  - Chloride: measured at 155-169 mg/L; above wet-weather limit of 150 mg/L but within interim permit limit of 189 mg/L
  - Copper: On border of copper limit; ongoing discussions to change basis for copper limit (based on assumption that 100% of flows from HCWWTP go to Pt. Mugu Lagoon; large portion actually recycled through Camrosa)

Scenario 4 - Off-Spec Water & Emergency Discharge

- Short-term occurrence of off-spec water can be mitigated by on-site storage at the AWT Plant and available storage at Reservoir 2
- Longer term occurrences or emergency discharge would be to the LA River via Discharge Point 005 (Calabasas Rd at Park Granada)
  - Total Capacity is 6 MGD, possible limitations at Arroyo Calabasas storm drain
  - Meets effluent limitations of Discharge Point 005

Discharge Point 005



Discharge Point 005 Effluent Limitations

Table 6a. Effluent Limitations Applicable to Discharge Points 001, 002, 003, and 005
(For footnotes, refer to pages 28 and 29)

Parameter	Units	Effluent Limitations				
		Average Monthly	Average Weekly	Max. Daily	Instantaneous Minimum	Instantaneous Maximum
Biochemical Oxygen Demand 5-day @ 20°C	mg/L	10	--	20	--	--
	lbs/day[1]	1.3E3	--	2.7E3	--	--
Total Suspended Solids	mg/L	5.0	--	10	--	--
	lbs/day[1]	6.7E2	--	1.3E3	--	--
pH	standard units	--	--	--	6.5	8.5
Settleable Solids	ml/L	0.1	--	0.2	--	--
Oil and grease	mg/L	5	--	10	--	--
	lbs/day[1]	6.7E2		1.3E3	--	--
Total Residual Chlorine[2]	mg/L	--	--	0.1	--	--
MBAS	mg/L	0.5	--	--	--	--
	lbs/day[1]	67	--	--	--	--
Mercury	µg/L	0.051	--	0.10	--	--
	lbs/day[1]	6.8E-3	--	1.3E-2	--	--
Cyanide	µg/L	4.2	--	8.5	--	--
	lbs/day[1]	0.56	--	1.1	--	--
Aldrin	µg/L	1.4E-4	--	3.0E-4	--	--
	lbs/day[1]	1.9E-5	--	4.0E-5	--	--
Alpha-BHC	µg/L	1.3E-2	--	2.6E-2	--	--
	lbs/day[1]	1.7E-3	--	3.5E-3	--	--
Dichlorobromomethane	µg/L	46	--	8677	--	--

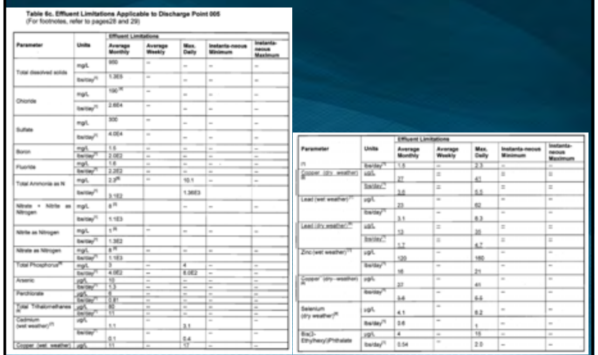


Table 6c. Effluent Limitations Applicable to Discharge Point 005
(For footnotes, refer to pages28 and 29)

Parameter	Units	Effluent Limitations: Average Monthly	Average Weekly	Max. Daily	Instanta-neous Minimum	Instanta-neous Maximum
Total dissolved solids	mg/L	950	–	–	–	–
	lbs/day	1.3E5	–	–	–	–
Chloride	mg/L	190	–	–	–	–
	lbs/day	2.6E4	–	–	–	–
Sulfate	mg/L	300	–	–	–	–
	lbs/day	4.0E4	–	–	–	–
Boron	mg/L	1.5	–	–	–	–
	lbs/day	2.0E2	–	–	–	–
Fluoride	mg/L	1.6	–	–	–	–
	lbs/day	2.2E2	–	–	–	–
Total Ammonia as N	mg/L	2.3	–	10.1	–	–
	lbs/day	3.1E2		1.36E3		
Nitrate + Nitrite as Nitrogen	mg/L	8		–	–	–
	lbs/day	1.1E3				
Nitrite as Nitrogen	mg/L	1	–	–	–	–
	lbs/day	1.3E2				
Nitrate as Nitrogen	mg/L	8	–	–	–	–
	lbs/day	1.1E3				
Total Phosphorus	mg/L	3	–	4	–	–
	lbs/day	4.0E2	–	8.0E2	–	–
Arsenic	µg/L	10	–	–	–	–
	lbs/day	1.3	–	–	–	–
Perchlorate	µg/L	6	–	–	–	–
	lbs/day	0.81	–	–	–	–
Total Trihalomethanes	µg/L	80	–	–	–	–
	lbs/day	11	–	–	–	–
Cadmium (wet weather)	µg/L	1.1	–	3.1	–	–
	lbs/day	0.1	–	0.4	–	–
Copper (wet weather)	µg/L	11	–	17	–	–

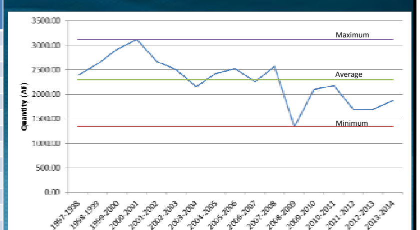
Parameter	Units	Effluent Limitations: Average Monthly	Average Weekly	Max. Daily	Instanta-neous Minimum	Instanta-neous Maximum
	lbs/day	1.5	–	2.3	–	–
Copper (dry weather)	µg/L	27	–	41	–	–
	lbs/day	3.6	–	5.5	–	–
Lead (wet weather)	µg/L	23	–	62	–	–
	lbs/day	3.1	–	8.3	–	–
Lead (dry weather)	µg/L	13	–	35	–	–
	lbs/day	1.7	–	4.7	–	–
Zinc (wet weather)	µg/L	120	–	160	–	–
	lbs/day	16	–	21	–	–
Copper (dry weather)	µg/L	27	–	41	–	–
	lbs/day	3.6	–	5.5	–	–
Selenium (dry weather)	µg/L	4.1	–	8.2	–	–
	lbs/day	0.6	–	1	–	–
Bis(2-Ethylhexyl)Phthalate	µg/L	4	–	15	–	–
	lbs/day	0.54	–	2.0	–	–

Scenario 4 – Reservoir Operations Methodology

- Started with historical daily RW production from Tapia from the past 17 years
- Subtracted average RW demand for the period of 2013-2015 (reflects current conditions)
- Subtracted 15% for brine disposal
- The net result is recycle water available for storage in Las Virgenes Reservoir

Scenario 4 – Reservoir Operations

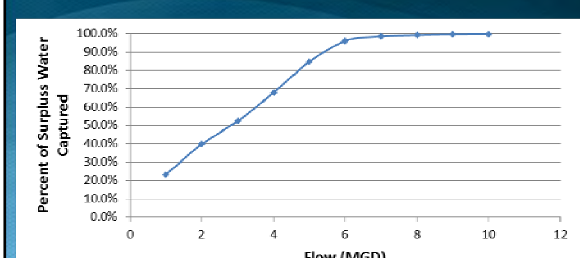
Year	Net RW Available for Storage (AF)
1997-1998	2392.38
1998-1999	2624.11
1999-2000	2920.47
2000-2001	3117.83
2001-2002	2674.31
2002-2003	2500.24
2003-2004	2158.17
2004-2005	2422.01
2005-2006	2531.30
2006-2007	2258.06
2007-2008	2567.30
2008-2009	1338.83
2009-2010	2098.71
2010-2011	2181.58
2011-2012	1695.43
2012-2013	1688.14
2013-2014	1867.10
Minimum	1338.83
Average	2296.23



Scenario 4 – AWT Plant Sizing

- This historical data was also used to determine the optimal size for the AWT plant
- The daily data determined that a 6 mgd production plant captures greater than 96% of daily surplus recycled water

Scenario 4 – Reservoir Capture Rate



Scenario 4 – Interagency Coordination

- State of California:
  - Department of Transportation (CalTrans) - encroachment permit for crossing Highway 101 for effluent pipeline or brine pipeline
  - Division of Drinking Water (DDW) – Lead agency in approving Scenario 4
  - Regional Water Quality Control Board (RWQCB) – final approval over NPDES discharge permit

Scenario 4 – Interagency Coordination

- Local Agencies:
  - City of Westlake Village -encroachment permit for pipelines to reach Las Virgenes Reservoir
  - City of Thousand Oaks – discharge of brine to the City's wastewater collection system and treatment of brine at Hill Canyon WRF
  - Camrosa Water District – City of TO has existing agreement with Camrosa Water District for use of Hill Canyon WRF effluent
  - Calleguas Municipal Water District – owns and manages the Salinity Management Pipeline (SMP)

Scenario 4 – Capital Costs

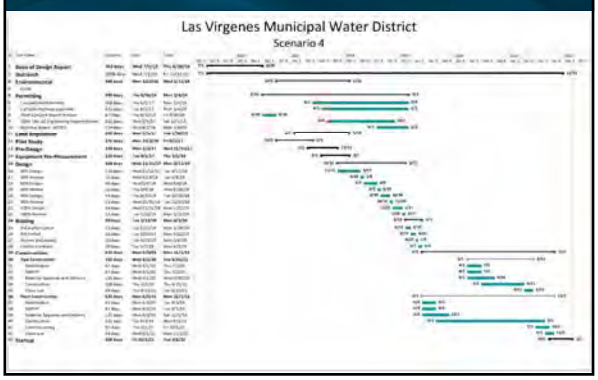
Item Number	Description	Estimated Cost
1	AWTP	$43,000,000
2	Land Acquisition	$2,000,000
3	AWT Pipeline	$1,100,000
4	AWT Outlet Pipeline	$6,300,000
5	Brine Line	$4,000,000
6	Mixing System	$500,000
	Subtotal	$56,900,000
	Contingency (25%)	$14,225,000
	Engineering & Admin (15%)	$8,535,000
	Estimated Total Construction Costs (rounded)	$79,700,000

SCENARIO 4 – Annual O&M Costs

Item Number	Description	Estimated Cost
1	RWPS West Pump Station	$50,000
2	AWTP	$2,066,500
3	Mixing System	$237,500
4	Westlake WTP	$30,000
5	Brine Discharge Fee	$450,000
	Subtotal	$2,834,000
	Contingency (10%)	$283,500
	Estimated Total O&M (rounded)	$3,120,000
	Imported Water Savings	($2,070,000)
	Net Total O&M (rounded)	$1,050,000

Estimated present worth calculated over 30 years is $60,000,000

SCENARIO 4 – Schedule

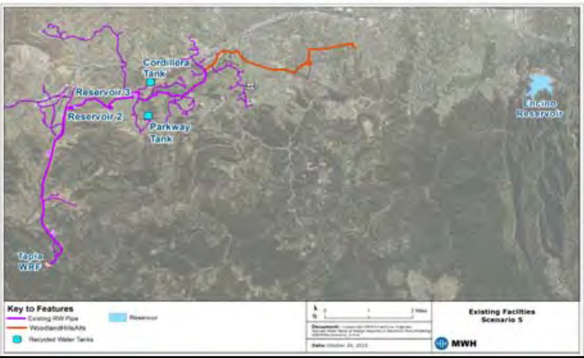


SCENARIO 5 OVERVIEW

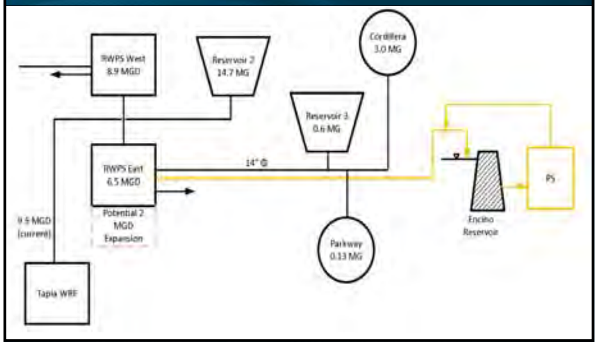
Scenario 5 - SUMMARY

- Existing facilities may require expansion
- Potential sites for pumping station
- New pipelines in congested areas
- Interagency Coordination:
  - Division of Safety of Dams (DSOD)
  - Division of Drinking Water (DDW)
  - Los Angeles DWP (and LASAN)
  - Los Angeles County Department of Public Health (LACDPH)

SCENARIO 5 – Existing Facilities



Scenario 5 - Schematic



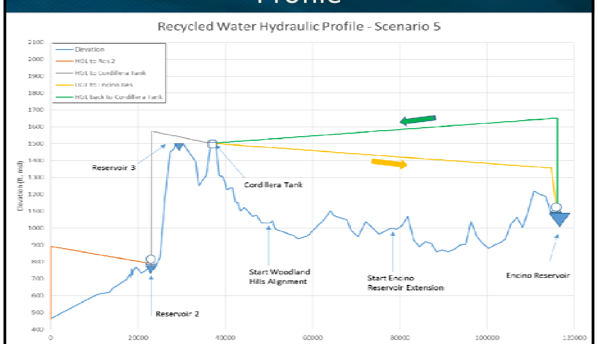
Scenario 5 – Proposed Facilities

- New Facilities include:
  - Wells Alignment (or Mulholland Alignment)
  - Pump Station at Encino Reservoir
  - Mixing system
  - Strainers and chlorination equipment
  - Expansion of RWPS East
  - Facilities required for discharge of excess water (To be determined)

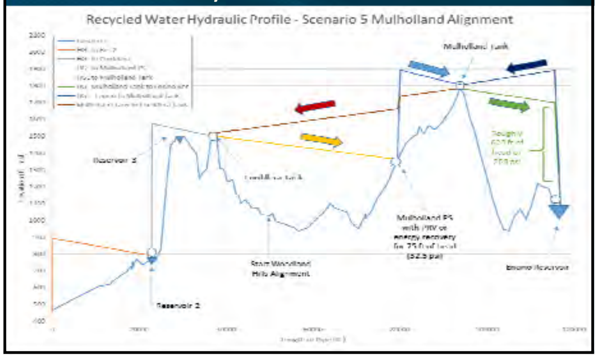
Scenario 5 – Proposed Facilities

Scenario 5 – Proposed Alignments

Scenario 5 – Wells Alignment Hydraulic Profile



Scenario 5 – Mulholland Alignment Hydraulic Profile



Scenario 5 – Alignment Comparison

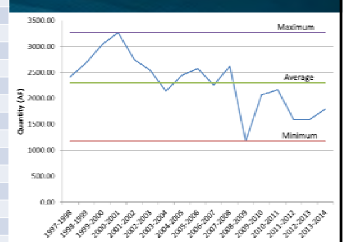
Item	Unit Price	Wells Alignment		Mulholland Alignment	
		Quantity	Cost	Quantity	Cost
Standard Pressure Pipeline	$450/LF	52,400 LF	$23,580,000	28,300 LF	$12,735,000
High Pressure Pipeline	$500/LF	27,500 LF	$13,750,000	52,500 LF	$26,250,000
Pump Station on Mulholland Rd.	$6,000/HP	--	--	4x300 HP	$7,200,000
Mulholland Tank	Lump Sum	--	--	1 MG	$3,000,000
Pump Station at Encino Reservoir	$6,000/HP	4x300 HP	$7,200,000	4x400 HP	$9,600,000
Regeneration at Encino Reservoir	Lump Sum	--	--	2x400 HP	$1,500,000
Land Acquisition	Lump Sum	--	--	1 acre	$1,000,000
Subtotal		$44,530,000		$61,285,000	
Contingency (25%)		$11,132,500		$15,321,250	
Engineering and Admin (15%)		$6,679,500		$9,192,750	
Total Construction Cost (rounded)		**$62,300,000**		**$85,800,000**	

Scenario 5 – Reservoir Operation

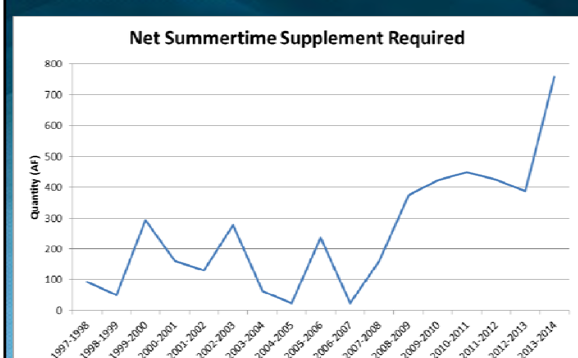
- Started with historical daily RW production from Tapia from the past 17 years
- Subtracted average RW demand for the period of 2013-2015 (reflects current conditions)
- Subtracted 400 AFY for seepage
- The net result is recycle water available for storage in Encino Reservoir

Scenario 5 – Reservoir Operation

Year	Net Storage Volume (AF)	Net Summertime Supplement Required (AF)
1997-1998	2414.56	-92.36
1998-1999	2687.18	-50.33
1999-2000	3035.85	-293.80
2000-2001	3268.03	-160.01
2001-2002	2746.25	-129.96
2002-2003	2541.45	-277.20
2003-2004	2139.02	-62.27
2004-2005	2449.42	-24.66
2005-2006	2578.00	-236.64
2006-2007	2256.55	-24.66
2007-2008	2620.35	-160.10
2008-2009	1175.10	-369.00
2009-2010	2069.07	-422.44
2010-2011	2166.56	-448.37
2011-2012	1594.62	-423.55
2012-2013	1586.05	-386.71
2013-2014	1796.59	-758.86
Minimum	1175.10	-24.66
Average	2301.45	-254.17
Maximum	3268.03	-758.86



Scenario 5 – Reservoir Operation



Scenario 5 – Water Quality and Treatment Requirements

- High organic content will exert an oxygen demand during storage at Encino Reservoir
- Requires installation of aeration and mixing system at the reservoir
- Water withdrawn from Reservoir will need to passed through self cleaning strainers and then chlorine will be added

Scenario 5 – Interagency Coordination and Permitting

- State of California
  - Regional Water Quality Control Board (RWQCB)
  - Division of Safety of Dams (DSOD)
- Local Agencies
  - Los Angeles Department of Water and Power (LADWP)
  - Los Angeles Sanitation (LASAN)
  - Los Angeles County Department of Public Health (LACDPH)

Scenario 5 – Capital Costs

Item Number	Description	Estimated Cost
1	RWPS East Pump Station Upgrade	$2,000,000
2	Pipeline	$37,330,000
3	Pump Station at Encino Reservoir	$7,200,000
4	Strainers and Chlorination System	$1,000,000
5	Mixing System	$500,000
	Subtotal	$48,030,000
	Contingency (25%)	$12,008,000
	Engineering & Admin (15%)	$7,205,000
	Estimated Total Construction Costs (rounded)	$67,200,000

Scenario 5 – Annual O&M Costs

Item Number	Description	Estimated Cost
1	RWPS East Pump Station	$262,500
2	Treatment	$138,000
3	Mixing System	$150,000
4	Encino Pump Station	$161,000
	Subtotal	$712,500
	Contingency (10%)	$71,000
	Estimated Total O&M (rounded)	$780,000
	Imported Water Savings	($230,000)
	Net Total O&M (rounded)	$550,000
	Remaining Recycled Water Value**	-

**Annual average of approx. 2,050 ac-ft of season recycled water will be stored in Encino Reservoir pending a decision on final end use.

Estimated present worth calculated over 30 years is $74,000,000

Scenario 5 – Remaining Recycled Water Value

- Annual average of approx. 2,050 ac-ft of season recycled water will be stored in Encino Reservoir

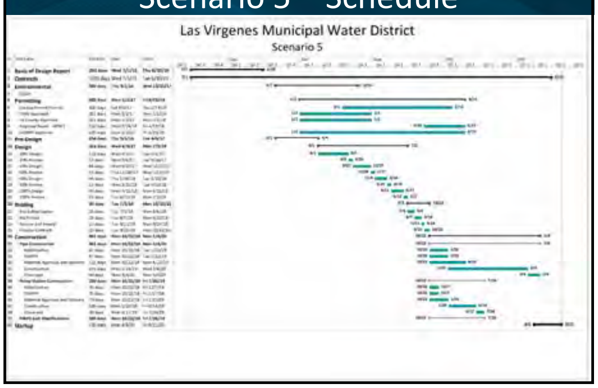
Price ($/AF)	Annual Water Savings	NPW of Annual Savings
$0	$0	$0
$300	$615,000	$12,503,696
$450	$922,500	$18,755,543
$900	$1,845,000	$37,511,087

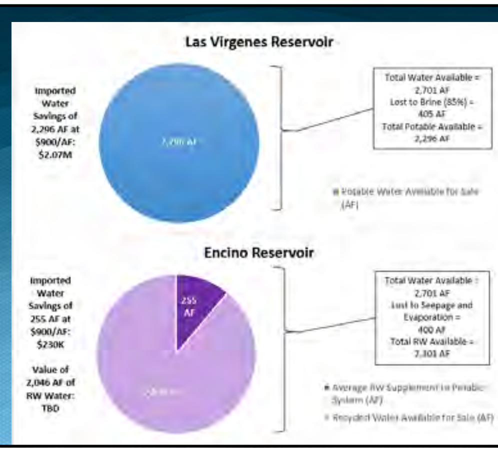
Scenario 4 estimated present worth calculated over 30 years is $60,000,000

Scenario 5 estimated present worth calculated over 30 years is $74,000,000

Difference in present worth estimation = $14,000,000

Scenario 5 – Schedule





Additional Questions from Seasonal Storage BODR Workshop # 3
March 15, 2016

Questions Posed:

Scenario 4

(1) What are the dollars per month per customer?
- Exact numbers depend on a more thorough financial analysis. A Finance Consultant will be retained for the project to help address this and other similar finance questions.

(2) How will benefits be shared between agencies?
- To be discussed between JPA.

(3) What infrastructure is needed to connect the agencies?
- A better understanding of the contract between agencies is needed to assess existing and future connections. This includes information on pipe sizes, capacities, etc.

(4) Which scenario provides greater water reliability?
- They both create greater water reliability in the current recycled water systems. However, Scenario 4 also provides greater water reliability in the potable water system.

(5) Why is Scenario 4 Present Worth less than Scenario 5 Present Worth?
- Present Worth is more associated with O&M costs than capital costs.
- Scenario 4 sees recycled water savings whereas similar savings have not been accounted for in Scenario 5 since we do not know yet how to value them. Once they are valued, a full discussion will address present worth in the final report.

(6) Was preventative maintenance included?
- Yes, preventative maintenance is imbedded within the costs we have shared thus far.
- MWH will include these items explicitly on the O&M breakdowns in the final report.

(7) What are the fixed and variable costs for the AWT? What are the assumptions on these numbers?
- MWH will include a more detailed breakdown of costs and assumptions in the final report.

(8) Can brine be sent to Pepperdine in the existing reclaimed water pipeline? (or deep well injection – fracking concerns)
- No, neither Pepperdine (Malibu Mesa Water Reclamation Plant) nor the upcoming Civic Center WWTP will have an ocean outfall. Pepperdine uses all of the RW it produced onsite, and trucks sludge to Tillman. Any excess wastewater they have above 0.165 mgd actually gets pumped up to Tapia. They have an NPDES permit that allows them to discharge up to 0.2mgd with a monthly average N of 3.5 mg/L to a nearby creek, but they never actually use it. It is there for emergency use. The new Civic Center Plant will reuse everything they treat as RW or with injection, and will have percolation pond for redundant capacity, but will not have an outfall. The will have sludge thickening and truck out their waste.

(9) Are there additional pumping costs for the 11 mile brine discharge line?
- No, in fact there may be energy recovery through this line since there is a large amount of elevation head and residual pressure available.
- Calculations and cost savings will be addressed in the final report.

(10) What are the operational conditions for a 7 day shutdown of imported water?
- To be discussed internally by LVMWD operations staff.

- Will be addressed in final report.

(11) What is the capital cost of a public campaign on the perception of IPR?

- To be evaluated by Katz.
- Will be included in final report.

<u>Scenario 5</u>

(1) What are the dollars per month per customer?

- Exact numbers depend on a more thorough financial analysis. A Finance Consultant will be retained for the project to help address this and other similar finance questions.

(2) Which scenario provides greater water reliability?

- They both create greater water reliability in the current recycled water systems. However, Scenario 4 also provides greater water reliability in the potable water system.

(3) What are the differences between agencies for a recycled water supplement?

- To be discussed between JPA.

(4) Was there a (LADWP) credit for the Woodland Hills extension taken into account in cost estimates?

- No, a credit by LADWP was not taken into account for current capital cost estimates. MWH will look into this further, adjust costs accordingly and include in the final report.

Workshop #4

Recycled Water
Basis of Design Report

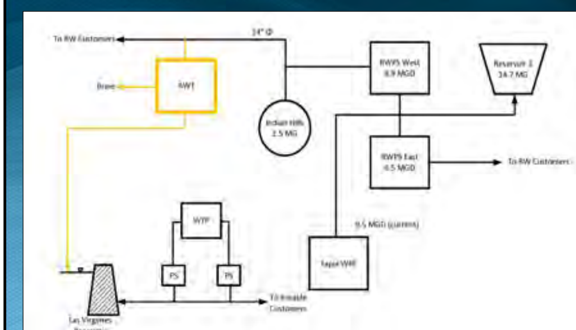
Workshop #4 – June 21, 2016

Agenda

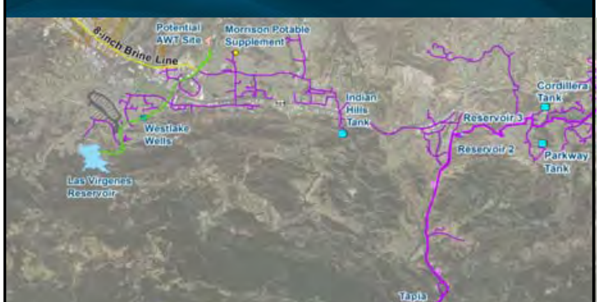
Time	Item
5:30 – 5:35	Call to Order
5:30 – 5:35	Introduction to Workshop, presented by General Manager Dave Pedersen
5:35 – 5:40	Summary of Scenarios
5:40 – 5:50	Project Updates: 1. Engineering & Regulatory, presented by James Borchardt and Oliver Slosser 2. Inter-agency, presented by General Manager Dave Pedersen
5:50 – 6:05	Break for Dinner
6:05 – 6:20	Risk Management, presented by James Borchardt
6:20 – 6:55	Scenario Evaluation, presented by James Borchardt and General Manager Dave Pedersen
6:55 – 7:00	Closing and Next Steps, presented by Dave Pedersen

Summary of Scenarios

Scenario 4 -Schematic



Scenario 4 –New Facilities



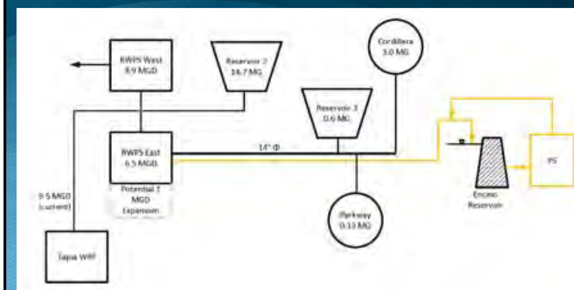
Scenario 4 – Capital Costs

Item Number	Description	Estimated Cost
1	AWTP	$46,700,000
2	Land Acquisition	$2,000,000
3	AWT Pipeline	$1,400,000
4	AWT Outlet Pipeline	$6,400,000
5	Brine Line	$10,500,000
6	Mixing System	$1,000,000
	Subtotal	$68,000,000
	Contingency (25%)	$17,000,000
	Engineering & Admin (15%)	$10,200,000
	Estimated Total Construction Costs (rounded)	$95,200,000

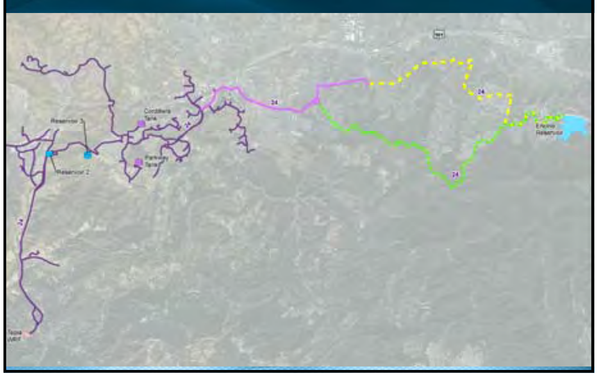
SCENARIO 4 – Annual O&M Costs

Item Number	Description	Estimated Cost
1	RWPS West Pump Station	$78,000
2	AWTP	$1,753,000
3	Mixing System	$237,500
4	Westlake WTP	$215,700
5	Brine Discharge Fee	$232,800
	Subtotal	$2,517,000
	Contingency (10%)	$251,700
	Estimated Total O&M (rounded)	$2,768,700
	Imported Water Savings	($2,374,000)
	Net Total O&M (rounded)	$395,700

Scenario 5 - Schematic



Scenario 5 – Proposed Facilities



Scenario 5 – Capital Costs

Item Number	Description	Wells Alignment	Mulholland Alignment
1	RWPS East Pump Station Upgrade	$2,000,000	$2,000,000
2	Pipeline	$37,330,000	$38,985,000
3	Pump Station at Encino Reservoir	$5,400,000	$9,600,000
4	Strainers and Chlorination System	$1,000,000	$1,000,000
5	Mixing System	$500,000	$500,000
6	Mulholland Pump Station, Tank, Energy Recovery	-	$12,700,000
	Subtotal	$46,230,000	$64,785,000
	Contingency (25%)	$11,557,000	$16,196,000
	Engineering & Admin (15%)	$6,934,000	$6,479,000
	Estimated Total Construction Costs (rounded)	$64,700,000	$87,460,000

Scenario 5 – Annual O&M Costs

Item Number	Description	Wells Alignment	Mulholland Alignment
1	RWPS East Pump Station	$326,600	$326,000
2	Treatment	$162,000	$162,000
3	Mixing System	$150,000	$150,000
4	Encino Pump Station	$189,000	$297,000
5	Mulholland Pump Station (with Energy Recovery savings)	-	$57,000
	Subtotal	$827,000	$992,000
	Contingency (10%)	$83,000	$99,000
	Estimated Total O&M (rounded)	$910,000	$1,091,000
	Imported Water Savings	($324,000)	($324,000)
	Net Total O&M (rounded)	$586,000	$767,000
	Remaining Recycled Water Value**	-	-

**Annual average of approx. 2,400 ac-ft of season recycled water will be stored in Encino Reservoir pending a decision on final end use.

Scenario 5 – Remaining Recycled Water Value

- Annual average of approx. 2,400 ac-ft of season recycled water will be stored in Encino Reservoir

Trade Ratio (Imported Water : Recycled Water)	Annual Water Savings
0	$0
1:5	$420,000
1:4	$530,000
1:3	$700,000
1:2	$1,100,000

Engineering Updates

- Las Virgenes Reservoir Operations
- DDW Surface Water Augmentation Regulations
- Future Supply/Demand
- Brine Discharge

Project Updates: Las Virgenes Reservoir Operations

- Previous Assumption: Seasonal Fill & Draw
  - Issue with emergency wintertime operations
  - Issue with reservoir drawdown
- Current Assumption: Continuous Fill and Draw
  - Allows emergency wintertime operations
  - Allows seasonal fill and draw
  - Stabilizes reservoir level
  - Complies with DDW Regulations

Project Updates: Surface Water Augmentation Regulations

- Requirements:
  1. 6 month theoretical retention time (draft reg.)
  2. Dilution:
     - 1% (100:1) dilution of any 24 hour inflow of purified water, measured at the outlet

     OR
     - 10% (10:1) dilution any 24 hour inflow of purified water, measured at the outlet, plus an independent treatment step

Project Updates: Supply & Demand

- Current approach captures all excess supply
- Demand based on 15-year historical record
- Growth projections

Future Supply Projections

Water Yield

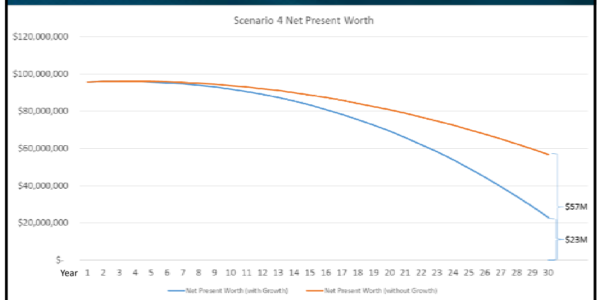
Scenario 4				
	Supply (AF)	Demand (AF)	Supply – Demand (AF)	Available for Storage (includes brine loss) (AF)
2016	9,300*	6,500*	2,800	2,380
2035	10,600 – 12,200	6,500	4,100 – 5,700	3,450 – 4,800
Scenario 5				
	Supply (AF)	Demand (AF)	Supply – Demand (AF)	Available for Storage (includes seepage) (AF)
2016	9,300*	6,500*	2,800	2,400
2035	10,600 – 12,200	7,100	3,500 – 5,100	3,100 - 4,700

*Using historical averages from 2001-2015

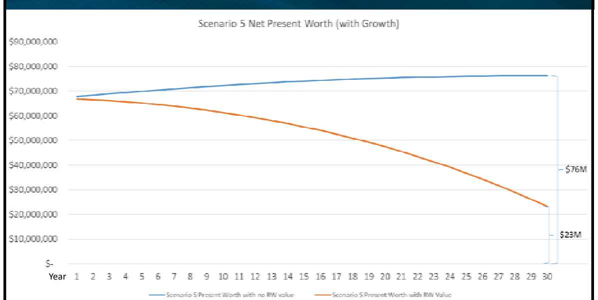
Net Present Worth

Net Present Worth	No Growth	Growth
Scenario 4	$57M	$23M
Scenario 5 (Assuming no exchange of water)	$73M	$76M
Scenario 5 (Assuming 1:2.4 unbalanced exchange of water)	$38.3M	$23M

Scenario 4 Project Cost



Scenario 5 Project Cost



Project Updates: Brine Line to SMP

Project Updates: Brine Line

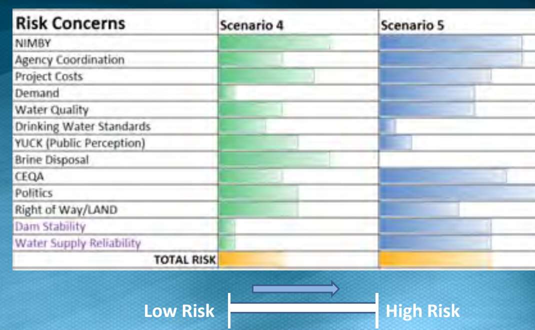
- To avoid risk associated with interim limits at Hill Canyon WTP and change in flow or base loading, the primary option for the Brine Line is to build an extension directly to the SMP

	Distance (LF)	Unit Cost ($/LF)	Total Cost
Alternative 1	60,100	175	$10,520,00
Alternative 2	59,900	175	$10,480,00
Alternative 3	59,500	175	$10,400,00

Project Updates: Inter-Agency Dave Pedersen

Dinner Break

Risk Management



Scenario Evaluation – Guiding Principles

Guiding Principles	Scenario 4	Scenario 5	Comments
Maximize Beneficial Reuse	☐	☐	
Seek Cost Effective Solutions	☐	☐	
Seek Partnerships beyond JPA	☐	☐	
Gain Community Support	☐	☐	
Govern with a Partnership	☐	☐	
Be Forward Thinking	☐	☐	

Scenario Evaluation – Objectives

Objectives	Scenario 4	Scenario 5	
Reuse 100% of Our Water	☐	☐	
Regional Partnerships	☐	☐	
Public Support for Project	☐	☐	
Cost/Benefit	☐	☐	
Beneficial to Water Users Including Rate Payers	☐	☐	
Maximize Funding Sources	☐	☐	
Public Perception and Acceptance	☐	☐	
Eliminate Unreasonable Use and Waste of Water	☐	☐	
Transparency	☐	☐	
Seasonal and Diurnal Equalization	☐	☐	
Balance of Supply and Demand (Right Balance)	☐	☐	
Reduce Reliance on Imported Water	☐	☐	
Regulatory Constraints and Framework	☐	☐	
TMDL Compliance in Malibu Creek and Santa Monica Bay	☐	☐	
Regulations	☐	☐	
Sustainability	☐	☐	
Siting of Reservoirs and other Infrastructure	☐	☐	
Protecting Beneficial Uses in Malibu Creek	☐	☐	
Environmental Stewardship and Leadership	☐	☐	

Scenario Evaluation – Risk Concerns

Risk Concerns			
NIMBY	☐	☐	
Agency Coordination	☐	☐	
Project Costs	☐	☐	
Demand	☐	☐	
Water Quality	☐	☐	
Drinking Water Standards	☐	☐	
YUCK (Public Perception)	☐	☐	
Brine Disposal	☐	☐	
CEQA	☐	☐	
Politics	☐	☐	
Right of Way/LAND	☐	☐	

Next Steps

SIGN-IN

Workshop
Plan of Action for Seasonal Storage of Recycled Water
June 21, 2016 at 5:30 PM

Acevedo, Mario	LADWP	[signature]
Aflaki, Roshnanak	LA Dept of Public Works - Sanitation	
Bigilen, Stephen	Stephens Video	attended
Caspary, Charlie	LVMWD	[signature]
Dagit, Rosi	Resource Conservation District of the Santa Monica Mountains	Rosi Dagit
Guzman, Josie	LVMWD	Josie Guzman
Iceland, Steve	TSD	[signature]
Johnson, Steven	Heal The Bay	[signature]
Lemieux, Keith	Lemieux-O'Neill	
Lemieux, Wayne	Lemieux-O'Neill	[signature]
Lemus, Alba	City Of Calabasas	[signature]
Lewitt, Jay	LVMWD	✓
Lippman, David	LVMWD	✓

SIGN-IN

Workshop
Plan of Action for Seasonal Storage of Recycled Water
June 21, 2016 at 5:30 PM

Mathews, John	TSD	
McCaffrey, Kristine	Calleguas MWD	
McReynolds, Mike	TSD	
Miller, Larry	LVMWD	
Mokhtari, Ray	Metropolitan Water District	
Mulligan, Susan	Calleguas MWD	
Norris, Mark	TSD	
Orkney, Janna	TSD	
Ouch, Janet	Katz & Associates	
Patterson, Don	LVMWD	✓
Paule, Mike	TSD	
Pedersen, Dave	LVMWD	✓
Peterson, Glen	LVMWD	attended
Polan, Len	LVMWD	attended

SIGN-IN

WORKSHOP
PLAN OF ACTION FOR SEASONAL STORAGE OF RECYCLED WATER
JUNE 21, 2016 AT 5:30 PM

Prichard, Ian	Camrosa Water District	
Reinhardt, Jeff	LVMWD	Jeff Reinhardt
Renger, Lee	LVMWD	Lee Renger
Reyes, Carlos	LVMWD	[signature]
Roberts, Dave	LVMWD	Dave Roberts
Russell, Dusty	Senator Pavley staff	
Sharpton, Debbie	Mountains Restoration Trust	DS
Skei, Rorie	Santa Monica Mountains Conservancy	Rorie Skei
Spurgin, Jay	City of Thousand Oaks	[signature]
Tsunehara, Yoshiko	LADWP	[signature]
Unger, Samuel	RWQCB	attended
Wall, James	TSD	J Wall
Washburn, Dennis	City of Calabasas Planning Commission	Dennis Washburn
Zhao, John	LVMWD	

SIGN-IN

WORKSHOP
PLAN OF ACTION FOR SEASONAL STORAGE OF RECYCLED WATER
JUNE 21, 2016 AT 5:30 PM

NAME	*AFFILIATION & EMAIL ADDRESS*	*SIGNATURE*
Brett Dingman	LVMWD bdingman@LVMWD.com	[signature]
[illegible]	LVMWD	[signature]
IAN PRICHARD	CAMROSA	[signature]
James Borchardt	MWH	✓
Oliver Slosser	MWH	✓
Areeba Syed	MWH	✓
Kyleen Marcella	MWH	✓
Sam Unger	RWQCB	
Michael Omarey	APOcleanwatertechnologies' info@bio-swift	[signature]

	Totals	
	Scenario 4	Scenario 5
Guiding Principles		
Maximize Beneficial Reuse	22	5
Seek Cost Effective Solutions	22	11
Seek Partnerships beyond JPA	15	12
Gain Community Support	23	5
Govern with a Partnership	14	10
Be Forward Thinking	32	1
Subtotal	**128**	**44**
Average	**21**	**7**
Objectives		
Reuse 100% of Our Water	25	7
Regional Partnerships	12	15
Public Support for Project	16	14
Cost/Benefit	21	9
Beneficial to Water Users Including Rate Payers	25	6
Maximize Funding Sources	16	12
Public Perception and Acceptance	12	18
Eliminate Unreasonable Use and Waste of Water	20	8
Transparency	18	6
Seasonal and Diurnal Equalization	17	8
Balance of Supply and Demand (Right Balance)	26	4
Reduce Reliance on Imported Water	30	2
Regulatory Constraints and Framework	7	19
TMDL Compliance in Malibu Creek and Santa Monica Bay	14	6
Regulations	9	18
Sustainability	26	5
Siting of Reservoirs and other Infrastructure	16	11
Protecting Beneficial Uses in Malibu Creek	16	4
Environmental Stewardship and Leadership	23	3
Subtotal	**349**	**175**
Average	**18**	**9**
Risk Concerns		
NIMBY	19	7
Agency Coordination	25	5
Project Costs	8	21
Demand	27	3
Water Quality	25	6
Drinking Water Standards	20	11
YUCK (Public Perception)	15	18
Brine Disposal	14	18
CEQA	18	6
Politics	21	5
Right of Way/LAND	17	10
Subtotal	**209**	**110**
Average	**19**	**10**
Grand Total	**686**	**329**
n	**36**	**36**
Average	**19**	**9**

	Scenario 4 Comments	Scenario 5 Comments

Guiding Principles

	Scenario 4 Comments	Scenario 5 Comments
Maximize Beneficial Reuse	•potable reuse > non-potable reuse •water produced can have universal use	•#5 maybe equal 20 years out. •Once commitments to purchase are locked up
Seek Cost Effective Solutions	•MF/RO + brine O&M cost is killer •long term O+M savings	•Depends on cost-sharing •too many ?s for 5 •DWP would lick up some cost •$ value of unused water in #5 •short term cost lower
Seek Partnerships beyond JPA	•LADWP	•leverage cost reduction within district
Gain Community Support	•Big! Ratepayer benefit •community meaning the LVMWD area	
Govern with a Partnership	•DPR is the future	•not necessarily good if outside JPA
Be Forward Thinking	•community will need water to drink and not for lanscaping •cutting edge! •water will become scarce •This is most important in my opinion	

Objectives

	Scenario 4 Comments	Scenario 5 Comments
Reuse 100% of Our Water	•Suports community and not the landscapes of golf course that benefits private interests and may not be sustainable in future climates	
Regional Partnerships		
Public Support for Project	•Hard to imagine selling IPR in Malibu	•Regional support •Except if partners impacted
Cost/Benefit	•water offset costs considered	•Depends on cost-sharing
Beneficial to Water Users Including Rate Payers	•Depends on cost-sharing	
Maximize Funding Sources		•lower up-front cost
Public Perception and Acceptance	•Will public support drinking recycled water?	•I would like to believe IPR has equal support •No Yuck factor
Eliminate Unreasonable Use and Waste of Water	•I believe cost are underestimated for #4	
Transparency		
Seasonal and Diurnal Equalization		
Balance of Supply and Demand (Right Balance)	•all used w/out loss to LA	
Reduce Reliance on Imported Water	•Major reduction •Depends on perspective: LVMWD/JPA, 4	•Depends on perspective: regionally, 5
Regulatory Constraints and Framework	•Surface Water Avg. Reqs are tough •More requirements for Scenario 4	
TMDL Compliance in Malibu Creek and Santa Monica Bay		
Regulations		
Sustainability		•Less electricity/more efficient +IPR at Tillman
Siting of Reservoirs and other Infrastructure		
Protecting Beneficial Uses in Malibu Creek		
Environmental Stewardship and Leadership		•Less electricity/more efficient +IPR at Tillman

Risk Concerns

	Scenario 4 Comments	Scenario 5 Comments
NIMBY		•pipeline route for #5 is different •Within district (lowest risk)
Agency Coordination		•DWP hard to work with
Project Costs		•Can't imagine IPR option being cheaper
Demand		
Water Quality		
Drinking Water Standards		
YUCK (Public Perception)	•This can be dispelled by education	•Public will appreciate RW to golf courses + •Should have higher weight than others
Brine Disposal	•Brine = very problmeatic + stricter regs -> risk •Brine line cost are too low +pumping will be req	
CEQA		
Politics	•Las Virgenes has more control	
Right of Way/LAND	•Have to buy AWPF site	

Las Virgenes - Triunfo Joint Powers Authority
4232 Las Virgenes Road
Calabasas, CA 91302
(818) 251-2100

MWH, now part of Stantec
300 N. Lake Avenue, Suite 400
Pasadena, CA 91101
(626) 796-9141