APPENDIX 3-1

Project 1: City of Lompoc, Lompoc Valley Leak Detection and Repair Project

- System Assessment (Leak Report) from Lompoc
- Cultural Resources Overlay Ordinance
- EPA Review Draft Control and Mitigation of Drinking Water Losses in Distribution Systems (EPA 816-D-09-001), November 2009, pp. 1-2
- "Water Loss – A Business Case for Action", Bouman, Bernie, PE, and Dan Barr, PE, Burgess & Niple, pp. 1-14 and 35-39
- Lompoc 2005 Urban Water Management Plan
- American Water Works Association (AWWA), Committee Report: Applying Worldwide BMPs in Water Loss Control, Water Loss Control Committee, AWWA Journal, August 2003, pp. 77
- System Maps – Other maps showing location of each agency's water mains
- DWR Water Conservation Guidebook No. 5: Water Audit and Leak Detection
- CUWCC Utility Operations Programs – (1.2 Water Loss Control, C. 6 provides details)
- CEQA Compliance
- Proposed Santa Barbara County IRWM Data Management System, Application for Prop 84 Planning Grant, Round 1, Santa Barbara County, IRWM Plan 2012, Task 4: Establish Data Management System, pp. 51, September 28, 2010

City of Lompoc ~ Leak Report

ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss	
2010								
305	S-520	605 E BIRCH	Jul-01	Jul-01	PINHOLE COPPER LEAK		20,000	6 AC
304	Q-520	1048 ARCHER CT	May-11	May-11	COPPER SERVICE LEAK		30,000	6 PVC
303	Q-510	1117 W BARTON, FARTON @ LANA	Apr-19	Apr-19	COPPER SERVICE LINE LEAK		100,000	8 PVC
301	Q-510	1325 JODI DRIVE	Apr-14	Apr-14	SERVICE LINE LEAK		500,000	8 PVC
302	Q-510	1356-1361 VILLAGE MEADOWS	Apr-05	Apr-05	COPPER SERVICE LINE LEAK		150,000	8 PVC
299	R-510	1405 NORTH H STREET - PANDA	Mar-24	Mar-24	8" MAIN BREAK		315,000	8 AC
300	Q-510	1004-1008 BELLFLOWER	Mar-22	Mar-22	COPPER SERVICE LINE LEAK		500,000	8 AC
298	Q-520	1120-1124 MARIGOLD WAY	Mar-17	Mar-17	SERVICE LINE LEAK		400,000	8 AC
297	T-550	317 NORTH DAISY	Mar-06	Mar-06	BROKEN SADDLE		20,000	4 AC
4,424	T-550	316 N POPPY	Feb-24	Feb-24	MAIN BREAK 4" AC		250,000	4 AC

Total Leaks Reported - 10 **Total Estimated Loss of 2,285,000 Gallons**

City of Lompoc ~ Leak Report

ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss		
2009									
296	Q-520	1113 HONEYSUCKLE WAY	Dec-28	Dec-28	PIN HOLE ON YOKE		1,500	8	AC
295	R-550	205 W CHESTNUT	Dec-26	Dec-26	BROKEN 4" WATER MAIN	7 DAY ADVENTIST	65,000	4	AC
294	P-570	1500 BLK W OLIVE	Dec-07	Dec-07	BROKEN YOKE	BODGER	10,000	10	AC
292	Q-520	1340 CAMILIA COURT	Oct-09	Oct-09	SERVICE LEAK		120,000	8	AC
293	S-540	727 NORTH 1ST STREET	Oct-05	Oct-05	SERVICE LEAK		1,000	8	AC
291	Q-520	1301 WEST BARTON AVENUE	Oct-01	Oct-01	SERVICE LEAK		50,000	8	AC
290	S-520	1239 RIVERSIDE DR	Sep-01	Sep-01	SERVICE LINE LEAK		20,000	6	AC
286	R-600	1395 MIGUELITO CANYON	Aug-24	Aug-24	COPPER SERVICE LEAK		5,000	8	AC
289	Q-560	613 WEST CYPRESS	Aug-23	Aug-23	BROKEN ANGLE STOP		1,260	8	AC
288	S-570	400 BLK SOUTH A ST, A-B ALLEY	Aug-09	Aug-09	MAIN LEAK / SADDLE		200,000	6	AC
287	Q-520	1305 WEST BARTON	Aug-04	Aug-04	COPPER SERVICE LEAK		50,000	8	AC
285	Q-570	1305 WEST BARTON AVE	Jul-30	Jul-30	COPPER LINE LEAK		100,000	8	AC
284	S-520	904 EAST BELL	Jul-23	Jul-23	STEEL SADDLE FAILURE		25,000	6	AC
283	R-530	906 N L STREET	May-21	May-21	COPPER YOKE LEAK		1,000	6	AC
282	Q-510	1113 BELLFLOWER LN	May-08	May-08	COPPER SERVICE LEAK		80,000	8	PVC
281	R-560	120 W HICKORY	May-07	May-07	SERVICE BREAK		10,000	6	AC
280	Q-560	917 & 921 W HICKORY	May-06	May-06	BLOWN OUT SADDLE		150,000	6	AC
278	Q-560	901 WEST CYPRESS	Apr-27	Apr-27	PINHOLE LEAK 3/4" COPPER		25,000	8	AC
277	R-520	509 BROOKSIDE	Apr-23	Apr-23	PINHOLE LEAK 3/4" COPPER		25,000	6	AC
279	S-570	1007 EAST OLIVE AVENUE	Apr-14	Apr-14	COPPER SERVICE LEAK		30,000	12	AC
276	R-510	1601 N H ST HYDRANT AT BACK	Mar-30	Mar-30	HYDRANT #764 HIT BY SEMI	BACKING SEMI TRUCK	166,000	8	AC
275	R-560	117 W OCEAN AVE IN ALLEY	Feb-18	Feb-18	CAST IRON MAIN BREAK		140,000	6	CI
273	P-550	420 NORTH Z STREET	Jan-12	Jan-12	BROKEN YOKE		1,800	6	AC
274	T-540	722 NORTH 6TH STREET	Jan-06	Jan-06	BROKEN SADDLE		60,000	6	AC

Total Leaks Reported - 24 **Total Estimated Loss of 1,337,560 Gallons**

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ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss		
2008									
272	R-530	900 NORTH H STREET	Dec-23	Dec-23	BROKEN HYDRANT BY MOVING VAN	BUDGET MOVING TRUCK	175,000	10	AC
271	Q-520	1312 STONEBROOK DRIVE	Dec-15	Dec-15	LARGE SERVICE LINE LEAK		150,000	6	AC
3,496	S-560	832 EAST OCEAN	Nov-27	Nov-27	3/4" COPPER SERVICE LINE LEAK		6,000	8	AC
3,495	R-540	1043 E PLACE	Nov-18	Nov-18	3/4 COPPER LEAK		175,000	6	AC
270	S-560	400 BLK SOUTH C-D ALLEY	Oct-23	Oct-23	6" AC MAIN BREAK	SOUTH OF R/R TRACKS	30,000	6	AC
269	S-560	1021 EAST CYPRESS ON 3RD	Oct-14	Oct-14	2" STEEL FLEX COUPLING	3RD STREET AT PEACH	30,000	10	AC
268	S-550	200 BLK N B ST	Oct-02	Oct-02	1" SADDLE LEAK		80,000	4	AC
267	P-530	1605 WEST OAK PLACE	Sep-08	Sep-08	COPPER SERVICE LEAK		30,000	10	AC
266	T-570	313 BARRINGTON	Aug-25	Aug-25	YOKE LEAK		5,000	6	AC
265	R-550	327 NORTH E STREET	Aug-11	Aug-11	COPPER LEAK		50,000	6	AC
263	Q-510	1001 BELLFLOWER	Aug-04	Aug-04	COPPER LEAK		100,000	8	AC
264	Q-520	1216 JASON DRIVE	Aug-01	Aug-01	COPPER LEAK		80,000	8	PVC
258	S-540	714 NORTH 2ND STREET	May-21	May-21	PINHOLE IN YOKE		1,000	4	AC
260	S-540	916 EAST AIRPORT	May-15	May-15	BROKEN NUT ON YOKE		500	4	AC
259	P-570	2407 BALBOA COURT	May-14	May-14	PINHOLE IN YOKE		1,200	6	AC
262	S-510	PINHOLE 1" COPPER	May-10	May-10	PINHOLE 1" COPPER		5,000	6	PVC
261	R-570	IN ALLEY BEHIND 511 S J STREET	May-09	May-09	4" AC FLEX BREAK		20,000	4	AC
255	S-540	D-E ALLEY AT AIRPORT	Feb-18	Feb-18	6" AC MAIN BLEW UP		500,000	6	AC
253	S-580	664 UNIVERSITY DRIVE	Jan-29	Jan-29	BLOWN SERVICE SADDLE		10,000	6	AC
254	R-580	765 MIG CYN W/O CREEK	Jan-07	Jan-07	12" AC COUPLING RUBBER		325,000	12	PVC

Total Leaks Reported - 20 **Total Estimated Loss of 1,773,700 Gallons**

City of Lompoc ~ Leak Report

ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss	
2007								
251	Q-520	1220 WEST BROOK	Sep-17	Sep-17	COPPER PINHOLE		15,500	6 AC
249	T-560	BERKLEY AT 7TH	Aug-30	Aug-30	CITY ELECTRIC BACKHOE HIT MAIN	BROKE AC COUPLING	6,000	6 AC
252	R-570	533 S E STREET	Aug-29	Aug-29	COPPER PINHOLE		10,800	8 AC
250	R-540	G/H ALLEY AT MAPLE	Aug-22	Aug-22	PINHOLE ON 3/4 INCH BALL VALVE		500	8 AC
248	R-520	1225 North H Street	Jul-10	Jul-10	Sheared Hyd - Horse Trailer	Sansone Pkg Lot	79,550	6 AC
245	Q-550	1195 W LAUREL AVE	Apr-22	Apr-23	WATER MAIN BREAK HYDRANT RUN		28,500	6 AC
246	T-550	409 N 7TH STREET	Apr-06	Apr-06	PIN HOLE COPPER		10,000	6 AC
244	P-570	1702 WEST FIR	Mar-22	Mar-22	PIN HOLE COPPER		10,000	6 PVC
243	S-510	920 EAST CALVERT	Feb-24	Feb-24	PIN HOLE COPPER LEAK		5,000	8 PVC
242	P-570	502 CORONADO DRIVE	Jan-12	Jan-12	SHEARED HYDRANT		90,000	10 AC
241	R-560	SOUTH ALLEY AT SOUTH B STREET	Jan-04	Jan-04	SHEARED HYDRANT		20,000	6 AC

Total Leaks Reported - 11 **Total Estimated Loss of 275,850 Gallons**

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ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss		
2006									
238	Q-550	228 N N STREET IN ALLEY	Dec-27	Dec-27	1" Galvanized tee broke		7,500	6	AC
237	S-560	SOUTH B STREET AT SOUTH ALLEY	Dec-07	Dec-07	6" AC FLEX BREAK		15,000	6	AC
236	Q-550	O St north of Laurel Ave	Oct-30	Oct-30	4" Main Coupling Broke		50,000	8	AC
234	P-510	V STREET AND CENTRAL AVENUE	Sep-26	Sep-26	SHEARD OFF HYDRANT		73,500	10	AC
235	R-570	300 BLK S E/F ALLEY	Sep-19	Sep-25	4" AC FLEX BREAK		100,000	6	AC
233	R-480	H STREET & HIGHLANDS ENTRANCE	Sep-12	Sep-12	VEHICLE VS HYDRANT		20,000	10	PVC
232	P-520	W/END AUDUBON 1600 BLK	Aug-22	Aug-22	CONTRACTOR PULLED OFF KICKER		40,000	8	AC
231	Q-560	115 SOUTH N STREET	Jul-27	Jul-27	COPPER LINE LEAK	OLD 4 INCH MAIN	10,000	4	AC
230	Q-550	1200 WEST LAUREL AVENUE	Jul-25	Jul-25	1" COPPER VS ELECTRIC BACKHOE	Backhoe won	2,000	6	AC
228	Q-510	350' E/O BARTON AVE ON CENTRAL	Jun-07	Jun-07	1.5" GLUE JOINT FAILURE	MEADOWS SERVICE LINE	50,000	10	AC
229	P-570	2000 MALIBU WAY BLOW OFF	Jun-01	Jun-01	PINHOLE IN 2" GALV RISER	BLOW OFF	5,000	6	AC
239	P-660	533 SOUTH E STREET	May-18	May-18	COPPER PIN HOLE LEAK		20,000	8	AC
240	R-570	FRICK UPPER PRESSURE STATION	May-04	May-04	CRACK 1 1/2" Brass Pipe		300,000	8	STL
227	Q-540	1117 W AIRPORT	Mar-17	Mar-17	5/8 ANGLE STOP BROKEN OFF PIPE		2,700	6	AC

Total Leaks Reported - 14 **Total Estimated Loss of 695,700 Gallons**

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ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss	
2005								
226	R-520	1209 N G STREET	Dec-30	Dec-30	PINHOLE IN 3/4" COPPER		5,000	6 AC
223	Q-520	1112 HONEYSUCKLE WAY	Dec-19	Dec-19	PIN HOLE IN 3/4" COPPER		100,000	8 AC
224	Q-550	640 NORTH Q STREET	Dec-12	Dec-12	ILLEGAL SADDLE ON 12" YOKE		10,000	8 AC
225	Q-570	Q & LOCUST	Dec-09	Dec-09	FIRE HYDRANT RUN BLEW		11,000	6 AC
222	S-520	1204 N C STREET	Nov-28	Nov-28	PIN HOLE IN COPPER YOKE		250	6 AC
221	Q-520	1377 VIOLA WAY IRRIGATION MTR	Nov-14	Nov-14	LEAK ON 2" GALVANIZED		250,000	8 AC
220	S-550	300 NORTH 2ND STREET	Sep-29	Sep-29	STEEL SADDLE BREAK		20,000	6 AC
219	R-560	117 WEST OCEAN AVENUE	Aug-15	Aug-15	HOLE IN 6" CAST IRON PIPE		200,000	6 CI
218	R-520	1110 PARKSIDE WAY	Jul-06	Jul-06	1/16" HOLE IN 3/4" COPPER		100,224	8 AC
217	S-520	Fire Station Number 2	Jun-21	Jun-21	1 1/2" PVC LEAK ON BO		3,000	8 AC
216	Q-510	1021 & 1025 BELLFLOWER LANE	May-31	May-31	1/16" HOLE ON 1" COPPER	60 DAY LEAK	100,000	8 AC
213	Q-550	823 WEST LAUREL AT FH#948	Mar-23	Mar-23	SHEARD HYDRANT #948		76,500	6 AC
212	S-550	619 EAST WALNUT AVENUE	Mar-18	Mar-18	STEEL SADDLE BREAK		72,000	4 AC
215	P-510	1801 WEST CENTRAL AVENUE	Mar-08	Mar-08	CRACKED ANGLE STOP		2,000	8 PVC
208	S-560	CYPRESS & SECOND	Feb-28	Feb-28	MAIN BREAK SERVICE SADDLE		15,000	6 AC
211	S-560	205 S SECOND STREET	Feb-27	Feb-27	STEEL SADDLE LEAK		80,000	6 AC
209	S-550	416 NORTH SIXTH STREET	Feb-15	Feb-15	PIN HOLE COPPER LEAK		10,000	6 AC
210	Q-520	1216 JASON DRIVE	Feb-01	Feb-01	PIN HOLE COPPER LEAK		5,000	8 PVC
207	R-570	OLIVE AVENUE AT J/K ALLEY	Jan-05	Jan-05	CONTRACTOR BROKE MAIN		5,000	6 AC

Total Leaks Reported - 19 **Total Estimated Loss of 1,064,974 Gallons**

City of Lompoc ~ Leak Report

ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss		
2004									
206	R-570	S H STREET AT LOCUST AVENUE	Dec-29	Dec-29	8" COUPLING RUBBED		50,000	8	AC
205	S-560	OCEAN AVENUE & 5TH	Dec-20	Dec-20	SHEARED OFF HYDRANT		45,000	8	AC
204	P-510	1641 WEST CENTRAL AVENUE	Nov-02	Nov-02	8" C900 SPLIT DUE TO TAP		5,000	8	PVC
203	R-540	700 NORTH H STREET (DOMINOES)	Nov-02	Nov-02	ELEC BROKE 1.25 SERV LINE		5,000	2	PVC
202	S-560	135 NORTH B STREET	Oct-21	Oct-21	LEAKING OLD REPAIR CLAMP		15,000	6	AC
201	S-570	419 SOUTH D STREET	Oct-07	Oct-07	STEEL SADDLE		5,000	4	AC
200	Q-520	1425 GLENN ELLEN LANE	Oct-03	Oct-03	BOTTOM PLATE		600	8	PVC
198	R-490	UPLANDS PUMP HOUSE	Jul-23	Jul-23	PUMP HOUSING BROKE		500,000	14	PVC
197	P-560	100 N Z STREET IN ALLEY	Jul-15	Jul-15	6" AC FLEX BREAK		30,000	6	AC
199	R-570	510 S L STREET	Jul-07	Jul-07	SADDLE LEAK		4,000	4	AC
196	R-560	700 BLK E OCEAN - SOUTH ALLEY	May-24	May-24	BROKEN T ON CORP ON SERV SADDL		4,000	6	AC
195	R-520	1300 N L ST	Apr-17	Apr-17	4" CUSTOMER LINE BROKE 1" SERV		87,000	6	AC
192	S-570	CORNER FIR AND CLEMENS	Mar-29	Mar-29	HYDRANT HIT BY CAR		8,000	8	AC
194	Q-520	1217 IRIS COURT - MEADOWS	Mar-26	Mar-26	BROKEN ANGLE STOP		3,000	8	AC
191	R-550	317 N K STREET IN ALLEY	Mar-10	Mar-10	CONTRACT HIT SADDLE		2,000	6	AC
190	S-550	IN ALLEY BEHIND 332 N 2ND	Mar-03	Mar-03	STEEL SADDLE BLEW		17,000	6	AC
189	R-560	105 WEST OCEAN IN ALLEY	Feb-05	Feb-05	6" CAST IRON MAIN BREAK	? 12/2003 EARTHQUAKE	648,000	6	CI
188	S-520	1220 N ORCHID	Jan-26	Jan-26	BLOWN SADDLE		10,000	6	AC
187	T-550	1 & 246 S/E CORNER	Jan-05	Jan-05	2" SERVICE LINE BREAK		36,000	10	AC

Total Leaks Reported - 19 **Total Estimated Loss of 1,474,600 Gallons**

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ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss	
2003								
186	S-570	917 EAST FIR AVENUE	Dec-18	Dec-18	1" COPPER LINE LEAK		40,000	6 AC
185	S-530	836 N D STREET	Dec-08	Dec-08	1" HOLE IN 12" AC COUPLING	ROLLED RUBBER	1,486,000	8 AC
183	R-520	AT HYDRANT #1251	Nov-21	Nov-21	HYDRANT HIT BY VEHICLE		144,000	6 AC
184	S-560	SOUTH ALLEY AT SOUTH B STREET	Nov-18	Nov-18	6" AC FLEX BREAK		26,000	6 AC
180	Q-550	WALNUT AVE AT N R STREET	Oct-20	Oct-20	6" AC FLEX BREAK BY CONT	GRANITE CONSTRUCTION	1,000	6 AC
182	O-510	2537 WEST CENTRAL AVENUE	Oct-01	Oct-01	LEAK ON 1.5 SERVICE LINE		10,000	8 AC
179	Q-510	1105 BELLFLOWER	Sep-29	Sep-29	3/4" COPPER LEAK		10,000	8 AC
178	S-510	909 & 913 CALVERT	Sep-17	Sep-17	3/4" COPPER LEAK		10,000	8 PVC
177	R-510	300 BLOCK COMMERCE COURT	Sep-10	Sep-11	HYDRANT KNOCK OVER		124,000	6 AC
176	Q-520	ARNOLD AVE AT ARCHER, HYD 1454	Aug-30	Sep-02	HYDRANT RUN OVER BY CAR	PD RPT # 0308-3002	140,000	6 AC
174	R-530	1040 NORTH H STREET	Jul-29	Jul-29	SHEARED HYDRANT		660,000	14 AC
175	S-560	B/C ALLEY AT HICKORY	Jul-27	Jul-27	VANDALISM - OPENED HYDRANT	LPD RPT # 03-08-0548	5,278	4 AC
173	S-540	821 & 825 NORTH H STREET	Jun-16	Jun-16	PINHOLE IN COPPER		400,000	6 AC
172	Q-560	O STREET AT SOUTH ALLEY FH	Jun-04	Jun-04	LEAK IN MAIN	NEW MAIN AND FH	10,000	4 AC
171	S-550	222 N D STREET C/D ALLEY	May-15	May-15	STEEL SADDLE		5,000	4 AC
170	P-550	323 N W ST & 320 N X ST	May-07	May-07	SERVICE SADDLE FAILURE		50,000	6 AC
168	P-540	V ST & AIRPORT	Apr-13	Apr-13	REPLACED HYDRANT	SHEARED HYDRANT	102,000	6 AC
169	Q-530	1300 WEST OAK AVENUE	Apr-01	Apr-16	REPAIR CLAMP PROBLEM	REDO FAILED REPAIR	153,000	10 AC
167	R-570	310 EAST LOCUST	Mar-17	Mar-17	3/4" COPPER LEAK		2,000	8 AC
165	R-510	1436 NORTH H STREET	Feb-15	Feb-15	PVC SERVICE LINE LEAK		3,000	4 AC
166	S-550	CHESTNUT AND D STREET	Feb-12	Feb-12	4" AC MAIN BREAK		10,000	8 PVC
164	S-540	504 E MAPLE	Jan-30	Jan-30	LEAK ON 5/8" COPPER YOKE		2,000	6 AC
163	Q-560	1208-1209 WEST HICKORY	Jan-29	Jan-29	1/8" LEAK IN 3/4" COPPER		200,000	6 AC
Total Leaks Reported - 23							**Total Estimated Loss of 3,593,278 Gallons**	
2002								
162	R-580	BETWEEN 5 & 6 SANTA CLARA	Dec-17	Dec-17	6" MAIN BREAK	BROKE BY CONTRACTOR	39,500	6 AC
Total Leaks Reported - 1							**Total Estimated Loss of 39,500 Gallons**	

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ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss		
2001									
75		224 225 226 229 N W/X ALLEY	Feb-22	Feb-22	1" STEEL SADDLE BREAK		10,000	6	AC
74		227-229 N K/L ALLEY	Feb-22	Feb-22	.75" SERVICE LEAK AT SADDLE		5,000	6	AC
73		416 & 420 S O PLACE	Jan-16	Jan-16	REPLACED 5' OF COPPER LINE		40,000	12	AC
Total Leaks Reported - 3							**Total Estimated Loss of 55,000 Gallons**		
2000									
77		400 SOUTH HAWTHORNE	Dec-19		8" MAIN BREAK		150,000	8	AC
76		316 N LUPINE IN ALLEY	Dec-07		4" AC FLEX BREAK BOTTOM		120,000	4	AC
78		1116 N POPPY	Nov-18		BLOWN BOTTOM PLATE		4,080	6	AC
79		1105 BELLFLOWER	Aug-21		LEAKING COPPER		30,000	8	AC
80		304 308 AMHERST	Jul-24		LEAKING VALVE AND BROKEN SPOOL		30,000	10	AC
82		1325 JODI DRIVE	Jul-17		PIN HOLE LEAK IN COPPER	LEAK APPROX 45 DAYS	301,950	8	PVC
81		100 BLOCK S I STREET	Jul-12		FLUSHING AFTER REPAIR		2,500	6	CI
85		600 BLOCK WEST LAUREL	Jun-28		4" MAIN BLOW OUT		90,000	4	AC
87		ENTRANCE TO P.D.	Jun-19		6" THREADS BROKE ON BURY		40,000	10	AC
86		700 BLOCK W LAUREL	Jun-01		MAIN BLOW OUT		100,000	8	AC
88		1101 N X STREET	May-15		1" COPPER SERVICE LEAK		82,261	6	AC
89		717 N D STREET	Apr-23		BROKEN PVC PIPE		1,000	6	AC
90		1333 NORTHBROOK	Feb-03		BROKEN LINE TO BLOW OFF		2,000	6	AC
91		500 S H/I ALLEY	Jan-16		6" RUBBER BLOW OUT		5,000	6	AC
92		1313 N G STREET	Jan-11		1" COPPER SERVICE LEAK		2,000	6	AC
93		O STREET & PINE AVENUE	Jan-04		LEAK ON 10" MAIN		35,000	10	AC
Total Leaks Reported - 16							**Total Estimated Loss of 995,791 Gallons**		

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ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss		
1999									
95		708 SUMMERWOOD	Nov-23		BROKEN 1 1/2" SERVICE		5,000	8	AC
94		PINE & V ST	Nov-16		BLOWN OUT TEE 8X8X6		360,000	6	AC
96		100 BLOCK S E/F ALLEY	Aug-01		LEAKING SADDLE		20,000	4	AC
97		916 EAST FIR	Jun-21		1" SERVICE SADDLE LEAK		40,000	6	AC
100		1600 EAST NECTARINE AVENUE	Apr-12		LEAKING METER GASKET		100	6	AC
99		1108 WEST BARTON AVENUE	Apr-01		PIN HOLE LEAK IN SERVICE	30 DAY LEAK	50,115	8	PVC
102		1300 WEST OAK AVENUE	Mar-02		LEAK IN 10" MAIN		144,768	10	AC
101		1300 W OAK AVENUE	Mar-01		SADDLE BREAK 10" MAIN		143,690	10	AC
103		500 NORTH T IN ALLEY	Feb-03		FLEX BREAK ON 4" AC PIPE		5,000	4	AC
Total Leaks Reported - 9							**Total Estimated Loss of 768,673 Gallons**		
1998									
106		1104 & 1108 HONEYSUCKLE WAY	Nov-02		PIN HOLE IN COPPER SERVICE		12,500	8	AC
109		1249 WESTBROOK DRIVE	Aug-03		BLOWN BOTTOM PLATE		750	6	AC
112		1601 ALCOTT AVENUE	Jul-10		SERVICE LEAK		2,000	6	AC
115		SKYVIEW & OLIVE	Jun-24		LEAKING 12" VALVE		20,000	12	AC
114		1600 WEST OLIVE AVENUE	Jun-11		KNOCKED OVER HYDRANT		60,000	12	AC
113		1009 NORTH R STREET	Jun-08		LEAKING YOKE		750	6	AC
117		609 E PRUNE AVENUE	May-21		PIN HOLE IN 3/4" COPPER		43,878	6	AC
116		1300 W PRUNE AVENUE	May-12		SERVICE LEAK		350	6	AC
120		1300 N L STREET	Apr-20		HYDRANT HIT		1,000	12	AC
118		123 S J STREET	Apr-06		COMPETATIVE PLUMBING BROKE 6"		4,000	6	AC
122		V STREET YARD	Feb-11		8" AC MAIN BREAK		1,020,000	8	AC
123		608/614 NORTH THIRD IN ALLEY	Jan-22		1" COPPER HAMMERED SHUT		20,000	6	AC
Total Leaks Reported - 12							**Total Estimated Loss of 1,185,228 Gallons**		

City of Lompoc ~ Leak Report

ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss
1990							
70		706 W OCEAN	Oct-14		LEAD SEAL		4 AC
69		400 E CYPRESS	Jun-29		LEAD SEAL		10 AC
68		218 W MAPLE	Jun-09		LEAD SEAL		4 AC
67		214 W MAPLE	Jun-09		LEAD SEAL		4 AC
66		"L"/OLIVE	May-20		CORROSION		8 STL
65		600 UNIVERSITY	Feb-21		COUPLING GASKET		8 AC
64		412 S "N"	Jan-08		COUPLING GASKET		10 STL
Total Leaks Reported - 7							**Total Estimated Loss of Gallons**
1989							
63		901 W ALDEN	Dec-12		STEEL SADDLE		6 AC
62		1012 W ANTHONY	Dec-10		STEEL SADDLE		6 AC
61		1009 W FIR	Nov-30		HOT SOIL		6 AC
60		207 S "C"	Nov-29		LEAD SEAL		6 PVC
58		330 S "F"	Oct-26		COUPLING GASKET		6 AC
57		LAUREL & "E/F"	Oct-25		BEAM BREAK		6 AC
56		LOCUST & "F"	Oct-24		STEEL SADDLE		8 AC
55		1409 W MAPLE	Oct-15		LEAD SEAL		6 AC
54		412 S "M"	Jun-15		COUPLING GASKET		6 PVC
52		424 N "D"	Apr-12		LEAD SEAL		10 AC
51		405 N "I"	Mar-03		STEEL SADDLE		4 AC
Total Leaks Reported - 11							**Total Estimated Loss of Gallons**

City of Lompoc ~ Leak Report

ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss
1988							
50		403 S "L"	Nov-13		COUPLING GASKET		6 PVC
49		337 S "L"	Aug-29		CORROSION		8 PVC
48		210 S "N"	Aug-17		STEEL SADDLE		8 AC
47		422 S "N"	Jul-05		CORROSION		10 STL
46		NORTH & "D"	Jun-29		CORROSION	NOT SURE WHICH MAIN	16 AC
45		409 N "A"	Jun-01		CORROSION		10 AC
43		117 S "E"	May-17		STEEL SADDLE		4 AC
40		NO ALLEY & "E/F"	Mar-31		LEAD SEAL		6 AC
39		309 S "L"	Mar-09		CORROSION		8 PVC
Total Leaks Reported - 9							**Total Estimated Loss of Gallons**
1987							
38		414 S "M"	Sep-22		COUPLING GASKET		6 PVC
36		NORTH & "I"	Sep-05		CORROSION		10 AC
35		401 S "L"	Jul-18		COUPLING GASKET		6 PVC
34		MAPLE & "O"	Mar-23		COUPLING GASKET		6 DI
Total Leaks Reported - 4							**Total Estimated Loss of Gallons**
1985							
30		304 S 7TH	Oct-25		STEEL SADDLE		10 AC
29		1300 N ORCHID	Oct-11		LEAD SEAL		6 AC
Total Leaks Reported - 2							**Total Estimated Loss of Gallons**
1984							
28		649 UNIVERSITY	Jul-25		BEAM BREAK		6 AC
27		338 S "D"	May-17		LEAD SEAL		10 AC
Total Leaks Reported - 2							**Total Estimated Loss of Gallons**

City of Lompoc ~ Leak Report

ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss
1983							
26		SO ALLEY & "J/K"	Dec-16		STEEL SADDLE		6 AC
25		420 N "J"	Oct-18		LEAD SEAL		4 AC
24		200 E LOCUST	Sep-20		TREE ROOTS		8 AC
Total Leaks Reported - 3							**Total Estimated Loss of Gallons**
1982							
23		LAUREL & "D/E" ALLEY	Nov-18		BEAM BREAK		6 AC
22		410 S "N"	Nov-15		COUPLING GASKET		10 STL
21		330 N "Z"	Aug-05		STEEL SADDLE		6 AC
20		513 E CHESTNUT	Jun-19		STEEL SADDLE		6 AC
Total Leaks Reported - 4							**Total Estimated Loss of Gallons**
1981							
19		1119 W LAUREL	Oct-23		STEEL SADDLE		6 AC
18		1300 W LAUREL	Oct-13		CONTRACTOR		4 AC
17		1401 W GUAVA	Oct-09		TREE ROOTS		6 AC
16		400 S "L/M" ALLEY	Sep-15		COUPLING GASKET		6 PVC
15		1300 N "V"	Sep-11		BEAM BREAK		10 AC
14		427 N "A"	Aug-12		CORROSION		10 AC
13		309 S "D"	Mar-04		LEAD SEAL		10 AC
12		115 S "E"	Jan-31		STEEL SADDLE		4 AC
11		111 S "E"	Jan-03		STEEL SADDLE		4 AC
Total Leaks Reported - 9							**Total Estimated Loss of Gallons**

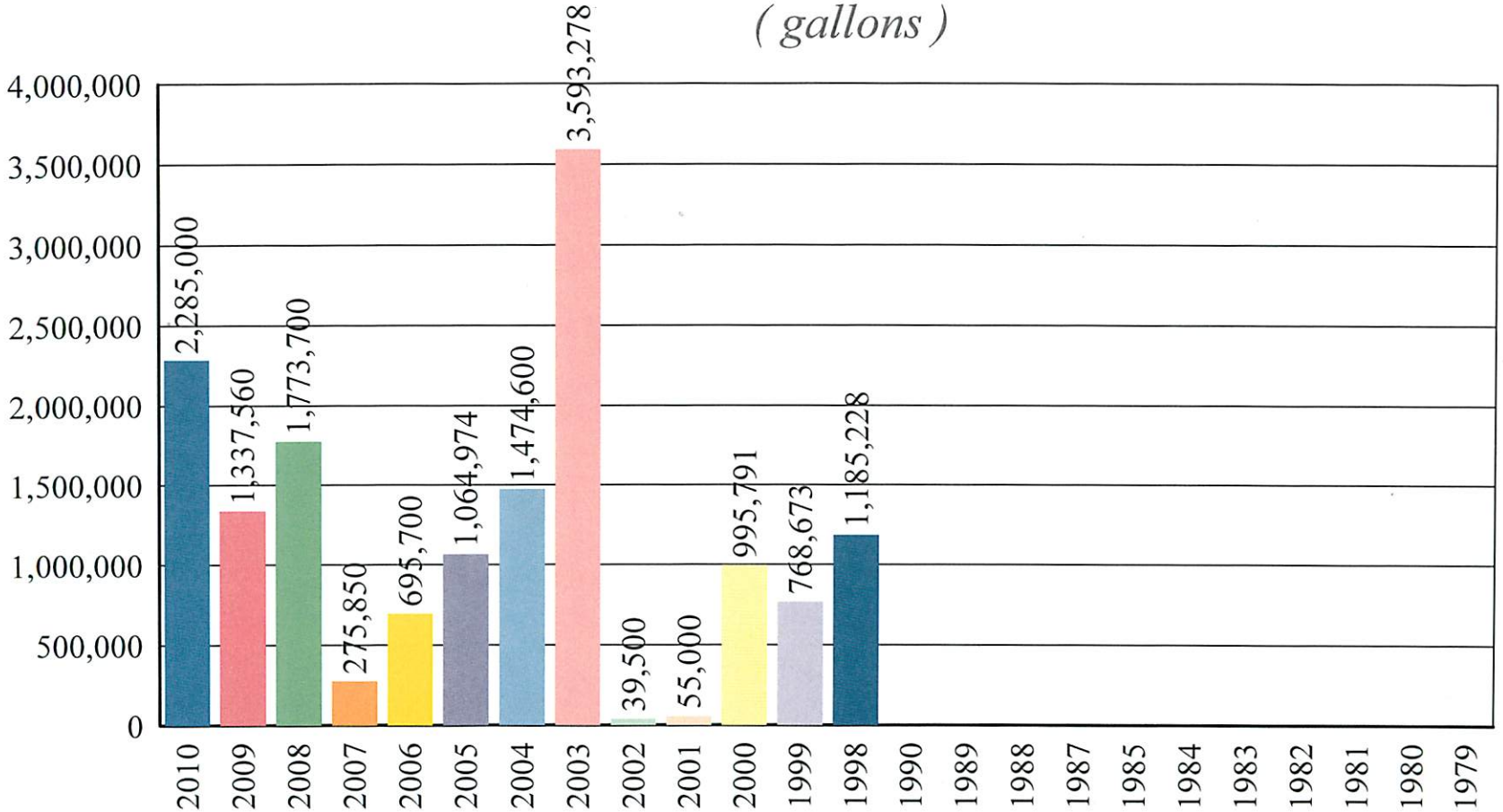
City of Lompoc ~ Leak Report

ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss
1980							
8		1505 W PINE	Aug-18		STEEL SADDLE		6 AC
7		1501 W PINE	Aug-18		STEEL SADDLE		6 AC
6		1500 W PINE	Aug-18		STEEL SADDLE		6 AC
5		S 1ST PLACE	Feb-25		BY OTHERS		6 AC
4		426 N "J"	Feb-25		LEAD SEAL		4 AC
3		422 N"J"	Feb-05		LEAD SEAL		4 AC
Total Leaks Reported - 6							**Total Estimated Loss of Gallons**
1979							
2	N-460	435 S "L/M" ALLEY	Nov-28		COUPLING GASKET		6 PVC
Total Leaks Reported - 1							**Total Estimated Loss of Gallons**

ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss

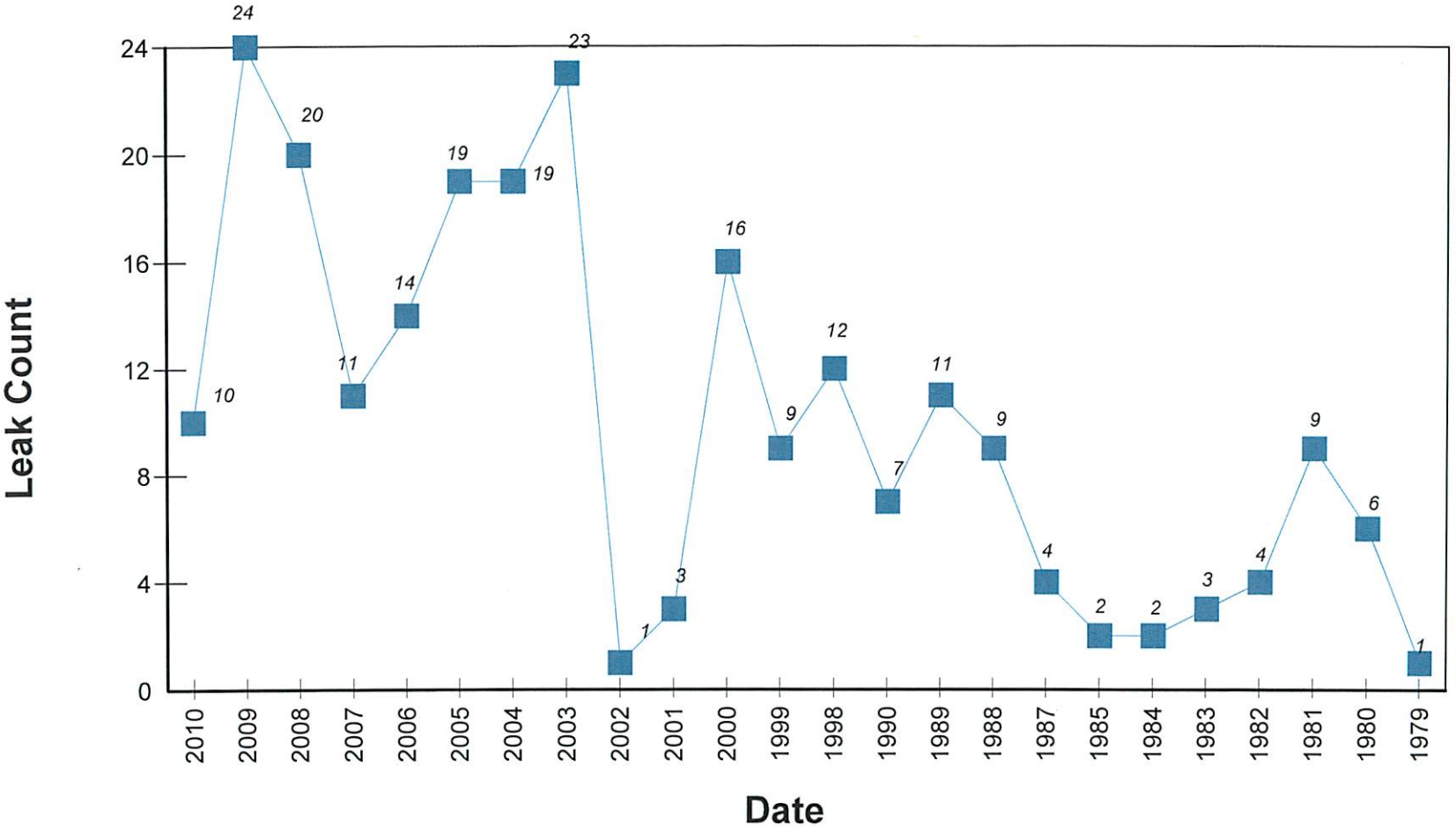
Estimated Water Loss

(gallons)



ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss

Number of leaks per year



City of Lompoc ~ Leak Report

ID	Page	Leak Location	Reported	Repaired	Repair Description	Remarks	Est. Loss

239 Records in Report

ORDINANCE NO. 1521 (06)

**An Ordinance Of The City Of Lompoc,
County Of Santa Barbara, State Of California
Adding Article 17 To Title 2 Of Chapter 50 Of The Lompoc City Code
Establishing A Cultural Resources Overlay District**

THE CITY COUNCIL OF THE CITY OF LOMPOC DOES ORDAIN AS FOLLOWS:

SECTION 1. Article 17 is hereby added to Title 2 of Chapter 50 (the Zoning Ordinance) of the Lompoc City Code to read as follows:

"Article 17. Cultural Resources Overlay District (CR).

Section 8750. Purpose and Intent.

The Cultural Resources Overlay District (CR) is intended to ensure protection of cultural resources within the City of Lompoc, while streamlining the process of development review within the Archaeological High Sensitivity Zone on the City's south side.

Section 8751. Effect of Provisions.

The provisions of this Ordinance will:

1. Establish a Cultural Resources Overlay District, identifying special development requirements for properties that are located south of Olive Avenue;

2. Add provisions to ensure protection of identified cultural resources within the City of Lompoc; and

3. Codify standard requirements that apply in case of accidental discovery of cultural artifacts during construction.

Section 8752. Definitions.

The definitions set forth in this section shall govern the construction of this Chapter.

1. Archaeological Resources. Archaeological resources consist of the physical remains of past human activity.

2. California Historical Resources Regional Information Center. The Central Coast Information Center, Department of Anthropology, University of California, Santa Barbara, Santa Barbara, CA 93106. The Central Coast Information Center is one of twelve independent regional Information Centers in California that comprise the California Historical Resources Information System (CHRIS). Each center maintains the statewide Historical Resources Inventory (HRI) database and related records for its area of responsibility.

3. Chumash Tribe. The Santa Ynez Band of Chumash Indians, headquartered in Santa Ynez, CA. Notices should be directed to the Chairman or Chairwoman of the Tribal Elders Council Governing Board for the Santa Ynez Band of Chumash Indians. The Elders request that the Tribal Elders Office be notified of any issues concerning archaeological disturbance, the finding of artifacts and/or human remains or the Native American Graves Protection and Repatriation Act. The Chumash Tribe's mailing address is P.O. Box 517, Santa Ynez, CA 93460.

4. Cultural Resources. Prehistoric and historic materials, features, and artifacts. Cultural Resources include, but are not limited to, historic structures, archaeological sites, archaeological isolates, and paleontologic resources (Reference Section 8754 of this Article).

5. Demolition. The removal, destruction, or partial destruction of any structure or structures, including walls.

6. Discretionary Permits. Permits which are not ministerial, those on which a decision must be made, including, for example, grading permits and development review permits, but not building permits.

7. Development Proposals. Any application for development granted or issued by the Planning Division, Building Division, or Engineering Division (development review, grading permit, building permit, or demolition permit).

8. Ground Disturbance. Any excavation, at any depth, for which a building, grading or planning permit is required, except excavation in areas and to depths that can be identified as having been previously disturbed.

9. High Sensitivity Zone. An area that includes a high density of recorded archaeological sites, although only a small proportion of its area has been surveyed. (The High Sensitivity Zone can be found on the Archaeological Sensitivity Zones Map in the Resource Management Element of the City's General Plan.) On a given project site, only the portion of that site with a slope of less than 30% will be considered to be within the high sensitivity zone.

10. Historic Archaeological Resources. Archaeological Resources that have been determined to meet one or more of the following criteria:

    (a) The resources are associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage;

    (b) The resources are associated with the lives of persons important in our past;

    (c) The resources embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual, or possess high artistic values; or

(d) The resources have yielded, or may be likely to yield information important in prehistory or history.

11. Historic Context. A unit created for planning purposes that groups information about historic properties based on a shared theme, specific time period, and geographical area.

12. Historic Property. A district, site, building, structure, or object significant in North American history, architecture, engineering, archaeology, or culture at the national, state, or local level.

13. Historic Resource. Includes, but is not limited to, districts, ensembles, thematic groups, corridors, structures, bridges, buildings, sites, cemeteries, landscape features, signs, plaques, archaeological sites or artifacts, or other objects that may have historic, cultural and/or architectural significance, locally, regionally, or nationally. A historic site is considered to be the location of a historic or archaeological event, activity, occupation, structure, object, or landscape feature, including existing buildings or structures on the site, which has historic significance.

14. Integrity. The authenticity of a property's historic identity, evidenced by the survival of physical characteristics that existed during the property's historic or prehistoric period.

15. Isolate. An individual archaeological artifact or group of artifacts.

16. Low Sensitivity Zone. An area having a low density of recorded archaeological sites; less available fresh water except for seasonal flows in the Santa Ynez River; less diversity of plant, animal, and mineral resources important to prehistoric and early historic peoples; steep slopes less suitable for habitation or other use; past cutting and terracing which would have destroyed, displaced, or damaged surface or shallow archaeological deposits; areas of recent and rapid geologic deposition which would have tended to bury all but the most recent archaeological sites; or urban development which would have buried or destroyed earlier sites. (The High Sensitivity Zone can be found on the Archaeological Sensitivity Zones Map in the Resource Management Element of the City's General Plan.)

17. Mission. The Misión La Purisima Concepción De María Santísima (Mission of the Immaculate Conception of Most Holy Mary), also called Mission Vieja de la Purisima, which was founded by Father Presidente Fermin de Lasuén on December 8, 1787, was the eleventh of the 21 Franciscan Missions in California. The Mission and its
related uses were located on the south side of the City of Lompoc. The Mission is named in the National Register of Historic Places (Site#78000775) and is identified as State Historic Landmark No. 928.

18. National Register Criteria. The established criteria for evaluating the eligibility of properties for inclusion in the National Register of Historic Places. (Ordinarily,

cemeteries, birthplaces, graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past 50 years are not considered eligible for the National Register.)

Criteria - Significance in North American history, architecture, archaeology, engineering, and culture present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

(a) That are associated with events that have made a significant contribution to the broad patterns of our history; or

(b) That are associated with the lives of persons significant in our past; or

(c) That embody the distinctive characteristics of a type, period, or method of construction, that represent the work of a master, that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(d) That yielded or may be likely to yield, information important in prehistory or history.

19. Native American. A member of any of the indigenous peoples of the Western Hemisphere. (Lompoc was traditionally Purismeño Chumash ethnographic territory. The local tribe is the Santa Ynez Band of Mission Indians, with headquarters in Santa Ynez, CA.)

20. Non-unique Archaeological Resource. An archaeological artifact, object, or site that does not contain information needed to answer important scientific research questions, where there is a demonstrable public interest in that information; has no special and particular quality such as being the oldest of its type or the best available example of its type; or has no direct association with a scientifically recognized important prehistoric or historic event or person. A non-unique archaeological resource need be given no further consideration, other than simple recording of its existence by the lead agency, if it so elects.

21. Paleontologist. A scientist who studies paleontology, learning about forms of life that existed in former geologic periods, chiefly by studying fossils.

22. Paleontologic Resources. Fossils that are studied for what they are able to reveal about the ecologies of the past, evolution, and humans' relationship to them.

23. Phase 1 Study. The assessment, by a qualified archaeologist, of a site through a review of archival records and a field survey of the project area. Field surveys on sites of high sensitivity are to be conducted on foot along transects spaced not more than 15 meters (approximately 50 feet) apart. Field surveys of sites of low

sensitivity are to be conducted so that selected areas where resources are expected to occur are examined.

24. Phase 2 Study. The assessment, by a qualified archaeologist, of an identified archaeological site to determine its extent, integrity, and significance.

25. Phase 3 Study. Data recovery by a qualified archaeologist, generally used when a significant site cannot be reasonably avoided or preserved by the proposed development.

26. Preservation. The act or process of applying measures necessary to sustain the existing form, integrity, and materials of a historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the ongoing maintenance and repair of historic materials and features, rather than extensive replacement and new construction. New exterior additions to historic structures are not within the scope of this treatment; however, the limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a preservation project.

27. Qualified Archaeologist. An archaeologist who meets the standards of the National Register in archaeology, prehistoric archaeology, or historic archaeology, whichever applies most closely to the site or artifacts in question.

The minimum professional qualifications in archaeology are a graduate degree in archaeology, anthropology, or closely related field, plus:

(a) At least one year of full-time professional experience or equivalent specialized training in archeological research, administration, or management;

(b) At least four months of supervised field and analytic experience in general North American archaeology; and

(c) Demonstrated ability to carry research to completion.

In addition to these minimum qualifications, a professional in prehistoric archaeology shall have at least one year of full-time professional experience at a supervisory level in the study of archeological resources of the prehistoric period. A professional in historic archaeology shall have at least one year of full-time professional experience at a supervisory level in the study of archeological resources of the historic period.

28. State Historic Preservation Office (SHPO). The California governmental agency charged with preserving and enhancing California's irreplaceable historic heritage as a matter of public interest so that its vital legacy of cultural, educational, recreational, aesthetic, economic, social, and environmental benefits will be maintained and enriched for present and future generations.

29. Substantial Adverse Change. Demolition, destruction, relocation or alteration of the resource or its immediate surroundings resulting in the significance of the resource being materially impaired.

30. Unique Archaeological Resource. An archaeological artifact, object, or site demonstrating, without merely adding to the current body of knowledge, a high probability of meeting any of the following criteria:

(a) Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information; or

(b) Has a special and particular quality such as being the oldest of its type or the best available example of its type; or

(c) Is directly associated with a scientifically recognized important prehistoric or historic event or person.

Section 8753. Applicability

This Article applies to all development proposals. The following development proposals shall comply with all of the provisions of this Article:

A. Development proposals for which applications were received by the Planning, Engineering, or Building Divisions, but not approved prior to the effective date of this Chapter.

B. Development proposals, grading permit applications and building permit applications filed after the effective date of this Chapter.

C. Private facilities, including utilities, in the public right-of-way.

D. Public facilities within and outside of the public right-of-way.

E. Development proposals for annexation and/or development of property outside City limits at the time of application.

Development proposals, grading permits and/or building permits issued, on or prior to the effective date of this Article, shall be exempt from the requirements of this

Article, but remain subject to any conditions of approval related to cultural resource protection that were applied to the proposed project(s).

Section 8753. 1 Demolition

Demolition that requires ground-disturbance is subject to the provisions of this Article.

Section 8753.2 Non-conforming Facilities

Non-conforming Facilities are subject to the requirements of Sections 8860 et seq., Non-conforming Uses, Structures, and Lots. New construction or demolition on sites with non-conforming structures shall comply with all the provisions of this Article.

Section 8753.3 Modifications to Existing Structures or Facilities

Modifications to existing structures or facilities that require a building permit are subject to the requirements of this Article, if the modifications will involve or require ground disturbance.

Section 8754. Types of Cultural Resources

There are several different types of cultural resources. These include: historic resources, paleontological resources, and archaeological resources classified as historic, unique, and non-unique. It is not uncommon to have more than one type of cultural resource located in the same area or on the same site. Areas such as river valleys and wetlands that were desirable for prehistoric creatures also may have provided construction materials, water and food sources for Native Americans. Explorers, missionaries and settlers may have later used these same sources, for many of the same reasons. Therefore, classification of some cultural resource sites can be difficult. For example, while there are no identified sites in Lompoc that are associated only with Paleontologic resources, there are combined sites where historic, historic archaeological and paleontologic remains have been found. Because there are no known paleontologic resource sites in Lompoc, specific recommendations, beyond those included in the standard accidental discovery conditions for cultural resources, have not been made.

Section 8755. Environmental Review

The City of Lompoc's General Plan, Resource Management Element, addresses Cultural Resource Protection, including historic structures and archaeological resources. This element divides the City into two areas with respect to archaeological resources, those in the high sensitivity zone and those in the low sensitivity zone. In addition, archaeological resources are classified as being historic, unique and historic, unique or non-unique. The following section discusses the requirements under this Ordinance for environmental review of cultural resources in these differing classifications.

A. Historic Structures. Individual environmental documentation shall be prepared for any proposal involving a historic structure, place or landmark, as a part of the evaluation of the proposed project.

B. Historic Archaeology - Single Issue Evaluation. In cases where the only environmental issue related to a proposed development within the Cultural Resources Overlay District, High Sensitivity Zone, or on or adjacent to a known historic archaeological site, is that of cultural resources that are known, or reasonably expected to be historic archaeological resources, the Negative Declaration prepared for this Ordinance and this Ordinance may be relied upon as having adequately addressed the archaeological impact of these subsequent

projects, pursuant to the California Environmental Quality Act (CEQA). When this is the case, all of the measures required by this Ordinance for development located in an archaeologically High Sensitivity Zone or on a known historic archaeological site, shall be fully implemented as set forth in Section 8758 of this Article.

C. Multiple Environmental Issues of Potential Significance. If there are potentially significant environmental issues, in addition to historic archaeological resources, associated with a proposed project within the Cultural Resources Overlay District, High Sensitivity Zone, or on or adjacent to a known historic or archaeological site, a full environmental review, in the form of a Negative Declaration or Environmental Impact Report (EIR), must be prepared, prior to project approval.

D. Unique Archaeological Resource. If an archaeological resource is determined to be unique but does not qualify as a historic archaeological resource, a Mitigated Negative Declaration or EIR must be prepared for the proposed project. A Phase 1 study must be prepared, as well as a Phase 2 or 3 investigation if determined to be warranted by a qualified archaeologist, as a part of the environmental evaluation of the project.

If a qualified archaeologist finds that an archaeological resource is unique and cannot be avoided or preserved in place by some other means, and data recovery through excavation is the only feasible mitigation, a data recovery plan, providing for adequately recovering the scientifically consequential information from and about the resource shall be prepared and adopted, prior to any excavation or further excavation being undertaken. Data recovery shall not be required for an archaeological resource if the lead agency determines that testing or studies already completed have adequately recovered the scientifically consequential information from and about the archaeological resource, provided that such determination is recorded in the environmental document and that such studies are deposited with the California Historical Resources Regional Information Center.

E. Low Sensitivity Zone. All projects in the Low Sensitivity Zone involving 20 acres or more in size shall be required to have a Phase 1 Study, and, if cultural resources are identified, a Phase 2 and/or 3 study, as directed by a qualified archaeologist. After the Phase 1-3 studies have been completed, an environmental document shall be prepared pursuant to CEQA.

F. Non-unique Archaeological Resource. If an archaeological resource is determined to be non-unique and archaeological resources are the only environmental issues associated with the proposed development or project, a Categorical Exemption may be prepared pursuant to CEQA.

If, however, because of other potentially significant environmental issues, a Negative Declaration or EIR is prepared for the project, the non-unique archeological resource and the effect of the project on it should be noted in the initial study or EIR, but does not need to be considered further in the CEQA process.

Section 8756. Historic Structures, Places and Landmarks

Lompoc's historic structures and places are identified in Table 4 of the City of Lompoc's Cultural Resources Study, prepared by Laurence W. Spanne, M.A. in October 1988, and retained in the office of the City Clerk. Lompoc's designated Historic Landmarks 1-8 are identified on pages 30 and 31 of the Lompoc Cultural Resources Study. Two Landmarks designated after the study was published are the Douglass-Willis House at 105 E. Olive Avenue and the Veterans Memorial Building on the south side of the intersection of Locust Avenue and "H" Street. All projects that involve changes to or impacts on designated historic structures, places, and landmarks shall be reviewed through the Lompoc Planning Commission's Architectural Review Process, as described in Title 3, Chapter 2, Article 1 of the Lompoc's Comprehensive Zoning Ordinance and the City's Architectural Review Guidelines, Lompoc City Code Section 8825.

Section 8757. Reserved For Future Use

Section 8758. Development Within the Archaeological High Sensitivity Zone.

The City of Lompoc's General Plan identifies areas of high archaeological sensitivity in the Archaeological Sensitivity Zones Map in the Resource Management Element of the City of Lompoc's General Plan. The delineation of these high sensitivity zones was made by Laurence Spanne, M.A. and is taken from his City of Lompoc Cultural Resources Study, prepared in 1988, a copy of which is on file in the City Clerk's office. Much of the High Sensitivity Zone is located in the south and southeast section of the City, against the south hills, and on the alluvial fan of Miguelito Creek. Significant historic, pre-historic, and paleontologic resources have been found in these areas. On a given project site, only the portion of that site with a slope of less than 30% will be considered to be within the high sensitivity zone.

The most important historic archaeological site in the City of Lompoc is the Misión La Purísima Concepción De María Santísima and its related activity sites (SBa – 220, SBa – 221). The Mission is located south of Olive Avenue in Lompoc. A portion of the Mission site is designated on the National Register of Historic Places (Site#78000775) and is identified as State Historical Landmark No. 928. The National Register site encompasses only a very small portion of the Mission and its related activity areas.

Section 8758.1. Cultural Resource Overlay District Requirements

The Cultural Resources Overlay District applies to all property, within the City of Lompoc, located south of the centerline of Olive Avenue and its extrapolation to the east, between "V" Street and Highway 1, as shown on the Archaeological Sensitivity Zones Map found in the Resource Management Element of the Lompoc General Plan. This area has been evaluated and determined to have historic archaeological value, based on the presence of the Mission, other known archaeological sites, and Mission- related uses. This Cultural Resources Overlay District will be reflected on the City's Zoning Map with the designation of "CR". If ground-disturbing development is proposed in this area, the property owner or applicant has the option of implementing measure A or B below.

A. Phase I Evaluation Prior to construction, the project applicant shall retain a qualified archaeologist to conduct a Phase 1 study of the subject property, in relation to the proposed development. If the project area, or a portion thereof, was previously surveyed to acceptable standards, the earlier Phase 1 study can be used to satisfy this requirement for the area that was surveyed. If cultural resources are found as a result of the Phase 1 study, a qualified archaeologist shall make recommendations regarding the need for additional investigation or measures necessary to protect the archaeological resources on the subject site (Phase 2 or 3 evaluation). As development occurs, measures included in the archaeologist's report shall be implemented. If evidence of prehistoric artifacts are discovered, the Chumash Tribe shall be consulted; or

B. Monitoring Prior to construction, the applicant shall retain a qualified archaeologist to monitor all ground-disturbing work associated with the proposed project. If evidence of prehistoric artifacts is discovered, the Chumash tribe shall be consulted. If artifacts of significance are identified during ground-disturbing work, the measures stipulated in the Archaeological Protection Program shall be followed, or the Program, as amended by a qualified archaeologist, shall be followed, to preserve or curate the artifacts.

Within 30 days after completion of a Phase 1 study or monitored ground-disturbing activity, the property owner shall provide the Planning Division with a report prepared by a qualified archaeologist, verifying that the monitoring occurred as required, discussing the results of the monitoring, and identifying the significance and disposition of any artifacts discovered during monitoring.

Section 8758.2 Cultural Resource Protection Program

The following Cultural Resource Protection Program shall be implemented in cases where cultural resources are uncovered, either while a project is being actively monitored by an archaeologist or accidentally during the course of construction.

Work shall stop until a qualified archaeologist has reviewed the find and determined if it qualifies as a historic resource or a unique resource. If the find is determined to be historic or unique by the qualified archaeologist, a plan for preservation of the material shall be developed by the archaeologist and implemented. If evidence of prehistoric artifacts is discovered, the Chumash tribe shall be consulted. Preservation in place shall be the preferred manner of mitigation. If data recovery through excavation is the only feasible mitigation, a data recovery plan, providing for adequate recovery of scientifically consequential information from and about the historical resource, shall be prepared and adopted, prior to any further excavation. Data recovery shall not be required for an archaeological resource if the lead agency determines that testing or studies already completed have adequately recovered the scientifically consequential information from and about the archaeological resource, provided that the studies are deposited with the California Historical Resources Regional Information Center.

Section 8758.3 Development Within the High Sensitivity Zone, Outside The Cultural Resources Overlay District

Development, including annexation proposals, on property within the High Sensitivity Zone, but outside the Cultural Resources Overlay District, shall comply with the requirements identified in 8758.1 above.

Historic archaeological sites within the High Sensitivity Zone that are currently within the City's jurisdiction are Archaeological site numbers SBa-1751 and SBa-2066. In addition, some isolates have been found within City jurisdiction and at many archaeological sites on United States Bureau of Prisons property, lying within City limits, and under federal jurisdiction.

Section 8759. Development Within The Archaeological Low Sensitivity Zone

All development proposals, involving parcels 20 acres or more in size, within the low sensitivity zone, including General Plan amendments, zone changes, annexations, subdivision maps, and parcel maps shall be required to conduct a Phase 1 study as a part of an environmental review of the proposal. The coverage of the Phase 1 study, the need for subsequent studies, and use of previous studies shall be as set forth in Section 8758.1.

Archaeological sites currently identified within the Low Sensitivity Zone, within the City's jurisdiction, that have historic value are Archaeological site numbers SBa –3576 and SBa - 1767H. Development on or near these known historic cultural resource sites, or on or near any cultural resource sites discovered subsequent to the adoption of this Article, must comply with the requirements identified in 8761.1.

Section 8760. Accidental Discovery During Construction

Because the Lompoc Valley has been identified as having potentially significant cultural resources throughout and has not been fully surveyed, each conditionally approved development application shall have the following three conditions applied to ensure that accidental finds of cultural resources are properly evaluated. This section applies to all conditionally approved development proposals, whether they are in the high sensitivity zone or the low sensitivity zone, even if a Phase 1 study has been undertaken.

A. In the event that cultural artifacts are unearthed during excavation, work shall stop and a qualified archeologist, meeting the professional qualifications standards of the Secretary of the Interior for Archaeology, shall evaluate the find. If determined to be necessary by the archaeologist, a plan for the preservation or curation of the artifacts from the site shall be prepared by the archeologist and implemented, while being overseen by that archeologist. If evidence of prehistoric artifacts is discovered, the Chumash tribe shall be consulted. Construction work may be allowed to continue on other parts of the construction site while mitigation takes place. The archeologist shall file a resource record detailing the materials found and their disposition, as required by the State Historic Preservation Office.

B. If paleontological artifacts are unexpectedly unearthed during excavation, an evaluation of the artifacts and the site shall be conducted by an experienced paleontologist. An appropriate plan for the preservation of the artifacts shall be prepared by the paleontologist and implemented, while being overseen by that paleontologist. Construction work may be allowed to continue on other parts of the construction site while mitigation takes place.

C. If human remains are accidentally discovered or recognized during construction, all site excavation or other disturbance shall cease and the County Coroner shall be notified. Excavation shall not resume until the Coroner has determined that the remains are not subject to investigation under Government Code Section 27491 and until any required recommendations on Native American Remains have been made under Public Resources Code Section 5097.98.; Health and Safety Code Section 7050.5(b); 14 Cal. Code Regs Section 15064.5(e); or other applicable law. Construction work may be allowed to continue on other parts of the construction site while the requirements identified above are being met.

Section 8761. TABLE OF REQUIREMENTS FOR CULTURAL RESOURCE EVALUATION

Location of Proposed Development	Required Cultural Resource Process
Designated historic structures, places and Landmarks.	• Projects that involve changes to or will impact these historic structures, places and landmarks are to be reviewed through the Lompoc Planning Commission's Architectural Review Process as described in Title 3, Chapter 2, Article 1 of the City's Zoning Ordinance and Architectural Review Guidelines. An Individual Environmental Assessment under CEQA must be conducted. • Apply standard cultural resource conditions.
Development on property within the identified Cultural Resource Overlay District, where archaeology is the only environmental issue.	• Retain a qualified archaeologist to conduct a Phase 1 evaluation of the site and proposed development and if cultural resources are identified, a Phase 2 and/or 3 study; or retain a qualified archaeologist to monitor all ground-disturbing activity associated with the proposed development and implement the Archaeological Protection Program when appropriate. • Apply standard accidental discovery cultural resource conditions.
Development within the High Sensitivity Zone not within the Cultural Resource Overlay District, where the archaeological resource in question is historic and archaeology is the only environmental issue.	• Retain a qualified archaeologist to conduct a Phase 1 evaluation of the site and proposed development, and if cultural resources are identified, a Phase 2 and/or 3 study; or retain a qualified archaeologist to monitor all ground-disturbing activity associated with the proposed development and implement the Archaeological Protection Program when appropriate. • Apply standard accidental discovery cultural resource conditions.
Development within the Low Sensitivity Zone on or adjacent to an identified archaeologically historic site, where archaeology is the only issue.	• Retain a qualified archaeologist to monitor all ground-disturbing activity associated with the proposed development and implement the Archaeological Protection Plan when appropriate. • Apply standard accidental discovery cultural resource conditions.

Development in the Cultural Resources Overlay District, High Sensitivity Zone, on or adjacent to a known archaeological site, where the resources involved are historic archaeological resources, and there are other environmental issues associated with the project.	• A full environmental review, in the form of a Negative Declaration or Environmental Impact Report (EIR) must be prepared, prior to project approval. This review shall include a Phase 1 evaluation and, if cultural resources are identified, a Phase 2 and / or 3 study shall be completed if it is determined to be necessary by a qualified archaeologist. The findings of these studies shall be incorporated into the environmental review document. • Apply standard accidental discovery cultural resource conditions.
Development within the high or low sensitivity zone where the archaeological resource is determined to be unique, but not historic.	• Conduct a Phase 1 evaluation of the site and proposed development, and if cultural resources are identified, a Phase 2 and/or 3 study, as determined to be necessary by a qualified archaeologist. Once the Phase 1-3 studies have been completed, an environmental document shall be prepared pursuant to CEQA. • Apply standard accidental discovery cultural resource conditions.
Development within the Low Sensitivity Zone	• All projects involving 20 acres or more in size shall be required to have a Phase 1 Study, and if cultural resources are identified, a Phase 2 and/or 3 study. Once the Phase 1-3 studies have been completed, an environmental document shall be prepared pursuant to CEQA. • Apply standard accidental discovery cultural resource conditions.
Citywide, on Discretionary Permits for Development	• Apply standard cultural resource conditions.

Section 8762. Violations / Penalties

Any firm corporation, or person, whether as principal, agent, employee, or otherwise violating or causing the violation of any of the provisions of this Article shall be guilty of a misdemeanor, and any conviction thereof shall be punishable by a fine of not more than one thousand dollars ($1,000.00) or by incarceration in the County jail for not more than six (6) months, or by both such fine and incarceration. Any violations of these provisions shall constitute a separate offense for each and every day during which such violation is committed or continued. In addition, any violation of the divisions of this Article is hereby declared to constitute a public nuisance and, as such, may be abated or enjoined from further operation.

Section 8763. Severability

If any portion of this article is held to be unconstitutional or otherwise invalid, the validity of the remaining sections, subsection, and clauses shall not be affected thereby. The City council hereby declares that it would have adopted this Article regardless of the fact that one or more sections, subsections, sentences, clauses, or phrases may be determined to be unconstitutional or invalid.

SECTION 2. This Ordinance is effective on the thirty-first day after its enactment.

PASSED AND ADOPTED on March 7, 2006, by the following electronic vote:

AYES: Councilmember: DeWayne Holmdahl, Michael Siminski, and Mayor Dick DeWees.

NOES: Councilmember: Will Schuyler

ABSENT: Councilmember: Janice Keller

Dick DeWees, Mayor
City of Lompoc

ATTEST:

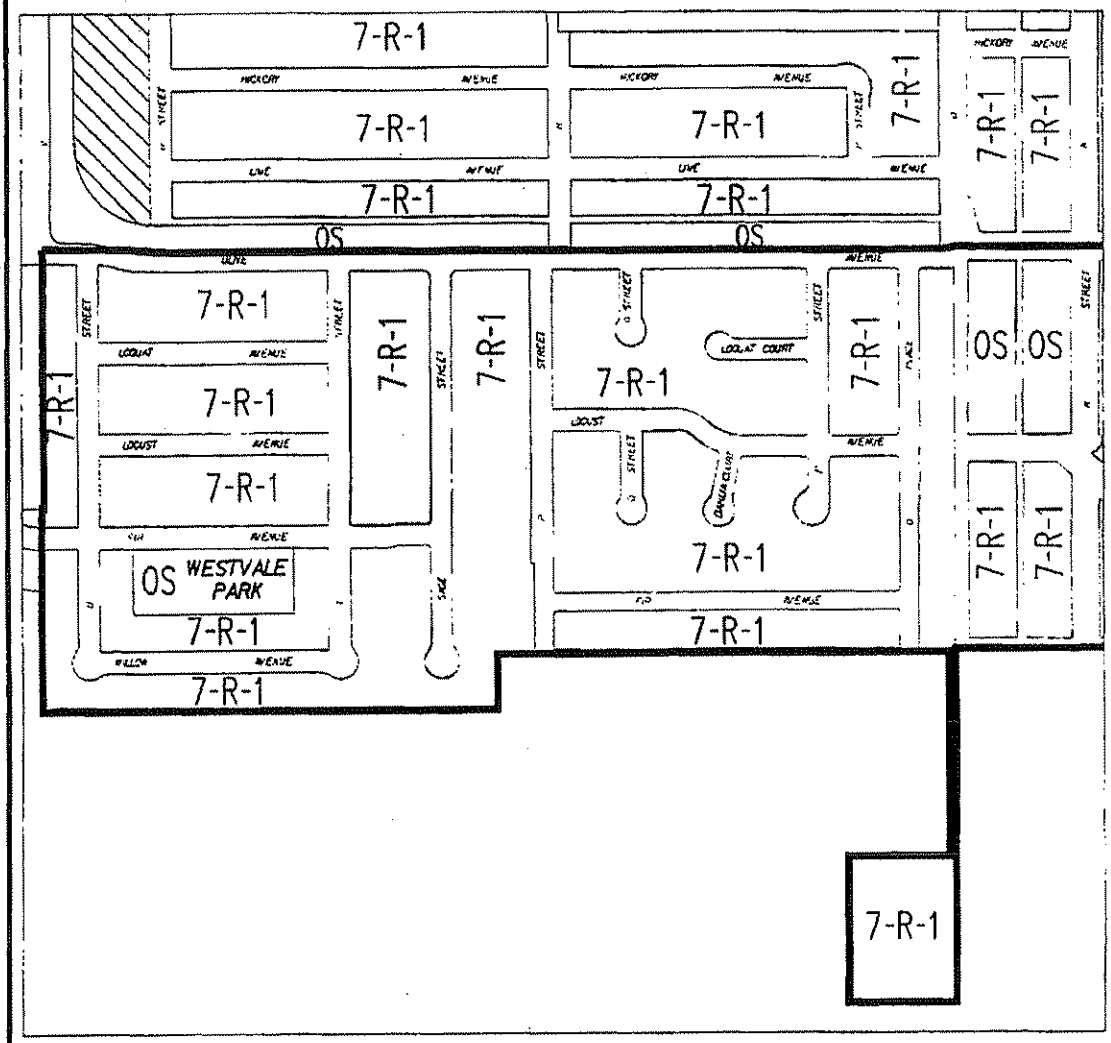
Donna N. Terrones, City Clerk
City of Lompoc

Attachment: A Exhibit A1 – Zoning Map Amendment (Existing)
Exhibit A2 – Zoning Map Amendment (Existing)
Exhibit A3 – Zoning Map Amendment (Existing)
Exhibit A4 – Zoning Map Amendment (Existing)

Exhibit B1 – Zoning Map Amendment (Proposed)
Exhibit B2 – Zoning Map Amendment (Proposed)
Exhibit B3 – Zoning Map Amendment (Proposed)
Exhibit B4 – Zoning Map Amendment (Proposed)

EXHIBIT A1

TEXT AMENDMENT (EXISTING)



10–R–1: Single Family Residential (10,000 SF)
7–R–1: Single Family Residential (7,000 SF)
OS: Open Space
PF: Public Facilities
R–2: Medium Density Residential

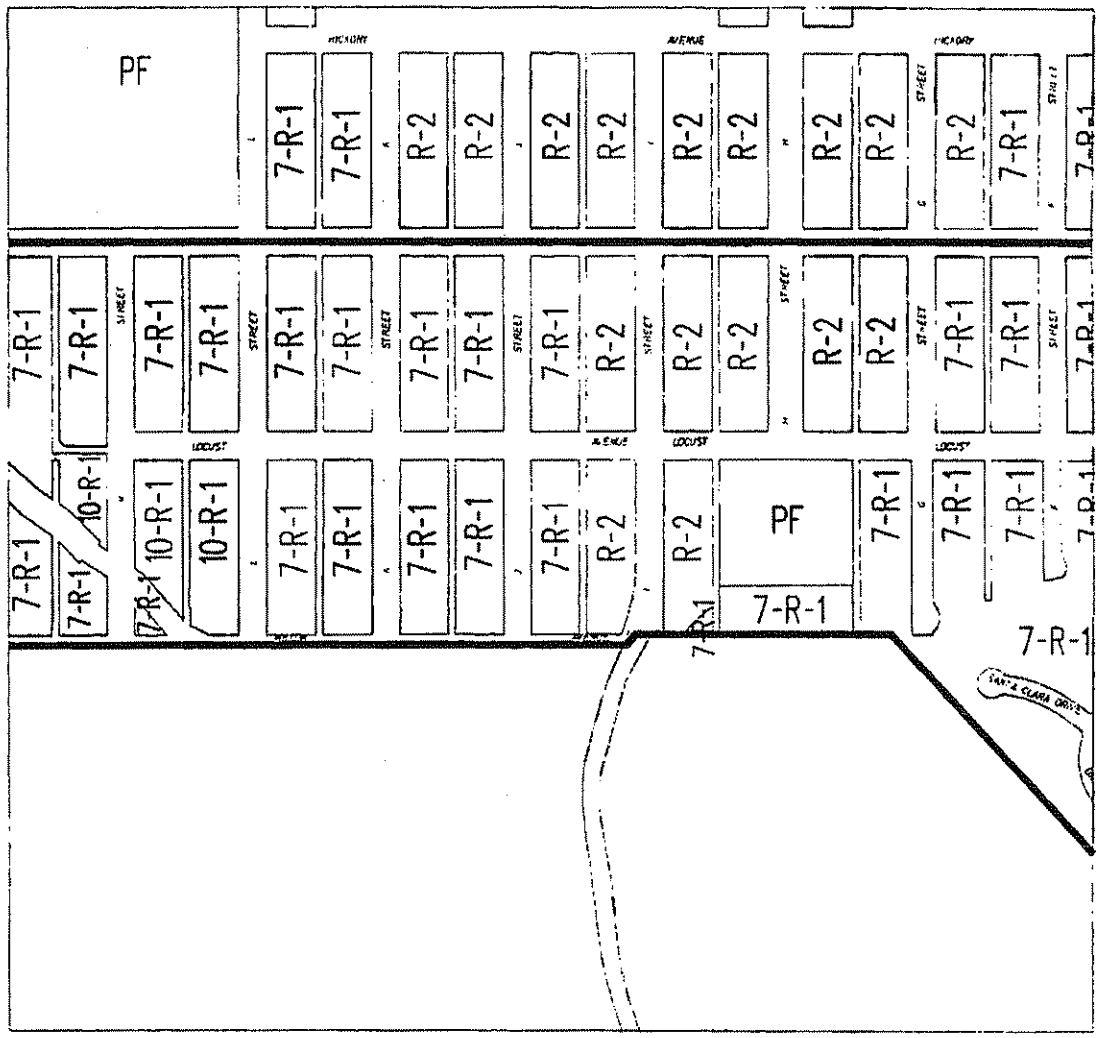
TA 05–03

NORTH

SCALE: 1" = 500'

EXHIBIT A2

TEXT AMENDMENT (EXISTING)



10–R–1: Single Family Residential (10,000 SF)
7–R–1: Single Family Residential (7,000 SF)
OS: Open Space
PF: Public Facilities
R–2: Medium Density Residential

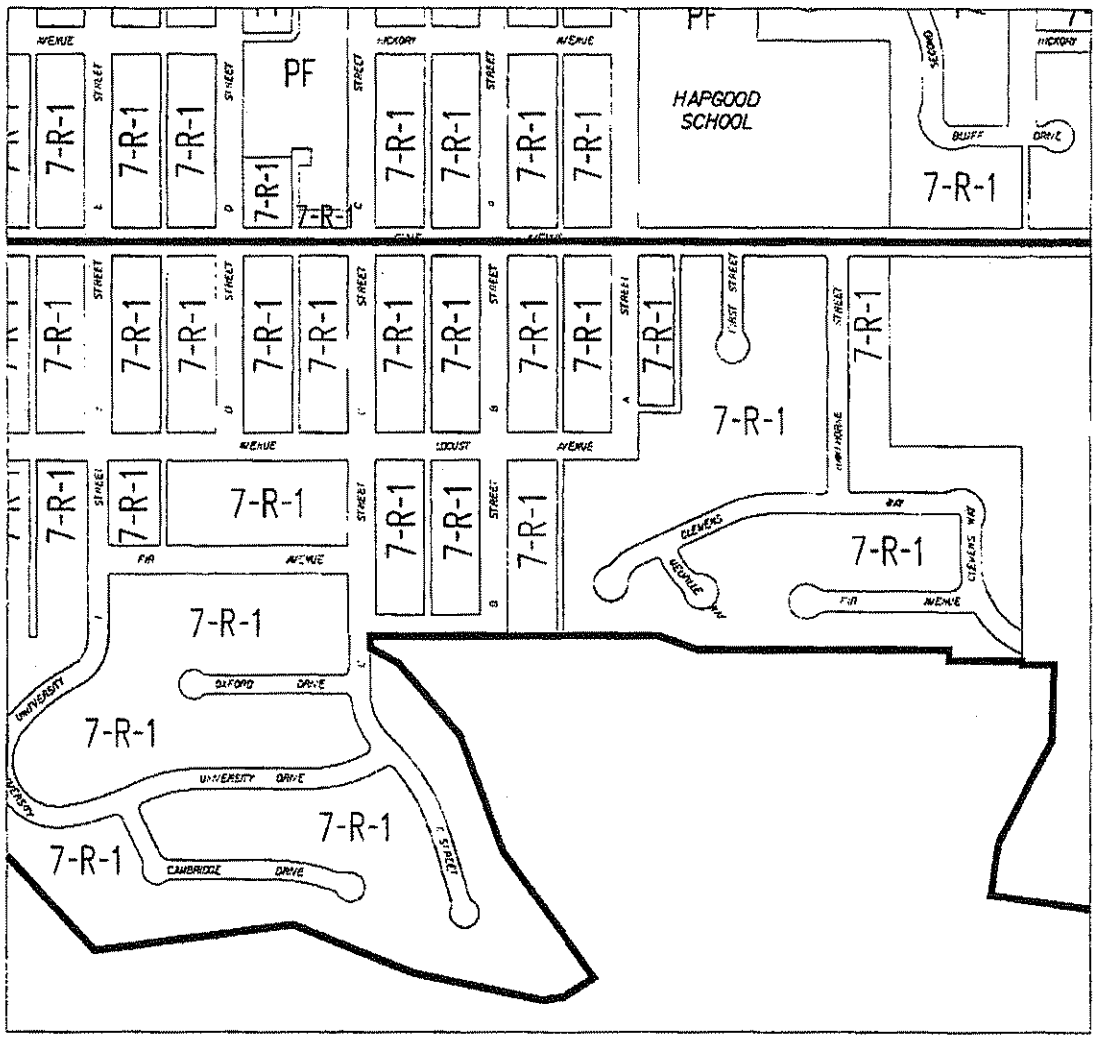
TA 05–03

NORTH

SCALE: 1" = 500'

EXHIBIT A3

TEXT AMENDMENT (EXISTING)



10–R–1: Single Family Residential (10,000 SF)
7–R–1: Single Family Residential (7,000 SF)
OS: Open Space
PF: Public Facilities
R–2: Medium Density Residential

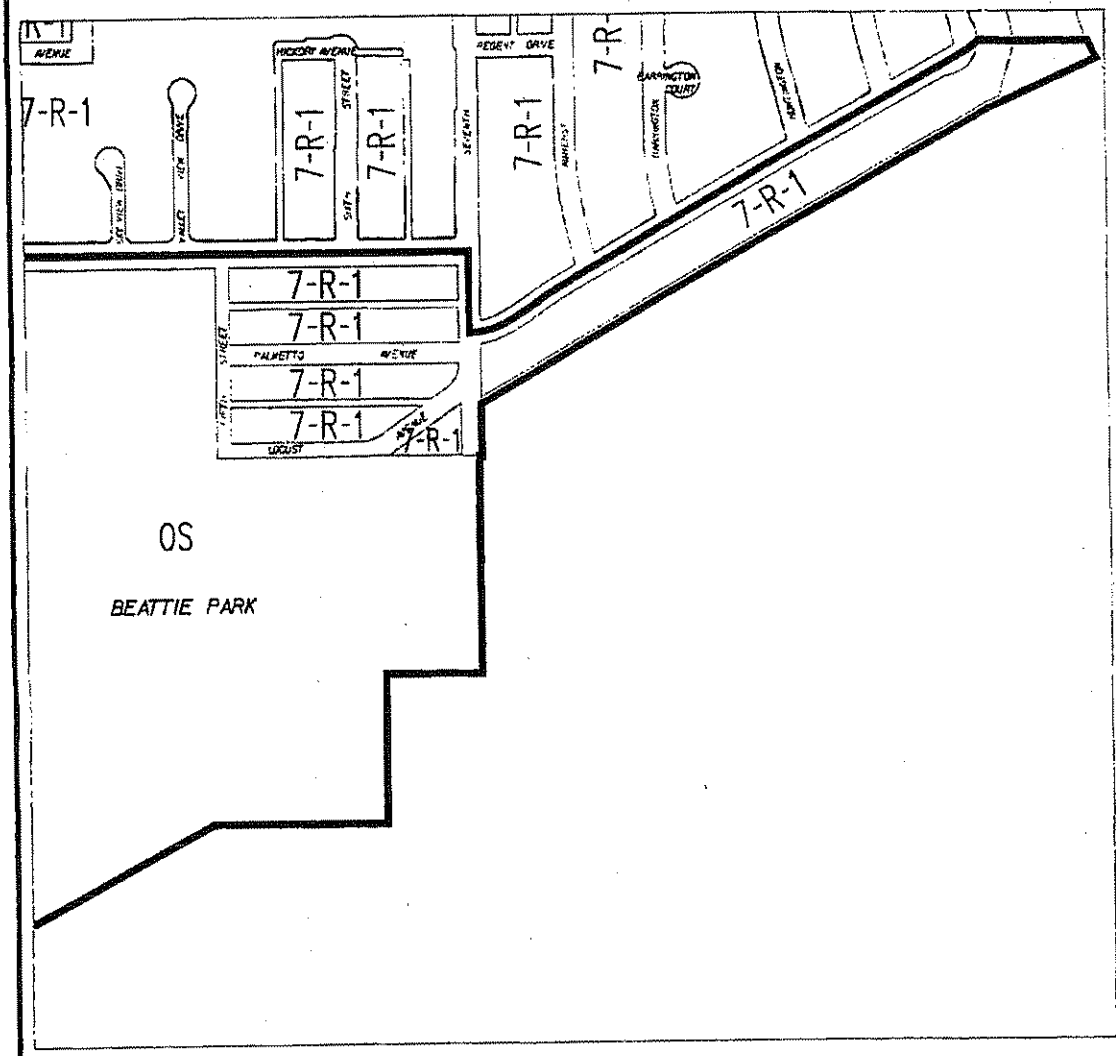
TA 05–03

NORTH

SCALE: 1" = 500'

EXHIBIT A4

TEXT AMENDMENT (EXISTING)



10–R–1:	Single Family Residential (10,000 SF)
7–R–1:	Single Family Residential (7,000 SF)
OS:	Open Space
PF:	Public Facilities
R–2:	Medium Density Residential

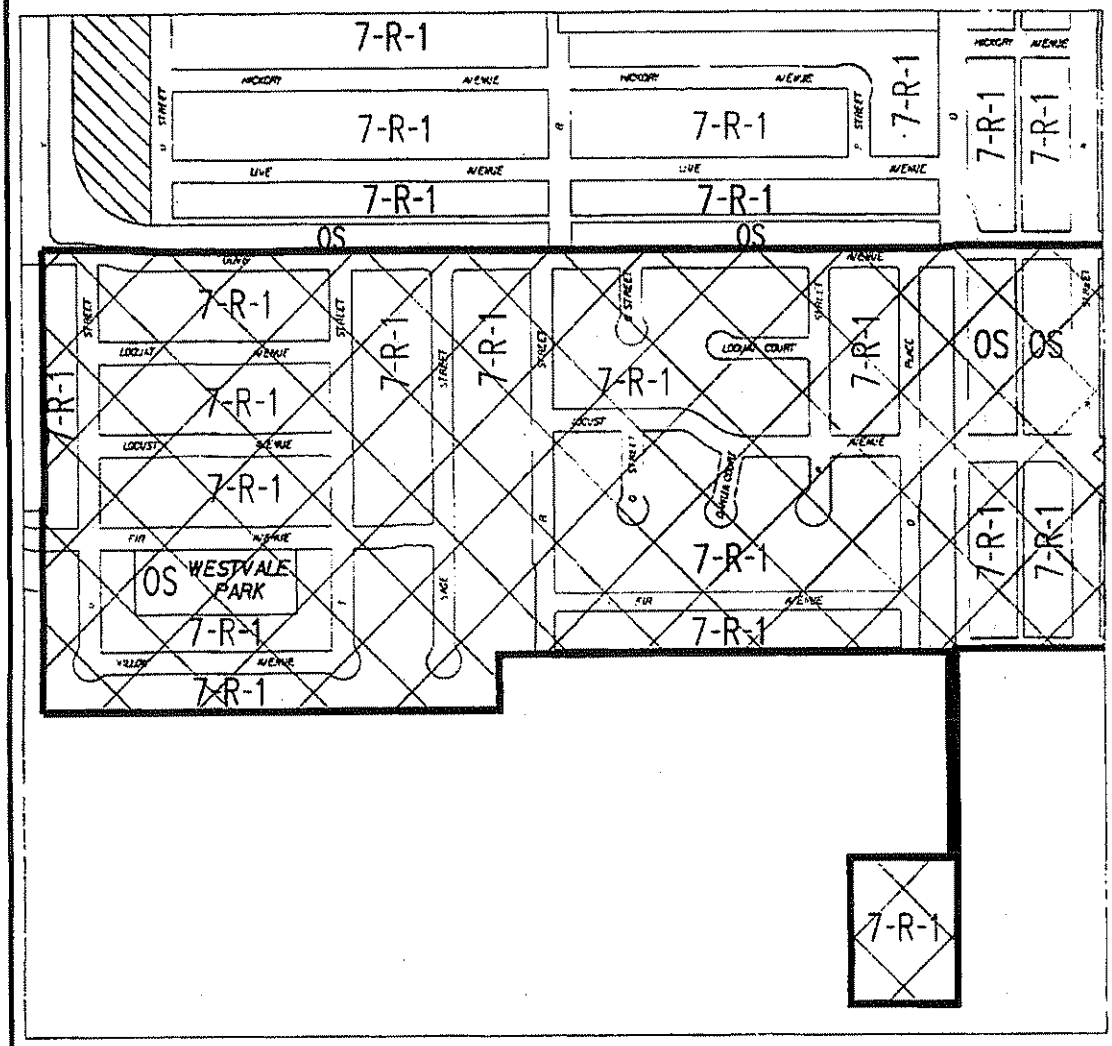
TA 05–03

NORTH

SCALE: 1" = 500'

EXHIBIT B1

TEXT AMENDMENT (PROPOSED)



10–R–1:	Single Family Residential (10,000 SF)
7–R–1:	Single Family Residential (7,000 SF)
OS:	Open Space
PF:	Public Facilities
R–2:	Medium Density Residential
	Cultural Resources (Overlay)

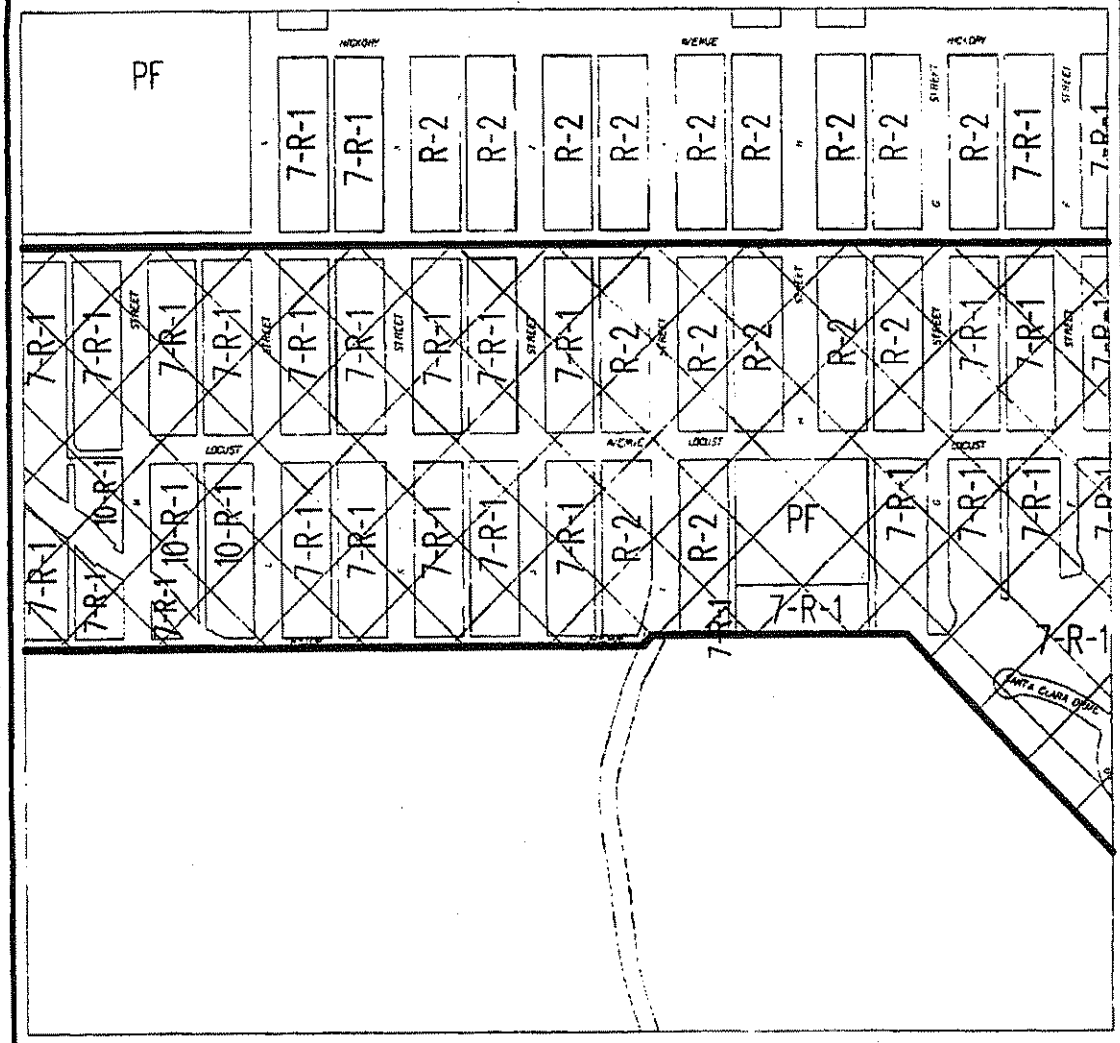
TA 05–03

NORTH

SCALE: 1" = 500'

EXHIBIT B2

TEXT AMENDMENT (PROPOSED)



10–R–1: Single Family Residential (10,000 SF)
7–R–1: Single Family Residential (7,000 SF)
OS: Open Space
PF: Public Facilities
R–2: Medium Density Residential

Cultural Resources (Overlay)

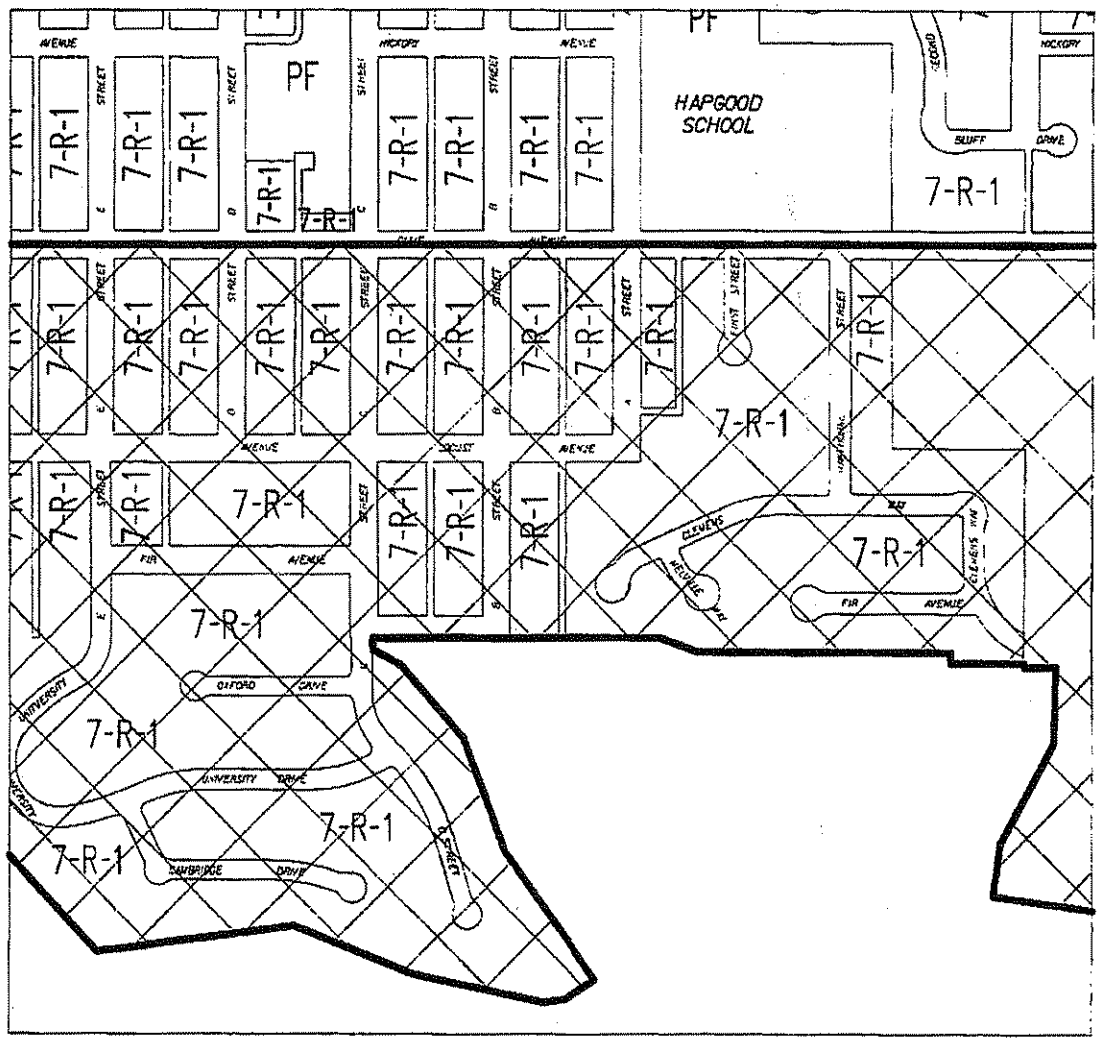
TA 05–03

NORTH

SCALE: 1" = 500'

EXHIBIT B3

TEXT AMENDMENT (PROPOSED)



10–R–1:	Single Family Residential (10,000 SF)
7–R–1:	Single Family Residential (7,000 SF)
OS:	Open Space
PF:	Public Facilities
R–2:	Medium Density Residential
	Cultural Resources (Overlay)

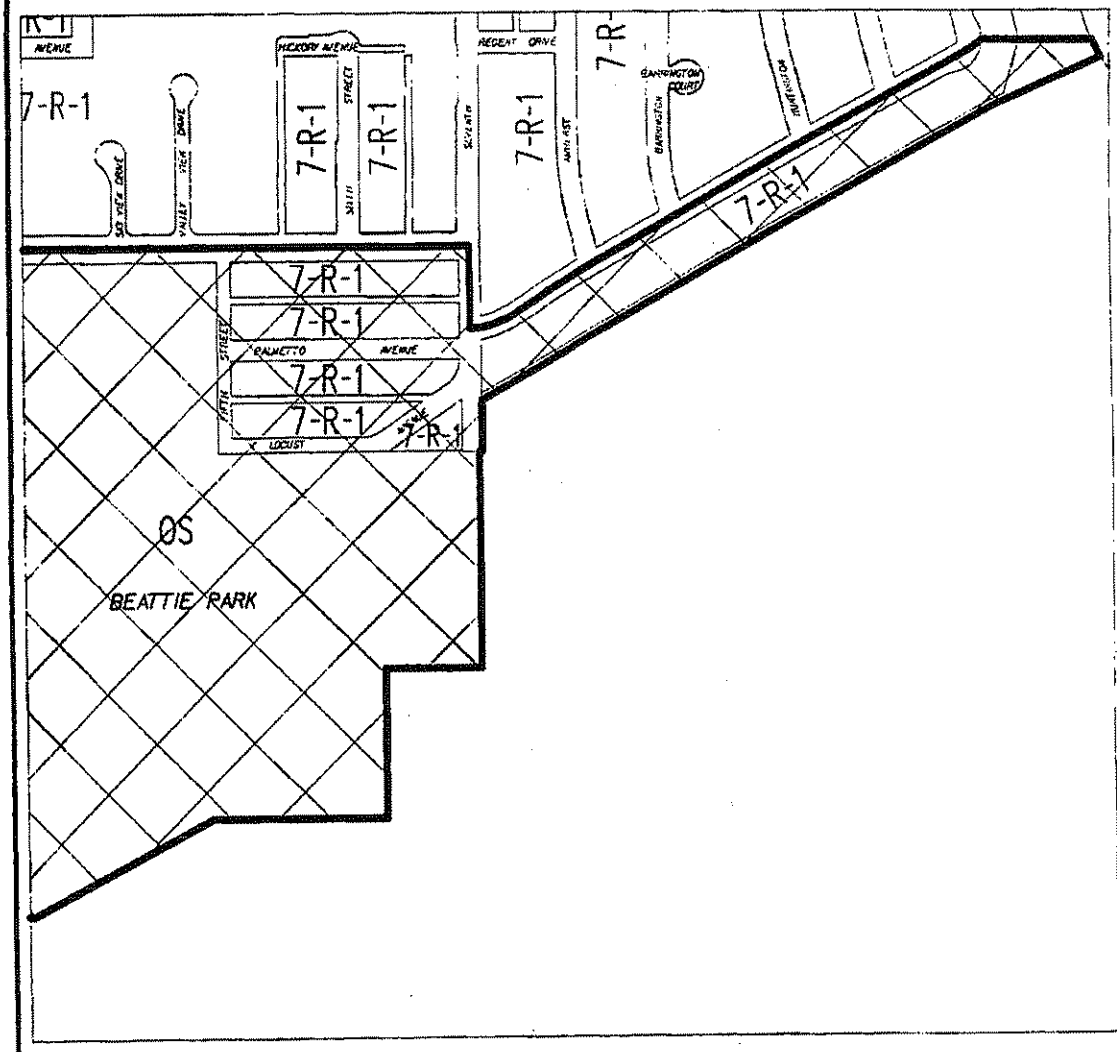
TA 05–03

NORTH

SCALE: 1" = 500'

EXHIBIT B4

TEXT AMENDMENT (PROPOSED)



10–R–1:	Single Family Residential (10,000 SF)
7–R–1:	Single Family Residential (7,000 SF)
OS:	Open Space
PF:	Public Facilities
R–2:	Medium Density Residential
	Cultural Resources (Overlay)

TA 05–03

NORTH

SCALE: 1" = 500'

CITY OF LOMPOC

ORDINANCE
CERTIFICATE OF ADOPTION

State of California)
County of Santa Barbara) ss
City of Lompoc)

I, DONNA N. TERRONES, the duly appointed City Clerk of the City of Lompoc, California, do hereby certify that the foregoing Ordinance No. 1521(06), was introduced at a regular meeting of the City Council of the City of Lompoc, California, held on the 21st day of February 2006, and was passed and adopted at a regular meeting of said Council, held on the 7th day of March 2006, by the following vote, to-wit:

AYES:	Councilmembers:	DeWayne Holmdahl, Michael Siminski, and Mayor Dick DeWees.
NOES:	Councilmembers:	Will Schuyler
ABSENT:	Councilmembers:	Janice Keller

That said Ordinance No. 1521(06) was then and there declared adopted and has been signed by the Mayor and attested by the City Clerk of said City of Lompoc.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the City of Lompoc, this 17th day of April 2006.

I declare under penalty of perjury that the foregoing is true and correct.

(SEAL)

Donna N. Terrones, City Clerk
City of Lompoc, California

Published: 3/03/06 and 3/17/06

CERTIFICATE OF ADOPTION

I hereby certify that the foregoing is a true copy of Ordinance No. 1521(06), of the City of Lompoc, California, Adding Article 17 to Title 2 of Chapter 50 of The Lompoc City Code Establishing a Cultural Resources Overlay District.

Donna N. Terrones, City Clerk
City of Lompoc, California

This guidance has been prepared for water management administrators, local government officials, system operators, and others who have an interest in developing programs to reduce losses from their drinking water distribution systems. The success of a water loss control program depends on the ability to tailor the program to the individual PWS. This guidance provides information on flexible tools and techniques that may help the PWS meet their water loss prevention needs.

1.2 GROWING CONCERNS PUBLIC WATER SYSTEMS FACE AND HOW A WATER LOSS CONTROL PROGRAM CAN HELP

A public drinking water system must provide enough water to meet demand at a reasonable cost while maintaining quality standards to protect public health. A PWS and its water management administrators must balance these goals at the same time they face growing concerns such as:

- Water availability
- Economic restrictions
- Population growth
- Climate change and drought
- Operational and maintenance costs
- Regulatory requirements
- Public service responsibility
- Social pressures and environmental stewardship

Many of these issues are inter-related. A water loss control program can help to address each of these issues.

Water Availability

The complexity of PWSs varies with a community's size, composition, and location. All systems depend on quality and abundant water sources to meet increasing water demands. A PWS's source may be ground water, surface water, ground water under the influence of surface water, purchasing finished water from another PWS or a combination of these sources. Each of these options requires resources and funds to locate, develop, treat, and maintain the source. When insufficient availability becomes an issue, a PWS has the option to find and develop another source or buy additional water from another PWS. However, finding a new reliable and adequate quality source may not always be easy or an option. A third option available to the PWS is to take a look at their process and operation and determine if there is any way to save water. This is when developing and implementing a water loss control program at the PWS becomes essential. Through a water loss control program, water that was previously lost can now be sold to the consumers, increasing revenue, meeting water demands and reducing the need

for other sources. Such a program may be able to defer development of new sources and reduce or eliminate the need to supplement supply from another PWS. The water loss control program is often the most economical solution.

Economic and Population Growth

Population growth can put an additional strain on a water system. Economic, manufacturing, and industrial growth in a community can also affect the ability of a water system to provide sufficient water. Some industries rely heavily on water such as food processing and beverage companies. These water demand increases must be met either by locating other sources, increasing the capacity of the existing water treatment facility, or investing in new capital improvement projects. A water loss control program can help find water that was previously lost in the system and potentially defer, reduce, or eliminate the need for more expensive alternatives.

Climate Change and Drought

Droughts are naturally occurring phenomena. Periods of drought can contribute to increased water demand and add strain to the PWSs source water supply. Drought effects can be especially critical in the more arid Southern and Western regions of the United States. Governmental agencies track drought data to predict water and resource needs. Drought maps like the one in Figure 1-1 for August of 2008 can be found at http://drought.unl.edu/dm. A water loss control program can help lessen the severity of the effects of drought and climate change on PWSs through retention of more water in their distribution system. This not only has the effect of retaining more water for the customers, but can lessen the amount withdrawn from the source.

Water Loss – A Business Case for Action

Bernie Bouman, PE and Dan Barr, PE

BURGESS & NIPLE
Engineers ■ Architects ■ Planners

Water Loss Program

Goals of a Water Loss Program

- Maximize revenues
- Minimize costs
- Equitable to customers
- Improve reputation
- Greener operations
- Meet any future regulations

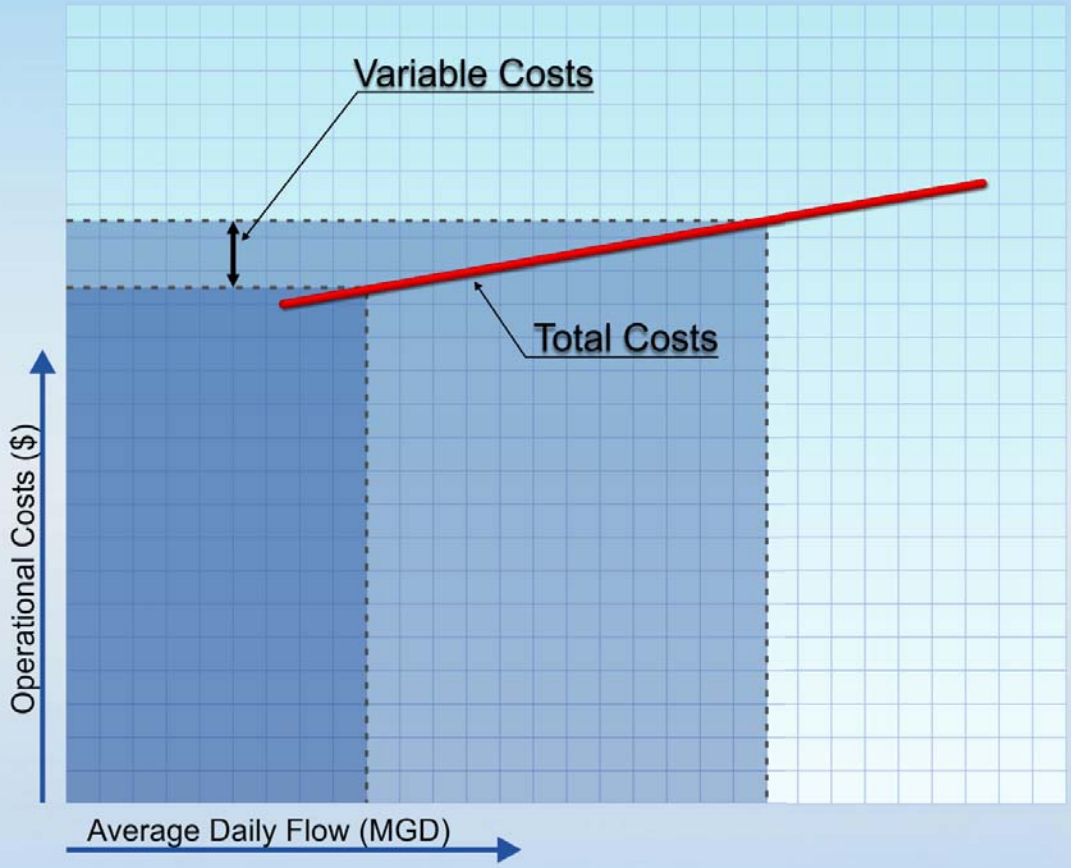
Goals of a Water Loss Program

Maximize Revenues

- 80 to 90% of all revenues are user fees
- Properly collect all revenue with accurate meters and eliminating theft

Goals of a Water Loss Program

Minimize Costs



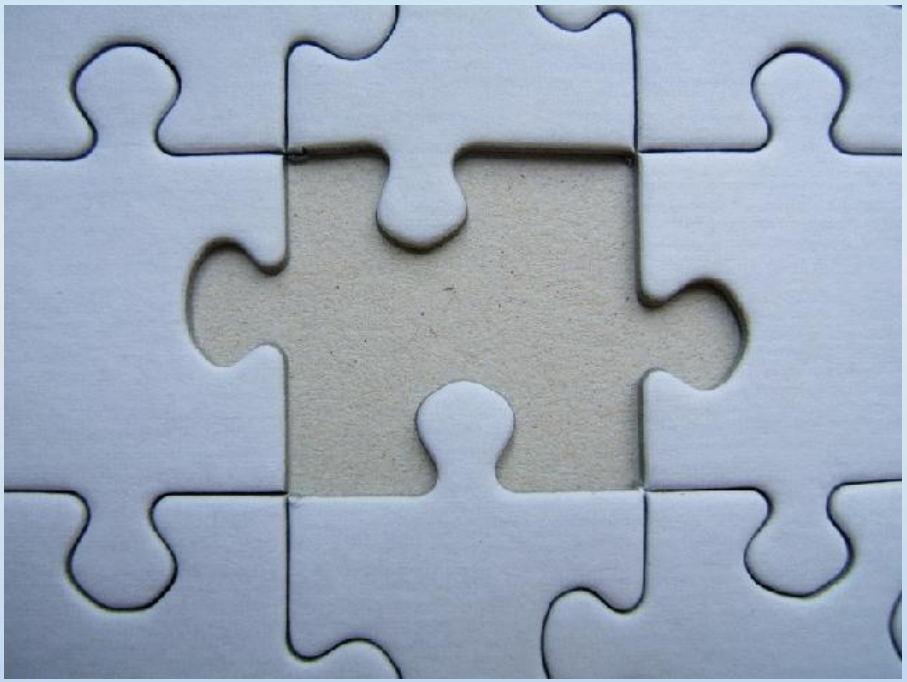
Unaccounted For Water

$$\frac{\text{Billed Consumption}}{\text{Plant Production}}$$

What is Missing?

Unmetered Consumption

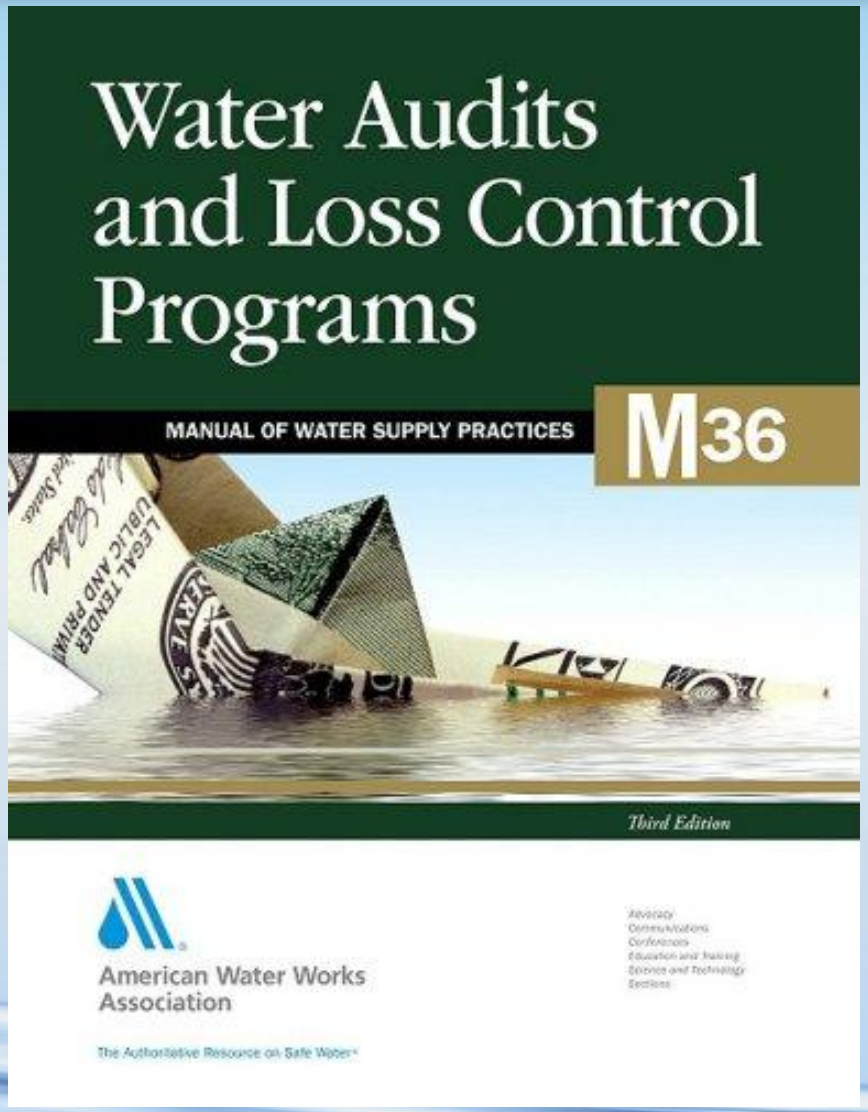
- Public Facilities
- Fire Protection
- Flushing
- Main Breaks
- Theft



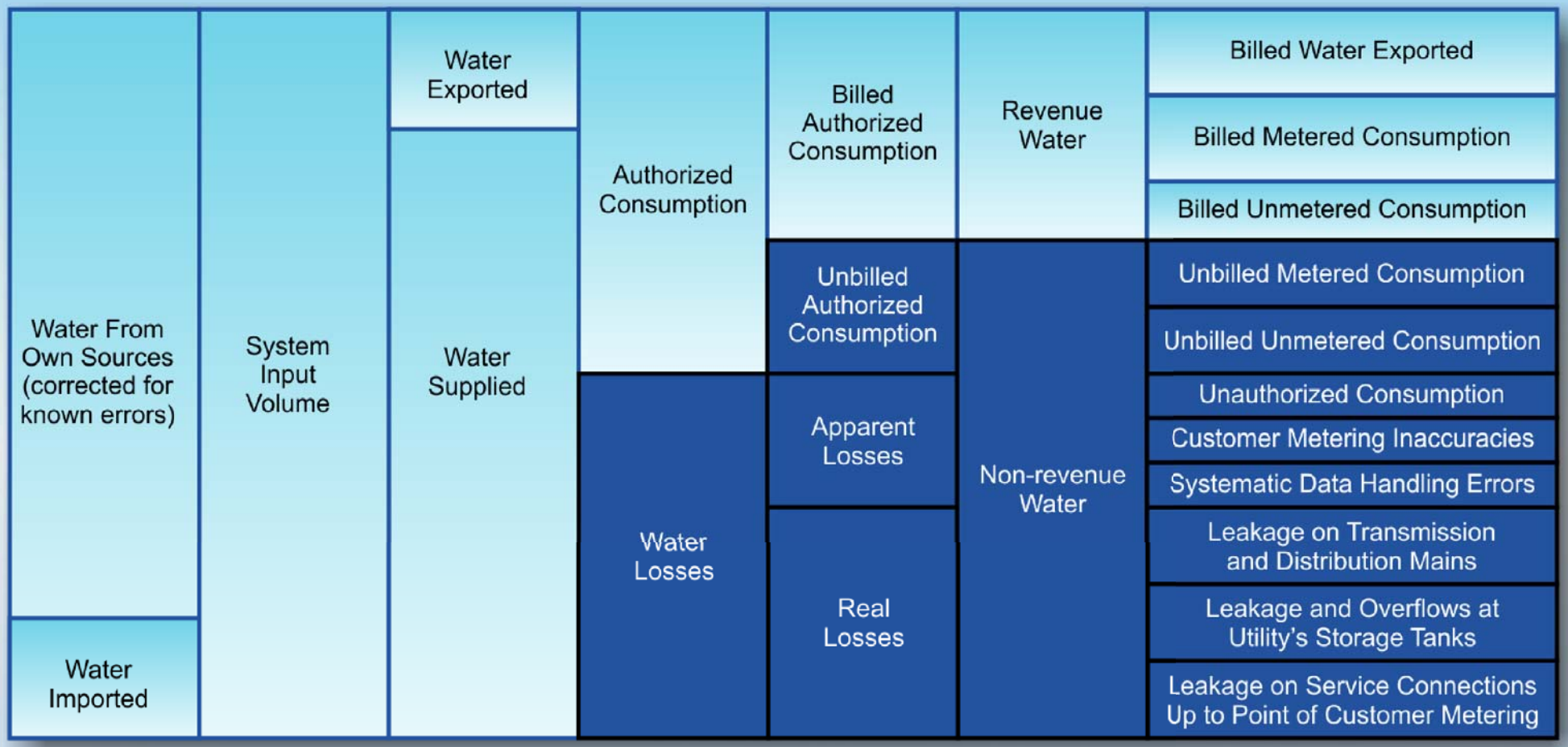
What Else?

- Benchmarking against other communities
- Making a business case for a water loss reduction program

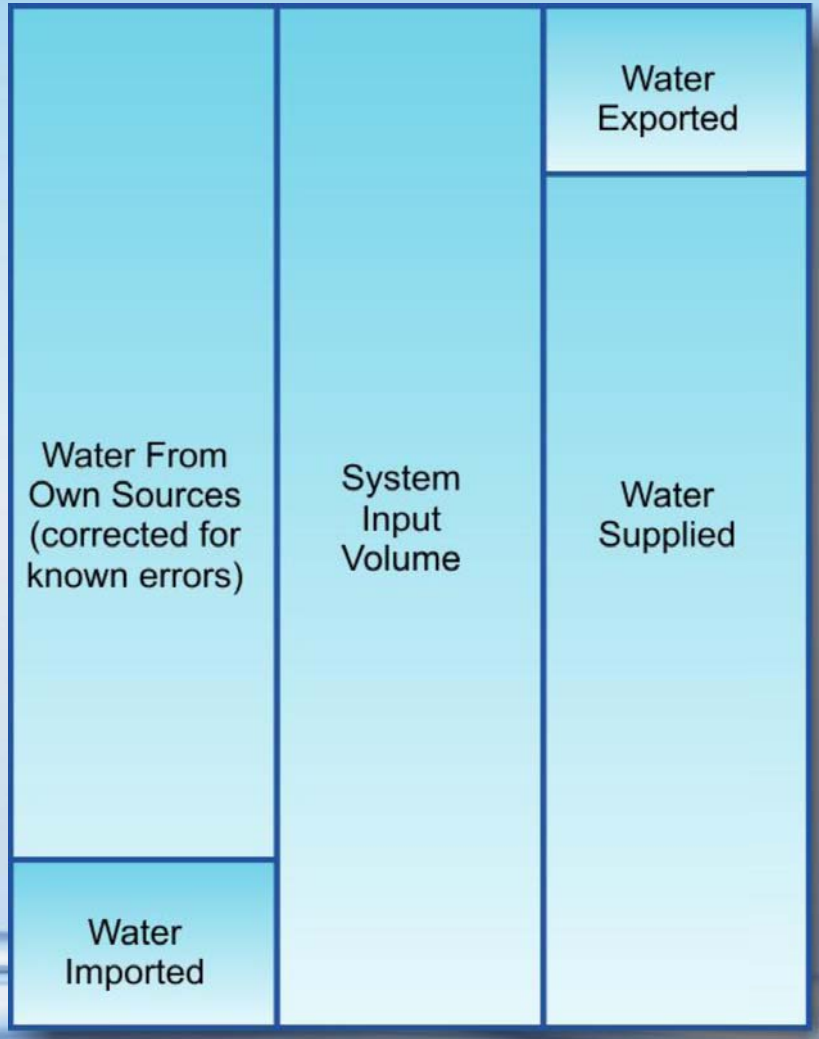
What's Next


Water Audits and Loss Control Programs
MANUAL OF WATER SUPPLY PRACTICES
M36
Third Edition
American Water Works Association
The Authoritative Resource on Safe Water

Modern AWWA Water Audit



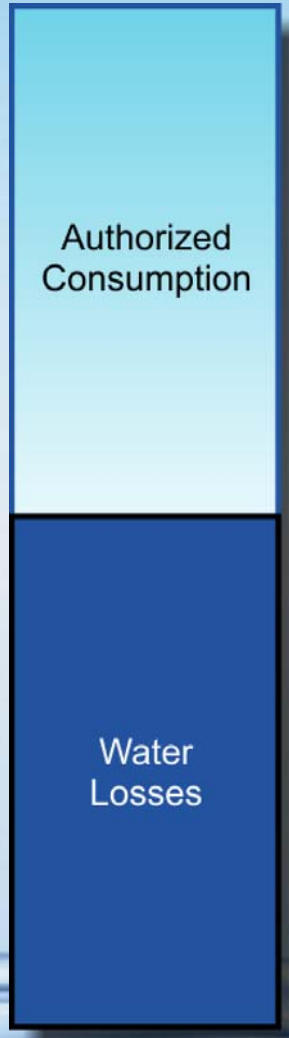
Modern AWWA Water Audit



System Input Volume

The annual volume input to the water supply system

Modern AWWA Water Audit



Authorized Consumption

The annual volume of metered and/or unmetered water taken by registered customers, the water supplier, and others who are authorized to do so.

Water Losses

The difference between the above:

System Input Volume – Authorized Consumption

Modern AWWA Water Audit

Apparent Losses

Unauthorized Consumption, all types of customer metering inaccuracies and systematic data handling errors including theft.

Real Losses

The annual volumes lost through all types of leaks, breaks, and overflows up to the point of customer metering

Modern AWWA Water Audit

Revenue Water	Billed Water Exported
	Billed Metered Consumption
	Billed Unmetered Consumption
Non-revenue Water	Unbilled Metered Consumption
	Unbilled Unmetered Consumption
	Unauthorized Consumption
	Customer Metering Inaccuracies
	Systematic Data Handling Errors
	Leakage on Transmission and Distribution Mains
	Leakage and Overflows at Utility's Storage Tanks
	Leakage on Service Connections Up to Point of Customer Metering

Revenue Water

Those components of the System Input Volume that are billed and produce revenue.

Nonrevenue Water

The sum of Unbilled Authorized Consumption, Apparent Losses and Real Losses.

Leakage Reduction

- Acoustic methods very cost effective
  - Start with pilot
- Pressure Management
- Area Master Meters
- Other Upcoming Technologies

Leakage Reduction

- Canton, OH Case Study
  - Surveyed about 280 miles of water mains
  - Found 80 leaks
    - 31 at hydrants
    - 19 at services
    - 23 on the main lines

Leakage Reduction

- Canton, OH Case Study
  - Estimated 773,520 gpd from identified leaks
  - Survey Cost $35,000
    - $100 to $150/mile

Leakage Reduction

Erie County, OH Case Study

- Surveyed 200 miles of water transmission main for a cost of $15,000

"Elimination of leaks paid for the survey.. and then some!"

- **Located 36 leaks that were repaired**
  - ***Reduction of 350,000 GPD of real water losses!***
  - ***Represents 12% of the water being purchased daily for Erie County!***
  - ***Resulted in a savings of $500 daily or $182,500 per year!***

Summary

- The AWWA M36 Water Audit Manual creates a business case and benchmarking tool.
- Starting points for water loss reduction include:
  - Auditing your accounting procedures
  - A meter testing and replacement program
  - A leak detection survey
- Continuous Improvement

City Of Lompoc

2005 Urban Water Management Plan

TABLE OF CONTENTS

DMM B - Residential Plumbing Retrofit

IMPLEMENTATION DESCRIPTION: The City provides free showerheads and faucet aerators, where existing fixtures do not meet the current low-flow plumbing standards to all customers who change out existing high flow toilets. Details of this program are found in DMM N. The number of showerheads and faucet aerators that have been distributed since 1990 is 3,568 and the number of faucet aerators distributed during the same time period is 4,788. Additionally, the City has not set a saturation requirement for single and multiple family housing, because the City's program is not based on replacement of showerheads and faucet aerators with time of sale.

IMPLEMENTATION SCHEDULE: The City will continue to implement this DMM.

CONSERVATION SAVINGS: The yearly estimated savings for the showerheads is .98 AF. This is based on a savings of 1.5 gallons per person and 2.92 persons per household. The yearly estimated savings for the faucet aerators is .31 AFY. This is based on a savings of 2.5 gallons per person and 2.92 persons per household.

DMM C - Distribution System Water Audits, Leak Detection and Repair

IMPLEMENTATION DESCRIPTION: The City of Lompoc has 132 miles of water mains in its underground water distribution system and 3.4 miles of water main in its surface water treatment system. The City's distribution system maintenance program includes record keeping, valve exercise, hydrant inspection and exercise, and leak repair.

The City also has a meter maintenance program to replace old meters and to identify and replace broken, stopped, and inaccurate meters. Overall an average of 400 small meters are replaced annually. The average annual replacement of large meters, three inches and above, is approximately 26. The exception will occur during the 2005-07 FY budgets, when $211,000 was approved to replace 477 meters, one-inch and larger with single-jet meters. These meters will improve water accountability and revenue with their increased accuracy.

All of the City's water customers are billed for their water usage from their water meters, and are charged a monthly service rate. The City's Water Treatment Plant tracks well pumpage from all of the City's wells. Additionally, approximately 5% of the water, which is pumped from the City's wells, is used for the City's Water Treatment Plant processes.

Also, the City's unaccounted for water usage for 2005 is estimated at 6%. The City does not have to augment its annual leak detection audit because of the low percentage of citywide leaks that are found.

IMPLEMENTATION SCHEDULE: The City has permanently incorporated this DMM into its operations and maintenance procedures.

METHODS TO EVALUATE EFFECTIVENESS: Annual records are kept for leak repairs, and for equipment maintenance and replacements. The City's average unaccounted for water losses for 2004 was approximately 6%. The unaccounted for water losses are projected to decrease to 5% from 2010 to 2025.

BUDGET: The FY 2005-07 Water Budget has $10,000 per year for purchase of water meters and a one-time request of $211,000 to replace one-inch and larger meters. Additionally, the budget includes $27,104 per year for water main repairs and $187,000 for water main replacement. Staff anticipates that the baseline figures, with yearly cost of living increases, will be seen in the FY 2005-2010 Water budgets, with the exception of the $211,000 for the purchase of meters.

DMM D - Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections

IMPLEMENTATION DESCRIPTION: The City is fully metered for all water customer sectors.

The City has a uniform pricing system for all customers. A billing unit is one hundred cubic feet, 748 gallons, commonly abbreviated hcf or ccf. For rate information, see DMM K. The adequacy of the City's rates is evaluated annually.

The City has not conducted a feasibility study to assess the merits of a program to provide incentives to switch mixed-use account to dedicated landscape meters.

The City's wastewater charges for customers are based on an average of water usage for the months of January, February, and March for residential and commercial users. A minimum monthly charge is available for all non-irrigation water meters. A separate extra strength wastewater charge is applicable to nonresidential users discharging suspended solids and biochemical oxygen demands (BODs) greater than 300 mg per liter into the wastewater system. These wastewater charges allow developers the option of requesting separate irrigation meters, if their development warrants these meters.

IMPLEMENTATION SCHEDULE: The City will continue to install and read meters on all new services.

METHODS TO EVALUATE EFFECTIVENESS: The City does not have a method for evaluating effectiveness.

CONSERVATION SAVINGS: The City does not have a method of evaluating conservation savings from this DMM.

BUDGET: Meter installation costs are part of new service connection fees.

BY AWWA WATER LOSS CONTROL COMMITTEE

COMMITTEE REPORT: Applying worldwide BMPs in water loss control

IN 2000, AN IWA TASK FORCE—WITH AWWA PARTICIPATION—ASSEMBLED A WATER AUDIT METHODOLOGY AS A BEST MANAGEMENT PRACTICE THAT IS APPLICABLE WORLDWIDE FOR TABULATING WATER USE AND LOSS.

For an expanded version of this article, go to e-JOURNAL AWWA at www.awwa.org.

Water resources today are less expensive and more accessible than they ever will be again, according to participants at a recent AWWA conference workshop on water resources. The North American water industry is facing growing challenges in developing new drinking water supplies, and the demands are staggering: source water protection, finished water quality, public health risks, infrastructure needs, competition, drought, customer expectations, limited funding, and, suddenly, security. Water resources management is further challenged as populations continue to grow and shift, often moving to warmer climates that are far removed from available water resources. Climate change, drought, and water shortages seem to be exerting an increasing impact on water supplies, and water is becoming a major factor in smart growth policy. It is a stark reality that the human population continues to grow, but the planet's available water is finite. Because new water resources have become increasingly difficult and costly to develop, it is evident that society must conserve water through efficient use and active loss control if it is to sustain this precious resource.

In recent years, water conservation has seen major advances in research, public education, and development of water-efficient fixtures in the home and the workplace. It is essential that all communities continue to promote effective conservation practices. However, in North America, water conservation tends to focus largely on the end user. In the wider context of demand management, water suppliers also have a duty to manage water responsibly and efficiently. The North American water industry has traditionally operated without consistent standards for water accounting and, not surprisingly, incurs high loss of both its treated water and a portion of the revenue to which it is entitled. It is striking that even during significant drought occurring in many areas of the United States since 2001, little emphasis has been placed on the need to motivate water suppliers to quantify and control their losses. With perhaps hundreds of water utilities billing sales of half or less of the total water they manage, it is essential that industry professionals, regulators, and policymakers begin to place emphasis on sound water accounting and loss control by water suppliers. Water and

TABLE 1 States Survey Project summary of findings*

Issue	Jurisdictions	States $n = 43$	Other $n = 3$	Total $n = 46$
Water loss policy	Ariz., Calif., Conn., Fla., Ga., Hawaii, Ind., Iowa, Kan., Ky., La., Md., Mass., Minn., Mo., N.C., Nev., N.H., N.Y., Ohio, Ore., Pa., R.I., S.C., Tenn., Texas, Utah, Vt., Va., Wash., W. Va., Wis., Wyo., DRBC,† SWFWMD,‡ SJRWMD§	33	3	36
Definition of water loss	Ariz., Calif., Ga., Hawaii, Kan., Md., Mass., Minn., Mo., Ore., Pa., R.I., S.C., Texas, Wis., DRBC, SJRWMD	15	2	17
Accounting and reporting	Ariz., Calif., Ga., Hawaii, Iowa, Kan., Ky., Md., Mass., Minn., Mo., N.Y., Ohio, Ore., Pa., R.I., Texas, W. Va., Wis., Wyo., SWFWMD, SJRWMD	20	2	22
Standards and benchmarks	Ariz., Calif., Ga., Hawaii, Ind., Kan., Ky., La., Md., Mass., Minn., Mo., N.C., Ohio, Ore., Pa., R.I., S.C., Texas, Utah, Wash., W. Va., Wis., DRBC, SWFWMD, SJRWMD	23	3	26
Goals and targets	Ariz., Calif., Fla., Ga., Hawaii, Kan., Ky., Maine, Md., Minn., Mo., N.M., Ohio, Ore., Pa., R.I., Texas, Wis., SWFWMD, SJRWMD	18	2	20
Planning requirements	Ariz., Calif., Conn., Fla., Ga., Hawaii, Iowa, Kan., Md., Mass., Minn., Mo., Nev., N.H., Ore., Pa., R.I., S.C., Texas, Vt., Va., Wash., W. Va., Wis., SWFWMD, SJRWMD, DRBC	24	3	27
Compilation and publication	Ariz., Calif., Hawaii, Kan., Ky., Minn., Pa., R.I., Wis., SWFWMD	9	1	10
Technical assistance	Alaska, Calif., Fla., Ga., Hawaii, Kan., Ky., Maine, Nev., N.D., Ore., Pa., R.I., S.C., Tenn., Texas, Vt., Wis., SWFWMD	18	1	19
Performance incentives	Calif., Ga., Hawaii, Ind., Iowa, La., Minn., N.C., R.I., Texas, Vt., SJRWMD	11	1	12
Auditing and enforcement	Ariz., Ga., Hawaii, Kan., Md., Minn., N.H., Ohio, Ore., Pa., S.C., Texas, Wis., SWFWMD, SJRWMD	13	2	15

*Source: Beecher Policy Research Inc., 2002
†DRBC—Delaware River Basin Commission
‡SWFWMD—Southwest Florida Water Management District
§SJRWMD—St. Johns River Water Management District

revenue loss recovery stands among the most promising water resource initiatives in North America. It makes sense to take steps to recover this water and revenue in order to mitigate the effects of drought and water shortages and to do so before developing new water sources and expensive supply infrastructure.

Because of high water loss, many drinking water systems have "untapped" water resources that can be cost-effectively recovered. These untapped resources are

- already treated to prevailing standards and ready for consumer use,
- energized to provide adequate pressure to reach the consumer,
- often sufficient to provide for the future expanding needs of the community, and
- sometimes unintentionally provided free to the consumer because no revenue is recovered.

ARTICLE DESIGNED TO PROVIDE TOOLS

The primary purpose of this article is to provide an AWWA-endorsed set of tools specifically designed to promote reliable water use tracking and to control unnecessary water and revenue loss in drinking water utilities. The article provides a brief description of the nature of losses occurring in water utilities and the traditional difficulties suppliers have encountered in managing this issue. The article also offers an internationally recognized methodology developed through the International Water Association (IWA) with AWWA as a major participant. This methodology is designed specifically for measuring and evaluating both valid water consumption and unnecessary water loss. Successful international approaches to control both water and revenue losses are also given. These methods represent an advancement in technology and policy and are submitted as current best management practices (BMPs) available in the emerging discipline of water loss control.

CURRENT UNDERSTANDING IS A MIX OF CONFUSING PERCENTAGE INDICATORS AND HIGH LOSSES

Historically, the quantitative management of drinking water supplies in North America—and most of the world—has been poorly executed, with only casual "water accounting" and high losses prevailing. Because water loss stresses water and energy resources, increases operating costs, and strips revenue, it is curious that this apparent lapse of effective water resource management has persisted. Water has been taken for granted in many parts of North America because of relatively abundant water re-

sources. Lack of strong public opinion regarding water loss gives water suppliers shelter to allow their water loss status to remain inconspicuous. It is now evident, however, that casual attitudes toward water management threaten sustainability of supplies.

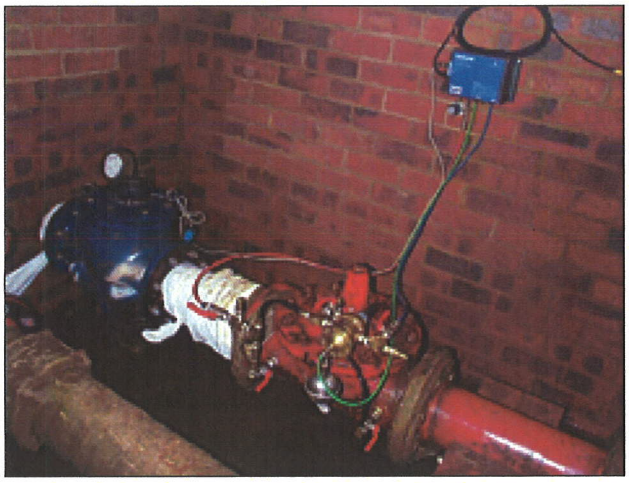


PHOTO: WRP (PTY) LTD.

This metering and pressure control chamber was used in a water loss project in Risidale, South Africa.

Although many think that "water loss" is synonymous with "leakage," the nature by which it occurs is actually threefold (Lambert & Hirner, 2000):

- **Terminology.** There has been a lack of standardized definitions of water and revenue losses.
- **Technical.** Not all water supplied by a water utility reaches the customer.
- **Financial.** Not all of the water that reaches the customer is properly measured or paid for.

The North American water industry has traditionally used the term "water accountability" to refer to its effectiveness in moving its product (water) to its customers. Water accountability, however, has never existed as a well-defined discipline, and a great inconsistency of methods exists among water supply managers and regulators. Often quoted but poorly defined, the "metered water ratio" and similar percentage indicators more frequently confuse rather than inform analysts when they attempt to evaluate the water loss status of suppliers (Kunkel & Beecher, 2001). Similarly, no standard definition has been found for the term "unaccounted-for water," a label whose nonperformance connotation reflects negatively on the water industry. Without reliable auditing methods, the actual scope of water loss remains a mystery. Still, numerous case-study accounts exist in the literature to confirm that water loss is a significant and overlooked occurrence in many water utilities (Buie, 2000; Lipton, 1999; Saltzgaber, 1999; Counts, 1997).

Most water utilities in North America do not regularly compile any type of formal water audit. This is a major shortcoming for the water industry. Often, the systems that do audit their supply merely conduct a simple comparison between water input to the distribution system and the total water consumption billed to customers. This difference, taken over the system input, has been used inconsistently for decades as an "unaccounted-for water percentage," the sole performance indicator of water loss status. The pitfalls of this ill-defined practice include the following:

- No consistent definitions for the various components of consumption or loss have been used throughout the United States. For example, many utilities include some amount of known system leakage (a loss) in an accounted-for category of their water audit, distorting their true water loss standing.
- Worldwide no consistent definition has been found for the term "unaccounted-for" water (Brown et al, 2000).
- Percentage indicators have been found to be suspect in measuring technical performance because the percentages can be skewed by varying levels of end-user consumption. Also, sundry definitions for the numerator and denominator are applied throughout the United States, making reliable performance comparisons impossible.
- Percentage indicators translate nothing about water volumes and costs—the two most important parameters in water loss assessments.

Guidance provided in the past by the AWWA Water Loss Control Committee (formerly the AWWA Leak Detection and Water Accountability Committee) also exhibited shortcomings typical of the times when its last report was published (Liston et al, 1996). This report was valuable in its auditing recommendation that all water consumption and losses should be quantified in terms of volume and cost impact to the supplier. Unfortunately, the report also recommended that "the goal for unaccounted-for water should be less than 10%," despite the fact it simultaneously recommended that "regardless of the water system's size, water loss should be expressed in terms of actual volume, not as a percentage." These conflicting statements reflect the difficulty the committee encountered in steering utilities away from weak practices, while not having adequate performance indicators to replace the traditional "percentage."

States Survey Project sets baseline. In an effort to determine a baseline for the current extent of accounting and loss control policies existing in the United States, the committee proposed a project to AWWA's Technical and Educational Council. The project was funded as a comprehensive survey of state and regional water agencies on their current water consumption and loss reporting requirements for drinking water suppliers. The project,[1] titled Survey of State Agency Water Loss Reporting Practices (Beecher Policy Research Inc., 2002), or the States Survey Project, was conducted in 2001. The survey was successful in garnering valuable

Ten Practices
Covered in the States Survey Project*

1. Water loss policy. Does the state have a policy regarding the loss of water by water utility systems? If so, where is the policy stated (statute, regulation, directive, other)? Which agency or agencies are responsible for implementing the water loss policy?

2. Definition of water loss. Does the state or agency provide a definition of water loss or unaccounted-for water?

3. Accounting and reporting. Does the state or agency provide a method to account for and report water loss?

4. Standards and benchmarks. Does the state or agency identify a standard or benchmark for water losses, such as a specific percentage?

5. Goals and targets. Does the state or agency specify a goal or target for water loss reduction?

6. Planning requirements. Does the state or agency address water loss issues in the context of water resource, conservation, or other planning requirements?

7. Compilation and publication. Does the state or agency compile and/or publish data on water losses by water utility systems?

8. Technical assistance. Does the state or agency provide any form of direct technical assistance to water utility systems to help reduce water losses?

9. Performance incentives. Does the state or agency provide any form of performance incentive for water loss reduction?

10. Auditing and enforcement. Does the state or agency implement any form of auditing or enforcement in relation to the water loss policy?

*Source: Beecher Policy Research Inc., 2002

information from 46 jurisdictions, including 43 state agencies and 3 regional agencies. The survey attempted to seek information regarding 10 practices, as shown in the sidebar on this page.

The reported findings note, "Proper management of any resource must include accurate measurement of the resource throughout its lifecycle. In any proper accounting system, checks and balances must be provided via the use of independent audits, consistent reports, and rational procedures. US water systems do not consistently account for water or apply consistent methods of water accounting." Additionally, the findings state, "Most analysts agree that a better system of accounting is the foundation for a better system of accountability for the drinking water supply industry." Figure 1 shows that state standards, as expressed by varying definitions of "unaccounted-for water percentages," vary from 7.5 to 20%, with some states using different standards set by different agencies. Table 1 gives a summary of findings for all 10 practices and shows that only one state—Hawaii—currently has jurisdictions with programs addressing all areas.

THE WAY FORWARD IS STANDARDIZED WATER ACCOUNTING AND ACTIVE WATER LOSS CONTROL

Without reliable methods to track water use and control loss in North America, the committee sought to gain knowledge of the best practices being used worldwide. Research found that considerable progress to better understand and control leakage losses had been made in the United Kingdom. With the implementation of privatization and a new regulatory structure in the UK water industry in 1989, water companies sought to gain efficiencies and found that leakage losses were a startling inefficiency in their operations. The companies banded together to jointly fund the National Leakage Initiative, a three-year research venture that studied existing leakage management practices and advanced a number of new approaches. The results of this endeavor were published in 1994 in the 10-volume series of reports *Managing Leakage* (WRc, 1994). During severe drought in 1995–96 the UK government regulator, the Office of Water Services, drew upon the findings of the National Leakage Initiative to impose new conditions on the water companies. Being regulated by the results of their own research, however, motivated the UK water industry to establish what is now likely the most advanced national system of water loss control in the world today. According to estimates (Lambert, 2001a), up to 85% of the recoverable leakage initially measured has been eliminated in England and Wales within this structure.

The IWA organized the Task Force on Water Losses in 1996. This international working group was chaired by Allan Lambert, former technical secretary to the UK National Leakage Initiative and chair of the working group that authored two of the *Managing Leakage* reports (WRc, 1994). Timothy G. Brown was the AWWA North American Task Force representative, which also included participants from France, Germany, and Japan. The task force conducted research over a three-year period to develop a well-defined water audit methodology and an array of rational performance indicators for water losses. This method was designed to serve as a recognized standard that could be applied internationally by

eliminating the confusion of terms that hindered reliable water tracking in the past. The task force also developed an array of rational performance indicators that allow systems to set targets, measure progress, and conduct reliable performance comparisons with other utilities. This work was published in 2000 in the IWA's *Manual of Best Practice: Performance Indicators for Water Supply Services*. The international water audit method has been tested in more than two dozen countries and serves as the basis for improved national and international performance comparisons in several of them.

A structured approach to reduce both real losses (physical losses) and apparent losses (paper losses) also exists and has proven successful in driving down losses in a number of international settings. The discipline of leakage management—effectively the control of real losses—has developed largely through the experience in the United Kingdom. Although not as advanced, the control of apparent losses has also begun to see a more structured approach. This article provides an overview of these international methods and provides them as the current BMPs in the field of water loss control. It is recommended that they become the standard methods for North American water suppliers to establish reliable water accounting and loss control practices in drinking water supplies.

INTERNATIONAL WATER AUDIT AND PERFORMANCE INDICATORS CREATED

Having a reliable water audit is the foundation of proper resource management for drinking water utilities. Just as banks provide statements of monies flowing into and out of accounts, the water audit displays how quantities of water flow into and out of the distribution system. Yet, as essential and commonplace as the financial balance sheet is to the world of commerce, water audits have been surprisingly uncommon in the water supply arena throughout most of the world (Thornton et al, 2002). In order for suppliers to reliably audit their supplies, a rational auditing method must be available. The international water audit methodology, shown as a chart in Figure 2, meets this requirement. Incorporating routine water auditing will require a long-term effort on the part of regulators to promote new policy into water resources statutes, as well as to see change in the mindset and habits of water utility managers.

All water is accounted for. The international water audit methodology was designed to include several essential features that have been lacking in the patchwork of auditing practices used traditionally throughout the world, including

- rational, standard terms and definitions;
- the tenet that all water is accounted for as either a consumptive use or a loss; thus, no water is classified as "unaccounted for";
- all components of water usage and loss are initially presented in units of volume for the period of reference;
- all components of water usage and loss are assigned an appropriate cost that reflects their impact to the water utility based on the prevailing economics; and
- an array of robust performance indicators that outperform simplistic, poorly defined output/input percentage indicators.

Fundamental to the international methodology is its use of rational terms and definitions. Also, because all water is accounted for, it is advocated that the term "unaccounted for" no longer be used in any manner in the water supply industry. Continued use of this aberration will only hinder efforts to implement true water accountability in drinking water supplies.

Water loss—the volume left after subtracting all authorized billed and unbilled water consumption from the system input volume—exists in two distinct components: real losses and apparent losses. Real losses are the physical loss of water from the distribution system and include leakage and tank overflows. These losses represent a waste of water resources, causing unnecessary infrastructure capacity, inflated production and energy costs, and undue stress on available water resources solely to meet the nonbeneficial demand of (mostly) system leakage. Apparent losses, or the "paper" losses, include customer meter inaccuracy, all manners of billing accounting errors, and unauthorized use, all of which result in lost revenue to the water utility. Apparent losses, reflecting error in the water measurement and documentation process, also compromise the compilation of accurate water usage data. Water usage data from 1995 (USGS, 1998) shows that of 40 bgd (15,145,000 m^3/d) of water withdrawn in the United States by water utilities, only 34 bgd (12,873,000 m^3/d) is documented as end-user consumption. The missing 6 bgd (2,272,000 m^3/d) is categorized simply as "public use/loss," reflecting the US Geological Survey's recognition that unmonitored municipal water use, accounting shortcomings, and leakage inhibit the ability to attain a true balance of withdrawal and use totals. Public use/loss—which is more than enough to meet the water needs of the 10 largest US cities—reflects the huge margin of error that exists in quantifying actual water consumption amounts versus water loss amounts in water utilities. By using a reliable water audit method, the North American water industry can greatly improve the reporting accuracy of valid consumption and losses for its water delivery components.

The financial distinction between real and apparent losses is also important. Real losses are usually valued at the short-term, marginal treatment/production costs or the price to purchase bulk water, whereas apparent losses exert an impact according to the retail sales cost. Because most systems charge more in their retail costs than the production or purchase price of their water, apparent losses are usually more

TABLE 2 City of Philadelphia, Pa., annual water audit in International Water Association format*

Category	Water *mgd (m³/d)*	Cost *$*	Fiscal Year 2002 Financial Data
Water delivery	261.10 (988,640)		$3,465 Apparent losses per million gallons—small meter accounts (0.63 and 0.5 in. [16 and 13 mm])
Master meter adjusted	–1.900 (–7,194)		$3,035 Apparent losses per million gallons—large meter accounts (1 in. [25 mm] and larger)
Corrected input volume	263.00 (995,834)		$2,988 Apparent losses per million gallons for municipal property accounts
Billed metered	177.60 (672,472)		$3,285 Apparent losses—overall average customer rate
Billed unmetered	0.594 (2,249)		$121.70 Real losses—short-term marginal cost per million gallons
Unbilled metered	0.548 (2,075)	24,342	$295,600 Real loss indemnity costs—added to total real loss cost
Unbilled unmetered	1.935 (7,327)	121,642	Water supply operating costs (fiscal year 2001 data)—$155,060,248
Total authorized water consumption	180.677 (684,123)		
Water losses†	82.323 (311,711)		

Apparent losses	Water *mgd (m³/d)*	Cost *$*	Real Losses	Water *mgd (m³/d)*	Cost *$*
Customer meter underregistration	0.176 (666)	211,448	Operator error/overflows	0 (0)	0
Bypassed flow to separate fire system	0.100 (379)	4,442	Unavoidable annual real loss	5.299 (20,064)	235,403
Unauthorized consumption	5.087 (19,262)	1,506,610	Recoverable leakage		
SCADA‡ system error	0 (0)	0	Active service lines	15.691 (59,413)	697,002
Customer meter malfunction	0.173 (655)	205,958	Abandoned service lines	17.345 (65,676)	770,456
Meter-reading/estimate error	0.973 (3,684)	1,166,958	Transmission and distribution main leaks	29.098 (110,178)	1,292,550
Accounts lacking proper billing	2.250 (8,519)	2,697,806	Measured leakage in district metered areas	0.358 (1,356)	15,903
Municipal properties	4.000 (15,146)	2,793,181	Main breaks	0.062 (235)	2,754
Billing adjustments	0.375 (1,420)	449,634	Other	1.336 (5,059)	59,361
Apparent loss total	13.134 (49,731)	9,036,038	Real loss total	69.189 (261,981)	3,369,029§
			Water losses total	82.323 (311,711)	12,405,066

*Fiscal year 2002: July 1, 2001–June 30, 2002
†Water losses equal Corrected input volume minus Total authorized water consumption.
‡SCADA—supervisory control and data acquisition
§Real loss total cost includes the sum of Real loss component costs plus Real loss indemnity cost of $295,600

costly than real losses, on a relative basis. Apparent losses occur at the "cash register" of the water utility, given that service is rendered but revenue is not recovered. It is usually appropriate that the costs of real losses include more than just marginal production costs. Particularly when source water is scarce or infrastructure development is contentious, additional environmental, construction, political, or social costs should be built into the real loss cost analysis. For many water systems, significant leakage recovery can extend the capacity of existing supply infrastructure, resulting in infrastructure expansion being deferred well into the future. New concepts, such as the economic level of leakage, or the appropriate level of leakage reduction a given utility should strive to attain based on prevailing economics, have evolved as a result of careful assessment of water loss costs.

Steps in constructing the water audit. The mechanics of compiling a good water audit are twofold—an initial "top-down" approach complemented by gradual "bottom-up" refinements. The top-down approach is largely a desktop exercise, whereby general information from readily available documentation is collected and reviewed to assemble a basic audit. Records that should be collected include water system input, customer billing summaries, leak repair summaries, average pressures, meter accuracy tests, permitted fire hydrant use, and any other records that substantiate how water was used and lost. By its nature, the top-down audit includes the use of a considerable number of estimates for components of water use and loss. While approximate in its reliability, the top-down audit can be assembled quickly and is advisable for water utilities compiling their first water audit. The bottom-up approach involves taking

field measurements and conducting investigations and research into the policy and practices of the water utility. Using night-flow analysis to obtain inferred measurements of leakage is an example of using actual field measurements in a bottom-up approach to replace rough estimates about the amount of system leakage used in a top-down water audit. It also serves to confirm any assumptions made regarding the volumes of apparent losses. Researching water utility policy and permit records regarding water use from fire hydrants is another bottom-up example. The bottom-up approach improves the accuracy of the water audit but requires more effort to gather field data and research practices. It is best for water utility managers to incorporate bottom-up methods into the water audit incrementally over time. Within several years a reliable water audit will begin to take shape. Several researchers have started to develop statistical methods to improve the accuracy of the top-down water audit in reflecting actual supply conditions.

A summary of the annual water audit and performance indicators for a recent year for the city of Philadelphia, Pa., is given in Table 2 and the sidebar on page 74. The Philadelphia Water Department and Water Revenue Bureau implemented the international method when it became available in 2000. The major categories of water use and loss shown on the summary sheet are supported in a detailed water audit document. If a water utility has historically conducted a water audit using the method outlined in *Water Audits and Leak Detection* (AWWA, 1999), it is relatively straightforward to reassign the components of this audit into the structure of the international method in a top-down approach.

Performance indicators for water loss control discussed. The international method includes a set of rational, well-defined performance indicators that are superior to the poorly defined output/input percentage often used in North America. The indicators give utilities the tools to set internal goals, as well as to make performance comparisons and to assist water loss benchmarking and accreditation efforts. Table 3 shows performance indicators that are defined in three distinct performance areas: water resources, operational, and financial (Alegre et al, 2000). IWA performance indicators are also distinguished as basic, intermediate, or detailed indicators. For water loss control the IWA methodology includes only basic and detailed indicators.

As shown in Table 3, the performance indicators for water losses, real losses, and apparent losses are merely the normalized version of the amount of water losses, real losses, and apparent losses in the water utility, respectively. The infrastructure leakage index (ILI) is a dimensionless ratio, and the remaining indicators are rationally and specifically defined percentage indicators. The indicator "nonrevenue water by volume" might be the one most closely associated by North American practitioners as the "percentage" so often quoted. This indicator has some value but only as a basic financial indicator. It is not useful for operational purposes because it does not indicate the amount of losses (real and apparent) occurring in the utility. The design of these indicators makes them amenable to use across a variety of system conditions and units of measure, thus allowing reliable performance comparisons and benchmarking. Performance indicator values for Philadelphia are shown in the sidebar on page 74.

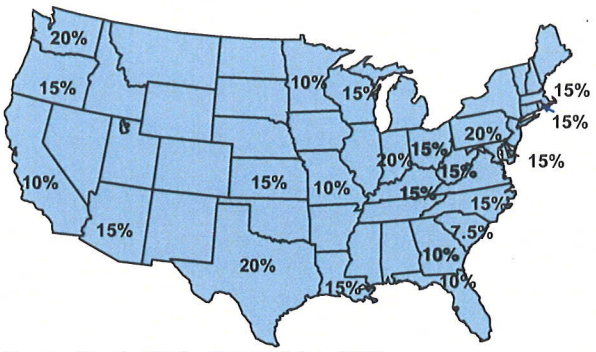
Many North American water utility managers have long held unsubstantiated beliefs that leakage cannot be reliably measured and that a certain (large) portion of system leakage is considered unavoidable or not economically justified to abate. These water loss misconceptions are rapidly giving way to several new realizations of the fast-developing discipline

TABLE 3 IWA* water audit methodology—performance indicators for water loss control†

Point of View	Water Resources	Operational	Financial
Basic, level 1	Inefficiency of use of water resources: real losses as a percentage of system input volume	Water losses: volume/service connection/year Real losses: volume/service connection/day *x*‡ when the system is pressurized	NRW_v§: volume of nonrevenue water as a percentage of system input volume
Intermediate, level 2			
Detailed, level 3		Apparent losses: volume/service connection/year ILI** (dimensionless); ratio of real losses to UARL††	NRW_c‡‡: value of nonrevenue water as a percentage of the annual cost of running the water system

*IWA—International Water Association
†Source: Alegre, H. et al, 2000. *Manual of Best Practice: Performance Indicators for Water Supply Services.* Published by IWA Publishing, London. www.iwapublishing.com. Used with permission
‡No water loss performance indicators exist for the intermediate point of view *x* in which service connection density is less than 32 per mile of mains; use "per mile of main" instead of "per service connection" for this indicator
§NRW_v—nonrevenue water by volume
**ILI—infrastructure leakage index
††UARL—unavoidable annual real losses
‡‡NRW_c—nonrevenue water by cost

FIGURE 1 Selected quoted standards from the States Survey Project



Source: Beecher Policy Research Inc., 2002
"Standards" are various forms of the inconsistently defined "unaccounted-for" water percentage indicator.

of leakage management, which recognizes the following:

- Leakage levels can be reliably measured using night-flow analysis in discrete zones of the water distribution system known as district metered areas (DMAs).
- Although all systems have a leakage component that is considered unavoidable, the international method features a calculation (Table 4) that is system-specific and gives a much lower level of leakage than amounts derived by dated, rule-of-thumb methods such as the Kuichling equation, which is still used by many North American water utilities.
- Conceptually for any water utility, an appropriate minimal level of leakage exists that is economically justified to seek. Striving to reduce current leakage levels to this "economic level of leakage" makes sense for most water utilities.

In applying the international method, the level of unavoidable annual real losses (UARL) represents the technically low level that could exist in a system if it successfully applies the current BMPs for leakage management. The calculation for UARL is system-specific; thus, the UARL level for one water supplier is not the same as another. The calculation takes into account the key variables that influence the amount of leakage existing in a distribution network. Factors include the length of water mains, average water pressure, number of service connections, and the average length of service connection piping from the curb-stop valve to the customer meter or property line for systems that do not use meters.

The numerical derivation of the UARL is based on data obtained from a substantial number of countries (Lambert et al, 1999). The UARL component values, given in Tables 4 and 5, were developed from analysis of night flows in DMAs just after all detectable leaks and breaks had been located and repaired (Bristol Water Services, 2001). They are representative of the minimum leakage that remains in well-run systems after active leakage control has been successfully used. The component values include minimal leakage amounts for background leakage, reported leaks, and unreported leaks (Lambert et al, 1998). Each component value amount is assigned to mains or pipelines, service connections from the water main to the curb-stop, and service connections from the curb-stop to the customer meter or property line. For water systems worldwide, the majority of the annual volume of leakage losses occurs on customer service connection piping, not water mains; therefore, the inclusion of service connection piping variables in this equation is most appropriate. Also, the role of water pressure levels on leakage rates has been determined to be a highly significant factor on minimal leakage levels that can be attained. Finally, the system age is not a factor in the calculation of the UARL.

The values shown in Tables 4 and 5 can be recalculated in pressure-dependent terms that are easier to apply for individual systems. The calculated UARL value for Philadelphia is listed in Table 6 as 5.299 mgd (20,064 m^3/d) for its 2002 fiscal year. This represents the theoretical minimum level of leakage that could exist in the city if all possible leakage reduction methods were successfully in place.

The ILI, defined as the dimensionless ratio of current annual real

FIGURE 2 International standard water audit format

<table>
<tr><td rowspan="5">Own sources</td><td rowspan="10">System input</td><td rowspan="2">Water exported</td><td rowspan="8">Authorized consumption</td><td rowspan="3">Billed authorized consumption</td><td rowspan="5">Revenue water</td><td>Billed water exported</td></tr>
<tr><td rowspan="2">Billed metered consumption</td></tr>
<tr><td>Billed unmetered consumption</td></tr>
<tr><td rowspan="8">Water supplied</td><td rowspan="2">Unbilled authorized consumption</td><td>Unbilled metered consumption</td></tr>
<tr><td>Unbilled unmetered consumption</td></tr>
<tr><td rowspan="5">Water imported</td><td rowspan="5">Water losses</td><td rowspan="2">Apparent losses</td><td rowspan="5">Non-revenue water</td><td>Unauthorized consumption</td></tr>
<tr><td>Customer metering inaccuracies and data handling error</td></tr>
<tr><td rowspan="3">(Allow for known errors)</td><td>Leakage on mains</td></tr>
<tr><td>Leakage and overflows at storages</td></tr>
<tr><td>Leakage on service connections up to point of customer metering</td></tr>
</table>

Source: Alegre, H. et al, 2000. Manual of Best Practice: Performance Indicators for Water Supply Services. *Published by IWA Publishing, London. www.iwapublishing.com. Used with permission*
All data are in volume, or average volume per day, for the standard reporting period—typically one year.

TABLE 4 Values assigned for the calculation of UARL via the IWA method*

Infrastructure Component	Background (undetectable) Leakage	Reported Leaks and Breaks	Unreported Breaks and Leaks
Mains	8.5 US gal/mi/h (20 L/km/h)	0.20 breaks/mi/year (0.124 breaks/km/year) at 50 US gpm (12 m^3/h) for 3 days' duration	0.01 breaks/mi/year (0.006 breaks/km/year) at 25 US gpm (6 m^3/h) for 50 days' duration
Service connections, main to curb-stop	0.33 US gal (1.25 L) /service connection/h	2.25 leaks/1,000 service connections/ year at 7 US gpm (1.6 m^3/h) for 8 days' duration	0.75 leaks/1,000 service connections at 7 US gpm (1.6 m^3/h) for 100 days' duration
Service connections, for 50 ft (15 m) average length from curb-stop to meter	0.13 US gal (0.50 L) /service connection/h	1.5 leaks/1,000 service connections at 7 US gpm (1.6 m^3/h) for 9 days' duration	0.50 leaks/1,000 service connections at 7 US gpm (1.6 m^3/h) for 101 days' duration

*The original metric units shown have been converted to US units and rounded; all flow rates are specified at a reference pressure of 50 m (70 psi); UARL—unavoidable annual real losses, IWA—International Water Association; Source: Lambert et al, 1999; reprinted from *Aqua*, vol. 48, issue 6, pp. 227–237, with permission from the copyright holders, IWA Publishing, ©IWA Publishing 1999

TABLE 5 Standard unit values used for the calculation of UARL*

Infrastructure Component	Background Leakage	Reported Leaks and Breaks	Unreported Leaks and Breaks	UARL Total
Mains—*US gal/mi of main/day/psi (L/km of main/day/m of pressure)*	2.87 (9.6)	1.75 (5.8)	0.77 (2.6)	5.4 (18.0)
Service connections, main to curb-stop—*US gal/service connection/day/psi (L/service connection/day/m of pressure)*	0.112 (0.60)	0.007 (0.04)	0.030 (0.016)	0.15 (0.80)
Service connections, curb-stop to meter—*US gal/mi of service connections/day/psi (L/km of service connections/day/m of pressure)*	4.78 (16.0)	0.57 (1.9)	2.12 (7.1)	7.5 (25.0)

*The original metric units shown have been converted to US units and rounded; all flow rates are specified at a reference pressure of 50 m (70 psi); UARL—unavoidable annual real losses; Source: Lambert et al, 1999; reprinted from *Aqua*, vol. 48, issue 6, pp. 227–237, with permission from the copyright holders, IWA Publishing, ©IWA Publishing 1999

TABLE 6 IWA calculation for UARL for a water distribution system*,†

Infrastructure Component	Quantity	Unit Rate for UARLs	Average Pressure	UARL *mgd (m^3/d)*
Mains	3,160 mi (5,084 km) of main	5.40 gal/mi/day/psi (18.0 l/km of main/day/m of pressure)	55 psi (38.7 m)	0.939 (3,554)
Service connections, main to curb-stop	474,657 service connections	0.15 gal/service connection/day/psi (0.80 L/ service connection/day/m of pressure)	55 psi (38.7 m)	3.916 (14,826)
Service connections, curb-stop to meter	(474,657)(12 ft)/5,280 ft per mi ([474,657][3.66 m]/1,000 m per km)	7.5 gal/mi/day/psi (25.0 L/km of service connections/day/m of pressure)	55 psi (38.7 m)	0.445 (1,684)
				5.299 (20,064)

*Calculation is for city of Philadelphia, Pa.—fiscal year 2002: July 1, 2001–June 30, 2002; IWA—International Water Association, UARL—unavoidable annual real losses, BMP—best management practice

†The IWA calculation for UARL is based on the theoretical minimal level of leakage that would still exist in well-run water distribution systems after all of today's BMP leakage interventions have been implemented. The calculation is system-specific and includes allowances based on key leakage factors: the miles of water main, the number of service connection pipes, the length of service connection piping beyond the curb-stop or property line, and the average operating pressure in the system. As a system-specific indicator, the UARL is a superior method to the generic methods traditionally referred to in North America, such as the Kuichling equation. This dated equation (circa 1880s) was derived as the number of "drops per second" from various system joints and appurtenances, leading to a rough number of 2,500–3,000 gpd/mi (5.88–7.06 $m^3/d/km$) of main. It does not include key leakage factors of system pressure and number of service connections. The calculation for UARL has been confirmed on data from more than 20 countries and is recognized by the IWA as the BMP measure of unavoidable leakage losses in water distribution systems.

City of Philadelphia, Pa., Annual Water Audit in International Water Association Format*

(Refer to data shown in Table 2)

PERFORMANCE INDICATORS FOR WATER SUPPLY SYSTEM LOSSES

Water resources performance indicator.

Inefficiency of use of water as a resource

= real losses over system input volume, %

= 69.189 mgd/263.000 mgd (261,981 m^3/d/995,834 m^3/d) 100% = **26.25%**

Operational performance indicators.

Water losses 82.323 mgd (311,711 m^3/d)

Apparent losses 13.134 mgd (49,731 m^3/d)

Real losses 69.189 mgd (261,981 m^3/d)

UARL† 5.299 mgd (20,064 m^3/d)

Infrastructure leakage index = ratio of real losses to UARL = 69.189/5.299 (261,981/20,064) = 13.1

Financial performance indicator for nonrevenue water.

Nonrevenue water = real and apparent losses and unbilled authorized consumption = 69.189 + 13.134 + 0.548 + 1.935

= 84.806 mgd (261,981 + 49,731 + 2,075 + 7,327 = 321,114 m^3/d)

Nonrevenue water by volume = nonrevenue water over system input volume, %

= 84.806 mgd/ 263.000 (321,114 m^3/d / 995,834 m^3/d) 100% = 32.24%

Nonrevenue cost ratio is the annual cost of nonrevenue water over the annual running costs for the water supply system—%

Nonrevenue water costs	$ 24,342	Unbilled unmetered water
	121,642	Unbilled unmetered (authorized usage)
	9,036,038	Apparent losses
	3,369,029	Real losses
	$12,551,051	Total nonrevenue water

Nonrevenue water cost ratio = ($12,551,051/$155,060,248) × 100% = 8.09%

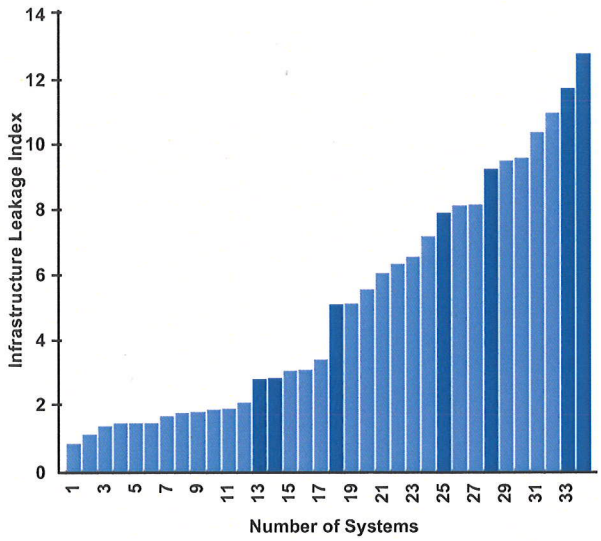
*Fiscal year 2002: July 1, 2001–June 30, 2002
†UARL—unavoidable annual real losses

losses over the UARL, gives a measure of leakage relative to the best level currently obtainable with today's technology for that system. During the development of the international method, data from more than 20 countries were gathered to test the reliability of the indicator. Figure 3 (Brown et al, 2000) shows ILI ratings for 34 systems from around the world, with seven North American systems shown in bold. Twelve systems operate with an ILI less than 2.0, or an admirably small level of active leakage that is less than two times the technically achievable low. Conversely, seven of the systems are observed to have ILI values greater than 8.0, or leakage greater than eight times the technically achievable low. Such systems likely have good reason—both economically and environmentally—to seek reduction of their relatively high level of loss. The largest group of systems—15 in all—have ILI values between 2.0 and 8.0, reflecting reasonable control of their leakage but a need to continue to seek further leakage reductions.

What level of ILI value should a water utility target? Again, prevailing economics should dictate this. As described in Table 7, where water is scarce, expensive, or both, justification exists to fund leakage reduction efforts to bring the ILI down toward a value of 1.0, or current annual real losses close to the UARL. If water resources are reliable and inexpensive, a level of leakage corresponding to an ILI somewhat higher than 1.0 can be targeted. The economic level of leakage (ELL) is defined as the appropriate leakage level for water suppliers to target. In theory, the ELL is derived as the level at which the cost of leakage reduction activities meets the cost of water saved through leakage reduction. For most systems, this translates to an ILI value somewhere between their current annual real losses and the UARL. The relationship between current annual real and apparent losses and their economic and unavoidable levels are shown in Figures 4 and 5, respectively.

Work continues internationally to devise a consensus means to assign the ELL, including part of the scope of work of the 2002–03 Evaluating Water Loss and Planning Loss Reduction Strategies project, which is being funded by the AWWA Research Foundation (AWWARF). A proper economic analysis of leakage should take into account not only the short-term costs—which are often relatively straightforward to calculate—but also the long-term, subjective costs of water loss. Environmental, social, and political costs also exist with any water resource, but such costs are more difficult to quantify. Until an accepted method is available, water utilities may attempt to determine their ELL using their own means.

FIGURE 3 Infrastructure leakage index for systems in the international data set



North American systems are shown in bold.

Alternatively, Table 7 was devised by the committee to offer general guidance to establish a long-term target ILI for utilities that have not determined an ELL.

The sidebar on page 74 shows that Philadelphia has an ILI of 13.1 or current annual real losses of 69.189 mgd (261,981 m^3/d) that are 13.1 times greater than its UARL of 5.299 mgd (20,064 m^3/d). The city's Water Accountability Committee is moving to set long-term leakage reduction targets that attempt to include specific Philadelphia economic and infrastructure influences to determine an approximate ELL. In the meantime, it suffices that leakage reduction is well justified in Philadelphia given that its ILI level above 8.0 warrants improved water resource management.

As advocated in this article, the IWA water audit methodology and performance indicators now stand as an available and highly effective means for drinking water suppliers worldwide to audit both the use and loss of the water that they manage. Systems applying the international performance indicators can move forward to implement water loss control interventions to reduce their losses and measure progress against targets.

REAL LOSSES CAN BE CONTROLLED BY IMPLEMENTING ACTIVE LEAKAGE MANAGEMENT TECHNOLOGY

Leakage causes many problems, indirectly requiring water suppliers to extract, treat, and transport greater volumes of water than their customers actually require. Also, the additional energy needed to supply leakage unnecessarily taxes energy-generating capabilities. It is estimated that water utilities consume from 2 to 10% of all power used in any country, and power can consume up to 65% of a water utility's operating budget (Crapeau, 2000; Pelli et al, 2000). Collectively, water utilities are the largest single user of electricity in the United States, consuming an estimated 75 billion kW·h annually, or about 3% of all electric power generated in the country (Von Sacken, 2001). It is possible that 5–10 billion kW·h of power generated in the United States is expended each year on water that is either leaked away or not paid for by customers. Obviously, water loss control is also a pertinent energy management issue.

Leaks and breaks often cause considerable damage and increase liability for water suppliers. They may also have a distinct effect on distribution system water quality because they are a potential source of contamination during low-pressure or backflow conditions. Leakage often finds its way into wastewater or stormwater collection systems and may be treated at a wastewater treatment plant—two rounds of expensive treatment without ever providing any beneficial use (Thornton et al, 2002). Watersheds are taxed unnecessarily by inordinately high withdrawals, sometimes limiting growth in a region because of restrictions on available source water. Leakage also requires larger infrastructure than is necessary to meet customer demand, a compelling factor in the infrastructure debate now occurring in the United States.

British leakage management terminology distinguishes among reported, unreported, and background leaks. Broken water mains are the most recognizable example of reported leaks, which, because of their damage-causing nature, are usually quickly reported and contained. However, unreported and background leaks (the smallest of leaks at joints and fittings) frequently escape the attention of the public and water suppliers but account for larger volumes of lost water because they run undetected for much longer periods of time. Most water utilities provide able response to reported leaks, but many never conduct regular searches (leak surveys) to find unreported leaks.

The four-component approach to control of real (leakage) losses, shown in Figure 4 (McKenzie & Lambert, 1992) has been developed as a template for water systems to maintain low leakage operations over a long-term horizon. The graphic shows that any system has a certain amount of recoverable leakage that can be reduced to its ELL value with the

TABLE 7 General guidelines for setting a target level ILI* (in lieu of having a determination of the system-specific economic level of leakage)†

Target ILI Range	Water Resources Considerations	Operational Considerations	Financial Considerations
1.0–3.0	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand.	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability.
3.0–5.0	Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management, water conservation) are included in the long-term planning	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place.	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population.
5.0–8.0	Water resources are plentiful, reliable, and easily extracted	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to supply shortages.	Cost to purchase or obtain/treat water is low, as are rates charged to customers.
Greater than 8.0	Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0—other than as an incremental goal to a smaller long-term target—is discouraged.		

*Infrastructure leakage index

proper combination of the four leakage controls. Although the graphic adequately explains "Speed and quality of repairs" and "Pipeline materials management," elaboration is given for the other components:

Active leakage control (Lambert et al, 1998).

- regular inspection and sounding of all water main fittings and connections—leakage surveys;
- innovative leakage modeling methods—the bursts and background estimates (BABE) model (Lambert & Morrison, 1996);
- metering of individual pressure zones;
- DMA metering—measuring total inflow per day, week, or month;
- continuous or intermittent night-flow measurements;
- short-period measurements at any time of day; and
- temporary or permanent placing of leak noise detectors and loggers.

Pressure management.

- pressure modeling using internationally applicable concepts such as the fixed and variable area discharge (FAVAD) paths model (Lambert, 2001b; May, 1994),
- controlling pressure close to but greater than the minimum standard of service,
- operating discrete pressure zones configured based on topography,
- limiting maximal pressure levels or surges in pressure, and
- nighttime pressure reduction where feasible to reduce losses from small background leaks.

Several innovations in the structure now existing in England and Wales stand out as particularly effective in driving down leakage losses. By creating DMAs that range in size from several hundred to several thousand properties, water usage patterns are monitored closely to infer leakage rates based on minimal night-flow rates. Important findings from the National Leakage Initiative spurred the development of leakage modeling concepts such as BABE, allowing development of software (McKenzie & Lambert, 1992) that quantifies various components of leakage and usage within a DMA. Better understanding of pressure–leakage relationships has resulted in the development of the FAVAD model. Establishing DMAs and using leakage-modeling techniques effectively provide a quantitative measure of leakage to the water utility manager. The amount of active leakage in a system can truly be measured. This information is available as the "bottom-up" contribution to the water audit, improving the accuracy and reliability of that document. Such measurements also form the basis for leakage reduction targets on a DMA basis. Flexibility exists in the manner in which DMAs are configured so that possible concerns for fire flow restrictions, closed valves, and customer expectations can be safely and economically managed. The effect of leakage run time has been exposed and incorporated as strategy. Leaks left to run for long periods of time create large annual loss volumes. In well-run systems worldwide, the greatest annual volume of real losses occur from long-running, small- to medium-sized leaks on customer service connections, except at very low densities of service connections (Brown et al, 2000). To achieve successful leakage control, water utilities must be effective in actively identifying leaks and in executing timely, lasting repairs.

Severe drought in the mid-1990s prompted the UK regulator to institute a key policy change, initially as an emergency measure, but one that is now permanently in place. This change requires water companies to conduct leak repairs on customer service connections, a responsibility that had traditionally rested with the customer. Shifting the responsibility for

these repairs to the companies has been highly successful in reducing leakage losses by reducing long leak run times. In the United States, many systems rely on their customers to repair leaking service connection pipes, an often inefficient practice that should be reevaluated.

Another major innovation of leakage management is the science of pressure management. Common engineering design of water supply systems calls for adequate pressure to ensure a specified minimal level of service. However, it is now understood that certain types of leaks are very sensitive to pressure. Excess pressure—which is not always carefully assessed by water system operators—has a cost in terms of higher leakage and unnecessary energy usage. Better understanding of high- and low-pressure variations gives suppliers more control in preventing surging ruptures and backflow conditions, thereby extending the life of infrastructure and safeguarding distribution system water quality. Pressure control has proven to be particularly effective in reducing background leakage. The use of selective pressure reduction during nighttime hours is an effective technique in economically reducing background leakage. This technique greatly challenges the levels set by the dated concepts of unavoidable leakage.

Leakage management methods are now widely recognized in many parts of the world as effective tools that have been applied successfully in a great variety of water system settings. These methods are viewed by the committee as current BMPs for controlling leakage losses in water distribution systems and are recommended for use by the North American water industry. Guidance publications describing the details of these methodologies are now available (Thornton et al, 2002; Alegre et al, 2000; McKenzie & Lambert, 1992).

METHODS ARE NEEDED FOR CONTROLLING APPARENT LOSSES

Apparent losses exert a significant financial effect on suppliers and customers and compromise efforts to reliably distinguish water consumption from real loss volumes. The latter impact undermines water resources' decision-making processes, which rely on accurate data. Financially, apparent losses represent service rendered without payment recovered. The short-term economic impact of apparent losses is usually much greater than real losses because apparent losses occur at the retail rate charged to customers, whereas short-term real losses occur at the lesser marginal production cost. Recovering apparent losses usually offers a speedy payback and requires few new resources to implement. Controlling apparent losses also improves equity in customer collections because a portion of apparent losses occurs when some active customers are inadvertently left out of the billing process. Paying customers effectively subsidize these nonpaying customers, exacerbating tensions surrounding water rate increases.

Apparent losses compromise the reliability of water consumption and real loss tabulations. Many water suppliers extract customer water consumption data from computerized billing systems that were established to manage billing operations—a cost accounting function. Unfortunately, many billing systems lack water accounting controls that ensure that needed cost adjustments for valid billing purposes do not corrupt actual water consumption data. Some utilities trigger needed billing cost adjustments by modifying customer metered consumption data to obtain the right cost adjustment. Many water professionals perceive customer meter inaccuracy as the sole paper loss that occurs in water supply systems. While numerous utilities have documented accountability improvements by replacing old and worn residential meters, or by right-sizing large meters, apparent losses have a number of components, including

- customer meter inaccuracy usually occurring because of meter wear, malfunction, or inappropriate size or type of meter;

FIGURE 4 Four-component approach to the control of real (leakage) losses

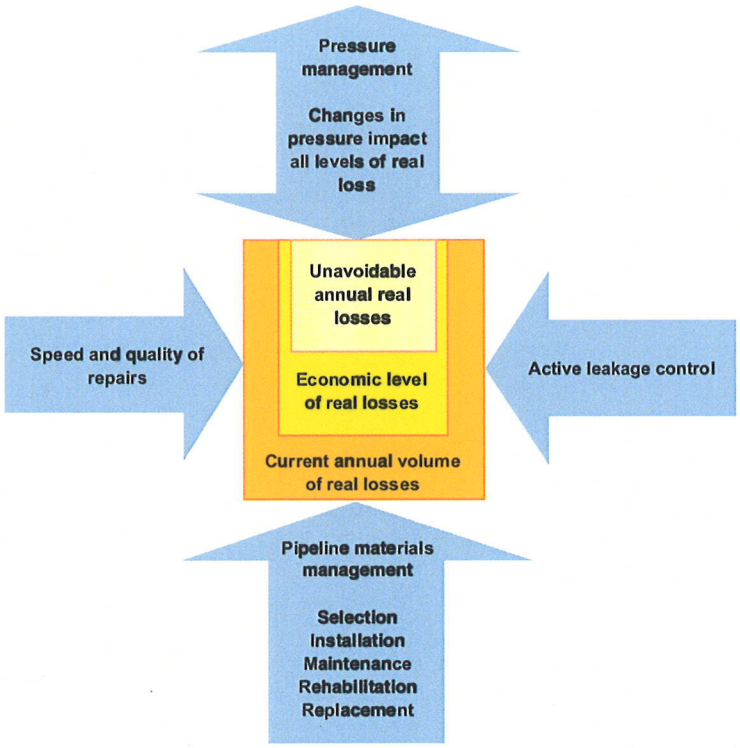
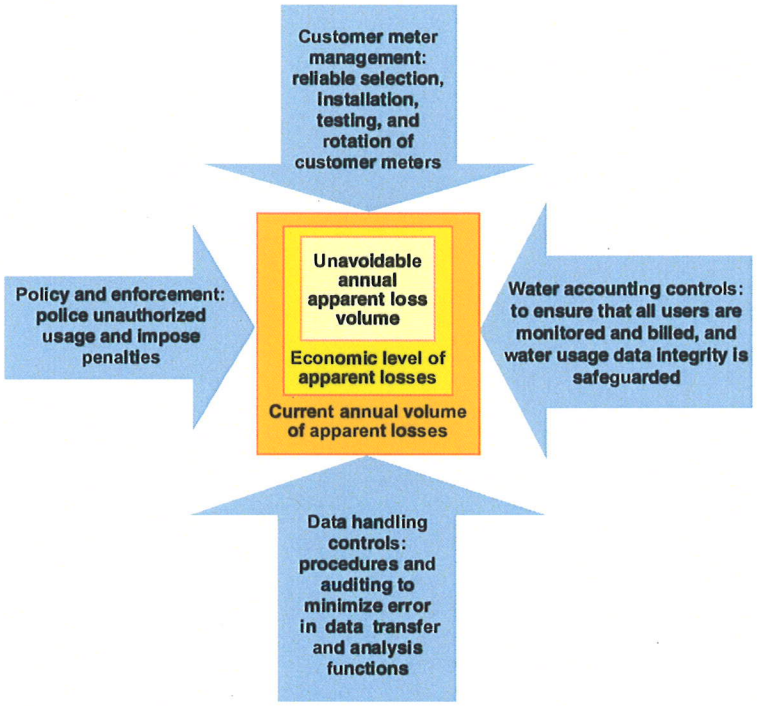


FIGURE 5 Four-component approach to the control of apparent losses



- data transfer error in getting customer metered consumption data into a database or billing system;
- data analysis error, including poor estimates of unmetered or unread accounts;
- poor accounting, including lack of controls that ensure accounts exist for all water users and that bills are issued or tabulated (even if water is supplied at no cost). (This includes procedural gaps that allow legitimate water users to exist in "nonbilled" status.);
- all forms of unauthorized consumption, including meter or meter-reading tampering, illegally opening fire hydrants, unauthorized tapping into service mains, or unauthorized restoration of water service connections after violation discontinuance by the water supplier;
- weak or nonexistent policy, including the often-used practice of not metering and billing municipally owned and public facilities, allowing unrestricted use of fire hydrants, lack of enforcement of existing statutes, and lack of promotion of the value of water.

Similar to real losses, a four-component approach to control apparent losses is offered in Figure 5. The notion that current, economic, and unavoidable levels of apparent loss exist for any water system follows the same logic as the assessment of real losses in a water supply system. The four-component approach guides the water manager in determining where the greatest amounts of apparent loss are believed to exist and offers interventions available to reduce overall apparent losses to the appropriate economic level. The nature of the interventions needed to control apparent loss in water supply systems parallels policies and controls that are used in the world of financial accounting. Here, all monies are placed in accounts that are routinely reported, audited, and reconciled. The approach to apparent loss control in water supply systems is in its infancy, and much work remains to bring it to a par with available real loss interventions. The approach given in Figure 5 is a framework that can guide water professionals in launching apparent loss reduction programs.

CONCLUSION

AWWA's States Survey Project substantiated long-held perceptions of many water analysts that weak and inconsistent water accounting structures exist in drinking water supply systems in North America. Water losses, manifested as both real (physical) losses and apparent (paper) losses, constitute a major inefficiency in water supplies because water and energy resources are wasted, revenue is not fully recovered, and water use and loss data integrity are compromised. With many pressures confronting today's water industry, water professionals can no longer regard water loss as an uncontrollable inevitability. And indeed they need not, as the discipline of water loss control has developed rapidly internationally and offers great potential as a resource and revenue recovery opportunity for North American water suppliers.

Working in cooperation with international water loss practitioners and the IWA, AWWA's Water Loss Control Committee participated in the development of new water auditing methods that were designed to serve as BMP structures in the field of water loss control. The committee recommends the following:

- The IWA methodology for the water audit (balance) and performance indicators should be recognized as the current BMP for quantitatively monitoring water use and water loss in drinking water systems.
- Water suppliers should make use of the performance indicators included in the international methodology, particularly the ILI. The percentage measure of nonrevenue water (all water not included in billings) over the delivery system input volume should be used with great caution as a general financial indicator only, having been found to be a poor operational performance indicator.

• The term "unaccounted-for water"—lacking a consistent definition—should no longer be used.

• The four-component approaches to controlling real and apparent losses should be used to economically control these losses.

Further work is needed in the field of water loss control, particularly to devise ways to calculate the economic loss levels that can assist in setting long-term loss reduction targets for water systems. Similarly, additional manuals and software are needed to provide these specific tools for water utility managers and regulatory officials. Recent publications and the forthcoming results of AWWARF's *Evaluating Water Loss and Planning Loss Reduction Strategies* project are making new material available to water utility managers. AWWA's *Water Audits and Leak Detection*, M36 (1999) will require rewriting or replacement by virtue of this committee report, and the committee is poised to undertake this initiative.

The international water audit methodology and loss control interventions represent a leap forward in technological and managerial advancement. With the extraordinary skills and dedication of North American water professionals, coupled with new and effective water loss methods, a new level of efficient water resources management can be realized in the twenty-first century.

ACKNOWLEDGMENT

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This article is the work of the AWWA Water Loss Control Committee. It was prepared by George Kunkel (chair) with contributions from committee members S. Bowns, F.S. Brainard, Bradford Brainard, K. Brothers, Timothy Brown, L. Counts, T. Galitza, Duane Gilles, Patti Godwin, Thomas Holder, W. Hutcheson, Thomas Jakubowski, Paul Johnson, D. Jordan, Don Kirkland, C. Leauber, R. Liemberger, J. Lipari, David Liston, James Liston, Dan Mathews, T. McGee, R. McKenzie, R. Meston, R. Ruge, J. Hock, M. Simpson, Julian Thornton, M. Shepherd, and Amy Vickers.

FOOTNOTES

[1]Beecher Policy Research Inc., Indianapolis, Ind.

If you have a comment about this article, please contact us at journal@awwa.org.

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Maps to add to the appendices for Project 1 – Lompoc Leak Detection

Exhibit ___, Lompoc, Water Mains Located Throughout City on Streets and in Alleys

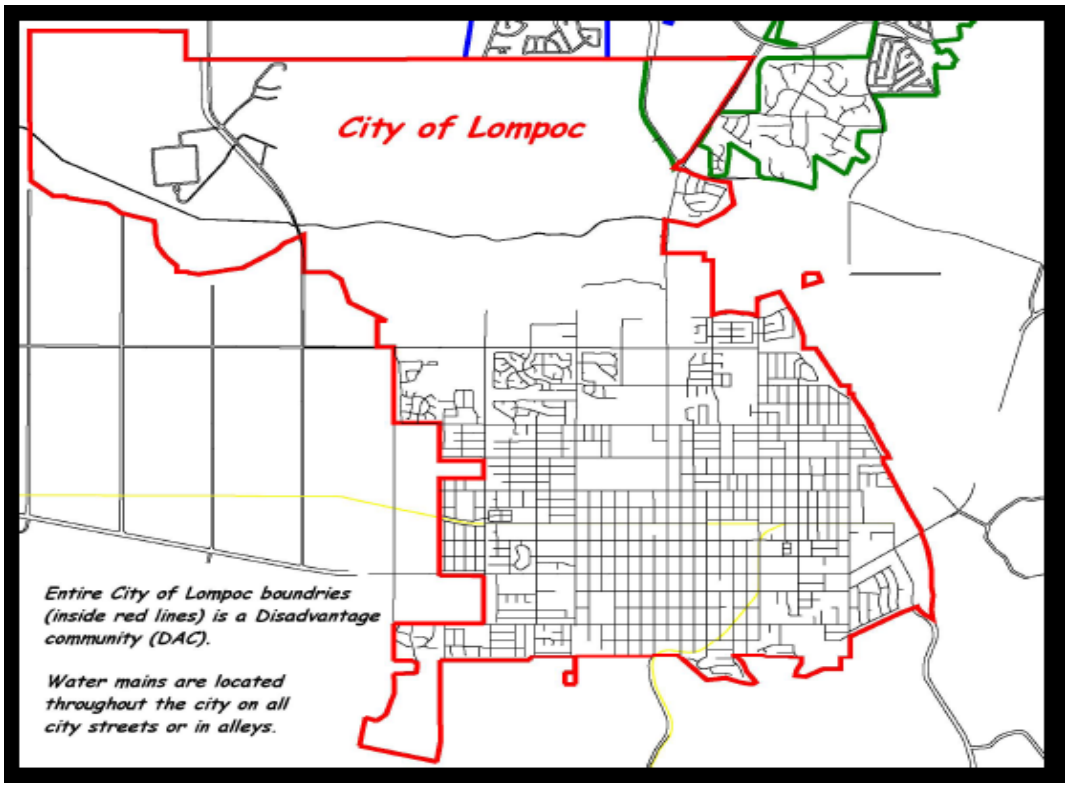


Exhibit ___ Mission Hills Community Services District

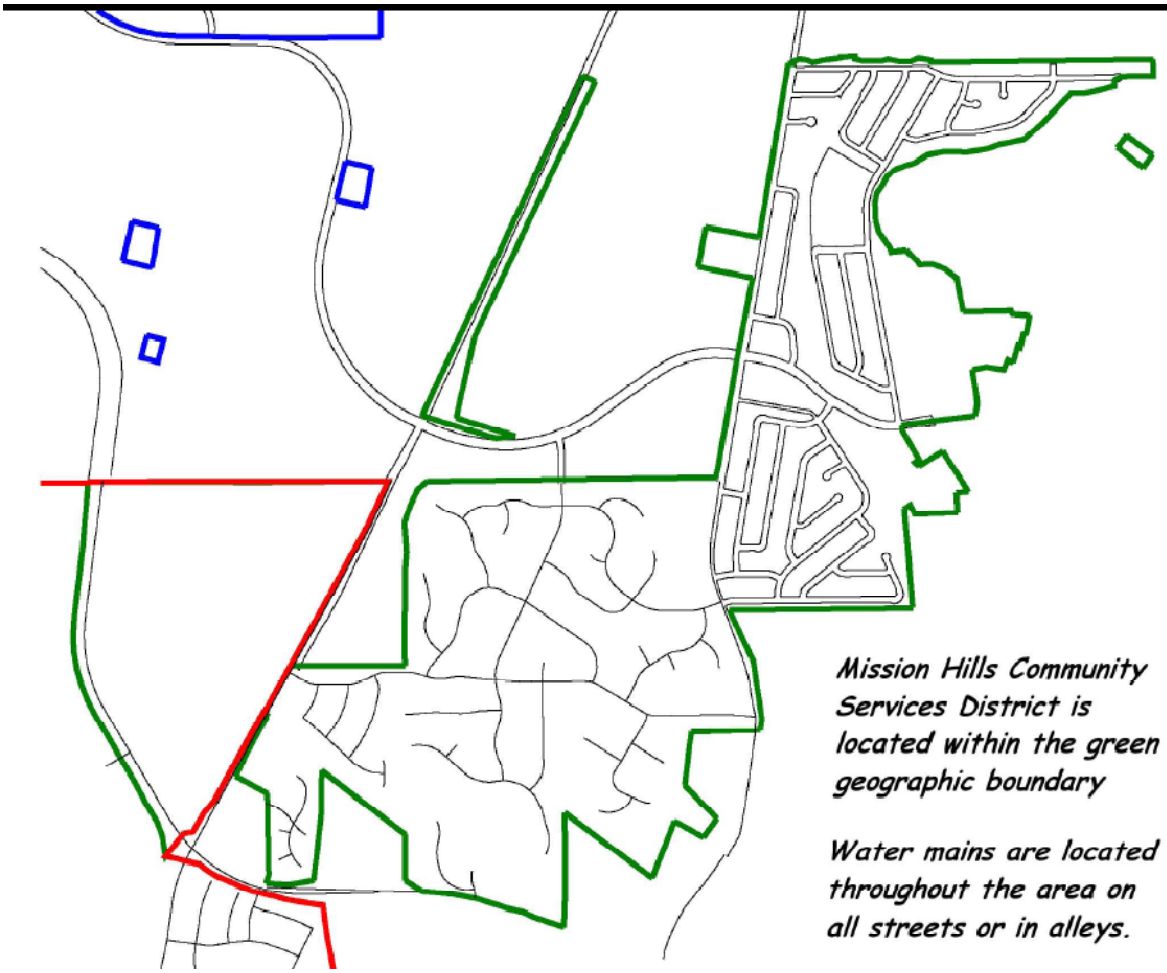
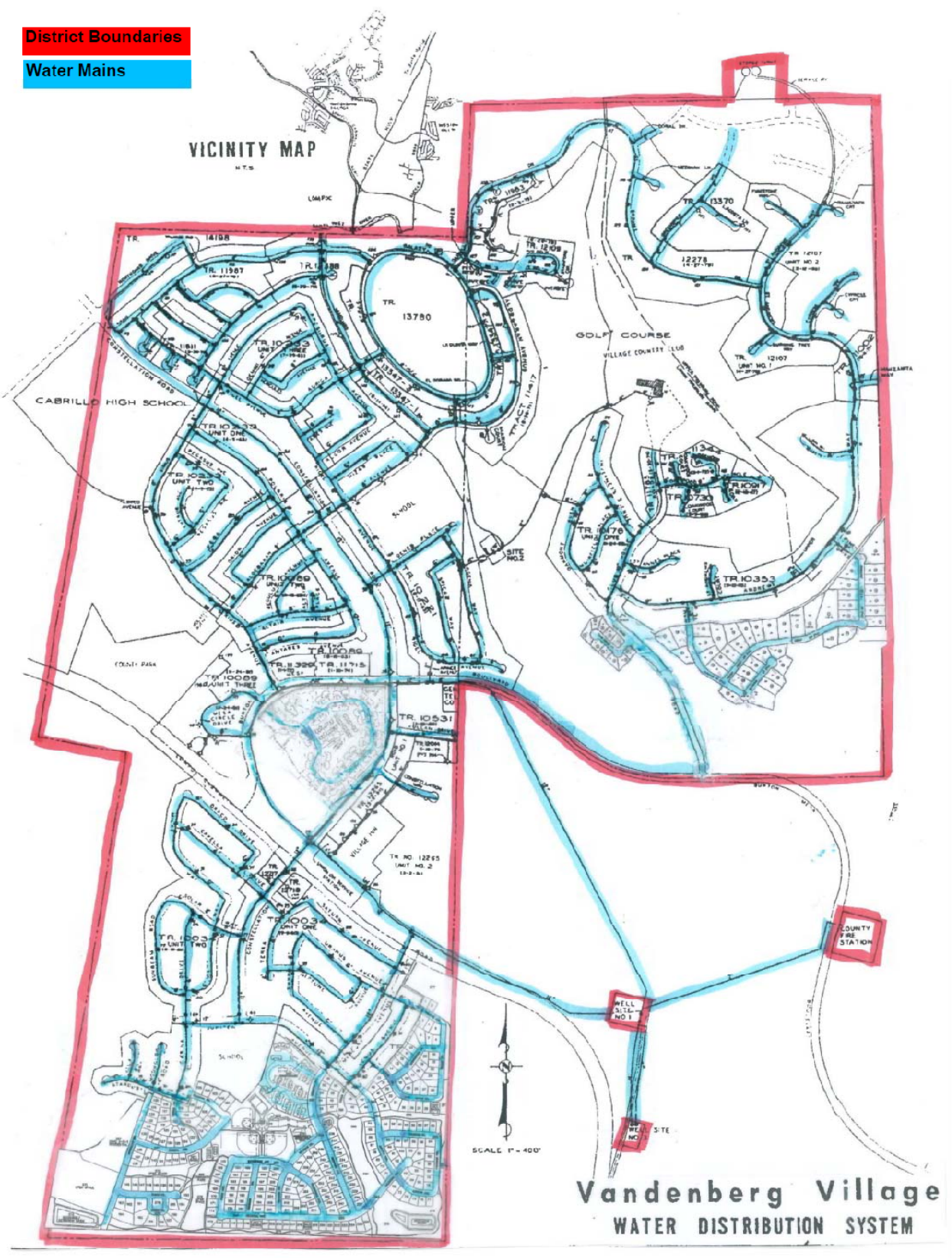
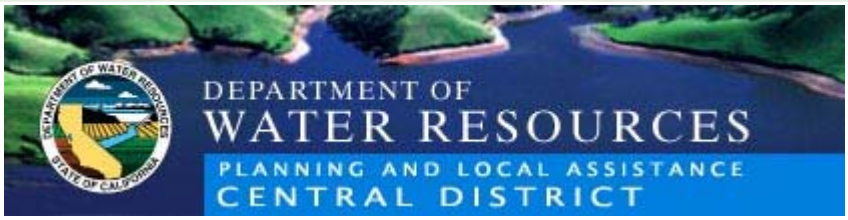


Exhibit ___Vandenburg Village Community Services District Project Map


District Boundaries
Water Mains
VICINITY MAP
CABRILLO HIGH SCHOOL
GOLF COURSE
VILLAGE COUNTRY CLUB
COUNTY FIRE STATION
WELL SITE NO 1
WELL SITE NO 2
SCALE 1" = 400'
Vandenberg Village
WATER DISTRIBUTION SYSTEM



North Central Region Office Department of **Water** Resources

(916) 376-9600

Street Address:

3500 Industrial Blvd.
West Sacramento, CA 95691

Mailing Address:

PO Box 942836
Sacramento, CA 94236

Conservation

Water Audit and Leak Detection

In the early 1980s, the Department of **Water** Resources conducted a survey with numerous **water** agencies to determine the amount of **water** lost from distribution systems due to leaks. The results of that survey indicated approximately 700,000 acre-feet of **water** are lost each year. In response, **DWR** prepared a **guidebook** (**Water Conservation Guidebook No. 5: Water** Audit and Leak Detection) to assist **water** agencies with quantifying potential **water** loss due to leaks (**Water** Audit) and establishing a program to locate leaks (Leak Detection).

Additionally, the Urban **Water** Management Planning Act (California **Water** Code, sections 10610-10656) requires **water** agencies (as defined by the Act) to establish (if economically feasible) fourteen Demand Management Measures (DMM) for **water** use efficiency. The **Water** Audit and Leak Detection program is the DMM addressed in **Water** Code section 10631(f)(1)(c). For members of the California Urban **Water Conservation** Council (CUWCC), this is Best Management Practice 3. http://www.cuwcc.org/m_bmp3.lasso

The **Water** Audit is an accounting procedure using agency data to determine **water** loss that may be due to distribution system leaks. The **Water** Audit requires the agency to determine an **audit** period and gather an assortment of data for that period. The **guidebook** defines the type of data necessary and provides worksheets as guidelines or for use in the **audit**.

In 2000, **DWR** released a Microsoft Excel Workbook, **Water** Audit Workbook (v2.0 2000). This software follows the worksheets of the **Guidebook**. It simplifies the **water** audit

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process by performing any calculations and linking any calculated data to other sheets that use the data. The final worksheet of the software summarizes the data and calculates a benefit-cost ratio. This workbook is available upon request.

Once an agency has determined the percentage of **water** loss and has performed a benefit-cost analysis to verify economic feasibility, a **Leak** Detection program may be established. The **leak** detection program is the field portion of the program. It requires knowledge of the layout of the distribution system and a good ear when using the sonic equipment. The **Guidebook** provides information on what steps are required to establish and perform a **leak** detection program.

North Central Region Office has **leak** detection equipment available for short-term loan to a **water** agency, and will provide assistance to local **water** agencies seeking to conduct a **water** **audit** and **leak** detection survey of their distribution system.

For additional information, contact
Kim Rosmaier
(916) 376-9628
krosmaie@**water**.ca.gov

Education Program

Education Materials:

DWR CONSERVATION MATERIALS AVAILABLE

Model **Water** Efficient Landscape Ordinance - Provides a sample ordinance for new and rehabilitated landscaping to promote landscape **water** efficiency.

WUCOLS (PDF, 4MB) - **Water** Use Classification of Landscape Plants. Provides guidance when selecting plant material while considering **water** requirements.

Graywater Guide (PDF, 1.2MB) - Provides guidelines and standards for incorporating a graywater system into a landscaping project.

Water Education Program - The Public Affairs Office has assembled a library of literature and multi-media products that can be used by all ages and interest groups. For a list of available information, see the **Water** Facts and Fun Catalog or the Graphic Services video catalog.

Related Links

California Regional Environmental Education Community (CREEC) http://www.creec.org

California Foundation for Agriculture in the Classroom
www.cfaitc.org
Project WET http://www.projectwet.org/
Yolo Basin Foundation http://www.yolobasin.org/
Irrigation Training and Research Center http://www.itrc.org

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Need Assistance?

1. Utility Operations Programs

Water utilities throughout California are implementing water conservation programs and providing services to the customers they serve. There are four subcategories that comprise signatory utility operation program responsibilities.

1.1 Operations Practices

This practice will outline several key actions that utilities shall take to better enable conservation program implementation, to supplement conservation incentives with regulations where appropriate, and to assist one another through the wholesaler-retailer relationship.

A. Implementation

Implementation shall consist of at least the following actions:

1) Conservation Coordinator (*formerly BMP 12*)
Designate a person as the agency's responsible conservation coordinator for program management, tracking, planning, and reporting on BMP implementation.

2) Water waste prevention (*formerly BMP 13*)

a) New development
Enact, enforce, or support legislation, regulations, ordinances, or terms of service that (1) prohibit water waste such as, but not limited to: single-pass cooling systems; conveyer and in -bay vehicle wash and commercial laundry systems which do not reuse water; non-recirculating decorative water fountains and (2) address irrigation, landscape, and industrial, commercial, and other design inefficiencies.

b) Existing users
Enact, enforce, or support legislation, regulations, ordinances, or terms of service that prohibit water waste such as, but not limited to: landscape and irrigation inefficiencies, commercial or industrial inefficiencies, and other misuses of water.

c) Water shortage measures
Enact, enforce, or support legislation, regulations, ordinances, or terms of service that facilitate implementation of water shortage response measures.

3) Wholesale agency assistance programs (*formerly BMP 10*)
This section addresses assistance relationships between regional wholesale agencies and intermediate wholesale agencies as well as between wholesale agencies and retail agencies.

a) Financial investments and building partnerships
When mutually agreeable and beneficial to a wholesaler and its retail agencies, a wholesaler

1.2 Water Loss Control *(formerly BMP 3) as amended September 16, 2009*

The goals of modern water loss control methods include both an increase in water use efficiency in the utility operations and proper economic valuation of water losses to support water loss control activities. In May 2009 the American Water Works Association (AWWA) published the 3rd Edition M36 Manual *Water Audits and Loss Control Programs*. BMP 1.2 will incorporate these new water loss management procedures and apply them in California. Agencies are expected to use the AWWA Free Water Audit Software ("AWWA Software") to complete their standard water audit and water balance.

A. Implementation

Implementation shall consist of at least the following actions:

1) Standard Water Audit and Water Balance. All agencies shall quantify their current volume of apparent and real water loss. Agencies shall complete the standard water audit and balance using the AWWA Water Loss software to determine their current volume of apparent and real water loss and the cost impact of these losses on utility operations at no less than annual intervals.

2) Validation. Agencies may use up to four years to develop a validated data set for all entries of their water audit and balance. Data validation shall follow the methods suggested by the AWWA Software to improve the accuracy of the quantities for real and apparent losses.

3) Economic Values. For purposes of this BMP, the economic value of real loss recovery is based upon the agency's avoided cost of water as calculated by the Council's adopted Avoided Cost Model or other agency model consistent with the Council's Avoided Cost Model.

4) Component Analysis. A component analysis is required at least once every four years and is defined as a means to analyze apparent and real losses and their causes by quantity and type. The goal is to identify volumes of water loss, the cause of the water loss and the value of the water loss for each component. The component analysis model then provides information needed to support the economic analysis and selection of intervention tools. An example is the Breaks and Background Estimates Model (BABE) which segregates leakage into three components: background losses, reported leaks and unreported leaks.

5) Interventions. Agencies shall reduce real losses to the extent cost-effective. Agencies are encouraged to refer to the AWWA's 3rd Edition M36 Publication, *Water Audits and Loss Control Programs* (2009) for specific methods to reduce system losses.

6) Customer Leaks. Agencies shall advise customers whenever it appears possible that leaks exist on the customer's side of the meter.

NOTICE OF EXEMPTION

TO: [x] Clerk of the Board
County of Santa Barbara
105 E. Anapamu Street, Room 407
Santa Barbara, CA 93101

Lompoc Valley Regional Leak Detection and Repair Program
Project Title

Citywide
Project Location

The City of Lompoc, proposes to complete a Citywide leak detection audit of the City's water distribution system and develop and implement a five-year plan for the repair and/or replacement of leaky water service lines and mains identified in the audit. Replacement or repair of water service lines will require trenching and/or directional drilling. The proposed project will not result in the expansion of system capacity through water line replacement. Any water service line repair or replacement needed within the City's Cultural Resources Overlay zone (areas south of the centerline of Olive Avenue) will be subject to monitoring of all ground-disturbing activity by a National Register Qualified Archaeologist, per the California State Historic Preservation Office's review of the City's Cultural Resources Overlay ordinance, prior to its adoption. The purpose of the project is to encourage water conservation through leak detection and repair. Beneficiaries of the project will be the residents of Lompoc.
Description of Nature, Purpose, and Beneficiaries of Project

City of Lompoc
Name of Public Agency Approving Project

City of Lompoc Water Division, Utility Department
Name of Person or Agency Carrying Out Project

Exempt Status: (Check One)

[x] Categorical Exemption. State type and section number
The proposed project is exempt from the California Environmental Quality Act (CEQA) based on its conformity with Section 21084 and Section 15302 of the CEQA Guidelines –replacement and reconstruction of existing structures and facilities where the new structure will be located on the same site as the structure replaced and will have substantially the same purpose and capacity as the structure replaced, including but not limited to: replacement or reconstruction of existing utility systems and/or facilities involving negligible or no expansion of capacity.
Reasons why project is exempt

_____

Stacy L. Lawson, Senior Environmental Coordinator *

* This evaluation was prepared on 08/30/10. Signature and filing with Santa Barbara County Clerk of the Board are pending Lompoc City Council acceptance of grant and approval of project, if awarded.

Notice of Exemption

To: Clerk of the Board
County of Santa Barbara
105 E. Anapamu St., Room 407
Santa Barbara, CA 93101
(805)568-2240
(805)568-2249 FAX
sbcob@co.santa-barbara.ca.us

From: Mission Hills Community Services District
1550 E. Burton Mesa Blvd.
Lompoc, CA 93436
(805) 733-4366
(805) 733-4188 (FAX)
mhcsd.org

Project Title: Lompoc Valley Regional Leak Detection and Repair Program

Project Location: Various locations with the boundaries of Mission Hills Community Services District (MHCSD) Lompoc, CA 93436

Description of Nature, Purpose, and Beneficiaries of Project:

Mission Hills Community Services District proposes to complete a District-wide leak detection audit of the District's water distribution system and develop and implement a five-year plan for the repair and/or replacement of leaky water service lines and mains identified in the audit. Replacement or repair of water service lines will require trenching and/or directional drilling. The proposed project will not result in the expansion of system capacity through water line replacement. The purpose of the project is to conserve water through leak detection and repair. Beneficiaries of the project will be the residents of Mission Hills, Mesa Oaks, The Bluffs, and Lands End.

Lead Agency: **Mission Hills Community Services District (MHCSD)**
Exempt Status:

Exempt per Section 15301(b) and 15302(c) of the 2010 California Environmental Quality Act (CEQA) Statute and Guidelines

Reasons Why Project Is Exempt:

This project is for the repair, replacement, or reconstruction of existing utility system facilities used to provide water service. The facilities will be located on the same site as the facilities replaced and will have substantially the same purpose and capacity.

Contact Person/Telephone: **Michael W. Riley**, MHCSD General Manager, (805) 733-4633

Signature **Date**

Date Received for Filing:

This evaluation was prepared on 12/8/10. Signature and filing with Santa Barbara County Clerk of the Board are pending MHCSD Board of Directors acceptance of grant and approval of project, if awarded.

Notice of Exemption

To: Clerk of the Board
County of Santa Barbara
105 E. Anapamu St., Room 407
Santa Barbara, CA 93101
(805)568-2240
(805)568-2249 FAX
sbcob@co.santa-barbara.ca.us

From: Vandenberg Village Community Services District
3757 Constellation Road
Lompoc, CA 93436
(805) 733-3417
(805) 733-2109 FAX
administration@vvcsd.org

Project Title: Lompoc Valley Regional Leak Detection and Repair Program

Project Location: Various locations with the boundaries of Vandenberg Village Community Services District (VVCSD)
Lompoc, CA 93436

Description of Nature, Purpose, and Beneficiaries of Project:

Vandenberg Village Community Services District proposes to complete a District-wide leak detection audit of the District's water distribution system and develop and implement a five-year plan for the repair and/or replacement of leaky water service lines and mains identified in the audit. Replacement or repair of water service lines will require trenching and/or directional drilling. The proposed project will not result in the expansion of system capacity through water line replacement. The purpose of the project is to conserve water through leak detection and repair. Beneficiaries of the project will be the residents of Vandenberg Village.

Lead Agency: VVCSD

Exempt Status:

Exempt per Section 15301(b) and 15302(c) of the 2010 California Environmental Quality Act (CEQA) Statute and Guidelines

Reasons Why Project Is Exempt:

This project is for the repair, replacement, or reconstruction of existing utility system facilities used to provide water service. The facilities will be located on the same site as the facilities replaced and will have substantially the same purpose and capacity.

Contact Person/Telephone: Joe Barget, VVCSD General Manager, (805) 733-2475

Signature **Date**

Date Received for Filing:

This evaluation was prepared on 12/8/10. Signature and filing with Santa Barbara County Clerk of the Board are pending VVCSD Board of Directors acceptance of grant and approval of project, if awarded.

Santa Barbara County

Application
for
Proposition 84
Planning Grant
Round 1

Santa Barbara County IRWM Plan 2012

Santa Barbara County Water Agency

Twitchell Reservoir
Guadalupe
Santa Maria
Casmalia
Vandenberg AFB
Lompoc
Figueroa
Santa Ynez
Solvang
Cachuma Lake
Gibraltar Reservoir
Juncal Reservoir
Goleta
Montecito
Santa Barbara
Carpinteria

Prepared by

CH2MHILL®

September 28, 2010

Task 4: Establish Data Management System

Introduction

The objective of this task is to establish a DMS, which will set up a process of data collection, storage, and dissemination to IRWM participants, stakeholders, the public, and the State. The type of data that will be included for dissemination may include technical information such as designs, feasibility studies, reports, and information gathered for a specific project in any phase of development including the planning, design, construction, operation, and monitoring of a project. This task will also include cross referencing of existing data in various databases such as:

The WDL that DWR maintains for the state, which stores data from various monitoring stations, including groundwater level wells, water quality stations, surface water stage and flow sites, rainfall/climate observers, and water well logs (http://wdl.water.ca.gov/).

The SWAMP created by SWRCB has standards required for any group collecting or monitoring surface water quality data, using funds from Propositions 13, 40, 50, and 84 (http://www.swrcb.ca.gov/water_issues/programs/swamp).

The GAMA program is maintained by the SWRCB and provides a comprehensive assessment of water quality in water wells throughout the State. GAMA has two main components, the California Aquifer Susceptibility (CAS) assessment and the Voluntary Domestic Well Assessment Project. The CAS combines age dating of water and sampling for low-level volatile organic compounds to assess the relative susceptibility of public supply wells throughout the State. Because water quality in individual domestic wells is unregulated, the program is voluntary and will focus, as resources permit, on specific areas of the State. Constituents to be analyzed include nitrate, total and fecal coliform bacteria, methyl tert-butyl ether, and minerals (http://www.swrcb.ca.gov/gama).

DWR maintains the Integrated Water Resources Information System (IWRIS), which is a data management tool for water resources data and not a database. IWRIS is a web based GIS application that allows entities to access, integrate, query, and visualize multiple sets of data simultaneously (http://www.water.ca.gov/iwris/).

California Environmental Resources Evaluation System (CERES) is an information system developed and maintained by the California Natural Resources Agency to facilitate access to a variety of electronic data describing California's rich and diverse environments.

The DMS as proposed in the 2007 Santa Barbara IRWM Plan needs improvements to include or better provide access to more local water-related information. Currently, Santa Barbara County maintains existing water resources-related and IRWM-related data on the Santa Barbara County Water Agency website located at: http://www.countyofsb.org/pwd/water/index.htm. This site also provides the forum for sharing of reports, public meeting dates, agendas, meeting minutes, and annual reports. In-depth data are not currently stored on the website and the GIS capabilities are not explored extensively.

The objective of the DMS for IRWM Plan 2012 is to store project related data and make it publicly available, is to ensure efficient use of available data, stakeholder access to data, and to ensure the data generated by IRWM implementation activities can be

integrated into existing State databases. A part of the effort of this task will be to explore financial and staff resources to implement the scope under this task.

Task 4.1 Review the Existing Data within the IRWM Region and Identify Data Needs

This task includes identifying and analyzing documents and data that are pertinent to updating the IRWM Plan. The principal task will be to conduct review of previous studies, e.g., City of Santa Barbara's Water Supply Planning Study; SMVWCD annual report, Reports of Santa Barbara County, monitoring reports required by adjudicator. The data gaps/data needs within the IRWM region will be identified from the existing documents.

Where appropriate, data management will be coordinated with State and Federal databases in a format consistent with SWAMP and GAMA.

Task 4.2: Develop a Web-based DMS

One of the objectives of the DMS is to make the data publicly available. This task includes development of a web-based DMS with easy access to the participating agencies including stakeholders. The DMS will serve as a data repository for various types of data (for example, project related data, water quality data). Depending on the type of data, the components and protocols for data assimilation from various sources into the DMS will be developed. For example, a library of information for spatial data can be complied into a Geographic Information System (GIS) on a project by project basis and shared with the stakeholders.

The RWMG will decide on the use of an appropriate website for developing the DMS. The existing system on the website management will be explored at the time of implementation of DMS. For example, the existing Santa Barbara County Water Agency website located at: http://www.countyofsb.org/pwd/water/index.htm also may serve as a resource for the development of the DMS. This site may also be continued to provide the forum for sharing of reports, public meeting dates, agendas, meeting minutes, and annual reports. All data used to support development of the IRWM will be outlined in a database and available for review on the website, which will provide links to information available on partner agency websites. Any required documentation of Proposition 50 will be made available on the DMS website by appropriate project administrators.

Task 4.3 Establish Typical Data Collection Technique

For data gathering a common data collection protocol will be developed to keep the web-based DMS up-to-date. The protocol will describe the use of common and compatible methods for data gathering, analysis, monitoring, and reporting formats. The data collection technique will be developed in such a way that any update on the website will be notified automatically to all the participating stakeholders to bring their attention on the changes made on the data bank.

Task 4.4 Develop Procedure for Adding Data to the DMS

Separate account login information and the website links will be set up to provide access to the DMS for all the stakeholders. Guidelines for uploading the information to the DMS will be developed. Stakeholders will access the website to retrieve information and/or contribute data to the DMS using their account login information.

Task 4.5 Maintain the DMS

The responsibilities for maintenance of the DMS will be explored by the RWMG. The RWMG will select the best approach for maintaining the DMS. This task will include the following:

Develop guidelines for maintaining the DMS system

Update information as it becomes available

Update calendar of meetings and workshops to inform the stakeholders for the upcoming events

Encourage participation from various stakeholders

Resolve any data management related issues

Task 4.6 Data Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) of data is a major task that involves reviewing the quality of data. This task includes description of the validation or quality assurance/quality control measures that will be implemented by the RWMG for data generated and submitted for inclusion into the DMS.

Under the QA/QC task an effort will be taken to update the datasets and to prepare a consistent format for all types of data.

Task 4.7 Data Sharing

This task includes a protocol preparation on how data collected for IRWM project implementation will be transferred or shared between members of the RWMG and other interested parties throughout the IRWM region, including local, State, and federal agencies. The data saved in the DMS will be distributed to the stakeholders. Efforts will be made to keep compatibility with the State databases including SWAMP, WDL, GAMA program, CEIC, and the CERES.

RWMG and public workshops will serve as the primary venue for information sharing. Other settings where information can be shared include quarterly project progress meetings, monthly agency coordination meetings, e-mail subscription lists, and monthly e-mail newsletters. These forums will serve to continue to facilitate the ongoing data sharing between stakeholders as well as the expansion of the existing Water Agency data warehousing activities.