Appendix F - Interim Water Loss Audit Report

GOFF WATER AUDITS

INTERIM WATER LOSS AUDIT REPORT

LAKE ARROWHEAD COMMUNITY SERVICES DISTRICT

INTERIM WATER LOSS AUDIT

LAKE ARROWHEAD COMMUNITY SERVICES DISTRICT

1. INTRODUCTION

Achieving a sustainable water supply and maintaining a reasonable water demand requires diligent participation by the suppliers of the water resources as well as the customers. The results from water loss management (WLM) team activities, monthly water loss reports, and annual water audits will help to identify and prioritize how best to control water demand and reduce water losses. The audit initially identified total water losses as the difference between LACSD's production and consumption data - both of which must be verified. The verified (adjusted) volume of water losses is then broken down into apparent and real water losses through investigations and analyses.

All apparent water losses are meter or data errors and do not affect the actual or real amount of water used or lost. For example, the production or consumption data is adjusted based on a meter error; but the water was still produced or consumed. Also, in the case of a consumption meter error, the water was used but not billed or paid for. Identified and estimated real water losses quantify leakage in the distribution system and authorized operational use like filter backwash, some of which cannot be recycled.

To meet increasing demands with limited water resources, LACSD must identify and reduce real water losses and water demand, pay much higher rates for additional water, and/or obtain additional water supplies. Through completion of the meter replacement program associated with conversion to automatic meter reading (AMR) technology, which improved the accuracy of metered consumption and billing by replacing all older meters with new meters, LACSD has taken a giant step to eliminate apparent losses, recover lost revenue and, most importantly, to determine the extent and magnitude of the real water losses. The potential for further reducing water demand and system water losses are estimated and discussed in the following sections. The interim water loss audit for 2006 results, which identifies and estimates the volume of all water uses and losses, are listed for review in Appendix A. The apparent and real system water losses identified and quantified during the audit are discussed in Sections 2 and 3.

QUANTIFIED WATER LOSS REDUCTIONS

LACSD's total system water losses for 2006 were reliably reduced from 15.7% to 9% of total adjusted production, through analyses of available data and fieldwork results. Based on experience with systems similar to LACSD and less reliable (but probable) estimates made without results from the recommended additional fieldwork, the remaining water losses were identified and quantified. There was an estimated 160 AFY (7.6%) of real water losses during 2006 plus about 50 AF of non-recycled filter backwash. The key is to identify and determine how much of these real water losses can be cost-effectively eliminated to reduce water demand and supply requirements. The audit was for 2006 but the results are applicable to 2007 and beyond.

POTENTIAL WATER LOSS REDUCTIONS FROM ADDITIONAL FIELDWORK

If the recommended fieldwork investigations are performed, they will improve the estimates for the specific sources of apparent and real water losses. The related results and analyses will also demonstrate the relative economic and water loss reduction potential for implementing various WLM activities to further reduce total system water losses by about 100 AF (5%).

The remaining recommended fieldwork and investigations, their costs and potential reductions are identified and discussed in Section 3.

WATER LOSS MANAGEMENT ACTIVITIES

The immediate establishment of a WLM team is critical to ensure that reliable and economical WLM activities are developed, selected, and implemented. The management and maintenance of reliable water supply, losses, consumption and demand data is dependent upon the cooperation, activities and reported results from many different divisions within LACSD.

The most important final result from this audit is to identify which activities will provide the quickest and most cost-effective method for reducing real water losses and water demand, so that LACSD can more efficiently use their available water supply and identify the best ways to manage and maintain a reliable water supply for their customers.

The associated costs and recoverable water losses and revenues for each WLM activities will be known following completion of the various recommended fieldwork and investigations, which must be completed for reliable water loss audit results. Based on the results of additional fieldwork, various WLM activities will be recommended for implementation. The spectrum of potential WLM activities includes supply and production, consumption data, customer meter maintenance and investigations, distribution system leakage and other water-loss associated programs. The different WLM activities are identified later in Section 4.

Most of the real water loss-related fieldwork is dependent on being performed during the non-irrigation season.

2. LACSD 2006 SYSTEM WATER LOSS ADJUSTMENTS TO 9%

The projected water demand in LACSD's Integrated Water Resources Program is based on LACSD's Strategic Plan goal of reducing total system water losses to approximately 9% of production; which in 2006 was 189 AF. Based on review and analyses of available consumption and production data from including the Bernina Water Treatment Plant (WTP) production meter and SCADA testing, CLAWA turnouts meter testing, and preliminary customer meter testing, the following volume and percentage adjustments and reductions were made in total water losses. These adjustments were calculated from the analyses of completed investigations and available data and the results are shown in Table 1 and explained in the paragraphs below. The associated data and analyses for the results presented below are shown in more detail in Appendices A and B.

Table 1: Interim Water Loss Reduction Estimates

	Water Loss Reductions	Volume (afy)	Percent Loss	Comments
a	2006 Total Unadjusted Consumption	2,145		
b	2006 Total Unadjusted Production	1,810		
c	Preliminary Unadjusted Water Loss Estimate	336	15.7 %	Volume = (a) - (b)
d	Production Meter Data Error	45	2.1 %	
e	New Baseline - 2006 Total Adjusted Consumption	2,100		Volume = (a) - (d)
f	*Adjusted Water Loss Estimate*	*291*	*13.8 %*	*Volume = (c) - (d); Percentage = (f) / (e)*
	Current Audit Adjustments			
g	Meter Read Lag Correction	26	1.2 %	Percentage = (g) / (e)
h	Customer Meter Error Estimate	60	2.8 %	Percentage = (h) / (e)
i	Repaired Distribution System Leaks	16	0.8 %	Percentage = (i) / (e)
j	Total Current Audit Adjustments	102	4.8 %	Sum of (g) to (i)
k	**Current Adjusted Water Loss Estimate**	**189**	**9.0 %**	**Volume = (f) - (j) Percentage = (k) / (e)**

Note these are the adjustments to date and do not include any water loss reduction results from the planned, additional required fieldwork investigations, which are identified and discussed later in Section 3.

PRODUCTION DATA ERRORS

LACSD's production data was corrected by 44 af (2.1%) by increasing its accuracy and reducing apparent and total water losses from:

- Bernina WTP production effluent meter error
- Supervisory Control and Data Acquisition (SCADA) system error
- CLAWA turnout error

The results and analyses are shown in Appendix D. The Cedar Glen WTP production effluent meter has not been evaluated yet but is a recommended fieldwork item. The effects on water losses from the production data error at Cedar Glen will not be known until the new meter is installed because the mechanical, hydraulic and electronic variables associated with large meters permit both under and over-registration.

2006 ADJUSTED PRODUCTION

As explained in the Introduction, production is used to define the water loss percentage. When production is adjusted, a new baseline or denominator is established, and the respective water loss percentages must be recalculated.

METER READ LAG ADJUSTMENTS

For 2006, this correction increased total annual consumption, which in turn reduced apparent and total water losses by 26 AF (1.6%). For future years, this adjustment can cause increases or reductions in total annual consumption depending on how consumption varies from one year to the next. In order to obtain and maintain reliable water loss data, the consumption data must match the production data with respect to the particular time period that is being evaluated. In the case of an annual audit, the water that was consumed in the month previous to the audit must be subtracted from the first month's consumption, as the twelfth month's consumption billed in the month after the Audit must be added back in to correct the annual consumption. Note that this may cause

significant error when water losses are calculated and monitored on a monthly basis. In order to eliminate such effects and potential errors, monthly water loss reports are generally calculated on a rolling, 12-month basis.

CUSTOMER METER ERROR

All available meter data were reviewed, including size, installation date, consumption, total flow-through (estimated from average consumption), accuracy test results, make and type. All of LACSD's residential meters will under-register with use and age so the key is to determine the volume and timing.

One set of meter error estimates yielded 50 AF based on analyses of age and flow-through combined with typical deterioration rates. A second set which derived meter error estimates from 30~100 AFY, was drawn from analyses of one random sample and another sample weighted for high-consumption account meters. A reasonable and representative estimate of 60 AFY was selected. The results are shown in Appendix E.

Comparative analysis of billed and metered consumption of upcoming years with previous years can demonstrate the actual recovered revenue compared with the predicted. This will be affected by reduction in customer consumption from higher bills and related conservation awareness. Improving the customer meter error estimate for 2006 will also improve the volume and significance of current real water loss estimates.

REPAIRED DISTRIBUTION SYSTEM LEAKS

As leaks were repaired during 2006, the estimated leakage rate and water losses were reduced. The total leakage estimated for all reported utility side leaks during 2006 was about 28 AF and the water loss reduction was estimated at 16 AF (depending on when they were reported and repaired). The results and analyses for the leakage estimates and leak repair reductions are shown in Appendix.

3. ADDITIONAL WATER LOSS REDUCTIONS AND RECOMMENDED FIELDWORK

Table 2 lists sources of both real and apparent water losses, which were identified and roughly estimated, have the potential for significant reductions. The recommended fieldwork will verify such potential. To be conservative, the minimum water loss potential estimates were used to develop their potential. The fieldwork and investigations related to these potential reductions are discussed below in Section 4.

Table 2: Potential Water Loss Reductions from Recommended Fieldwork

	Potential Yield	
Apparent Water Losses	**afy**	**%**
Production Error at Cedar Glen WTP & Wells	0 +/- 25 afy	0 +/- 1.2 %
Consumption Change: Meter Replacement	20 to 50 afy	1.0 to 2.4 %
Real Water Losses		
Unreported Detectable Distribution System Leakage & Repair	40 to 100 afy	1.9 to 4.8 %
Distribution System Pressure Management	20 to 40 afy	1.0 to 1.9 %
Unmetered Customer-Side Leakage	20 to 100 afy	1.0 to 4.8 %
Minimum Estimated Potential Yield	75 afy	3.6 %

Fieldwork needs to be conducted to better define these estimates. The fieldwork listed below is divided into the types of water losses that would be addressed.

TOTAL WATER LOSSES: PRODUCTION DATA

- Install production meters on Bernina and Cedar Glen WTP effluent to develop more accurate production data
- Perform repeat of volumetric testing at Bernina WTP, including SCADA errors to compare with previous results and newly installed effluent meter flow accuracy.
- Perform meter accuracy testing at Cedar Glen WTP, including SCADA errors to determine accuracy of influent meter and refine estimate of previous production data (to be developed)
- Recalibrate SCADA based on accuracy test results
- Perform accuracy testing at LACSD individual well meters order to quantify the volume of water used and lost in the treatment process

APPARENT LOSSES: CUSTOMER METER ERROR

- Adjust meter error and apparent and total water loss estimates, based on results of recommended fieldwork.
- Compare consumption at newly installed meters with previous consumption to derive estimate of reduced apparent water losses and recovered revenue
- Use data logging function from Firefly[1] on new AMR metered accounts to profile flows to determine percentage of residential consumption at different flows used for accuracy testing (which will enable appropriate weighting of accuracy test results in order to derive improved estimate for average accuracy)

REAL LOSSES: SYSTEM AND CUSTOMER-SIDE LEAKAGE

- Perform distribution system and customer service leakage fieldwork during non-irrigation periods to avoid usage between 2 to 4AM and usage sounds which interfere with listening for leaks (except for identifying irrigation leakage)
- Implement pressure management to reduce pressure is the most direct way to reduce the volume and rate of leakage. The Hydraulic Model and other practical experience should be reviewed, evaluated and used to identify areas where high pressures can be reduced during the night; obviously while maintaining all safety and fire protection requirements.
- Repair leaks (many utilities ignore or postpone repairing small leaks because they don't seem worthwhile but the expense of LACSD water supplies may justify increased repair rates)
- Perform MNF study in specified DMAs to provide a reliable sample for assessing the significance of unreported distribution system leakage. The four identified DMA's include a total of approximately 1,000 customers; which represents about 12% of all LACSD customers. The work plan is in Appendix G.

[1] A universally compatible AMR system, which enables utilities to log data (archive consumption data at user-definable intervals). For example, LACSD can log customer usage during the night to determine if there is a service, irrigation or plumbing leak.

- Perform leak detection survey based on the results from the MNF study. The study should be scheduled during non-irrigation season and could provide additional training for LACSD staff.
- Locate and identify existing below detectable limits (BDL) plumbing leaks (< 0.10 gpm), which are not metered if they are the only leak in a customer's establishment and not running simultaneously with other water use.

4. WATER LOSS MANAGEMENT PROGRAM

The fieldwork will be discussed with WLM team members and decided whether to be performed, depending upon the significance of identified and estimated leakage, and other factors such as estimated and survey costs compared with return on investment (ROI), and the effects of interruption of service and maintenance of fire protection. The respective results from the various fieldwork and investigations must be evaluated by representatives from each of the water loss-related divisions responsible for such activities.

Establish a dedicated LACSD WLM team composed of representatives from at least, Operations, Customer Service, Finance, Distribution, Water Resources, Engineering, Conservation and Management. The team must have joint responsibility for overview of all water loss-related activities and expenditures and identify and select the pertinent water loss-related system characteristics and performance indicators (as shown in Appendix A). Decisions must be made on a business case basis. WLM activities costs must be estimated and evaluated from various perspectives, including their impact on water resource requirements, water demand, ROI and other economic indicators. See a preliminary format for economical review in Appendix G.

A manager must be chosen who is responsible for supervising the submittal and review of monthly data and reporting to all Team members regarding scheduled WLM activities and progress with selected water loss-related system characteristics, assets and performance indicators, as well as for collecting any additional data required to complete the business case analyses and perform the annual audit.

The WLM team will select the most beneficial and efficient WLM activities. The respective and associated costs and recoverable water losses and revenues for each WLM activities will be determined following the performance, results and analyses of the fieldwork.

- Develop and maintain a regular and reliable Production Meter and SCADA System maintenance and accuracy program. Improve the Production Data and Reports; e.g., show Bernina and Cedar Glen withdrawals and production separately.
- Develop Standard Review, Reporting and Evaluation Procedures on a Monthly, Seasonal and Annual Basis to Maintain Reliable and Accurate Consumption Data. Continue the Audit-revised report format, which shows Filter Backwash (see Appendix C). In order to eliminate confounding 'meter read lag' effects and potential errors, monthly water loss reports continue to use calculations based on a rolling, 12-month basis.
- The effective management and determination of meter error will begin with comparative analysis of billed and metered consumption during next year with the previous years, which will demonstrate the actual recovered revenue vs the predicted. Changes will be affected by an expected reduction in customer consumption from higher bills and their renewed conservation awareness.

- The business case must be evaluated for in-house versus a contracted meter maintenance, repair, recalibration and testing program for customer meters. Perform investigations using the new AMR data logging and reporting technologies to identify leaking services, provide reliable and accurate consumption and billing data and monitor the condition of LACSD's meter inventory.
- Leak Detection Survey, Leak Repairs and Water Main and Service Replacement to Reduce Leakage and Maintain the Distribution System
- Use Pressure Control, Reduction and Management to Reduce Leakage in the Distribution System and Customer's Homes and Facilities
- Continue Irrigation and Household Surveys and Investigate Ordinances and Other Methods to Identify and Resolve Customer-side Service and Plumbing Leakage and Illegal Usage

APPENDICES

A. **AUDIT AND SUMMARY SPREADSHEETS**
B. **AUDIT RESULTS AND ANALYSES REPORT**
C. **REVISED MONTHLY OPERATIONS REPORT**
D. **PRODUCTION DATA ERROR CALCULATION**
E. **METER ERROR CALCULATION**
F. **2006 LEAKAGE AND WATER LOSS RECOVERY FROM LEAK REPAIRS**
G. **PRELIMINARY WATER LOSS MANAGEMETN ACTIVITIES ECONOMICS TABLE**

APPENDIX A: DRAFT SUMMARY: WATER LOSS AUDIT SPREADSHEET

LAKE ARROWHEAD Community Service District (LACSD)

Audit Study Period: Calendar 2006 : January 1, 2006 to December 31, 2006

Prepared By: *GOFF Water Audits*

SYSTEM CHARACTERISTICS				
Water Resource Allotment	2.72	MGD	992.54	MGY
Average Metered Production	673.7	MGD	2067.5	
Population: LACSD Service District	10,500	based on A&N analyses		
Service Area	10	square miles		
Distribution System Served	175	miles		
Service Density	45	services /mile		
Average Pressure	85	psi		
No. of Residential; Commercial et al	7,717		152	services
Allotment per person	259	gpppd		
Domestic; Total Consumption per person	136	gpppd	154	gpppd
Treatment Plant Operational Costs	$0.26	$ / Kgals	$83	$/AF
Total Annual Cost of Operating Water System	$5,750,000	$ / Year		
Average Water Rates	$5.09	$ / Kgals	$1,659	$/AF

			Non-Revenue Water	
		MGY	**MGY**	**%**
1C	Total UnAdjusted Finished Water PRODUCTION	699		
2H	Total UnAdjusted Billed Metered CONSUMPTION	590	109	
	PRELIMINARY UNADJUSTED WATER LOSSES =		109	15.7%
3E	Total Adjusted PRODUCTION	685	95	13.9%
13	Total Adjusted CONSUMPTION / USES	633	52	7.5%
10	Total Identified Apparent Loss Estimate		41	6.0%
12L	Total Identified Real Loss Estimate		81	11.8%
14	Total Identified NRW & UnReported Uses =		58	8.5%
15	Minimum UnAvoidable Annual NRW Losses =		11	1.6%
15D	REMAINING UNIDENTIFIED, UNESTIMATED NRW		0	0.00%

APPENDIX A: DRAFT SUMMARY: WATER LOSS AUDIT SPREADSHEET

PERFORMANCE INDICATORS					
	Performance Indicators	**Value**	**Unit**	**US Utility Averages**	**Notes**
1	Avg Production / Water Allotment		MGD / MGD		
2	Identified Apparent Losses	41	MGY		
3	Identified Apparent Loss / Service	14	gals/day/service		
4	Identified Apparent Loss / Person	11	gals/day/person		
5	Apparent Lost Revenue	$208,385	$ / Year		
6	Identified Real Losses	81	MGY		
7	Identified Real Losses; Leak per service	28	gals/day/service	17	
8	Identified Real Losses; Leak per main-mile	1,264	gals/day/mile	10,000	
9	Real Losses/ Production	11.8%	Ratio or %		
10	Costs of Identified Real Losses	$20,593	$ / Year		
11	Identified Apparent / Real Losses	51%	Ratio or %		
12	Identified Apparent $/ Real Loss $	10.1	Ratio or %		
13	Estimated Potential UAAL Minimum	11	MGY		
14	Estimated Potential UARL Minimum	22	MGY		
15	Estimated Minimum UAL * / Production	4.8%	Ratio or %		
16	Minimum UnAvoidable Annual Loss Cost	$60,312	$ / Year		
17	UARL Calculated from AWWA Formula **	182	gals/service/day	17	
18	Infrastructure Leakage Index (ILI) ***	0.2	Ratio or %	7.4	
19	Potable Water Irrigation / Production	TBD	Ratio or %		
20	WW Reuse Irrigation / Production	TBD	Ratio or %		
21	WasteWater Influent / Production	TBD	Ratio or %		
22	New Accounts / year	60	Meters / year		*A & N data*
23	New Demand / year	3	MGY		

* UAL = Unavoidable Annual Losses = UAAL + UARL	where, UARL =	1,432,986	gals/day
** UARL= UnAvoidable Annual Real Losses (gallons/day)		523	MGY
= (5.41Lm + 0.15Nc + 7.5Lp) x P		182.1	gals/day/service
*** ILI = Real Loss Potential / UARL = Current Annual Real Loss(CARL) / UARL		8,188	gals/day/mileofmain

APPENDIX A: DRAFT WATER LOSS AUDIT RESULTS SPREADSHEET

LAKE ARROWHEAD COMMUNITY SERVICES DISTRICT (LACSD)

Audit Study Period: Calendar 2006 : January 1, 2006 to December 3 — AFY Acre Feet / Year

Prepared By: *GOFF Water Audits* — MGY Million Gallons / Year

	2A BILLED, METERED WATER CONSUMPTION = *REVENUE WATER*						
	CUSTOMER METER SIZE (inches)	**Services**		**(AFY)**	**(MGY)**		**Notes**
	5/8 "	7,170.0	0.7	1,351.2	440.3	M	
	1"	876.0	0.1	243.3	79.3	M	
	1.5"	82.0	0.0	38.3	12.5	M	
	2"	61.0	0.0	83.8	27.3	M	
	3"	1.0	0.0	3.2	1.0	M	
	4"	5.0	0.0	66.9	21.8	M	
	6"	2.0	0.0	22.9	7.5	M	
	TOTAL =	8,197.0	1.0	1,809.6	589.7		
	Commercial Irrigation Services		*0.0*	*3.9*	*1.3*	M	
	Residential Irrigation Services		*0.0*	*33.6*	*10.9*	M	
	CUSTOMER CLASSIFICATION						
2B	Residential	7,717.0	0.9	1,603.4	522.5	M	
2C	Commercial	152.0	0.1	205.2	66.9	M	
2D	Fire Protection		0.0	0.8	0.2	M	
2E	TOTAL =			1,809.4	589.6	M	
2F	**TOTAL BILLED METERED CONSUMPTION**			**1,809.5**	**589.6**	**M**	**Avg Class & Size Totals**

				NET WATER LOSS		**Measured**	
		AFY	**MGY**	**AFY**	**%**	**or Estimated**	**Notes**
I	**AVAILABLE WATER RESOURCES**					M / E	
a	TOTAL WITHDRAWAL from LAKE ARROWHEAD	1,566.0				M	
b	ANNUAL RAINFALL	900-23,000				M	
c	ANNUAL EVAPORATION	(3,070.0)				E	
d	GROUNDWATER ALLOTMENT	200-450				E	
e	CLAWA: PURCHASED WATER ALLOTMENT	500-1000				E	
If	TOTAL WATER RESOURCES AVAILABLE =	3,100-26,000				E	
1	**WATER SUPPLIED**						
1A	*RAW WELLWATER: Irrigation water for LACC*	114.4	37.3			M	
1B	COMBINED PLANT INTAKES from LAKE	2,018.4	657.7		0.9	M	
1C	WTPs FILTER BACKWASH to WASTE	(101.7)	(33.1)		(0.0)	M	
1D	WTPs RECYCLED FILTER BACKWASH	52.1	17.0		0.0	M	
1E	COMBINED WELLS to SYSTEM	109.5	35.7		0.1	M	
1F	CLAWA: PURCHASED WATER	67.1	21.9		0.0	M	
1G	**METERED UNADJUSTED PRODUCTION (1B to 1F)**	**2,145.4**	**699.1**		**1.0**	**M**	
	PRELIMINARY UNADJUSTED WATER LOSS =			**335.8**	**0.2**		
1G	METERED UNADJUSTED PRODUCTION	2,145.4	699.1				
	ADJUSTMENTS to PRODUCTION						
1I	BERNINA WTP PRODUCTION ERROR (3.8% > Reported)	(43.3)	(14.1)		(0.0)	M	
1J	*CEDAR GROVE WTP PRODUCTION ERROR*	*TBD*	*TBD*			E	
1K	*ION EXCHANGE PLANT WASHWATER from WELLS*	*TBD*	*TBD*			E	
1L	*ION EXCHANGE PLANT METER ERROR*	*TBD*	*TBD*			E	
1M	CLAWA: METER ERROR: (101.8% OVER-Registration)	(1.2)	(0.4)		(0.0)	M	
1N	subTotal Production Adjustments =	(44.5)	(14.5)		(0.0)	M	
1N	**TOTAL ADJUSTED PRODUCTION**	**2,100.9**	**684.6**			**E**	
1P	**WATER LOSS ADJUSTED FOR PRODUCTION =**			**291.4**	**0.1**	**E**	

				NET WATER LOSS		Measured	
		AFY	MGY	AFY	%	or Estimated	Notes
	CONSUMPTION ADJUSTMENTS						
2F	TOTAL BILLED METERED CONSUMPTION	1,809.5	589.6			M	
3	BILLED UNMETERED:	0.0	0.0			E	
4	UNBILLED METERED	2.0	0.7			E	from 2005 audit
5	UNBILLED UNMETERED: AUTHORIZED WATER USES						
5A	Fireflow Tests	0.6	0.2			M	
5B	Fire Fighting, Prevention & Training	1.5	0.5			E	
5C	Main & Hydrant Flushing	0.3	0.1			E	
5D	Street, Storm Sewer and Sanitary Sewer Cleaning (all metered)	0.2	0.1			E	
5E	Public Facilities, Irrigation (all metered)	0.0	0.0			M	
5F	Distribution System Activities	s	0.1			E	
5G	Construction Activities	1.2	0.4			E	
5H	Water Quality & Meter Testing	0.1	0.0			E	
5I	UNBILLED UNMETERED: SubTotal	4.2	1.4		0.0	E	
5J	*vs AWWA Default Estimate = 1.25% of Production =*	26.3	*8.6*		*0.0*	E	
5K	**TOTAL AUTHORIZED ADJUSTED CONSUMPTION:**	**1,815.7**	**591.6**	**285.2**	**0.1**	**E**	
6	**POTENTIAL WATER LOSSES = APPARENT & REAL LOSSES**			**285.2**	**0.1**	**E**	
7	**TOTAL NON REVENUE WATER =**			**291.4**	**0.1**	**E**	
	IDENTIFIED & ESTIMATED APPARENT LOSSES						
8	DATA PROCESSING NRW ADJUSTMENTS						
8A	Accounting, Data Process Error	0.0	0.0			E	
8B	Credit & Debit Adjustments	0.0	0.0			M	
8C	Meter Read Lag Correction	26.2	8.5			E	
8D	Stopped Meters; Consumption Error from Zero Reads	12.8	4.2			E	
8E	SubTotal Data Processing Error (NRW)	39.0	12.7		0.0	E	
8F	**SubTotal Adjusted Consumption**	**1,854.7**	**604.4**	**246.2**	**0.1**	**E**	
9	**CONSUMPTION METER ERROR**						
9A	Meter Error Estimate From Age/Flowthru Analyses	50.3	16.4			E	8,200 meters; Avg = 0.2AFY
9B	Field-tested Meter Error: Under-Registered	30 ~ 100				E	
	Use Average of 9A & 9B	60.0	19.6			E	
9C	Improved Estimate from Additional Field Testing	TBD				E	
9D	AMR Program: Consumption Difference Analyses	TBD				E	
9E	Unmetered Condensate & Evaporative Cooling Use	0.5	0.2			E	
9F	UnMetered BDL Customer-side: Irrigation/Plumbing Leaks	20.9	6.8			E	
9G	Unauthorized Consumption & Theft : Not Reported	TBD				E	
9H	Use AWWA Default Estimate = *0.25% of Production* =	5.3	1.7			E	
9I	SubTotal Consumption Meter Error & Theft	86.6	28.2		0.0	E	
9J	**SubTotal Adjusted Consumption**	**1,941.3**	**632.6**	**159.6**	**0.1**	**E**	
10	**IDENTIFIED APPARENT LOSS TOTAL**			**125.6**	**0.1**	**E**	
11	**REAL WATER LOSS POTENTIAL**			**159.6**	**0.1**	**E**	

				NET WATER LOSS		Measured	
		AFY	MGY	AFY	%	or Estimated	Notes
11	REAL WATER LOSS POTENTIAL (includes not yet identified UAAL *)			159.6	0.1	E	
12	**IDENTIFIED & ESTIMATED REAL WATER LOSSES**						
12A	Reservoir seepage, overflow, and evaporation	3.1	1.0			E	from 2005 audit
12B	Storage Tank & Booster Station Pump spills	6.1	2.0			E	from 2005 audit
12C	Hydrants, Booster Station, PRVs & DS Controls	1.5	0.5			E	from 2005 audit
12D	Main, Service, Hydrant Leak Repair WL Reduction	16.2	5.3			E	used AWWA/IWA formula
	Total WL Reductions from Leakage Repairs =	27.0	8.8	132.6	0.1	E	
12F	UnReported, Detectable, Reparable Leakage	100.0	32.6		0.0	E	
12H	Total DS Real Losses from Leakage	127.0	41.4	32.6	0.0	E	
12I	Total Identified Real Water Losses	247.8	80.8		0.1	E	
13	TOTAL CONSUMPTION plus LOSS Adjustments	2,068.3	674.0	32.6	0.0	E	
14	TOTAL IDENTIFIED WATER USES & LOSSES =			301.2		E	
15	MINIMUM UNAVOIDABLE ANNUAL WATER LOSSES (UAWL) =			32.6	0.0	E	
15A	MINIMUM NIGHT FLOW (Full-system rough estimate)			TBD		E	
15B	UNAVOIDABLE ANNUAL REAL LOSSES(UARL) (estimate 67%) *			21.8	0.0	E	
15C	UNAVOIDABLE ANNUAL APPARENT LOSSES(UAAL)(estimate 33%)			10.8	0.0	E	
15D	REMAINING TOTAL UNIDENTIFIED, UNESTIMATED NRW =			0.0	0.0	E	

* Undetectable (< 1gpm) & Non-Reparable Leakage: e.g., from main joints

12J	UnMetered BDL Customer-side: Irrigation/Plumbing Leaks	20.9	6.8		0.0		
12K	Metered Customer-side RL: Service, Irrigation, Plumbing	100.0	32.6		0.0	E	
12L	**subTotal Customer-side Real Losses**	**120.9**	39.4		**0.1**		

APPENDIX B: DRAFT ANALYSES & RESULTS LACSD 2006 AUDIT SPREADSHEET of WATER LOSSES

- *Units shown below are in Acre-Feet per Year (AFY)*
- *procedure meets and exceed current AWWA Auditing guidelines*
- *All data are based on Calendar-Year 2006; except where specified.*

2F	TOTAL BILLED METERED CONSUMPTION	1,810
1G	METERED UNADJUSTED PRODUCTION (1B to 1F)	2,145
	PRELIMINARY UNADJUSTED WATER LOSS	336

PRODUCTION ADJUSTMENTS

1I	BERNINA WTP & SCADA PRODUCTION DATA ERROR	-43
1M	CLAWA: METER ERROR: (101.8% OVER-Registration)	-1

BERNINA WATER TREATMENT PLANT (WTP)
LACSD's two treatment plants pump water from three different locations in Lake Arrowhead. Neither plant has an effluent meter; therefore the finished water production has always been calculated using the metered influent flow and the filter backwash and recycled water flows. For this Audit, the Bernina WTP finished water effluent flow; i.e., water supplied to the distribution system, was volumetrically tested using the change in storage tank elevation vs the calculated production volume. The results varied at the different pump rates, but the tests demonstrated that the volumetrically-measured flow rate was 3.8% lower than the calculated production. Bernina WTP's influent was found to be over-registering flows by 1.5%.

SCADA DATA ACCURACY +/or ERROR:
The electronic transfer of production data by LACSD's SCADA system is regularly checked and calibrated. These results were reviewed and analyzed by the Auditor. The errors were reported and the appropriate adjustments were regularly made. The production data is reported from reading the SCADA system daily at 8 AM. This reported SCADA data was included in the test and found to be 2.3% high.

LACSD's available production data is calculated and reported in their Monthly Operations Report; where the combined Plant production is reported. Since the Cedar Glen WTP data has not yet been tested and validated, the following calculation was made in order to get a rough estimate of Bernina WTP's production, which could then be separated out and adjusted based on the test results.

Only the Combined Plant data are reported on the 2006 Water Operations Monthly Data Report. *GOFF* was given Bernina WTP's backwash and recycled filtration water volumes, which were then used as proportional percentages to roughly derive Bernina WTP's combined meter and SCADA data error and to adjust total production. This will be more accurately adjusted after the Cedar Glen WTP fieldwork.

	Combined Intakes	Backwash	Recycled
Annual Total	2,018	-102	52
only BERNINA	1178	-59	30
3.8% ADJUSTMENT of Bernina=		-43	AFY
CPU value	Filter BW	Recycled	2006 Total

CLAWA PURCHASED WATER SUPPLY METER ERROR

At the Auditor's request, the accuracy of CLAWA's water meter, which provides LACSD's purchased water, was tested by *McCall's Meters* of Hemet, using AWWA-approved methods. The results showed that LACSD has been receiving and paying for 1.2% more water than CLAWA delivers. Depending on the rate, if or when LACSD must purchase more significant volumes of water, the accuracy of CLAWA's meter must be regularly maintained and reported; normally at the suppliers expense.

ADDITIONAL SOURCES OF POTENTIAL PRODUCTION DATA ERROR

1J	*CEDAR GLEN WTP PRODUCTION ERROR*	*TBD*
1K	*ION EXCHANGE PLANT WASHWATER from WELLS*	*TBD*
1L	*ION EXCHANGE PLANT METER ERROR*	*TBD*

The Cedar Glen WTP has several complicating factors, which do not permit volumetric testing of the flowrate. The Auditor recommended that effluent meters be installed at both plants. Inspections and investigations were made to identify the correct type of production meter by McCall's Meters of Hemet. LACSD has ordered the recommended meters to be purchased and installed on the finished water effluents for each WTP. Once installed, results from comparative testing of the new meters vs the influent meter will permit LACSD's 2006 total production data to be more accurately adjusted.

Meters for filter backwash & recycled water volumes account for about 7% of total production; which is currently more than either the water supplied from CLAWA or LACSD wells. These meters should be regularly maintained, tested

and calibrated as it is important for the water budget to accurately meter and continue to record these valid operational uses of LACSD's water resources. The production calculations, which have been and will be used until the effluent meters are purchased and installed, include metered filter backwash and recycled water volumes.

There has been no accuracy testing of any of LACSD's well meters. According to an agreement established with the Country Club to permit LACSD to construct and operate their wells and ion exchange WTP, some of the well production is not treated and used directly for irrigation by the Club. In 2006, LACC used about 114 AFY. LACSD's individual well meters have been recommended for accuracy testing in order to quantify the volume of water used and lost in the treatment process. All water used to purge and or clean LACSD Wells is after the individual well meters and therefore the ion exchange WTP master meter production volume is correct. However, all raw water used for these processes should still be identified and estimated and monitored in order to determine their significance and if methods to reduce such usage would be appropriate and cost effective.

1N	TOTAL ADJUSTED PRODUCTION	2,100
2F	TOTAL BILLED METERED CONSUMPTION	1,809
1P	WATER LOSS ADJUSTED FOR PRODUCTION =	291
5K	TOTAL AUTHORIZED ADJUSTED CONSUMPTION:	1,816
6	POTENTIAL APPARENT & REAL LOSSES	285

After production is adjusted, water loss is recalculated by subtracting Total Consumption from Total Adjusted Production.

7	TOTAL NON REVENUE WATER =	291

Total Non-Revenue Water equals the Potential Apparent and Real water losses below, plus the Unbilled Metered & Unmetered Consumption and Use.

IDENTIFIED & ESTIMATED APPARENT LOSSES

8C	Meter Reading Lag Correction	26

The Audit is based on Calendar-Year 2006. Thus, water billed in January and February 2006, which was consumed in November and December of 2005 was calculated and subtracted out of the 2006 Total Consumption. Likewise, water billed in January and February of 2007, which was consumed in November and December 2006 was calculated and added back in to the 2006 Total Consumption. The difference between the two calculations is the 'meter read lag adjustment' of 26.2 AFY, which increases the total consumption in 2006.

8D	Stopped Meters; Consumption Error from Zero Reads	13

This estimate was developed from the percentage of bills with 'zero' reads.

9A	Meter Error Estimate From Age/Flowthru Analyses	50

This estimate was based on analyses of LACSD's meter inventory regarding the meter's age (install date) and total flowthru during the life of the meter. Most of the meters are about fifteen years old; i.e., installed in 1991-92. In most cases, meter accuracy deteriorates at about 0.25% per year. Many residential meters may have an optimum life of about 15 years; however, national industry guidelines recommend replacing the meter after it has registered 1-1.5 MG.

9B	Field-tested Meter Error: Under-Registered	30 ~ 100

A random and high-consumption-weighted sample of about forty 15 year-old meters from Books 1,2, 9, 10, 17 & 18 were pulled and bench-tested for accuracy by *McCall's Meters* of Hemet, CA. These results demonstrated that most meters were under-registering only 1-2%, but two (about 5%) of the meters tested were non-operative meters, which lowered significantly lowered the overall accuracy and increased the *apparent water loss* estimate for meter error. The range of 30~100 reflects the differences between the random, weighted and non-operative-included average accuracy results.

	Use Average of 9A & 9B	60

An average of the two estimates was used for the Audit, until the results are in from the 9D; consumption change analyses from the meter replacement program.

9D	AMR Program: Consumption Difference Analyses	TBD

Compare and analyze consumption of accounts metered through newly installed AMR meters with their previous consumption to derive estimate of reduced apparent water losses and recovered revenue. Data must be collected by LACSD for *GOFF* to perform the analyses. *GOFF* will combine the meter accuracy results and determine an extrapolated meter error estimate for the entire inventory to adjust 2006 total water consumption.

9I	Unmetered BDL Customer-side: Irrigation/Plumbing Leak	21

If a small leak in a home's toilet, faucet, shower is only 0.1 gpm, it may not register on the meter. This estimate was developed from LACSD reports from Household conservation surveys and records of houses with plumbing and service leaks.

9L	Use AWWA Default Estimate = *0.25% of Production* =	5

There were no LACSD records for 2006 for theft and illegal use. AWWA uses a default volume for those without records of 0.25% of Total Production.

9J	Subtotal Adjusted Consumption	1,941

Estimates for the various sources of Apparent Losses were added to adjust the total consumption data; which when subtracted from total adjusted production leaves the potential volume for Real Water Losses. Tentatively, without the results from the additional recommended Apparent Loss-related fieldwork, the data indicate the potential for 70 AFY or about 70% more Real Losses.

10	IDENTIFIED APPARENT LOSS TOTAL	126
11	REAL WATER LOSS POTENTIAL	156
12	IDENTIFIED & ESTIMATED REAL WATER LOSSES	
12D	Main, Service, Hydrant Leak Repair WL Reduction	16

This estimate was developed from LACSD's Monthly Distribution Records, where there were 43 mains and 80 services repaired. As leaks are repaired, water is recovered. The estimated water leakage losses are converted to recovered water during 2006, based on when they occurred. E.g, a leak reported and repaired in the middle of March, will only reduce 2006 water losses by 3.5/12, as the water is re-accounted each month.

12F	Unreported, Detectable, Reparable Leakage	100

This estimate for LACSD's entire 175 miles of distribution system was based on a previous Leak Detection Survey performed in 1992 of 52 miles of mostly steel lines, where most of LACSD's leaks were occurring.

12H	Total DS Real Losses from Leakage	127

Thus, from the Potential Real Water Loss Total of 178 AFY calculated above on line 11, about 127 AFY, or 70%, have been identified and estimated. The remainder, about 50 AFY is used as the estimate for Unavoidable Annual Water Losses.

Based on normal system operations and equipment maintenance and deterioration, every system has a reasonable amount of economically acceptable, unavoidable losses. E.g., AWWA and IWA are working together to develop standards and formulae for determining the Economic Levels of Leakage (ELL) and Apparent Losses.

Based on the proportions from the Audit Spreadsheet's current results, this 50 AFY volume is thus broken down into two estimated components:

- 67% = Unavoidable Annual Real Losses(UARL) = 30 AFY
- 33% = Unavoidable Annual Apparent Losses(UARL) = 30 AFY

15	Minimum Unavoidable Annual NRW LOSSES (UAL)	33
15A	MINIMUM NIGHT FLOW (Full-system estimate)	
15B	Unavoidable Annual Real Losses (UARL) (67%)	22
15C	Unavoidable Annual Apparent Losses (UAAL) (33%)	11
15D	Remaining Total Unidentified, Unestimated NRW	0

14	TOTAL IDENTIFIED WATER USES & LOSSES =	283.1

From the results of this *DRAFT*, 283 AFY of 335 AFY or about 85% of Potential Water Losses have been identified and estimated.

CUSTOMER-SIDE LOSSES from SERVICE, IRRIGATION & PLUMBING LEAKS
NOTE: The estimates for Customer-side Losses shown below have already been accounted on the spreadsheet. Based on LACSD Household surveys and LACSD-reported service leaks, the Auditor estimates that these losses potentially amount to from 2%-5% of Production, or 6%-35% of total water losses.

12I	Unmetered BDL Customer-side: Irrigation/Plumbing Leak	20.9
12J	Metered Customer-side RL: Service, Irrigation, Plumbing	100.0
12K	Subtotal Customer-side Real Losses	120.9

APPENDIX C - 2006 REVISED MONTHLY OPERATIONAL REPORTS

MONTH	*COMBINED WELLS TO IRRIGATION*	*TRANSFER TO 1 GV LAKE*	COMBINED WELLS TO SYSTEM	COMBINED PLANT INTAKES	FILTER BACKWASH TO WASTE	RECYCLE PART OF BACKWASH	PURCHASE FROM CLAWA	FINISHED WATER DELIVERED TO DISTRIBUTION
JANUARY	0.00	0.00	*14.21*	83.79	-4.19	1.45	12.34	107.60
FEBRUARY	0.00	0.00	*12.36*	66.02	-4.32	2.02	16.39	92.47
MARCH	0.00	0.00	*13.29*	71.25	-3.94	1.60	18.52	100.72
1ST QUARTER TOTAL	**0.00**	**0.00**	**39.86**	**221.06**	**-12.45**	**5.07**	**47.25**	**300.79**
APRIL	0.00	0.00	*12.21*	75.98	-4.56	1.51	6.63	91.77
MAY	0.00	0.00	*18.72*	142.06	-10.17	4.70	8.03	163.34
JUNE	1.38	0.00	*12.20*	231.75	-13.06	7.95	5.17	244.01
2ND QUARTER TOTAL	***1.38***	***0.00***	**43.13**	**449.79**	**-27.79**	**14.16**	**19.83**	**499.12**
SEMI-ANNUAL	***1.38***	***0.00***	**82.99**	**670.85**	**-40.24**	**19.23**	**67.08**	**799.91**
JULY	*23.45*	*0.00*	0.73	294.49	-12.65	13.65	0.00	296.22
AUGUST	*21.37*	*0.00*	2.35	288.27	-13.03	7.95	0.00	285.54
SEPTEMBER	*17.27*	*32.38*	0.00	271.25	-12.83	4.12	0.00	262.54
3RD QUARTER TOTAL	***62.09***	***32.38***	**3.08**	**854.01**	**-38.51**	**25.72**	**0.00**	**844.30**
OCTOBER	*18.54*	*0.00*	0.00	213.00	-12.40	5.50	0.00	206.10
NOVEMBER	*0.00*	*0.00*	11.46	162.74	-8.67	1.19	0.00	166.72
DECEMBER	*0.00*	*0.00*	11.99	117.77	-1.90	0.47	0.00	128.33
4TH QUARTER TOTAL	***18.54***	***0.00***	**23.45**	**493.51**	**-22.97**	**7.16**	**0.00**	**501.15**
ANNUAL TOTAL	***82.01***	***32.38***	**109.52**	**2018.37**	**-101.72**	**52.11**	**67.08**	**2145.36**
			BERNINA ONLY	1177.63	-59.35	30.40		

Cols F&G Estimated based on % of Combined BW & Recycled

NOTE: The production data recorded in Bernier's Water Operations Monthly Data can not be added up or validated correctly, because Filter Backwash losses were not permitted to be shown on this report. The Recyled Backwash has been subtracted out of the Combined Plant Intakes, so that it is not double-counted.

[1] *Transfer of water pumped up from Lake Arrowhead, back to Grass Valley Lake flows by gravity in pipe; just before meter entering Bernina WTP*

APPENDIX D: VOLUMETERIC TESTING OF PRODUCTION METER (PLANT INFLUENT) AT BERNINA WTP

	BERNINA ONLY	1177.63	-59.35	30.40	1,148.68	3.8% ADJUSTMENT of Bernina=	-43.27 AFY	-2.1%	UAW
		CPUvalue	Filter BW	Recycled	2006 Total				

Group C						
about 1 ft	33 mins					
Elevation	1.1 ft	45,575	gals	1,382.04	gpm	*1381.047*
manual meter		41,888	gals	1269.33	gpm	*1269.333*
CPU Read		44,277	gals	1341.72	gpm	*1341.727*
Chart Recorder		1.94	MGD	1374.22	gpm	
Avg CPU & Chart =				1357.97	gpm	
Manual Meter Underregistration =				88.64	gpm	
Manual Meter Error =				6.5%		
Manual Meter Accuracy =				93.5%		

PUMP GROUPS	**VOLUME**	**FLOWRATE**		**FLOWRATE**
I hour = 60 mins	(gals)	??		(Mins/Volume)
1.8 ft	74,577 gals	1243	gpm	*1243*
manual meter	75,548 gals	1259	gpm	*1259*
CPU Read	81,314 gals	1355	gpm	*1355*
Chart Recorder		1347	gpm	
Avg CPU & Chart =				
Manual Meter Registration Error =		0	overregistration	
GROUP A Production Data Error =		0	overregistration	
(if CPU Read is used for Recording Production? vs Elevation gpm)				

ESTIMATED ERROR FROM AVERAGE OF PUMP GROUPS

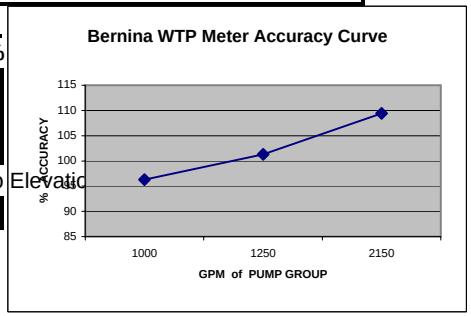
USED DATA FROM THE LONGER SET

ASSUMED EQUAL TIME FOR @ GROUP

A	8.3		
C	-6.7		
A&C	9.7		
AVG =	3.8	%	OVER-REGISTRATION
2006 PROD =	2,018	AF	
ERROR =	76.0	AF	OVER-REGISTRATION

I hour = 60 mins				
1.5 ft	62147 gals	1036	gpm	*1036*
manual meter	59840 gals	997	gpm	*997*
CPU Read	58269 gals	971	gpm	*971*
Chart Recorder		1056	gpm	
Avg CPU & Chart =				
Manual Meter Underregistration =		0	underregistration	
GROUP C		0	underregistration	
(CPU Read vs Elevation gpm)				

Formulae	**GPM**	**Accuracy%**
0.962878217	1000	96.3
1.013025568	1250	101.3
1.09423275	2150	109.4
1.023378845	Manual Meter compared to Elevatio	
(Average)		



I hour = 64 mins				
3.3 ft	136724 gals	2136	gpm	*2136*
manual meter	149600 gals	2338	gpm	*2338*
CPU Read	151450 gals	2366	gpm	*2366*
Chart Recorder		2361	gpm	
Avg CPU & Chart =				
Manual Meter Registration Error =		8.6%	overregistration	
GROUP A&C Production Data Error =		9.7%	overregistration	
(if CPU Read is used for Recording Production? vs Elevation gpm)				

BERNINA ONLY	1177.63	-59.35	30.40
	CPU value	Filter BW	Recycled

pump up from the lake at three different places; currently B is not available.

CPU is the reported production data: it comes off the meter then thru RPU and then to a SCADA system

APPENDIX E: METER ERROR ANALYSES of McCALL'S LACSD CUSTOMER METER TEST RESULTS

METER ERROR ESTIMATE CALCULATION — **Apparent Water Losses**

based on 2006 Water consumption in AFY

Meter Size	Number	Mean	Sum	Worst Accuracy Maximum Error %	Best Accuracy Minimum Error %	Using Maximum Error in AFY	Using Minimum Error in AFY	Using Minimum w/o NonOps Error in AFY	Sample # Meters	Sample is % of :Inventory
5/8	7,170	0.2	1351.2	93.05%	94.08%	**93.91**	**79.99**	**7.28**	37	0.52%
1	876	0.3	243.3	95.29%	99.53%	**11.46**	**1.14**	**1.14**	11	1.26%
1.5	82	0.5	38.3	97.78%	98.38%	**0.85**	**0.62**	**0.62**	3	3.66%
2	61	1.4	83.8	97.15%	98.83%	**2.39**	**0.98**	**0.98**	2	3.28%
3	1	3.2	3.2							
4	5	13.4	66.9							
6	2	11.5	22.9							
	8,197	0.2	**1809.6**			**108.61**	**82.73**	**10.03**	53	0.65%
	Total 200 6 Productrion =		**2108.0**		**Water Losses=**	**5%**	**4%**	**0.5%**		

COMBINED TOTAL of MC'CALL'S METER TEST RESULTS

Meter Size	Book	Sensus Serial #	Reading CFX1	FLOWRATE GPM 100	15	2		arithmetic & weighted averages based on consumption @ flowrate Arithmetic	15-70-15%	67-22-11%
				ACCURACY IN PERCENT						
2"	9 or 10	2"	31951020	100	100	94.5	99.2	98.16667	99.175	99.395
2"	9 or 10	2"	40409856	99.4	98.9	90.1	97.7	96.13333	97.655	98.267
							98.45	**97.15**	**98.42**	**98.83**
				50	8	1.5				
11/2"	1 or 2	32236607	157110	99	98.3	96.1	97.8	97.8	98.075	98.527
11/2"	1 or 2	45787898	87053	99.6	95.9	93.5	96.3	96.33333	96.095	98.115
11/2"	9 or 10	45787897	15082	98.2	102	97.4	100.7	99.2	100.74	98.5
							98.26667	**97.78**	**98.30**	**98.38**
				40	4	3/4				
1"	9 or 10	46181104		99.1	99.2	99.5	99.2	99.26667	99.23	99.166
1"	9 or 10	46181167		100.2	100.1	99	100	99.76667	99.95	100.046
1"	9 or 10	46181026		99.1	99.7	99.7	99.6	99.5	99.61	99.298
1"	9 or 10	46496048		100.1	100.1	100	100.1	100.0667	100.085	100.089
1"	9 or 10	48068943		99.1	99.8	99.8	99.7	99.56667	99.695	99.331
1"	1 or 2	46181072	291216	99.5	99.1	99.8	99.5	99.46667	99.265	99.445
1"	1 or 2	46212317	858047	101	101.2	95	99.1	99.06667	100.24	100.384
1"	1 or 2	52333459		100.2	100.4	100.7	100.4	100.4333	100.415	100.299
1"	1 or 2	44470679		21	110	100	69.3	77	95.15	49.27
1"	1 or 2	43080744		99.8	100	99.8	99.9	99.86667	99.94	99.844
1"	1 or 2	46181087		101.3	102	97.8	100.4	100.3667	101.265	101.069
							97.01818	**97.67**	**99.53**	**95.29**

Meter Size	Book	Sensus Serial #	Reading CFX1	FLOWRATE GPM 100	15	2		arithmetic & weighted averages based on consumption @ flowrate Arithmetic	15-70-15%	67-22-11%			
				ACCURACY IN PERCENT									
				15	2	1/4							
5/8"	46255330	9 or 10		100	100	99.7	100	99.9	99.79	99.967	99.9	99.79	99.967
5/8"	46200884	9 or 10		100.2	100.1	99.8	100.1	100	99.89	100.134	100	99.89	100.134
5/8"	44129815	9 or 10		98.4	99	98.3	98.8	98.7	98.48	98.521	98.7	98.48	98.521
5/8"	46255160	9 or 10		100	100	99.8	100	99.93333	99.86	99.978	99.93333	99.86	99.978
5/8"	44497525	9 or 10		100.4	100.1	99.1	100	99.73333	99.385	100.191	99.73333	99.385	100.191
5/8"	43116358	9 or 10		100.1	100.1	99.8	100.1	100	99.89	100.067	100	99.89	100.067
5/8"	46254942	9 or 10		100	100	99.9	100	99.96667	99.93	99.989	99.96667	99.93	99.989
5/8"	46255312	9 or 10		100	100	99.8	100	99.93333	99.86	99.978	99.93333	99.86	99.978
5/8"	46255155	9 or 10		100.1	100	100	100	100	100	100.067	100	100	100.067
5/8"	45243723	9 or 10		100	100	99.7	100	99.9	99.79	99.967	99.9	99.79	99.967
5/8"	46200657	9 or 10		99.3	99.5	99.3	99.4	99.4	99.345	99.344	99.4	99.345	99.344
5/8"	45255131	9 or 10		100.1	100	99.8	100	99.93333	99.86	100.045	99.93333	99.86	100.045
5/8"	44472177	9 or 10		97.2	97	98.8	97.3	97.7	98.305	97.332	97.7	98.305	97.332
5/8"	43111665	9 or 10		0	0	0	0	0	0	0	100.0667	99.975	100.681
5/8"	46200588	9 or 10		101	100.1	99.9	100.2	100.0667	99.975	100.681	99.13333	98.785	99.658
5/8"	42646155	9 or 10		99.9	99.5	98.5	99.4	99.13333	98.785	99.658	99.63333	99.615	99.354
5/8"	44472164	9 or 10		99.2	99.7	99.6	99.6	99.63333	99.615	99.354	99.93333	99.86	99.978
5/8"	46255269	9 or 10		100	100	99.8	100	99.93333	99.86	99.978	99.46667	99.21	99.891
5/8"	46255305	9 or 10		100.1	99.7	99	99.7	99.46667	99.21	99.891	99.83333	99.87	99.811
5/8"	46254718	9 or 10		99.8	99.8	99.9	99.8	99.83333	99.87	99.811	100.0333	99.96	100.145
5/8"	42646126	9 or 10		100.2	100.1	99.9	100.1	100.0333	99.96	100.145	88.43333	86.6	91.537
5/8"	46266848	9 or 10		93	90.3	85.1	89.9	88.43333	86.6	91.537	100.0667	100.085	100.346
5/8"	46255184	9 or 10		100.5	100	100.1	100.1	100.0667	100.085	100.346	99.96667	99.82	100.123
5/8"	46200666	9 or 10		100.2	100.1	99.7	100.1	99.96667	99.82	100.123	98.96667	98.325	99.558
5/8"	40255687	9 or 10		99.8	99.7	97.8	99.4	98.96667	98.325	99.558	99.93333	99.86	100.045
5/8"	38592576	1 or 2		100.1	100	99.8	100	99.93333	99.86	100.045	99.9	99.79	100.101
5/8"	54373399	1 or 2		100.2	100	99.7	100	99.9	99.79	100.101	99.83333	99.76	99.811
5/8"	44472154	1 or 2		99.8	99.9	99.7	99.9	99.83333	99.76	99.811	99.53333	99.185	99.79
5/8"	45853538	1 or 2		99.9	99.9	98.9	99.8	99.53333	99.185	99.79	99.93333	99.86	100.179
5/8"	46266239	1 or 2		100.3	100	99.8	100	99.93333	99.86	100.179	99.86667	99.775	99.632
5/8"	45511295	1 or 2		99.5	100	99.7	99.9	99.86667	99.775	99.632	99.73333	99.495	99.923
5/8"	44497475	1 or 2		100	100	99.3	99.9	99.73333	99.495	99.923	99.93333	99.86	99.978
5/8"	45511328	1 or 2		100	100	99.8	100	99.93333	99.86	99.978	91.13333	85.065	97.744
5/8"	37076782	1 or 2		0	0	0	0	0	0	0	93.83333	89.69	97.957
5/8"	39754242	1 or 2		99.9	100	80.1	93.3	91.13333	85.065	97.744	96.6	94.125	99.309
5/8"	46200648	1 or 2		99.2	100	86.3	95.2	93.83333	89.69	97.957	98.88	98.37	99.46
5/8"	46266412	1 or 2		100.2	100.2	92.1	97.5	96.6	94.125	99.309			
							93.77027	**93.54**	**93.05**	**94.08**			

APPENDIX F: DISTRICT ANALYSES - MINIMUM NIGHT FLOW FIELDWORK

A District Metered Area (DMA) of 300-2,000 services is selected, which can be isolated and fed by a measured water source; which is either metered or supplied from a tank. The fieldwork is performed to measure the water use when it is at a minimum; i.e., during early morning hours without irrigation; normally from 2-4AM. The water use volume is determined either by reading the customer meters, or by estimation based on average number of flushes per residential service. The water use is then subtracted from the metered or measured water volume, which supplied the DMA. The remainder is an estimate for leakage in the DMA.

The following tasks must be performed for typical DMA investigations:

1- Identify & select valves necessary to isolate DMA(s); and verify that these valves operate properly.
2- Test & Calibrate Plant effluent meters, tanks & SCADA system.
3- Determine most efficient method to estimate customer water use from 2-4AM.
4- Identify fieldwork, personnel, overtime and scheduling requirements.

As discussed, LACSD must first verify that the four districts identified by Bob Bernier are 'isolatable', can be served by the respective tanks, whose elevations, volume and dimensions can be calibrated to function as 'metered or measured supplies' to each of their defined districts. All are located in Pink Pressure Zone 2. The data for # Lots and Customers were developed in 2002 by Bob Bernier.

Potential DMAs	# Lots	Customers	Gravity-Fed
1. Potomac / Wabash	725	415	Yes
2. Banff	310	190	Yes
3. Summit	112	95	No
4. Spy Glass / Amador	560	235	No
Total		**935**	

LACSD can use the following methods to determine customer use; 2-4AM.

1- All meters within the DMA can be read at the beginning and end of the test. LACSD must identify time required to read all meters, in order to determine if it will be possible and/or practical to read from 1:30-2:30AM, and again from 3:30-4:30AM...which is probably prohibitive, re: readers and equipment.

2- Residential water use at this time is mostly toilet flushing; which is roughly approximated as an average of 0.45 +/-0.2 gals/service/hr. This estimate can obviously be improved by identifying # persons/service; or by reading a representative sample of the customer meters in the DMAs from 2-4AM.

Since there are limiting factors; i.e., meter reading, a third alternative is recommended:

1- Perform at least a workweek of reading MNFlowrates leaving the Bernina and Cedar Grove WTPs and CLAWA, from 2-4AM. This will determine the magnitude of combined leakage & water use for the entire LACSD system; the potential water loss and associated costs, which can be reduced; and thus the potential cost effectiveness of the required investments to continue the study.

2- If the potential losses are significant and, LACSD can be readily isolated into the DMAs; then conduct the studies; i.e., a workweek of reading MNFlowrates from the respective DMA tanks, from 2-4AM. This will provide an estimate of the relative differences between the DMAs.

GOFF Water Audits

Appendix F: LEAKAGE & WATER LOSS REDICTIONS from LEAK REPAIRS

IWA Leakage Data were used for Calculating Estimates				*gals*
Mains	*20,000*	*1.1 days*		*22,000*
Services		*6500*	*16 days*	*104,000*
Cust-side			*6,500 46 days*	*299,000*

2006	**Main**	Volume gallons	**Service Repair**	Volume gallons	**Hydrant Repairs**	Volume gallons	LEAKAGE TOTALS	(0.5/12 to 11.5/12) LeakRepair WaterLoss Reductions
Jan	*2*	44000	*6*	624000	10	2990000	3658000	152416.67
Feb	*3*	66000	*7*	728000	1	299000	1093000	136625
Mar	*1*	22000	*2*	208000	0	0	230000	47916.667
Apr	*3*	66000	*4*	416000	0	0	482000	140583.33
May	4	88000	3	312000	0	0	400000	150000
Jun	3	66000	10	1040000	0	0	1106000	506916.67
Jul	5	110000	9	936000	1	299000	1345000	728541.67
Aug	4	88000	10	1040000	0	0	1128000	705000
Sep	5	110000	11	1144000	0	0	1254000	888250
Oct	5	110000	8	832000	0	0	942000	745750
Nov	7	154000	8	832000	0	0	986000	862750
Dec	1	22000	2	208000	0	0	230000	220416.67
	43	946,000	80	8,320,000		Gals/yr	9,266,000	5,285,167
						AFY	**28.4**	**16.2**

Miles	**# LEAKS**	**YEAR**
74	253	2001
40	235	2002
45	184	2003
38	272	2004
7	299	2005

2006 ?	Total # LEAKS	LEAK DETECTION FEET	??
Jan	8	*2,500*	388,655
Feb	10	*10,000*	208,596
Mar	3	*4,700*	236,000
Apr	7	*10,800*	199,360
May	7	*12,000*	36,178
Jun	13	*0*	
Jul	14	*0*	
Aug	14	0	
Sep	16	0	
Oct	13	0	
Nov	15	0	
Dec	3	16,600	
	123	56600	

APPENDIX G

DRAFT ECONOMIC ANALYSES & PRIORITIZATION of WATER LOSS MANAGEMENT ACTIVITIES

	2006	VOLUME	WATER LOSS	WATER [1] VALUED	COST of LOSS
	units	AFY	%	@ $ / AF	$ / YR
	Total Production	2,145		$83	
	Total Consumption	1,809		$1,659	
	Preliminary Water Loss	336	15.7%		
3.8%	**APPARENT LOSSES**	**UAW**			
39.5%	Production Meter Error	30	1.4%	$83	$2,523
60.5%	SCADA System Error	47	2.2%	$83	$3,868
	Error @ Cedar Glen et al	TBD	TBD		
	Customer Meter Error 1st Round Accuracy Testing Results	9	0.4%	$1,659	$15,006
	AMR Meter Replacement Program Use Average 2.5% Under-Registered	37	1.7%	$1,659	$60,773
	Inappropriate Meter Type& Size	10	0.5%	$1,659	$51,429
	Customer-side Leaks: Service, Plumbing, Irrigation BDL Flowrate (<0.1 gpm)	21	1.0%	$1,659	
	Data, Meter Read & Software Errors	15	0.7%	$1,659	$24,885
	UnAuthorized Use / Theft	5	0.2%	$1,659	$8,295
	REAL LOSSES				
	DS Leakage; # breaks(100)	65	3.0%	$83	$5,395
	improve rate by 20% in minor leaks	13	0.6%	$83	$1,079
	prioritize leakage by DS Area	40	1.9%	$83	$3,320
		75	3.5%	$83	$6,225
	decrease by 10 psi; 6hrs/day(25%)	1	0.1%	$83	$95
	Main & Service Leaks			$83	
	Customer-side Leaks: Plumbing, Irrigation			$1,659	
	Customer Service Leaks			$1,659	

1: WATER VALUED: $83 vs THE REPLACEMENT COST FOR AN ADDITIONAL UNIT OF WATER

WMLA	WLMA PROGRAM COST $ / YR	WLMA COST $ / AF	ESTIMATED WL REDUCTION %	ESTIMATED WL REDUCTION AFY	NET UAW REDUCTION %	COST / BENEFIT PERIOD years	ROI	CONF LEVEL % +/- %
New Meters	$60,000	$28	100.0%	30				
Maintenance Program	$15,000	$322	100.0%	47				
Maintenance Program	$15,006	$33	98.5%					
Replacement Program	$1,308,000	$723	98.5%					
Flowrate-profile Firefly Program & More Sensitive Meters	$25,000	$806	98.5% 67%					
Standardized Methods	$15,000	$1,000	99.5%					
Patrol, Fines & Ordinance	$35,000	$7,000	60%					
DS Repairs & Leakage Reports	$250,000 @$2,500/repair	$3,846	90%	59				
Leak Repair Rate			75%					
DMA & Minimum Night Flowrates			50%					
Leak Detection Surveys								
Pressure Management								
Main Replacement Program								
Billing & Incentive Pgms								
Utility-Owned Services								