Palmdale Water District

Final Water System Master Plan Update

March 2001

MONTGOMERY WATSON

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Executive Summary

This Palmdale Water District (District) Water Master Plan has been developed by Montgomery Watson in conjunction with the District staff to evaluate the existing water distribution system and determine system improvements over the next ten years, covering only the District's main system. The process of performing this work included the development of a detailed, 24-hour computer model of the District's transmission system to simulate existing and future conditions. In addition, an in-depth analysis of the water sources available to the District has been conducted and available alternatives for meeting the District's future water needs have been developed.

GROWTH AND DEMAND PROJECTIONS

Growth projections for the District have been developed based on proposed development projects, and discussions with the City of Palmdale (City). Water production needs for future scenarios have been determined based on historical water production records and future projected growth. Water duty factors (demand per area) were developed and assigned based on land use designations of future parcels. Average day demands were determined using the water duty factors and projected development locations, combined with water allocated for the Littlerock Creek Irrigation District (LCID), average day water needs were determined. Future water demands calculated from the City's population projections confirm the projections based on development projections. Current maximum day demands were determined from actual field records and future maximum day demands were determined by applying a peaking factor of 1.93 to the future anticipated average day demands. Peak hour demands were similarly determined by field data and by the application of a 1.65 peaking factor for existing and future demands. A summary of the development and water demand information is shown in **Table ES-1**.

Table ES-1
Summary of Projected Information

Year	Population	Percent Buildout	Water Demands			
			Average Annual		Maximum Day	Peak Hour(1)
			(acre-ft/yr)	(mgd)	(mgd)	(mgd)
1999	87,042	36.1%	24,000	20.9(2)	34.1(2)	56.3
2010	130,570	48.2%	33,400	30.4	58.7(3)	96.9
2020	161,467	66.8%	45,100	40.8	78.8(3)	130.0

Note: 1. Based on a peaking factor of 1.65.
2. Based on field data.
3. Based on a 1.93 peaking factor.

WATER SUPPLIES

The District should be able to meet the future water demand projections by developing available additional water supplies. The average water supply deficit amounts to 500 acre-ft/yr in year 2010 and 12,200 acre-ft/yr in year 2020, assuming the District pumps groundwater at the historic maximum pumping level. The remaining deficit amounts could be met through a combination of water conservation, additional SWP entitlements, additional Littlerock Creek yield, and water reclamation. The following is a list of recommendations regarding water supplies.

1. To maintain the ratio of annual groundwater to surface water use at 40:60, the District should equip already drilled wells followed by construction of new wells as demands increase.
2. The District should continue its current public awareness and education programs to promote voluntary water conservation. The District should also implement additional conservation measures such as water audits and plumbing retrofits. Many conservation measures such as landscape ordinances will require the District to work closely with the City to ensure both development and effective enforcement of such policies.
3. An investigation on enhancing yield from Littlerock Creek should be conducted. The study should include reservoir storage, conveyance capacity, water quality and water rights to optimize the District's benefits from this source of supply.
4. Although there are some uncertainties currently associated with the Monterey Agreement, the District should continue to monitor and pursue appropriate opportunities to purchase additional SWP entitlement.
5. A detailed evaluation of banking SWP deliveries during wet years and drawing on banked supplies during periods of constrained Delta water supplies may bring to light opportunities for the District to exchange delivery flexibility for additional reliability and/or funding. The evaluation should include means for banking supplies in a non-adjudicated groundwater basin, details on recharge facilities required and impacts of flexible delivery on the District's operations.
6. Recharge of reclaimed water from the Palmdale WRP should continue to be pursued. Currently, a portion of the effluent is lost to evaporation. By optimizing the recharge of reclaimed water, the District may be entitled to that volume in the event of a basin adjudication.
7. The District should consider a conjunctive use approach in managing its sources of supply. If a legal and/or institutional framework can be set for the District to maximize conjunctive use of surface, groundwater and reclaimed water resources with minimal risk, the approach would go a long way towards providing adequate supplies to meet future demands.
8. The District should carefully monitor potential water rights litigation in the basin and take necessary steps to protect its rights.

EXISTING SYSTEM MODIFICATIONS

The existing distribution system and facilities appear to be in generally good condition. The only major recommendation for the existing system is the construction of a tank in the 2850 pressure zone. The remainder are somewhat minor modifications. The recommended modifications are as follows and the anticipated cost, excluding costs for replacing leaking pipelines, is approximately $2,398,000.

1. Connect 2950 Zone pocket to 3000 Zone.
2. Install a pressure regulating valve (PRV) at Palmdale & Division.
3. Install a valve at 3 MG Tank to allow an additional portion of the 2800 pressure zone to receive flow directly from the Clearwell Booster Station during peak demand periods.

4. Replace a few undersized mains.
5. Install a storage tank in the 2850 pressure zone.
6. Install portable generator hookups at two booster stations.
7. Replace leaking pipelines to minimize the unaccounted for water losses.

FUTURE SYSTEM CAPITAL IMPROVEMENTS

The Capital Improvement Program (CIP) necessary for the year 2010 is predicated on projected growth as identified in Section 3. If the growth occurs at a different pace, then the recommended improvements may need to be implemented sooner or later than the anticipated 10 year period. The improvements include surface water treatment capacity, groundwater pumping capacity, storage tanks, pipelines, booster stations, and miscellaneous other facilities.

The recommended future system needs are addressed by an evaluation of the existing system after the modifications to the existing system are implemented. The costs for all of the identified future system improvements should be allocated to future customers, as described in Section 9. If no additional growth occurs, these future improvements would not be necessary. A total of 10 groundwater wells are recommended to provide enough water production capacity to meet 40 percent of the maximum day demand to the distribution system. Additionally, 10 mgd of surface water supply is necessary and would be accomplished with a new water treatment plant. As a result of the hydraulic analyses, it is recommended that four new booster pump stations be used to move water through the system. A total of 25.0 MG of additional storage at eight storage facilities throughout the distribution system will be required. The storage facilities and their appurtenances would be implemented as demand increases with population growth. A summary of the major proposed facilities and the future system capital improvement recommendations is shown in **Table ES-2**.

Table ES-2
Summary of Future Capital Improvements

Description	CIP Cost ($)	Storage (MG)	Wells (No.)	Booster Pumps (No.)	Other
A - Entire System	19,860,000	5	-	1	WTP
B - 2800 Zone	2,190,000	4	1	-	-
C - 2850 Zone	8,280,000	8	4	1	-
D - 2950 Zone	2,990,500	2	5	-	-
E - 3000 Zone	none	-	-	-	-
F - 3200 Zone	1,770,000	1	-	1	-
G - 3250 Zone	2,910,000	3	-	1	-
H - 3400 Zone	2,810,000	3	-	1	-
Total	**40,810,000**	**26**	**10**	**5**	

Note: Facilities summarized are major facilities only. CIP costs are for all facilities.

All of the recommended improvements for the next ten years are based on the assumed growth rate predicted by the City. If the number of services supplied by the District increases at a slower or faster rate than predicted, the improvements should be implemented over either a longer or a shorter time period, respectively. In essence, the timing of the improvements is directly related to the number of new services. Conversely, improvements to the system need to be made soon enough that the level of service for existing customers is not degraded by the addition of new customers. The key is to determine a method of identifying when the recommended facilities should be constructed, based on the number and location of new connections added in the District's service area.

All of the recommended improvements for the next ten years are based on the assumed growth rate predicted by the City. If the number of services supplied by the District increases at a slower or faster rate than predicted, the improvements should be implemented over either a longer or a shorter time period, respectively. In essence, the timing of the improvements is directly related to the number of new services. Conversely, improvements to the system need to be made soon enough that the level of service for existing customers is not degraded by the addition of new customers. The key is to determine a method of identifying when the recommended facilities should be constructed, based on the number and location of new connections being made to the District. As the primary improvements are the new treatment plant, wells, and storage tanks (including clearwells), each pressure zone has been analyzed to determine an appropriate indicator of when the facilities should be constructed. **Table ES-3** shows the indicators determined for each major facility.

Table ES-3
Timing of Improvements

Service Zone	Primary Facilities	Indicator
Entire System	10 mgd WTP with 5.0 MG Clearwell, Aqueduct turn-out, 120 hp booster pump, 4,000 feet of 20-inch pipeline, 1,500 feet of 16-inch pipeline	Construct after 482 new connections.
2800	4.0 MG of storage capacity, one groundwater well	Construct well after 1,482 new connections and 1 MG of storage capacity for each 712 new connections.
2850	8.0 MG of storage capacity, 120 hp booster pump, 4 groundwater wells, 8,300 feet of 20-inch pipeline, 6,000 feet of 16-inch pipeline.	Construct 4.0 MG storage tank, booster pumps and pipelines immediately. Construct 1.0 MG of additional storage capacity for each 711 new connections and one well for each 454 new connections.
2950	2.0 MG of storage capacity, 5 groundwater wells	Construct storage after 1,770 new connections and one well for each 495 new connections.
3200	1.0 MG of storage capacity, 9,600 feet of 16-inch pipeline	Construct with Sierra/Pearblossom Hwys. Development.
3250	3.0 MG of storage capacity, 175 hp booster pump, 8,000 feet of 16-inch pipeline	Construct with lower half of College Park Palmdale (CPP) development.
3400/3400+	3.0 MG of storage capacity, 8,700 feet of 16-inch pipeline, 55 hp booster pump.	Construct 1.0 MG tank on west side of 3400 Zone for 37 new connections. Construct 2.0 MG tank, 8,700 feet of 16-inch pipeline, and 55 hp booster pump with upper half of CPP development.

FINANCIAL

The financial impacts of recommended system modifications and improvements were evaluated by individual pressure zone, but the results of these impacts are presented by grouping several pressure zones together. This grouping was done to be consistent with previous financial analyses and to ensure that monies already collected would continue to be allocated to their appropriate facilities. Financial analyses regarding the 2800 Zone and the 2850 Zone were grouped together, as were the 2950 Zone and the 3000 Zone. The 3250 Zone analyses were grouped with the 3200 Zone and the 3400+ Zone analyses were grouped with the 3400 Zone. **Table ES-4** presents the cost, number of new connections, and the anticipated average costs per connection, by service zone.

Table ES-4
Cost of Improvements per Connection

Service Zone	New Connections	Cost(1) ($ Million)	Cost per Connection(2) ($)
Entire System	-	40.33	n/a
2800/2850	6,535	8.66	4,203
2950/3000	4,381	4.21	4,289
3200/3250	773	7.58	9,596
3400/3400+	879	2.92	11,409
Total/Total/Average	12,569	63.71	5,069

Notes: 1. Cost includes $25 million beyond CIP costs shown in Table ES-2 for improvements identified as described in Section 10.
2. Cost per connection as described in Section 10.

Section 1
Introduction

This section provides a project overview and an outline of the master plan. A brief background of the master planning work conducted to date, a discussion of the objectives and scope of work, a description of the report sections to follow, and a listing of abbreviations and definitions used in this report are some of the items included in this section.

BACKGROUND

Prior to World War II, the southern Antelope Valley was primarily an agricultural economy. With the end of the war and the subsequent military developments at Edwards Air Force Base and Palmdale Airport, the economy of the area began to change to the economy of a municipality. The District was an important partner in this phenomenal change.

As part of its dynamic growth, the District had a water system master plan prepared by Montgomery Watson in August, 1982. This master plan provided recommendations for water system improvements for growth projecting through the year 1995. A subsequent period of extremely rapid development occurred in the late 1980's that quickly outstripped the capacity of the facilities planned in 1982. In August, 1988, the District developed an update of the 1982 master plan. This updated plan also provided water system improvements through the year 1995. In 1996, Montgomery Watson developed an updated master plan to meet the District's needs to provide for water system requirements into the 21st century. However, the District is now in need of a new updated master plan due to decreased and modified population growth rates in the Palmdale area.

AUTHORIZATION

This Water Master Plan has been developed in accordance with an agreement between the District and Montgomery Watson, dated May 26, 2000 and titled "Engineering Services for the Update of PWD's 1996 Master Plan."

ACKNOWLEDGMENTS

Montgomery Watson wishes to acknowledge and thank Dennis LaMoreaux, General Manager; Jon Pernula, Facilities & Operations Manager; Matthew Knudson, Engineering Supervisor; and the rest of the District staff for their assistance and goodwill in assembling the information required for this report.

PROJECT STAFF

The following Montgomery Watson staff was principally involved in the preparation of this Water Master Plan:

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DATA SOURCES

In preparation of this master plan, the District staff supplied many reports, studies, and other sources of information. In addition, material was obtained from other sources such as the City of Palmdale Planning Department, United States Geographical Survey (USGS), Los Angeles County, Southern California Association of Government (SCAG), Environmental Systems Research Institute, Inc. (ESRI), and others. Pertinent materials included water system maps, planning and development information, historical records, billing data and detailed facility information. Numerous meetings were held with District staff and with representatives from agencies with information pertaining to the District's operations. In addition, extended interactions were held with the District's operational staff during the hydraulic model development and calibration stages to utilize their knowledge and information. A list of the people contacted and the information received is presented in Appendix A.

OBJECTIVE AND SCOPE OF WORK

The primary objectives of the District are to provide the high degree of performance and reliability that is necessary for the quantity, pressure, and quality required to furnish cost-effective and fiscally responsible water services. This Water Master Plan has been developed to assist the District in achieving these objectives, and the primary steps identified are: (1) evaluate the needs and availability of water for a 20-year horizon, to the year 2020 and (2) identify necessary water service facilities for a 10-year horizon, to the year 2010. The scope of work for this master plan update includes the following tasks.

- Collect and review background data.
- Upgrade the District's EPANET water system model to H2ONET
- Develop 10 and 20 year water demand projections.

- Evaluate area water supplies and recommend a strategy for obtaining adequate water for a 20-year planning period.
- Develop system criteria including peaking factors, maximum pipeline velocities, minimal fire residual pressures, minimum and maximum allowable system pressures and minimum allowable storage volumes for emergency, operational, and fire fighting purposes.
- Evaluate existing system performance through the development of a computer-based hydraulic model.
- Identify, and determine costs for, any needed facilities for the existing system.
- Evaluate and identify future system needs, within the ten-year facility-planning period, utilizing previously determined information and the computer hydraulic model.
- Develop a Capital Improvement Program for future system improvements including facility costs.
- Develop a financial plan for allocating costs of system modifications individually for the existing system and for the ten-year future system.

MASTER PLAN OUTLINE

The following sections of this master plan describe the existing and future systems, water sources, and recommended system modifications.

Section 2 discusses the study area and population projections and Sections 3 and 4 describe the system's water requirements and water sources, respectively. Section 5 compares the water requirements and the water sources. Section 6 describes the selection, development, and calibration of the computer hydraulic model and Section 7 describes the planning criteria and methodologies utilized. Section 8 describes the existing system, and Section 9 describes the future system and anticipated costs of facilities. Section 10, describes the financial impacts of both existing system modifications and future capital improvements. Section 11 affords a summary of the study and provides an inclusive list of recommendations.

Appendix A summarizes the references contacted and the data sources used. Appendix B gives a listing of current water quality regulations. Appendix C presents the production data from calibration day, and Appendix D presents the large user diurnal curves. Appendix E presents well and booster pump controls, and Appendix F presents storage tank calibration data.

ABBREVIATIONS

To conserve space and improve readability, abbreviations have been used in this report. Each abbreviation has been spelled out in the text the first time it is used. Subsequent usage of the term is usually identified by its abbreviation. The abbreviations used are shown in **Table 1-1**.

Table 1-1
Abbreviations

Abbreviation	Explanation
µg/l	Microgram per liter
ac	Acres
AC	Asbestos-cement
acre-ft	Acre-feet
acre-ft/yr.	Acre-feet per year
ADD	Average Day Demand
ADP	Average Day Production
AMCL	Alternate Maximum Contaminant Level
Aqueduct	California Aqueduct
AVEK	Antelope Valley-East Kern Water Agency
AVWG	Antelope Valley Water Group
Bay-Delta	Bay-Delta Estuary
$CaCO_3$	Calcium Carbonate
CAD	Computer Aided Drafting
CALFED	Joint State-Federal Bay-Delta Program
CDC	Center for Disease Control and Prevention
CDHS	California Department of Health Services
CDWR	California Department of Water Resources
cfs	Cubic Feet per Second
CIF	Capital Improvement Fee
CIP	Capital Improvement Program
City	City of Palmdale
COP	Certificate of Participation
CPP	College Park Palmdale
CSDLAC	County Sanitation District of Los Angeles County
CSR	Control Setpoint Record
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
D/DBP	Disinfectant/Disinfection By-product
DEM	Digital Elevation Model
Delta	Sacramento-San Joaquin Delta
District	Palmdale Water District
DU	Dwelling Unit
DWRSIM	CDWR computer model

Table 1-1 (continued)
Abbreviations

DWSAP	Drinking Water Source Assessment and Protection Program
EIR	Environmental Impact Report
EPA	United States Environmental Protection Agency
EPS	Extended Period Simulation
ESA	Endangered Species Act
ESIP	Existing System Improvement Program
ESRI	Environmental Systems Research Institute, Inc.
FACA	Federal Advisory Act Committee
fps	Feet per second
GO	General Obligation
GIS	Geographical Information System
gpad	gallons per acre per day
gpcd	gallons per capita per day
gpd	gallons per day
gpd/ft	gallons per day per foot
gpm	gallons per minute
gpm/ft	gallons per minute per foot
H.S.	High School
HAA	Haloacetic Acid
HCP	Habitat Conservation Plan
HGL	Hydraulic Grade Line
HOA	Hand, Off, Auto setting
HOAT	Hand, Off, Auto, Timer setting
hp	Horsepower
hwy	Highway
IESWTR	Interim Enhanced Surface Water Treatment Rule
IOC	Inorganic Chemical
ISE	Initial System Evaluation
ISO	Insurance Services Organization
LACDPW	Los Angeles County Department of Public Works
LACFD	Los Angeles County Fire Department
LCID	Littlerock Creek Irrigation District
LCL	Locally Controlled Level
LCR	Lead and Copper Rule

Table 1-1 (continued)
Abbreviations

LTC	Local Time Clock
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDD	Maximum Day Demand
MDP	Maximum Day Production
MG	Million Gallons
mgd	Million Gallons per day
mg/L	milligrams per liter
MOU	Memorandum of Understanding
MW	Montgomery Watson
MWC	El Dorado and Westside Mutual Water Companies
µg/L	micrograms per liter
NA	Not Available
NAD27	North American Datum 1927
ND	Non Detect
NPDWR	National Priority Drinking Water Regulations
NTU	Nephelometric Turbidity Units
O&M	Operations and Maintenance
OST	On Site Tank
PCE	Tetrachloroethylene
pCi/l	picocuries per liter
PEIR	Program Environmental Impact Report
PEIS	Programmatic Environmental Impact Statement
pH	Negative log of Hydrogen Ion concentration
PHD	Peak Hour Demand
PIC	Palmdale Irrigation Company
PID	Palmdale Irrigation District
PQL	Practical Quantitation Level
PROD	Programmatic Record of Decision
PRV	Pressure Regulating Valve
psi	Pounds per square inch
PVC	Polyvinyl Chloride
RPHL	Recommended Public Health Level
SCADA	Supervisory Control and Data Acquisition
SCAG	Southern California Association of Government

Table 1-1 (continued)
Abbreviations

SCE	Southern California Edison
SDWQ	Safe Drinking Water Act
SOC	Synthetic Organic Chemical
SWP	State Water Project
SWRCB	State Water Resources Control Board
SWTR	Surface Water Treatment Rule
Tax Reform Act	Tax Reform Act of 1986
TCE	Trichloroethylene
TCR	Total Coliform Rule
TDS	Total Dissolved Solids
THM	Trihalomethane
TOC	Total Organic Carbon
TOD	Time of Day
TOU	Time-Of-Use
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VOC	Volatile Organic Chemical
WLL	Warrick Liquid Level
WRP	Palmdale Water Reclamation Plant
WSM	Water Service Map
WTP	Water Treatment Plant

Section 2
Study Area, Population and Development

This section describes the District's service areas and the study area of this master plan. It also includes a population study and an evaluation of the development for the District's primary service area. Historical population data within the District has been collected and used as a basis to project the population growth within the District to the year 2020. The spatial and temporal distribution of the projected population growth is based mainly on the information collected from the District and the City of Palmdale (City) Planning Department. Development of parcels within the District is also described.

DISTRICT SERVICE AREAS

The District is located within the Antelope Valley area of northern Los Angeles County approximately 60 miles north of Los Angeles, as shown on the general vicinity map in **Figure 2-1**. The District encompasses an area of about 187 square miles overlying more than 30 non-contiguous areas scattered throughout the southern Antelope Valley including the communities of Juniper Hills and Llano. The boundaries of the District's service areas are shown in **Figure 2-2**. There are three non-contiguous areas that can be considered the District's principal areas for water supply, water service, and water resource management. These three areas are:

- A primary service area of approximately 35 square miles. This area is the District's primary area for water service, water supply, water treatment, water storage, and transmission and distribution facilities.
- A federal land area of approximately 65 square miles upstream of the District's Littlerock Dam within the Angeles National Forest. This area encompasses the drainage area of Littlerock Creek to Littlerock Dam. The District's responsibilities include enhancing, protecting and managing the quality and quantity of the District's water supply at Littlerock Dam.
- A non-contiguous secondary area of approximately two square miles, northwest of the District's primary service area within the City. This area is served by two water purveyors: El Dorado Mutual Water Company and Westside Mutual Water Company (MWCs). Water is wheeled to the MWCs through facilities owned by the Antelope Valley-East Kern Water Agency (AVEK).

MASTER PLAN STUDY AREA

The study area of this master plan focuses on the District's primary service area, which includes the District's primary water service connections, water supplies, and facilities for water treatment, storage, transmission and distribution. Although the study area defined for this master plan does not include the Littlerock Creek drainage area, the water supply from this watershed is included in the supply analysis of this master plan. The non-contiguous secondary area serviced

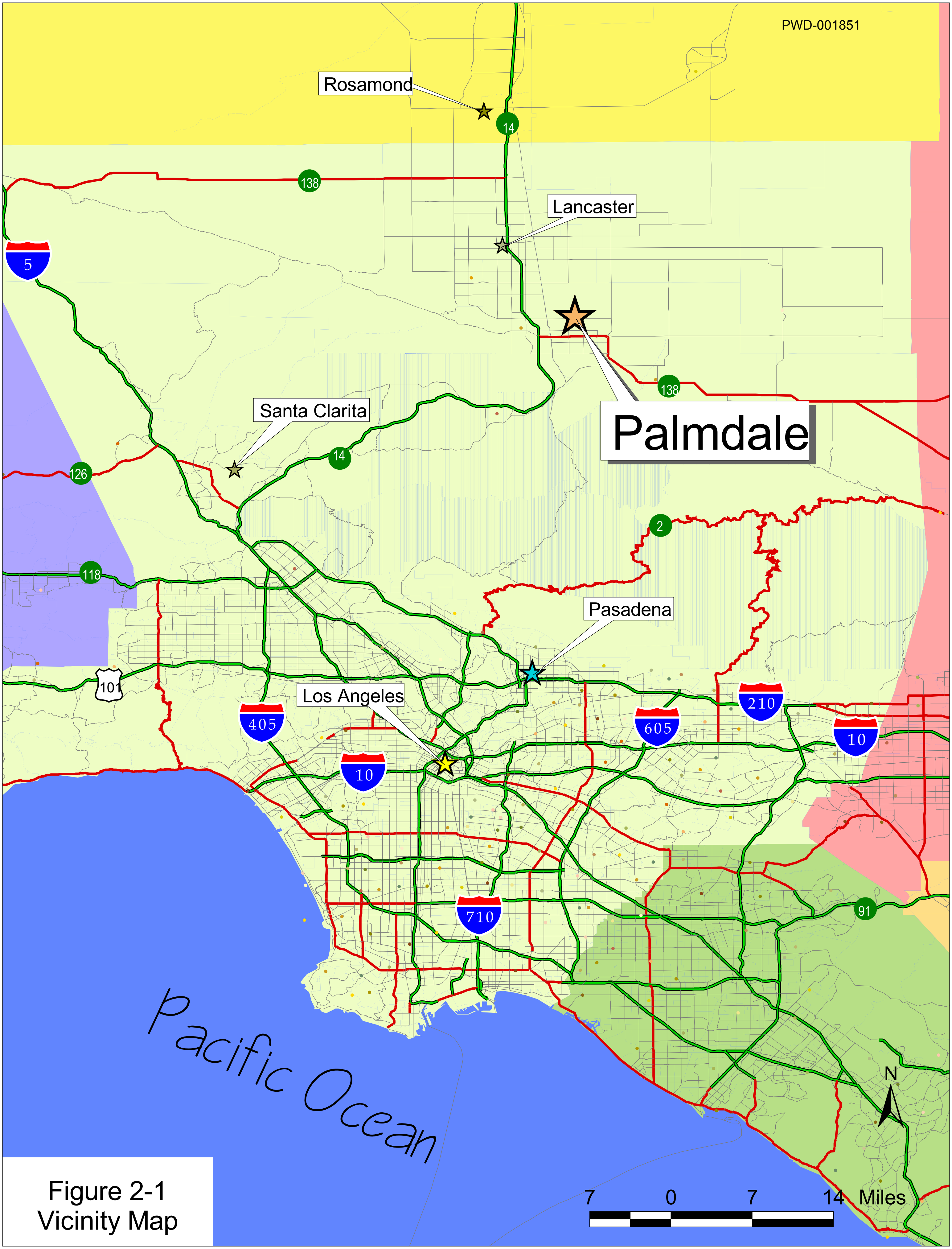

Figure 2-1
Vicinity Map

Insert Figure 2-2
Palmdale Water District Boundaries
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by the MWCs is not included in the study area of this master plan, nor are other non-contiguous portions of the District's service area to the east.

The District's primary service area (the study area of this master plan) covers the central and southern portions of the City and includes adjacent areas of unincorporated Los Angeles County (County). The District's primary service area boundary and its relation to the City boundary are shown on **Figure 2-3**. The City's General Plan covers not only the City limits, but also includes adjacent areas outside of the City limits. Thus, although the District's primary service area extends beyond the City boundary, it remains within the City's sphere of influence. The District's primary service area is approximately bordered by Avenue P on the north, 70th Street East on the east, the Antelope Valley Freeway (Highway 14) on the west, and extends into the foothills of the San Gabriel Mountains on the south.

In addition, the District also serves water to customers outside its primary service area in accordance to agreements with nearby water agencies, the Littlerock Creek Irrigation District (LCID) and the Los Angeles County Waterworks District No. 40 (LACWW), and the regional water wholesaler, the Antelope Valley East-Kern Water Agency (AVEK). These customers are listed below and are included in the analysis of this master plan

- City of Los Angeles Department of Airports
- Crestmore Village Water Company
- Federal Aviation Administration
- Heritage Park Airplane Museum
- Lockheed Martin Skunkworks
- Red Cross Regional Headquarters and Blackbird Museum
- United States Air Force Plant 42

STUDY AREA CLIMATE AND GEOLOGY

The major water courses flowing through the District's primary service area are: Armagosa Creek, Anaverde Creek, and Littlerock Creek. The climate within the District includes hot, dry summers and mild winters with wide temperature differences between day and night. Temperatures in the summer months vary between an average low of 71°F and an average high of 95°F; in the winter months, the average temperature extremes vary from 30°F to 58°F, respectively. Average annual precipitation is 6.7 inches in the northerly portion of the District (District Weather Station) and 12 inches in the southerly San Gabriel Mountain area. Elevations in the primary service area of the District vary from 2,600 feet in the northerly area to over 3,800 feet in the southerly area.

STUDY AREA POPULATION

Since the District's primary service area boundary does not coincide with the City boundary, population studies prepared by the City can not be used directly to estimate the population served by the District. The population served by the District is estimated from best available data. The estimated historical District populations between 1990 and 1999 are shown in **Table 2-1**. The data from the 1996 Water System Master Plan had been estimated under the assumption that the

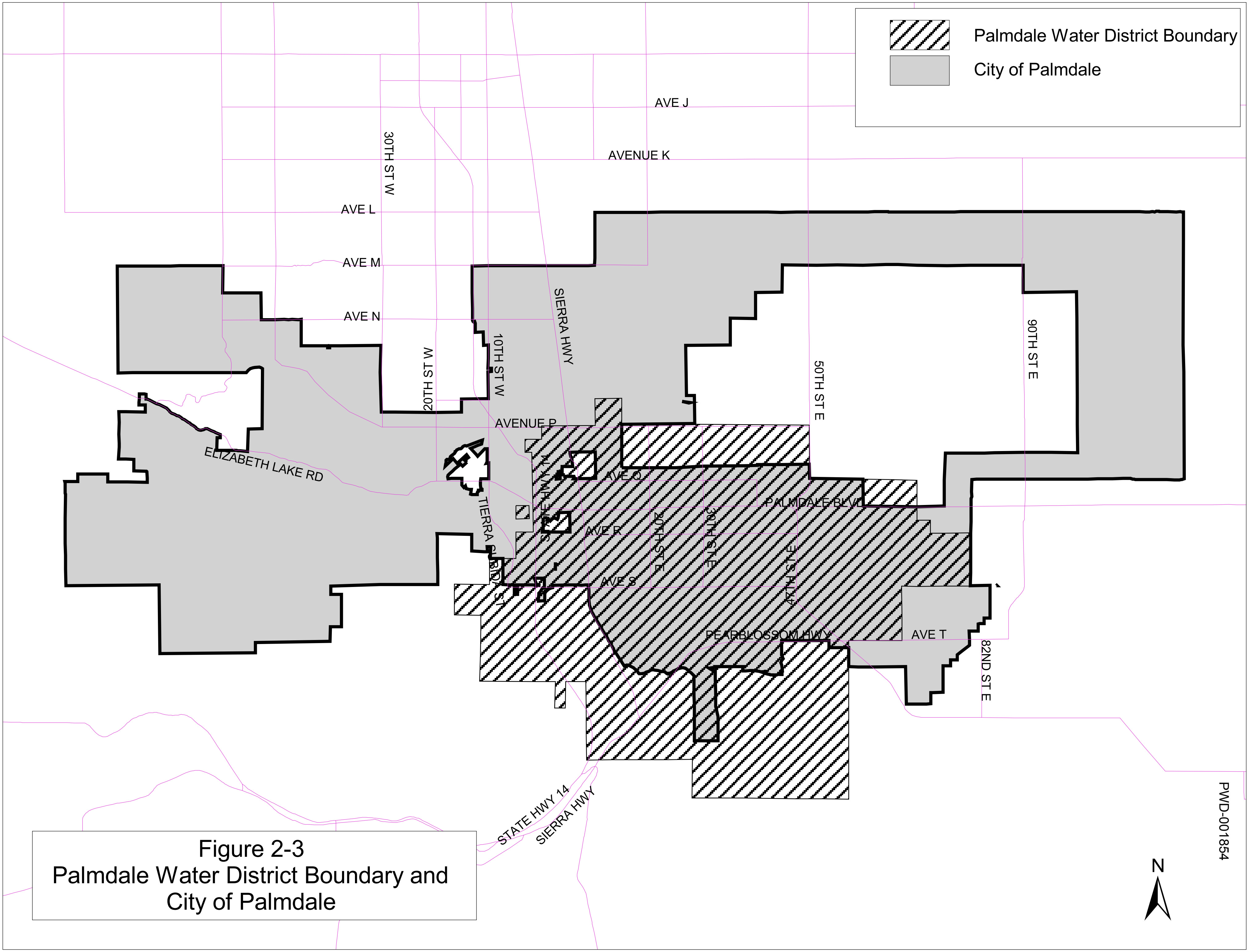


Figure 2-3
Palmdale Water District Boundary and
City of Palmdale

PWD-001854

District population between 1990 and 1994 grew at the same rate as the City population. An examination of the number of active service connections for the District between 1995 and 1999 revealed that for this latter period, the District's growth rate was lower than the City's overall growth rate. Thus, for 1995 through 1999, the District population was estimated based on the apparent growth rate of the number of active service connections.

Table 2-1
Historical District Population

Year	District Population	Source
1990	58,324	1996 Water System Master Plan
1991	63,447	
1992	67,792	
1993	74,939	
1994	80,106	
1995	84,546	Estimated from growth trend of District's active number of connections
1996	84,946	
1997	84,174	
1998	84,813	
1999	87,042	

In order to project future population growth within the District, the City's population projections have been used in conjunction with numerous references to estimate the future population that the District can expect to serve. The references used to develop District population numbers include:

- City population studies
- Demographic studies by California Department of Finance
- Population projections by Southern California Association of Governments (SCAG)
- Development summaries from the City Planning Department
- General Plan and designated land use categories from the City
- 1990 census tract boundaries
- City boundary
- Boundaries of unincorporated Los Angeles County areas
- Field observations throughout the District
- Discussions with City Planning Department staff

The references listed above include two sources of population growth projections for the Palmdale area. One was prepared by the City Planning Department while the other was prepared by SCAG. There are some discrepancies between the two sources of data. Since the City Planning Department has greater knowledge of proposed developments and trends in the local area and the District works regularly with the City on water-related issues in the area, the population estimates conducted for the District are based on the City data rather than the SCAG data.

The latest available population projections from the City were prepared in 1995, and are shown **Table 2-2**. According to the City Planning Department, growth in the Palmdale area during the last 5 years has not been as rapid as previously anticipated. However, the City indicated that recent trends are pointing to growth acceleration such that by the year 2020, actual populations should be as high as currently projected. Based on discussions with the City Planning Department, the year 2000 population projection was scaled back prior to calculating the District's population based on the City projections.

Table 2-2
City Population Projections

Census Tract	City	Unadjusted Total		
		2000	2010	2020
9101	Palmdale	1,200	1,500	1,704
9101	Unincorporated	1,058	1,376	1,783
9101	Subtotal	2,258	2,876	3,487
9102	Palmdale	26,089	55,000	73,260
9102	Unincorporated	10,000	10,900	12,000
9102	Subtotal	36,089	65,900	85,260
9104	Palmdale	15,421	19,000	23,631
9104	Unincorporated	3,357	5,474	7,908
9104	Subtotal	18,778	24,474	31,539
9105	Palmdale	19,500	22,069	25,899
9105	Unincorporated	329	384	472
9105	Subtotal	19,829	22,453	26,371
9106	Palmdale	22,500	24,756	28,503
9106	Unincorporated	3,496	3,601	3,733
9106	Subtotal	25,996	28,357	32,236
910701	Palmdale	22,279	42,706	52,449
910701	Unincorporated	1,338	1,376	1,426
910701	Subtotal	23,617	44,082	53,875
910702	Palmdale	15,000	22,000	29,955
910702	Unincorporated	2,267	3,003	4,253
910702	Subtotal	17,267	25,003	34,208
TOTAL		143,834	213,145	266,976

Note: Projections received from the City of Palmdale.

The City's population data are summed by census tracts and, within each census tract, divided into population within the City limit and population in unincorporated County area. The census tract boundaries are overlaid on District and City boundaries in **Figure 2-4.** Since neither the City nor the census tract boundaries match the District's boundary, factors were developed to prorate the data to reflect that portion of the population that is served by the District. These prorating factors were developed based on analysis of land use, area of empty parcels and development trends within each census tract.

Current and future District population are estimated using City population projections and adjusted with factors as described above as presented in **Table 2-3**. The current District population is estimated to be 89,200 and is projected to reach 130,570 by the year 2010 and 161,500 by the year 2020. This projection is lower than the previous projection presented in the 1996 Water System Master Plan. The lower projection reflects the reduced development rate

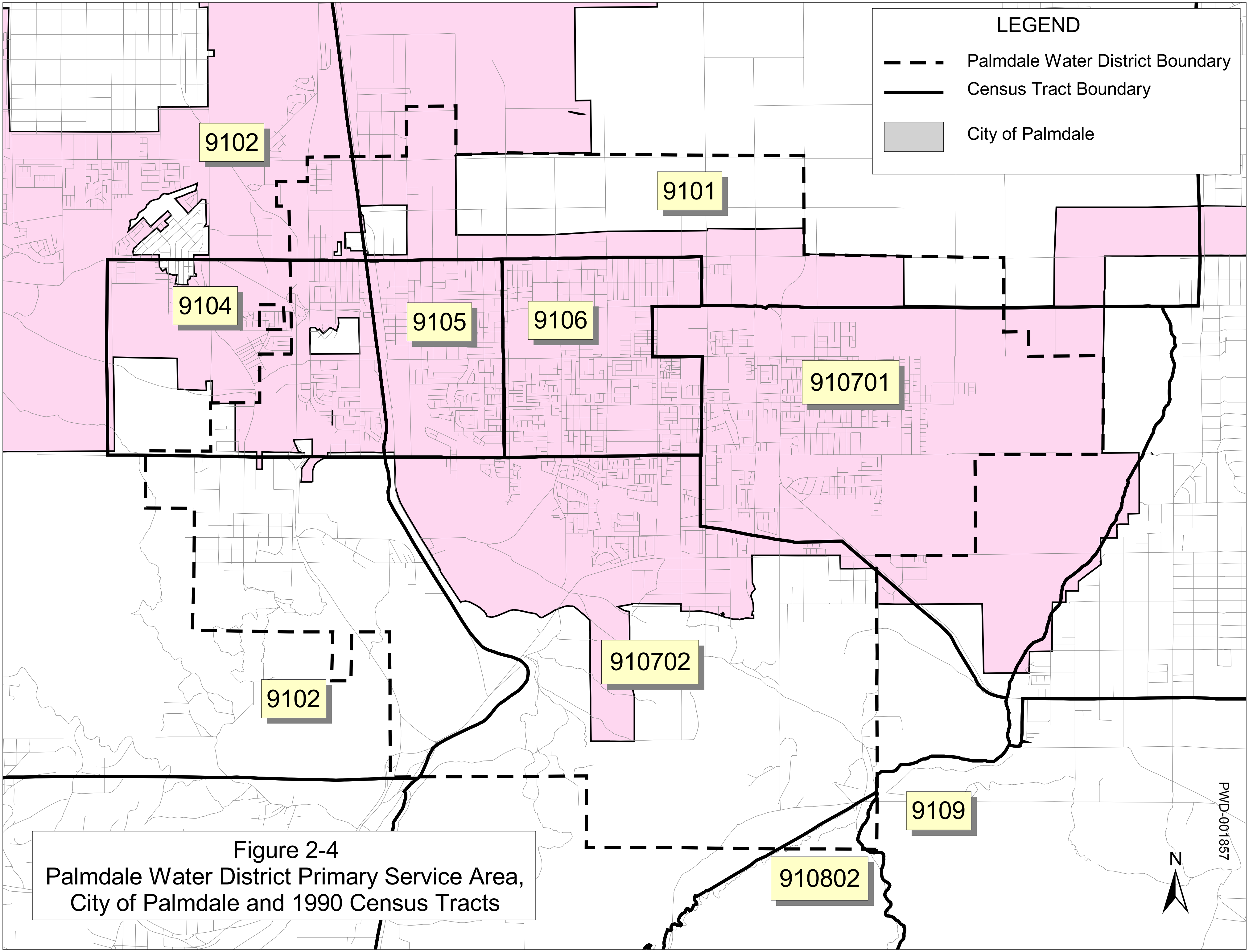


Figure 2-4
Palmdale Water District Primary Service Area,
City of Palmdale and 1990 Census Tracts

that the area has experienced in the last five years. The historical District population, the previous growth projections and the current growth projects are graphically shown in **Figure 2-5**.

Table 2-3
Projected District Population

Census Tract	City	Percentage of Census Tract within District Boundary			District Population		
		2000	2010	2020	2000	2010	2020
9101	Palmdale	65%	65%	65%	768	975	1,108
9101	Unincorporated	5%	5%	5%	52	69	89
9101	Subtotal	-----	-----	-----	820	1,044	1,197
9102	Palmdale	3%	3%	2%	770	1,650	1,465
9102	Unincorporated	10%	40%	50%	984	4,360	6,000
9102	Subtotal	-----	-----	-----	1,754	6,010	7,465
9104	Palmdale	30%	30%	30%	4,552	5,700	7,089
9104	Unincorporated	8%	30%	40%	264	1,642	3,163
9104	Subtotal	-----	-----	-----	4,817	7,342	10,253
9105	Palmdale	100%	100%	100%	19,188	22,069	25,899
9105	Unincorporated	100%	100%	100%	324	384	472
9105	Subtotal	-----	-----	-----	19,512	22,453	26,371
9106	Palmdale	100%	100%	100%	22,140	24,756	28,503
9106	Unincorporated	100%	100%	100%	3,440	3,601	3,733
9106	Subtotal	-----	-----	-----	25,580	28,357	32,236
910701	Palmdale	98%	98%	98%	21,484	41,852	51,400
910701	Unincorporated	0%	0%	0%	0	0	0
910701	Subtotal	-----	-----	-----	21,484	41,852	51,400
910702	Palmdale	98%	98%	98%	14,465	21,560	29,356
910702	Unincorporated	35%	65%	75%	781	1,952	3,190
910702	Subtotal	-----	-----	-----	15,246	23,512	32,546
TOTAL		-----	-----	-----	89,212	130,570	161,467

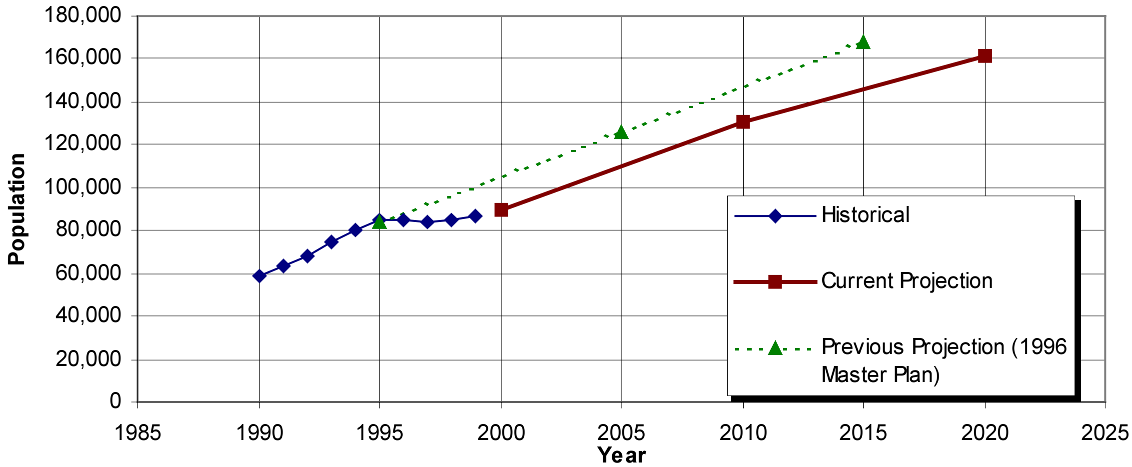


Figure 2-5
Historical and Projected Population

STUDY AREA LAND USE AND DEVELOPMENT

The District's primary service area falls within the City's sphere of influence. Therefore, information from the City was used to determine locations and dates of future development. The references used to identify development trends within the District boundaries include:

- Development summaries from the City Planning Department
- General Plan and designated land use categories from the City
- 1990 census tract boundaries
- City boundary
- Boundaries of unincorporated Los Angeles County areas
- District's Water Service Maps (WSM)
- Field observations throughout the District
- Discussions with City Planning Department staff
- Discussions with District staff

Using the WSM, the development status of each parcel was determined by the existence of a service connection. If no service connection is shown on the WSM, then that parcel is considered undeveloped. Proposed development plans that are on City and District records were used to determine areas with growth in the near future. In a few cases, parcels with service connections were considered undeveloped, based on the development information. **Figure 2-6** shows the location of undeveloped parcels.

For the development analysis in this Master Plan, the City's 19 land use types were grouped into six categories: Commercial, Industrial, Public Facilities, Residential-Low, Residential-Medium and Residential-High. Commercial land use consists of the following land use types: business parks, downtown commercial, community commercial, neighborhood commercial and regional commercial. Industrial land use consists of the following land use types: airport, community manufacturing and industrial. Public facilities land use consists of open space and public

Insert Figure 2-6
Current Developed Area and Development Projections
8 ½ x 11 color map

facilities such as schools and public buildings. Residential-Low consists of those parcels that are zoned for 0-2 dwelling unit (du)/acre. Residential-Medium consists of those parcels that are zoned for 2-6 du/acre, which consists of most single-family homes. Residential-High consists of those parcels that are zoned for 10-16 du/acre, and consists of mainly apartment buildings, condominiums and townhouses. The currently developed and total available acreage of each land use category within the District's boundary is shown below in **Table 2-4**. Thirty-six percent of the total land area within the District is currently developed. Of the developed area, 72.9 percent is used for residential purposes.

Table 2-4
Current Land Use

Land Use Category	Current Development (acres)	Percent of Developed Area	Current Development as Percent of Total Area	Total Area in District (acres)	Percent of Total Area
Commercial	895	8.5%	29.3%	3,056	10.4%
Industrial	786	7.4%	21.5%	3,655	12.5%
Public Facilities	871	8.2%	71.9%	1,211	4.1%
Residential-Low	2,051	19.4%	19.6%	10,452	35.7%
Residential-Medium	5,435	51.4%	54.2%	10,025	34.2%
Residential-High	528	5.0%	59.5%	887	3.0%
Total	10,566		36.1%	29,287	

Areas with expected development for the years 2010 and 2020 were determined based on current development trends, discussion with City and District staff, and population projection numbers. Residential development is generally occurring east and south of current development, and areas along the foothills. One major development anticipated in the area is College Park, located southwest of 47th Street East and Barrel Springs Road. Current plans show that this development will contain 847 homes, a community college and a golf course. Industrial development is likely to occur in the northern side of the District, as Caltrans has proposed to relocate State Highway 138 by creating a freeway at the current location of Avenue P-8. These future growth locations are also shown on **Figure 2-6**. Buildout occurs when all parcels are developed to the maximum allowed based on land use designations. By 2020, it is expected that several census tracts in the center of Palmdale (tracts 910500 and 910600) will be close to buildout. Medium and high density residential will approach buildout by 2020. **Table 2-5** summarizes the acreage and percent of buildout for each land use classification within the District for year 2010 and 2020 development projections.

Table 2-5
Percent of Buildout by Land Use Categories

Land Use Categories	2010		2020	
	Acres Developed	Percent of Buildout	Acres Developed	Percent of Buildout
Commercial	1,458	47.7%	1,843	60.3%
Industrial	1,103	30.2%	2,038	55.8%
Public Facilities	1,068	88.2%	1,194	98.6%
Residential-Low	2,418	23.1%	3,703	35.4%
Residential-Medium	7,392	73.7%	9,981	99.6%
Residential-High	728	82.1%	819	92.3%
Total	14,113	48.2%	19,578	66.8%

Section 3
Water Production and Demand

An analysis of the historical quantity of water produced and projection of future water production requirements is given in this section. In addition, a detailed evaluation of water demands within the District's primary service area is presented. The water demand projections are based on population and land development projections presented in Section 2 of this report.

EXISTING WATER PRODUCTION

The District obtains its water from the following three sources:

- Littlerock Creek Watershed
- State Water Project (SWP)
- Groundwater wells

Both Littlerock Creek and the SWP supply water to the Palmdale Water Treatment Plant and the treated water is then provided to the distribution system. The groundwater wells are spread throughout the system. In 1999, approximately 58 percent of the water produced was supplied through the treatment plant and 42 percent was supplied by groundwater. A summary of historical annual production, from 1990 through 1999, is shown in **Table 3-1**.

The maximum day production (MDP) for 1990 through 1999 has been based on the highest combined production of all sources. The amount of maximum water production and the day that it occurred are also shown in **Table 3-1**. A peaking factor between maximum day production and average day production has been determined to vary historically between 1.63 and 2.11 since 1990. A maximum day demand (MDD) factor of 1.93 times the average day demand (ADD) was chosen as the factor used for subsequent water system analysis. This factor was selected due to its highest frequency of occurrence over the last 10 years. Based on field data collected, the peak hour demand (PHD) is 1.65 times the MDD, or 3.18 times the ADD.

The most recent year with complete production and consumption records, 1999, was used as the basis for detailed water production analyses. Information was analyzed on an annual, monthly, and daily basis. Monthly production data was evaluated for the wells in each of the pressure zones and for the treatment plant. **Figure 3-1** shows monthly well production and treatment plant production for 1999.

Table 3-1
Historical Annual Water Production

Year	Production (MG)	ADP[1] (mgd)	Maximum Day	MDP[2] (mgd)	MDP:ADP Multiplier
1990	5,804	15.9	July 13	29.2	1.84
1991	5,199	14.2	July 29	24.3	1.71
1992	5,109	14.0	July 17	29.6	2.11
1993	5,978	16.4	June 28	31.7	1.93
1994	6,718	18.4	June 27	37.7	2.05
1995	7,247	19.9	August 3	38.2	1.92
1996	7,665	21.0	August 24	34.8	1.66
1997	7,547	20.7	August 7	34.3	1.66
1998	6,724	18.4	August 3	35.5	1.93
1999	7,627	20.9	July 28	34.1	1.63

Note: 1. ADP is average day production.
2. MDP is maximum day production.

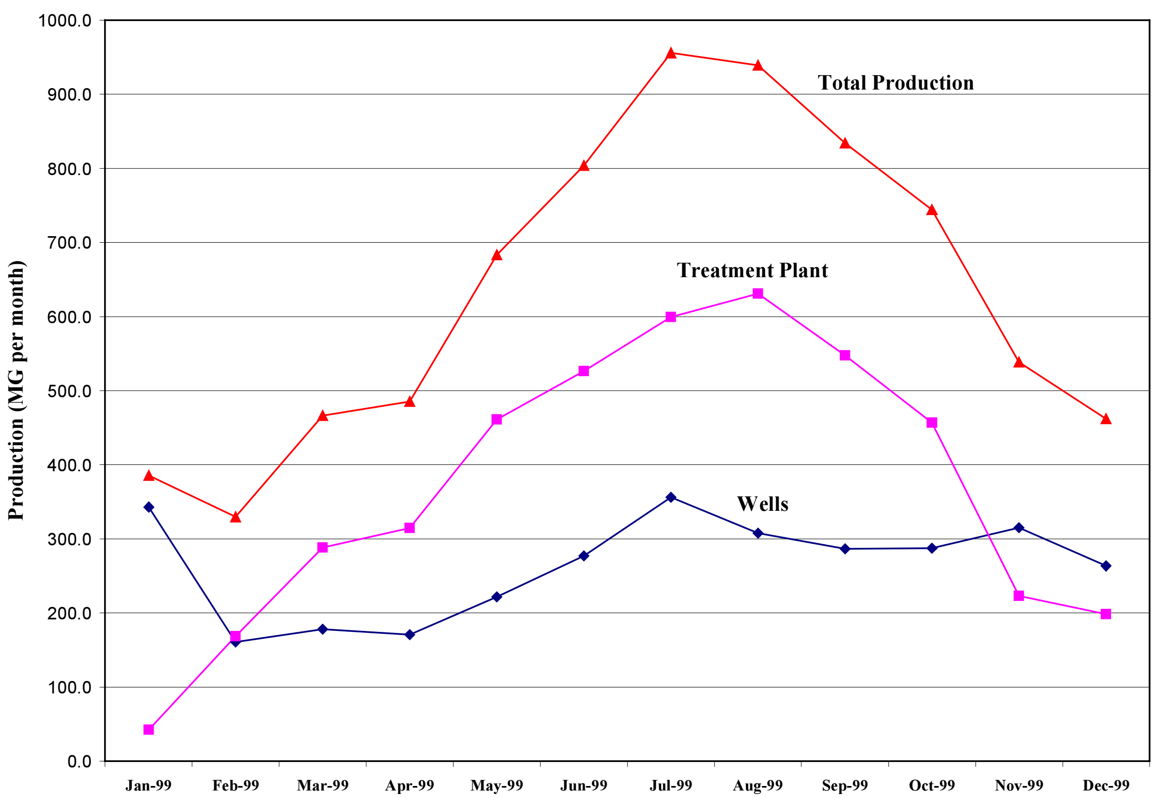


Figure 3-1
1999 Monthly Water Production

EXISTING WATER DEMANDS

Annual historical water consumption data for the past five years has been used to evaluate average annual demands. As shown in **Table 3-2**, total water consumption has been somewhat consistent over the past five years. The difference in volumes between water produced and water consumed is defined as unaccounted water, or the water losses within a system. Unaccounted water may be attributed to leaking pipes, unmetered water use, or any other event causing water to be withdrawn and not measured, such as hydrant flushing and fire fighting. Average percentages of water produced for unaccounted water per year are shown in **Table 3-2** and an historical depiction of production, consumption, and unaccounted for water losses is shown in **Figure 3-2**. The percentage of unaccounted for water losses has been declining, in part due to the District's replacement policy for leaking pipelines.

Table 3-2
Historical Water Consumption

Year	Annual Consumption (MG)	ADC(1) (mgd)	Percent Increase	Percent Water Loss
1995	6,466	17.7	2.9%	10.8%
1996	6,992	19.2	7.5%	8.8%
1997	6,856	18.8	-2.0%	7.4%
1998	6,142	16.8	-11.6%	8.7%
1999	7,242	19.8	15.2%	5.1%

Note: 1. ADC is average day consumption.

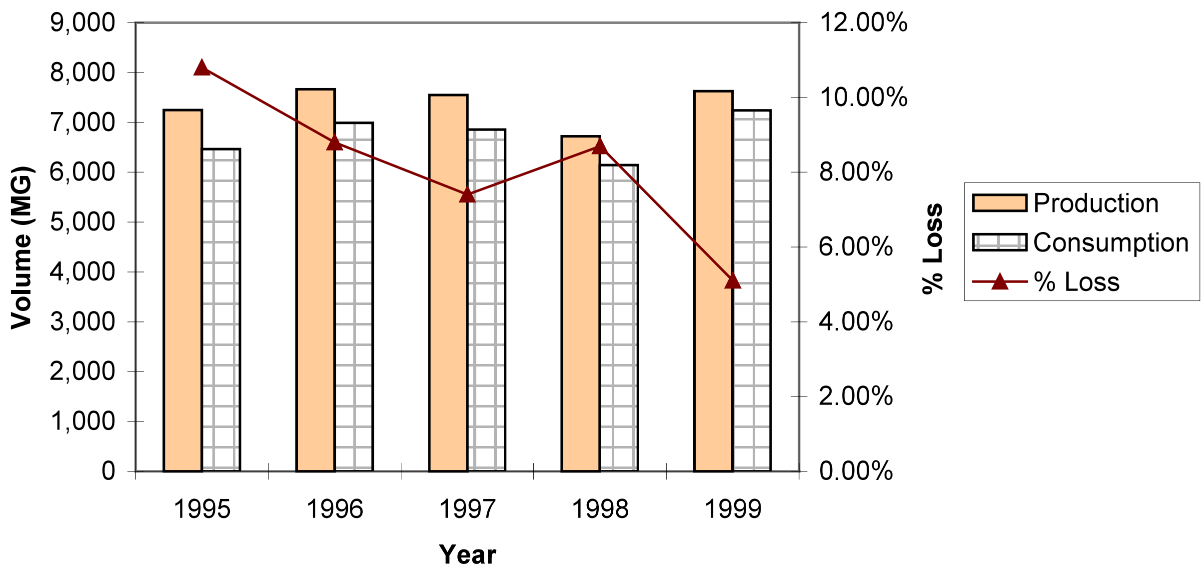


Figure 3-2
1995-1999 Production and Consumption

Detailed water demand information has been obtained from the District's water meter readings. The District reads water meters on a monthly basis. Based on the available information, it is not possible to develop demand information more detailed than on a monthly basis. Therefore, maximum day production information is utilized in analyzing the hydraulic system.

The District supplied billing information including every meter read record for service connection during 1999. As shown in **Figure 3-3**, over 80 percent of the consumption is for residential uses. The commercial (vaulted) classification is for all service connections in a vault; some large multi-family residences are also in this category. Including the multi-family connections in the vaulted commercial billing classification, 86.8 percent of consumption is for residential uses. The remaining 13.2 percent is for commercial, industrial, irrigation, and construction customers. There is also significant seasonal variation of consumption over the course of the year, as shown in **Figure 3-4**.

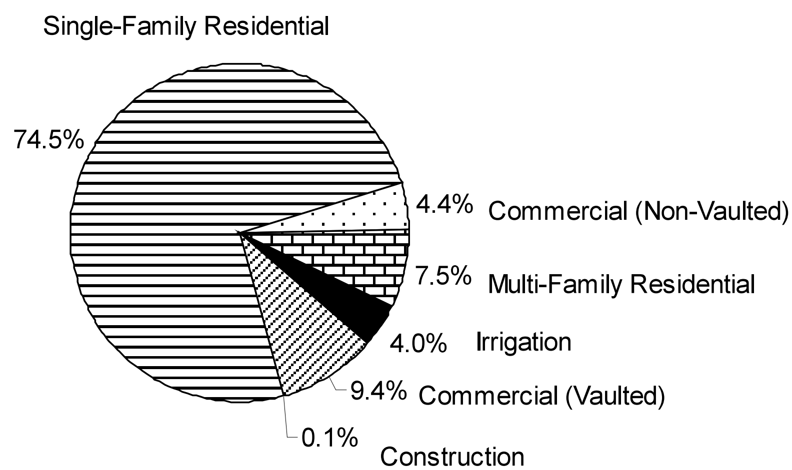


Figure 3-3
Water Use by Billing Classification

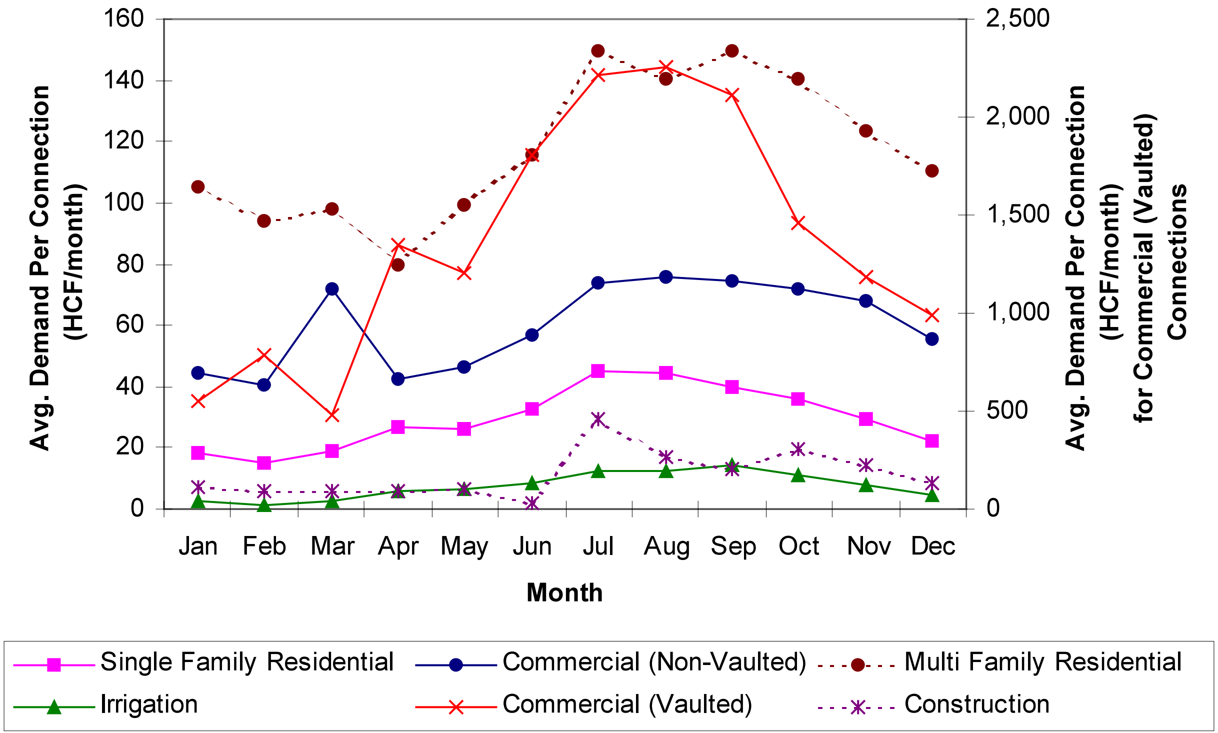


Figure 3-4
Average Demand per Connection

Demands by pressure zone are shown in **Table 3-3**. From the table below, the greatest amount of demand is in the 2800 pressure zone. The 2850, 2950 and 3000 pressure zones also contain a substantial portion of demands. The zones higher in the foothills each contain only minimal percentages of demand, compared to the entire District.

Table 3-3
1999 Demands by Pressure Zone

Pressure Zone	Average Demand (gpm)	Percent of Total
2800	6,904	47.6%
2850	2,162	14.9%
2950 (Dahlitz & LEC)	3,598	24.8%
2950 (Hilltop & Westmont)	125	0.9%
3000	1,325	9.1%
3200 (Underground)	132	0.9%
3200 (Tovey)	61	0.4%
3250	72	0.5%
3400 (UEC)	131	0.9%

The ten largest service connections are shown in **Table 3-4**. These ten largest users use an average of 661 gpm over the course of the year, equal to 347 MG/year. These large represent 4.9 percent of the total consumption.

Table 3-4
Ten Largest Water Users

Description	Average Consumption[1] (gpm)	WSM Number
Lockheed Martin Skunkworks	154	62-51
Ray K Farris	67	48-66
R & R Investments	64	42-54
City Of Palmdale, Pelona Vista Park	63	46-45
Monte Vista Comm Association	57	42-60
California Investors VII	54	40-60
City Of Palmdale, Dominic Massari Park	53	48-78
City Of Palmdale, William McAdam Park	51	50-63
Sierra Vista Mobile Homes	51	48-63
Palmdale High School	47	48-57
Total	661	

Note: 1. Consumption based on average demand for the year 1999.

DEMAND PROJECTIONS TO YEAR 2020

Future water production scenarios were evaluated: the 20-year horizon to year 2020 for water source planning issues and the 10-year horizon to year 2010 for developing future system facility improvements. For both periods, the water production requirements are calculated using proposed developments and confirmed by population projections.

Water Production Requirements by Development Projections

The selected methodology to estimate future water production requirements is based on development. Based on development projections, land use classifications and water duty factors, future production requirements are estimated. A water duty is the daily water use per acre of a given land use type.

Table 3-5 summarizes the water use factors that have been developed for each land use category presented in Section 2 of this report. The assumptions used to develop these water use factors are listed after the table.

Table 3-5
Future Water Duty Factors
(All usage factors in gpd/acre)

Land Use Type	DU/ acre	Pop/ DU	Pop/ acre	Per Capita Use	Indoor Use	Fraction Irrig.	Applied Water	Outdoor Use	Total Use	Percent Indoor	Percent Outdoor
Commercial			34.0	30	1020	0.05	2026	101	1121	91%	9%
Industrial			54.0	30	1620	0.05	2026	101	1721	94%	6%
Public Facilities			25.0	30	750	0.15	2026	304	1054	71%	29%
Residential Low	1	3.38	3.4	85	287	0.50	2026	1013	1300	22%	78%
Residential Medium	6	3.38	20.3	85	1724	0.30	2026	608	2332	74%	26%
Residential High	16	3.38	54.1	85	4597	0.10	2026	203	4799	96%	4%
Open Space-Rec & Parks			2.0	30	60	0.50	2026	1013	1073	6%	94%

The following assumptions apply to the calculations for the land use water use factors:

- Outdoor use is the fraction of irrigation multiplied by the applied water factor, 2,026 gpd/acre.
- Commercial indoor water use is based on number of jobs created per acre of new commercial development from Palmdale General Plan at 30 gpd/employee. Outdoor use is based on 5 percent irrigated area at 55 percent of net evapotranspiration (ET).
- Industrial indoor water use is based on number of jobs created per acre of new industrial development from Palmdale General Plan at 30 gpd/employee. Outdoor use is based on 5 percent irrigated area at 55 percent of net evapotranspiration.
- Public facilities indoor water use is based on 25 jobs per acre of development at 30 gpd/employee. Outdoor use is based on 15 percent irrigated area at 55 percent of net evapotranspiration.
- Residential indoor demand is based on 85 gpd/person from minimum month residential use. Residential density from City General Plan. Population density assumed to be 3.38/DU from California DOF estimates. Outdoor demand is based on assumed landscape coverage at 55 percent of net evapotranspiration.
- Open space-recreation & parks indoor demand based on assumed 2 employees per acre at 30 gpd per employee. Outdoor demand based on 60 percent irrigation area at 55 percent of net evapotranspiration.
- Annual percent applied water is 55 percent of net evapotranspiration (turf ET less effective precipitation) from AWWARF Report: Residential End Uses of Water, 1999. Net ET for Palmdale area is 49.5 in/yr.

The land use factors derived in **Table 3-5** combined with the development projections for years 2010 and 2020 in Section 2 can be used to determine water production requirements within the

District boundary. In **Table 3-5**, separate calculations were performed for open space and public facilities, but for this calculation, an average value is used, at 1,063.5 gallons per acre per day (gpad). Factors for all other land use classifications are as shown. Using these land use factors, total production requirements within the District's primary service area boundaries will be 10,423 MG/yr for year 2010 and 14,190 MG/yr for year 2020.

Some of the service connections are outside the District's primary service area, as noted in Section 2; most notably Lockheed Martin Skunkworks. Taking the demand for Lockheed for the maximum month from the 1996 Master Plan at 186 gpm and from the 1999 billing data at 229 gpm, an increase in demand at Lockheed is estimated to be about 6 percent a year. Taking this growth rate for Lockheed into consideration for the service connections outside the District's boundary, these connections are estimated to have a current demand of 81 MG/yr, a demand of 125 MG/yr in year 2010 and a demand of 165 MG/yr in year 2020.

Thus, the total production requirements for the District's primary service area will be 10,548 MG/yr in year 2010 and 14,355 MG/yr in year 2020.

Water Production Requirements by Population Projections

Another methodology to estimate future water production requirements is based on population growth projections and production requirements per capita. This methodology will be used to confirm the projections determined by the development methodology. Population growth projections were presented in Section 2 of this report. A per capita production requirement of 240 gallons per capita per day (gpcd) was derived from the 1999 total production of 7,627 MG (see Table 3-1) and the estimated District population of 87,042 (see Section 2). Per capita usage is affected by the relative mix of residential and non-residential usage. Increased commercial and industrial developments increase per capita use. This per capita usage factor was then evaluated by comparing population growth trends with employment growth trends. The employment growth rate was used as an indication of commercial development and the population growth rate was used as an indication of residential growth.

Figure 3-5 shows the growth trends for population and employment in the Palmdale area, using projections from the City. From 1995 to 2010, the growth rate in the population and employment is approximately equal. From 2010 to 2020, the growth rate in employment is greater than the growth rate in population, by approximately 23 percent.

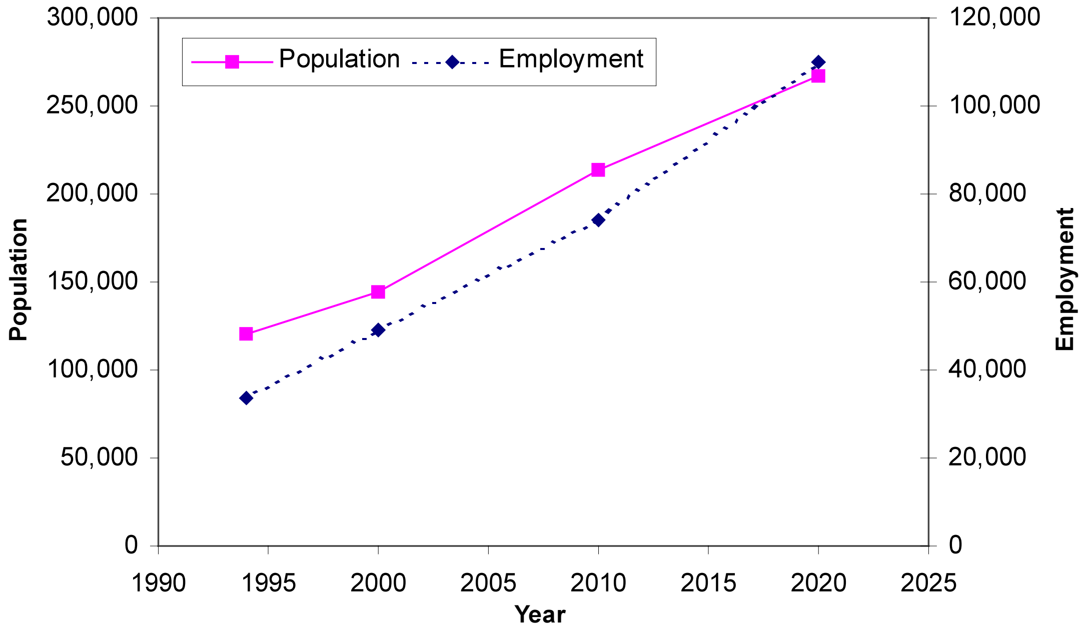


Figure 3-5
Population and Employment Projections in the Palmdale Area

Since the growth rate in both the residential and commercial sectors are expected to be similar between current and 2010, the 1999 per capita production of 240 gpcd can be used for production requirements for 2010. Since the growth rate for employment is expected to exceed the growth rate for population from 2010 to 2020, the commercial sector will use more water relative to the residential sector. Therefore, the per capita production for 2020 is adjusted by increasing the non-residential portion (13.8 percent of total water use) by 23 percent. Thus, per capita production will increase to 248 gpcd by the year 2020.

The population estimate as described in Section 2 is 130,600 for the year 2010 and 161,500 for the year 2020. Taking the per capita production of 240 gpcd for year 2010 and 248 gpcd for year 2020, total production requirements for the District's primary service area will be 11,441 MG/yr for year 2010 and 14,598 MG/yr for year 2020 using the population methodology.

Projected Water Supply Requirements

The two methodologies for determining water production requirements are summarized in **Table 3-6**. The population methodology confirms the demand projections from the development methodology, as two methodologies give demand projections within five percent of each other.

Table 3-6
Water Production Requirements, Comparison of Two Methodologies

Methodology	2010 (MG/yr)	2020 (MG/yr)
Development	10,548	14,355
Population	11,441	14,598

For further analysis, the development methodology projection number will be used, as this is generally considered more accurate than the population methodology, since there are multiple factors used for the water duty methodology, while there is only one factor used for the population methodology. In addition, the development methodology locates where growth will occur; this assists in the modeling and analysis of the future system.

Water production varies from year to year based on weather conditions. Historical production data per connection is compared to a trend line to determine the annual variation. This analysis shows that historical production per connection ranges from 91.2 to 110.7 percent of the trend. The above normal annual production is based on the maximum historical variation in annual water production above the historical trend. Water supply planning should be based on the above normal production values since these are likely to occur during hot, dry years when surface water supplies are likely to be inadequate. The above normal production requirement is calculated as 10.7 percent greater than average production requirements.

In addition to the demands of the District's customers, the Littlerock Creek Dam and Reservoir Rehabilitation, Operation and Maintenance Agreement (Palmdale Water District, 1992) entitles LCID to purchase 25 percent of the yield in Littlerock Reservoir; up to 1,000 acre-ft/yr during any calendar year from the District. In addition, LCID may, at its option, deliver a portion of its SWP entitlement to the District for treatment. The maximum amount of Littlerock Creek or SWP water treated and delivered to LCID is limited to 2,000 gpm or 2.9 mgd.

The total water supply needs of the District include both the demands of its customers and delivery obligations to LCID. **Table 3-7** shows the average supply needs of the District, requiring 45,100 acre-ft/yr in 2020.

Table 3-7
Projected Water Supply Requirements [3]

	Year	
	2010	**2020**
Average Annual Demand (acre-ft/yr)		
Palmdale Water District	32,400	44,100
Littlerock Creek Irrigation District	1,000 [1]	1,000 [1]
Total Average Annual Demand	**33,400**	**45,100**
Above Normal Annual Demand (acre-ft/yr)		
Palmdale Water District	35,900	48,800
Littlerock Creek Irrigation District	1,000 [1]	1,000 [1]
Total Above Normal Annual Demand	**36,900**	**49,800**
Maximum Day Demand (mgd) [2]		
Palmdale Water District	55.8	75.9
Littlerock Creek Irrigation District	2.9 [1]	2.9 [1]
Total Maximum Day Demand	**58.7**	**78.8**

Note: 1. Littlerock Creek Irrigation District may be limited to less than 1,000 acre-ft/yr (with a maximum rate of 2000 gpm or 2.9 mgd) based on the flows into Littlerock Reservoir.
2. MDD is 1.93 times normal annual demand.
3. Demand projection is based on development methodology.

Section 4
Existing Water Sources and Reliability

The District has three existing sources of water supply: surface water from Littlerock Creek Reservoir, local groundwater, and State Water Project (SWP). Each of these sources is described below. **Figure 4-1** shows the historical production from these sources. Production from Littlerock Creek and SWP are combined as water treatment plant production. During 1985-87, the District received SWP deliveries through AVEK before the District's water treatment plant was on-line.

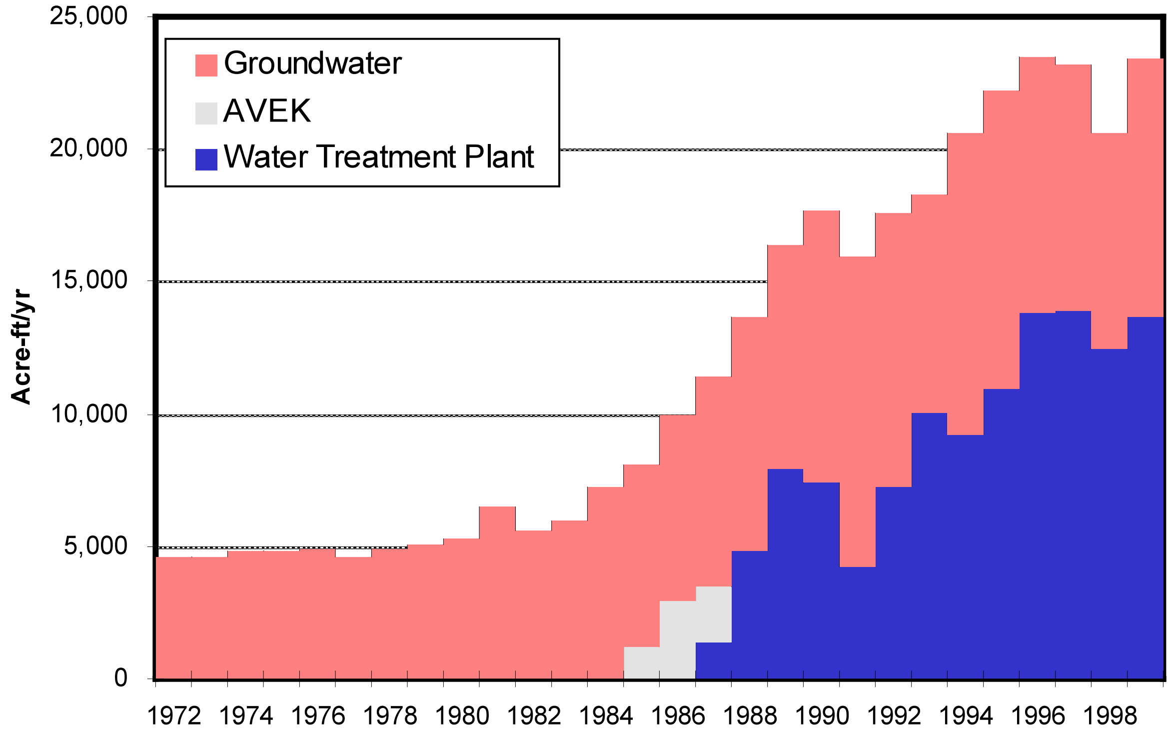


Figure 4-1
Historic Annual Water Production

LITTLEROCK CREEK

Littlerock Creek Dam and Reservoir, located about seven miles southeast of the Palmdale Civic Center, intercepts flows from Littlerock and Santiago Canyons. These two water courses are fed by runoff from a 65 square mile watershed in the Angeles National Forest. Inflow to the reservoir is seasonal and varies widely from year to year. For the period 1949-1999, annual inflow has ranged from 1,293 acre-ft (1960-61) to 74,163 acre-ft (1977-78). The average inflow for the available data was 13,285 acre-ft/yr. The median inflow for this period was 6,707 acre-ft/yr. The difference between the median (50th percentile) and the average demonstrates that dry years occur more frequently than wet years and that wet years tend to be more extreme. **Figure 4-2** shows the annual variation in Littlerock Creek Reservoir inflows.

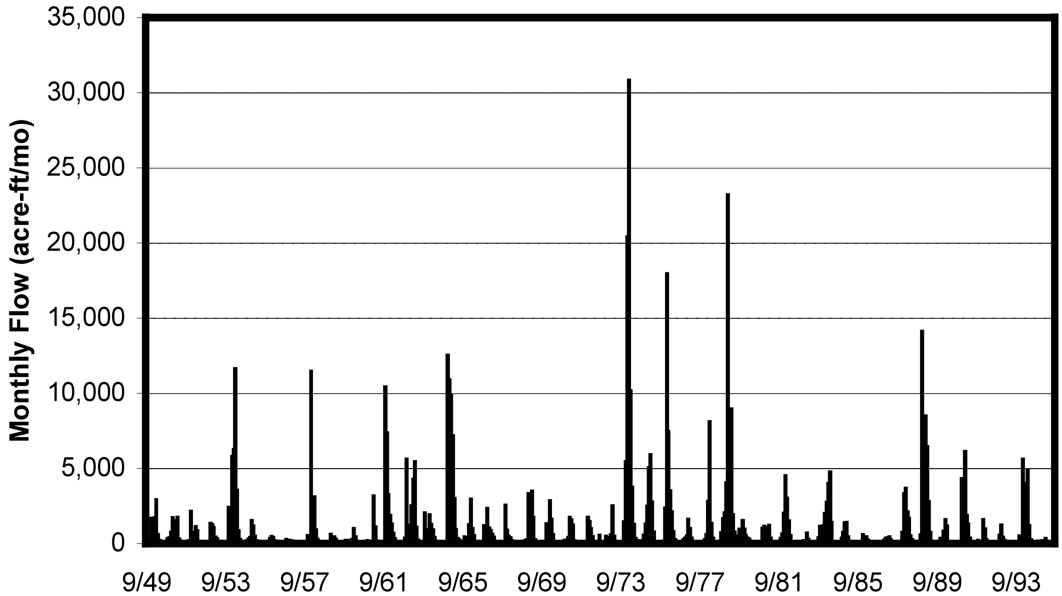


Figure 4-2
Littlerock Creek Reservoir Monthly Inflows

Water Rights for Littlerock Creek Supply

The District and LCID jointly hold long-standing water rights to divert 5,500 acre-ft/yr from Littlerock Creek flows. Under terms of a 1922 Agreement between the two districts, LCID has the exclusive right to the first 13 cubic feet per second (cfs) measured at the point of inflow to the reservoir. Flow in excess of 13 cfs is shared by the two districts with 75 percent going to the District and 25 percent to LCID. Each district is entitled to 50 percent of the reservoir's storage capacity.

In 1992, the District and LCID entered into an agreement to rehabilitate the dam. This agreement gives the District the authority to manage the reservoir. In lieu of monetary contributions by LCID for the dam rehabilitation, LCID granted ownership of its water rights to the District for the fifty-year term of the agreement. LCID is entitled to purchase from the District, in any one calendar year, 1,000 acre-feet of water or 25 percent of the yield from the reservoir, whichever is less. Upon termination of the 1992 Agreement, the terms of the 1922 Agreement will again define the rights and responsibilities of the parties with respect to the dam and waters stored in the reservoir.

Facilities for Littlerock Creek Supply

In 1924, the District and LCID jointly constructed Littlerock Creek Dam. The original dam was a multiple-arch, reinforced concrete structure with a maximum height above bedrock of 170 feet, a crest length of 720 feet, and a crest elevation of 3,272 feet. The original reservoir was designed to impound 4,300 acre-feet with a spillway elevation of 3,258 feet. The original outlet works consisted of two parallel 24-inch diameter steel pipelines with tandem 24-inch gate valves on the upstream and downstream ends of each outlet pipe. Each outlet pipe was also provided with two 12-inch diameter butterfly valves for normal reservoir releases.

Silt accumulates in the reservoir at a rate of about 30 to 40 acre-ft/yr, and there has been no large-scale sediment removal since the original dam was constructed. Siltation covered the original outlet works inlet structure and the structure had to be raised in 1964; however, siltation continued to cause problems with the outlet works. Based on a 1989 aerial survey, the storage capacity had been reduced to 1,780 acre-ft by sedimentation.

For years, there was concern about the adequacy of the design and the overall stability and safety of the dam. A number of engineering studies were conducted which indicated the original dam did not meet required seismic safety criteria. In 1988, the California Department of Water Resources (CDWR) Division of Safety of Dams found the dam to be unsafe and required either repair or alteration to meet safety requirements or breaching of the dam so it could not store water. In response to this order, the District and LCID commenced with a rehabilitation project to meet seismic requirements and to raise the spillway elevation to regain a portion of the storage capacity lost to siltation.

In 1994, the rehabilitation project was completed. In this project, the crest elevation was raised to 3,279 feet and the spillway was raised to 3,270 feet increasing the reservoir capacity to 3,511 acre-ft. A roller-compacted concrete gravity buttress was constructed between the downstream portions of the existing buttresses to strengthen the existing dam. The new spillway section was designed to pass a 100-year flood event having a peak outflow rate of 19,100 cfs with 2.5 feet of residual freeboard. The Probable Maximum Flood event having a peak outflow of 76,800 cfs would overtop the dam crest. Overtopping of the crest is acceptable during extreme flood events due to the dam design characteristics. A new outlet works was constructed as part of the rehabilitation including a 42-inch diameter outlet with a 24-inch diameter wye to allow a future low level intake in the event the reservoir sediment is removed (Woodward-Clyde, 1993).

Maintaining the reservoir storage capacity by annual sediment removal is extremely important to the future of the reservoir as a water supply for the communities of Palmdale and Littlerock. Therefore, the District is in the process of hiring a consultant to do a biological assessment on the removal of sediment from Littlerock Reservoir. At the same time, the District is working with the U.S. Forest Service to amend the EIR/EIS concerning the removal of sediment due to the recent critical habitat designation for the arroyo southwestern toad. The District is also in the process of getting necessary permits and approval from the Corps of Engineers, Regional Water Quality Control Board, the California Department of Fish and Game and the U.S. Fish and Wildlife Service, if needed.

The District proposes to remove approximately 54,000 cubic yards (approximately 33 acre-ft) of sediment from Littlerock Reservoir. The District proposes to use front-end loaders and 25-ton dump trucks to excavate and haul material offsite for disposal. Equipment would avoid sensitive vegetation in the reservoir bed or perimeter of the reservoir. Sediment would be hauled offsite to commercial gravel pits. Following sediment removal, the reservoir area would be graded to flatten any scrapes resulting from the excavation activities.

The arroyo southwestern toad (*Bufo californicus*), an endangered species, will be a major concern during the sediment removal process. The United States Fish and Wildlife Service (USFWS) designated about 182,360 acres of land in Southern California as critical habitat for the toad (February 7, 2001). Of this total, about 1,480 acres of the Littlerock Creek watershed has been designated critical habitat. The affected area includes about 5.9 miles of Little Rock Creek and adjacent uplands, from the South Fork confluence downstream to the upper end of Little Rock Reservoir (in the vicinity of Rocky Point Picnic Ground), and approximately 1.1 miles of Santiago Creek and adjacent uplands upstream from the confluence with Little Rock Creek.

Section 7(a)(2) of the Endangered Species Act (ESA) requires federal agencies to ensure that the actions they fund, authorize or carry out do not destroy or adversely diminish the value of critical habitat for the survival and recovery of the species. Federal actions including issuing of permits for work on private land require Section 7 consultation with USFWS. The ESA authorizes the USFWS to issue permits for the take of listed species incidental to otherwise lawful activities. An incidental take permit application must be supported by a habitat conservation plan (HCP) that identifies conservation measures that the permittee agrees to implement to minimize and mitigate for the requested incidental take.

The District wants to ensure that any incidental take of the toad is minimized and that necessary precautions are taken to protect the toad. Based on existing information regarding the toad's distribution and habitat, impacts of sediment removal are minimized by keeping the removal operations within the confines of the existing reservoir and by conducting sediment removal during the fall months to avoid breeding period (late February to early July). The District feels strongly that sediment removal operations must occur no later than October 2001 and conclude by November 2001 to coincide with the period of reservoir drawdown and to avoid the toad's breeding period. The District plans to have all permits and essential documents on file by August 2001 in order to hire a contractor to perform the proposed sediment removal.

From the Littlerock Reservoir, water is conveyed to Lake Palmdale through an 8.5 mile long open canal, commonly referred to as the Palmdale Ditch (Ditch). Up until Fall 1999, the Ditch was unlined. Lining of the Ditch with bentonite was a two-phased project that began in 1998 and concluded in late 1999. The capacity of the Ditch is estimated to be about 25 cfs. Flows into the Ditch are measured at the outlet works of the dam and at Lake Palmdale to track conveyance losses. Historically, when the Ditch was unlined, losses were estimated at about 17-20 percent of the flow. Available data evaluated for the year 2000 indicate that the bentonite lining of the Ditch has reduced losses to approximately 9 percent of the flow.

Reliability of Littlerock Creek Supply

The reliability analysis for the reservoir is based on the yield from the reservoir using actual hydrology from 1949 to 1999 for Littlerock Creek and Santiago Creek obtained from the Los Angeles County Department of Public Works (1999). Evaporative losses are estimated using typical monthly data for the Antelope Valley and the reservoir area-capacity curve. Diversions, spills, and ending storage are calculated on a monthly basis. Total annual diversions are the sum of the monthly diversions.

The District provided information on reservoir operational constraints. One constraint is a limitation on diversions to the maximum Ditch capacity between the Reservoir and Lake Palmdale (25 cfs) less a 9 percent conveyance loss. The second constraint is to maintain a minimum reservoir pool of 500 acre-feet for recreational purposes from initial annual fill until Labor Day. This constraint results from the use of Davis-Grunsky funds for a portion of the dam rehabilitation (District, 1999).

Using the 1949 to 1999 hydrology, the analysis projects available annual diversions ranging from 1,178 to 15,900 acre-feet per year. The average annual yield from the reservoir is estimated to be 7,396 acre-feet/yr. Conveyance losses of 9 percent reduce this yield to 6,920 acre-ft/yr. Supply reliability data is shown in **Table 4-1**. **Figure 4-3** shows the annual yield probability of Littlerock Creek Reservoir with and without conveyance losses of 9 percent. As shown, the probability of having enough yield for the District to divert their full water rights of 5,500 acre-ft/yr (which includes supply to LCID) is approximately 50% of the time.

Table 4-1
Littlerock Creek Reservoir Supply Reliability

Percent of Time Available (%)	Total Diversions[1] (acre-ft/yr)	Yield to the District[2] (acre-ft/yr)
5	14,120	12,849
50	6,753	5,982
95	1,709	1,555
Minimum	1,178	1,072
Average	7,396	6,920
Maximum	15,900	14,469

Note: 1. Diversions are based on 25 cfs Ditch capacity.
2. Yield assumes 9 percent conveyance loss in the Ditch.

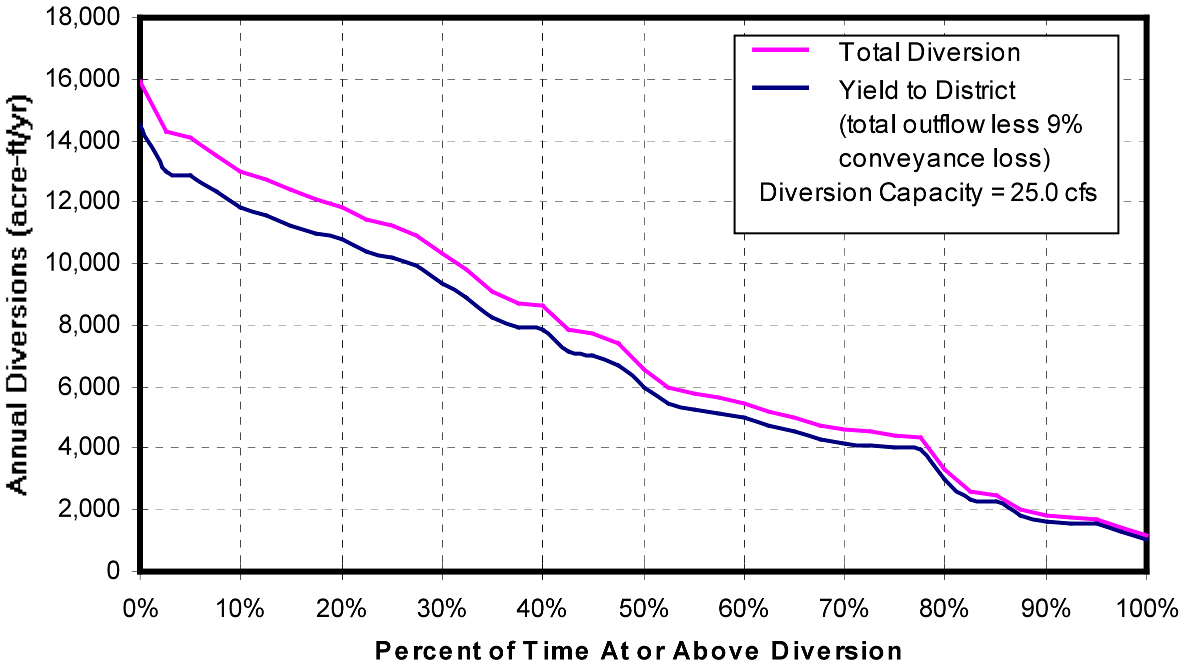


Figure 4-3
Littlerock Creek Reservoir Annual Supply Reliability

Littlerock Creek Water Quality

Water quality regulations, current as of March 9, 2001, are summarized in Appendix B. Water quality data sampled in January 2000 from Littlerock Creek is summarized in **Table 4-2**. The table shows no objectionable water quality characteristics. This single sample is not likely to be representative of water quality during peak runoff periods; however, it gives an indication of water quality after settling, as would occur in Lake Palmdale. Littlerock Creek water diverted to Lake Palmdale is treated at the District's water treatment plant. This facility is discussed later with the SWP supply.

Table 4-2
Littlerock Creek Water Quality
(Single Sample Taken in January, 2000)

Constituent	mg/l	Constituent	mg/l
Chemical Parameters			
Cations		Anions	
Calcium	32.7	Sulfate	24.2
Magnesium	14.2	Chloride	7.4
Sodium	22.4	Nitrate	<2.0
Potassium	2.5	Perchlorate	ND
Manganese	0.08		
Fluoride	ND		
Iron	ND		
Physical Parameters			
Total Hardness as $CaCO_3$	147	Specific Conductance	360 μmho/cm
Total Alkalinity as $CaCO_3$	148	Odor	2 TON
Total Dissolved Solids	192	Color	10 Units
pH	8.3 units	Turbidity	1.8 NTU
Radioactivity			
Gross Alpha	2.2 pCi/l		

Costs of Littlerock Creek Supply

Production costs for Littlerock Reservoir water include capital recovery for dam rehabilitation, capital recovery for treatment plant, operations and maintenance (O&M) for dam, O&M for conveyance facilties, and O&M for treatment plant. In addition, if the District begins the annual sediment removal operation, annual silt removal to maintain current storage may cost approximately $250,000 per year. Based on the ten year average diversion of 5,209 acre-ft per the agreement between PWD and LCID, the cost of Littlerock Creek Supply totals $353.11/acre-ft, as summarized in **Table 4-3**.

Table 4-3
Littlerock Creek Reservoir Supply Costs

Item	Cost per acre-ft
Littlerock Reservoir Raw Water	$216.39/acre-ft (1)
Water Treatment	$88.73/acre-ft (2)
Annual Sediment Removal	$47.99/acre-ft (1)
Total Unit Cost	$353.11/acre-ft

Notes:
(1) Based on the ten year average diversion calculated per Agreement between PWD and LCID.
(2) Based on actual volume treated in treatment plant in 1999.

GROUNDWATER

The District's primary service area has historically been supplied with groundwater pumped from deep wells. Generally, the groundwater in the area is of excellent mineral and bacteriological quality. However, the groundwater supplies in much of the Antelope Valley are in overdraft because annual pumping exceeds replenishment. The following sections generally describe water rights, hydrogeologic conditions and facilities, reliability, water quality and costs of groundwater production.

Water Rights for Groundwater

Since the Antelope Valley Basin is not adjudicated, the groundwater yield has not been allocated among the pumpers. Rather, each groundwater pumper has a correlative right to pump the water required for beneficial uses. Since the basin is currently in overdraft, any of the parties could file suit to adjudicate water rights. Previously, adjudication was not considered an acceptable approach by many of the Antelope Valley pumpers, and instead, a basin management approach was being pursued. However, this effort was thwarted in the fall of 1999 when a farming company filed two lawsuits against water agencies. Since then, there has been no further joint effort toward the development of a regional groundwater management plan.

Hydrogeologic Conditions and Facilities for Groundwater

Figure 4-4 presents a generalized hydrogeologic map of the Antelope Valley Groundwater Basin and identifies the location of the major subbasins. The District's primary service area overlies three subbasins of the Antelope Valley Groundwater Basin: the Lancaster, Buttes, and Pearland subbasins. In addition, the District overlies a portion of the San Andreas Rift Zone, which also contains water-bearing deposits. The District pumps groundwater from the Lancaster and Pearland subbasins and from the San Andreas Rift Zone, but does not currently pump from the Buttes subbasin. Presently, the District has 26 equipped wells and 4 additional wells that have been drilled but not yet equipped (see **Table 4-4**). Well No. 9, which was in operation at the publication of the 1996 Master Plan, was abandoned in 1997 when oil was found in the well and rehabilitation costs would have exceeded the benefits of the well's production capacity.

Lancaster Subbasin. The Lancaster subbasin is located in the center of the Antelope Valley Basin and consists of alluvial deposits in excess of 2,000 feet thick. The southernmost portion of the Lancaster subbasin lies within the District service area and is bounded by a bedrock ridge on the south and by the Buttes and Pearland subbasins on the east. Alluvium reaches a thickness of about 1,100 feet in the northern portion of the District service area. Two aquifer zones underlie the District service area. The principal (upper) aquifer is generally unconfined with a saturated thickness of as much as 600 feet. The deep (lower) aquifer is confined and within the District service area is several hundred feet thick. However, the thickness of the deep aquifer increases to over 1,000 feet to the north. Layers of fine-grained lake deposits that impede vertical flow separate the two aquifers.

Declining water levels in the Lancaster subbasin have caused concern for many decades. The primary influence on water levels in the Lancaster subbasin is pumping. Agricultural use has historically represented a significant portion of extraction from the subbasin. However, since the

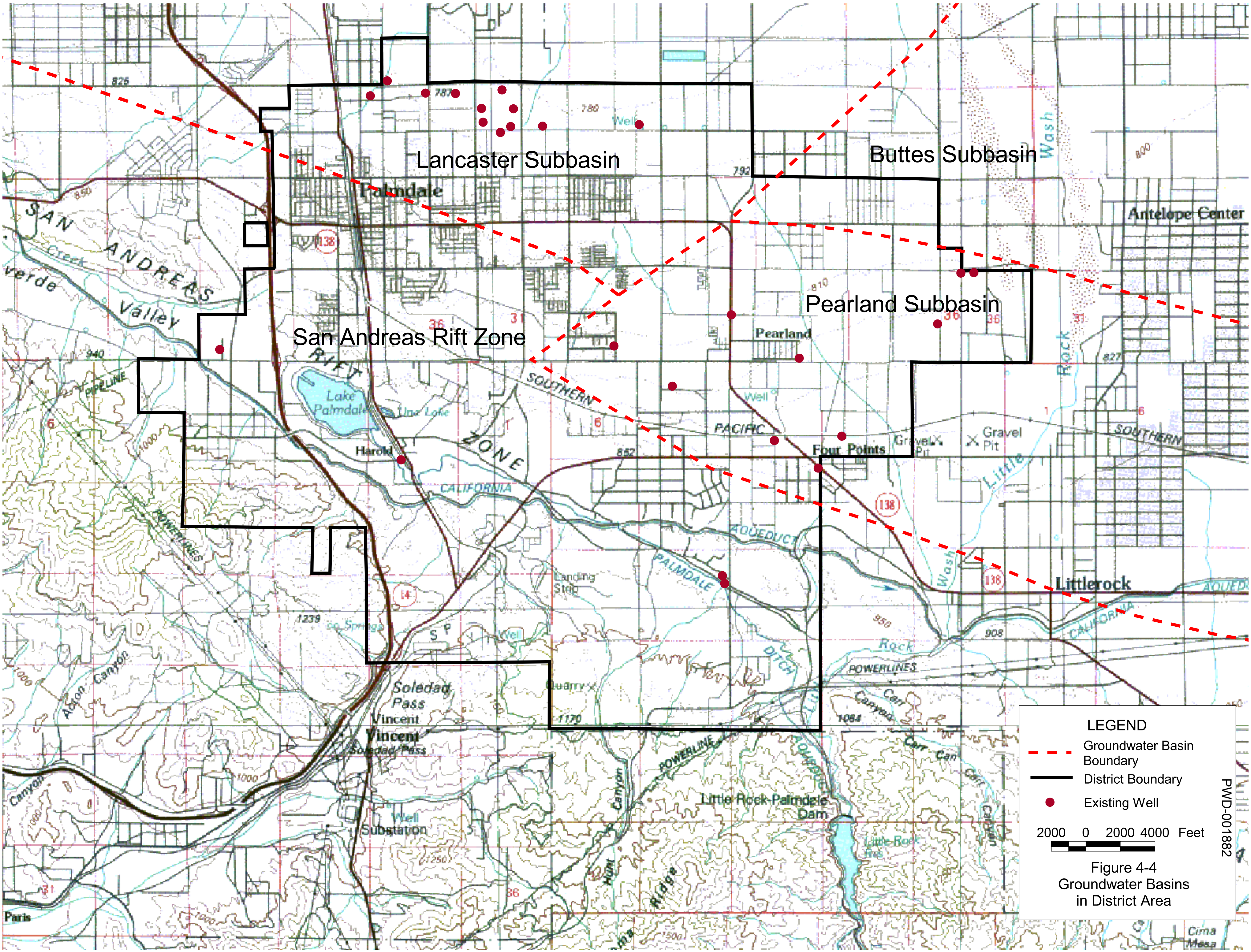


Figure 4-4
Groundwater Basins
in District Area

PWD-001882

Table 4-4
Well Information

Groundwater Basin Subbasin	Well No.	Year Drilled	Well Depth (ft)	Casing Diameter (in)	Motor Capacity (hp)	Date of Pump Test	Normal Pump Operating Conditions (Test 1)		Groundwater Level			Specific Capacity (gpm/ft)	Overall Plant Efficiency (%)	Unit Energy Usage (kwh/ acre-ft)	Annual Average Pumping Cost ($/acre-ft)[1]
							Discharge (gpm)	TDH (ft)	Static (ft)	Pumping (ft)	Drawdown (ft)				
Lancaster	2A	1968	900	16	500	7/1/99	1,501	802	550	566	16	90	61.3%	1339.7	$69.59
Lancaster	3A	1960	848	16	500	5/10/99	1,726	779	541	569	29	61	70.4%	1133.5	$61.13
Lancaster	4A	1970	830	16	350	5/10/99	1,050	787	529	578	49	21	62.9%	1281.4	$63.60
Lancaster	6A	1983	1010	16	125	5/6/99	339	764	527	594	67	5	63.4%	1234.3	$143.86
Lancaster	7A	1985	920	16	600	5/11/99	1,527	758	517	543	26	58	67.7%	1146.2	$56.46
Lancaster	8A	1987	960	16	600	5/10/99	1,968	790	522	545	23	86	69.7%	1160.5	$59.74
Lancaster	10	1956	694	16	100	5/13/98	292	688	447	485	37	8	58.2%	1210.7	$65.07
Lancaster	11A[2]	1963	900	16	350	10/24/89	1,161	768	535	565	29	40	19.2%	4094.9[2]	$72.78
Lancaster	14A	1965	900	16	250	5/6/99	1,335	575	539	561	22	61	70.2%	839.2	$128.07
Lancaster	15[2]	1960	800	16	500	10/25/89	998	794	549	604	56	18	18.0%	4514.1[2]	$84.69
Lancaster	23A	1977	857	16	500	5/11/99	1,303	822	533	595	63	21	55.8%	1507.9	$96.66
Lancaster	24	1985	920	16	150	5/11/99	537	757	531	548	17	31	60.1%	1290.3	$95.37
Pearland	9	Well has been abandoned			---	---	---	---	---	---	---	---	---	---	---
Pearland	16	1960	550	14	40	6/3/99	122	467	212	234	22	6	48.1%	994.0	$81.69
Pearland	20	---	472	16	60	5/18/99	279	457	187	224	37	8	63.9%	732.8	$56.21
Pearland	21	---	348	10	30	6/3/99	190	401	184	201	17	11	47.7%	860.6	$57.35
Pearland	22	1974	400	16	75	5/13/99	362	314	129	171	41	9	60.6%	530.2	$39.87
Pearland	25	1989	600	16	125	5/14/99	514	378	123	189	66	8	53.7%	721.6	$83.01
Pearland	26	1989	480	16	50	5/13/99	239	462	225	276	51	5	50.9%	928.4	$63.65
Pearland	27[3]	---	---	---	100	---	600	516	---	---	100	6	60.0%	---	---
Pearland	28[3]	---	---	---	100	---	600	516	---	---	100	6	60.0%	---	---
Pearland	29[3]	---	---	---	75	---	400	483	---	---	67	6	60.0%	---	---
Pearland	30	1989	410	16	150	5/14/99	516	453	183	224	41	13	59.2%	782.7	$31.53
Pearland	32	1989	570	16	60	6/3/99	256	503	305	394	89	3	54.9%	937.5	$104.69
Pearland	33	1991	465	16	75	5/14/99	462	492	197	265	68	7	53.4%	943.1	$67.56
Pearland	34A[3]	---	---	---	30	---	200	449	---	---	33	6	60.0%	---	---
Pearland	35	1991	500	16	75	7/1/99	352	529	215	286	72	5	48.7%	1112.3	$103.12
San Andreas	5	---	193	8	5	7/1/99	99	84	23	36	13	8	28.6%	301.8	$386.61
San Andreas	17[4]	1966	400	10	20	10/8/97	245	309	39	92	54	5	72.4%	437.5	$115.62
San Andreas	18	1954	108	8	5	5/18/99	110	69	24	27	3	34	33.8%	207.5	$115.62
San Andreas	19	1961	350	14	5	5/18/99	119	72	23	51	28	4	27.4%	269.5	$115.62
Total[5]							19,402								$71.02

Notes:
1. Energy cost based on 1999 power rates and usages.
2. Gas-driven wells. Energy usage is based on thermal input to gas engine and reported overall efficiency. Unit energy usage for gas-driven wells in therm/acre-ft.
3. Well drilled but not equipped. Capacity shown is based on initial pump test.
4. Well 17 currently out of service due to water quality problems.
5. Total capacity shown for all wells whether equipped or not. Total cost is the capacity weighted average of all costs.

mid-1960s, agricultural pumping has declined from over 150,000 acre-ft/yr to less than 40,000 acre-ft/yr in the mid-1990s. However, this number may have increased by as much as 50 percent since then due to additional carrot farming in the region. By contrast, groundwater extraction for municipal use has increased substantially in the last 20 years. Groundwater levels east of Lancaster have declined by as much as 200 feet between 1932 and 1990 due to heavy groundwater extraction.

Based on 1998 to 1999 well pump tests, yields and corresponding drawdowns, the saturated alluvium has transmissivity values as high as 130,000 gallons per day per foot (gpd/ft). Depths to water vary, depending on location and season, but were in the range of 450-550 feet in 1999. The average seasonal variation on groundwater levels is approximately 40 feet.

In 1999, the District operated 12 wells in the Lancaster subbasin pumping approximately 7,300 acre-ft/yr, 75 percent of the District's total annual groundwater production, and 31 percent of the District's total annual production. Typical specific capacity of the District wells in this area range from 5 to 90 gallons per minute per foot (gpm/ft) of drawdown.

Pearland Subbasin. The Pearland subbasin is located southeast of the Lancaster subbasin and underlies a portion of the District service area. In the vicinity of the Pearland subdivision, the subbasin is bounded on the south by bedrock, on the north by a fault separating it from the Buttes subbasin and on the west by the basin boundary with Lancaster subbasin. Good recharge during wet years leads to complete recovery from the prior effects of pumping. Groundwater levels respond rapidly to runoff from Big Rock and Little Rock Creeks, which are the main recharge sources to the subbasin. The single aquifer zone within the Pearland subbasin consists of alluvial deposits with an average saturated thickness of about 250 feet. Transmissivity values are estimated to be on the order of 19,000 gpd/ft, based on well yield and drawdown data available from 1999.Outflow appears to occur from the Pearland subbasin into the Lancaster subbasin, although no quantitative data has been gathered. Generally, groundwater levels are about 125-305 feet below the ground surface. The average seasonal fluctuation in the groundwater level is approximately 30 feet. Over the long term, groundwater levels in monitored wells have remained stable.

Currently the District operates ten wells in the Pearland subbasin, pumping approximately 2,200 acre-ft/yr, which is 23 percent of the total annual groundwater production, and ten percent of total production. Typical specific capacities of wells in the Pearland subbasin are on the order of 8 gpm/ft of drawdown.

Buttes Subbasin. The Buttes subbasin of the Antelope Valley Basin is located southeast of the Lancaster subbasin. A small portion of the subbasin underlies the District service area; however the District does not pump water from this subbasin. The Buttes subbasin is separated from the Pearland subbasin by a fault that impedes flow from one subbasin to the other. The aquifer zone within the Buttes subbasin consists of water-bearing alluvial deposits over granite bedrock. Saturated alluvium appears to be 150 feet thick with a fairly low transmissivity. Historical water levels are similar to those of the Pearland subbasin. Good recharge during wet years leads to complete recovery from the prior effects of pumping. Groundwater levels respond rapidly to runoff from Big Rock and Little Rock Creeks, which are the main recharge sources to the subbasin.

San Andreas Rift Zone. Within the San Andreas Rift Zone, two general groundwater-bearing areas are defined on the basis of geologic mapping and topographic expression. These areas generally lie east and west of the intersection of Pearblossom Highway and Barrel Springs Road. The area to the east is a narrow valley and probably has poor groundwater production potential. The area to the west is a broader valley with more extensive groundwater-bearing deposits. District Well Nos. 5 and 17 are located in the western area while District Well Nos. 18 and 19 are located in the eastern area.

Northwest-southeast trending faults may have associated fine-grained gouge zones that separate the groundwater-bearing areas into compartments, but the actual location of individual faults and their influence on groundwater movement have not been explored. The groundwater-bearing sediments have been formed in the rift zone by alluvial deposition and/or shearing of harder rocks. Information available on the maximum depth of the sediments is insufficient to make generalizations, but the log of one well within the western area shows that sand and gravel were encountered at a depth of 210 feet. The log of District Well No. 19, located within the eastern area, shows that a hard packed sand was encountered at a depth of 340 feet.

The depth to water along the San Andreas Rift Zone is generally about 25 feet below the ground surface. The seasonal groundwater level fluctuations are typically about 15 feet. Over the long term, groundwater levels in sediments within the fault zone have remained relatively stable, suggesting that the groundwater-bearing sediments have not been overdrawn.

Currently, the District operates three wells (Well Nos. 5, 18, and 19) in the San Andreas Rift Zone pumping approximately 150 acre-ft/year, which is two percent of the total annual groundwater production, and less than one percent of the total annual production. Well No. 17 was taken out of service in May 1997 due to elevated nitrate concentrations. Pump testing indicate that the specific capacity of the in-service wells are 8, 34, and 4 gpm/ft of drawdown, respectively. Well yields range from 100-120 gpm. Prior to being taken out-of-service, Well No. 17 had the highest yield of 245 gpm.

Reliability of Groundwater

One main goal in managing a groundwater basin is to evaluate the basin's maximum groundwater yield that can be withdrawn and used without producing undesirable effects. Safe yield is commonly defined as "the maximum rate of extraction from a groundwater basin which, if continued over an indefinitely long period of years, would result in the maintenance of certain desirable fixed conditions." Extraction in excess of safe yield can cause environmental damage, such as progressive groundwater surface declines, excessive pumping lifts, land surface subsidence, and water quality degradation.

A study prepared for the District by Law Environmental in 1991 evaluated the potential yield of the Antelope Valley groundwater basin. In this study, the safe yield was estimated using a groundwater balance which quantified the inflow, outflow, and change in storage to the groundwater basin. Using groundwater data from 1956 to 1990, the safe yield was estimated to be about 47,400 acre-ft/yr (Law Environmental, 1991). Total groundwater production in the basin for 1990 exceeded the safe yield by about 31,000 acre-ft. This study reported an accumulated overdraft for the period 1956 to 1990 of 2.5 million acre-ft or about 71,400 acre-ft/yr.

Safe yield estimates prepared by the United States Geological Services (USGS) (1993) were reported in the Final Report - Antelope Valley Water Resource Study for the Antelope Valley Water Group (AVWG) (Kennedy/Jenks Consultants, 1995) to range from 31,200 to 59,100 acre-ft/yr. A yield of 59,100 acre-ft/yr was used for the supply evaluations in the AVWG report with an assumed reliability of 100 percent. If the 59,100 acre-ft/yr yield were apportioned among the various pumpers according to use, the District's share of the safe yield would be about 6,200 acre-ft/yr. Reliability values were not assigned to groundwater production in excess of safe yield because of the long-term uncertainty in continuing such extraction. However, given the large storage capacity of the basin, it is unlikely that the supply reliability will be affected unless pump lifts become uneconomical or water quality degradation occurs. If the withdrawals continue at the present rate, pumping water from wells in much of the area could become impractical because of deep water levels. The cost of pumping ultimately sets the practical economic development of the groundwater. Generally, municipal pumpers can cope with higher pumping costs better than agricultural users. Reduction of groundwater levels can also lead to land subsidence, which has been observed in parts of the Lancaster subbasin.

Groundwater Water Quality

Water quality data from 1998 to 2000 for the groundwater wells in service are presented in **Table 4-5.** The range and average of constituents are reported for each subbasin. Certain generalizations can be made with regard to relative water quality of the various subbasin. A discussion of water quality regulations, current as of March 2001, is included in Appendix B. Proposed regulations that may affect the District include a proposed MCL for radon of 300 pCi/L. EPA has also proposed the Groundwater Treatment Rule, which would require 4-log virus reduction unless the likelihood of microbiological contamination is remote. Regulations are also being considered to reduce the acceptable level of various volatile organic compounds (VOCs), such as trichloroethylene (TCE) and tetrachloroethylene (PCE), but these were not detected in the District's water system, so these additional regulations should not affect the District. Groundwater quality meets standards for all other regulated constituents.

Lancaster Subbasin. Water quality analyses were performed on the following wells from the Lancaster Subbasin: 2A, 3A, 4A, 6A, 7A, 8A, 10, 11A, 14A, 15, 23A and 24. The overall quality of samples analyzed is excellent with all constituents analyzed meeting the current drinking water quality standards of EPA and the CDHS. The radon concentration in eight of the twelve wells is above the proposed MCL of 300 pCi/L, with the average radon concentration at 318 pCi/L. Radon is a naturally occurring constituent from the geology of the region. See Appendix B on Water Quality Regulations for information about the proposed alternate MCL. The average total dissolved solids (TDS) concentration for the Lancaster Subbasin is 160 mg/L. Comparison of analytical results of historical water quality analyses, including the 1996 Master Plan, indicates that mineral concentrations have generally remained about the same with minor fluctuations.

Table 4-5
Summary of Source Water Quality

Constituent	Units	California MCL	Public Health Goal[i]	Palmdale Lake	Lancaster[e]			Pearland[f]			San Andreas[g]		
					Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.
Cations													
Calcium (Ca)	mg/l			34.4	17.2	28.7	7.1	37.0	49.3	12.2	59.2	87.5	44.7
Magnesium (Mg)	mg/l			16.2	5.6	11.2	2.0	7.3	11.2	3.8	11.1	11.6	10.7
Sodium (Na)	mg/l			42.1	36.8	52.3	24.2	24.0	35.0	8.3	47.2	67.2	22.4
Potassium (K)	mg/l			2.7	1.5	2.2	1.1	1.8	2.4	1.0	(<1)	(<1)	(<1)
Anions													
Chloride (Cl)	mg/l	250[a]		74	13.4	33.8	4.0	11.3	22.4	6.0	38.0	81.0	6.7
Fluoride (F)	mg/l	2		0.15	0.3	0.5	0.1	0.2	0.3	0.1	0.2	0.3	0.2
Nitrite (as N)	mg/l	1		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate (as $N0_3$)	mg/l	45		(<2.0)	1.6	4.4	ND	4.7	12.3	ND	16.8	16.8	16.8
Sulfate (SO_4)	mg/l	250[a]		41.4	24.5	49.2	16.2	34.6	58.7	19.6	40.6	56.6	23.5
Perchlorate (ClO_4)	µg/l	18[b]		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Inorganic Chemicals													
Aluminum (Al)	µg/l	1000	60	**133**	32.5	**84.0**	(<50)	12.7	**65.0**	(<50)	34.5	**69.0**	(<50)
Antimony (Sb)	µg/l	6	20	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic (As)	µg/l	50		3.2	2.5	2.5	ND	0.4	3.6	ND	2.6	7.7	ND
Barium (Ba)	µg/l	1000		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium (Be)	µg/L	4		NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium (Cd)	µg/l	5	0.07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium (Cr)	µg/l	50	2.5	ND	**5.5**	**14.8**	ND	1.4	**13.6**	ND	ND	ND	ND
Copper (Cu)	µg/l	1300[d]	170	ND	(<50)	(<50)	(<50)	(<50)	(<50)	(<50)	(<50)	(<50)	(<50)
Cyanide (CN)	µg/l	200	150	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron (Fe)	µg/l	300[a]		126	(<100)	(<100)	(<100)	(<100)	(<100)	(<100)	(<100)	(<100)	(<100)
Lead (Pb)	µg/l	15[d]	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese (Mn)	µg/l	50[a]		ND	(<30)	(<30)	(<30)	(<30)	(<30)	(<30)	(<30)	(<30)	(<30)
Mercury (Hg)	µg/l	2	1.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel (Ni)	µg/l	100	3	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium (Se)	µg/l	50		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver (Ag)	µg/l	100[a]		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium (Tl)	µg/l	2	0.1	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc (Zn)	µg/l	5000[a]		ND	(<50)	(<50)	(<50)	(<50)	(<50)	(<50)	(<50)	(<50)	(<50)
General Parameters													
Alkalinity	mg/l			111	98.8	131.0	70.8	117.2	132.0	86.8	191.0	212.0	169.0
Color	Units	15[a]		10	(<3)	(<3)	(<3)	(<3)	(<3)	(<3)	(<3)	(<3)	(<3)
Hardness	mg/l			153	71.7	124.0	40.0	124.5	165.0	50.4	194.0	263.0	157.0
Foaming Agents (MBAS)	mg/l	0.5[a]		(<0.02)	(<0.02)	(<0.02)	(<0.02)	(<0.02)	(<0.02)	(<0.02)	(<0.02)	(<0.02)	(<0.02)
Odor-Threshold	TON	3[a]		1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
pH	Units	6.5-8.5[a]		8.15	8.1	8.5	7.6	7.8	8.3	7.5	7.7	7.8	7.5
Specific Conductance	µmhos/cm	900[a]		530	289.2	420.0	225.0	333.9	410.0	225.0	557.0	770.0	375.0
Total Dissolved Solids	mg/l	500[a]		277	159.8	230.0	113.0	192.8	235.0	132.0	318.7	445.0	213.0
Turbidity[h]	NTU			3.1	0.2	0.9	0.1	0.1	0.2	0.1	0.1	0.2	0.1
Radioactivity													
Gross Alpha Activity	pCi/l	15		2.6	1.8	3.6	0.7	(<1)	(<1)	(<1)	2.7	3.4	2.0
Radon	pCi/l	300[c]		NA	**317.7**	**448.0**	120.0	**333.9**	**584.0**	204.0	284.3	**420.0**	136.0
Bacteriological													
Giardia (cyst)	#/100ml			ND	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cryptosporidium (oocyst)	#/100ml			ND	NA	NA	NA	NA	NA	NA	NA	NA	NA

Bold indicates that concentration exceeds either the Public Health Goal or the proposed Maximum Contaminant Level
ND - Non Detect (detection limit shown in parenthesis where data was available).
NA – No Data Available
[a] Secondary Standard - based on odor, taste, and appearance.
[b] Interim Action Level established by State of California Department of Health Services
[c] Proposed MCL
[d] Action Level
[e] Constituent concentrations presented for the Lancaster subbasin are based on water quality data from Well Nos. 2A, 3A, 4A, 6A, 7A, 8A, 10, 11A, 14A, 15, 23A, and 24
[f] Constituent concentrations presented for the Pearland subbasin are based on water quality data from Well Nos. 16, 20, 21, 22, 25, 26, 30, 32, 33, and 35
[g] Constituent concentrations presented for the San Andreas subbasin are based on water quality data from Well Nos. 5, 18, and 19
[h] Under the interim Enhanced Surface Water Treatment Rule, turbidity must be less than 0.3 NTU in 95% of samples collected in a month, never to exceed 1 NTU. Applies to surface water and groundwater under the influence of surface water systems
[i] PHGs are established to be protective of public health. PHGs are analogous to MCLs in that they are based solely on health effects, while MCLs consider technology and economics.

Pearland Subbasin. Water quality analyses were performed on the following well from the Pearland Subbasin: 16, 20, 21, 22, 25, 26, 30, 32, 33 and 35. Analyses of water samples collected from wells in the Pearland subbasin indicate that the overall groundwater quality meets all current EPA and CDHS drinking water quality standards. The average reported radon concentration is three of nine wells is above the proposed MCL of 300 pCi/L, with the average radon concentration at 334 pCi/L. Radon is a naturally occurring constituent from the geology of the region. See Appendix B on Water Quality Regulations for information about the proposed alternate MCL. The average total dissolved solids (TDS) concentration for the Pearland Subbasin is 193 mg/L. Historic water quality data, including data contained in the 1996 Master Plan, indicate that mineral concentrations have remained generally similar over the years with no evident deterioration in water quality over time.

San Andreas Rift Zone. Based upon samples of three wells along the San Andreas Fault (Wells 5, 18, and 19), groundwater in the rift zone has variable mineral characteristics; however, the overall groundwater quality meets current EPA and CDHS drinking water standards. Only Well No. 5 has a radon concentration above the proposed MCL of 300 pCi/L. The most notable characteristic of the rift zone's groundwater quality is the higher concentration of TDS. The average TDS concentration for the San Andreas Rift Zone is 319 mg/L. However, the maximum measured TDS concentration of 445 mg/L remains below the secondary standard of 500 mg/l established by CDHS.

Costs of Groundwater

Energy costs for pumping groundwater are listed in **Table 4-4**. As shown, the capacity weighted average cost for pumping groundwater is $71.02 per acre-ft. In addition, sodium hypochlorite is generated from salt at each well head to provide hypochlorite disinfection of the groundwater. The average disinfection cost, based on a 1 ppm dose, is $1.3 per acre-ft. Thus, the unit cost of producing groundwater totals $72.32 per acre-ft.

STATE WATER PROJECT

The California SWP was initiated by the State legislature in 1959 and was ratified by the state's voters in the 1960 general election when they approved the California Water Resources Development and Bond Act; more commonly known as the Burns-Porter Act. These measures provided for construction of facilities to collect and store runoff from northern California, and a system of aqueducts to deliver this water to areas of water shortage throughout the state. The SWP is operated and maintained by the CDWR.

Entitlement for SWP

Thirty water supply agencies in California signed contracts with the state for deliveries of SWP water in the early 1960s. Since that time, one of the original contractors sold its entitlement. The remaining 29 contractors have entitlements for delivery of 4.23 million acre-ft/yr through the year 2035. The District is one of those contracting agencies. The first stage facilities of the state project, including the aqueduct which passes through the District service area, were completed in 1972. The District has been able to take delivery of SWP water since 1985. Prior to the year

2000, the District was entitled to annual deliveries of SWP water of 17,300 acre-ft/yr. In the 1996 Master Plan, Montgomery Watson recommended that the District purchase an additional 3,100 acre-ft/yr of SWP water. Since then, the District has actually purchased an additional 4,000 acre-ft/yr on December 30, 1999. The additional entitlement was obtained from Belridge Water Storage District, whose office is located in Bakersfield, California. The District's current SWP entitlement is 21,300 acre-ft/yr.

Facilities for SWP

The initial facilities of the SWP include Oroville Dam and Lake Oroville, the Edmund G. Brown California Aqueduct, the South Bay Aqueduct, the North Bay Aqueduct, and a portion of San Luis Dam and Reservoir. Water is conveyed from the Sacramento-San Joaquin Delta through the California Aqueduct to Southern California. The aqueduct includes five pumping stations to lift water from the San Joaquin Valley over the Tehachapi Mountains. The aqueduct then splits into the West and East Branches. Water delivered to the District is conveyed through the East Branch, which has a capacity of 1,683 cfs. The District receives its entitlement deliveries from a 30 cfs connection on the East Branch near Lake Palmdale. The water is conveyed to Lake Palmdale through a 30-inch diameter pipeline and a power recovery station (currently out of service).

SWP water and Littlerock Creek water are stored in Lake Palmdale, which has a capacity of about 4,129 acre-ft and a maximum surface area of 234 acres. Evaporation from Lake Palmdale varies with the volume of stored water and can be up to 1,200 acre-ft/yr. Stored water is conveyed from the lake through a 42-inch pipeline to the District's water treatment plant. This plant was originally constructed in 1987 with a 12 mgd capacity. The conventional water treatment plant includes chemical addition, flocculation, sedimentation, filtration and disinfection. In response to the rapid growth of the late 1980s, the plant was expanded to its current 30 mgd capacity. However, the District's water supply permit from CDHS requires one filter to be kept off-line as a reserve which limits the plant capacity to 28 mgd.

Reliability of SWP

The reliability of SWP water is affected by many factors including hydrologic conditions, state and federal water quality standards, protection of endangered species, and water delivery requirements. In 1995, two actions had a significant impact on SWP reliability: the Monterey Agreement and the Water Quality Control Plan for the Bay-Delta Estuary. The components of these programs are discussed in detail in the 1996 Master Plan. Since 1996, however, the CALFED Bay Delta Program was established and will have a marked impact on SWP reliability.

CALFED Bay Delta Program

The Sacramento-San Joaquin Delta in northern California covers 738,000 acres, which include a myriad of waterways and islands. The Delta is a critical portion of the SWP water transportation system since water released from Oroville Dam must flow from north of the Delta to the export pumps in the southern portion of the Delta, causing a reversal in the normal flow direction.

To resolve conflicting needs within the Delta, the Bay-Delta Accord was signed in December 1994. The accord created the CALFED Bay Delta Program, a consortium of state and federal agencies. The mission of the CALFED Program is to develop a long-term, comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta system. The program is being conducted in three phases:

Phase I	Define Bay-Delta problems, identify actions to address the problems, and combine actions into several comprehensive solutions.
Phase II	Prepare a programmatic environmental impact document, perform technical analyses to refine the alternative plans, and develop an implementation process.
Phase III	Prepare site-specific environmental documents for the preferred alternative.

Phase I was completed in September 1996. This phase identified three alternatives listed below, each of which includes four common elements: water use efficiency, ecosystem restoration, water quality protection and levee system integrity.

Alternative 1	Existing System Conveyance. Delta channels would be maintained essentially in their existing configuration. Several improvements would be made in the south Delta.
Alternative 2	Modified Through-Delta Conveyance. Significant improvements to north Delta channels would accompany the south Delta improvements contemplated under Alternative 1.
Alternative 3	Dual-Delta Conveyance. The dual-Delta conveyance alternative is formed around a combination of modified Delta channels and a new canal or pipeline, connecting the Sacramento River in the north Delta to the SWP and CVP export facilities in the south Delta.

Essentially, delta conveyance and water storage provide the major difference between alternatives. Delta conveyance options include conveying water using the existing system of channels through the Delta, modifying the system of channels in the Delta, or constructing an isolated Delta conveyance facility. Storage options include conjunctive use/groundwater banking, North-of-Delta surface storage, In-Delta surface storage and South-of-Delta surface storage. Various storage capacities are being evaluated.

A draft Phase II report was completed and the Draft Programmatic Environmental Impact Statement/Report (PEIS/PEIR) was issued in March 1998. During a 105-day public review period, several thousand comments were received on the PEIS/PEIR. A revised Phase II Report was issued in December 1998. The preferred alternative incorporates elements similar to some of the elements in Alternatives 1 and 2. While the preferred alternative includes a diversion facility on the Sacramento River and channel to the Mokelumne River, the size of the facility would be considerably smaller than that proposed in Alternative 2. If, after additional analysis, the diversion facility is not constructed, the preferred alternative would be most similar to Alternative 1. All in all, the preferred alternative includes long-term levee protection, water quality protection, ecosystem restoration, water use efficiency, water transfers, watershed management, storage and Delta conveyance elements. At this point in time, the preferred alternative is programmatic in nature, defining broad approaches to meet CALFED purposes. The alternative does not yet define site-specific actions that will be implemented. The eight program elements (ecosystem restoration, water quality, levee system integrity, water use efficiency, water transfer, watershed, storage, and conveyance) will continue to be refined in the future and will be implemented in stages. A revised Draft PEIS/PEIR was released for a 90-day public review on June 25, 1999. The Final PEIS/PEIR was issued on July 21, 2000.

The Programmatic Record of Decision (PROD) was issued on August 28, 2000, and the CALFED agencies have commenced implementation of the Preferred Program. The PROD indicates implementation will take 30 years or more. Initially, the CALFED program will focus on Stage 1, which is the first seven years of implementation. The Delta solution implemented by CALFED will have an effect on SWP supply reliability for Palmdale Water District.

DWRSIM Modeling

The CDWR utilizes a computer model called DWRSIM to simulate operation of the SWP. The model operates the SWP on a monthly basis, using the actual hydrology from 1922 through 1994. The output of the model provides an estimate of annual quantities of water that could be available to meet SWP entitlement requests based upon operational studies. The model takes into account many variables and assumptions such as minimum Delta outflow requirements, facility improvements, and pumping operation at the Delta export pumps. The most significant factors that affect the SWP supply estimates are the future demand, Delta environmental requirements, and SWP facilities. Assumptions common to all DWRSIM model runs are shown in **Table 4-6**.

Montgomery Watson reviewed recent DWRSIM model runs to estimate the future reliability of SWP water for the District (CDWR, 1999). These simulation runs are preliminary and assumptions are continually changing to reflect technical and modeling improvements. However, the current runs are considered technically adequate for the CALFED conveyance/storage refinement process. Our analysis is based on DWRSIM model runs 771 and 786. These runs represent current and future demand, for SWP water without CALFED improvements. Assumptions related to each run are summarized in **Table 4-7**.

Table 4-6
Assumptions Common to All DWRSIM Model Runs

- 1995 Water Quality Control Plan (WQCP) Bay-Delta Accord Standards. No minimum flows at Vernalis, including the pulse flows, are imposed. Instead, alternative flow and export requirements are imposed as discussed under Central Valley Project Improvement Act (CVPIA) (b)(2) Delta Action 1.
- The following Anadromous Fish Restoration Program (AFRP) CVPIA(b)(2) Actions as per November 20, 1997 AFRP Document, are included.
    - AFRP Upstream Flows
        - Clear Creek
        - Keswick
        - Nimbus
    - AFRP Delta Actions
        - Delta Action 1 - Vernalis Adaptive Management Plan Flows (VAMP) and export reduction.
        - Delta Action 3 - Additional X2 days at Chipps Island from March to June.
        - Delta Action 4 - Maintain Sacramento River flows at Freeport from 9,000 to 15,000 cfs.
        - Delta Action 5 - Ramping of Delta Exports during May.
        - Delta Action 6 - Close Delta Cross Channel gates in October through January in all water year types.
        - Delta Action 7 - July flows and exports based on X2 position in June.
- Stanislaus River operations have changed with the New Melones Interim Operation Plan. Tuolumne minimum pulse flow requirements per Federal Energy Regulatory Commission (FERC) Agreement, have been coincided with VAMP flows during the April and May pulse period.

Table 4-7
Assumptions for DWRSIM Model Runs 771 and 786

Criteria	Model Run 771	Model Run 786
Conditions	Existing	No Action
Level of Hydrology[3]	1995	2020
Level of Water Demand	1995[1]	2020[2]
Wheeling for Central Valley Project	None	128 TAF/year
Trinity River Minimum Fish Flows Below Lewiston Dam	340 TAF/year	--
Water Management Criteria	Low	High

1 South of Delta SWP Demand varies from 2,644 to 3,529 TAF/year; Maximum SWP Interruptible Demand is 84 TAF/month; South of Delta CVP demand including Level II Refuge demand of 288 TAF/year is 3,433 TAF/year.

2 South of Delta SWP Demand varies from 3.6 to 4.2 MAF/year. Maximum SWP Interruptible Demand is 134 TAF/month; South of Delta CVP demand is 3.5 MAF/year including Level II Refuge demand of 288 TAF/year; New EBMUD American River Diversion as a Supplemental Water supply of 115 TAF/year is not included.

3 Includes new American River Water Forum demands.

Overall, model run 771 represents existing system conditions, 1995 levels of hydrology and demand, and low water management criteria. Model run 786 represents 2020 levels of hydrology and demand, existing conditions, no action, and high water management criteria. The most significant difference between these two runs is variable supply and demand years as well as the allowable wheeling for the Central Valley Project.

Evaluation of these runs facilitates a comparison between 1995 and 2020 SWP reliability for the District. These runs represent the most conservative estimate of SWP reliability as they are based on the existing facilities only. For the evaluation, the total deliveries were scaled up by 22 percent to account for the additional 4,000 acre-ft/yr entitlement purchased by the District. This scaling was necessary because the DWRSIM model runs are based on 1995 entitlements (17,300 acre-ft/yr was rounded up to 18,000 acre-ft/yr) and did not account for the additional 4,000 acre-ft/yr entitlement purchased by the District.

Figure 4-5 shows the reliability of the SWP existing facilities for both 1995 and 2020 demand. This figure indicates that the District can expect to receive delivery of its full SWP water entitlement about 61 percent of the time at 1995 demand levels. However, at year 2020 demand levels, the District would receive its full entitlement only about 54 percent of the time. Without construction of additional facilities, the reliability of the SWP supply will decrease in the future as water use increases in the areas of origin and demands for SWP water increases.

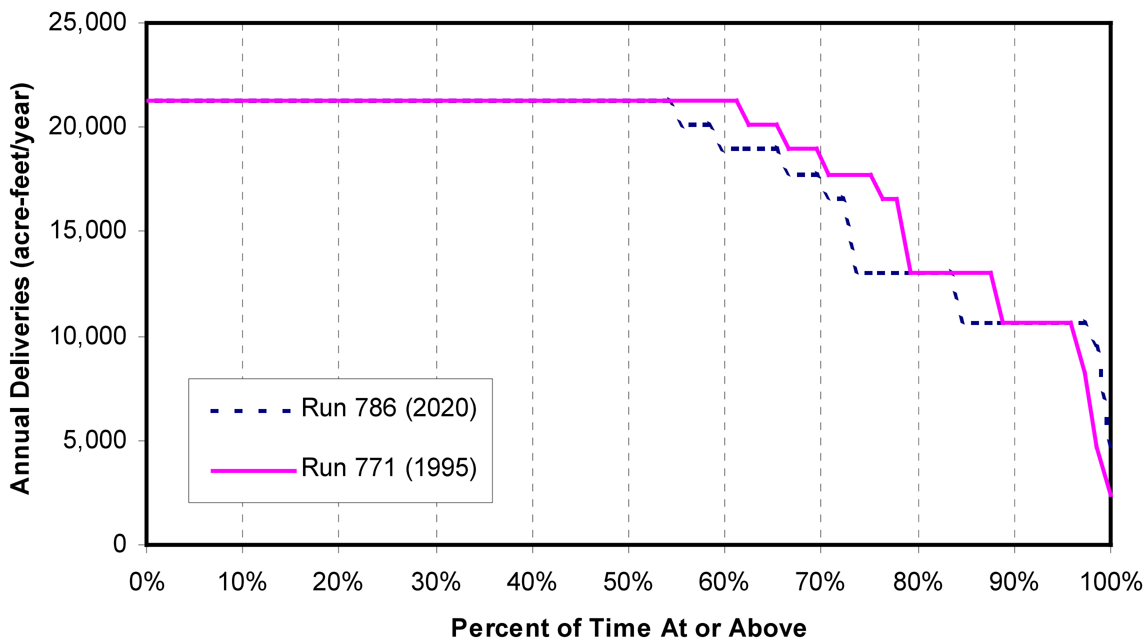


Figure 4-5
SWP Annual Supply Reliability

The District, along with AVEK and LCID, formed the Antelope Valley State Water Contractor's Association to provide a forum for communication and cooperation on water issues in the

Antelope Valley, particularly as it pertains to SWP water. Each agency has capacity rights in the East Branch of the California Aqueduct, which traverses the Antelope Valley, and have combined entitlements totaling 162,000 acre-ft/yr.

State Water Project Water Quality

Water quality data sampled in January 2000 from the aqueduct is summarized in **Table 4-8**. The table shows no objectionable water quality characteristics. Water quality regulations, current as of March 2001, are discussed in Appendix B. Historically, the turbidity of SWP water is widely variable, ranging from less than 1 NTU to over 50 NTU, and averaging about 20 NTU. These variations are largely seasonal, with extreme peaks following storms in northern California and dust storms along the California Aqueduct.

Table 4-8
State Water Project Water Quality
(Single Sample Taken in January, 2000)

Constituent	mg/l	Constituent	Mg/l
Chemical Parameters			
Cations		Anions	
Calcium	46.1	Sulfate	63
Magnesium	18.6	Chloride	145
Sodium	84.7	Nitrate	4.7
Potassium	3.9	Perchlorate	ND
Manganese	ND		
Fluoride	ND		
Iron	0.12		
Physical Parameters			
Total Hardness as $CaCO_3$	198	Specific Conductance	765 µmho/cm
Total Alkalinity as $CaCO_3$	92	Odor	1 TON
Total Dissolved Solids	421	Color	10 Units
pH	8.5 units	Turbidity	1.9 NTU
Radioactivity			
Gross Alpha	2.2 pCi/l		

SWP water blends with inflow from Littlerock Creek in Lake Palmdale and is subsequently treated at the Palmdale Water Treatment Plant. Through conventional treatment processes including coagulation, sedimentation, filtration and disinfection, the treatment plant produces water that meets all water quality regulations. The highest single turbidity measurement in the treatment plant effluent for 1999 is 0.2 NTU, which is far below the turbidity performance standards. The long detention time of Lake Palmdale, combined with normal coagulation and filtration required for removal of turbidity, reduce concentrations of asbestos fibers found in the raw SWP water to negligible levels. In addition, no instances of *Giardia* or *Cryptosprodium* were found in the treatment plant effluent.

This high quality treated water is conveyed to customers through the potable water distribution system. In some locations, the treated water is blended with disinfected groundwater. There are a number of regulations that control water quality at the customer location. Based on 1999 data, the District is not in violation of any existing limits. Total coliform, lead and copper are all below action levels or criteria. Sulfate is also far below the proposed criteria. One potential concern is EPA's proposed Stage 2 Disinfectant/Disinfection By-Product (D/DBP) Rule, which modifies the methodology THM and HAA levels are calculated. The District is in compliance with the Stage 1 D/DBP Rule set to take effect in 2001, but there are a few corners of the system where THM levels may be above proposed criteria set in the Stage 2 D/DBP Rule. Continued monitoring of the regulation is recommended.

Costs of SWP

The cost of producing treated water from the SWP supply includes the cost of SWP charged by CDWR, the costs of Palmdale Water Treatment Plant and operation and maintenance of the associated facilities. Annual assessments levied by CDWR are composed of the items listed in **Table 4-9**. The District is annually assessed its share of fixed costs of the SWP and payments must be made to the state each year for capital and minimum operation and maintenance cost components, whether or not any water is delivered. The unit cost calculated is based on the District's full entitlement of 21,300 acre-ft/yr. The unit cost of treatment is based on the District's actual cost from 1999. As shown in the table, the unit cost of SWP water including treatment is approximately $287 per acre-ft.

Table 4-9
State Water Project Costs

Component	2001 Charge
Water System Revenue Bond Surcharge	$224,462
Capital Cost – Delta Water Charge	$196,282
Capital Cost – Transportation Charge	$327,738
Min OMP&R – Delta Water Charge	$262,191
Min OMP&R – Transportation Charge	$595,727
Variable OMP&R – Transportation Charge	$1,762,159
Min OMP&R – Off-Aqueduct Power Facilities	$860,334
Capital Cost – East Branch Enlargement	($5,187)
Min OMP&R – East Branch Enlargement	$12
Total Charge by CDWR	$4,223,718
Full Entitlement (acre-ft/yr)	$21,300
PWD 1999 Treatment Cost per Acre-feet	$89
Total Unit Cost per Acre-Feet	**$ 287**

Notes: With the exception of treatment cost, the costs shown were obtained from the CDWR Statement of Charges for 2001 for Palmdale Water District. The unit treatment cost was provided by the District based on actual costs from 1999.

SUMMARY OF EXISTING SOURCES

As detailed above, the District draws upon three sources of water to serve its customers: Littlerock Creek, the State Water Project and local groundwater. The reliability of each water source is summarized below in **Table 4-10**.

Table 4-10
Summary of Existing Sources and Reliability
(Probability of Occurrence)

Water Sources	Available Supply (acre-ft)		
	at 50% of the time	at 95% of the time	at 100% of the time
Littlerock Creek	5,982 (1)	1,555	1,072
State Water Project (2)	21,300	10,650	4,730
Groundwater (3)	varies	Varies	varies

Notes:
(1) Water rights from Littlerock Creek watershed is limited to 5,500 acre-ft/yr.
(2) Using Run 786, See SWP discussion above for more details
(3) Groundwater Basin currently in overdraft conditions. Reliability of supply to PWD depends partially on actions of other pumpers.

The supply reliability is presented as the probable minimum supply quantities that can be expected at the selected probability of occurrences of 50 percent, 95 percent and 100 percent of the time. Reliability factors for groundwater are not included since the basin is not adjudicated and groundwater availability is effected by actions of other pumpers in the basin. In addition, the topic of safe yield and basin overdraft affects may require additional studies. Historically from 1972 to 1999, the District has pumped annual groundwater quantities as low as 4,592 acre-ft/yr to as high as 11,648 acre-ft/yr.

In addition to the probability of occurrence, the supply reliability analysis can also be presented as a function of weather. **Table 4-11** shows the available supply anticipated under three conditions as described below:

- **Average Year:** This represents annual water supply in years with average weather conditions. The supply quantities shown are average yields for each supply source derived from models based on historical hydrology.
- **Three Consecutive Dry Years:** This represents annual water supply averaged over three consecutive dry years. The supply quantities shown are the three-year running averages derived from models based on historical hydrology. Since the SWP water originates from Northern California while the Littlerock Creek is a local water source, the minimum yields due to drought conditions for the two sources have not historically occurred simultaneously. Thus, the three consecutive dry year yields have been presented in two ways. Method 1 shows the result of evaluating each source independently. Method 2 shows the occurrence of minimum three-year average total surface supply and reports the contribution of each source to that minimum.

- **Single Driest Year:** Similar to the scenario above, the driest year for the two surface water sources have historically not occurred simultaneously. Thus, the one driest year yields have been presented as both the result of independent source evaluation (labeled as Method 1 in the table) as well as the result of aggregate surface water source evaluation (labeled as Method 2 in the table). The yields are derived from models based on historical hydrology.

With the SWP water comprising a greater portion of the District's total surface water supply compared to Littlerock Creek water, a dry year in Northern California that decreases SWP supplies can have greater impacts on the District than a dry year that impacts only the Littlerock Creek supply. This is evident from the one driest year analysis. The driest year for Littlerock Creek occurs with the historical hydrology from 1951, which results in a modeled yield of only 310 acre-ft from Littlerock Creek. However, the same year hydrology yields 21,300 acre-ft from SWP for a total surface water supply of 21,610 acre-ft. In contrast, the driest year for SWP delivery occurs with the historical hydrology from 1977, which results in a modeled yield of only 4,733 acre-ft from SWP. Despite the 4,760 acre-ft yield from Littlerock Creek for that same hydrology year, the total surface water supply for the District is at a low 9,494 acre-ft.

Since the minimal yield of the two water sources do not coincide and the minimal SWP yields have greater impact on the District than local droughts in the Antelope Valley, the demand and supply analysis from this point on will define dry years as the occurrence of minimal total surface water supply (Method 2 in Table 4-11).

Table 4-11
Summary of Existing Sources and Reliability
(Function of Average or Dry Years)

Water Sources	**Available Supply (acre-ft)**				
	Average Year	3 Consecutive Dry Years		1 Driest Year	
	------	Method 1	Method 2	Method 1	Method 2
Littlerock Creek	4,405	2,217	2,919	310	4,760
State Water Project (1)	18,060	11,044	11,044	4,733	4,733
Total Surface Supply	-----	-----	13,963	-----	9,493
Groundwater (2)	varies	varies	Varies	varies	varies

Notes:

Method 1 derived from evaluation of each source independently. Method 2 based on occurrence of minimal total surface supply and reports the contribution of each source to that total.

(1) Using Run 786, See SWP discussion above for more details

(2) Groundwater Basin currently in overdraft conditions. Reliability of supply to PWD depends partially on actions of other pumpers.

Section 5
Comparison of Water Demand and Supply

This section compares the current and projected water production requirements (referred to as "water demand" in this section) to the existing water supplies to evaluate the adequacy of existing supplies to meet future demands. Where existing water supplies can not meet anticipated demands, alternatives for balancing the water demand and supply situation are discussed.

WATER DEMANDS AND EXISTING WATER SUPPLIES

The water demands projected for 2000, 2010 and 2020 developed in Section 3 of this report are listed in **Table 5-1** along with the availability of existing water supplies developed in Section 4 of this report.

Table 5-1
Demand vs. Existing Surface Water Supply

	Supply and Demand Requirements (acre-ft/yr)								
	Average Year			3 Consecutive Dry Years			1 Driest Year		
Year	2000	2010	2020	2000	2010	2020	2000	2010	2020
Demand PWD	24,000	32,400	44,100	26,600	35,900	48,800	26,600	35,900	48,800
Demand LCID	1,000	1,000	1,000	730	730	730	1,000	1,000	1,000
Lake Palmdale Evaporation	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Total Demand	26,200	34,600	46,300	28,530	37,830	50,730	28,800	38,100	51,000
Littlerock Creek	4,405	4,405	4,405	2,919	2,919	2,919	4,760	4,760	4,760
State Water Project	18,060	18,060	18,060	11,044	11,044	11,044	4,733	4,733	4,733
Total Surface Water Sources	22,465	22,465	22,465	13,963	13,963	13,963	9,493	9,493	9,493
Supply Deficit to be made up by Groundwater or Other Sources	(3,735)	(12,135)	(23,835)	(14,567)	(23,867)	(36,767)	(19,307)	(28,607)	(41,507)

Note: 3 Consecutive Dry Years and 1 Driest Year based on lowest total surface water supply.

The average year demands shown for the District are projected average annual demands (also referred to as normal demands) discussed previously in Section 3 of this report. The dry year demands shown for the District are above-normal demands as calculated in Section 3. The demand shown for LCID is based on the terms of the agreement between the District and LCID. When Littlerock Creek yield is above 4,000 acre-feet, LCID is entitled to 1,000 acre-feet per year. When Littlerock Creek yield falls below 4,000 acre-feet, the LCID entitlement drops to 25 percent of the Littlerock Creek yield. The "demand" taken by evaporation from Lake Palmdale is assumed to remain at 1,200 acre-ft/yr.

The supply availability shown in the table above is derived from Section 4 of this report. Average year supplies represent average modeled yield from Littlerock Creek and SWP using historical hydrology. Dry year supplies represent the contribution of each source to the occurrence of minimum total surface water yield as projected by models based on historical hydrology.

The difference between total water demand and available water supply from Littlerock Creek and SWP is presented as the amount of supply required from groundwater or other new sources of supply in order to meet demands. The District's historical groundwater production between 1972 and 1999 has ranged from 4,592 to 11,648 acre-ft/yr. If groundwater production is limited to this historical range, the District can meet existing demands with existing sources during average weather conditions, but by 2010 demand levels, groundwater extraction would have to exceed the current historical maximum rate to meet the greater demands. However, during dry year conditions for current (year 2000) and future demand levels, groundwater production far exceeding the historical maximum of 11,648 acre-ft/yr will likely be required in order to meet projected demands without new water supply sources (See **Table 5-2**). Given the current overdraft condition of the groundwater basin, continued pumping at elevated quantities without active recharge will not be a sustainable solution for the region. Thus, development of additional water sources or conservation measures will be necessary in order to meet projected future demands.

Table 5-2
Demand vs. Existing Surface Water Supply and Historical Maximum Groundwater Extraction

	Supply and Demand Requirements (acre-ft/yr)								
	Average Year			3 Consecutive Dry Years			1 Driest Year		
Year	2000	2010	2020	2000	2010	2020	2000	2010	2020
Demand PWD	24,000	32,400	44,100	26,600	35,900	48,800	26,600	35,900	48,800
Demand LCID	1,000	1,000	1,000	730	730	730	1,000	1,000	1,000
Lake Palmdale Evaporation	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Total Demand	26,200	34,600	46,300	28,530	37,830	50,730	28,800	38,100	51,000
Littlerock Creek	4,405	4,405	4,405	2,919	2,919	2,919	4,760	4,760	4,760
State Water Project	18,060	18,060	18,060	11,044	11,044	11,044	4,733	4,733	4,733
Total Surface Water Sources	22,465	22,465	22,465	13,963	13,963	13,963	9,493	9,493	9,493
Supply Deficit to be made up by Groundwater or Other Sources	(3,735)	(12,135)	(23,835)	(14,567)	(23,867)	(36,767)	(19,307)	(28,607)	(41,507)
Groundwater Extraction @ Historical Max Rate	11,648	11,648	11,648	11,648	11,648	11,648	11,648	11,648	11,648
Supply Surplus / (Deficit)	7,913	(487)	(12,187)	(2,919)	(12,219)	(25,119)	(7,659)	(16,959)	(29,859)

FUTURE WATER SOURCES

To balance the supply deficit anticipated for average weather years at future demand levels and for dry weather conditions at current and future demand levels, a number of alternatives are available to the District. Some of these alternatives may be short-term solutions to meet demands in a given dry year while others may be long term solutions to ensure water supply adequacy for the District's customers. A combination of these alternatives will likely be required as water demands continue to grow for the District.

Increase Groundwater Production

One alternative to balance the water deficit is to increase groundwater production as demands increase. Historically, the District has supplied approximately 40 percent of demand with groundwater. The District may choose to continue this ratio and increase groundwater pumping as demand increases. Groundwater would be pumped to meet the 40 percent ratio during average weather conditions. This level of groundwater pumping will be referred to as "base level" pumping in subsequent discussions. As base level pumping increases with increasing demand, additional wells will have to be constructed.

During dry years when surface water supplies are low, additional groundwater extraction above 40 percent of demand may be required to meet total demand. This additional extraction above the base level pumping should be short-termed events. Once enough surface water is available to supply 60 percent of demand, groundwater pumping should be reduced back to the base level of 40 percent of demand.

Although increasing groundwater extraction is necessary to meet projected demands, it is important to note that the groundwater basin is in overdraft and coordination of pumping activities with other users in the basin will be required to maintain the long term productivity of the groundwater supply.

Water Rationing

A portion of the water deficit during dry years may be balanced by rationing water to the consumers. This alternative is a short-term solution that could be used in cases of severe water shortages. During prolonged dry weather conditions, such as three consecutive years of dry weather, rationing of water to decrease demand by 10 percent may be implemented. In a very severe water shortage year, water rationing to decrease demand by as much as 20 percent may be implemented. Water rationing can be disruptive to customers and should not be utilized unless there are severe water shortages.

Water Conservation

Voluntary or enforced water conservation measures such as water use education and low flow plumbing fixtures may help decrease water demands. Retrofitting older homes with new low flow plumbing fixtures will decrease indoor water use while encouraging low water requirement landscapes may decrease residential outdoor water use. The District currently has a number of conservation programs in place and is considering a host of additional programs.

General Education. The District produces a yearly "Water Awareness Program" brochure that is sent out to every teacher in the Palmdale School District. This brochure outlines the District's up-coming contests and events for the year. The water awareness program is intended to develop an awareness of water conservation and protection of a valuable resource that will carry over into adult life. A more immediate benefit occurs when the child takes home what has been learned and is instrumental in reducing water use in the home. The school program provides for tours of the District's treatment plant and Littlerock Dam, staff presentations on conservation and the environment, contests and curriculum materials.

The District has successfully used its mascot, "Aquadog", in promoting public water awareness. Aquadog has been visible for the last four years in many school functions and community events. Aquadog has his own music so when a public service announcement is placed on TV for water conservation his message gets through to all. Aquadog has been in the two videos the District has produced for water education and conservation.

Over the past five years, the District has sponsored a poster and jingle contest or a poster and story contest for grades three through seven. In the year 2000, the District also included a coloring contest of Aquadog for kindergarten through second grade. The theme for the contests are designed to educate and bring water awareness to the forefront especially in the month of May, which is Water Awareness Month. Winning entries are displayed at the District's Water Awareness Fair in May and other District functions.

In 1998 and 1999, the Water Education Foundation was invited to the District to provide a workshop on California Water for teachers in the Palmdale School District. Extra education packets are bought and distributed to teachers that participate in the District's poster and jingle contests. The District has formed a good relationship with the teachers and parents to provide information and materials for projects on request.

Brochures outlining water conservation measures are available at the District's public counter and by mail upon request. The District mails a quarterly newsletter to its customers entitled Water News which includes tips for water conservation and a water tolerant flower of the quarter. In the year 2000, the PWD started giving welcome packets to all new customers. Each packet includes information on water conservation and other conservation items the District has purchased for water awareness.

Community Events. The District currently has a five-member water awareness committee. The Committee's Mission Statement was approved on September 22, 1997 and reads as follows, "*To provide Education and public Awareness on water conservation and the Environment*." The District's Water Awareness Committee finds sponsors to help finance many events and it also invites small water districts nearby to join in the festivities. In 1999, other water agencies' sponsorships and 10 percent of the sponsorship money went to buy water conservation books for the youth library in Palmdale. The District was able to buy more than $2,000 worth of books for the youth library on water conservation and the environment. In the year 2000, 10 percent of the sponsorship money plus money received from other water districts will be used to build a portable kiosk for the library books so that schools may check out the kiosk for a week at a time when they are studying water issues.

In 1997, the District sponsored its first Annual Water Awareness Fair. The Fair is designed to educate children and adults about water and the environment in a fun and entertaining way. The Fair has been a great success for the last few years in education as well as public information

Since 1995, the District has participated in the California Water Awareness Campaign, sponsored by the Association of California Water Agencies (ACWA). The campaign advisory committee has several subcommittees, of which the District has served on the education and public relations/marketing committees each year. Through the campaign and participation in public functions, the District has expanded public awareness of the importance of water conservation, which has resulted in an increase in requests for pamphlets and information on methods of water conservation.

Public awareness of water conservation is further augmented by the District's participation in several community functions including: the City of Palmdale Fall Festival, the Antelope Valley Home and Garden Show and Fair, the ACWA Conference Educational Display Booth, the Jones Intercable Joshua Jones 500, the Antelope Valley Airport's the Santa Fly-in and the City of Palmdale Chamber Christmas Parade.

Large User Programs. Water conservation information programs targeted to specific large users can have significant results. Special efforts are made to work with local government offices to encourage them to set an example for the community. The Palmdale City Council adopted an environmental resolution in 1993 to protect the quality and quantity of local water resources. The District performs individual water audits, consultations, provides brochures, and retrofit devices for larger water users. In 1993, the City of Palmdale passed a Water Efficient Landscape Ordinance implementing water use standards for new commercial and industrial landscapes. These standards include low water use plants, requirements for re-circulating fountains, and efficiency standards for irrigation systems. Individual consultations with existing large water users and the public education program are utilized to reduce water use at large landscape areas.

The above water awareness, education and conservation programs may help decrease per capita and per acreage water demand in the future. It is difficult to quantify exact amounts of demand reduction as a result of education and awareness programs. Some quantification may be done with conservation programs such as appliance retrofits. The California Urban Water Conservation Council developed a list of 14 comprehensive conservation Best Management Practices (BMPs) and projected water savings of approximately 10 percent to 15 percent for those BMP's which could be quantified. If the District continues with current conservation efforts and aggressively pursues additional conservation means as demands grow in the region, it may be possible for the District to achieve 10 percent decrease in demand by 2010 demand levels and 15 percent decrease in demand by 2020 demand levels.

Purchase Additional SWP Entitlement

Purchasing of additional SWP entitlement may balance the water deficit during average years when adequate supply is available for the District to take water close to its entitled amount. In dry years, however, the quantity of SWP available will still be limited regardless of the full entitlement amount. The Monterey Agreement developed by the SWP Contractors and CDWR in 1995 has been the vehicle through which permanent entitlement transfers took place on a willing buyer-willing seller basis. In September 2000, the appellate court ruled that the EIR on the agreement was inadequate. DWR has filed an appeal with the Supreme Court. With the legal issues surrounding this primary vehicle for recent entitlement transfers, the prospects of future permanent transfers, whether under this agreement or under the original terms of the SWP contract, are more uncertain. Despite the uncertainty, the District should continue to monitor opportunities for additional entitlement purchase, since local water supplies are limited and can not, by itself, sustain continued demand growth.

In addition to additional permanent entitlement to augment average year water supply, the District could also purchase water from the SWP Turnback Pool when it is available. However, this is not a reliable long-term supply. It can potentially be used to offset groundwater pumping during localized droughts when local runoff and recharge are limited.

Water Transfers

Water transfers involve the sale or exchange of water or water rights among individuals or agencies. Water transfers provide the ability to obtain water from imported sources when needed in times of drought and to gain access to water that would not ordinarily be available. Core transfers could be used in conjunction with local groundwater storage to provide increased supplies during drought periods. However, water transfer agreements may involve potential reallocation of supplies during a drought emergency, potential political resistance to transfer agreements, and potential adverse impacts associated with increased Delta transfers especially if originating north of the Delta. Water transfers currently require a significant amount of institutional negotiation to satisfy all affected agencies.

Enhanced Littlerock Creek Yield

The evaluation of yield from Littlerock Creek indicates there is potential to increase the yield from this source. To maximize benefit from increased yields, however, the District would have to first secure additional water rights to this source. Once rights are secured, one potential measure for increasing yield is the removal of accumulated silt from behind the dam. Removal of the silt would increase storage capacity from about 3,500 acre-ft to about 5,300 acre-ft. This increased volume would allow the District to capture additional yield and increase its average supply from this source. The effectiveness of this option can not be evaluated until a revised area-capacity curve representing the de-silted reservoir is generated. Another potential measure is to increase the capacity of the Ditch to convey greater flows. However, this measure may have limited effectiveness since the storage capacity in Lake Palmdale is limited.

Groundwater Recharge

As steps towards maintaining the sustainability of the groundwater basin as a reliable water source, the District should investigate direct recharge opportunities to aid groundwater basin recovery from continual pumping. Potential sources for recharging groundwater basins include imported water, local runoff and reclaimed water. Opportunities for purchasing imported water for active recharge include the SWP Turnback Pool and Interruptible (surplus) SWP supplies. Opportunity for recharging local runoff include in-stream ponding for recharge in Littlerock Creek. Although flows downstream of Littlerock Dam currently recharges the Pearland and Buttes subbasins as it flows north, active ponding closer to the dam could ensure greater recharge of the Pearland subbasin, which spills into the Lancaster subbasin, both of which basins are actively pumped by the District. By using the runoff for recharge, assuming the District secures the associated water rights, the District may be able to maintain rights to the recharged amount even under a basin adjudication scenario. For direct recharge of reclaimed water, refer to the reclaimed water paragraphs below.

As an alternative, sources to be used for direct recharge may be used in-lieu of groundwater pumping where permissible. This type of in-lieu program achieves similar results in terms of groundwater level recharge; however, the institutional and legal implications may vary greatly and would require in-depth analysis prior to implementation. In addition, the water quality effects of recharging imported or reclaimed water would require additional studies.

Water Banking

Banking water in the Antelope Valley Groundwater Basin may provide the District with a means of increasing supply reliability and securing funding for recharge projects. The CDWR has loan/grant programs that fund recharge studies and projects that provide long-term reliability for the local users and provide benefits to the Delta during constrained periods (e.g. dry years). The District may be able to negotiate for banking surplus SWP water during wet years and decreasing SWP deliveries during dry periods (thus benefiting the Delta) in exchange for funding and additional SWP reliability.

Water Reclamation

The County Sanitation District of Los Angeles County (CSDLAC), District 20 operates the Palmdale Water Resources Plant (WRP) located on 30th Street East, southeast of the Palmdale Airport. It is a secondary treatment facility with a capacity of 15 mgd and is currently treating approximately 8.3 mgd. Most of the effluent is discharged to percolation/evaporation ponds located on airport land. A small percentage is used for irrigation on the airport property. The Antelope Valley Water Resource Study completed in November 1995 examined the potential use of reclaimed water for irrigation purposes and identified within the District's service area a demand of 1,815 acre-ft/yr, of which about half is demand for secondary treated effluent and the other half requiring tertiary treatment. The Reclamation Concept and Feasibility Study prepared in 1997 further evaluated potential irrigation uses within the City of Palmdale. The Palmdale Water Reclamation Concept Study (June 2000) examined reclaimed water uses other than irrigation. This study concluded that recharging highly treated reclaimed water into groundwater basins is technically feasible and would have costs comparable to alternate water supplies. The study indicated that a total of 10 mgd recharge may be feasible. If 10 mgd is actually recharged, the District would gain 11,200 acre-ft/yr of groundwater rights through recharge. However, the WRP service area is served by both the District and Los Angeles County Waterworks Districts, District 40. Thus, the District may not receive all the effluent rights for recharge.

Conjunctive Use Approach

This approach essentially stores water for dry weather use by maximizing surface water use during wet and average weather years. Additional imported water could be purchased in wet years for groundwater recharge. During dry weather years when surface water is not available, groundwater would be pumped at a greater rate. This approach could mitigate the overdraft situation in the groundwater basin, but would lead to greater water level fluctuations. This is not an additional source of water, but a means to optimize the utilization of existing sources.

Regional Groundwater Basin Management Plan

A regional groundwater basin management plan would provide the framework for many of the supply alternatives listed above. The common plan could allow all pumpers to maximize surface water use during wet years, utilize the basin for seasonal storage, extract from the aquifers to meet dry year demands and still maintain groundwater pumping within safe yield limits. Without a common plan, the groundwater basin management efforts of each pumper would vary and may even conflict. Disputes may lead to lawsuits, which may ultimately lead to formal adjudication of the groundwater basins.

GROUNDWATER BASIN ADJUDICATION

The adjudication of groundwater rights is a process in which the rights of groundwater producers are defined by the courts. Adjudication can be accomplished through negotiation resulting in a stipulated decree or through an adversarial trial process.

State and case law have defined rights to water in an underground basin as:

- Overlying – the right to take water from the ground underneath the land for use on overlying land
- Appropriative – the right to take water that is surplus to the need of overlying users for non-overlying uses (such as exportation and municipal use)
- Prescriptive – the right to use water through the adverse taking of non-surplus water

In addition, the courts have defined rights to recover return flows from the use of imported water and to recover stored water. In order of priority, imported water return flow has the highest priority followed by overlying rights and appropriative rights. Between overlying users, their rights are of equal priority whereas between appropriators, the rule is first in time, first in right.

The Supreme Court in the Pasadena decision (1949) established the doctrine of mutual prescription where all water rights have the same priority and the amount is based on pumping during the five-year prescriptive period. In the San Fernando decision (1975), the Supreme Court restricted the application of mutual prescription and affirmed the right to recover imported water returns. The recent Supreme Court decision in the Mojave Basin adjudication (August 2000) reaffirmed the priority of overlying use over appropriative users and allowed overlying pumpers to reject "blanket" adjudications which ignored their prior rights.

These court decisions have raised many implications for groundwater extraction from the Antelope Valley basin. The *San Fernando* case essentially resulted in the division of the safe yield into two portions: "native safe yield" which is derived from precipitation over the watershed and "imported water yield" which is derived from imported water used in the basin. This approach could be applied to the Antelope Valley. Rights to the native safe yield would likely be divided between the overlying pumpers. If there were any surplus native safe yield, that water would be divided among the appropriators. Since the safe yield of the basin is on the order of 31,000 to 58,000 acre-ft/yr, it seems unlikely that any surplus native safe yield would be available for appropriation.

Since the SWP contractors (AVEK, PWD and LCID) are responsible for water importation into the valley, it is likely that they would obtain rights to the return flow of imported SWP water. In addition, the water importers would have the right to recover any imported water they store in the basin for later use. Assuming the percentages used in the *San Fernando* case, about 20 percent of the applied imported water may return to the basin for recapture. This return water would be allocated specifically to the three importing agencies in proportion to the amount of water imported.

Whether any of the appropriative rights have ripened to prescriptive rights is unknown and would likely be determined by the court.

Although the recent decisions allow the use of mutual prescription if all parties stipulate to such a judgment, recent actions by certain Antelope Valley overlying landowners to quiet title to their overlying rights may limit its use. In summary, adjudication of water rights in the Antelope Valley is likely to result in reduced groundwater rights for the municipal water agencies, possibly to only the return flows from imported water use. This would lead to increased reliance on imported water supplies to meet projected demands.

WATER DEMAND AND FUTURE WATER SOURCES

A combination of the source alternatives listed above would likely be necessary to meet the District's growing demands. The feasibility of developing each potential source is a function of numerous economical, social, political, legal and environmental factors that can change rapidly. Simultaneous pursuits of a number of potential water sources may yield the District higher probability of meeting projected demands.

One potential combination of future water sources for the District to meet projected demands is presented below. This scenario meets current and future demands during both average and dry years through a combination of the following potential sources:

- Increase Groundwater Production – Continue to set base groundwater pumping to 40 percent of demand. This is based on the current situation where the groundwater yield has not been allocated among the pumpers and each pumper may extract groundwater for beneficial uses.

- Water Conservation – 10 percent demand decrease by 2010 and 15 percent demand decrease by 2020.
- Water Rationing – 20 percent when demand reaches 2020 levels and three consecutive dry years occur; 10 percent when demand reaches 2020 levels and the one driest year occurs.
- Withdrawal of Recharged Groundwater – This is the amount of groundwater withdrawal necessary beyond the base pumping rates during dry years. To offset the additional water level drawdown associated with this additional pumping, the basin can be recharged with a combination of reclaimed water, local runoff and/or SWP water.

This scenario is illustrated in **Table 5-3** below. As shown, groundwater extraction above base pumping levels is only required during dry years. This above base level extraction ranges from 4,000 to 11,000 acre-ft/yr. If for instance reclaimed water were to be recharged during average as well as dry years, this active recharge would offset adverse groundwater level impacts caused by the additional dry year extraction.

Table 5-3
Demand vs. Future Surface Water Supply
Scenario 1

	Supply and Demand Requirements (acre-feet)								
	Average Year			3 Consecutive Dry Years			1 Driest Year		
Year	2000	2010	2020	2000	2010	2020	2000	2010	2020
Demand PWD	24,000	32,400	44,100	26,600	35,900	48,800	26,600	35,900	48,800
Demand LCID	1,000	1,000	1,000	730	730	730	1,000	1,000	1,000
Lake Palmdale Evaporation	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Total Demand	26,200	34,600	46,300	28,530	37,830	50,730	28,800	38,100	51,000
Littlerock Creek	4,405	4,405	4,405	2,919	2,919	2,919	4,760	4,760	4,760
State Water Project	18,060	18,060	18,060	11,044	11,044	11,044	4,733	4,733	4,733
Groundwater - Base Pumping @ 40% of demand	9,600	12,960	17,640	10,640	14,360	19,520	10,640	14,360	19,520
Water Rationing - 10% and 20%	0	0	0	0	0	4,880	0	0	9,760
Water Conservation - 10% and 15%	0	3,240	6,615	0	3,590	7,320	0	3,590	7,320
Total Sources	32,065	38,665	46,720	24,603	31,913	45,683	20,133	27,443	46,093
Surplus (Deficit) Subtotal	5,865	4,065	420	(3,927)	(5,917)	(5,047)	(8,667)	(10,657)	(4,907)
Withdrawal of recharged groundwater	0	0	0	4,000	6,000	5,100	9,000	11,000	5,000
Surplus (Deficit) Total	5,865	4,065	420	73	83	53	333	343	93

In the above scenario, groundwater base level pumping would exceed the historical maximum pumping rate of 11,648 acre-ft/yr by the year 2010. Dry year base level pumping may reach

19,520 acre-ft/yr by the year 2020. This level of groundwater extraction may tax the groundwater resources. One approach to mitigate some of the effects of groundwater pumping involves conjunctive use of groundwater and surfaces water resources. Surface water use would be maximized when available. Surplus water would be recharged. Groundwater would be extracted when surface water supplies are low. Using hydrologic records from 1950 to 1994 and demand levels at year 2020, a model of conjunctive use scenario was constructed. This is illustrated in **Figure 5-1**. The model is based on the same assumptions as the above scenario, however, when accounting for the surplus water during wet years, the conjunctive use approach results in the ability to meet 2020 demands without the recharge of reclaimed water. Any recharge of reclaimed water would be for the purpose of offsetting the base level groundwater pumping rather than to mitigate any extra extractions during dry years.

It is important to note that the base level groundwater pumping in the above analysis is permissible in the current non-adjudicated groundwater basin, but may be reduced if the basin becomes adjudicated. If this occurs, the District would need to secure additional water sources to meet demand. Ultimately, if the area continues to grow at rates greater than the availability of water resources, developers may be required to supply their own water source or water rights as part of their development.

RECOMMENDATIONS

Based on the evaluation of existing and future water sources, the following actions are recommended:

1. To maintain the ratio of annual groundwater to surface water use at 40:60, the District should equip already drilled wells followed by construction of new wells as demands increase.
2. The District should continue its current public awareness and education programs to promote voluntary water conservation. The District should also implement additional conservation measures such as water audits and plumbing retrofits. Many conservation measures such as landscape ordinances will require the District to work closely with the City to ensure both development and effective enforcement of such policies.
3. An investigation on enhancing yield from Littlerock Creek should be conducted. The study should include reservoir storage, conveyance capacity, water quality and water rights to optimize the District’s benefits from this source of supply.
4. Although there are some uncertainties currently associated with the Monterey Agreement, the District should continue to monitor and pursue appropriate opportunities to purchase additional SWP entitlement.
5. A detailed evaluation of banking SWP deliveries during wet years and drawing on banked supplies during periods of constrained Delta water supplies may bring to light opportunities for the District to exchange delivery flexibility for additional reliability and/or funding. The evaluation should include means for banking supplies in a non-adjudicated groundwater basin, details on recharge facilities required and impacts of flexible delivery on the District’s operations.

6. Recharge of reclaimed water from the Palmdale WRP should continue to be pursued. Currently, a portion of the effluent is lost to evaporation. By optimizing the recharge of reclaimed water, the District may be entitled to that volume in the event of a basin adjudication.
7. The District should consider a conjunctive use approach in managing its sources of supply. If a legal and/or institutional framework can be set for the District to maximize conjunctive use of surface, groundwater and reclaimed water resources with minimal risk, the approach would go a long way towards providing adequate supplies to meet future demands.
8. The District should carefully monitor potential water rights litigation in the basin and take necessary steps to protect its rights.

Section 6
Model Selection, Development and Calibration

MODEL EVALUATION

There is an abundance of network analysis software in the marketplace, each with a variety of features and capabilities. In the last master plan, a model was created using EPANET software.

H_2ONET, a hydraulic and water quality modeling software package which integrates EPANET with a database structure inside of the AutoCAD environment, was chosen as the modeling software for the existing and future water systems. Due to its power and simplicity, H_2ONET was selected as the software of choice for modeling the distribution system.

METHODOLOGY

The model methodology follows a logical progression of events including data acquisition, model construction, allocation of demands, model calibration and system evaluation. The first four events are described here and the system evaluations are presented in the Existing System and Future System sections, respectively.

Computer Program

H_2ONET version 3.1, which works with AutoCAD 2000, was used in creating the system model. The EPANET model constructed for the 1996 Water Master Plan was upgraded to H_2ONET version 3.1.

Computer Model

The hydraulic analysis model has been developed to be a detailed system model. The previous model contained all pipes greater or equal to 10-inches in diameter. In this model, all pipelines greater than or equal to 8-inches in diameter are modeled, and 6-inch diameter pipelines are modeled if they are in pipeline loops or connected to wells or storage tanks. The small hydropneumatic systems without a storage tank are modeled only by a demand node, even if there are 6 or 8-inch pipelines in the system.

Data Acquisition

Initially, available data was gathered for all of the system's physical facilities. The data came from a wide variety of sources as discussed earlier and includes pipeline locations, types, ages, sizes, and number of line breaks; tank locations, elevations, sizes, volumes, and ages; well location, depth, casing diameter, age; well pump design operating points, pump curves, operational controls, and ages; booster pump locations, operating points, pump curves, operational controls, and ages; hydropneumatic tanks locations, settings, sizes, ages; and pressure regulating valve locations, sizes, settings, ages.

Data was also gathered on production and consumption information including historical production information for annual, monthly, and daily quantities; historical consumption from meter reads for each service connection for the year 1999, land use and zoning maps of the District and other information to be used in the development of water production determinations and water demand allocations.

Model Construction

A base map was obtained from the District showing all streets and parcels in the District's primary service area. This base map, the basis of the District's GIS system, was constructed using the NAD27 datum, California State Plane Zone V coordinate system.

The District's Water Service Map (WSM) and the base map were used as the basis for identifying the location of all pipelines. The 1996 model pipe locations were moved to match the base map. All pipes and facilities in the 1996 model were checked, and some pipes and facilities were redrawn to more accurately show their locations. The additional smaller diameter and new pipelines were also added to the model. A separate pipeline is defined wherever two or more pipes intersect, and wherever a pipeline changes size. Junctions are defined at the intersections of two or more pipelines, or at the location where any pipeline changes size. Model inputs for pipelines include the pipeline length, diameter, roughness and pressure zone. The pipeline length is calculated automatically in H_2ONET. Junction input information include elevation, demand, and pressure zone.

Storage tanks are modeled as cylindrical tanks and input with their locations and pressure zones determined from the system map and their elevations, diameters, and ages as listed in the supplied tank summary report. Hydropneumatic tanks are listed in the existing facility summary and shown on the system schematic but are not included in the model.

The treatment plant Clearwell is modeled as a variable head reservoir based on the level in the tank on calibration day. This permits the tank to give as much water as the Clearwell booster pumps can pump.

Each well and well pump is modeled with a tank to represent the well and a pump coming out of the tank into the system. The wells are input with the bottom elevation as ground elevation, initial water level as depth to groundwater (pumping water level), well number and pump curve information. The depth to groundwater comes from District data for September 2000 where available, otherwise, an estimate has been developed based on the Southern California Edison (SCE) test result under conditions of typical operations. Pump curves were constructed from the most recent SCE test results, and modeled, where possible, as exponential 3-point curves. However, many of the SCE tests include only one useable data point. Under this condition, the well pump was modeled with a design point.

Booster pumps are input similar to well pumps, with the booster number and pump curve. The pump curves in the model for the Clearwell pump station came from construction submittals. All other pump curves were determined similarly to the methodology used for well pumps.

Well and booster pump controls were input using on and off times, based on the time of day controls for calibration day (September 8, 2000), where available. For wells and boosters that are not controlled by time of day controls, tank level or pressure controls were input into the model.

Pressure regulating and relief valves are input with their locations, pressure zones, valve settings and minor loss coefficients. Though both the main and bypass valves were input into the model, under certain conditions the model cannot run with both valves; therefore, the bypass valves were closed for purposes of model simulation.

The identification scheme used in the existing system model is based on type of facility. Junctions were assigned even numbers and pipes were assigned odd numbers, with no letter designation in front of the number. Tanks begin with the letter T, booster pumps with the letter B, valves with the letter V, well pumps with the letters WP and wells with the letter WT.

The future system numbering scheme is similar to the numbering scheme for the existing system, but utilizes additional number sets. Nodes are even numbered beginning with 10,000 and pipes are odd numbered beginning with 10,001. Tanks, valves and wells have identification schemes starting with the same lettering scheme as the existing system, but also have the word NEW at the end of the identification.

Elevations for the model were taken from 7.5-minute 30-meter USGS DEMs. The DEMs were adjusted to the proper coordinate system, and then ground elevations were extracted and input into the model for every junction and well. The DEMs have a published accuracy of the Root Mean Squared Error (RMSE) = 10 feet, which indicates that the overall errors may be on the order of 10 feet, but any individual point may have greater errors. In general, the DEMs are quite accurate, but contain a few scattered points that are incompatible with neighboring elevations and have the potential to lead to incorrect conclusions.

Demand Allocation

Demands are allocated based on areas of influence with respect to “demand” junctions. The existing system model is comprised of 3,161 pipes and 2,254 junctions. The distribution system arrangement and the locations of the junctions are evaluated with respect to determining which junctions would become demand junctions. Demand junctions are nodes to which a portion of the total system demand has been allocated, based on their areas of influence. Every area of the District is divided into demand polygons and each demand polygon includes one demand junction. Demand junctions are selected based on pressure zone boundaries and proximity to other junctions. The District model includes 1551 demand junctions, or approximately 69 percent of the total number of nodes. After selection of demand junctions, Thiessen polygons were created around the demand junctions, considering the pressure zone boundaries.

Consumption data for each service for year 1999 was obtained from the District, including information containing the service ID, street address, billing classification, and monthly meter reads. From the information collected, the annual consumption rate was estimated for each service connection by summing the year’s worth of monthly demands and dividing by the number of days of the year to obtain an average day consumption rate (in gpm) for that connection. For service connections without a full year's data, average demands for that type of service connection were assigned to those services. Some service connections were not counted, however, because closed accounts are expunged from the billing database. The demand for these service connections was counted later in the process when demands were scaled to production, to account for water loss. It is recommended that closed accounts be kept, rather than expunged, from the billing database.

The location of each service connection was geocoded using the street address from the billing database and street centerline information. This geocoding process electronically places the location of each service on a map. Services without normal street address information (such as most irrigation meters) were located by hand. The service connections and demand polygons were correlated, assigning each service connection to the appropriate demand polygon. The total consumption for the services within each demand polygon was summed to calculate a demand for each demand polygon. The summed demands were adjusted to total production to account for water losses, and assigned to the proper demand node in the model. The demands were then adjusted to average day production, to account for water loss and other unaccounted use. The demands were then adjusted to maximum day production by applying the factor between maximum day and average day demands. This methodology is much more accurate than previous methodologies because the actual meter reads for each service connection are taken into account, rather than approximated by population or demand.

In the model, demands for large users and irrigation meters were separated from the remaining demands, in order to assign these demands separate diurnal curves.

Future demands were allocated based on the parcels selected for development by the year 2010 as shown in **Figure 2-6** and water duty factor shown in **Table 3-5**. The total demand for each parcel (or group of parcels) was calculated based on the size of the parcel, land use classification and water duty factor. Once the future demands were determined, the demands were assigned to the closest existing demand node. For a few parcels without existing pipe in the region, additional demand nodes and pipes were added to the future model to serve those regions.

Diurnal Curve

The existing system model was created as a 24-hour extended period simulation (EPS) model. A 24-hour EPS model is one with different demands during different hours of the day, with greater demands during peak hours. Hourly summaries are determined for the treatment plant and well productions, and for the contributions to the distribution system from storage tanks. A rise in storage tank level from one hour to the next indicates that water leaves the distribution system during that hour. Volumes of water entering or leaving the system have been calculated for each of the storage tanks and added to, or subtracted from, the system total.

Diurnal curve creation is performed based on data gathered by District staff on September 8, 2000. Where available, data was obtained from the District's SCADA system, including tank levels, well and booster pump on and off times, flow meters and pressure meters. Information not available on SCADA was collected by hand. The District staff did an excellent job of collecting a large amount of information for an entire day. Information collected includes readings on tank levels every hour, booster pump status, flow and pressure every two hours, well pump status, flow and pressure every four hours and PRV settings, pressures, and flows every two hours.

Using this data, a diurnal curve was created, with factors for each hour, representing the demand for that hour compared to the average for the entire day. The diurnal curve for the entire system is shown in **Figure 6-1**. **Table 6-1** provides an hourly summary of water contributed to the system by the treatment plant, wells, and storage tanks. In addition, tables are included in the Calibration Appendix, Appendix C, providing detailed hourly backup on the water contributions to the system from tanks and wells.

The diurnal curve created is quite similar to expected demand patterns. However, there are a few recommendations, which if implemented, would provide substantial amounts of additional data. These recommendations would erase some of the uncertainty in the data collection, enhance or provide for additional diurnal curves and provide for better monitoring of system conditions.

- Connect Well No. 5 to SCADA.
- Measure inter-zone flows, especially those at booster stations.
- Calibrate flow and pressure meters regularly.

Diurnal curves were created separately for irrigation connections and non-residential large users. These diurnal curves are shown in Appendix D.

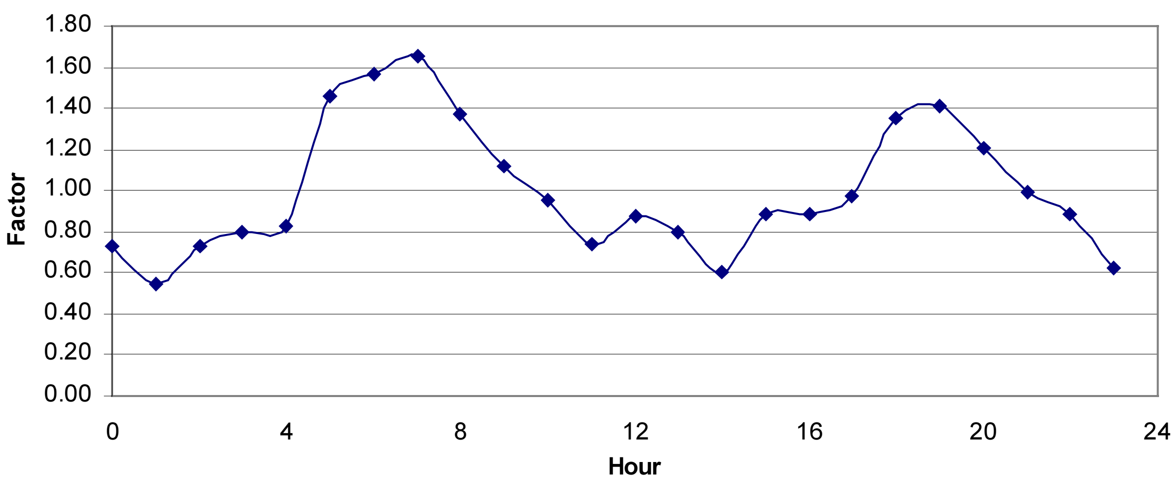


Figure 6-1
Diurnal Curve for Palmdale Water District (September 8, 2000)

Table 6-1
Calibration Day Production Summary
(September 8, 2000)

Hour	Treatment Plant Clearwell	Wells	Storage	Total
	Plant effluent rate each hour **(mgd)**	Well production rate each hour **(mgd)**	Change in tank vol. as flow rate for each hour **(mgd)**	Consumption for every hour **(mgd)**
0	21.2	14.0	-14.1	21.1
1	21.1	16.9	-22.1	15.8
2	18.6	18.0	-15.5	21.1
3	18.2	19.1	-14.5	22.9
4	21.2	18.4	-15.6	24.0
5	24.6	17.7	-0.2	42.0
6	27.0	17.3	0.8	45.2
7	26.0	17.8	3.7	**47.5**
8	24.9	17.6	-3.1	39.4
9	24.8	16.8	-9.3	32.4
10	24.7	15.6	-12.9	27.4
11	24.7	12.4	-15.6	21.4
12	24.6	7.0	-6.5	25.1
13	24.5	4.1	-5.6	23.0
14	24.4	4.3	-11.2	17.5
15	25.4	3.9	-3.7	25.6
16	15.8	4.4	5.3	25.5
17	22.5	4.7	0.7	27.9
18	15.3	3.7	19.8	38.9
19	27.2	4.2	9.2	40.5
20	27.0	5.1	2.6	34.8
21	26.9	7.0	-5.3	28.6
22	25.1	6.3	-5.8	25.5
23	21.5	7.9	-11.5	18.0

CALIBRATION

Calibration of the hydraulic model was performed based on data gathered by District staff on September 8, 2000, as described earlier in the diurnal curve section. A copy of the Control Setpoint Record (CSR) for September 8, 2000 was also received, containing the controls in effect for the well pumps and the booster pumps during the day. This report indicates if the pump is being controlled by the level in a tank, by the time of day, or by another parameter as listed in Appendix E. For calibration day, the pump and wells were controlled purely using the CSR rather than manually.

Fire hydrant tests were conducted at 17 locations throughout the distribution system on September 6 and 7, 2000. Tank levels and pump and booster on/off statuses were obtained from the SCADA system for times of the fire flow tests. Fire hydrant tests measured static pressures prior to opening a fire hydrant, and residual pressures resulting from opening an adjacent fire hydrant. The eighteen fire hydrant tests are depicted in **Table 6-2** with the hydrant location, hydrant number, static and residual pressure, actual flow, and calculated flow at 20 psi residual. In addition, the model results are shown including the model node number where the fire test was simulated and the static and residual pressures measured at the modeled node. Finally, a comparison of results is shown between the field data and the modeled data summarizing the differences between the static and residual pressures.

Two phases of calibration are conducted: 1) simulating fire hydrant flow tests to match field results, and 2) modifying the model until it mimicked the field operations on the day of calibration. Several indicators are utilized to determine if the model actually mimicked the field operations; water levels in storage tanks, pump run times when they were controlled by tank levels, and node static and residual pressures from the fire hydrant flow tests. To obtain a model that closely reflected the actual system operating conditions it became necessary to adjust some of the PRV settings and modify the pipeline roughnesses. This also acted as the "debugging" phase for the computer model where any modeling discrepancies or data input errors were discovered and corrected.

The results of the field data versus the modeled data are very good. For the fire flow tests, the model is an average of 1.6 psi (2.9 percent) lower for static pressure, 2.0 psi (3.1 percent) lower for residual pressure and the pressure drop is 0.6 psi greater compared to the field data. For the 24-hour calibration, the total for all calibration points is 2.7 percent higher in the model compared to the field data. Compared to the field data, the total production is 4.0 percent higher in the model, flows 5.0 percent higher in the model, pressures 0.6 percent higher in the model and the tanks are an average of 0.2 ft higher (0.5 percent) in the model. **Figure 6-2** shows the distribution of calibration for the various calibration points; this graph shows the average calibration slightly high, but close to zero percent off, with only a few outliers. The modeled versus field data for total production and the storage tanks are shown in Appendix F.

Possible causes for these small discrepancies between the model and field data include the following reasons:

- Fire flow tests in the model are based on flow at the nearest model node. The hydrant run and losses through the hydrant are not included in the model.
- Temporal variance in demand between various days. The diurnal curve created for calibration day was also used to determine demand at each hour for the fire flow tests. However, demands change from day to day.
- Spatial variance in demand between different times. The demand allocation spatially distributed the demand using annual average billing data. All demand nodes, except for irrigation and large users were assigned the same diurnal curve. Yet, demand varies spatially from day to day.
- There are possible inaccuracies in elevation data.
- There are possible inaccuracies in pressure and flow monitoring devices. The devices are not calibrated on a regular basis, and there is a lack of proper upstream and downstream distance for many flow meters at many wells.
- Groundwater levels fluctuate. A nominal groundwater level was used in the model, which many not accurately represent the calibration days.

Table 6-2
Fire Hydrant Test Data Comparison

Pressure Zone	WSM	Flowing Hydrant	Residual Hydrant	Date	Time	Field Testing Data				Model Data			Comparison		
						Static Pressure (psi)	Residual Pressure (psi)	Pressure Drop (psi)	Flow (gpm)	Static Pressure (psi)	Residual Pressure (psi)	Pressure Drop (psi)	Static Pressure (psi)	Residual Pressure (psi)	Pressure Drop (psi)
2800	46-66 & 48-66	Castala Dr & Janus Dr	In front of 37813 Janus Dr	9/6/00	10:30	66	57	9	2784	60	51	9	-6	-6	0
2800	50-57	Ave Q-11 & Rita St	17th St E & Ave Q-10	9/6/00	9:00	67	60	7	2882	63	60	3	-4	0	-4
2800	50-75	Monaco Ln & 52nd St E	Monaco Ln & Rivera Ct	9/6/00	10:50	62	56	6	2353	57	50	7	-5	-6	1
2800	52-60	Ave Q-4 between 27th & 28th St	27th St E & Ave Q-4	9/6/00	10:09	80	74	6	2784	75	63	12	-5	-11	6
2800	58-48	Ave P-3 & Carolside Ave	3rd St E & Ave P-3	9/6/00	9:33	63	56	7	2577	58	48	10	-5	-8	3
2850	46-75	Lupine St & Cantlewood Dr	In front of 5134 Cantlewood Dr	9/6/00	11:20	76	70	6	1210	74	69	5	-2	-1	-1
2850	48-78	Rockie Ln & Opal Ave	Rockie Ln & Madrid Ct	9/6/00	11:05	76	70	6	1267	73	68	5	-3	-2	-1
2950	36-66	Ave T-4 & Valley Spring Rd	In front of 36155 Valley Spring Dr	9/6/00	8:55	52	23	29	768.9	49	25	24	-3	2	-5
2950	42-57	Zinnia St & Upper Ct	Daisy St & Upper Ct	9/6/00	11:58	89	81	8	1353	93	86	7	4	5	-1
2950	42-78	Douglas Fir Ct & Alder St	Alder Dr & Laurel Ave	9/6/00	11:35	68	58	10	1163	67	62	5	-1	4	-5
2950	46-48	Sumac Ave & Ave R-4	Ave R-4 E & 3rd St E	9/6/00	13:31	100	88	12	3490	100	80	20	0	-8	8
3000	34-75	In front of 5238 Ave T-12	53rd St E & Ave T-12	9/7/00	9:17	53	44	9	2148	49	33	16	-4	-11	7
3000	40-63	Nickel St & Jojoba Ter	In front of 3140 Dolomite Ave	9/7/00	9:39	117	110	7	3516	110	98	12	-7	-12	5
3200	38-51	Lakepoint Ln & Cierro Crest Pl	Lakepoint Ln & Lago Lindo Rd	9/6/00	14:38	152	90	62	1353	159	103	56	7	13	-6
3200	44-42	In front of 816 W. Ave R-12	Ave R-12 & Tye Pl	9/6/00	13:47	105	74	31	1138	104	76	28	-1	2	-3
3250	36-64 & 36-66	32nd St E & Ave T-6	32nd St E & Ave T-2	9/7/00	8:40	102	55	47	1186	109	59	50	7	4	3
3400	38-42	Camares Dr & Ave S-14	Camares Dr & Barrel Springs Rd	9/6/00	14:15	87	71	16	503.4	88	72	16	1	1	0

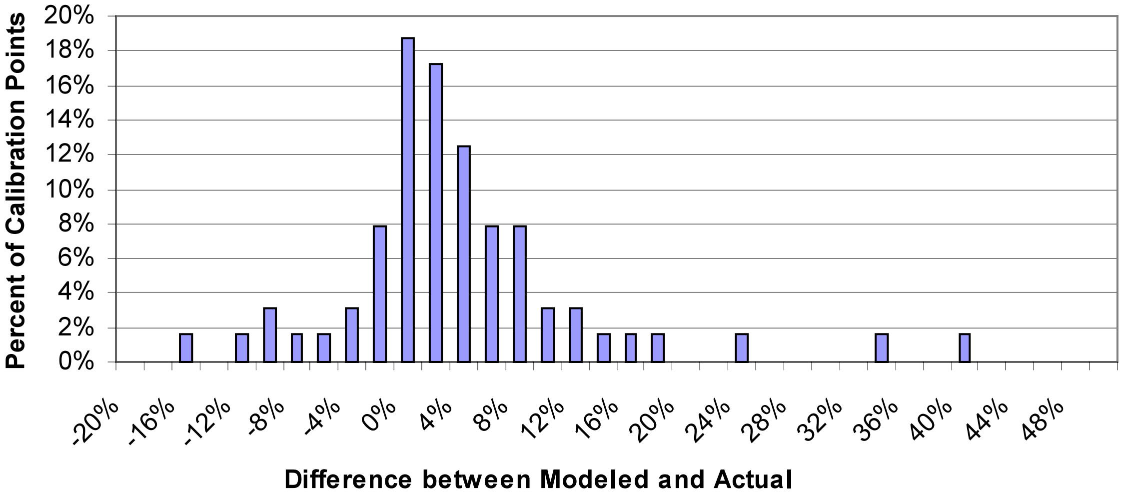


Figure 6-2
Distribution of Calibration Points

Section 7
Planning Criteria and Analysis Methodology

This section presents the planning criteria and methodologies for analysis used to evaluate both the existing system and the future system facilities and planning level opinions of probable costs.

MODEL RUN ANALYSIS

Various analyses were performed using the calibrated model presented in Section 6. The calibrated model was modified, changing the model from a specific calibration day to reflect more generic maximum day conditions. Demands were increased from calibration day production to maximum day production. Wells and booster pumps running under time-of-use conditions (TOU) were run 19 hours per day in the model (from 5 pm to 12 noon). Wells and booster pumps not on TOU were controlled by tank levels, if appropriate, or run 24 hours per day.

The modified model, generalized to existing maximum day conditions, was used for analysis of system pressures, velocities, fire flow capacities and booster capacities, based on the planning criteria below. By running the model for a 24-hour period, using maximum day conditions, locations with system pressures at demand nodes above and below and velocities above planning criteria were identified. Fire flow requirements were run at each demand node to check for ability to deliver fire flow while maintaining system pressure. The model was also used to analyze whether booster pumps are sufficient to maintain levels in all storage tanks, under maximum day conditions. Where planning criteria are not met, recommendations were made and tested using the model to determine the effectiveness of the recommendation.

For the future system (year 2010), future maximum day demands were added to the model. Using the recommendations in the previous master plan as a starting point, future system recommendations were added to the model. Using an iterative process, recommendations were added to the model, the model run, results checked to ensure all planning criteria met, and then recommendations modified based on model results.

PLANNING CRITERIA

Planning criteria are used in the evaluation of both the existing and future system hydraulic models. A list was developed of typical planning criteria used in the systems of similar water purveyors, local codes, engineering judgment, commonly accepted industry standards, and input from District staff. The “industry standards” are typically ranges of acceptable values for the criteria in question and therefore, they are utilized more as a check to confirm that the values being developed are reasonable. A list of planning criteria used in the evaluation of the District’s system is shown in **Table 7-1**.

There are three primary evaluation criteria: 1) acceptable pressures, 2) maximum acceptable pipeline velocities, and 3) adequacy of storage volumes for operational, emergency, and fire flow requirements.

Table 7-1
Planning Criteria

Description	Value	Units
Maximum Pressure	120	psi
Minimum Pressure -		
Maximum Day	40	psi
Peak Hour	30	psi
Adjacent to a Fire	20	psi
Maximum Pipeline Velocity (Existing Pipelines)		
Transmission Pipelines (10-inch dia. and greater)	8	fps
Distribution Pipelines (<10-inch dia.)	6	fps
Pump Stations	10	fps
Maximum Pipeline Velocity (Future Pipelines)		
Transmission Pipelines (10-inch dia. and greater)	6	fps
Fire Fighting Capabilities		
Parks (2 hrs)	750	gpm
Single Family Residential (1 du/acre or less, 2 hrs)	750	gpm
Single Family Residential (1-2 du/acre, 2 hrs)	1,000	gpm
Single Family Residential (greater than 2 du/acre, 2 hrs)	1,250	gpm
Medium Residential (2 hrs)	2,000	gpm
Multi-Family Residential (3 hrs)	3,000	gpm
Commercial and Industrial (3 hrs)	3,000	gpm
Schools and Public Facilities (3 hrs)	3,000	gpm
Lockheed Martin (4 hrs)	3,600	gpm
Terry Lumber (4 hrs)	4,500	gpm
Emergency Reservoir Storage Volume	1 MDD	MG
Operational Reservoir Storage Volume	25% MDD	MG
Pump Efficiency Requirements	60%	

Node Pressures

Node pressures are evaluated under two scenarios: peak hour and maximum day plus fire. Nodes which experienced pressures greater than 120 psi, and nodes which experienced pressures less than 40 psi during the average hour of the MDDs, 30 psi during the peak hour demands, or 20 psi during a fire analysis, are identified. The peak hour occurred at hour 7 during the maximum day. Model output is evaluated for demand nodes with average pressures less than 40 psi and those with minimum pressure less than 30 psi. Only demands nodes were used in the pressure analysis because only locations where customers are served need to meet such pressure requirements. Nodes with pressures that could not be brought within acceptable parameters are identified and are presented as part of the analysis of both the existing and future scenarios in Sections 7 and 8.

Pipeline Velocities

Distribution system pipelines are evaluated based on meeting the greater of maximum day plus fire flows or peak hour flows. Pipelines with velocities greater than 10 fps for pump stations, greater than 8 fps for transmission pipelines and greater than 6 fps for distribution pipelines are identified. Pipelines with velocities that could not be brought within acceptable parameters are identified and are presented as part of the analysis of both the existing and future scenarios. Additional factors are considered during the development of recommendations for improvements to existing facilities. These factors include the amount of leaks historically experienced by pipelines, the age of facilities, and the phasing of needs combined with facilities scheduled for improvements for other reasons.

For future planning, it is recommended that pipelines be designed at a much lower criteria than those for existing pipelines. Lower velocities are recommended in order to reduce head loss (and pumping costs) and to minimize surge in pipelines. Therefore, a planning criteria of a velocity of 6 fps is used for future planning purposes.

Fire Flow Criteria

Maximum day plus fire flow situations were evaluated at every demand node in the existing and future system. Fire flow criteria were determined by land use type, as shown in **Table 7-1** above. Each demand node was given a fire flow criterion based on the maximum fire flow requirement for the services that demand node represents. Two locations, Lockheed Martin and Terry Lumber, were analyzed using higher fire flow requirements than other locations of the same land use, due to expected higher fire flow demands. Using the model, each demand node was evaluated to determine if the fire flow requirement could be met at that node while maintaining pressure at 20 psi at all demand nodes in that pressure zone. Where fire flow criteria could not be met using a single node and fire flow demand is above 1,250 gpm, then the fire flow analysis was done using two neighboring nodes, Fire Department requirements allow fire flows above 1,250 gpm to be flowed out of two neighboring hydrants. Nodes with fire flow requirements that could not be brought within acceptable parameters are identified and are presented as part of the analysis of both the existing and future scenarios in Sections 7 and 8.

Storage Volumes

The total required volume of storage in a water system consists of water for operational, emergency, and fire fighting uses. Original water sources, such as water from the treatment plant and the groundwater wells, and storage sources, such as storage tanks throughout the system, are both utilized in determining quantities of water available to meet customer demands. Storage available is calculated as the total storage volumes in tanks, plus well peaking capacities above maximum day production requirements.

Operational Storage

Operational storage is the quantity of water required to moderate daily fluctuations in demand beyond the capabilities of the production facilities. The production rates of the water sources and the available storage capacity are coordinated to provide a continuous treated water supply. Based on economic considerations, systems are often designed to produce the average flow on the day of maximum demand. Water must be stored to supply the peak flows, which exceed the maximum day production rate. Operational storage is then replenished during off-peak hours when the demand is less than the production rate. The quantity of this operational storage is a judgment decision based on knowledge of the District and on knowledge of other, similar, systems. A typical recommendation by the American Water Works Association is to supply a volume equal to one-quarter of the demand experienced during one maximum day. It is therefore recommended that the District have 25% of maximum day demands available in storage tanks for operational storage.

Emergency Storage

The volume of water allocated for emergency uses is typically determined based on the historical record of emergencies experienced, and on the amount of time expected to lapse before the emergency can be corrected. Possible emergency situations include events such as water contamination, earthquakes, the loss of electrical power, several simultaneous fires, and other unplanned events. Because the occurrence and magnitude of an emergency situation is not subject to accurate evaluation, the volume of emergency storage is generally based upon engineering judgment or utility policy. An emergency supply volume equivalent to the demand experienced during one maximum day is determined to be appropriate for the District. However, this emergency supply does not have to be stored merely in the storage tanks; instead, it has to be available for all remaining sources unaffected by the emergency.

During an emergency, electronic and print media notices can be distributed to inform the public of the situation and to discourage all extraneous water uses. By utilizing these communications, customers in other districts have been known to reduce their water consumption by one-half to two-thirds. Therefore, an emergency volume of one maximum day of demand could result in three or more days of water use during an emergency situation.

Fire Protection Storage

Water storage for fighting fires is regulated in quantity by Los Angeles County and has been assumed as shown in **Table 7-1**. For this analysis, it is assumed that storage requirements are based on land use type. Storage requirements would be based on fire flow requirements shown above in **Table 7-1**. It is anticipated a commercial fire (3 hours, 3,000 gpm) could occur in the 2800, 2850, 2950 or 3000 pressure zones and a low-density residential fire (2 hours, 750 gpm) could occur in the 3200, 3250 or 3400 pressure zones. Due to high fire demand, analysis allows for a 4 hour, 4,500 gpm fire in the 2800 pressure zone to account for requirements at Terry Lumber.

According to the Insurance Services Organization (ISO), required fire flows may be met by a combination of pumping and storage. A 1,250 gpm fire for two hours would require 150,000 gallons, a 2,000 gpm fire for two hours would require 240,000 gallons, and a 2,500 gpm fire for three hours would require 420,000 gallons of water. Many of the areas in the foothills have sprinkler systems and/or water holding tanks to satisfy fire-fighting requirements. It is outside the District's scope to attempt to provide additional fire protection to these residences.

Water stored for fire fighting purposes may, by use of pressure regulating valves, also be available to fight a fire occurring in a lower pressure zone. This ability to "share" water allocated to meet fire flow requirements leads to a calculation of storage volumes which is not as constrained by pressure zone boundaries. Fires can also be fought with water from a lower zone by utilizing booster pumps to lift water to a higher zone.

Pump Capacity and Efficiency

Booster pump filling capacity was analyzed based on the ability of the booster pumps to fill tanks to acceptable levels. Booster pumps should be able to fill tanks such that levels at the end of the day are the same or higher than those in the beginning of the day, based on maximum day demands.

Booster and well pumps should be at 60% efficiency or higher. If the efficiency is lower, then energy is wasted and pump service is recommended.

Section 8
Existing System Analysis

This section describes the existing system facilities and provides an understanding of the existing system operations. The existing system consists of Littlerock Dam and Reservoir, the Ditch, Lake Palmdale, a service connection from the SWP, one water treatment plant, seven pressure zones and a number of other facilities, as shown in **Table 8-1**. **Figure 8-1** depicts an overview of the facility locations within the District and **Figure 8-2** is a schematic representation of all of the facilities and their interactions.

Table 8-1
Palmdale Water District Facilities

Facility Type	Number
Littlerock Dam and Reservoir	1
Lake Palmdale	1
Service connection from SWP	1
Water Treatment Plant	1
Pressure Zones	7
Wells (operating)	25
Booster pumps	43
Storage tanks	19
Hydropneumatic tanks	7
Pipeline	1,800,000 feet
Pressure regulating stations	14
Valves	5,034
Fire hydrants	2,222
Air/Vacuum stations	284
Sample Stations	19
Blow-offs	362

Note: Data current as of May 5, 2000.

A computer hydraulic model of the existing system has been developed to model the existing system, to identify areas for existing system improvements, and to evaluate alternative system improvements. The methodology of the model's construction, and a detailed description of the investigations and analyses, are presented in Section 6 of this master plan. Part of the model development involved "skeletonizing" the existing system to develop model inputs. Therefore, not all system elements are modeled but adequate detail in modeling is employed to accurately represent system operations. Facilities which are not included in the model are so noted in the following summary tables of existing facilities and are represented as "dashed" facilities in **Figure 8-2**.

FACILITIES

Surface Water Facilities

Lake Palmdale is supplied water from the Littlerock Reservoir and from the SWP Aqueduct. Water is conveyed from Littlerock Reservoir through an approximately 8.5 mile-long open ditch

Insert Figure 8-1
Palmdale Water District Existing System Facilities and Pipe by Pressure Zone
11 x 17 color map

Insert Figure 8-2
Palmdale Water District Existing Schematic
11x17 color

to Lake Palmdale, and water from the SWP enters Lake Palmdale via a direct connection between the SWP Aqueduct and the lake. Water from Lake Palmdale is supplied to the treatment plant which provides conventional treatment including chlorination. The computer hydraulic model of the existing system models the 6 MG Clearwell as the sole source of surface water and does not model the treatment plant or any facilities upstream of the treatment plant.

Water from the treatment plant enters the distribution system from the 6.0 MG Clearwell via the Clearwell Pump Station to the 2800 and 2950 pressure zones. Under conditions when the Clearwell Pump Station is out of service, the 3.0 MG Clearwell and transfer pump station can be used to service the system.

When the 6.0 MG Clearwell is out of service, water from the treatment plant enters the distribution system by two routes, by gravity to the 3.0 MG Clearwell and out to the system and through the low head transfer pump station to the 2800 pressure zone. Water flowing by gravity to the 3.0 MG Clearwell is boosted to either the 2800 or the 2950 pressure zones. The suction side of the low head transfer pumps is connected between the treatment plant and the 3.0 MG Clearwell. The head difference between the treatment plant and the 2800 Zone is such that during low flow conditions, one of the pumps can be replaced with a spool allowing water to flow by gravity. Gravity flow is currently not possible at higher flows due to excessive headlosses in the transmission pipelines.

Pressure Zones

There are seven primary pressure zones within the District, and each zone is labeled by the approximate Hydraulic Grade Line (HGL) within the zone. **Table 8-2** lists the zones, the highest and lowest elevations served, and the maximum and minimum pressures encountered in each zone, based on the HGL. There are water customers at elevations above the 3400 Zone; these are small groups of residences, served via dedicated booster pumps and hydropneumatic tanks. In this report, areas above the 3400 Zone are referred to as being in the 3400+ Zone. No modeling of services in the 3400+ Zone has been performed.

Table 8-2
Pressure Zones

Pressure Zone	Highest Elevation (ft)	Lowest Elevation (ft)	Minimum Pressure (psi)	Maximum Pressure (psi)
2800	2,690	2,550	29	108
2850	2,700	2,650	50	79
2950	2,850	2,650	35	121
3000	2,900	2,700	38	162
3200	3,090	2,810	48	114
3250	2,990	2,850	54	114
3400	3,240	3,010	57	183

Note: 1. Elevations above 3,350 feet are served by booster pumps and hydropneumatic tanks.

Each of the facilities within the District provide water to a particular pressure zone; detailed descriptions of the zone contributions of each facility are given in the detailed facility sections. For example, the Groundwater Wells section describes how each well operates with respect to the pressure zones. **Figure 8-3** shows the approximate pressure zone boundaries throughout the District.

The 2950 pressure zone consists of two regions which are hydraulically isolated from one another. The main section stretches across the District from east to west; the other is located in the southeast region of the District's service area. The 3200 Zone consists of two non-contiguous pressure zones, located in the southwest region of the District's service area.

Groundwater Wells

There are 25 operating well and pump combinations (referred to herein as wells) within the District. A summary of the physical and operational data of the wells currently in service is presented in **Table 8-3**. An 'A' designation following the well number indicates that this is a replacement well at this location. The original well was replaced, usually due to age and/or poor performance. Two of the wells are gas driven (Well Nos. 11 and 15) and the remainder are powered by electricity.

In addition to these wells, there are four locations (Well Nos. 27, 28, 29, and 34A) on the east side of the District where wells have been drilled and pump tests have been conducted. Wells have not been equipped at these locations due to a current lack of development near the well sites. Chlorination is performed at each well and all groundwater receives chlorine disinfection prior to entering the distribution system.

SCE, the local electricity purveyor, implements a different electricity rate structure for users of large quantities of electricity. This rate structure includes higher rates during peak electricity usage times and is referred to as a TOU rate structure.

All of the wells utilize constant speed pumps, and the majority of them have been recently tested by SCE regarding their operations and efficiencies. SCE tests have been obtained where available, and pump design points have been used where SCE tests did not provide sufficient information to develop complete pump curves. The District measures static and pumping levels in each well monthly.

The majority of the wells pump directly into the distribution system, adjacent to their physical location. The remaining wells (Well Nos. 5, 14A, 18, 19) pump into adjacent holding tanks from which booster pumps lift the water to the appropriate system pressure. Controls for the wells, criteria for when the wells are either on or off, are given later in this section. The pressure zone served by each well is indicated in **Table 8-3**. The well locations are shown in **Figure 8-1** and are schematically represented in **Figure 8-2**.

Booster Pumps

There are 43 booster pumps located within the District, some of which are only used on an as-needed basis. The booster pumps vary in size from 10 to 150 hp and boost water in four of the

Insert Figure 8-3
Palmdale Water District Pressure Zones
11x17 color map

Table 8-3
Well and Pump Facilities

Well No.	Location	Pump (hp)	Year Drilled	Casing Diameter (in)	Flow (gpm)	TDH (ft)	Pressure Zone Served
2A	39400 20th St. East	500	1968	16	1,501	802	2800
3A	2163 East Ave. P-8	500	1960	16	1,726	779	2800
4A	2475 East Ave. P-8	350	1970	16	1,050	787	2800
5	1036 Barrel Springs Rd.	5	1965(1)	8	99	84	2950
6A	39455 10th St. East	125	1983	16	339	764	2800
7A	39395 25th St. East	500	1985	16	1,527	758	2800
8A	2200 East Ave. P	600	1987	16	1,968	790	2800
10	3701 East Ave. P-8	100	1956	16	292	688	2800
11A(2)	39501 15th St. East	n/a	1963	16	1,161	768	2800
14A	39401 20th St. East	250	1965	16	1,335	575	2800
15(2)	1003 East Ave. P	n/a	1960	16	998	794	2800
16	4125 East Ave. S-4	40	1960	14	122	467	2950
17(3)	718 Denise Ave.	20	1966(1)	10	245	309	3200
18	4640 Barrel Springs Rd.	5	1954	8	110	69	3250
19	4640 Barrel Springs Rd.	5	1961	14	119	72	3250
20	5680 Pearblossom Hwy.	60	1973(1)	16	279	457	3000
21	36525 52nd St. East	30	1973(1)	10	401	190	2950
22	5401 East Ave. S	75	1974	16	362	314	2850
23	2202 East Ave. P-8	500	1977	16	1,303	822	2800
24	2701 East Ave. P-8	150	1985	16	537	757	2800
25	37520 70th St. East	125	1989	16	514	378	2950
26	4701 Katrina Place	50	1989	16	239	462	2850
27(4,5)	Future Well	n/a	1989	16	n/a	n/a	2950
28(4,5)	Future Well	n/a	1989	16	n/a	n/a	2950
29(4.5)	Future Well	n/a	1989	16	n/a	n/a	2950
30	7392 East Ave. R	150	1989	16	516	453	2950
32	37301 35th St. East	60	1989	16	256	520	2800
33	7160 East Ave. R	150	1991	16	462	491	2950
34(4.5)	Future Well	n/a	1991	16	n/a	n/a	2950
35	36549 60th St. East	150	1991	16	352	529	3000

Note: 1. Exact age unknown; drilled prior to the year shown.
2. Gas driven.
3. Well is out of service due to water quality problems.
4. SCE test data was not available.
5. Not included in existing system computer model.
6. n/a indicates the information is not available.

seven primary pressure zones. Controls for the booster pumps, criteria for when the pumps are either on or off, are given later in this section. **Table 8-4** shows a summary of booster pump information. The booster pump locations are shown in **Figure 8-1** and are schematically represented in **Figure 8-2**. Booster pumps, shown dashed in **Figure 8-2**, are not included in the hydraulic model.

Table 8-4
Booster Pump Summary

Name	Location	Suction Facility	Discharge Facility	Horse power
Clearwell 2800 No.1	700 East Ave. S	6M Clearwell	2800 Zone	100
Clearwell 2800 No.2	700 East Ave. S	6M Clearwell	2800 Zone	200
Clearwell 2800 No.3	700 East Ave. S	6M Clearwell	2800 Zone	200
Clearwell 2950 No.1	700 East Ave. S	6M Clearwell	2950 Zone	250
Clearwell 2950 No.2	700 East Ave. S	6M Clearwell	2950 Zone	250
Clearwell 2950 No.3	700 East Ave. S	6M Clearwell	2950 Zone	150
3MG LH No. 1(1)	850 East Ave. S	WTP, prior to 3 MG	2800 Zone	50
3MG LH No. 2(1)	850 East Ave. S	WTP, prior to 3 MG	2800 Zone	50
3MG LH No. 3(1)	850 East Ave. S	WTP, prior to 3 MG	2800 Zone	50
3MG LH No. 4(1)	850 East Ave. S	WTP, prior to 3 MG	2800 Zone	50
Well 14A	39401 20th St. E	Well 14A Tank	2800 Zone	75
2.6 mg Transfer (1)	850 East Ave. S	3 MG	2800 Zone	30
3MG 150hp No. 1(1)	850 East Ave. S	3 MG	2950 Zone	150
3MG 50hp No. 2(1)	850 East Ave. S	3 MG	2950 Zone	50
Ave. S No. 1(1)	700 East Ave. S	2.6 MG	2950 Zone	75
Ave. S No. 2(1)	700 East Ave. S	2.6 MG	2950 Zone	75
45th St. No. 1	36510 45th St. E	45th St. Tanks	3000 Zone	150
45th St. No. 2	36510 45th St. E	45th St. Tanks	3000 Zone	150
45th St. No. 3	36510 45th St. E	45th St. Tanks	3000 Zone	150
25th St. No. 1	25th St. E, S/O Ave. S	25th St. Tanks	3000 Zone	50
25th St. No. 2	25th St. E, S/O Ave. S	25th St. Tanks	3000 Zone	100
25th St. No. 3	25th St. E, S/O Ave. S	25th St. Tanks	3000 Zone	100
25th St. No. 4	25th St. E, S/O Ave. S	25th St. Tanks	3000 Zone	100
25th St. No. 5(2,3)	25th St. E, S/O Ave. S	25th St. Tanks	3000 Zone	100
Hilltop(3)	35609 Cheseboro Rd.	Hilltop Reservoir	3000 Zone	10
Ave. T-8 No. 1	4250 East Ave. T-8	3000 Zone	3250 Zone	15
Ave. T-8 No. 2	4250 East Ave. T-8	3000 Zone	3250 Zone	15
Ave. T-8 No. 3(4)	4250 East Ave. T-8	3000 Zone	3250 Zone	50
Lower EC No. 1	36809 El Camino Dr.	Lower El Camino Res.	3200 Zone	75
Lower EC No. 2	36809 El Camino Dr.	Lower El Camino Res.	3200 Zone	75
Underground No. 1	36336 El Camino Dr.	Underground Res.	3400 Zone	75
Underground No. 2	36336 El Camino Dr.	Underground Res.	3400 Zone	40
5 mg No. 1(3)	2404 Old Nadeau Rd	5 MG	3250 Zone	20
5 mg No. 2(3)	2404 Old Nadeau Rd	5 MG	3250 Zone	20
Palmdale Hills(3)	4640 Barrel Springs	Well Nos.18 & 19 Res.	3250 Zone	10
V-5(3)	4640 Barrel Springs	Well Nos.18 & 19 Res.	3250 Zone	30
Well 5 No. 1(3)	S/O Barrel, W/O Sierra	Well 5 Tank	3200 Zone	30
Well 5 No. 2(3)	S/O Barrel, W/O Sierra	Well 5 Tank	3200 Zone	50
Well 5 No. 3(3)	S/O Barrel, W/O Sierra	Well 5 Tank	3200 Zone	50
Well 5 No. 4(3)	S/O Barrel, W/O Sierra	Well 5 Tank	3200 Zone	100
3900 Booster(3)	36200 El Camino Dr.	Upper El Camino Res.	3600 Zone	50
3600 ft. No. 1(3)	601 Lakeview Dr.	3400 Zone	3600 Zone	20
3600 ft. No. 2(3)	601 Lakeview Dr.	3400 Zone	3600 Zone	20

Note:
1. Currently used only under emergency conditions
2. Emergency pump.
3. Not included in computer model.
4. Fire pump.

Storage Tanks

There are 19 storage tanks within the District's system, and 16 different storage tank sites. Three of the sites, 25th St., 45th St., and 47th St., contain two tanks each. The tanks range in size from 41,000 gallons to 5.0 MG, with a total system storage tank capacity of approximately 34.7 mg. **Table 8-5** shows a summary of storage tank information. The storage tank locations are shown in **Figure 8-1** and are schematically represented in **Figure 8-2**. Tanks shown dashed in **Figure 8-2** are not included in the hydraulic model.

Tanks operate either fully as storage tanks, with the capability to provide water at adequate pressure by gravity to a pressure zone, or simply as holding tanks for well pumps. Holding tanks are situated adjacent to wells, and groundwater is pumped by the wells at adequate head to fill the holding tanks. Booster pumps are located downstream of the holding tanks to lift the holding tank water to distribution system pressure. Holding tanks are so noted in **Table 8-5**.

Table 8-5
Storage Tank Summary

Name/Description	Volume (MG)	Pressure Zone Served	Diameter (feet)	Bottom Elev. (feet)	Overflow Elev. (feet)	Type	Year Built
6 MG Clearwell	6.0	WTP	206	2,748	2,772	Steel	1999
3 MG Clearwell	3.0	2800	104	2,748	2,782	Steel	1960
25th Street	2.0	2800	106	2,750	2,780	Steel	1976
25th Street	4.0	2800	154	2,750	2,780	Steel	1987
45th Street	3.0	2800	130	2,738	2,770	Steel	1988
45th Street	4.0	2800	150	2,738	2,770	Steel	1990
Well No. 14(1)	0.1	2800	27	2,580	2,602	Steel	n/a
2.6 MG Reservoir	2.6	2950	160	2,800	2,835	Steel	n/a
Walt Dahlitz	1.5	2950	104	2,923	2,954	Steel	1993
Lower El Camino	2.0	2950	106	2,918	2,950	Steel	1988
Well No. 5(1)	0.126	2950	30	2,838	2,860	Steel	1963
Hilltop	0.07	2950	30	2,913	2,932	Steel	1966
Westmont	0.126	2950	30	2,914	2,936	Steel	1963
47th Street	2.0	3000	106	2,970	3,000	Steel	1987
47th Street	3.0	3000	132	2,970	3,000	Steel	1990
5 MG Reservoir	5.0	3000	160	2,966	3,000	Steel	1988
Well Nos. 18 & 19(1)	0.041	3200	27	3,036	3,051	Steel	n/a
El Camino Underground	1.5	3200	104	3,159	3,185	Concrete	1994
Ana Verde Tovey	0.3	3200	40	3,114	3,146	Steel	1963
Upper El Camino	0.3	3400	40	3,356	3,388	Steel	1963
Total Storage	**40.663**						

Note: 1. Holding tank.

Hydropneumatic Tanks

There are seven hydropneumatic tanks within the District's system. Hydropneumatic tanks are typically installed to either reduce cycling of pumps, to provide additional peaking storage on very small systems, or to provide surge protection to the distribution system. The majority of the hydropneumatic tanks in the District serve small clusters of homes in the mountain foothills. Hydropneumatic tanks installed in the seven primary pressure zones are no longer utilized as hydropneumatic tanks due to system changes after their installation, and currently act as "wide spots" in the pipelines. Therefore, the only operating hydropneumatic tanks are those serving isolated water customers. **Table 8-6** shows a summary of hydropneumatic tank information. The hydropneumatic tanks are schematically represented in **Figure 8-2**. Hydropneumatic tanks shown dashed in **Figure 8-2** are not included in the hydraulic model.

Table 8-6
Hydropneumatic Tank Summary

Location	Suction Facility	Service Area	Size (gallons)	Operational
Ave. T-8 Booster Sta.	3000 Zone	3250 Zone	3,800	Yes
3 MG Reservoir(1)	3 MG Reservoir	2950 Zone	10,000	No
3600-ft Booster Sta.(1)	3400 Zone	3600 Zone	6,900	Yes
5 MG Reservoir(1)	5 MG Reservoir	3250 Zone	6,000	Yes
Palmdale Hills(1)	Well 18 & 19 Res.	3250 Zone	1,500	Yes
Al's Tank(1)	3400 Zone	3400+ Zone	5,200	Yes
V-5(1)	Well 18 & 19 Res.	3400 Zone	5,200	Yes

Note: 1. Not included in existing system computer model.

Pipelines

District pipelines range between 4 and 42-inch in diameter and the majority are constructed of asbestos-cement (AC). The remainder of the pipelines are constructed of ductile iron, welded steel, and a small amount of polyvinyl chloride (PVC). No summary of the total lengths of pipelines by material type is available. **Table 8-7** summarizes the total lengths of pipeline in the District, by pipe size, as of May 5, 2000. **Figure 8-1** shows the pipelines by pressure zones. **Figure 8-4** shows the pipelines in the model by diameter. The oldest pipelines are constructed of steel and many of these have experienced excessive leakage. The District is involved in an ongoing, prioritized, replacement program for these older, leakage-prone pipelines. The District has also implemented a policy of not allowing installation of new dead-end pipelines and is in the process of reducing the number of dead-ends in the system.

Insert Figure 8-4
Palmdale Water District Pipelines by Diameter
11x17 color map

Table 8-7
Pipeline Summary

Pipeline Diameter (inches)	Total Length of Pipeline (feet)
4	36,564
6	359,359
8	669,217
10	114,515
12	345,408
14	17,775
16	142,695
18	10,925
20	89,248
24	39,295
30	1,610
42	1,400
Total	**1,799,631**

Pressure Regulating Stations

There are 14 pressure regulating stations and one pressure relief station within the District. Most of the pressure regulating stations have two PRVs; a main valve and a second, smaller valve referred to as a bypass valve. The smaller valve is given a slightly higher pressure setting than the main valve to allow it to respond to small pressure changes in the system without opening the larger valve. If the second valve cannot pass enough water and the downstream pressure continues to fall, the main valve will open to pass additional water. The pressure relief station consists of a relief valve that relieves excess pressure to the downstream pressure zone. The PRV settings are checked on a quarterly basis and, besides minor adjustments to the settings, the stations have not required intensive maintenance. **Table 8-8** shows a summary of pressure regulating station information. The modeled pressure regulating station locations are schematically represented in **Figure 8-2**.

Table 8-8
Pressure Regulating Station Summary

Name/Location	Delivery Pressure Zone	Main Valve Setting (psi)	Main Valve Size (in)	Bypass Valve Setting (psi)	Bypass Valve Size (in)
45th St. E and Avoca[1]	2800	75	3	n/a	n/a
3rd St., N/O Ave. Q	2800	33	6	38	2
40th St. E and Sorrell	2850	62	8	70	4
47th St. E and Fort Tejon Rd.	2850	73	8	75	4
65th St. E and Ave. S	2850	63	8	68	4
37311 47th St. East (MHP)[2]	2850	42	6	49	2
Well No. 16, 4125 E. Ave. S-4	2850	69	4	72	1
25th St. E, N/O RR, S/O Ave. S	2950	77	8	78	2
30th St. E and Fairfield	2950	84	10	85	3
37th St. E, N/O RR and Napa Way	2950	67	8	68	3
40th St. E and Ave. S-11	2950	64	12	65	3
47th St. E, S/O RR	2950	76	12	79	3
Well No. 20, 5680 Pearblossom	2950	78	4	n/a	n/a
45th St., S/O RR at Intersection	2950	NIS	4	NIS	n/a

Note: 1. Pressure relief valve only.
2. Not included in the existing system computer hydraulic model.
3. NIS indicates the valve is not in service.

FACILITY OPERATIONS

The primary facilities of operational concern are the treatment plant and the wells. All of the existing facilities require routine maintenance and knowledgeable operators, but pipelines, tanks, valves, and other facilities do not require day-to-day adjustments in their operating parameters. This section describes the operations of the treatment plant and wells in additional detail.

In general, the District operates facilities to provide safe, high quality water, in sufficient quantities, at a reasonable price to its customers. One of the factors involved in providing water at a reasonable price is the District's ability to take advantage of SCE's TOU program whenever possible. The TOU program involves utilizing a variable rate schedule for high energy using facilities, such as pumps. The rate schedule is configured to cost more to run these facilities during the peak, and the super-peak, hours than it does to run the facilities during the off peak hours. The peak hours are defined as 1:00 pm to 5:00 pm, Monday through Friday starting on the first Sunday in July and ending on the first Sunday in October, excluding weekends and holidays. The District schedules their TOU facilities for shutdown at noon instead of 1:00 pm to provide time for operators to compensate for any equipment malfunctions.

On the average, the treatment plant operates about 10 hours per day during the winter (2-3 months per year), 18 hours per day during spring and autumn (3-4 months per year) and 24 hours per day during the summer (6 months per year). The treatment plant operations are controlled by demand via the 6 MG Clearwell and associated booster station. When the water level in the 6

MG Clearwell reaches its upper limit, the treatment plant must be shut down to keep the 6 MG Clearwell from overflowing. The treatment plant is not on the TOU program.

There are eight different types of controls for determining when the wells and booster pumps operate. Descriptions of these controls are given in **Table 8-9**. The pumps can operate based on more than one of the eight control schemes. As an example, a well could operate based on both Warrick Liquid Level (WLL) and Time of Day (TOD). The well would produce water during the TOD hours of operation unless the level in the controlling tank reached its maximum set-point during the operational hours. If the tank level then fell below the on set-point during the set hours of operation, the well would again produce water. Nine of the wells and 11 of the booster pumps are on the TOU program. Copies of the daily operational tables for the model calibration day and for the day of maximum water production, indicating the controls and set-points for each day, are included in Appendix E.

Table 8-9
Well and Booster Pump Controls

Abbreviation	Name	Description
TOU	Time of Use	Will not allow pump to run during peak hours
WLL	Warrick Liquid Level	Controlled by designated tank levels
LCL	Locally Controlled	Controlled by designated tank levels
TOD	Time of Day	Controlled by computerized time of day set-points
LTC	Local Time Clock	Controlled by locally input time of day set-points
OST	On Site Tank	Controlled by on-site tank levels
HOA	Hand, Off, Auto	On-site control set by local on or off. Automatic setting allows remote computer control.
HOAT	Hand, Off, Auto, Timer	Remote computer sets on, off, automatic, or timer control.

ANALYSES

In general, the District appears to have a good distribution system. Because of the strong network of existing transmission pipelines, there are no requirements for increasing the sizes of major pipelines. The existing system has been analyzed to determine any recommended modifications to ensure the reliability and flexibility of serving existing customers. Recommended improvements are minor for the existing system. The system evaluation is based on the criteria as described in Section 7, 1) node pressures, 2) pipeline velocities, 3) fire flow criteria, 4) storage tank volumes, 5) booster pump capacities and efficiencies and 6) leaking pipelines.

Node Pressures

All of the node pressures, except two, are greater than or equal to 30 psi under peak hour conditions. There are 20 demand nodes that are below 40 psi during average of maximum day conditions. **Table 8-10** lists all of the nodes with low pressures under maximum day conditions including their locations and a recommended modification to alleviate the pressure problem. **Table 8-11** lists all of the nodes with low pressures under peak day conditions including their locations. Note that all locations with low peak hour pressures are also listed in **Table 8-10**. **Figure 8-5** shows the areas where the pressures are outside the planning criteria.

Insert Figure 8-5
Palmdale Water District High and Low Pressure Areas
11x17 color map

Table 8-10
Junctions with Low Pressures under Maximum Day Conditions

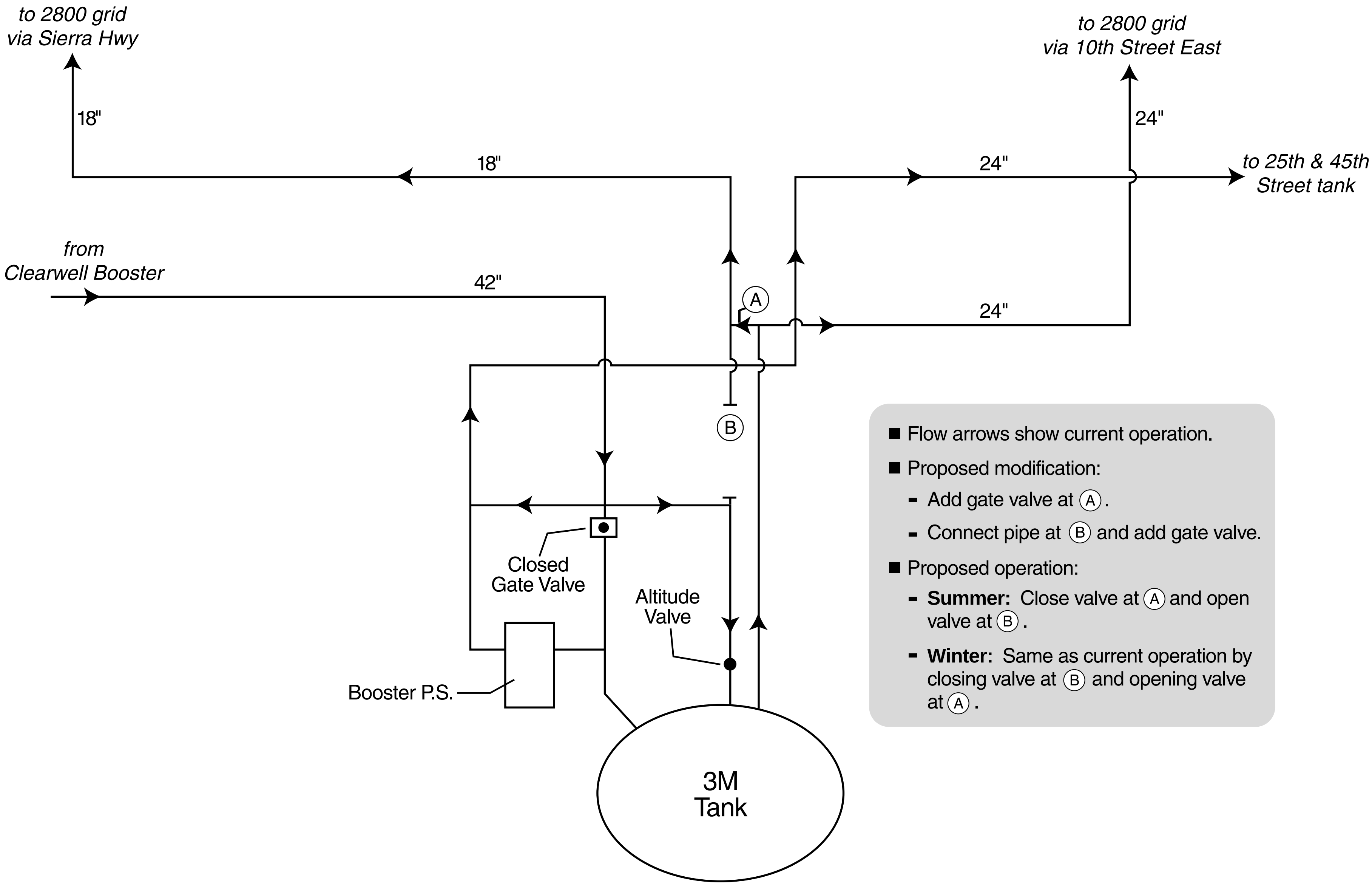
Model ID	Pressure (psi)	Location	Pressure Zone
688	34	Palmdale & Division	2800
498	34	Q-12 & 5th	2800
4324	35	Sierra & RR	2800
2234	36	6th S/O Q-12	2800
122	37	Q-12 & 6th	2800
364	37	R-15 & 27th	2800
3206	38	30th & R-14	2800
3222	38	29th & R-16	2800
3220	38	29th & Short	2800
3218	38	R-15 W/O 29th	2800
3216	38	R-15 & 29th	2800
2252	38	Sierra S/O R	2800
492	38	Oak Hill & Portland	2800
488	38	Oak Hill & R-8	2800
512	38	35th & R-14	2800
2852	38	Palm Vista & R-5	2800
314	39	R-8 & 47th	2800
3214	39	29th & R-14	2800
500	39	5th N/O Q-12	2800
3234	39	R-15 & Dalzell	2800

Table 8-11
Junctions with Low Pressures under Peak Hour Conditions

Model ID	Pressure (psi)	Location	Pressure Zone
498	29	Q-12 & 5th	2800
688	29	Palmdale & Division	2800

All low pressure points are in the 2800 pressure zone. It is recommended that the pressure be raised by feeding the 18-inch diameter pipeline in Sierra Highway directly from the Clearwell Pumping Station (2800) rather than by gravity from the 3MG Tank during the summer months. Valves should be modified and operated as shown schematically on **Figure 8-6**. During the autumn, winter and spring months, the system should be operated similar to the existing system. This proposal raises the pressure to meet planning criteria at all points in the 2800 pressure zone, at both maximum and average flows, at minimal cost to the District. This recommendation is schematically shown in **Figure 8-6**.

In addition, to ensure adequate pressure in the west corner of the 2800 pressure zone, an 8-inch PRV should be installed at Palmdale & Division.



PWD-001940

Figure 8-6

Recommended Modification to Raise Pressures in the 2800 Zone

There are 22 locations of over-pressurization of the system not directly attributable to being located immediately downstream of a pump station. These nodes experienced pressures over 120 psi, up to a maximum of 171 psi. **Table 8-12** lists all of the nodes with high pressures under maximum day conditions including their locations and a recommended modification to alleviate the pressure problem. **Figure 8-5** shows the areas where the pressures are outside the planning criteria.

Table 8-12
Junctions with High Pressures under Maximum Day Conditions

Model ID	Pressure (psi)	Location	Pressure Zone
1004	171	Tierra Subida & Hacienda	3400
4164	151	Barrel Springs & 3rd	3200
4220	150	El Camino & S-14	3400
4204	150	Lago Lindo & Martin	3200
4234	149	Barrel Springs & Vista del Lago	3400
1002	145	Tovey & Sierra Ancha	3400
4178	144	Rozalee & Harold	3200
4222	142	Sugarloaf & China	3400
4342	140	R-8 W/O 7th West	3200
4168	140	Harold & Rozalee	3200
4202	137	Barrel Springs & Lago Lindo	3200
4236	136	Barrel Springs & Ginger	3200
4186	136	Cierro Crest & Lakepoint	3200
4182	134	Barrel Springs & 5th	3200
4170	132	Harold & 5th	3200
4286	132	T & Aspern	3200
4200	132	Lago Lindo & Upland	3200
4210	132	Shasta & Upland	3200
4198	124	End of Heritage	3200
3634	124	Spanish Broom & Tobira	3000
988	122	Spanish Broom & Desert Willow	3000
3636	122	El Camino & Lakeview	3400

The majority of the high pressure points are located in the southwest corner of the District, in the foothills. Though the homes in this region are at high pressures, the District has taken active steps to reduce the pressure in many of these homes from approximately 300 psi to 140 psi by recently constructing the El Camino Underground Booster Station. All homes in this region have individual PRVs at the service connections; this decrease will greatly increase the lifespan of the individual PRVs. It is not recommended that the pressure be reduced further at any of these locations.

Pipeline Velocities

The system has also been evaluated for violations of the maximum velocity criteria under maximum day conditions. Eight locations exceeded the criteria during some hour of the maximum day. **Table 8-13** lists all the pipelines that are out of the acceptable velocity tolerance including their locations and a recommended modification to alleviate the velocity problem.

Table 8-13
Pipes with High Velocities

Model ID	Maximum Velocity (ft/s)	Pipe Diameter (in)	Location	Recommendation
6275	11.1	2	Well 18 Outlet	Increase pipeline diameter to 4-inch.
2335	10.2	8	3rd St PRV outlet	No change recommended.[1]
2309	10.2	8	3rd St PRV inlet	No change recommended.[1]
6121	8.7	6	3rd St PRV	No change recommended.[1]
6147	7.5	4	Well 5 Booster #2 Discharge	Increase pipeline diameter to 8-inch.
5761	6.5	8	Barrel Springs Rd, 2nd St to Aspern St	Increase pipeline diameter.[2]
5759	6.3	8	Barrel Springs Rd, Aspern St to 3rd St	Increase pipeline diameter.[2]
5755	6.2	8	Barrel Springs Rd, 3rd St to 5th St	Increase pipeline diameter.[2]

Notes: 1. The suggested solution to raise low pressures also greatly reduces flow through this PRV and associated pipeline, therefore no change will be necessary.
2. This pipeline only is nominally above the planning criteria for velocity. However, it is also very close to the recommendation for replacing leaky pipe. Therefore, it is recommended that this pipeline be replaced with a 12-inch diameter pipe.

Fire Flow Capacities

Each demand node was analyzed for the ability to meet fire flow criteria set in Section 7. Two demand nodes do not meet the fire flow requirements. The demand nodes with insufficient fire flow capacities are listed in **Table 8-14** with recommended modifications to meet fire flow criteria.

Table 8-14
Demand Nodes with Insufficient Fire Flow Capacities

Model ID	Fire Flow Criteria (gpm)	Available Fire Flow at 20 psi (gpm)	Pressure Zone	Location	Recommendation
1012	3,000	2,590	2950	Fort Tejon & Pearblossom	See recommendation below.
4070	750	700	2950	37th St East & Ave S-12	See recommendation below.

Recommendation: To increase fire flow capacities in the 2950 zone (Hilltop & Westmont Tanks), eliminate the zone and combine it with the 3000 pressure zone. To eliminate the zone, abandon Westmont Tank and the 4 and 6-inch pipeline that runs along 42nd Street East from Pearblossom Hwy to Westmont Tank. Also, connect the existing 8-inch pipelines in Avenue T-2, T-4 and T-6 with the 12-inch pipeline in 42nd Street East, and open the normally closed gate valves at 42nd Street East and Pearblossom Hwy, 52nd Street East and Avenue T-8 and 55th Street East and Avenue T-8.

Storage Volumes

According to the planning criteria discussed in Section 7, the operational storage requirement is 25 percent. Under maximum day conditions, the model was analyzed to verify this assumption. For each tank, the high and low water levels were determined. The difference in these levels is the amount of storage that is required for operational use only. The total operational storage in this scenario is 7.69 MG, which is 22.2 percent of the District's total available storage. Therefore, the operational storage planning criteria assumption of 25 percent is applicable to the District.

The District currently has 19 storage tanks and are located in six of seven pressure zones. For those pressure zones that are broken into two hydraulically isolated sections, the storage and emergency supply analyses are performed individually for each section.

Table 8-15 provides a total and per zone analysis of the storage volumes required and of the storage volumes available. In this analysis, well peaking capacity is the total capacity of each well, subtracting the actual production for maximum day, 1999. In order to be conservative, the analysis also removes the capacity of the largest well (No. 8A), assuming it is out of service. The analysis presented in Table 8-14 indicates that the District has adequate storage capacity for their existing situation. Across the entire system, the total storage volume required is approximately 51.5 MG and the available storage capacity is 52.5 MG. Investigating pressure zones individually, it was assumed that water would only be transferred across pressure zones via PRVs to the next lower pressure zone, under normal conditions. Under these criteria three pressure zones, 2850, 3200 and 3400, show a water deficit. The deficit in the 3200 and 3400 zones are minimal, but the 2850 zone shows significant deficit (2.4 MG). Therefore, additional storage is recommended for the 2850 pressure zone.

Emergency Power Requirements

Emergency power is necessary to operate pumps in the event of a power outage. The District currently has stationary emergency generators at the main office, water treatment plant and 6MG Clearwell. The District also owns four mobile generators (30 kW, 275 kW, and two 350 kW) and has eight sites with emergency hookups (Sodium hypochlorite generator at WTP, Well Nos. 18 & 19, Well No. 5, Well No. 25, 3900 Booster Station, Underground Booster Station, 3600 Booster Station and 3MG site). An additional emergency hookup is currently being installed at Avenue T-8 Booster Station. There are also two existing gas-powered wells (Well Nos. 11A and 15) and one existing booster with a gas engine drive (25th Street).

Two small pressure zones, fed by the Hilltop and 5 MG boosters cannot be served with the loss of electrical power. Thus, it is recommended that emergency hookups to portable generators be installed at the Hilltop Booster Station and 5 MG Booster Station. Two additional 30 kW mobile generators should also be purchased for use at these stations, if no electrical power is available for the entire District.

Using the current gas-powered devices, if no electrical power is available, the District has the ability to supply all service connections with water for more than four days, with the exception of the Hilltop hydropneumatic zone and 5MG hydropneumatic zone. This analysis was

Table 8-15
System Storage Analysis

Description/Criteria	Entire System	2800	2850	2950 (Dahlitz & LEC)	2950 (Hilltop & Westmont)	3000	3200 (Underground)	3200 (Tovey)	3200 (T-8)	3400
Production for 1999 (MG)	7626.85	3628.48	1136.49	1891.21	65.86	696.20	69.32	32.20	38.07	69.01
ADD (MG)	20.895	9.941	3.114	5.181	0.180	1.907	0.190	0.088	0.104	0.189
MDD (MG)	40.328	19.186	6.009	10.000	0.348	3.681	0.367	0.170	0.201	0.365
Fire Flow Required (gpm)	4500	4500	3000	3000	3000	3000	750	750	750	750
Fire Duration (hrs)	4.000	4.000	3.000	3.000	3.000	3.000	2.000	2.000	2.000	2.000
Operational Storage (25% of MDD)	10.082	4.797	1.502	2.500	0.087	0.920	0.092	0.043	0.050	0.091
Fire Storage (MG)	1.080	1.080	0.540	0.540	0.540	0.540	0.090	0.090	0.090	0.090
Emergency Storage (1 MDD)	40.328	19.186	6.009	10.000	0.348	3.681	0.367	0.170	0.201	0.365
Total Volume Required (MG)	51.490	25.063	8.052	13.040	0.975	5.142	0.548	0.303	0.342	0.546
Storage Tanks (MG)	34.663	16.100	0.000	6.226	0.196	10.000	1.500	0.300	0.041	0.300
Water Treatment Plant Clearwell (MG)	6.000	0.000	0.000	6.000	0.000	0.000	0.000	0.000	0.000	0.000
Well Peaking Capacity (MG)	11.861	9.181	0.263	1.384	0.274	0.468	0.000	0.000	0.292	0.000
Sub-Total Storage Available	52.524	25.281	0.263	13.610	0.470	10.468	1.500	0.300	0.333	0.300
Sub-Total Surplus Storage	1.034	0.218	(7.789)	0.570	(0.506)	5.326	0.952	(0.003)	(0.009)	(0.246)
Available Through PRVs	0.000	0.000	5.390	(0.570)	0.506	(5.326)	0.000	0.000	0.000	0.000
Surplus Storage	**1.034**	**0.218**	**(2.398)**	**0.000**	**0.000**	**0.000**	**0.952**	**(0.003)**	**(0.009)**	**(0.246)**

performed using the hydraulic model, assuming average day demands, unlimited gasoline supply, and using three current generators at the three hydropneumatic booster stations and Underground Booster Station, and moving the fourth between the sodium hypochlorite generator at the WTP and Well No. 5. Under these conditions, a few locations in the Avenue T-8 zone would receive water under 40 psi, since this zone would be fed by gravity from Well 18 & 19 Tank under this scenario. To raise the pressures in this zone, an additional mobile generator is necessary to run the Avenue T-8 Booster Station.

Pump Capacity and Efficiency

As discussed in the planning criteria in Section 7, the booster pumps should be able to maintain levels in tanks under maximum day demands and fill the tanks in the three days starting from empty tanks. The model was analyzed under maximum day demand conditions to determine whether the tank levels are maintained. The booster pumps should have enough capacity such that the tanks are at the same or higher level at the end of the day compared to the beginning. The model results show that the two tanks in the 3000 pressure zone (47th Street and 5MG) cannot be filled to the starting levels if time of use controls are followed at 25th and 45th Street Booster Stations. However, if time of use controls are not followed, there is more than adequate pumping capacity.

The model was also analyzed under the scenario of all tanks starting empty and maximum day demand demands. Within three days, even following time of use controls, all tanks can be filled to the normal operating range. Therefore, based on these two analyses, booster pump capacity is sufficient.

The most recent SCE pump test data was analyzed to identify well and booster pumps with low efficiency. Those pump with efficiency under 60 percent in the most recent SCE test are listed in **Table 8-16**. It is recommended that the regularly used pumps listed below be serviced in order to improve energy usage.

Table 8-16
Well and Booster Pumps with Low Efficiencies

Wells	Efficiency
Well 5	28.6%
Well 10	58.2%
Well 16	48.1%
Well 18	33.8%
Well 19	27.4%
Well 21	47.7%
Well 23A	55.8%
Well 25	53.7%
Well 30	59.2%
Well 32	54.7%
Well 33	53.4%
Well 35	48.7%

Booster Pump	Efficiency	Comments
Hilltop	40.0%	
3600 Booster 2	58.6%	
T-8 Booster 1	51.7%	
T-8 Booster 2	45.2%	
3M 75hp	46.8%	Emergency use only
3M 150hp	56.2%	Emergency use only
3M Low Head 1	59.2%	Emergency use only
3M Low Head 3	57.8%	Emergency use only
5MG Booster 1	52.3%	
5MG Booster 2	51.6%	
Palmdale Hills	58.0%	
V-5	58.7%	
Well 5 Booster 1	43.0%	Currently being rebuilt
Well 5 Booster 3	48.6%	

Leaking Pipelines

An investigation has been made into the leaking pipeline situation based on leak reports shown on the 1-inch = 1,000 feet system leak map. Pipelines are identified by street name and by model number and the number of leaks occurring in the pipelines since 1990 are summarized. Only pipelines that have not been replaced since 1990 are listed. **Table 8-17** summarizes the leaking pipelines prioritized by number of leaks, including all identified pipelines with five or more leaks in a short segment of pipe. It is recommended that those pipelines with greater than ten leaks be replaced; monitoring should continue for the remainder. For those pipelines under 8-inch in diameter, when replaced, the pipeline size should be increased to an 8-inch diameter pipe.

Table 8-17
Pipelines with Five or More Leaks

Street	Cross Streets	# of Leaks	Diameter (in)	Length (ft)	Recommendation
42nd St East	Ave T-2 & Ave T-8	51	4, 6	1950	Abandon.
Ave Q-6	17th St E & 20th St E	37	6	1290	Replace main.
Ave Q-7	Stanridge Ave & Larkin Ave	15	6, 8	1530	Replace main.
8th St East	Ave P-12 & Ave Q	14	10	1180	Replace main.
Ave T-12	40th St E & 42nd St E	14	4, 8	1010	Replace main.
11th St East	Palmdale Blvd & Ave Q-12	13	8	1360	Replace main.
Lakeview Dr	El Camino Dr & Antelope Valley Fwy	12	8	3010	Replace main.
11th St East	Ave Q-12 & Ave R	11	8	1110	Replace main.
16th St East	Palmdale Blvd & Ave Q-11	11	6	1050	Replace main.
42nd St East	Ave T-12 & Barrel Springs Rd	10	8	1460	Replace main.
30th St East	Palmdale Blvd & Ave R	9	12	2620	Monitor for leaks.
Ave Q	9th St E & 10th St E	9	10	700	Monitor for leaks.
Barrel Springs Rd	Lakepointe Dr & Sierra Hwy	9	8, 10	2280	Replace main.[1]
11th St East	Ave Q & Palmdale Blvd	8	6	2830	Monitor for leaks.
9th St East	Ave Q-4 & Palmdale Blvd	8	6	1490	Monitor for leaks.
45th St East	Penca St & Pearblossom Hwy	7	20	950	Monitor for leaks.
6th St East	Ave P-14 & Ave Q	6	6, 8	2000	Monitor for leaks.
Ave Q	10th St E & 12th St E	6	10	1350	Monitor for leaks.[2]
10th St East	Ave Q-3 & Ave Q-6	5	12	990	Monitor for leaks.[2]
10th St East	Ave Q-6 & Palmdale Blvd	5	12	760	Monitor for leaks.[2]
20th St East	Ave Q & Ave Q-5	5	12	1590	Monitor for leaks.
40th St East	Ave S-4 & Noll Dr	5	16	510	Monitor for leaks.
Ave Q	15th St E & 16th St E	5	10	730	Monitor for leaks.[2]
Ave Q-11	15th St E & 16th St E	5	6	590	Monitor for leaks.
Ave Q-7	30th St E & Glenbrush Ave	5	6	860	Monitor for leaks.
Maureen St	Palmdale Blvd & Ave Q-10	5	6	760	Monitor for leaks.
Stanridge Ave	Ave P-12 & Ave Q	5	6	1330	Monitor for leaks.
Sumac Ave	Ave Q-3 & Ave Q-7	5	6	1140	Monitor for leaks.

Notes: 1. Though this pipeline only has nine leaks, it also is nominally above the planning criteria for velocity. Therefore, it should be replaced with a larger pipe (suggested 12-inch).
2. These pipelines have a larger parallel pipe in the same pressure zone. When these need to be abandoned, it may be appropriate to merely abandon the pipeline rather than replace the main.

RECOMMENDATIONS

This section presents an Existing System Improvement Program (ESIP) for the District with respect to the existing system. This master plan is developed based on the current (2000) water system configuration. The ESIP itemizes and prioritizes facilities requirements necessary at this document's writing, therefore, if the implementation date of the plan changes it will not affect the suggested order of improvements.

The existing distribution system and facilities generally appear to be hydraulically adequate to serve existing needs. High and low pressure occurrences outside the accepted tolerances are minimal, and there are only two locations where the pressures fall below criteria in the event of a fire. Looking at the system as a whole, storage volumes appear to be sufficient to meet operational, emergency, and fire fighting circumstances, but on closer examination, there is insufficient storage capacity in the 2850 pressure zone. A 2.5 MG tank (and pipe connecting the tank to the existing system) is recommended for the 2850 pressure zone. However, in Section 9, a larger tank is recommended for the 2850 zone, so the cost presented below for tank and connecting pipe has been prorated between the existing system and future system. The remainder of the hydraulic recommendations consists of small pipe connections or valve additions. Existing system improvements which could be addressed to reduce the amount of unaccounted for water consist of replacing pipelines prone to leakage in the older section of the District's service area. The following list contains the recommended improvements for the existing system and costs for the recommended improvements are shown in **Table 8-18**.

Table 8-18
Existing System Improvement Program and Cost Estimates

Project	Cost Estimate
Connect 2950 zone pocket to 3000 zone	$34,000
Add pipe and gate valves at 3MG Tank site	$65,000
Install 8-inch PRV at Palmdale & Division	$90,000
Replace Pipeline: Well No. 18 Outlet	$9,000
Replace Pipeline: Well No. 5 Booster No. 2 Outlet	$44,000
Replace Pipeline: Ave Q-6 from 17th St E to 20th St E	$171,000
Replace Pipeline: Ave Q-7 from Stanridge Ave to Larkin Ave	$202,000
Replace Pipeline: 8th St E from Ave P-12 to Ave Q	$177,000
Replace Pipeline: Ave T-12 from 40th St E to 42nd St E	$134,000
Replace Pipeline: 11th St E from Palmdale Blvd to Ave R	$327,000
Replace Pipeline: Lakeview Dr from El Camino Dr to Antelope Valley Fwy	$398,000
Replace Pipeline: 16th St E from Palmdale Blvd to Ave Q-11	$139,000
Replace Pipeline: 42nd St E from Ave T-12 to Barrel Springs Rd	$193,000
Replace Pipeline: Barrel Springs Rd from Lakepointe Dr to Sierra Hwy	$370,000
Install Portable Generator Hookup at 5MG Booster Station	$10,000
Install Portable Generator Hookup at Hilltop Booster Station	$10,000
Two 30 kW Mobile Generators	$30,000
Total	$2,398,000

The following additional recommendations are based on MW's experience in working with the District:

1. Keep closed accounts in the billing database, rather than expunging them.
2. Connect Well No. 5 to SCADA.
3. Measure inter-zone flows, especially those at booster stations.
4. Calibrate flow and pressure meters on a regular basis.

Section 9
Future System Analysis

The purpose of this section is to describe the analyses regarding the anticipated future water distribution system in the District's primary service area. These analyses include the assumptions utilized, the hydraulic model developed, the results determined from analyses performed, and the suggested Capital Improvement Program developed in response to analyses' results. The future system is anticipated to model a time from of ten years in the future, year 2010, based on demand projections, as presented in Section 3.

ASSUMPTIONS

The following is a list of assumptions used, including a brief explanation of the assumptions rationale or origin.

1. Future water demands are based the demand projections (development methodology) outlined in Section 3, based on the location, land use type and water duties.
2. Over the year, surface water and groundwater sources will provide 60 percent and 40 percent of the water demand, respectively.
3. Water treatment plants will produce water at a constant rate. The proposed water treatment plant has a capacity of 10 mgd.
4. Four drilled wells in the Pearland subbasin will be equipped, with a total capacity of 2.6 mgd.
5. New wells will produce 800 gpm and 400 gpm in the Lancaster and Pearland subbasins respectively.
6. Existing groundwater wells will produce water in the year 2010 according to their existing pump curves.
7. All existing wells and booster stations currently on TOU rates will remain so. All existing wells and booster stations not on TOU rates will remain so. All future wells and booster stations will be on TOU rates.
8. The future maximum day situation will be modeled with the largest groundwater well (No. 8A) out of service.
9. The total amount of water to be provided from water sources (surface water and groundwater) will be equal to the MDD. Water for peaking above the MDD, emergency uses, and fire fighting uses will be provided from storage tanks.
10. A maximum day to average day peaking factor of 1.93 is applicable to the future system.
11. LCID have a constant demand of 2,000 gpm for all scenarios.

SYSTEM CONFIGURATION

The calibrated existing system model is utilized as a baseline for the development of the future system model, representing the maximum day of demand in the year 2010. The peak hour for the year is identified as the hour of maximum demand during the maximum day of operation. In general, demands in the model are allocated based on population growth locations as identified in the development projections in Section 3. Each of the demand nodes in the model are allocated based on the parcel size and water duty factors. Specific demand locations are identified as described in Section 3. For all existing customers, it is assumed that future demands will be the same as current demands.

The District has stated a goal of providing 60 percent surface water and 40 percent groundwater to the system by the year 2010. The demand is projected to be 58.7 mgd for 2010 MDD. The current capacity of the water treatment plant is 28.0 mgd and wells are 18.4 mgd (assuming that the TOU status of wells is the same as on 2000 calibration day). Therefore, an additional 12.3 mgd of supply is necessary to meet 2010 MDD. However, under MDD, the ratio between of 60 percent surface water to 40 percent groundwater may not necessarily be met.

Additional surface water capacity was assumed to be provided by a new treatment plant located at a higher elevation, supplied from the California Aqueduct (SWP water) and/or the Palmdale Ditch by gravity. It is assumed that this treatment plant will be 10.0 mgd in size and will feed the 2950 zone by gravity and the 3000 zone by pumping. The proposed site is at the northwest corner of 47th Street East and the Aqueduct. For this treatment plant, a pipeline (approximately 4,000 feet) from the Ditch is needed, as well as an additional Aqueduct turn-out and booster station from the treatment plant to the 3000 pressure zone. A 3 MG Clearwell is also needed in conjunction with the treatment plant.

Existing wells are assumed to continue to provide water based on their current operating conditions in the future. Those current wells on TOU rates during 2000 calibration day will be assumed to be on TOU rates for future conditions, and be off-line for five hours a day. The existing wells not on TOU rates will be assumed to run 24-hours a day, if needed. The exception to this is Well No. 8A. Well No. 8A is the largest capacity well in the system and, to provide reliability and redundancy in the system, it is assumed that this well is out of service. Future wells are assumed to be on TOU rates, and be off-line for five hours a day.

The number of wells needed were estimated assuming that 40 percent of maximum day demands can be met from groundwater sources, with TOU policies in place. To meet the 2010 MDD, 23.5 mgd of groundwater capacity is needed. With a current well capacity of 18.4 mgd, an additional 5.1 mgd of well capacity is needed, assuming that wells run 24-hours a day. However, considering TOU policies, the District needs an additional 6.4 mgd of well capacity. The additional groundwater capacity is assumed to be provided by a combination of wells which are already cased and tested, and new wells. The cased and tested wells are located in the Pearland subbasin, in the 2850 and 2950 Zones. New wells are located in Lancaster and Pearland subbasins because of the greater reliability and historical production capabilities in compared with the San Andreas subbasin. Only one new well is recommended in the Lancaster subbasin, because the majority of growth is expected elsewhere in the District. It is assumed that cased and tested wells will have capabilities as reported in Section 4 of this report. It is assumed that each new well located in the Lancaster and Pearland subbasins could provide normal operating flows of 800 and 400 gpm, respectively. These normal operating flow assumptions are based on District knowledge of well production capacities in the subbasins.

Ten additional groundwater wells, with a continuous capacity totaling 4,600 gpm (6.62 mgd) have been identified and added to the hydraulic model, one within the Lancaster subbasin and the remainder within the Pearland subbasin. These wells are necessary to provide the additional capacity to meet the goal of providing 40 percent of the total system water by groundwater. Four of the ten wells are the existing cased wells with a total continuous capacity of 1,800 gpm (2.59 mgd) and will become operational as demand dictates. All four of these are in the 2950 pressure zone. Of the remaining six wells, one is located in the 2800 pressure zone, four are in the 2850 pressure zone and one is in the 2950 pressure zone. The well in the 2800 pressure zone (Lancaster subbasin) has an assumed capacity of 800 gpm (1.15 mgd). Those in the Pearland subbasin have an assumed capacity of 400 gpm (0.58 mgd) per well for a total continuous capacity of 2,400 gpm (3.46 mgd). The well locations have been chosen by considering the proximity to existing wells and major transmission pipelines. Pumping water levels are assumed to be similar to the closest existing wells for each of the new well locations.

A schematic of the future facilities is shown in **Figure 9-1** and a layout of the future facility locations is shown in **Figure 9-2**.

STORAGE ANALYSIS

The storage requirements analysis is presented prior to the configuration of the hydraulic model to demonstrate how much water is required in the system as a whole, and in each pressure zone, based on water quantity needs and not on the ability of the system to move the water between locations. The storage analysis assumes that MDD of water is provided by the water sources and therefore additional storage water is needed for operational peaking, emergencies, and fire fighting uses only. The quantities of water determined to be necessary could be provided from any combination of storage tanks and additional groundwater capacity.

It is assumed that the 2950 pressure zone currently served by Hilltop and Westmont Tanks will be merged into the 3000 pressure zone. It is also assumed that the 3200 pressure zone areas fed by Avenue T-8 boosters and the Palmdale Hills Booster will become part of the 3250 pressure zone.

Storage Requirements

The demand for LCID is included in the allocation of the total MDDs for each pressure zone in the storage analyses. The LCID demand is not included in the calculations of water necessary for operational or emergency storage and it is assumed that no fire flows would be provided to LCID from the District.

Water storage is needed for three purposes: operational storage, emergency storage, and fire fighting. Descriptions of the water quantity goals for the three purposes are given in Section 7 and are briefly reiterated here. Operational storage provides water to the distribution system when total demands are greater than the average demands on the maximum day. This allows the water sources to produce water at a constant rate, relying on a contribution from operational storage to the system when demands are greater than the maximum day average and allowing storage of water when demands are less than the maximum day average. This operational

Insert Figure 9-1
Palmdale Water District Future System Facilities
11x17 color map

Insert Figure 9-2
Palmdale Water District Future Schematic
11x17 color figure

volume has been assumed to be 25 percent of one maximum day's demand, excluding the LCID demand. For the system as a whole, this is equivalent to 13.81 MG.

Emergency storage is water stored for unexpected circumstances. These circumstances could include earthquakes, power outages, water contamination, or the simultaneous occurrence of multiple fires. The quantity of water relegated for emergency storage varies widely among water purveyors, depending upon the type of emergency expected and the reliability of existing water sources, balanced against the degree of acceptable risk and the cost of storage. It has been assumed that enough emergency storage should be available to supply a quantity of water equal to one maximum day's demand, excluding the LCID demand. For the system as a whole, this is equivalent to 55.25 MG.

The maximum fire protection requirement, for the entire system, is based on a 4,500 gpm flow for four hours. The maximum required fire storage volume for the system as a whole, based on this requirement, is 1.08 MG. Therefore, the total storage demand for the system as a whole is the sum of the operational, emergency, and fire storage demands, or 70.15 MG.

A summary of the storage requirements for the system as a whole, and for each of the individual pressure zones, is given in **Table 9-1**. Each pressure zone is allocated operational and emergency storage requirements based on the anticipated demand for that zone compared to the total system demand. Fire storage requirements are developed for each zone individually, and the system as a whole only requires enough fire storage to combat one fire. Therefore, the individual fire storage requirements do not total the requirement for the entire system.

Storage Available

Water for storage can come from several different sources. These sources include storage tanks, groundwater wells dedicated for peaking, or, in the event of an emergency or a fire, from the difference in a pump's continuous (24-hour) capacity compared to its normal operating capacity. This additional capacity, identified in **Table 8-1**, is equal to the difference in the quantity of water available if the pumps operate 24 hours per day versus the quantity of water available during their normal operations.

The District currently has 19 storage tanks with a combined storage volume of 34.66 MG. However, one storage tank is recommended to be taken out of service, reducing the total existing storage to 34.54 MG. The 6 MG Clearwell provides for additional storage, but it must be pumped to serve customers. Well peaking capacity (well capacity above maximum day production) is also available as storage. Future wells are assumed to run on TOU for 19 hours per day under maximum day conditions; the five hours that the wells are not expected to run can credited against storage. Thus, future wells have a peaking capacity of 1.38 MG. Existing wells peaking capacity is the amount of water available above the amount required to meet maximum day demands. Projected maximum day demands for 2010 are 55.3 MG. Assuming that both treatment plants are running at full capacity and future wells are running 19 hours a day (1.38 MG available for peaking from future wells), then 12.01 MG is required from existing wells, leaving 10.15 MG available for peaking, as shown in **Table 9-2**.

Table 9-1
Future System Storage Analysis

Description/Criteria	Entire System	2800	2850	2950	3000	3200 (Underground)	3200 (Tovey)	3250	3400 (UEC)	3400 (College Park)
Production for 2010 (MG)	10,451	4,453	1,673	2,609	1,070	120	77	167	119	163
ADD (MG)	28.6	12.20	4.58	7.15	2.93	0.33	0.21	0.46	0.33	0.45
MDD (MG)	55.3	23.55	8.85	13.80	5.66	0.63	0.41	0.88	0.63	0.86
Fire Flow Required (gpm)	4,500	4,500	3,000	3,000	3,000	750	750	3,000	3,000	3,000
Fire Duration (hrs)	4.0	4.0	3.0	3.0	3.0	2.0	2.0	3.0	3.0	3.0
Operational Storage (25% of MDD)	13.82	5.89	2.21	3.45	1.41	0.16	0.10	0.22	0.16	0.22
Fire Storage (MG)	1.08	1.08	0.54	0.54	0.54	0.09	0.09	0.54	0.54	0.54
Emergency Storage (1 MDD)	55.26	23.55	8.85	13.80	5.66	0.63	0.41	0.88	0.63	0.86
Total Volume Required (MG)	70.16	30.51	11.60	17.78	7.61	0.88	0.60	1.64	1.33	1.62
Storage Tanks (MG)	34.54	16.10	0.00	6.23	10.07	1.50	0.30	0.04	0.30	0.00
Water Treatment Plant Clearwell (MG)	6.00	3.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00
Existing Wells Peaking Capacity (MG)	10.15	7.86	0.92	0.89	0.23	0.00	0.00	0.25	0.00	0.00
Future Wells Peaking Capacity (MG)	1.38	0.24	0.48	0.66	0.00	0.00	0.00	0.00	0.00	0.00
Sub-Total Storage Available	52.07	27.20	1.40	10.78	10.30	1.50	0.30	0.29	0.30	0.00
Sub-Total Surplus Storage	(18.09)	(3.31)	(10.20)	(7.01)	2.69	0.62	(0.30)	(1.35)	(1.03)	(1.62)
Available Through PRVs	0.00	0.00	0.00	2.69	(2.69)	(0.30)	0.30	0.00	0.00	0.00
Total Surplus Storage	**(18.09)**	**(3.31)**	**(10.20)**	**(4.31)**	**0.00**	**0.32**	**0.00**	**(1.35)**	**(1.03)**	**(1.62)**
Recommended Storage	**25.00**	**4.00**	**8.00**	**7.00**	**0.00**	**0.00**	**0.00**	**3.00**	**1.00**	**2.00**
Additional Through PRVs	0.00	0.00	2.50	(2.50)	0.00	0.00	0.00	0.00	0.00	0.00
Surplus Volume	6.91	0.69	0.30	0.19	0.00	0.32	0.00	1.65	(0.03)	0.38

Table 9-2
Well Peaking Capacity for Future Storage Analysis

	Total Capacity (MG)	Production to Meet Demand (MG)	Peaking Capacity (MG)
Existing WTP	28.00	28.00	0.00
Future WTP	10.00	10.00	0.00
Future Wells	6.62	5.24	1.38
Sub-Total		43.24	
Total Demand		55.25	
Existing Wells	22.16	12.01	10.15

Additional Storage Required

There are many emergencies that may affect one or more pressure zones without affecting the entire system. It has been determined that if an emergency is localized to a subset of zones, there would be water available from other zones to assist with the emergency conditions. In addition, it is normally assumed that a fire can be contained to a single area and typically, water master plans usually evaluate the occurrence of one fire at a time. Inter-zone transfers are only meaningful as a method of transferring water from one zone to another; they do not add any net storage to the system. Based on the history of the area, the most probable emergency is an earthquake. In the event of an earthquake, it is assumed that more than one pressure zone would be affected, therefore, the storage analysis is conducted based on an emergency affecting the entire District.

Under the assumption that an emergency and/or fire could affect the entire distribution system, there will be no benefit from transferring water from one pressure zone to another. The exception to this is the automatic transfer of water that will occur through PRVs. This PRV water transfer is assumed to happen only to the adjacent lower pressure zone.

It was the District's request that all storage volumes be implemented via the construction of new storage tanks, and that additional well capacity not be considered in this analysis for storage volumes. These are two good practices, since the storage volume would not need to be pumped in case of emergency, and the water would be available in the event of a power outage. Recommendations for storage tanks are developed based on minimum pressure zone requirements, actual tank site locations, and District requests. District staff identified specific locations for tanks, and these sites are utilized to complete the storage analysis. The designated storage tank locations and volumes are also included in the computer hydraulic model.

Based on the above analyses, 25 MG of additional storage facilities are recommended, as shown in **Table 9-1**. The two College Park pressure zones, 3250 and 3400 will require storage tanks. A 3 MG tank is recommended for the 3250 pressure zone (additional size compared to analysis since pumping will also occur out of the tank) and 2 MG for the 3400 pressure zone. A 1 MG tank is recommended at the current Upper El Camino Tank site. Four MG of additional storage is recommended at the 45th Street Tank site to feed the 2800 pressure zone. Storage for the 2850 zone can be placed in the 2850 zone, or in higher zones, and sent by PRV in case of emergency. Thus, an 8 MG Tank is recommended for the 2850 zone, with the remaining 2.5 MG deficit placed in the 2950 zone. A 2 MG tank to feed the 2950 zone is recommended at the Lower El

Camino Tank site; additional storage is necessary in the western section of the 2950 zone because it is quite difficult to feed this region if the current water treatment plant is out of service. It is recommended that the remaining 5 MG of storage needed for the 2850 and 2950 pressure zones function also as the Clearwell for the new water treatment plant.

RECOMMENDATIONS

The following recommendations presented are necessary to meet sufficient pressures, pipeline velocities and fire flow, as described in the criteria in Section 7 for all existing and future customers, based on 2010 MDD and the sources listed above. These recommendations also assume that all recommendations made for the existing system have been implemented. Only transmission pipelines greater than 16-inch diameter and those connected to facilities are discussed in this section; distribution and smaller transmission pipelines will also be necessary, but are not discussed here.

New Water Treatment Plant

A new 10 mgd water treatment plant is recommended on the east side of the system at 47th Street East north of the Aqueduct, to serve the 2950 pressure zone by gravity and 3000 pressure zone by pumping. The WTP will receive raw water from the Aqueduct and the Ditch via gravity. To get water to the treatment plant, 4,000 feet of 20-inch pipe on 47th Street between the Aqueduct and the Ditch is necessary to bring Ditch water to the plant. It is recommended the existing 16-inch Aqueduct crossing be used for raw water from the Ditch. To bring Aqueduct water to the treatment plant, an additional turn-out from the Aqueduct will need to be constructed. A 5 MG Clearwell is recommended for the new WTP, along with a 120 hp booster station from WTP to feed the 3000 zone (three 3200 gpm boosters at 50 ft head). To feed the 2950 pressure zone by gravity, it is recommended that the 20-inch diameter pipeline in Avenue T-8 from 47th Street East to Chesboro Road, in Chesboro Road from Avenue T-8 to Avenue T and in Avenue T from 57th Street East to 62nd Street East be converted from the 3000 pressure zone to the 2950 pressure zone. With this zone conversion, Wells 20 and 35 will pump to the 2950 zone rather than the 3000 zone. To reach this pipeline, utilize the existing 16-inch pipeline in 47th Street East from the treatment plant to Avenue T-8 for gravity flow to the 2950 pressure zone. However, 16-inch pipeline is insufficient for gravity flow, and a second parallel 16-inch pipeline is necessary along this section of 47th Street East. Lastly, a PRV at 47th Street East and Avenue T-8 from the 3000 pressure zone to the 2950 pressure zone is recommended in emergencies, in order to allow water to flow to the 2950 zone from the 47th Street Tanks, if needed. Gravity flow to the 2950 pressure zone is highly recommended in order to save energy costs for pumping water to a higher zone and the breaking head at another location.

College Park

The College Park development is proposed in the southeastern section of the District. This development will be served by two pressure zones, the 3250 pressure zone and the 3400 pressure zone. The 3250 pressure zone will be served by a booster pump station feeding from the 47th Street Tanks and feed the 3 MG College Park Tank at the southern end of the College Park development. A 175 hp booster station is recommended (three 765 gpm boosters at 300 feet head).

The District also plans to place the current 3200 zones fed by the Avenue T-8 boosters and the Palmdale Hills booster as part of the 3250 zone. With this modification, pressures at some locations with the existing 3200 zones may be raised above the planning criteria to as high as 160 psi, and the District may need to install individual PRVs at some homes. With the construction of the 47th Street Booster Station, the Avenue T-8 Booster Station will only be needed for emergency purposes.

It is recommended that the existing 16-inch pipe in the 3250 pressure zone along Avenue T-8 from 45th Street East to 47th Street East and along 47th Street East from Avenue T-8 to the 47th Street Tanks be divided, and various segments used for different purposes. The section south of 47th Street Tanks will continue to be part of the 3250 zone, as the 47th Street Boosters will be pumping into this pipe. The section from along 47th Street East from the 47th Street Tanks to Avenue T-8 will be used for various projects relating to the new water treatment plant, as discussed earlier. It is recommended the section in Avenue T-8 from 45th Street East to 47th Street East be converted to the 3000 pressure zone, to allow looping in that zone.

The 3400 pressure will be fed by a booster station at the future College Park Tank and pump to a 2MG Tank along Mt. Emma Road. A 55 hp booster station is recommended (three 380 gpm boosters at 185 ft head). It is expected that the region currently fed by the V-5 booster will be incorporated as part of the 3400 pressure zone. Sixteen-inch diameter pipes are necessary between the booster station and the tank to ensure sufficient fire flow for the proposed college.

Wells 18 & 19 currently feed into a small tank, and the Palmdale Hills and V-5 boosters pump out of the tank into small hydropneumatic zones. However, with the College Park development, these two zones will become part of larger pressure zones. Therefore, it is recommended that the existing V-5 booster pump be used to pump water from Well 18 & 19 Tank into the 3250 pressure zone.

2850 Pressure Zone

Some new development is expected in the region surrounded by Palmdale Blvd, 60th Street East, Avenue R, and 70th Street East. This region is slated to be served by the 2800 pressure zone. However, the highest point in this region is at an elevation of approximately 2670 ft. For this location to be served at 40 psi, it would need to be served at a hydraulic grade of 2762 ft. In the model, the southern parts of this region can only nominally be served at 40 psi if all of the wells in the Lancaster subbasin are running. The nearest tank is 45th Street Tank, which is about 4 ½ miles away. This tank normally operates at about 2785 feet; the head losses in the existing pipes are too large to maintain the pressure. Rather than constructing an additional tank in the eastern section of the 2800 pressure zone and only maintaining nominal pressures, it is recommended that this region be served by the 2850 pressure zone to ensure sufficient pressure for new development in this region.

Since there is no storage currently in the 2850 pressure zone, 8 MG of storage capacity is recommended for the 2850 pressure zone, at 47th Street East and Avenue T-6. It is recommended that two 4 MG tanks be constructed; one in the near future and a second tank as required by future development. A booster station at the current 45th Street Tank site is recommended to pump water from the 2800 pressure zone to the 2850 pressure zone. Rather than pumping water to the 3000 pressure zone and breaking head back to the 2850 pressure zone, it is energy efficient to merely pump water to the 2850 pressure zone. This also provides greater flexibility to operate the system, allowing water from either treatment plant to easily serve the 2850 pressure zone. A 120 hp booster station (four 1600 gpm boosters at 80 ft of head) is recommended. A 20-inch pipeline is needed to connect the booster station and tank to the 2850 system, with 20-inch pipelines along 45th Street East from the 45th Street Tanks to Pearblossom Highway, along Pearblossom Highway from 45th Street East to 47th Street East, and along 47th Street East from Fort Tejon Road to Avenue T-6. In addition, a 16-inch pipeline is recommended along Avenue R-11 and Avenue R-12 to move water from the booster station and tank eastward throughout the 2850 pressure zone and serve as a backbone to the system. The recommended location for this pipeline is along Avenue R-12 from 47th Street East to 55th Street East, along 55th Street East from Avenue R-11 to Avenue R-12 and along Avenue R-11 from 55th Street East to 57th Street East.

As development grows east, it is also recommended that Well 30 and 33 serve the 2850 pressure zone rather than the 2950 pressure zone.

Sierra Highway and Pearblossom Highway

Based on conversations with District staff, there is a possibility for development in the region of Sierra Highway and Pearblossom Highway. Only minimal demands are expected for this region, but there is a primary concern of protecting this region in the event of a fire, if development takes place. This development would be a part of the 3200 pressure zone, and be fed from the booster station at Well No. 5. A 1 MG storage tank is recommended at SW ¼, Sec. 11, T5N, R12W, W/o Sierra Hwy, plus a 16-inch diameter pipeline along Sierra Highway, then west to the tank.

DISCUSSION OF RESULTS

The development of the future maximum day hydraulic model began with the assumption that the existing wells and boosters would operate in the same patterns as they currently operate. To balance the hydraulic model, and to minimize the number of additional facilities, it became apparent that the existing facilities would operate differently in the future than they do currently. These differences would include pump on and off times, number of pumps utilized at different times, optimum storage tank levels for various conditions, number of hours of operation of the treatment plant, and others. The District's future system may have a different TOU rate schedule or different operational goals depending on costs of operation and maintenance of various facilities.

The power of the computer hydraulic model is that it can be continuously updated to reflect the changing conditions experienced in the distribution system. This model is evaluated and analyzed under one set of conditions that indicates the need for particular system improvements. These improvements are based on the modeling and operational assumptions and are expected to be conservative for the District's ten year development horizon.

CAPITAL IMPROVEMENT PROGRAM AND TIMING OF IMPROVEMENTS

This section presents a Capital Improvement Program (CIP) for the District with respect to required future system improvements based on the analyses performed, listing the cost and timing of various improvements.

A total of 10 groundwater wells are recommended to provide enough water capacity to meet 40 percent of the average of the MDD to the distribution system. Additionally, 10 mgd of surface water is necessary and would be produced with a new water treatment plant. As a result of the hydraulic analyses, it is recommended that four new booster pump stations be used to move water through the system. A total of 25.0 MG of additional storage is allocated to eight storage facilities throughout the distribution system. The storage facilities and their appurtenances would be implemented as demand increases due to population growth.

Capital costs are developed based on costs obtained from industry manufacturers, from recent facility improvement costs in the District, and from Montgomery Watson's experience working on similar water master planning projects. Pipeline costs have been calculated using recent cost data for work completed by Montgomery Watson in other communities. All estimates have been adjusted to an Engineering News Record Construction Cost Index of 7,066 (Los Angeles, December 2000) and are consistent with the American Association of Cost Engineers guidelines for developing reconnaissance-level estimates which should range between 50 percent above and 30 percent below actual capital expenditures. A 20 percent contingency is included in the cost estimates. Engineering, administration and legal costs are estimated to be 25 percent of construction costs.

Recommended improvements for the CIP, discussed earlier, are identified in **Table 9-3**. A facility cost estimate has been developed for each project, in Year 2000 dollars. CIP projects identified for the two specific developments are expected to occur within the ten year horizon of this master plan but, if not, the facilities identified should be constructed in accordance with the actual implementation of the development. Each recommended improvement project is identified by a letter and a number. The letter designates the pressure zone in which the project is scheduled to be implemented and the number simply identifies the particular project.

The District's previous water master plan update included a ten year CIP, of which, only a handful of recommendations were implemented, since the growth rate was much lower than previously projected. Many of these recommendations were listed in **Table 9-3**. The CIP in the previous two master plans were based on a greater growth rate projection than that utilized in this master plan and, therefore, provided facilities for growth in water system demands beyond the current ten year planning horizon of 2010. The remainder of the facilities identified as part of that CIP are listed in **Table 9-4**. Some of the facilities previously identified are no longer recommended. These facilities have also been listed in **Table 9-4**. These facilities were evaluated and are included here for completeness.

All of the recommended improvements for the next ten years are based on the assumed growth rate predicted by the City. If the number of services supplied by the District increases at a slower or faster rate than predicted, the improvements should be implemented over either a longer or a shorter time period, respectively. In essence, the timing of the improvements is directly related to the number of new services. Conversely, improvements to the system need to be made soon enough that the level of service for existing customers is not degraded by the addition of new customers. As the primary improvements are the new treatment plant, wells, and storage tanks (including clearwells), each pressure zone has been analyzed to determine an appropriate indicator of when the facilities should be constructed. The timing recommendations are based on the number of equivalent units, which are calculated based on the number and size of new service connection. A standard ¾-inch new residential connection is equal to one equivalent unit; new service connections with larger diameter connections or greater fire flow requirements count as more than one equivalent unit. **Table 9-3** shows the indicators determined for each major facility.

Table 9-3
Capital Improvement Program and Timing of Improvements

Description	Indicator	Cost ($)[1]
A. Entire System		
1. 10 mgd Water Treatment Plant Conventional Plant with Ozone Disinfection (WTP) – 47th & Aqueduct	Construct with first 482 equivalent units. Count all equivalent units in the 2850, 3200 (T-8), 3250 and 3400 zones. In the 2950 and 3000 zones, count only the equivalent units east of 37th Street East. Count each 0.29 MG/yr LCID takes as one equivalent unit.	$15,450,000
2. 4,000 ft of 20-inch pipe – 47th St. E. from Ditch to Aqueduct – raw water	Construct with new WTP (A-1).	$690,000
3. Aqueduct Turn-Out	Construct with new WTP (A-1).	$750,000
4. 5 MG Clearwell – New WTP	Construct with new WTP (A-1).	$1,800,000
5. 120 hp booster pump – WTP to 3000 zone	Construct with new WTP (A-1).	$560,000
6. 1,500 ft of 16-inch pipe – 47th St. E. from WTP to Ave. T-8	Construct with new WTP (A-1).	$210,000
7. Engineering		$200,000
8. Environmental		$200,000
Sub-Total for Entire System		**$19,860,000**
B. 2800 Zone		
1. One new well in Lancaster subbasin	Construct with first 1,482 equivalent units.	$750,000
2. 4MG Tank – 45th Street Tank site	Construct 1 MG storage for every 712 equivalent units.	$1,440,000
Sub-Total for 2800 zone		**$2,190,000**

Table 9-3 (cont.)
Capital Improvement Program and Timing of Improvements

Description	Indicator	Cost ($)[1]
C. 2850 Zone		
1. 4 MG Storage Tank – 47th St. E. & Ave. T-6	Construct as soon as possible.	$1,440,000
2. 4 MG Storage Tank – 47th St. E. & Ave. T-6	Construct 1 MG storage for every 711 additional equivalent units.	$1,440,000
3. 6,300 feet of 20-inch pipe – 47th St. E between Ave. T-6 & Ft. Tejon Rd.	Construct as soon as possible.	$1,090,000
4. 120 hp booster pump from 2800 to 2850 zones – 45th St. Tank site	Construct as soon as possible.	$560,000
5. 2,000 feet of 20-inch pipe – 45th St. E. from 45th St. Tanks to Pearblossom Hwy. and Pearblossom Hwy. from 45th St. E. to 47th St. E.	Construct as soon as possible.	$350,000
6. 6,000 feet of 16-inch pipe – Ave. R-12 from 47th St. E. to 55th St. E., 55th St. E. from Ave. R-11 to Ave. R-12 and Ave. R-11 from 55th St. E. to 57th St. E.	Construct as soon as possible.	$1,010,000
7. Four Pearland subbasin new wells	Construct one well for every 464 equivalent units.	$2,400,000
Sub-Total for 2850 zone		**$8,280,000**
D. 2950 Zone		
1. 2 MG Storage Tank – Lower El Camino Tank site	Construct with first 1,770 equivalent units.	$780,000
2. 12-inch PRV at 47th St. E. & Ave. T-8	Construct with new WTP (A-1).	$110,000
3. Four Pearland subbasin equip existing cased wells	Equip one well for every 495 equivalent units.	$1,500,000
4. One Pearland subbasin new well	Construct with first 2,479 equivalent units.	$600,000
Sub-Total for 2950 zone		**$2,990,000**
E. 3000 Zone		
No improvements requiring capital expenditures.		
F. 3200 Zone		
1. 1 MG Storage Tank –SW ¼, Sec. 11, T5N, R12W, W/o Sierra Hwy	Construct with development in region at Sierra & Pearblossom.	$450,000
2. 4,800 ft. of 16-inch pipe – between Sierra Hwy & 1 MG Tank to the west	Construct with development in region at Sierra & Pearblossom.	$660,000
3. 4,800 ft. of 16-inch pipe – between Well No. 5 and end of item No. 2	Construct with development in region at Sierra & Pearblossom.	$660,000
Sub-Total for 3200 zone		**$1,770,000**
G. 3250 Zone		
1. 3 MG Tank – College Park	Construct with lower half of College Park development.	$1,080,000
2. 175 hp booster pump to 3 MG Tank – 47th St. E. Tank site	Construct with lower half of College Park development.	$720,000
3. 8,000 ft of 16-inch pipe – Booster station to tank	Construct with lower half of College Park development.	$1,100,000
Sub-Total for 3250 zone		**$2,910,000**

Table 9-3 (cont.)
Capital Improvement Program and Timing of Improvements

Description	Indicator	Cost ($)[1]
H. 3400 Zone		
1. 1 MG storage tank – Upper El Camino Tank site	Construct after 37 equivalent units in west side of 3400 zone.	$450,000
2. 2 MG Tank – Mt. Emma Rd.	Construct with upper half of College Park development.	$780,000
3. 55 hp booster pump to 2 MG Tank – College Park Tank site	Construct with upper half of College Park development.	$330,000
4. 8,700 ft of 16-inch pipe – Booster Station to 2 MG Tank	Construct with upper half of College Park development.	$1,250,000
Sub-Total for 3400 zone		**$2,810,000**
Total Future (10-year CIP)		**$40,810,000**

Notes: 1. Costs include 20% for contingencies and 25% for engineering, administration and legal costs.
2. LA ENR Construction Cost Index of 7,066.

Table 9-4
Previously Identified Capital Improvements Beyond Ten Year Horizon

I. 3250 Zone
1. 2 MG storage tank – SW ¼, Sec. 18, T5N, R11W, near west section line (3250 zone)
2. 18-inch pipe between 5 MG and 2 MG storage tanks in Sections 12 & 18 (3250 zone)
3. Booster pump station at 5 MG tank site to 2 MG tank (3250 zone)
J. 3400 Zone
1. Hydropneumatic pressure system – 2 MG tank site, Section 11, T5N, R12W
2. Booster pump station – 2 MG tank site, Section 18, T5N, R12W, near west section line
3. 14-inch pipe between 2 MG tank, Section 18 and 2 MG tank, Mount Emma Road
4. Hydropneumatic pressure system – 2 MG tank site, Mt. Emma Road
K. Improvements No Longer Required
1. 3 MG and 4 MG storage tanks at 62nd St. E. and Ave. S-8
2. 3,000 feet of 24-inch pipe along 62nd St. E. between 3 MG & 4 MG Tanks and Ave. S
3. 9,300 feet of 24-inch pipe along Ave. S between 45th St. E. & 62nd St. E.
4. 2,800 feet of 24-inch pipe along 60th St. E. between Ave. S & Ave. R-8
5. 75 hp at Ave. S Booster Pump No. 3
6. 150 hp at 3MG High Pressure Booster Pump No. 3
7. 0.5 MG Storage Tank – Sierra Hwy. S/O Aqueduct
8. Booster Pump Station, 0.5 MG Tank site, Sierra Hwy.

Section 10
Financial

In its August 1988 Master Plan Update, the District developed the costs for facilities that were anticipated or needed to support growth in the customer base through 1995 and developed a mechanism for determining an appropriate level for the Capital Investment Fee (CIF). The District again updated its Master Plan in 1996, adjusting the CIF to reflect the new capital spending program. The District has subsequently modified the CIF to adjust to updated costs and to reflect additional projects that were necessary to service new accounts connecting to the system.

In the current Master Plan update, Montgomery Watson has taken account of all facilities currently in place and determined that additional facilities will be needed to serve new customers over the next ten years. Costs for capital facilities to meet additional demands over the next ten years have been developed, accounting for projections of growth in each of the service zones and the improvements necessary to service that growth.

Use of the CIF to recover facility costs, already incurred or planned, that are necessary to serve new customers is appropriate. The appropriate level for the CIF is determined by the overall cost level necessary to support growth, the allocation of these costs to the various service zones, the amount of fees already collected from new connections, and the number of new connections expected in each of the service zones.

ALLOCATION OF FEES

Cost of Facilities Necessary To Support New Connections

Section 9 detailed the assumptions and analysis to determine the facilities requirements to meet projected growth in the District over the next ten years. In Section 9, the facilities needed during the next ten years were specifically identified. Through the use of hydraulic modeling, the facilities required to meet design and operational criteria were identified for each service zone. Table 9-3 details the required projects and provides the estimated cost for each project by service zone, with the total cost of the ten year program projected to total $40.8 million.

Projected New Connections

In the analysis in Section 3, the total water production requirements in 2010 and 2020 were determined based on a development methodology. This methodology was chosen since it allowed allocation of growth to the different service zones based on projected development patterns. Based on this methodology, water demand in 2010 would total about 10,500 million gallons per year, compared to the 1999 requirement of about 7,625 million gallons per year. The difference represents growth in the system, for which new facilities will be required. In **Table 10-1**, this growth is allocated to individual service zones to project the number of equivalent single family residential connections. The conversion to equivalent residential units was based on a projected usage per average residential unit of 0.29 million gallons per year. Dividing the projected increase in water demand for each service zone by this factor provides an estimate of the number of new equivalent residential units for the service zone. This amount was adjusted for the projected increase in commercial, industrial and multi-family connections, which in general requires greater meter sizes (often due to fire flow requirements) than single family residential units. This adjustment, labeled C&I equivalents, was based on historical growth trends for all zones except the 3400 zone. For the 3400 zone an estimate of C&I factors were developed based on the anticipated developments in College Park. The result as shown in Table 10-1 is that system-wide the number of total equivalent units in 2010 is expected to increase by about 12,569 units.

Table 10-1
Projected New Connections By Service Zone

Service Zone	Additional Demand by 2010 (MG/yr)	Projected Connections from Demand	Projected C&I Equivalents	Total New Equivalent Connections
2800/2850	1360.97	4693	1842	6535
2950/3000	1025.23	3535	846	4381
3200/3250	223.38	770	3	773
3400/3400+	212.91	734	145	879
Total	2822.50	9733	2836	12569

Notes:
Estimated demand per equivalent single family connection = 0.29 MG/yr
Projection of C&I equivalents is based on historical trend and College Park anticipated development.

Allocation of Costs To Service Zones

Table 9-3 detailed the improvements and costs by service zone that were necessary to meet the demands projected for 2010. The row titled “2001 Master Plan Project Costs” in **Table 10-2** below summarizes the costs from Table 9-3 for each service zone. In addition to these new costs, additional costs must be included for each service zone, as shown in Table 10-2. The row titled “Net Pre-1996 Adjustment” represents previous years’ projects that were designed to service growth, net of prior CIF collections. The values in this row tie to the numbers shown in the General Manager’s August 2000 report to modify the CIF. In addition, the following major expenditures have occurred since the last master plan, each of which were necessary in order to provide service to new customers: the purchase of additional State Water Project water rights, the Clearwell and booster station, and the Underground Tank booster station. While “Net Pre-1996 Adjustments” take into account collections prior to 1996, additional CIF collections have occurred since that time that must be reflected in determining the total amount of costs remaining to be collected through the CIF. These are also shown in Table 10-2. The net costs to be collected through the CIF, therefore totals approximately $64.7 million.

Table 10-2
Detailed Allocation of Costs to Service Zones ($ Thousands)

	All Zones	2800/2850	2950/3000	3200/3250	3400	Total
Net Pre-1996 Adjustment	**$8,477**	**($593)**	**$944**	**$3,219**	**($45)**	**$12,002**
Projects Completed But Not In Above:						
SWP Entitlement	$4,087					4,087
Clearwell Expansion and Boosters	$6,228		$734			6,962
Booster Pump @ El Camino Tank					$365	365
Add'l CIF Collected to 8/00	(1,588)	(886)	(453)			(2,927)
Average COP Principle Due After 2010	(10,963)					(10,963)
Add Back COP Principle Included in Pre-1996 Adjustment	14,350					14,350
2001 Master Plan Project Costs ($000's)	19,860	10,470	2,990	4,680	2,810	40,810
Total Costs to Recover ($000's)	**$40,451**	**$8,991**	**$4,215**	**$7,899**	**$3,130**	**$64,686**

As shown in Table 10-2, some facilities provide service to all zones so costs are allocated to each of the zones according to the number of connections in each of the service zones. Facilities located in each zone provide some service to higher zones as well. Following the process developed in the 1988 Update and also followed in the 1996 update, the costs in each zone are allocated as 75 percent in-zone and 25 percent to higher zones. This allocation provides an equitable sharing of costs, except in passing costs from the 3200 zone to the 3400 zone. Since there are relatively small number of connections in the 3400 zone who will benefit from the lower facilities, the “pass-through” costs are allocated on a percentage of connections basis. Costs in the 3200 zone, therefore, have been allocated at 55 percent to in-zone and 45 percent to zone 3400.

Capital Investment Fee Calculations

The Capital Investment Fee (CIF) represents the amount that new customers connecting to the system should pay in order to compensate the District and existing customers for the facilities necessary to serve the new customers.

Table 10-3
CIF Calculation For Each Service Zone

Fee Calculations ($/Connection):	2800/2850	2950/3000	3200/3250	3400 &Higher
Costs Affecting All Zones	$3,218	$3,218	$3,218	$3,218
2800’ & 2850’ System Facilities	$1,032	$373	$373	$373
2950' & 3000' System Facilities		$722	$638	$638
3200' & 3250' System Facilities			$5,617	$4,044
3400' & Higher System Facilities				$3,561
Total Projected Fee	$4,250	$4,312	$9,846	$11,834
Current Fee	$3,761	$3,360	$6,866	$8,867
Increase	13.00%	28.34%	43.40%	33.46%

As shown in Table 10-3, the CIF is projected to increase moderately across all zones. The fee increases are the results of the following:

1. Addition of ozone disinfection to the future water treatment plant to meet anticipated drinking water regulations.
2. General increase in unit construction cost for pump stations and groundwater wells since the 1996 Master Plan Update.
3. Accounting for higher unit costs in smaller capacity reservoirs, which were previously underestimated.
4. A decrease in the number of projected new connections over which to spread the costs of required facilities (12,569 versus 14,788 in the 1996 Update).

ALTERNATIVE FINANCING SOURCES

Pay-As-You-Go

Pay-as-you-go financing requires that an agency have adequate revenue generation or reserves to fund capital improvements. Reserves can be built up in advance to pay for future facility requirements by raising fees prior to the need for capital facilities. The funds can provide for either all or part of the capital costs. Using pay-as-you-go funding reduces the overall costs of capital facilities by avoiding the costs associated with arranging alternative financing (bond issue costs, legal and financial advisers, etc.) and interest expenses (which over time can exceed the principal by several times depending on the interest rate).

For pay-as-you go financing, the District could use its water rate revenues. However since the projects in the plan benefit new, rather than existing, customers, it is more appropriate that they be funded from the Capital Improvement Fee collected from new connections to the system rather than from water rates. To fully fund the projects on a pay-as-you-go basis could require excessively high fees in order to pay for the facilities, particularly if major capital projects come early in the planning period and are not evenly distributed over time.

Pay-as-you-go funding often leads to inequities since customers today are paying the full costs for facilities that will provide benefits to future customers. To achieve a more equitable sharing of the cost burden, other funding sources usually have to be utilized in addition to pay-as-you-go, due to the differences in timing between accumulation of reserves and the capital spending requirements.

Drinking Water State Revolving Fund Loan Program

Through a jointly financed program between the federal Environmental Protection Agency (EPA) and the State of California, the Drinking Water State Revolving Fund Loan Program can provide low interest loans to water utilities to help pay for improvements. Under the program loans are issued for up to 20 years at a fixed interest rate equal to 50 percent of the State's average interest rate paid on general obligation bonds sold during the previous calendar year. Loans granted during 2001 can be expected to have an interest rate below 3 percent for the life of the loan. Repayment under the program must begin within six months after completion of the project.

Generally, loans are limited to $20 million for any one project, with a cap of $30 million available to a single water utility in a single fiscal year. These amounts may be modified if it is determined that excess funds are available that cannot otherwise be obligated before the EPA obligation deadline.

Loans are granted based on a set of priority criteria that give highest priority to projects that have direct health implications. Also high on the priority list is insufficient water source capacity that results in water outages. Funds are allocated to applicants based on the priority categories until all funds are obligated.

While the DWSRF provides a very desirable source of funding, the District will not be able to utilize the program to fund its CIP projects necessary to serve new District customers. Federal law makes any project whose purpose is primarily to serve growth ineligible for funding under the revolving fund program. Projects that are not primarily to serve growth can have up to a 10 percent provision for oversizing related to projected growth, but anything beyond that would not be eligible for funding. Consequently, District projects under the CIF program would be ineligible.

General Obligation Bonds

General Obligation (G.O.) bonds are backed by the full faith and credit of the issuer. As such they also carry the pledge of the issuer to use its taxing authority to guarantee payment of interest and principal. The issuer's general obligation pledge is usually regarded by both investors and ratings agencies as the highest form of security for bond issues. As a result, G.O. bonds generally have the lowest long term costs.

Because G.O. bonds are viewed as being more secure than other types of bonds, they are usually issued at lower interest rates, have fewer costs for marketing and issuance, and do not require the restrictive covenants, special reserves, and higher debt service coverages typical of other types of bond issues.

The ultimate security for G.O. bonds is the pledge to impose a property tax to pay for debt service. Use of property taxes, assessed on the value of property, may not fairly distribute the cost burden in line with the benefits received by the District's customers. While the ability to use the taxing authority exists, the District could choose to fund the debt service from other sources of revenues, such as water rates or from the CIF. Use of the CIF to pay the debt service would provide the most equitable matching of benefits with costs, since debt service on projects that benefit primarily new customers would be paid from fees collected from those same new customers.

In California, the ability to issue new G.O. debt was severely limited by Proposition 13 (1977) which required that any new debt issue that could affect property taxes must be approved by the electorate by a two-thirds majority. (This requirement still applies even if the intent of the issuer is to use revenue sources other than property taxes to pay debt service since the taxing authority is still in place.) Consequently, few G.O. bonds have been approved over the intervening years. While not an impossible task, the cost, time, and resources required to educate the public and gain approval for G.O. bonds are likely to be substantial.

G.O. bonds are attractive due to lower interest rates, fewer restrictions, greater market acceptance, and lower issue costs. However the difficulties in securing a two-thirds majority make them less attractive than other alternatives, such as revenue bonds and certificates of participation.

Revenue Bonds

Revenue bonds are long term debt obligations for which the revenue stream of the issuer is pledged for payment of principal and interest. Because revenue bonds are not secured by the full credit or taxing authority of the issuing agency, they are not perceived as being as secure as general obligation (G. O.) bonds. Since revenue bonds are perceived to have less security and are therefore considered riskier, they are typically sold at slightly higher interest rates (frequently in the range of 0.5% to 1.0% higher) than would be the case for G.O. bonds. The security pledged is that the system will be operated in such a way that sufficient revenues will be generated to meet debt service obligations.

Typically issuers provide the necessary assurances to bondholders that funds will be available to meet debt service requirements through two mechanisms. The first is provision of a debt reserve fund. The debt reserve fund is usually established from the proceeds of the bond issue. The amount held in reserve in most cases is based on either the maximum debt service due in any one year during the term of the bonds or the average annual debt service over the term. The funds are deposited with a trustee to be available in the event the issuer is otherwise incapable of meeting its debt service obligations in any year. The issuer pledges that any funds withdrawn from the reserve will be replenished within a short period, usually within a year.

The second assurance made by the borrower is a pledge to maintain a specified minimum coverage ratio (sometimes referred to a "times coverage") on its outstanding revenue bond debt.

The coverage ratio is determined by dividing the net revenues of the borrower by the annual revenue bond debt service for the year, where net revenues are defined as gross revenues less operation and maintenance expenses. Depending on the perceived risks associated with a borrower, minimum coverage ratios are usually within the range of 1.1 to 1.3, meaning that net revenues would have to be from 110 percent to 130 percent of the amount of revenue bond debt service. To the extent that the borrower can demonstrate achievement of coverage ratios higher than required, the marketability and interest rates on new issues may be more favorable.

Issuance of revenue bonds would be authorized pursuant to the provisions of the Revenue Bond Law of 1941. Specific authority to issue a specified amount in revenue bonds requires approval by a majority of voters casting ballots. To limit costs (and risks) associated with seeking approval through elections, authorization is typically sought for the maximum amount of bonds that will be needed over the planning period. Upon receiving authorization, the agency actually issues bonds as needed, up to the authorized amount. Bonds issued under the Revenue Bond Law of 1941 are limited to paying a maximum interest rate of 12 percent.

Revenue bonds issued by the District could qualify as tax-exempt bonds so that interest earned by bondholders could be exempt from both federal and California income taxes. As tax exempt debt, the bonds would have a lower interest cost than would taxable bonds. However, the bonds would also be subject to provisions of the Tax Reform Act of 1986 (hereafter referred to as the Tax Reform Act) regarding tax-exempt debt.

Once bonds are issued, the Tax Reform Act, as subsequently amended, requires that the proceeds be substantially used for capital projects within a three year period. Bond issues must be sized, therefore, to assure that the proceeds are utilized within the three year period. In addition the Tax Reform Act has provisions restricting arbitrage, which is the difference between the interest earnings on the bond proceeds and the interest payments. Prior to 1986, agencies were able to borrow long term funds in excess of their current needs and invest the proceeds at an interest rate higher than on the borrowings thus earning arbitrage. The Tax Reform Act now restricts the ability to earn arbitrage through onerous documentation and reporting requirements and the requirement to turn over arbitrage earnings to the government.

Use of revenue bonds provides a viable option for providing the needed financing for the District. The District will need to consider, in conjunction with its financial advisers, the feasibility of issuing the bonds as tax-exempt versus taxable bonds.

Since the costs of issuing bonds is usually a subject to economies of scale, that is the larger the bond issue the less the percentage of the bond issue that must be devoted to bond issue costs, having one larger bond issue is more economical than several smaller bond issues. For example, a bond issue of $50 million will have lower issue costs than two separate issues of $25 million. The District and its financial advisor would need to determine appropriate issue size(s).

Alternatives for Structuring Bond Debt

For either G.O. bonds or Revenue bonds, there are a number of variations for structuring the debt that may provide benefit to the District. Long term municipal bonds have traditionally been issued as fixed rate instruments, that is, the interest rate is fixed over the life of the bonds. But, as seen also in the home mortgage marketplace, there is a market for variable rate bonds in which interest rates change (up or down) over time in accordance with a specified indicator. Typically, variable rate bonds are subject to a specified floor and ceiling on the rates to protect both the issuer and the investor from excessive risk from rate fluctuations. The primary advantage to the issuer of a variable rate bond is that, by assuming part of the interest-rate risk, the issuer can achieve substantial interest rate savings compared to fixed rate issues. The issuer does, however, have less certainty about future debt service costs and may incur higher costs in the future.

The District may also achieve interest rate savings through the use of an “interest rate swap” arrangement. In “swaps”, the District would issue variable rate bonds that are matched or “swapped”, usually through the auspices of a brokerage house or bank, with another agency that has issued fixed rate bonds. By entering into a swap arrangement, the District could take advantage of the lower interest rates of a variable bond while protecting from the fluctuations that may accompany variable instruments. There are costs and some risks associated with swaps. The District would need to thoroughly explore this option with its financial advisors before embarking on a swap program.

Certificates of Participation

Certificates of Participation (COPs) are a form of lease purchase financing. COPs represent participation in an installment purchase agreement through marketable notes, with ownership remaining with the agency. COPs typically involve four different parties-- the public agency as the lessee, a private leasing company as the lessor, a bank as trustee, and an underwriter who markets the certificates. Because there are more parties involved, the initial cost of issuance for the COP and level of administrative effort for the District may be greater than for bond issues. The District has previous experience in issuing COPs and may have lower overall costs than would otherwise be the case. Due to the widespread acceptance of COPs in financial markets, COPs are usually easier to issue than other forms of lease purchase financing, such as lease revenue bonds.

The certificates are usually issued in $5,000 denominations, with the revenue stream from lease payments as the source of payment to the certificate holders. From the standpoint of the agency as the lessee, any and all revenue sources can be applied to payment of the obligation not just revenues from the projects financed, providing more flexibility. Unlike revenue bonds, COPs do not require a vote of the electorate and have no bond reserve requirements, although establishing a reserve may enhance marketability. In addition, since they are not technically debt instruments, COP issues do not count against debt limitations for the agency.

While interest costs may be marginally higher than for revenue bonds, a COP transaction is a flexible and useful form of financing that should be considered for financing of the capital program at the District.

Commercial Paper (Short Term Notes)

To smooth out capital spending flows without the costs of frequent bond issues, many public agencies have moved to use of short term commercial paper debt. As with bonds issued by the public agencies, commercial paper instruments are typically tax-exempt debt, thus providing a lower interest cost to the agency than would prevail if the commercial paper were taxable. Commercial paper is usually issued for terms ranging from as short as a few days to as long as a year, depending on market conditions. As the paper matures, it is resold ("rolled over")at the then prevailing market rate. As a result, the paper can in effect "float" over an extended time period, being constantly renewed. The short term rates paid on commercial paper are frequently much lower than those on longer term debt.

The primary advantage for the District in using commercial paper is to provide interim funding of capital projects when revenues and reserves are insufficient at the time to fully fund capital projects but either (1) the total amount needed is too small to justify a bond issue or (2) while funds are not currently available, they will be building up within two to five years to sufficient levels to repay the commercial paper borrowing. Commercial paper funding can provide the "bridge" to smooth out the fund flows.

As with other forms of debt funding, there are costs associated with commercial paper issuance. Many of the costs are similar to those of issuing bonds. With commercial paper, however, there is often a requirement that a line of credit be established that will guarantee payment of the commercial paper should it not be possible to roll the paper over at any given maturity date. The cost of the credit line is usually based on the full amount of commercial paper authorized, whether issued or not, so the total commercial paper authorization must be carefully determined to maximize the benefit to the District while minimizing costs.

While the interest rate for a particular commercial paper issue is fixed until its maturity, the short maturities and frequent rollovers of the debt effectively make commercial paper much like a long term variable rate bond. Consequently, there is some exposure to interest rate risk in using commercial paper as a funding mechanism. However, unless inflationary pressure is great, the risk is fairly low.

The strategy now being used by a number of water agencies is to issue commercial paper up to the authorized limit, then pay-off the commercial paper outstanding through a revenue bond issue. The District gets the benefit of low short term interest rates while still being able to convert to long term fixed rates through the bond issue. This is an appropriate strategy during relatively stable interest rate environments, but not when interest rates are rising or expected to rise substantially.

The District will need to confer with its legal and financial advisors to determine if sufficient authorization currently exists to implement a commercial paper program.

Assessment Bonds

Water facilities for the District could theoretically be financed with assessment bonds issued under the Community Facilities Law of 1911. This law provides that a public entity may form a special district for the purpose of making any improvement that is in the public interest. It is unlikely that this is a feasible option for the District since many of the master plan facilities are of general benefit throughout the District rather than localized benefits that could be encompassed within an assessment district. It would be possible, though probably impractical, to establish separate districts for each of the zones for which a CIF has been established. The passage of Proposition 218 several years ago made the creation of assessment districts much more difficult than in the past and imposed specific requirements to which the local agency must adhere. Discussion of the issues surrounding use of assessment bonds follows, even though it is not a recommended option.

The governing body of the entity initiating the special district must pass a resolution authorizing the project by a two-thirds vote. Approval by the County Board of Supervisors is required when unincorporated property is involved. An election of the property owners is required only if property owners representing over 50 percent of the assessed valuation in the proposed district petition for an election.

The law requires that the proposed project benefit the property upon which the assessment is made since a lien is placed against the property. If the property owner fails to pay assessments, foreclosure proceedings can be initiated. Because the liens are on the property rather than the agency, they do not represent an encumbrance of the agency and therefore not covered by any debt limitations. Interest costs are limited to 12 percent annually under the law.

While assessment bonds are a possible option for the District, the costs of establishing the assessment district, determining the amount of assessment against each property, and the potential costs of an election need to be considered.

Mello-Roos Community Facilities Act

The Mello-Roos Community Facilities Act was enacted by the California Legislature to provide an alternative method for financing essential public facilities and services directed especially to developing areas and areas undergoing rehabilitation. As with assessment bonds, Mello-Roos provisions are primarily intended to projects benefiting limited areas rather than general benefit projects. It does not appear to be a feasible option for the District for financing most of the improvements envisioned in the Master Plan, but may have application under limited circumstances.

Appendix A
References and Data Sources

Table A-1
People Contacted

Name	Organization
Laurie Lile	City of Palmdale (Planning)
Mike Behen	City of Palmdale
Art Trinkle	Metrex System Corp.
Janell Stevens	County of Los Angeles Fire Department
Matt Havens	Palmdale School District
Rod Holtz	City of Palmdale (Facilities & Parks)

All individuals contacted, apart from the District, are listed in **Table A-1**. A detailed list of all information obtained is presented in **Table A-2**.

Table A-2
Summary of Information

Description of Item	Date	Source
EPANET model	Jan, 1996	MW
Water Service Maps	June, 2000	District
Monthly Billing information for each service	1999	District
Daily and monthly production data for each source	1995-1999	District
Department of Health Services Inspection Report	1998	District
Quarterly PRV Station Check	1994-2000	District
Reservoir Information	July, 2000	District
Edison Well Pump and Booster Pump Tests	1998-2000	District
Control Setpoint Record, Wells & Boosters	July, 2000	District
List of SCADA Measuring Points	July, 2000	District
Distribution System - Pipeline, Valve, Fire Hydrant & Misc. Quantities	July, 2000	District
Mainline Replacement/Upgrades from 1-1-1995 to 7-12-00	July, 2000	District
Domestic Service Pipe Map Scale 1"=1000'	July, 2000	District
Pipe Leak Location Map	July, 2000	District
City of Palmdale Boundary	July, 2000	City
City of Palmdale General Plan Land Use Map	Jan, 1993	City
Base Map - Streets and Parcels	July, 2000	Metrex
Scanned USGS Contours	July, 2000	Metrex
Mainline Replacement Costs		District
Locations of Pipes and Facility - Planned/Construction in Progress	July, 2000	District
Urban Water Master Plan	December 29, 1995	District
City of Palmdale General Plan	Jan, 1993	District
Littlerock Dam Effluent Flow Record	1998-2000	District
Sediment Removal at Littlerock Reservoir and the Arroyo Toad		District
Water Quality Data for each source		District
List of proposed future developments	July, 2000	District
Water Loss and Use Analysis		District

Table A-2 (cont.)
Summary of Information

Yearly Production Summary	1997-2000	District
Department of Finance Population and Housing Estimates	1995-2000	City
City of Palmdale Zoning Map	Dec, 1994	City
North Los Angeles County Subregion 2020 Growth Projection Report (SCAG)	Oct, 1995	City
Antelope Valley Water Resource Study	Nov, 1995	District
Information about Antelope Valley State Water Contractors Association		District
Tank altitude valve "closed" settings		District
List of PRV stations with meters		District
Characteristics of PRVs (to determine minor loss coeff.)		District
Gate book schematics for all facilities		District
City of Palmdale Residential Development Summary	Mar, 2000	City
City of Palmdale Commercial and Industrial Development Summary	Mar, 2000	City
Hydrology Reports	July, 2000	LACDPW
CALFED Information (website)	August, 2000	CALFED
DWRSIM Model Runs	August, 2000	CDWR
Calibration Day Manually Collected Data/Pie Charts	September 8, 2000	District
Calibration Day SCADA Data	September 8, 2000	District
College Park Specific Plan (Draft)	February, 1999	City
Specific Plan Plant 10 Palmdale Lockheed Advanced Development Company	1992	City
Joshua Hills Specific Plan	May, 1983	City
City of Palmdale Avenue S Corridor Area Plan	June 10, 1998	City
Fire Prevention Regulation #8	August 15, 1991	LACFD
30-meter Digital Elevation Models (DEMs) for Palmdale, Littlerock & Ritter Ranch		USGS
Water System Master Plan	Jan, 1996	MW
Active and Inactive Accounts in each Pressure Zone	Oct, 2000	District
Elevations at Selected Intersection from Sewer Maps		District
Well Static and Pumping Levels	Oct, 2000	District
Palmdale Water Reclamation Study	June, 2000	District
Palmdale Water District Capital Improvement Fee Schedule and Policy	October 26, 2000	District
Southern California Edison Agricultural & Pumping Rate Schedules	1998	District
Palmdale Water District Emergency Generators		District
Proposed Water System and Pressure Zone Changes	January, 2001	District
Utility Record (Cost of Electricity and Gas at all Facilities)	1999	District
Certificate of Participation Installment Payments Sheet	Apr, 1998	District
PWD Capital Improvement Fee Structure and Policies	October 26, 2000	District
PWD Capital Improvement Fee Schedule and Policy	October 26, 2000	District
2000 Rates for Raw and Treated Water for LCID	May 2, 2000	District
Well NaOCl Generation Cost Year 2000	January 22, 2001	District
State Water Project Invoice to PWD from DWR	July 1, 2000	District
1996 Master Plan Recommended Improvement Costs	2000	District
2001 and 2002 Capital Improvement Fee Determination		District

Appendix B
Water Quality Regulations

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) and California Department of Health Services (CDHS) Drinking Water Regulations govern domestic water requirements. In the past few years, there have been significant changes in water quality accompanied by improvements in the understanding of the health effects of trace chemicals in water as well as the levels of detection of these chemicals. Public awareness has increased significantly due to organic solvent and pesticide contamination of groundwater. As a result, the monitoring and protection of drinking water quality have become more complex and expensive.

This section describes the content of the present federal and state drinking water regulations and provides a discussion of future regulations that will affect drinking water systems. The information is current as of March 9, 2001.

Safe Drinking Water Act and Amendments

The Safe Drinking Water Act (SDWA), originally enacted in 1974, gave the federal government, through the EPA, the authority to set standards for drinking water quality in water delivered by community (public) water suppliers. In 1986, Congress passed sweeping amendments to the SDWA. Included in the 1986 amendments were requirements for the EPA to set standards for 83 compounds, requirements to establish criteria for filtration of surface water supplies, as well as requirements for all public water systems to provide disinfection. In August 1996, Congress passed a new set of Amendments to the SDWA. The new Amendments will impact the process EPA uses to establish drinking water standards and will specifically impact the standard-setting process for radon, arsenic, sulfate, disinfection by-products, and ground water disinfection.

California Safe Drinking Water Act

As a primacy state, California drinking water regulations must be at least as stringent as federal regulations. State regulations can be more stringent than federal requirements. CDHS is charged with administering the California Safe Drinking Water Act.

The EPA has established the following water quality regulations that apply to water treatment plants and distribution systems:

The EPA National Primary Drinking Water Regulations (NPDWR, 1975); originally adopted standards for 22 compounds as "interim" standards in 1975. After the 1986 Amendments to the SDWA, these are no longer referred to as "interim" standards.

The EPA Secondary Drinking Water Regulations (EPA, 1979, 1991); advisory in nature and to be applied as determined by the states.

EPA's Trihalomethane Regulation (EPA, 1979).

EPA Requirements for Special Monitoring (EPA, 1980) for Sodium and Corrosivity Characteristics.

EPA's Phase I Regulations for 8 Volative Organic Compoundss (final July 1987); Phase I package includes requirements for monitoring unregulated compounds.

EPA's Surface Water Treatment Rule (SWTR) (final June 29, 1989).

EPA's revised Total Coliform Rule (TCR) (final June 29, 1989).

EPA's Phase II Regulations for Synthetic Organic Compounds and Inorganic Compounds) (final January 30, 1991, and July 1991).

EPA's Lead and Copper Rule (final June 7, 1991).

EPA's Phase V Drinking Water Regulations; (final July 17, 1992): cover 23 inorganic and organic compounds.

EPA's Stage 1 D/DBP Rule and the Interim Enhanced Surface Water Treatment Rule (final December 16, 1998).

EXISTING REGULATIONS

The EPA is establishing new drinking water standards and monitoring requirements for many additional contaminants pursuant to the federal SDWA Amendments. CDHS has adopted even more stringent standards for a number of inorganic chemicals (IOCs), volatile organic chemicals (VOCs) and synthetic organic chemicals (SOCs). Also, CDHS is proposing Recommended Public Health Levels (RPHLs) in drinking water for all regulated contaminants. Under these new rules, several of the most common contaminants found in Southern California groundwater basins would be regulated at levels below the existing maximum contaminant levels (MCLs). For instance, the VOCs, trichloroethylene (TCE), and tetrachloroethylene (PCE), both with an MCL of 5 micrograms per liter (µg/l), would have RPHLs of 2.5 and 0.7 µg/l, respectively. Failure to comply with RPHLs would require public water systems to prepare Water Quality Improvement Plans and could ultimately result in mandated treatment of groundwater sources even if MCLs are not exceeded.

Enhanced Surface Water Treatment Rule

On June 29, 1989 EPA published the final Surface Water Treatment Rule (SWTR). The filtration and disinfection requirements included in the Enhanced SWTR are treatment techniques to protect against the potential adverse health effects of exposure to *Giardia lamblia,* viruses, *Legionella,* and heterotrophic bacteria, as well as other pathogenic organisms that are removed by these treatment techniques. The Enhanced SWTR has resulted in agencies constructing filtration facilities on unfiltered supplies and upgrading existing filtration plants to comply with the regulations.

On December 16, 1998 the EPA published the final Interim Enhanced Surface Water Treatment Rule (IESWTR). The IESWTR includes the following:

- Establishes a requirement to achieve a 2-log reduction in *cryptosporidium* for surface water systems that filter;
- Lowers the existing turbidity performance standards from 0.5 NTU in 95% of the monthly measurements never to exceed 5 NTU, to 0.3 NTU in 95% of the monthly measurements never to exceed 1 NTU;
- Establishes requirements for continuous monitoring of individual filter effluents;
- Individual filters not performing adequately (as defined) require an exceptions report to the State and may require a Comprehensive Performance Evaluation;
- Establishes requirements for covers on new finished water reservoirs;
- States will be required to conduct periodic sanitary surveys (every three years);
- Certain systems must compile a disinfection profile and prepare a disinfection benchmark;
- Haloacetic acids (HAA) monitoring must begin within three months of publication of the final rule (quarterly monitoring of four distribution system samples for HAAs for one year) to determine if systems serving greater than 10,000 people must compile a disinfection profile and prepare a disinfection benchmark. Trihalomethanes (THMs) and HAA monitoring to determine if a disinfection profile and disinfection benchmark are required, must occur in the same year.

The Interim ESWTR applies to surface water systems, and ground water under the direct influence of surface water systems, serving greater than 10,000 people. These systems must comply by December 16, 2001.

Stage 1 Disinfectant/Disinfection By-product (D/DBP) Rule

On December 16, 1998 the US Environmental Protection Agency (EPA) published the final Stage 1 D/DBP Rule. As stated above, the Stage 1 D/DBP Rule lowered the existing standard for trihalomethanes (THM) as well as established new standards for disinfectants and other byproducts.

The previous MCL for total trihalomethanes (THMs) was 100 μg/l; however, under the final Stage 1 D/DBP) Rule, the EPA developed a revised MCL for THMs of 80 μg/l. In addition, the D/DBP rule established an MCL of 60 μg/l for HAA.

In summary, the Stage 1 D/DBP Rule includes the following:

- Lowers the existing THM standard from 0.10 mg/L to 0.080 mg/L;
- Establishes new standards for HAAs at 0.060 mg/L, bromate at 0.010 mg/L and chlorite at 1.0 mg/L;
- Establishes limits for disinfectants within the distribution system (Maximum Residual Disinfectant Levels);

- Establishes enhanced coagulation requirements wherein certain systems must achieve specific reductions of DBP precursor material (as measured by Total Organic Carbon concentrations);
- Applies to all size public water systems;
- Includes an MCLG of zero for chloroform as originally proposed in July 1994 (and not an MCLG of 300 µg/l as was proposed in a March 1998 Notice of Data Availability).

Large surface water systems (serving greater than 10,000 people) must be in compliance with the Stage 1 D/DBP Rule by January 1, 2002. Ground water systems and small surface water systems must comply by December 16, 2003. Utilities in California will determine whether or not they are in compliance after the collection of four quarters of data. Since the compliance date for the Stage 1 DBP Rule is January 1, 2002, that means a utility will not be able to determine compliance until the fourth quarter of 2002.

California DHS Groundwater Disinfection and Monitoring Policy. In July 1994 CDHS established a groundwater disinfection and monitoring policy. According to CDHS, to "....assure that coliform contamination does not go undetected, the Department has established a raw water monitoring policy for sources which are disinfected. This policy applies to supplies which are disinfected at the source or are blended in the distribution system with other supplies which carry a disinfectant residual."

Initial monitoring of the raw water source prior to disinfection is recommended at a minimum of once a month. The CDHS policy provides recommendations for follow-up if a positive coliform bacteria is detected and actions to be taken if coliform bacteria are detected on an ongoing basis. As stated in the CDHS document, this policy applies only to systems that disinfect wells at the source, or blend with supplies in the distribution system that carry a disinfectant residual.

Lead and Copper Rule

The Lead and Copper Rule (LCR) was published June 1991 and established a treatment technique that includes requirements for home tap monitoring at worst case sites, corrosion control treatment, source water treatment, lead service line replacement, and public education. The LCR establishes "action levels" in lieu of MCLs. The action level for lead was established at 0.015 mg/L while the action level for copper was set at 1.3 mg/L. An action level is exceeded when greater than 10 percent of samples collected from the sample pool contain lead levels above 0.015 mg/L or copper levels above 1.3 mg/L. Unlike an MCL, a utility is not out of compliance with the LCR when an action level is exceeded.

Arsenic

EPA finalized a rule reducing the MCL for arsenic on January 16, 2001, lowering the standard from 50 µg/L to 10 µg/L. Arsenic is a naturally occurring inorganic contaminant found in some groundwater and surface water supplies. Arsenic occurs in both the organic and inorganic forms. Only inorganic forms of arsenic are regulated by EPA, which include arsenite (As^{+3}) and arsenate (As^{+5}).

Uranium

EPA established a standard for uranium on Decmeber 7, 2000, and set the MCL at 30 μg/L. At the same time, EPA determined they will not establish revised standards for radium, beta particles, photons and alpha emitters.

PROPOSED REGULATIONS

Several regulations are under development at the federal level that could adversely affect water utilities using or planning to use groundwater to augment their supplies. Several pending regulations could be significant for local groundwater: radon, groundwater treatment rule, Stage 2 D/DBP rule, and sulfate. These new regulations are summarized below.

Radon

Under the 1996 Amendments to the SDWA, the EPA had to publish for public comment a risk reduction and cost analysis for a potential radon standard by February 6, 1999 and then propose a regulation by August 6, 1999. At the present time the MCL for radon is anticipated to be set around 300 pCi/L, based on carcinogenicity from inhalation. A final regulation was supposed to be published by August 6, 2000, but has not yet been released.

Under the 1996 Amendments, if the MCL for radon is established at a level such that the contribution of radon from water to radon in indoor air is lower than background levels of radon in outdoor air, then EPA is to establish an "alternate MCL (AMCL)." At the present time the AMCL will likely be set around 4,000 pCi/L. A public water system would be allowed to comply with the higher AMCL (and not the MCL), only if there is an EPA-approved "multimedia mitigation program" in effect for the State or for a given public water system. What would constitute a "multimedia mitigation program" has not yet been defined.

Groundwater Treatment Rule

The Groundwater Treatment Rule proposed by EPA would require disinfection to inactivate viruses unless the likelihood of microbiological contamination is remote. Since many local groundwater supplies are not routinely disinfected, this rule could require the addition of chlorine or chloramines at wells. However, the District currently disinfects all of its wells using either chlorine gas or sodium hypochlorite. No additional groundwater disinfection is anticipated at this time. Nevertheless, below is a brief summary of the status of the Groundwater Treatment Rule.

For many years EPA has been attempting to develop a set of groundwater regulations that would mirror, somewhat, the approach of the Surface Water Treatment Rule (e.g., determine which groundwater systems would be required to provide source water disinfection and/or maintain a disinfectant residual in the distribution system). Currently, under the 1996 Amendments to the SDWA, EPA has a deadline of May 2002 to promulgate a final regulation. The proposed regulation has been written and is currently under review at the Office of Management and Budget (submitted to OMB in December 1999). Early in 1999, EPA staff released a draft of the

Groundwater Rule that discussed possible source water and distribution system monitoring requirements for vulnerable systems, periodic sanitary surveys, and possible disinfection requirements for undisinfected systems when deficiencies could not be corrected. The entities that were discussed as indicators of possible fecal contamination of groundwater included *E. coli*, enterococci, and coliphage.

EPA published the proposed Groundwater Rule on May 10, 2000. The public comment period will close on August 9, 2000. The rule covers what EPA considers to be appropriate use of disinfection and best management practices to control occurrences of bacterial and viral pathogens or fecal contamination indicators in groundwater. Surface water systems that add untreated groundwater to the distribution system will fall under the jurisdiction of this rule. In summary, the State will conduct sanitary surveys to identify well deficiencies and to assess hydrogeologic sensitivity with the intent of determining which wells do not provide sufficient protection from contamination. A 4-log virus reduction is the criteria for treatment or disinfection, but it is not an absolute requirement. In lieu of 4-log virus reduction (by chlorine or other means), source water sampling is required within 24 hours of finding a positive coliform in the distribution system under the Total Coliform Rule monitoring.

Stage 2 D/DBP Rule

EPA has negotiated new limitations for THMs and HAAs as discussed under the Stage 1 D/DBP Rule. However, the second stage of the D/DBP Rule is underway. In March 1999, the EPA formed a committee [commonly referred to as the Federal Advisory Act Committee (FACA Committee)] of interested stakeholders to negotiate the next set of regulations. EPA staff indicates that they intend to publish the proposed rules in February 2001 and publish the final rules by May 2002.

Currently, the committee is focusing on the following components of the D/DBP Rule:

- The 80 μg/L and 60 μg/L for THMs and HAAs, respectively, from the Stage 1 DBP Rule will not change;
- The method of compliance, however, will be changed with compliance determined for each individual sample location, and no longer using an average of the entire distribution system;
- The new method of determining compliance is being referred to as a Locational Running Annual Average. Compliance will be based on a running annual average of results for each individual location;
- Systems will be required to conduct an Initial System Evaluation (ISE) to determine the appropriateness of the current THM/HAA sample locations;
- The ISE will require monitoring at 8 additional sample locations (separate from and in addition to the current THM sample locations);
- ISE monitoring will be conducted every other month for one-year;
- For a system using chloramines, the 8 sample locations would be distributed as follows: 2 samples at or near the entry point to the distribution system, 2 samples at locations with an average residence time, and 4 samples at sample locations with anticipated high THM and HAA levels. For a system using chlorine the 8 sample locations would be distributed as follows: one sample at or near the entry point to the distribution system two samples at

locations representing an average residence time in the distribution system, and five samples from locations anticipated to have high levels of THMs and HAAs;
- The results from the ISE will be used to revise the current sample locations for State review and approval;
- The committee is considering ISE alternatives to allow systems to avoid the additional monitoring but still gather information to allow a review and assessment of the current THM sample locations (these alternatives include (a) historical THM/HAA monitoring from similar locations, (b) chlorine residual data from the Total Coliform Rule, (c) calibrated network hydraulic models, (d) distribution system tracer studies, (e) low THM/HAA levels, (f) combinations of the above;
- The M/DBP FACA committee intends that the final sample plan would include the following four locations: one at or near the entry point to the distribution system, one at a location representing average residence time, one at a location representing highest expected THM values, and one at a location representing highest expected HAA levels;
- Monitoring under the new sample plan will be once every 90 days (plus or minus a small amount of time) with one sample collected during the month with the highest DBP levels historically.

One potentially significant unresolved issue is whether or not the bromate MCL (Stage 1 MCL of 10 μg/L) will be lowered to 5 μg/L.

Long-Term (2) Enhanced Surface Water Treatment Rule

At the present time, the FACA committee is also focusing on a Long-Term (2) Enhanced Surface Water Treatment Rule (ESWTR) proposal that would include the following requirements:

- There will be source water monitoring requirements for *cryptosporidium* (using EPA Method 1623) and *E. coli*.
- For systems serving over 10,000 people, systems would be required to monitor for 2 years and could collect either 24 samples or 48 samples in that time period.
- Systems that collect 24 samples would determine source water *cryptosporidium* concentration based on the maximum 12 month average (e.g. based on the two year sampling, they would determine 12 monthly running annual averages covering months 1-12, 2-13, 3-14, etc.,) and use the maximum annual average to determine the source water concentration.
- Systems that collect 48 samples would use the mean of the 48 results to determine the source water concentration.
- Based on the source water concentration of *cryptosporidium*, systems would be moved into the following categories for additional treatment requirements:
  - <0.075 oocyst/Liter would require no further action,
  - >0.075 oocyst/Liter and less than 1.0 oocyst/Liter would require an additional 1 log reduction (this could be achieved through combination of two 0.5 log credit steps),
  - >1.0 oocyst/Liter and <3.0 oocyst/Liter would require an additional 2 log reduction, with at least 1 log through inactivation, and
  - >3.0 oocyst/Liter would require and additional 2.5 log, with at least 1 log through inactivation.

- Inactivation would be defined to include not only UV, chlorine dioxide and ozone, but also membranes, bag filters, and bank infiltration.
- Much more detail is needed to define the activities ("toolbox") that would provide utilities with the needed log reduction credit, but items being considered include source water protection, relocating intake, managing timing of withdrawal, meeting a lower turbidity performance standard (e.g., 0.015 NTU), peer review programs such as the Partnership for Safe Water, and demonstration of increased system performance.

Sulfate

A proposed sulfate standard was originally included in the Phase V group of compounds (final standards published July 1992). In 1990, EPA proposed standards of either 400 mg/L or 500 mg/L. When the final Phase V standards were published in July 1992, however, EPA deferred the sulfate standard. On December 22, 1994 EPA re-proposed the standard for sulfate. The MCLG and MCL were proposed at 500 mg/L. The sulfate standard was never finalized.

The health effects associated with ingestion of high levels of sulfate are diarrhea and are considered to be acute health effects and temporary. There is no information indicating long-term health effects associated with exposure to high levels of sulfates. Health effects are typically seen in those people who are not acclimated to a given water (with high levels of sulfate) that include travelers, infants and new residents.

The EPA is authorized (but not required) by the 1996 Amendments to the SDWA to promulgate a regulation for sulfate. The agency was required to complete a joint project with the Centers for Disease Control and Prevention (CDC) by February 6, 1999 that would establish a reliable dose-response relationship regarding the adverse public health effects of sulfate in drinking water. The EPA must consider sulfate for regulation by August 6, 2001.

Additional Issues Under the 1996 Amendments

The following section provides information on additional regulatory issues addressed in the 1996 Amendments to the SDWA.

Source Water Protection

The 1996 Amendments to the SDWA established a new source water quality assessment program. By August 6, 1997 the EPA shall publish guidance for primacy states to carry out source water assessment programs within the state's boundary. The states must then submit their program to EPA by February 6, 1999. The 1996 Amendments also established a new coordinated and comprehensive protection of groundwater resources program within a state. CDHS has develop a drinking water source assessment and protection program (DWSAP) to comply with EPA regulations. Assessments for all public systems must be completed by May 2003.

Effective Date of Regulations

Under the 1996 Amendments compliance with regulations is required three years after promulgation. The deadline can be extended for up to two years for all systems by the EPA in the regulation or for specific public water systems by the state if it is determined that additional time is needed for the capital improvements required.

Contaminant Candidate List

In March 1998 EPA published the final “Drinking Water Contaminant Candidate List” as required under the SDWA Amendments of 1996. This list will serve as the starting point for possible future regulations. The contaminants on this list are not subject to any current or proposed drinking water regulation, are known or anticipated to occur in public water systems, “and may require regulation under SDWA.”

By August 2001, EPA will select five or more contaminants from the list and determine whether to regulate them. If the EPA determines that regulations are necessary, then the regulations must be proposed by August 2003 and final by February 2005. The criteria EPA will use to determine if a regulation is needed is whether regulating a compound presents “a meaningful opportunity to reduce health risk.”

Appendix C
Calibration Day Production Information

Table C-1
Calibration Day Well and Treatment Plant Production

Hour	Clearwell 2800 Flow Rate (gpm)	Clearwell 2950 Flow Rate (gpm)	Well 2A Flow Rate (gpm)	Well 3A Flow Rate (gpm)	Well 4A Flow Rate (gpm)	Well 5 Flow Rate (gpm)	Well 6 Flow Rate (gpm)	Well 7A Flow Rate (gpm)	Well 8A Flow Rate (gpm)	Well 10 Flow Rate (gpm)	Well 11 Flow Rate (gpm)	Well 14 Booster Flow Rate (gpm)	Well 15 Flow Rate (gpm)	Well 16 Flow Rate (gpm)	Well 18 Flow Rate (gpm)
0	8307	6386	1529	1681	0	40	78	1133	1260	169	1167	0	675	0	0
1	8294	6328	1529	1681	689	40	275	1447	1890	248	1050	0	675	0	0
2	8346	4551	1529	1681	861	75	275	1447	1890	248	1083	0	675	0	0
3	8397	4264	1529	1681	861	96	271	1447	1890	248	1133	0	671	0	0
4	8418	6298	1529	1681	72	101	267	1453	1886	248	1100	0	664	0	0
5	10609	6451	1529	1692	0	103	267	1471	1864	83	1100	0	664	0	22
6	12273	6488	1530	1693	0	103	267	1471	1864	0	1017	0	664	133	68
7	11572	6486	1530	1693	0	103	267	1471	1864	0	1233	0	664	150	0
8	10843	6461	1535	1672	0	98	235	1481	1849	0	1083	0	645	167	14
9	10799	6446	1542	1630	0	96	31	1489	1834	0	950	0	643	133	60
10	10754	6407	1542	1630	0	75	0	1489	1834	0	1183	0	643	150	0
11	10731	6388	1542	163	0	72	0	1489	1834	0	1000	0	643	117	0
12	10761	6332	797	0	0	84	0	323	397	0	1250	0	651	33	0
13	10775	6244	0	0	0	111	0	0	0	0	1083	0	661	0	0
14	10741	6214	0	0	0	88	0	0	0	0	1033	0	661	0	68
15	11422	6219	0	0	0	49	0	0	0	0	1033	0	661	0	0
16	5465	5492	0	0	0	65	0	0	0	0	1133	0	640	0	0
17	9361	6297	0	0	0	88	0	0	0	0	1200	0	632	0	0
18	5082	5567	0	0	0	85	0	0	0	0	1050	0	632	0	0
19	12485	6370	0	0	0	81	0	0	0	0	1233	0	632	0	70
20	12461	6320	562	0	0	83	0	0	0	0	983	0	632	0	1
21	12423	6260	1534	0	0	88	0	0	0	0	1267	0	632	0	0
22	11619	5784	1534	0	0	88	0	0	0	0	1117	0	632	0	0
23	10843	4117	1534	1518	0	88	0	0	0	0	1033	0	632	0	0
AVERAGE	10857	5991	992	801	108	85	94	716	909	47	1102	0	650	38	13

Note: Data from calibration day, September 8, 2000.

Table C-1 (cont.)
Calibration Day Well and Treatment Plant Production

Hour	Well 19 Flow Rate (gpm)	Well 20 Flow Rate (gpm)	Well 21 Flow Rate (gpm)	Well 22 Flow Rate (gpm)	Well 23 Flow Rate (gpm)	Well 24 Flow Rate (gpm)	Well 25 Flow Rate (gpm)	Well 26 Flow Rate (gpm)	Well 30 Flow Rate (gpm)	Well 32 Flow Rate (gpm)	Well 33 Flow Rate (gpm)	Well 35 Flow Rate (gpm)	Well Production (gpm)	Treatment Plant (gpm)	Total Production (gpm)
0	0	0	226	0	0	433	433	0	493	0	382	0	11,678	12,713	24,391
1	0	146	226	0	0	433	500	0	493	0	382	0	15,445	10,879	26,324
2	0	224	226	0	484	433	483	0	493	0	382	0	16,571	8,815	25,386
3	0	224	226	0	1210	433	483	0	493	0	382	0	15,378	10,562	25,939
4	0	85	215	350	1155	433	417	0	493	250	382	0	14,744	12,750	27,494
5	31	0	204	396	701	471	483	0	516	254	410	0	16,381	12,940	29,321
6	94	0	204	396	0	483	517	0	521	254	424	321	17,811	12,974	30,786
7	0	269	204	396	0	483	483	0	521	254	424	386	17,506	12,947	30,453
8	21	288	218	396	0	483	467	0	521	237	424	364	16,595	12,907	29,502
9	91	288	223	382	0	374	473	0	509	187	390	341	16,059	12,853	28,912
10	0	106	223	381	0	180	0	0	503	187	365	341	15,201	12,795	27,995
11	0	0	223	381	0	0	0	0	503	187	122	341	13,016	12,719	25,736
12	0	0	164	38	0	0	434	250	67	25	0	341	9,371	12,576	21,947
13	0	0	0	0	0	0	467	239	0	0	0	311	7,433	12,458	19,891
14	97	0	0	0	0	0	517	239	0	0	0	296	7,520	12,433	19,953
15	0	0	0	0	0	0	450	239	0	0	0	296	8,658	11,711	20,369
16	0	0	0	0	0	0	500	16	0	0	414	296	2,233	11,789	14,021
17	0	0	0	0	0	0	517	0	0	0	460	352	7,043	11,864	18,907
18	0	0	0	0	0	0	0	0	0	0	460	363	1,303	11,937	13,240
19	100	0	0	0	0	0	0	0	0	0	460	363	9,105	12,690	21,795
20	2	0	0	0	0	0	0	0	482	0	460	363	9,769	12,580	22,349
21	0	0	0	0	0	0	0	0	507	0	460	363	11,490	12,044	23,534
22	0	0	0	0	0	0	0	0	507	0	460	12	11,853	9,901	21,754
23	0	0	0	0	0	140	0	0	507	0	15	0	10,321	10,107	20,428
AVERAGE	19	71	111	136	154	189	313	43	332	80	317	237	17,750	5,991	23,741

Note: Data from calibration day, September 8, 2000.

Table C-2
Calibration Day Tank Production

Hour	3MG Tank		25th Street Tanks		45th Street Tanks		47th Street Tanks		5MG Tank		Walt Dahlitz Tank		Lower El Camino Tank	
	Water Level (ft)	Vol. Change (gpm)	Water Level (ft)	Vol. Change (gpm)	Water Level (ft)	Vol. Change (gpm)	Water Level (ft)	Vol. Change (gpm)	Water Level (ft)	Vol. Change (gpm)	Water Level (ft)	Vol. Change (gpm)	Water Level (ft)	Vol. Change (gpm)
0	9.7	1,165	19.9	0	16.6	0	23.1	2,806	25.9	3,509	11.4	1,856	11.5	770
1	10.8	1,589	19.9	2,738	16.6	0	24.1	3,648	27.3	4,512	13.5	1,591	12.2	1,210
2	12.3	1,589	20.7	1,711	16.6	0	25.4	3,087	29.1	4,011	15.3	353	13.3	330
3	13.8	1,483	21.2	2,053	16.6	0	26.5	2,526	30.7	3,259	15.7	88	13.6	-220
4	15.2	1,377	21.8	1,027	16.6	1,929	27.4	1,964	32.0	2,256	15.8	1,237	13.4	0
5	16.5	2,118	22.1	684	17.1	0	28.1	-1,403	32.9	-1,504	17.2	-88	13.4	330
6	18.5	2,118	22.3	0	17.1	1,929	27.6	-1,684	32.3	-2,256	17.1	-707	13.7	330
7	20.5	1,377	22.3	-1,369	17.6	0	27.0	-1,122	31.4	-1,003	16.3	-265	14.0	220
8	21.8	0	21.9	-684	17.6	0	26.6	1,122	31.0	1,253	16.0	177	14.2	440
9	21.8	424	21.7	0	17.6	0	27.0	2,245	31.5	2,256	16.2	884	14.6	550
10	22.2	635	21.7	3,422	17.6	0	27.8	1,403	32.4	1,504	17.2	972	15.1	990
11	22.8	424	22.7	3,422	17.6	4,629	28.3	-281	33.0	251	18.3	1,325	16.0	1,100
12	23.2	-847	23.7	4,107	18.8	2,700	28.2	-1,684	33.1	-1,755	19.8	972	17.0	990
13	22.4	-1,059	24.9	2,053	19.5	4,244	27.6	-1,684	32.4	-1,755	20.9	1,149	17.9	990
14	21.4	-741	25.5	3,764	20.6	6,172	27.0	-1,964	31.7	-2,005	22.2	1,060	18.8	1,430
15	20.7	741	26.6	1,027	22.2	1,929	26.3	-1,684	30.9	-1,755	23.4	1,237	20.1	1,100
16	21.4	-1,271	26.9	-3,422	22.7	4,244	25.7	-2,526	30.2	-2,256	24.8	707	21.1	1,100
17	20.2	106	25.9	-684	23.8	0	24.8	0	29.3	-1,253	25.6	530	22.1	1,100
18	20.3	-1,800	25.7	-5,133	23.8	-4,244	24.8	-561	28.8	-1,755	26.2	-530	23.1	440
19	18.6	-318	24.2	1,027	22.7	-4,629	24.6	-1,122	28.1	-1,755	25.6	-442	23.5	440
20	18.3	530	24.5	0	21.5	-2,700	24.2	561	27.4	-1,003	25.1	353	23.9	660
21	18.8	1,483	24.5	1,369	20.8	-1,929	24.4	1,403	27.0	-251	25.5	884	24.5	770
22	20.2	1,589	24.9	0	20.3	-1,929	24.9	1,684	26.9	1,755	26.5	442	25.2	550
23	21.7	318	24.9	2,738	19.8	0	25.5	2,245	27.6	1,755	27.0	353	25.7	770
24	22.0		25.7		19.8		26.3		28.3		27.4		26.4	
AVERAGE	19.39	516	23.59	863	19.37	537	26.25	268	30.22	109	20.78	534	18.45	679

Note: Data from calibration day, September 8, 2000.

Table C-2 (cont.)
Calibration Day Tank Production

Hour	Underground Tank		Upper El Camino Tank		Hilltop Tank		Westmont Tank		Ana Verde Tovey Tank		Well 5 Tank		Well 18 & 19 Tank		Total Tank Production (gpm)
	Water Level (ft)	Vol. Change (gpm)	Water Level (ft)	Vol. Change (gpm)	Water Level (ft)	Vol. Change (gpm)	Water Level (ft)	Vol. Change (gpm)	Water Level (ft)	Vol. Change (gpm)	Water Level (ft)	Vol. Change (gpm)	Water Level (ft)	Vol. Change (gpm)	
0	21.2	-106	27.1	-63	17.5	0	20.0	0	23.1	-63	18.0	-97	15.2	-5	9,773
1	21.1	0	26.7	16	17.5	0	20.0	1	22.7	-31	16.9	79	15.0	-8	15,344
2	21.1	-106	26.8	-63	17.5	0	20.0	2	22.5	-47	17.8	-115	14.7	-13	10,740
3	21.0	741	26.4	0	17.5	-9	20.0	-2	22.2	94	16.5	70	14.2	-18	10,065
4	21.7	953	26.4	47	17.4	18	20.0	0	22.8	157	17.3	-79	13.5	-25	10,860
5	22.6	212	26.7	-78	17.6	18	20.0	0	23.8	-219	16.4	88	12.5	10	167
6	22.8	-212	26.2	-157	17.8	-18	20.0	0	22.4	-31	17.4	35	12.9	75	-577
7	22.6	-106	25.2	-204	17.6	-18	20.0	0	22.2	110	17.8	-132	15.9	-53	-2,565
8	22.5	-212	23.9	-141	17.4	26	20.0	0	22.9	141	16.3	18	13.8	-13	2,128
9	22.3	-106	23.0	188	17.7	-9	20.0	0	23.8	-78	16.5	35	13.3	55	6,444
10	22.2	-106	24.2	172	17.6	26	20.0	0	23.3	-78	16.9	26	15.5	-20	8,948
11	22.1	-106	25.3	235	17.9	-9	20.0	0	22.8	-110	17.2	0	14.7	-18	10,864
12	22.0	-106	26.8	0	17.8	0	20.0	2	22.1	125	17.2	9	14.0	-18	4,497
13	21.9	0	26.8	-47	17.8	-9	20.0	-2	22.9	141	17.3	-97	13.3	-35	3,890
14	21.9	-106	26.5	47	17.7	-9	20.0	0	23.8	-31	16.2	70	11.9	105	7,794
15	21.8	0	26.8	47	17.6	-18	20.0	5	23.6	-78	17.0	53	16.1	-13	2,592
16	21.8	-106	27.1	-16	17.4	26	20.1	-6	23.1	-94	17.6	-9	15.6	-53	-3,681
17	21.7	-106	27.0	-110	17.7	18	20.0	0	22.5	-47	17.5	0	13.5	-18	-464
18	21.6	-106	26.3	-47	17.9	-9	20.0	0	22.2	94	17.5	-97	12.8	-20	-13,768
19	21.5	0	26.0	94	17.8	0	20.0	0	22.8	157	16.4	88	12.0	103	-6,358
20	21.5	-106	26.6	0	17.8	-9	20.0	0	23.8	-63	17.4	-44	16.1	-5	-1,825
21	21.4	-106	26.6	63	17.7	0	20.0	0	23.4	-47	16.9	62	15.9	-18	3,683
22	21.3	0	27.0	0	17.7	-9	20.0	0	23.1	-47	17.6	0	15.2	-8	4,027
23	21.3	0	27.0	-63	17.6	-18	20.0	0	22.8	-63	17.6	-53	14.9	-23	7,960
24	21.3		26.6		17.4		20.0		22.4		17.0		14.0		
AVERAGE	21.79	9	26.16	-1	17.64	0	20.01	0	22.91	-2	17.09	0	14.22	-1	3,511

Note: Data from calibration day, September 8, 2000. Data for Tovey Tank for hours 0 to 15 from September 11, 2000.

Appendix D
Large User Diurnal Curves

Diurnal curves were created separately for irrigation connections and non-residential large users. The diurnal curves for irrigation meters and the large user parks (Paloma Vista, McAdam and Massari) were created based on information from discussions with City Parks & Recreation staff on time of irrigation. The diurnal curve for Palmdale High School was based on information from school personnel on time of irrigation and field data collected for several schools in Palos Verdes, California. The diurnal curve for Lockheed Martin was based on demand estimates in the Specific Plan for Plant 10. The remaining customers were assigned a diurnal curve adjusted for the service connections with separate diurnal curves. These diurnal curves are shown in **Figure D-1** through **D-5**.

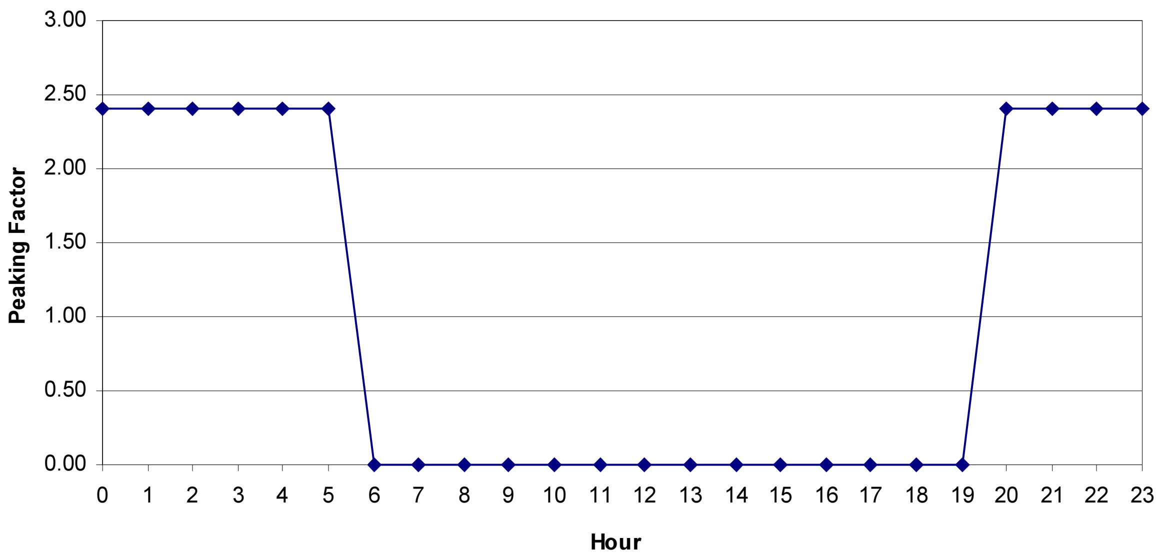


Figure D-1
Diurnal Curve for Irrigation Meters

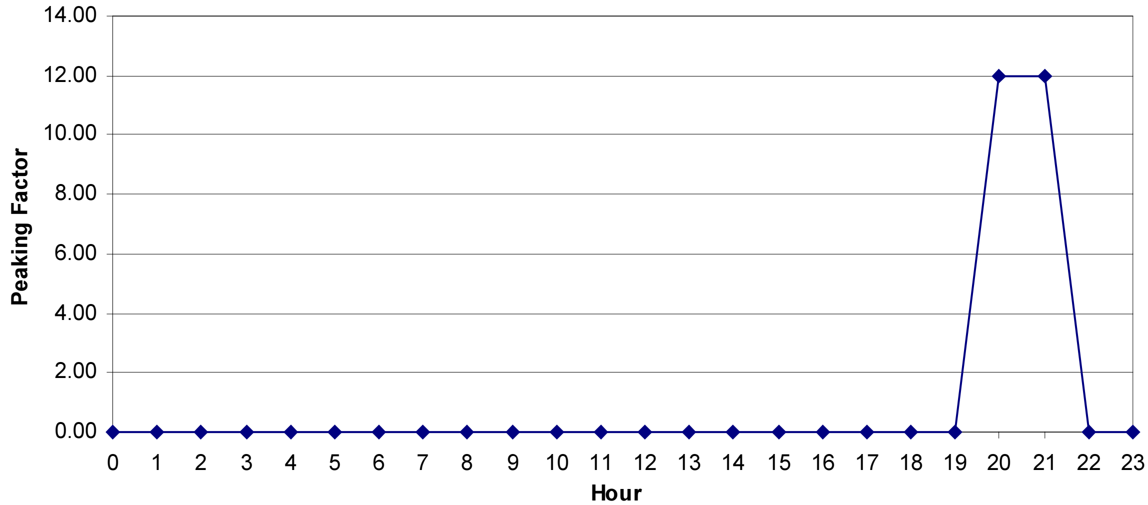


Figure D-2
Diurnal Curve for City of Palmdale Parks (Pelona Vista, McAdam & Massari)

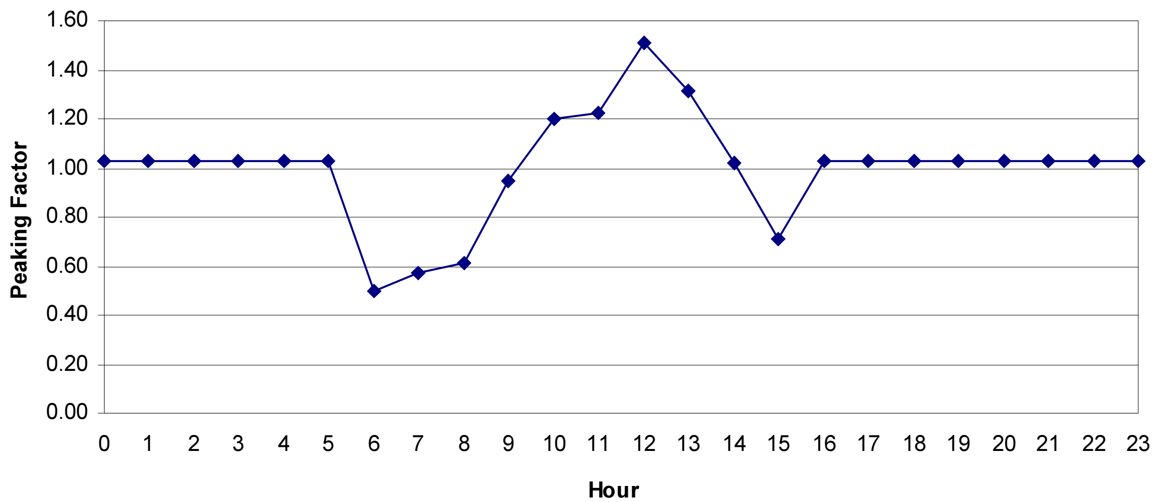


Figure D-3
Diurnal Curve for Palmdale High School

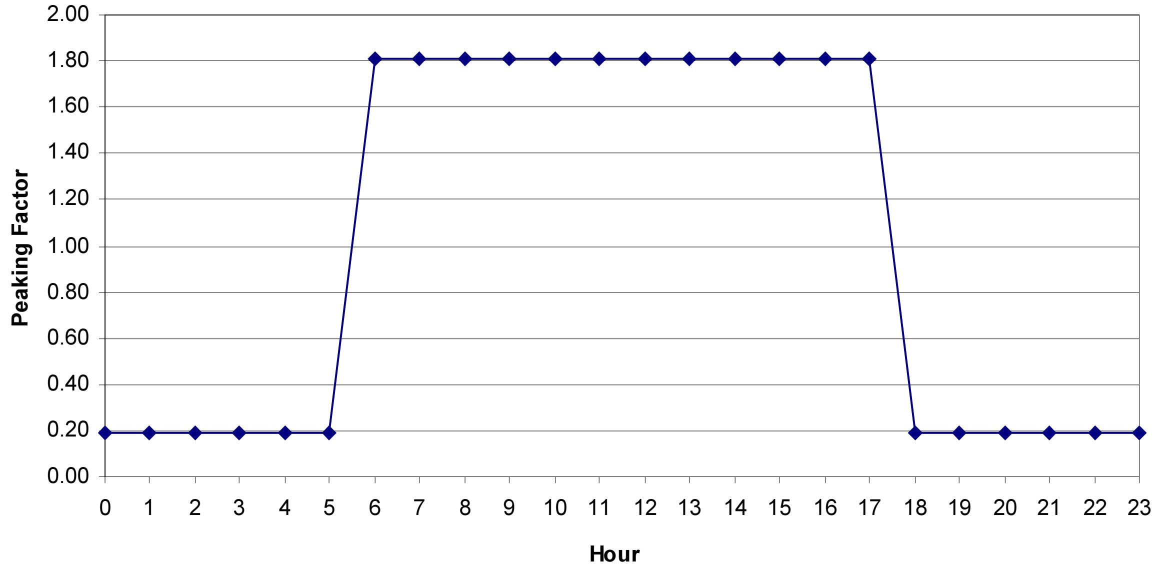


Figure D-4
Diurnal Curve for Lockheed Martin Skunkworks

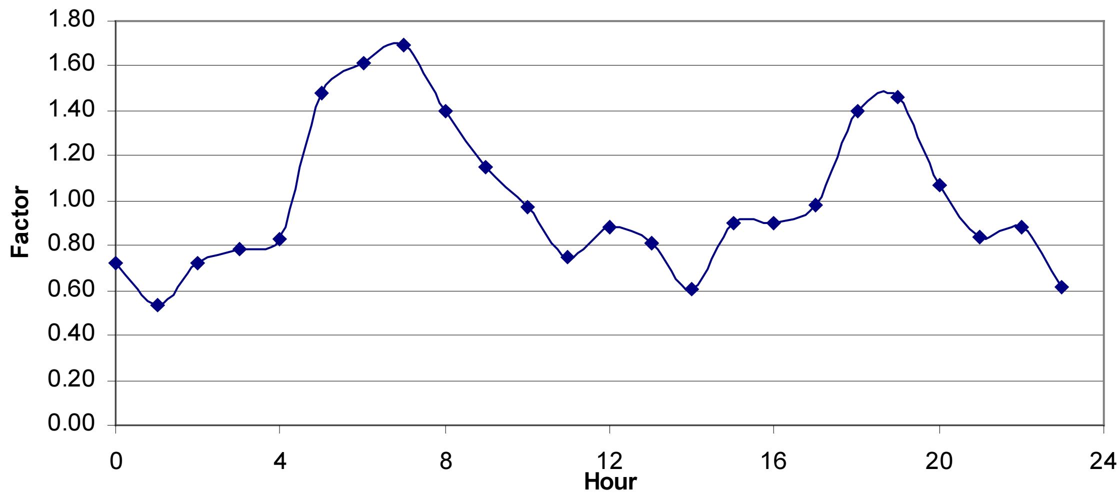


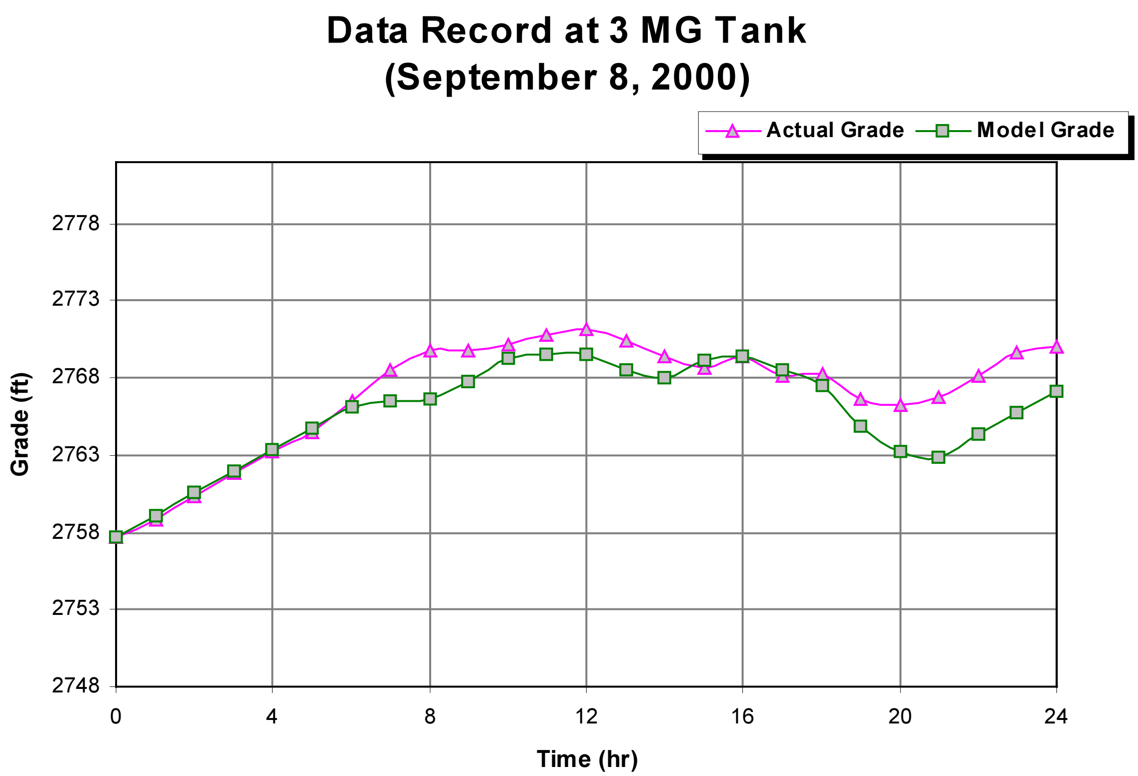
Figure D-5
Diurnal Curve without Large Users & Irrigation

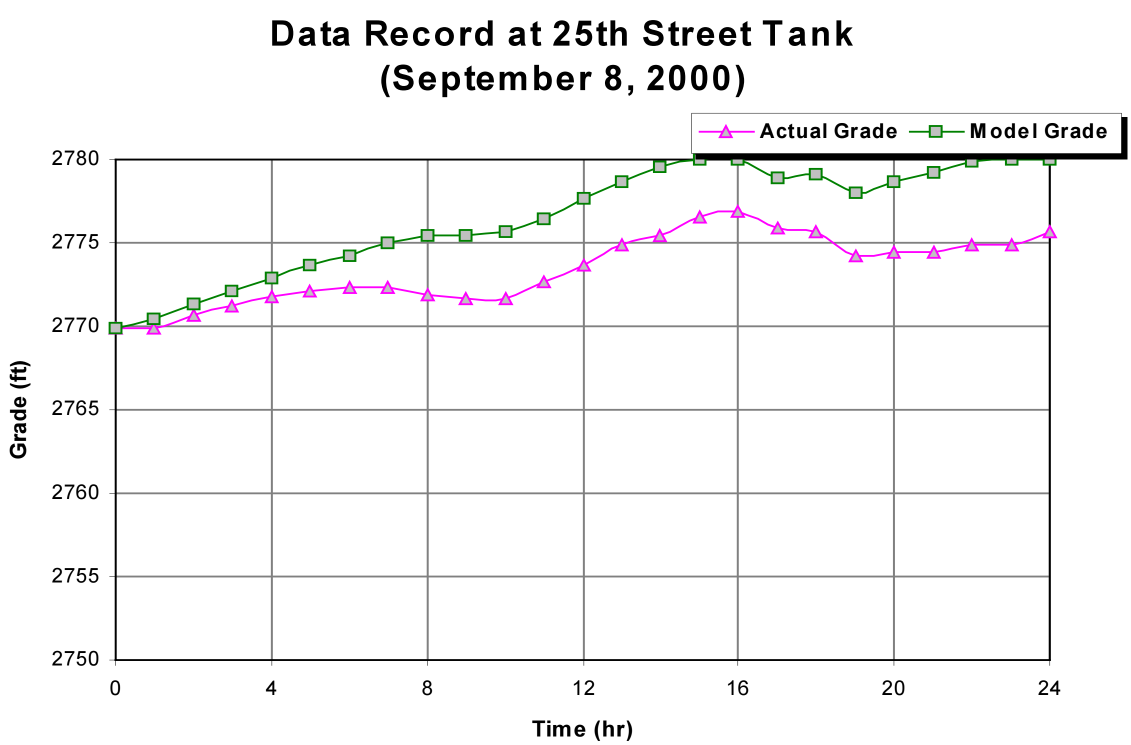
Appendix E
Well and Booster Pump Controls

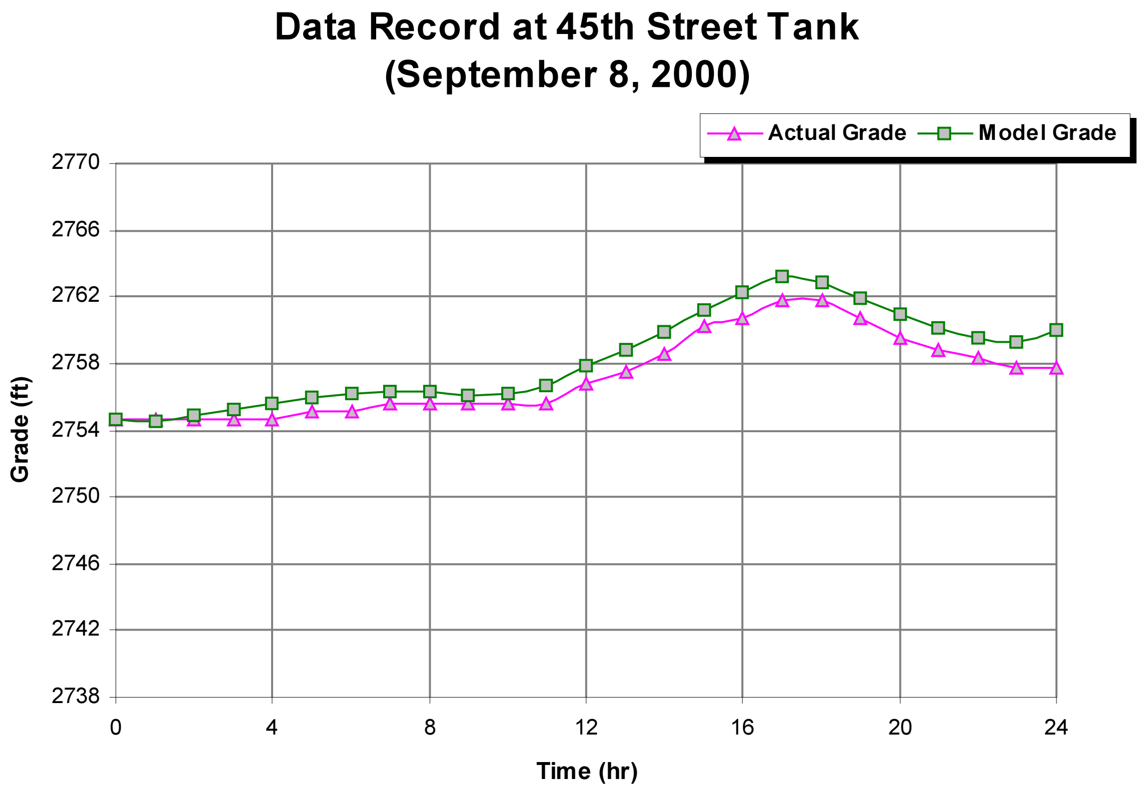
The following table, the Control Setpoint Record (CSR), shows the well and booster controls from calibration day, September 8, 2000.

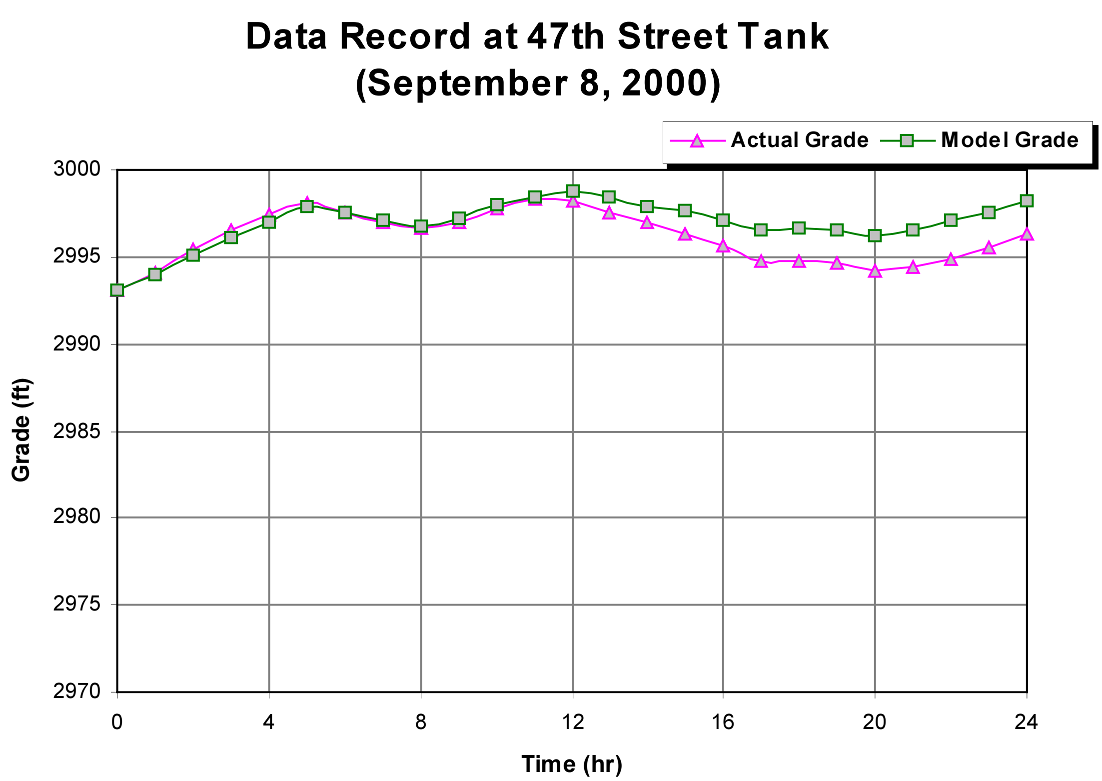
Insert Control Setpoint Record
Two 8 ½ x 11 sheets
original submitted by paper

Appendix F
Storage Tank Calibration Data

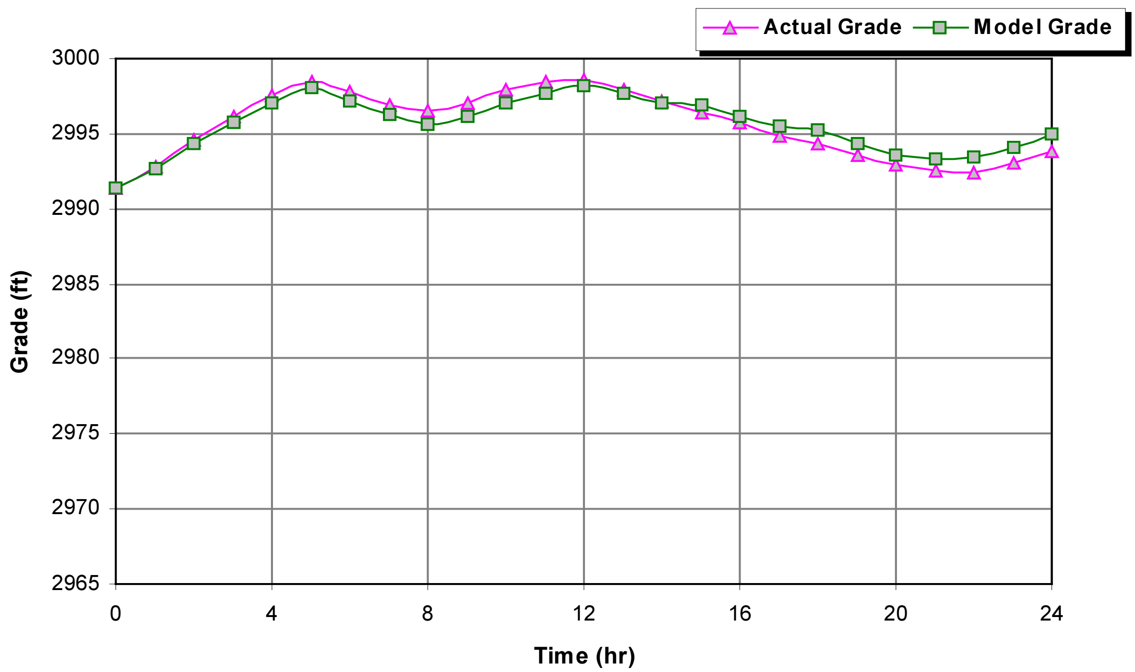




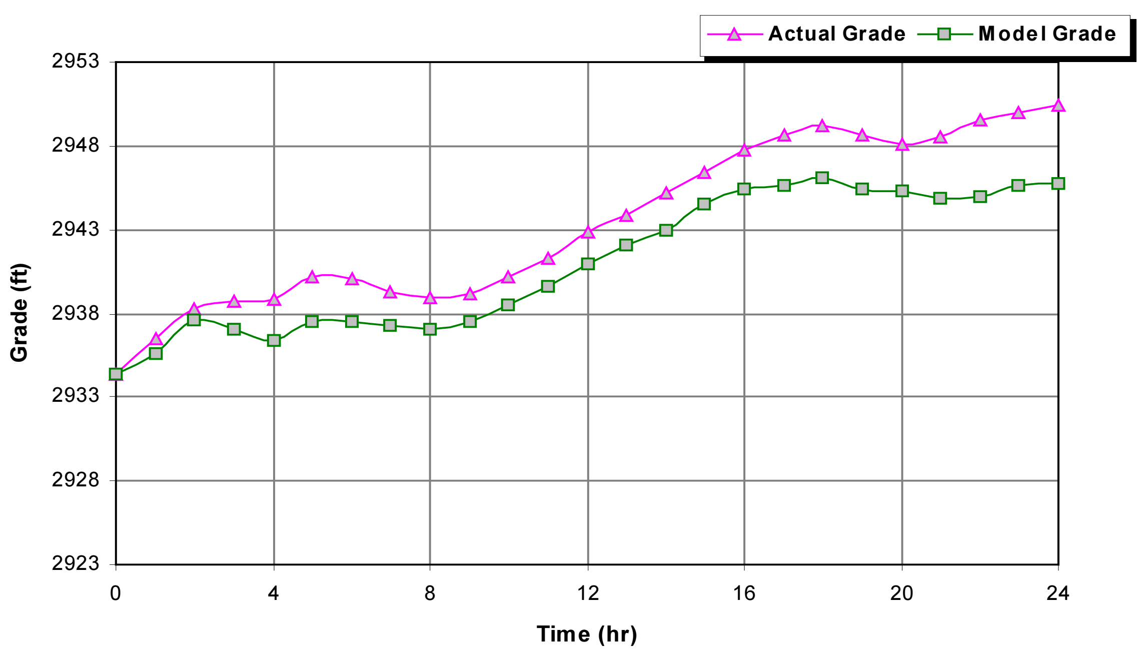

Data Record at 45th Street Tank
(September 8, 2000)
Actual Grade
Model Grade
Grade (ft)
2770
2766
2762
2758
2754
2750
2746
2742
2738
0
4
8
12
16
20
24
Time (hr)


Data Record at 47th Street Tank
(September 8, 2000)
Actual Grade
Model Grade
Grade (ft)
3000
2995
2990
2985
2980
2975
2970
0
4
8
12
16
20
24
Time (hr)

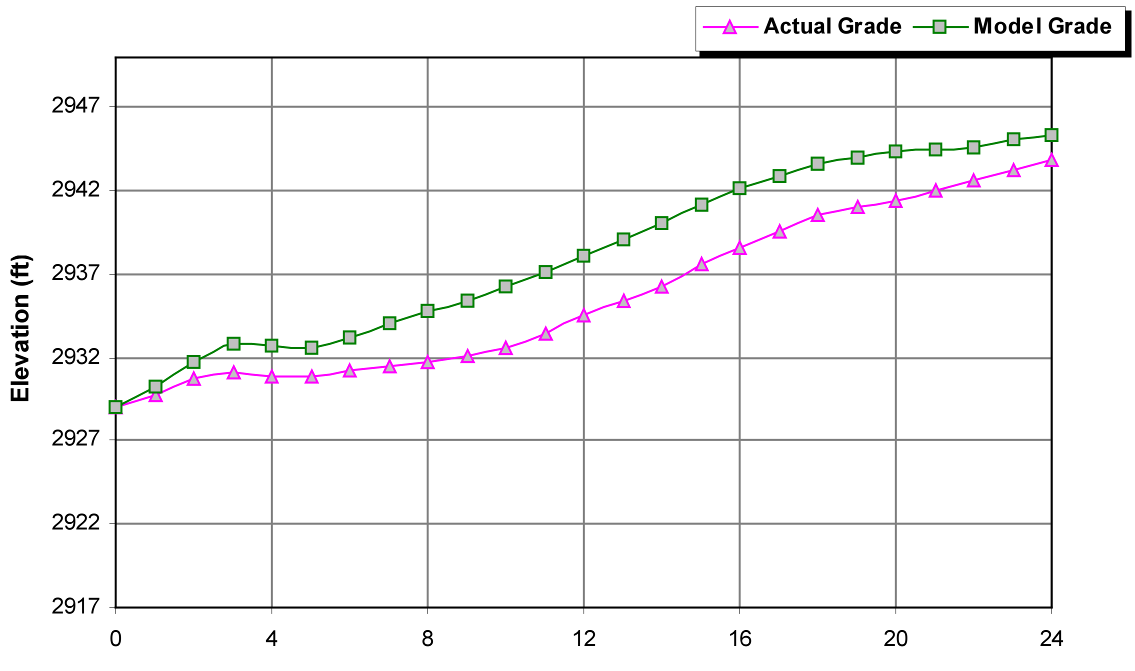
Data Record at 5 MG Tank
(September 8, 2000)



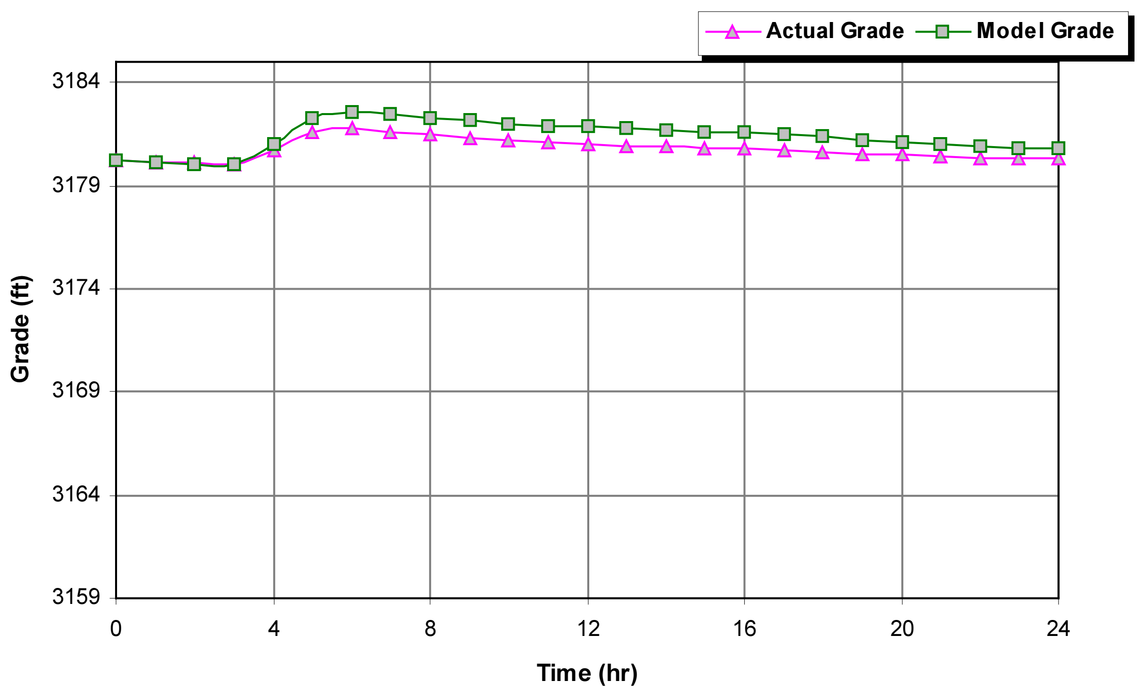
Data Record at Walter Dahlitz Tank
(September 8, 2000)

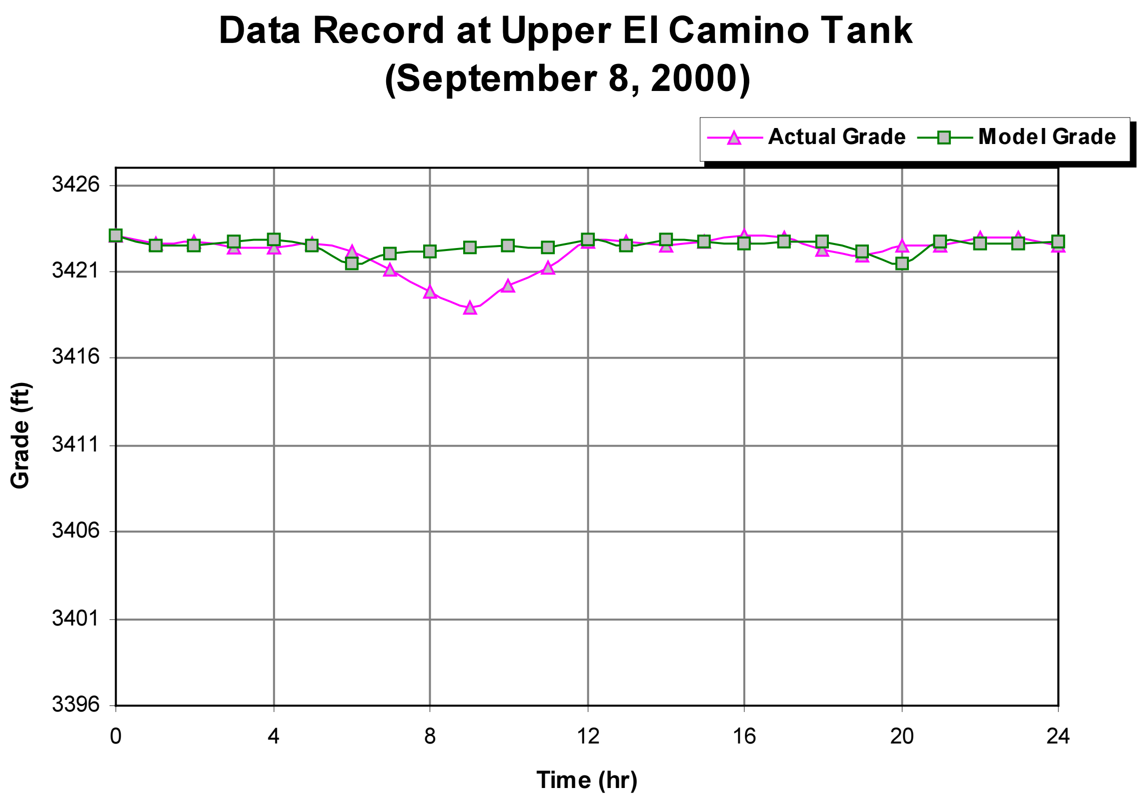


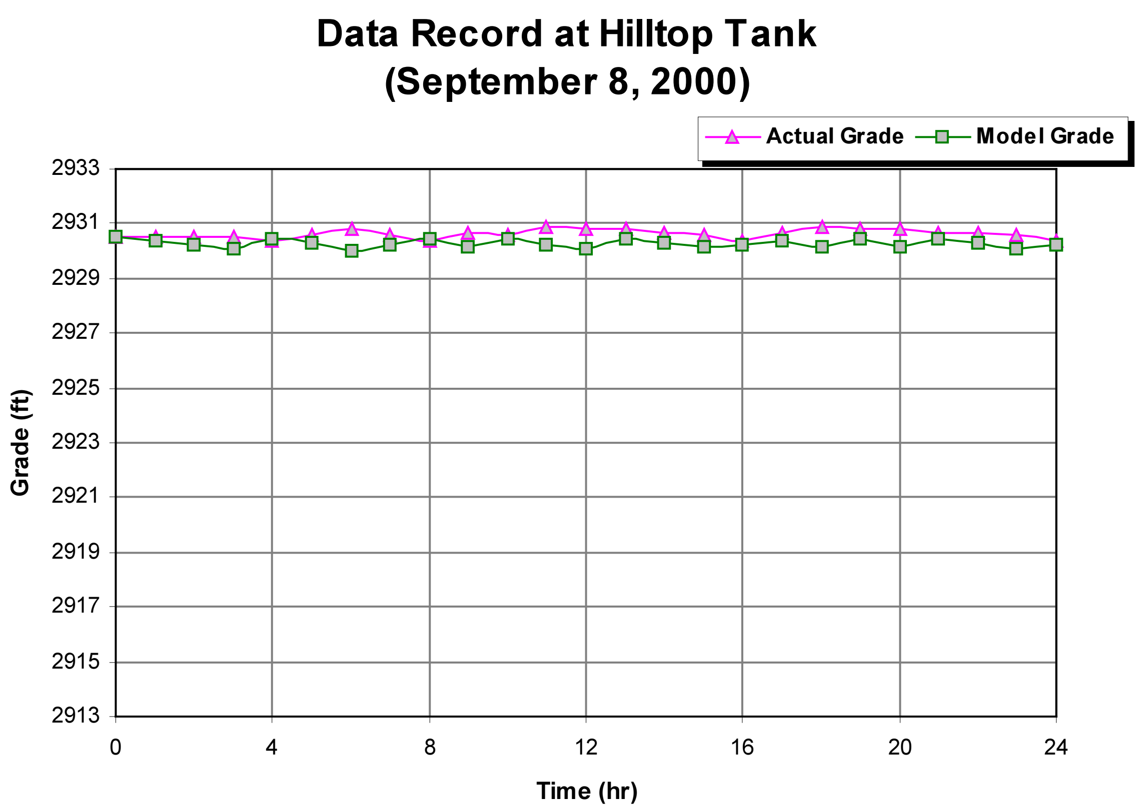
Data Record at Lower El Camino Tank (September 8, 2000)

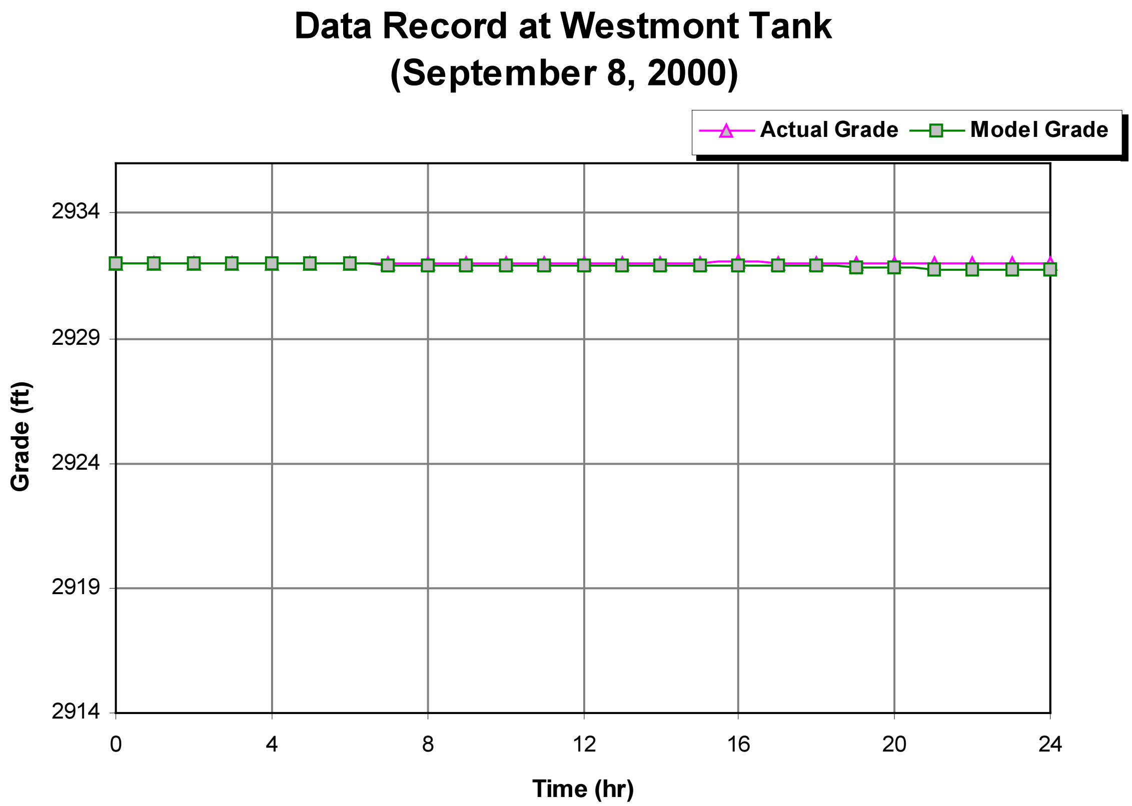


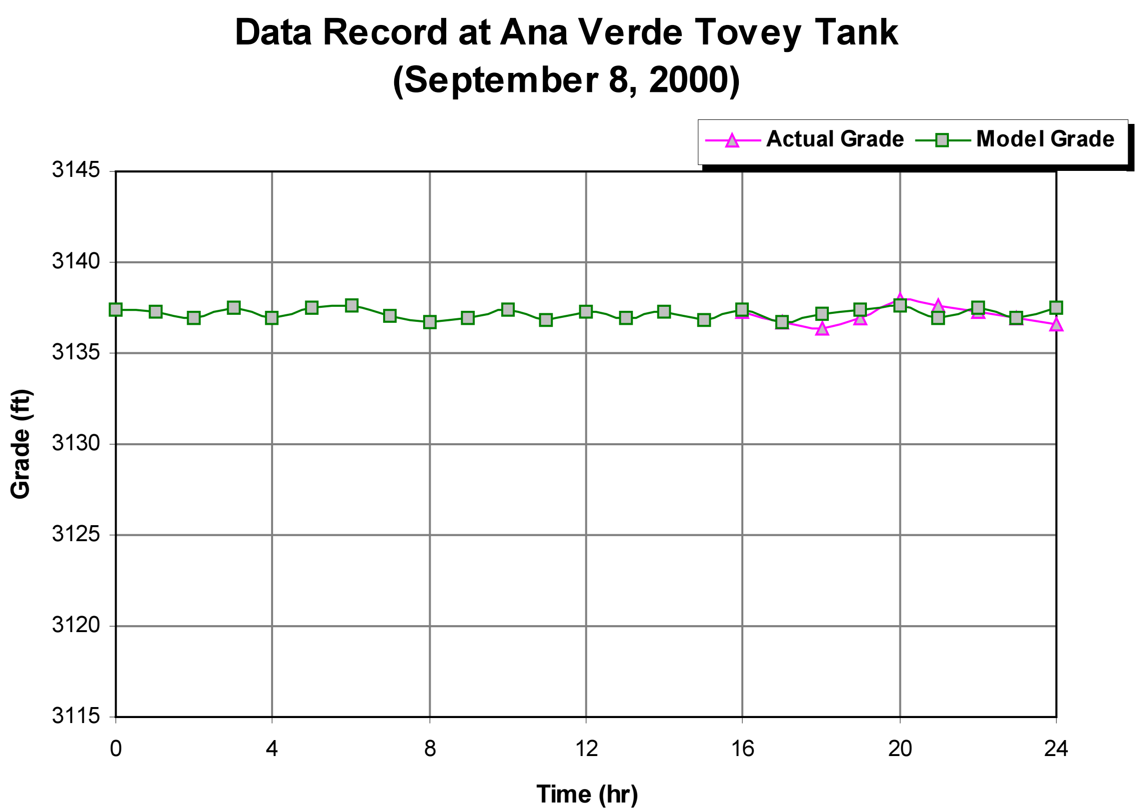
Data Record at El Camino Underground Tank (September 8, 2000)

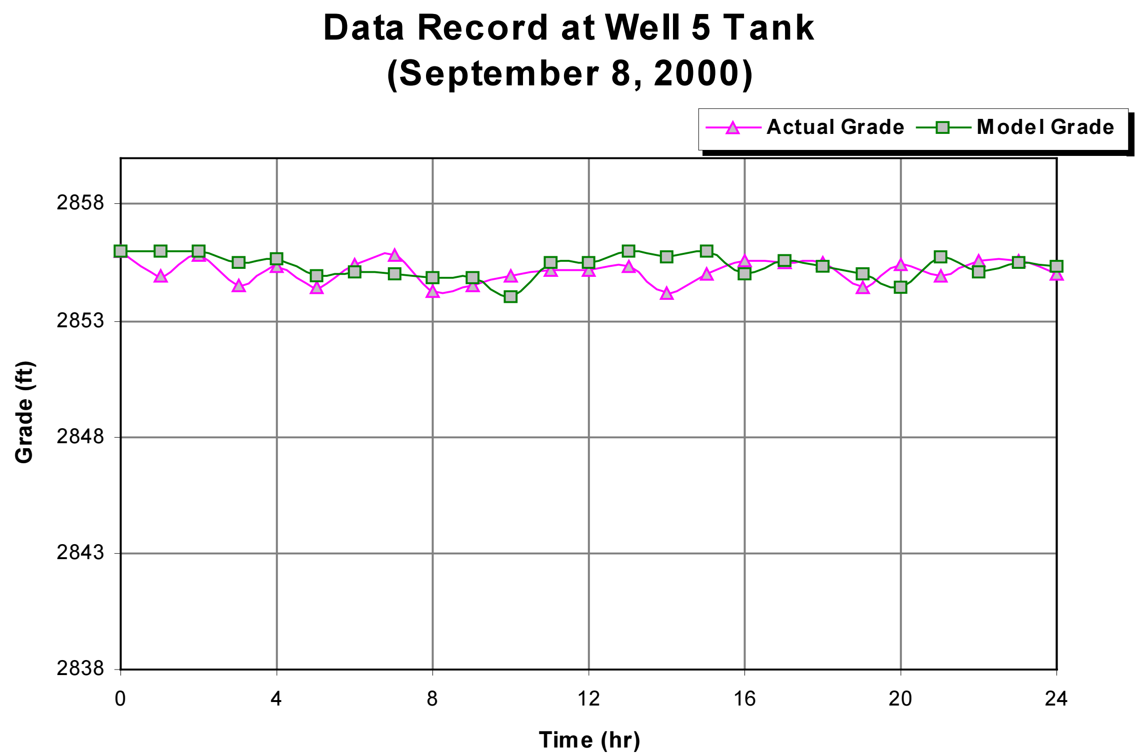


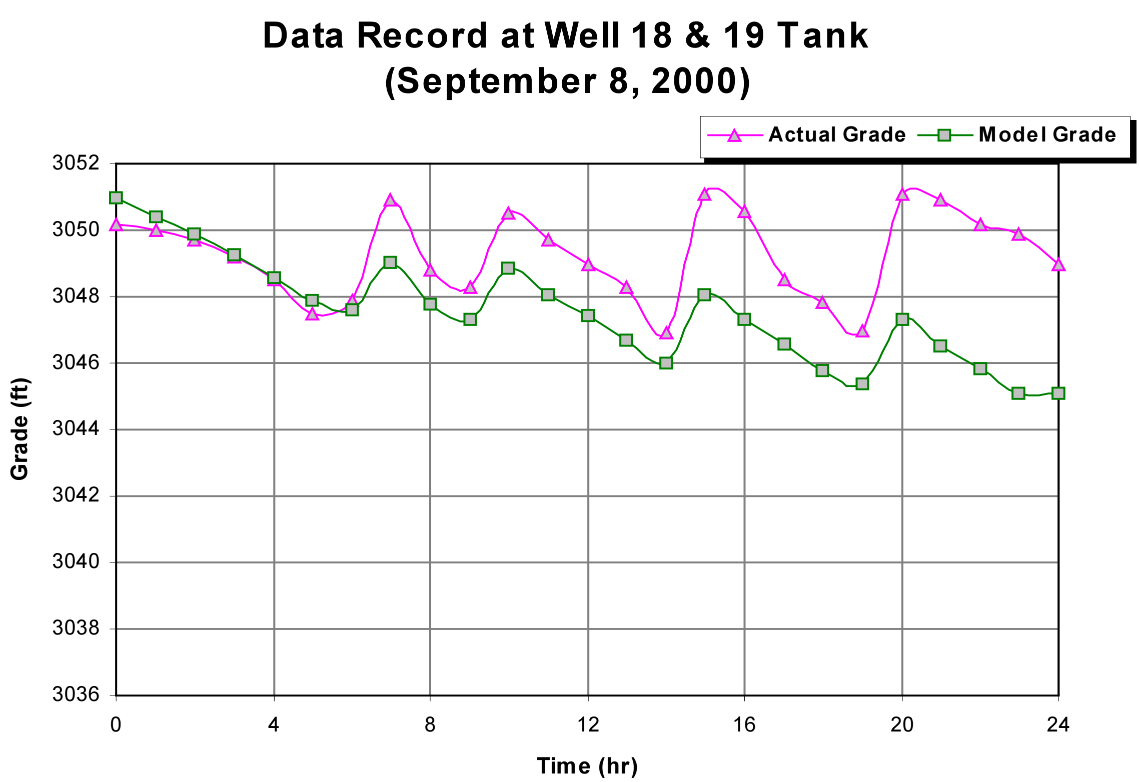

Data Record at Upper El Camino Tank
(September 8, 2000)
Actual Grade
Model Grade
3426
3421
3416
3411
3406
3401
3396
Grade (ft)
0
4
8
12
16
20
24
Time (hr)


Data Record at Hilltop Tank
(September 8, 2000)
Actual Grade
Model Grade
2933
2931
2929
2927
2925
2923
2921
2919
2917
2915
2913
Grade (ft)
0
4
8
12
16
20
24
Time (hr)


Data Record at Westmont Tank
(September 8, 2000)
Actual Grade
Model Grade
Grade (ft)
2934
2929
2924
2919
2914
0
4
8
12
16
20
24
Time (hr)


Data Record at Ana Verde Tovey Tank
(September 8, 2000)
Actual Grade
Model Grade
Grade (ft)
3145
3140
3135
3130
3125
3120
3115
0
4
8
12
16
20
24
Time (hr)


Data Record at Well 5 Tank
(September 8, 2000)
Actual Grade
Model Grade
Grade (ft)
2858
2853
2848
2843
2838
0
4
8
12
16
20
24
Time (hr)


Data Record at Well 18 & 19 Tank
(September 8, 2000)
Actual Grade
Model Grade
Grade (ft)
3052
3050
3048
3046
3044
3042
3040
3038
3036
0
4
8
12
16
20
24
Time (hr)