MASTER WATER PLAN

APPENDIX B
MODEL RESULTS

VALLEY OF THE MOON WATER DISTRICT

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CHAPTER 1
INTRODUCTION

INTRODUCTION

The original Master Water Plan for the Valley of the Moon Water District was completed in 1984 (*1984 Plan*). Although numerous improvements and changes have since been made to the water system, the *1984 Plan* contains background information regarding both the historical development of water supplies and the service area, and information about the area's characteristics (geography, topography, climate and hydrology). The *1984 Plan* continues to be the best source for this information and it has not been repeated herein.

In 1998, an updated Master Water Plan (*1998 Update* – Ref. #1) acknowledged the various improvements made to the water system since the preparation of the *1984 Plan*, and recommended numerous improvements based upon operating data and hydraulic model analyses.

Since 1998, the District has completed most of the recommended improvements listed in the *1998 Update*. In fact, the District currently has a five year Capital Improvement Program (CIP) that indicates completion of most of the recommended improvements in the *1998 Update* within the next five years. Additionally, a parallel aqueduct installed by the Sonoma County Water Agency (Agency) has increased the available water pressure during peak water use periods.

This Master Water Plan acknowledges the many improvements made to the water system since preparation of the *1998 Update* and recommends additional improvements based upon recent operating data and current hydraulic model analyses.

PURPOSE

The primary purpose of this Master Water Plan is to identify recommended improvements to the water system in order to sustain reliable service to the District's customers through the planning year of 2030. A priority schedule is provided to suggest the order in which improvements should be made along with the probable costs for budgeting purposes.

SCOPE

The scope of work associated with preparation of this Master Water Plan included the following:

1. Review and evaluate recent water production and water use records.
2. Establish design criteria for supply, pumping, storage and distribution facilities.
3. Review entitlement study projections and identify the effects on design criteria.
4. Update the computerized model of the existing water system and add an extended time period model.

5. Assist with hydrant flow tests and recalibrate the model.
6. Identify improvements to the water system using the hydraulic model and projections of future needs.
7. Prepare a Master Plan Map showing the major supply, storage and distribution facilities needed for the projected development of the service area.
8. Develop a priority schedule that identifies the order in which recommended improvements should be implemented.
9. Estimate probable cost of the recommended improvements.

CHAPTER 2
EXECUTIVE SUMMARY

EXISTING WATER SYSTEM

General

The Valley of the Moon Water District was formed in 1960 by combining numerous water companies. In acquiring those systems, the District inherited many old water storage tanks and thousands of feet of undersized, old steel water main showing the effects of age. Through an ongoing capital improvement program (CIP), the District has replaced most of the aging and undersized infrastructure.

The District's service area extends from the Trinity Oaks Subdivision in the north, to the Temelec Subdivision in the south end of the Sonoma Valley. In 2005, the service area population was approximately 23,142 persons and there were 6,771 active service connections.

The District's supply facilities include ten Sonoma County Water Agency (Agency) turnouts, four active District wells, one leased well and one standby well. Distribution facilities consist of fourteen water storage tanks, eleven booster pump stations, three hydro-pneumatic tanks and approximately 92 miles of water distribution mains.

Water Supply

The District obtains the majority of its potable water from the Agency at the ten turnouts located on the Sonoma aqueduct. The District is entitled to 8.5 million gallons per day (MGD) on the average day of the maximum water use month, with an annual limit of 3,200 acre-feet. Unfortunately, the Agency's water supply and transmission system is temporarily impaired as improvements that would allow full delivery of entitlements have been delayed by litigation. For this reason, the Agency and its contractors are currently operating under a Memorandum of Understanding Regarding Water Transmission System Capacity Allocation During Temporary Impairment (M.O.U. – Ref. #6) that reduces each contractor's entitlement until such time as the temporary impairment is lifted. The Agency M.O.U. restricts the District's entitlement to 4.9 MGD on the average day of the maximum month. The term of the M.O.U. expires on September 30, 2008.

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The District has four active water supply wells, one leased well and one well on standby status. The District is currently in the process of constructing a new well at the old Verano well site. The anticipated total capacity of all 6 active District wells will be 750 GPM, or about 800 acre-feet of annual production capacity. The District has sought to develop additional well supplies in the past in order to supplement Agency supply and possibly delay the necessity for parallel aqueduct segments. A recent report by Brown & Caldwell (B&C Report – Ref. #12) indicates that additional well sites will be difficult to develop and some may prove to be infeasible.

Storage Tanks

The Agency provides water storage for the District and the City of Sonoma in their Eldridge and Sonoma Tanks, which have a combined capacity of 18 million gallons (MG). The Agency is required to provide enough storage to be able to deliver entitlement flows to the District and the City of Sonoma during the highest historical seven consecutive day demand period. Current computer modeling indicates those tanks will empty by the end of the seven day period under full entitlement flows unless additional improvements are made to the Agency's delivery system (but not under current Agency M.O.U. entitlements). No allowance for fire flows or needs other than the high demand use during the seven day period is provided.

The District's water system includes fourteen water storage tanks with a total capacity of 5.5 MG. The tanks range in size from 0.022 MG to 2 MG. Tank construction includes redwood, concrete, bolted and welded steel. There are also three hydro-pneumatic tanks used in conjunction with the Trinity Oaks well and with the booster pump stations for Donald and Chestnut pressure zones. The hydro-pneumatic tank used in conjunction with the Trinity Oaks well is presently in standby status.

Booster Pump Stations

The District's water distribution system includes ten booster pump stations. The booster pump stations lift water from the Aqueduct zone to upper service zones, or boost water from the Agency aqueduct to tanks that would otherwise not fill completely. The Saddle booster pump station is no longer used after construction of the Glen Ellen booster pump station. A new booster pump station at Agua Caliente Road is currently under construction, and will be used to keep the 2.0 MG Hanna tank full during summer high demand periods.

Water Mains

The District's distribution system includes approximately 92 miles of water mains ranging in size from less than 2-inches up to 14-inches in diameter. More than 75 percent of water mains are either 6 or 8-inches in diameter, and more than 95 percent are between 4 and 12-inches in diameter. Most of the small diameter mains that were prevalent the distribution system have been replaced in the past 10 years due to an aggressive capital improvement program (CIP). Most of the remaining smaller diameter mains are included for replacement in the current CIP.

Monitoring/Controls

The District currently monitors all tank levels and has monitoring and control capabilities at all wells and booster pump stations. Recent upgrades to system monitoring facilities included installation of remote telemetry on the Agency's flow meters at Eldridge and Sonoma Tanks.

LAND USE & POPULATION

General

Future District water facilities and supply needs will be determined by the land use policies governed by the County of Sonoma (County). The County has begun the process of updating the 1989 General Plan (*1989 Plan* – Ref. #3)and until the update is completed and adopted, the *1989 Plan* will remain the guiding land use document.

In May 1992 the County Board of Supervisors adopted a growth limitation plan for the Sonoma Valley. Under the growth limitation plan, new residential connections in the Sonoma Valley (including the District) are limited to 90 per year (60 in urban areas, 30 in rural areas). There are exceptions for low cost housing and no limitations on commercial connections. Total growth within the District's boundaries is estimated to be less than 68 connections per year overall.

Service Area

The District's existing service area comprises approximately 7,315 acres of developed and undeveloped land (Figure 1). On February 1, 2006, the Sonoma County Local Agency Formation Commission (LAFCO) approved the District's latest sphere of influence boundary, which is now considered co-terminus with the District's service area (Figure 3).

Population Projection

A memorandum prepared for the Water Agency in November 2005 by Maddaus Water Management (Maddaus Memo – Ref. #8)) includes population and water use projections for the District's service area to 2030. The projections conveniently span the same planning period of this report and using them assures consistency with the Agency's water supply planning efforts. Table 2-1 shows the population projections:

Table 2-1[1]

POPULATION PROJECTIONS FOR VALLEY OF THE MOON

2004	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
22,526	22,665	23,359	24,055	24,753	25,109	25,466

[1]Information excerpted from Table 1-1 of Maddaus Memo.

HISTORIC & PROJECTED WATER USE

General

The District's Annual Reports for years 2000/2001 to 2004/2005 were analyzed to identify overall historical water use and water use by class. The reports include the quantity of water purchased from the Agency, the quantity produced by District wells, sales volumes and the estimated volume of unaccounted for water.

Water use projections are based on those made in the Maddaus memo to the Agency. The Agency used these projections in the preparation of their Draft 2005 Urban Water Management Plan (2005 UWMP – Ref. #10 (adopted Oct. 2006)), the planning document they use for water supply and facilities planning through 2030 and to establish Contractor's entitlement limits. As a result, the District's and Agency's planning efforts will be consistent.

Historical Water Use

Annual water production for the five years studied is shown in Table 2-2. Both the water volume purchased from the Agency and volume produced from District wells are listed.

Table 2-2
HISTORICAL ANNUAL WATER SUPPLY VOLUMES

Source	Units	2000-01	2001-02	2002-03	2003-04	2004-05
Agency	Million Gal.	933.45	940.38	937.98	1,028.65	950.04
	Acre-Feet	2,865	2,886	2,879	3,157	2,916
Wells	Million Gal.	215.43	182.16	167.98	136.44	124.66
	Acre-Feet	661	559	515	419	383
Totals	Million Gal.	1,148.88	1,122.54	1,105.96	1,165.09	1,074.70
	Acre-Feet	3,526	3,445	3,394	3,576	3,298

Water sales have accounted for 87 to 90 percent of total water production. Ten to 13 percent of water production has been unmetered. Unmetered uses include water utilized for construction, fire fighting and training, maintenance, evaporation, meter losses, and unaccountable losses. Unaccountable losses (leaks mostly) have averaged 6.8 percent of the total over the five year period. An unaccountable water loss percentage of seven percent is considered average for water systems of similar makeup and age.

Unit Water Use

Unit water production has varied during the five years studied. See Table 2-3. Maximum monthly water use does not appear to follow any particular trend and is most likely weather dependent. The ratio between average day of the maximum month and the average day averaged 1.53 over the period. This figure is similar to the one (1.50) listed in the *1998 Update* (Ref. #1). Average per capita water production during the period was 134 gallons per day.

Table 2-3
UNIT WATER PRODUCTION

	2000-01	2001-02	2002-03	2003-04	2004-05
Average Annual Per Capita Production (GPD)	138	134	132	138	127
Average Day Max. Month Per Capita Production (GPD)	197	203	221	205	197
No. Active Connections	6,687	6,685	6,704	6,743	6,771
Average Annual Production Per Connection (GPD)	471	460	452	473	435
Average Day Max. Month Production Per Connection (GPD)	673	697	758	700	673

Factor: ADMM/AA	1.43	1.52	1.68	1.48	1.55

Water Use by Class

The predominant meter class is residential with over 86 percent of all water sales attributable to residential end uses. The bulk of the remaining water sales are attributable to commercial and institutional uses.

An equivalent single family dwelling unit (ESD) is defined as the average day water use for a single family detached residence during the maximum demand month. The ESD is a convenient unit for projecting future demands. The District currently considers one ESD to be 490 GPD. Over the five year period, one ESD was determined to be approximately 483 gallons per day (GPD), suggesting that the District's figure continues to be reasonable and appropriate.

Water Demand Projection (2030)

Water demand projections were also made in the 2005 Maddaus Memo presented to the Agency. Population and demand projections along with gross and net annual demands, after considering possible savings from water conservation measures, are presented in the Maddaus memo and repeated herein for reference. See Table 2-4. The unit demands listed in the table are the result of applying the unit demand multipliers derived from the historical production analysis to the Maddaus Memo demand projections.

Table 2-4

DEMAND PROJECTIONS

	Fiscal Year				
	2009/10	**2014/15**	**2019/20**	**2024/25**	**2029/30**
Population	23,359	24,055	24,753	25,109	25,466
No. of Connections	6,917	7,122	7,328	7,434	7,539
Annual Demand (AC-FT)					
Gross Annual Demand	3,953	4,075	4,196	4,259	4,322
Conservation Savings	205	324	409	462	504
Net Annual Demand	3,748	3,751	3,787	3,797	3,818
Net Unit Demands:					
Ave. Day (MGD)	3.35	3.35	3.38	3.39	3.41
ADMM (MGD)	5.4	5.4	5.4	5.4	5.5
Est. Max. Day (MGD)	10.0	10.0	10.1	10.2	10.2

Water Conservation

The District has a long history of promoting water conservation efforts but is also required to implement certain best management practices (BMPs) as a condition of the M.O.U with the Water Agency.

Water conservation efforts are predicted to significantly reduce the District's gross water demands. The Maddaus Memo estimates that by 2010 the District's water savings due to the various conservation efforts could total 205 acre-feet annually, and increase to 504 acre-feet annually by 2030. The sources of these significant savings include the California Urban Water Conservation Council (CUWCC) BMPs, impending changes to housing standards and the plumbing code, and other BMPs the District might implement on their own. It is important that the District implement as many BMPs as are practicable as the Agency has assumed significant savings in water demands will be achieved in the future and the anticipated savings are reflected in the annual entitlement limits for the District set forth in the Agency's 2005 UWMP (Ref. #10).

Fire Protection

Fire protection for the District is provided by Sonoma Valley Firemed System and by the Glen Ellen Fire Department. The Sonoma Valley and Glen Ellen fire chiefs have indicated that a fire flow of 2,500 gallons per minute (GPM) should be provided in commercial areas. In residential areas, a fire flow of 1,000 GPM would be desirable and a minimum fire flow of 500 GPM should be available everywhere. These flows should be available for a two hour period under maximum day demand conditions while maintaining a residual pressure of 20 pounds per square inch throughout the distribution system.

Annual fire flow volumes are insignificant in comparison to total demands, and were therefore ignored when projecting future demands.

PROJECTED SYSTEM REQUIREMENTS

Water Supply Requirements

At the current time, the District is limited to a maximum monthly purchase of 4.9 MGD as set forth in the Agency M.O.U. Besides the maximum monthly entitlement limitation, the District is restricted to 3,200 acre-feet of water purchases from the Agency on an annual basis. The District is currently using more than 3,200 acre-feet annually and uses local wells to make up any shortfall.

The Agency's Draft 2005 UWMP lists projected annual water entitlement delivery to the District in five year increments. By 2030, projected entitlement to the District is 3,729 acre-feet or 529 acre-feet more than the current entitlement. This figure purportedly will be incorporated into the next iteration of the Restructured Agreement for Water Supply (Ref. #5), expected sometime after adoption of the new Water Supply and Transmission System EIR (Ref. #13), perhaps around 2008. It is expected however, that entitlement increases may be granted incrementally as the Agency has pending requests for additional rights to Russian River water that must be approved prior to significantly increasing deliveries to any of the contractors. The water rights issues are not anticipated to be resolved before 2016. The District will need to continue to rely on local supply sources in the interim

District Wells

The Agency M.O.U. suggests (but does not require) that each water contractor work towards developing 40 percent of their water supply needs from local sources during the temporary impairment period, which is anticipated to end in September 2008. Local supply sources could also be used to reduce reserve storage requirements.

In 1999 the District commissioned Luhdorff & Scalmanini to prepare a groundwater master plan. The 1999 Master Ground Water Plan (L&S Plan – Ref. #11) identified five locations within the District that may be suitable as production well sites. The L&S Plan estimated that a total of 2.57 MGD (1,780 GPM) of groundwater production might be possible from wells located in the District.

However, the B&C Report (Ref. #12) evaluated the feasibility of locating wells on ten sites within the District. They concluded that only three of the ten sites are feasible for development of new wells and only one site (the location of an abandoned well on Verano Avenue) stands out as having real potential. The District is currently developing a well at the Verano Avenue site. Anticipated production capacity is expected to be approximately 200 GPM.

The District's current annual well production is averaging approximately 400 acre-feet. Well production capacity could increase to approximately 800 acre-ft. with the new Verano Ave. well and changes to current operational practices.

Storage Requirements

Recommended storage requirements for each pressure zone are presented in the report by Brelje & Race entitled, 1999 Water Storage Plan (*1999 Storage Plan* – Ref. #2). Most of the recommendations in that report remain valid but need to be updated to reflect the storage that has been constructed since its preparation.

Storage requirements for the Aqueduct and Trinity Oaks pressure zones (served directly from the SCWA aqueduct without pumping) differ from other zones as equalizing storage is not required, and in some cases fire storage requirements may be reduced as it can be considered to be available in Agency tanks. Pumped zones on the other hand, do require equalizing and fire storage reserves. Reserve storage may be located outside the particular pressure zone it is intended for so long as there is a reliable means to transfer the volume to that zone should there be an emergency. The District's pumped zones are shown on Figure 4.

Table 2-5 lists the 2005 storage requirements and existing capacity for each zone as published in the *1999 Storage Plan*. Requirements for the Sonoma Mountain zones have been added. The *1999 Storage Plan* projections were based on the number of projected service connections in each zone and their respective average demands. While the current number of services in each pressure zone was not determined for this report, the *1999 Storage Plan* projection of 6,900 total service connections within the District in 2005 is only two percent over the actual total of 6,780. The small difference in service connections results in storage volume requirements that are slightly conservative, but within an acceptable range of accuracy for each zone.

Table 2-5
2005 STORAGE REQUIREMENTS AND EXISTING CAPACITY

Pressure Zone	Operating	Reserve	Fire	Total[1]	Existing
	Volume (x1,000 Gallons)				
Trinity Oaks	0	33	0	33	0
Glen Ellen	152	203	300	655	650
Madrone	174	278	150	602	2,000
Temelec	226	301	300	827	1,200
Sonoma Mountain 4 & 5	16	38	0[2]	54	54
Sobre Vista 2	29	38	120	187	240
Chestnut 2 & 3	82	109	120	311	320
Donald/Michael	10	13	120	143	200
Aqueduct (Main Zone)	0	2,101	150	2,251	800
Totals	689	3,114	1,260	5,063	5,464

[1]Values (except Sonoma Mountain zones) reproduced from Table 3.5 "Storage Requirements by Zone – 2005", in the 1999 Water Storage Plan (Ref. #2).

[2] Fire storage volume requirement for the Sonoma Mountain Homestead area provided by a private irrigation system.

The District's projected storage requirements for the end of the planning period (2030) based upon the recommended storage criteria is listed by pressure zone in Table 2-6 below.

Table 2-6
PROJECTED STORAGE REQUIREMENTS (2030)

Pressure Zone	Operating	Reserve	Fire	Total
	Volume (1000 Gallons)			
Trinity Oaks	0	33	0	33
Glen Ellen	167	225	300	692
Madrone	191	300	150	641
Temelec	247	329	300	876
Sonoma Mountain 4 & 5	16	38	0	54
Sobre Vista 2 & 3	108	144	120	372
Chestnut 2 & 3	90	120	120	330
Donald/Michael	11	14	120	145
Aqueduct (Main Zone)	0	2,307	150	2,457
Totals	830	3.510	1,260	5,600

A comparison of current storage volumes to projected requirements for 2030 suggests a total shortfall of 140,000 gallons. A zone by zone comparison suggests that there is currently a significant storage shortfall in the Aqueduct zone of 1.45 MG and a projected 2030 shortfall of 1.65 MG. The shortfalls are actually 0.6 MG greater due to the lower water levels in the Bolli tanks in the summer months due to high system demands. The actual projected 2030 shortfall is then 2.3 MG. Fortunately storage located upstream in the Madrone and Glen Ellen pressure zones can be transferred into the Aqueduct zone and the deficit is also offset by well production capacity within the Aqueduct pressure zone. The Madrone pressure zone currently has a storage surplus of 1.4 MG decreasing to a projected surplus of approximately 1.35 MG in 2030. This volume is available to the Aqueduct zone thereby decreasing its shortfall to approximately 1.0 MG. Production wells in the Aqueduct pressure zone currently produce the equivalent of approximately 0.42 MGD. Well production is projected to increase to 0.61 MGD once the new Verano Well goes online. The storage shortfall will then be approximately 0.4 MG.

The Glen Ellen pressure zone is projected to have a small shortfall of approximately 40,000 gallons in 2030. As there is no local supply in that area, the District should consider increasing storage to accommodate an extended curtailment of the Aqueduct supply. Because storage located in Glen Ellen can also be used in lower zones, locating additional storage facilities there would be an efficient use of resources.

Booster Pumps

Two pumps, each capable of pumping the maximum day demand should be available at each booster pump station for reliability. At locations where more than one booster pump station serves a pressure zone, the combined pumping capacity should be at least the maximum day demand with the largest single pump out of service.

Distribution Network

The District's distribution piping network was analyzed using computer modeling software. The water system as it exists today was analyzed for deficiencies under varying demand conditions. After identifying improvements that would eliminate or reduce system deficiencies, the model was run again with future demand conditions and checked for additional problem areas. Typical system deficiencies identified with the model include areas of low pressure, high pipeline velocity, inadequate networking, and inadequate fire flow capacity. System deficiencies identified during the various model runs are listed in Table 2-7.

Table 2-7
SUMMARY OF HYDRAULIC MODEL RESULTS

Project ID	Map No.	Deficiency	Recommended Improvement
1	18-K	Low Fire Flow; Low Pressure Area	Extension and loop connection from Robin Drive to Warm Springs Road (380 LF - 8").
2	18-K	Low Fire Flow; Low Pressure Area	Parallel main in Warm Springs Road from Saddle Road to new looped main (570 LF - 8").
3	22-M	Emergency Transfer; Water Quality	Modify Eldridge PSV to include 2-inch combination PSV/PRV and 6” PRV in parallel.
4	23-N	Flow to Hanna Tank; Low Fire Flow	Parallel main in Madrone Road from Agency turnout to Maplewood Drive (980 LF - 8").
5	26-O	Low Pressure Area; Low Fire Flow; High P/L Velocity	Parallel main in Agua Caliente Road from Agency turnout to Vailetti Drive (1,600 LF - 8").
6	26-P	Low Pressure Area	Main extension in Park Avenue from Park Avenue well to Elev. 150 +/- (1,050 LF - 6"); Transfer ±30 services to new Zone 2 main.

Note: New Agua Caliente Booster Pump Station No. 2 is intended to aid filling of Hanna Tank. Project ID No. 4 would also serve to fill the tank and help increase fire flows to low flow areas. The District may wish to consider the parallel main in the future as it would add additional benefits over the pump station, with reduced operating expenses.

In addition to the required improvements to District facilities, the modeling revealed that long periods with very high demands will severely stress the Agency’s aqueduct system causing overall dips in system pressure. Construction of one or two of the Agency’s planned parallel aqueduct segments will alleviate the problem.

The future system (2030) was also analyzed in a similar fashion. All recommended improvements were included in the model along with updated demands corresponding to demand projections. No additional system deficiencies were identified by the modeling. However, the EPS model indicates that unless at least two of the four planned parallel aqueduct segments are constructed, system pressures will dip severely after a few days of maximum month demand conditions.

MASTER WATER PLAN

General

The Master Water Plan contains recommendations and cost estimates used to develop an on-going capital improvement program (CIP). The Plan identifies improvements to supply, storage, booster pumping, valves and piping, and other operational aspects in order to meet recognized standards of reliability, quality, and quantity for the District's customers through the end of the 2030 planning period. The Plan shows the sizes and locations of recommended improvements and identifies the most logical order in which the improvements should be made.

Supply

The primary supply source for the District is the Agency's Sonoma aqueduct. The recent construction of the parallel segment between the Eldridge Tanks and Madrone Road appears to have improved flows to and pressures in the northern areas of the District's Aqueduct pressure zone and in the Madrone pressure zone. However, the improvements to service will diminish as the District and City of Sonoma demands continue to increase.

Hydraulic modeling indicates that if two of the planned parallel aqueduct segments are constructed, deliveries and pressures from the existing turnouts would be adequate to serve the District to the end of the planning period (2030). Specifically, the 26,000 LF segment of 24-inch diameter pipe from the Los Guillicos tank to the turnout at Trinity Oaks, and the 17,000 LF segment of 20-inch diameter pipe from Madrone Road to the turnout at Railroad and Verano Avenues. The District will need to participate, with the City of Sonoma and the Agency, in funding and construction of these facilities within the next 10 to 15 years unless additional local supply sources are developed. While the final two planned segments would provide only minimal service improvements within the District, they would improve delivery system redundancy and reliability.

Hydraulic modeling indicates that unless new local supply sources are developed and/or improvements made to the Sonoma Aqueduct before 2030, severe pressure and fire flow deficiencies will occur within the District during the peak demand season as water levels in District and Agency storage tanks fall, and potentially drain completely during high demand periods. Operating pressures in a number of localized areas would drop below 20 psi, the minimum allowed under current State Department of Health requirements. (Note: DHS is considering proposed changes that would require a minimum of 40 psi at all times except during fire flow conditions.)

Luhdorff & Scalmanini investigated the potential of developing additional groundwater sources in the District (Ref. #11). They concluded that several new wells could be developed on the valley floor within the Aqueduct pressure zone and that their expected capacity would be between 100 and 400 GPM each, with likely yields around 300 GPM. The valley floor would be the ideal location for new wells as they could take advantage of the existing, well networked piping system and would be located directly in the zone with the highest demands and least volume of reserve storage. The more recent B&C Report (Ref. #12) is much more pessimistic regarding the potential to develop local groundwater supplies within the District.

The District has begun developing a new well at the Verano Avenue site with an expected yield of 200 GPM, but may not develop any additional wells due to the findings in the B&C Report. Despite the inherent challenges of finding suitable well sites, it is recommended that the District continue their test well program until either the desired peak production capacity of 2.0 MGD is achieved or the potential well options identified in the B&C Report have been exhausted.

Storage

The storage recommendations in this report are an update of the more thorough analysis performed for the 1999 Water Storage Plan (Ref. #2). However, as well production capacity is currently not expected to exceed 800 acre-feet the recommended reserve storage capacity for each pressure zone has been revised. One day of reserve storage continues to be the recommended volume, a recognized standard of both Title 22 of the California Administrative Code and the American Water Works Association. Development of additional reserve storage is encouraged since the current well capacity is likely to be insufficient to sustain minimum needs since service outages longer than one day have occurred in the past. Additional reserve storage would also allow peak demands to be withdrawn from District tanks thereby reducing demand on Agency supply facilities.

Storage in the Agency tanks may be available to the District during an extended service outage although the Agency does not guarantee delivery during emergencies.

Table 2-8 lists the recommended locations and volumes of storage facilities the District should add during the planning period. Recommended storage volumes could be reduced if additional groundwater supplies were developed.

TABLE 2-8
RECOMMENDED STORAGE IMPROVEMENTS

Name	Existing Volume	Proposed Volume	Notes
Glen Ellen #2	-0-	Up to 0.5 MG	Key location for additional reserve storage. Supplements storage for current customers, and increases overall system reliability and flexibility.
Cavedale[1]	-0-	Up to 1.0 MG	Key location for additional reserve storage. Supplements storage for current customers, and increases overall system reliability and flexibility.
Moon Mountain[1]	-0-	0.16 MG	Storage for future customers. Increases system reliability and flexibility.

[1] Cavedale & Moon Mountain are currently undeveloped areas within the District Sphere of Influence. They may or may not be developed within the planning period for this Report.

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Storage will need to be provided for the Cavedale area at the time of development. It's an area that could be served from the Aqueduct pressure zone or, following some piping modifications, be incorporated into Madrone pressure zone with its slightly higher hydraulic gradient (supplied by the Madrone and Hanna turnouts). Switching the Cavedale area to the Madrone pressure zone could be accomplished at any time and would eliminate one of the worst low pressure areas of the District (Serres Road area). The Cavedale Road tank is estimated to require a minimum storage volume of 0.2 MG. However, because its location would be an excellent site for placement of additional reserves, a tank with up to 1.0 MG in capacity is recommended. A new booster pump station at the Cavedale tank site would supply water to the proposed Moon Mountain tank.

Booster Pump Stations

No booster pump station improvements are recommended at this time. The Saddle booster pump station was previously recommended to be eliminated and that recommendation remains valid. One future booster pump station, to serve the future Moon Mountain area, will be required. This pump station would include two pumps capable of supplying the maximum day demand for the 90 potential customers in this zone. The second pump would serve as a standby unit.

Water Main Replacements and Additions

A number of water main replacements recommended in the *1998 Update* (Ref. #1) still remain to be accomplished. It is understood that most are included in the District's current 5-year CIP, so all have been included herein and assigned the highest priority (1). Pipeline replacements are listed in Table 7-4 along with their estimated current (2006) costs. The listed costs should be considered budgetary and include allowances for planning, design and construction but do not reflect site specific impacts such as terrain, number of service connections, etc. Most replacement projects are needed because existing mains are undersized or approaching the end of their useful life.

The recent hydraulic modeling effort indicated that construction of several new water mains would improve pressure and fire flows, reduce high line velocities and provide more reliable service (due to redundant piping) in several areas. These recommended distribution system improvements are listed in Table 6-4 and again in Tables 7-4, 7-5 and 7-6 with their estimated costs (also shown graphically on Exhibit II). The recommended replacement and parallel mains have been assigned a priority (1, 2 or 3) depending upon their relative benefit to the distribution system.

Completing all main replacements and new main installations in about 15 years would maintain acceptable levels of service. Based on this criterion, Priority 1 distribution system improvements should be scheduled for construction in the initial five years, Priority 2 improvements should be constructed in the next five years, and the remainder during the last five.

Monitoring/Controls

A central monitoring system for all District tanks, pumps and wells has been installed. The system has recently been expanded to include monitoring of several Agency facilities. Consideration should be given to future monitoring of flows and pressures at each Agency turnout and at District-operated pressure regulating valves, and remote operational control of isolation valves at several of the Agency's turnouts. Having the ability to remotely close valves at several of the turnouts will allow for adequate turnover in the District's water tanks.

SUMMARY OF COSTS

Supply

Total estimated project costs for two recommended parallel aqueduct segment improvements are listed in Table 2-9. The District's share of the costs is also shown. The 2001 costs have been adjusted to 2006 dollars by assuming an inflation rate of 5% annually for the nearly 6 year period.

Table 2-9
PARALLEL AGENCY AQUEDUCT COSTS

Segment No.	Length	Diameter	2001 Cost	Current Cost
2	26,000 LF	24	7.05 M	9.5 M
4	17,000 LF	20	4.45 M	6.0 M
		Total Cost	**$11.5 M**	**$ 15.5 M**
		Estimated District Share	**$ 6.6 M**	**$ 8.9 M**

While the District may not pursue additional well capacity beyond the new well currently under construction, the pursuit of additional local supply sources should be considered. Additional groundwater supplies may be able to be developed at the other feasible sites identified in the B&C Report or at other sites identified in the future. A reasonable budget allowance that would provide for all costs associated with development of future wells would be $1.5 M (planning, right-of-way acquisition, environmental documentation, design, exploratory program, and construction).

Storage Facilities

Only one area needs additional storage in the near term, the Glen Ellen pressure zone. It is recommended that the storage tank have a capacity of 0.5 MG and would be ideally located on the east side of the area, somewhere in the vicinity of Mound Avenue. The recommended budget allowance for a welded steel tank on a site to be acquired by the District is $1.7M.

Distribution Network

Estimated costs of the recommended distribution network improvements are listed in Tables 7-5 through 7-7. A summary of the estimated costs by priority are listed in Table 2-10.

Table 2-10
SUMMARY OF DISTRIBUTION SYSTEM IMPROVEMENT COSTS

Priority 1 Distribution System Improvements:	$	2,324,000
Priority 2 Distribution System Improvements:	$	396,000
Priority 3 Distribution System Improvements:	$	335,000
TOTAL All NEW IMPROVEMENTS:	$	3,055,000

The combined cost of all recommended improvements, including the District's share of the parallel Agency aqueduct segments is $13.7 M. Each well the District elects to construct will increase the total by approximately $1.5 M. Facilities for future customers should be financed with connection fees or paid for by development interests.

CHAPTER 3
EXISTING WATER SYSTEM

GENERAL

The Valley of the Moon Water District was formed in 1960 by combining numerous water companies, some of which date back to the turn of the century. In acquiring those systems, the District inherited many old water storage tanks and thousands of feet of water main that are undersized by modern standards. Most of the old mains consisted of steel piping that was showing the effects of age and corrosion at least 10 years ago. An ongoing, aggressive capital improvement program (CIP) has allowed the District to replace most of the aging and undersized infrastructure. Only a few of these inadequate facilities remain, nearly all being scheduled for replacement under the District's current CIP program.

The District's service area extends from the Trinity Oaks Subdivision, located just north of the unincorporated community of Glen Ellen, to the Temelec Subdivision located in the southern end of the Sonoma Valley, a distance of over nine miles and encompassing an area of approximately 7,315 acres. The service area is less than three miles wide at its widest point. See Figure 1. In 2005, the service area population was approximately 23,142 persons and there were 6,771 active service connections.

The District's water supply is derived from ten Sonoma County Water Agency (Agency) turnouts, four active District wells and one leased well. The District also has one standby well. Distribution facilities consist of fourteen water storage tanks, ten booster pump stations, three hydro-pneumatic tanks and approximately 92 miles of water distribution mains and appurtenances.

WATER SUPPLY

<u>Sonoma Aqueduct</u>

The Sonoma County Water Agency (Agency) is the chief water wholesaler to cities and water districts in Sonoma and Marin Counties. The Agency withdraws water from the underflow of the Russian River which is then treated and transmitted to the Agency's water contractors via a series of pumping stations and large diameter aqueducts. The District obtains the majority (84 to 88 percent during the five year study period) of its potable water from the Agency. The Agency meters water to the District at ten turnouts located on the Sonoma aqueduct that generally bisects the District. Each turnout includes a meter, backflow prevention assembly and at least one pressure reducing valve (PRV). The locations of the Sonoma Aqueduct and turnouts are shown on Figure 2. The turnouts are listed by the numbers assigned to the PRV's. More specific information regarding each turnout (name, meter size, etc.) is listed in Table 3-1. The hydraulics of the Sonoma Aqueduct determines the maximum delivery rate through each turnout and the regulator valves generally set the pressure in the District's water system.

INSERT FIGURE 1 - SERVICE AREA HERE

INSERT FIGURE 2 - KEY FACILITIES MAP HERE

Table 3-1
SONOMA COUNTY WATER AGENCY TURNOUTS

No.	Name	Function	Valve Type	Valve Sizes	Meter Size	Pressure Zone
PRV-1	Verano	Agency Turnout	Reducing	6" & 2"	6"	1
PRV-2	Verano & Main	Agency Turnout	Reducing	10"	6"	1
PRV-3	Verano & Fifth	Agency Turnout	Reducing	8"	6"	1
PRV-4	Boyes	Agency Turnout	Reducing	6" & 2"	6"	1
PRV-5	Altimira	Agency Turnout	Reducing	6" & 2"	6"	1
PRV-6	Agua Caliente	Agency Turnout	Reducing	6" & 2"	6"	1
PRV-7	Hanna	Agency Turnout	Reducing	12" & 8"	6"	1B
PRV-9	Madrone	Agency Turnout	Reducing	6" & 2"	6"	1B
PRV-10	Eldridge	District Valve	Sustaining	6"	N/A	1B
PRV-11	Glen Ellen	Agency Turnout	Reducing	6" & 4"	6"	1F
PRV-12	Trinity Oaks	Agency Turnout	Reducing	6" & 2"	6"	1C
PRV-13	Hanna Lower	District Valve	Regulating	12”	N/A	1

The District is one of the Agency's original prime contractors and is entitled to representation on the Water Advisory Committee that oversees the operation of the Agency. By the terms of the Restructured Agreement for Water Supply, dated July 2006, the District is entitled to 8.5 million gallons per day (MGD) on the average day of the maximum water use month (usually August), with an annual total limit of 3,200 A.F. Previous agreements stipulated that 1.4 MGD of the District’s entitlement must be obtained upstream of the Agency's Eldridge Tank (from the District's Glen Ellen and Trinity Oaks turnouts), however, this stipulation is omitted from the current agreement.

In order to increase the volume of water that the Agency can deliver between the Eldridge and Sonoma Tanks, the Agency installed a booster pump station at the Eldridge Tank in the spring of 1997. This pump station was intended to increase aqueduct pressures at District turnouts downstream of the Eldridge Tanks and make more water available to the District at higher pressures. However, the pump station is rarely, if ever, used as the increase in downstream pressures and flows along the aqueduct were much less than anticipated.

The Agency has plans to complete a parallel aqueduct along the entire length of the Sonoma Aqueduct. One segment (the Eldridge-Madrone section) was completed recently. This segment of approximately 8,000 LF of parallel piping has increased hydraulic pressures at the turnouts and within the District’s lower pressure zone during the summertime and has helped maintain higher average water levels in the Agency’s terminal storage tanks in Sonoma.

There are four remaining parallel segments planned for construction that when completed will considerably improve the aqueduct’s delivery capacity and operating pressures at all aqueduct turnouts in the District. All sections of the parallel aqueduct were originally scheduled for completion by about 2013 however, due to litigation over the adequacy of the environmental documentation prepared for these and other capacity-related improvements, construction on the remaining segments has been delayed indefinitely.

District Wells

The District has four active water supply wells, and one well on standby status. The standby well in Trinity Oaks only serves that neighborhood and has minimal impact on the rest of the system. District well locations are shown on Figure 2. The names, capacity and status of each well are listed in Table 3-2.

Table 3-2
DISTRICT WELLS

No.	Well Name	Capacity	Status	Motor Hp	Pressure Zone
W-1	Donald	110 gpm	Active	15	1 Aqueduct
W-3	Mountain Ave.	110 gpm	Active	15	2D Chestnut
W-4	Park Avenue	90 gpm	Active	7-1/2	1 Aqueduct
W-5	Agua Caliente	120 gpm	Active	25	1 Aqueduct
W-6	Trinity Oaks	50 gpm	Standby	5	1C Trinity Oaks
	Larbre	120 gpm	Lease	25	1 Aqueduct

The Donald, Park, and Mountain Avenue wells were rehabilitated and activated in the mid to late 1990's and have been operating regularly since. While the Donald well is activated by timer control, the remainder of District wells are turned on in the late spring, and run continually through early fall.

The District has sought to develop additional well capacity to further supplement the Agency supply and provide an emergency back-up supply should the Agency supply be temporarily interrupted. In 1998, the District had a groundwater master plan prepared for the purpose of identifying potential new well sites within the District's service area (Ref. #11). In January, 2006 a new well site study was completed by Brown and Caldwell (B&C Report - Ref. #12), which studied the feasibility of ten potential new well sites. The B&C Report indicated only three potentially feasible well sites of the ten. To date, no new wells have been completed. However, a new well is currently underway with an anticipated capacity of approximately 200 gpm. No additional wells are currently planned.

STORAGE TANKS

Sonoma County Water Agency

Water storage for the District and the City of Sonoma (City) is provided primarily by the Agency's Eldridge and Sonoma tanks (See Figure 2). The total combined capacity of the Eldridge and Sonoma tanks is 18 million gallons (MG). Based on the District's and City's present entitlements of 8.5 MGD and 6.3 MGD respectively, the Agency is obligated to provide a minimum storage volume of about 22 MG (1.5 times the entitlements). This volume is available if the excess capacity in the Agency tanks situated along other portions of their transmission system is considered. In addition to meeting the minimum storage obligations stipulated in the Agreement, the Agency is required to provide adequate storage capacity (volume defined by computer modeling) to ensure deliveries during the highest historical seven consecutive day demand period. The modeling assumes that the tanks are 90 percent full at the beginning of the period and may be nearly empty at the end. No allowances for fire demands or needs other than the high demand use during the seven day period is assumed. Hydraulic modeling performed by Agency staff indicates that no additional storage will be necessary along the "improved" Sonoma Aqueduct to satisfy the seven consecutive day demand scenario.

Valley of the Moon Water District
The District's water system includes fourteen water storage tanks with a total capacity of 5.5 MG. Tank locations are shown on Figure 2. The tanks range in size from 0.015 to 2.0 MG. Tank construction includes redwood, concrete, bolted steel and welded steel. One active tank is more than 95 years old. The system also includes three hydro-pneumatic tanks. Additional information regarding each tank is presented in Table 3-3.

Table 3-3
DISTRICT STORAGE TANKS

No.	**Name**	**Capacity (MG)**	**Type**	**Pressure Zone**	**Year Built**
T-1	Temelec 1	0.200	Welded Steel	1A-Temelec	1968
T-2	Temelec 2	1.000	Welded Steel	1A-Temelec	1985
T-3	Donald	0.200	Welded Steel	1-Aqueduct	1963
T-4	Hill	0.500	Welded Steel	1F-Glen Ellen	2006
T-6	Bolli 1	0.400	Welded Steel	1-Aqueduct	2001
T-7	Bolli 2	0.400	Welded Steel	1-Aqueduct	2001
T-8	Chestnut	0.320	Welded Steel	2D-Chestnut	1992
T-9	Hanna	2.000	Welded Steel	1B-Madrone	1977
T-10	Lower Sobre Vista	0.030	Concrete	2E-L.Sobre Vista	Pre-1909
T-11	Upper Sobre Vista	0.210	Bolted Steel	3E-U.Sobre Vista	2002
T-12	Saddle	0.150	Redwood	1F-Glen Ellen	1987
T-13	Trinity Oaks	0.030	Redwood	1C-Trinity Oaks	Pre-1909
T-14	Lower Homestead	0.032	Bolted Steel	4E-L. Homestead	2006
T-15	Upper Homestead	0.022	Bolted Steel	5E-U. Homestead	2006
H-1	Trinity Oaks	0.001	Hydro-pneumatic	1C-Trinity Oaks	Unknown
H-2	Donald	0.002	Hydro-pneumatic	2B-Michael	1990
H-3	Chestnut	0.003	Hydro-pneumatic	3D-Hillcrest	1992

BOOSTER PUMP STATIONS

The District's water distribution system includes ten booster pump stations. With the exception of the Arnold Drive booster station, the booster pump stations lift water from the Aqueduct zone to upper service zones. The Arnold Drive booster station is necessary to overcome high head losses through the abnormally long transmission main to the Temelec area. The locations of the booster pump stations are shown on Figure 2. More specific information on each booster pump station is provided in Table 3-4.

Table 3-4
BOOSTER PUMP STATIONS

No.	Name	Capacity (GPM, Each)	No. of Pumps	Pressure Zone Pumps From	Pressure Zone Pumps To
PS-1	Arnold Drive	500	2	1-Aqueduct	1A-Temelec
PS-2	Donald	2@100, 1@300	3	1-Aqueduct	2B-Michael
PS-4	Chestnut	100	2	2D-Chestnut	3D-Hillcrest
PS-5	Agua Caliente	350	2	1-Aqueduct	2D-Chestnut
PS-6	Lower Heaven Hill	110	2	1-Aqueduct	2E-L.Sobre Vista
PS-7	Upper Heaven Hill	100	2	2E-L.Sobre Vista	3E-U.Sobre Vista
PS-8	Saddle	95	1	1F-Glen Ellen	1Fa-Glen Ellen
PS-9	Glen Ellen	400	2	SCWA Aqueduct	1F-Glen Ellen
PS-10	Hanna (AC Road)	800	2	1-Aqueduct	1-Hanna Tank
PS-11	Sonoma Mountain - Lower	26	2	3E-U Sobre Vista	4E-L.Sonoma Mtn Homestead
PS-12	Sonoma Mountain - Upper	17	2	4E-L Sonoma Mtn Homestead	5E-U Sonoma Mtn Homestead

HYDRO-PNEUMATIC TANKS

Hydro-pneumatic tanks provide a means to accomplish pressure-based control of a well or pump. The District's water system includes three hydro-pneumatic tanks. The hydro-pneumatic tanks are located at the Trinity Oaks Well Site (W-6), the Donald Tank Site and Chestnut Pump Station (PS-4). The hydro-pneumatic tank at W-6 has a capacity of 1,000 gallons and is not in service. The hydro-pneumatic tank (H-2) at the Donald Tank Site has a capacity of 2,000 gallons and operates in conjunction with Booster Pump Station PS-2 to serve the Upper Michael Drive area. The hydro-pneumatic tank (H-3) at the Chestnut Booster Pump Station (PS-4) has a capacity of 3,000 gallons and serves the Woodland Avenue, Cragmont Drive and Upper Hillcrest Avenue areas. A listing of the hydro-pneumatic tanks may be found in Table 3-3 with the other storage facilities.

WATER MAINS

The District's distribution system includes approximately 92 miles of water mains with a wide range of sizes. During the past few years, the District has been aggressively replacing piping segments identified in the previous Water Master Plan as being inadequate. Most of the piping was replaced due to inadequate capacity (3-inches in diameter and smaller), age and susceptibility to corrosion (steel pipe). The locations and sizes of existing water mains are shown on Exhibit I, located at the back of this document. An inventory of distribution system piping is presented in Table 3-5.

Table 3-5
WATER MAIN INVENTORY

Pipe Diameter		Length Feet	Miles
14"		2,720	0.52
12"		19,900	3.77
10"		26,820	5.08
8"		148,810	28.18
6"		222,840	42.20
4"		41,430	7.85
3"		5,020	0.95
< 3"		18,640	3.53
	Totals	486,180	92.08

MONITORING/CONTROLS

The District currently has monitoring equipment for all tank levels and monitoring and control capabilities at the pumps and wells. Flows through turnouts are controlled by the pressure in the Sonoma Aqueduct, the valve (pressure reducing/sustaining) setting at each turnout and the static pressure in the District's distribution system. Donald well operates by timer. Booster pumps are also controlled by storage tank liquid level information transmitted via radio telemetry equipment. Tank levels are also observed and noted by system operators during regular tank site visits. Alarms show at the District’s Supervisory Control and Data Acquisition (SCADA) monitor and are transmitted to pagers worn by operations staff.

Recent upgrades to system monitoring facilities include installation of remote telemetry on the Agency’s flow meters at Eldridge and Sonoma tanks. These new facilities will allow the District to monitor flows through the aqueduct on a continuous basis, and determine the overall volume flowing to the District through the eight turnouts in that reach of the Aqueduct.

CHAPTER 4
LAND USE & POPULATION

GENERAL

Future District water facilities and supply needs will be determined by land use policies. General plans and land use planning efforts typically have a time horizon of no more than 15 to 20 years whereas major water supply improvements are designed to last 50 years or more. The planning of these improvements should be based upon the longer time frame and therefore land use and population growth projections must be extended beyond the planning horizons of current County planning reports. By having differing time lines, there is always a risk that future changes in land use policies may render a projection inaccurate. However, the Sonoma Valley has developed at a moderate and predictable pace and is likely to continue doing so into the future, thus reducing the potential of a deviation between this plan and other more short-term planning documents.

The primary planning period for this report is the District's FY 2029/30. The end of the planning period is far enough into the future to allow for orderly implementation of the recommended improvements, but not so far that there will be significant deviations between predicted and actual population growth that might result from future adjustments to County-adopted land use policies.

SERVICE AREA

The District's existing service area comprises approximately 7,315 acres of both developed urban and largely undeveloped rural agricultural land. The District's service area boundary was shown incorrectly on all prior report mapping. The boundary, as reviewed and approved on February 1, 2006 by the Local Agency Formation Commission (LAFCO), has been revised and shown correctly on all maps and figures within this document.

Figure 3 shows the potential areas of growth within the District's Sphere of Influence. In previous plans, the Sphere of Influence was not co-terminus with the District's boundary. Recent policy implemented by LAFCO requires the Sphere of Influence to be within a district's boundary. Figure 3 has been adjusted to accommodate this requirement.

SONOMA COUNTY GENERAL PLAN

In 1989, the County adopted a revised General Plan (*1989 Plan*). The District's service area is located entirely within the Sonoma Valley planning area (Area 9) as defined therein. Shortly after the General Plan was adopted, the County recognized that the document's population projection for 2005 was less than the actual 1989 population. Revisions to the *1989 Plan* were subsequently incorporated, in 1991 and again in 1994. Although general plans are usually updated every five years, no update has yet been completed since 1994. A Draft General Plan, with a planning horizon of 2020, has been prepared but no firm time line for its adoption has been published. Until such time as the update is completed and adopted, the *1989 Plan* will remain the guiding land use document.

GROWTH MANAGEMENT PLAN LIMITATIONS

In May 1992, the Sonoma County Board of Supervisors adopted a residential growth management plan for the Sonoma Valley. The growth management plan remains in effect today. The primary reason for adopting a growth management plan was to slow growth due to capacity limitations of the wastewater treatment, storage and disposal facilities owned and operated by the Sonoma Valley County Sanitation District. Under the growth management plan, new connections in the District are limited by the following criteria:

- Sixty dwelling units allotted per calendar year within the Urban Service Area as depicted on the *1989 Plan's* Land Use Map.
- Thirty dwelling units allotted per calendar year within the remaining rural portions of Area 9, with a limit of one dwelling unit per lot.
- Unused allotments maybe carried over to the following year.
- Second units, residential care facilities, homeless shelters and farm worker housing are exempted from the plan.
- Additions and remodeling of existing units are exempted from the plan.
- Special provisions are provided to multi-lot owner "low" and "very low" income developments.
- Commercial, institutional or industrial (CII) development is exempt under the plan.

Brelje & Race previously analyzed the impact that the growth management plan would have on residential growth within the District. That analysis predicted a maximum increase of about 48 dwelling units per year within the District's boundaries. Subsequently, maximum and minimum demand forecasts were developed by John O. Nelson and published in the 1999 Strategic Water Supply Plan (Ref. #4). The minimum demand forecast was based upon Brelje & Race's estimate of 48 new single family dwelling units per year, but also includes ten equivalent single-family dwellings (ESD's) of new non-residential connections, and ten ESD's of new connections exempt from the growth management plan for a total of 68 new ESD's annually. (An ESD refers to the average water consumption of a single family residence). The maximum demand forecast was developed assuming complete utilization of developable property within the District's Sphere of Influence, at the maximum growth potential, and would be achieved by 2050. The maximum demand forecast yielded an annual growth rate of 116 ESD's annually. Actual growth since implementation of the growth management ordinance has been substantially lower than even the minimum demand forecast.

POPULATION PROJECTION

Several reports have been prepared during the past twenty years that include an estimate of the District's ultimate population and the approximate time when that population will be achieved. While nearly all of the ultimate population projections are similar, the predicted time frame over which the ultimate population will be achieved has varied. In general, the ultimate population (estimated as high as 32,000 persons) has been predicted to be reached by 2050 even with the growth management plan in place.

More Recently, a memorandum prepared by Maddaus Water Management to the Sonoma County Water Agency entitled "Revised Customer Water Demand Projections Summary of Data Inputs, Assumptions and Results," dated November 22, 2005 (Maddaus Memo – Ref. #8) included population projections to 2030 for the District's service area. The projections were developed using sophisticated statistical methods and computer modeling. These projections are certainly more accurate than prior estimates and as accurate as any new projection Brelje & Race could possibly make. Fortunately the population projection spans the same period as this report's planning period. Utilization of the Maddaus projections will ensure consistency with Agency's water supply planning efforts. The following table lists the information contained in Table 1-1 of the Maddaus memo.

Table 4-1[1]

POPULATION RESULTS FOR VALLEY OF THE MOON

Population						
2004	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
22,526	22,665	23,359	24,055	24,753	25,109	25,466

[1]Information excerpted from Table 1-1 of Maddaus Memo.

Insert Figure 3 Here – Sphere of Influence

CHAPTER 5
HISTORIC & PROJECTED WATER USE

GENERAL

Water use within the District varies by water use class and in the case of the single-family class, by community. The various water use classes include single-family residential, multi-family residential, commercial, institutional, irrigation, fire, and unmetered uses. The District's Annual Reports for the five year study period were analyzed to identify overall historical water use and water use by class. The reports include the quantity of water purchased from the Agency, the quantity produced by District wells, sales volumes to customers and the annual volume of unaccounted for water.

While historical data was analyzed as part of the preparation of this report, it was not used for the purpose of making water use projections. Instead population and water use projections set forth in the Maddaus Memo (Ref. #8) to the Sonoma County Water Agency was utilized. The projection figures reported in the Maddaus Memo were also used during preparation of the Agency's Draft 2005 Urban Water Management Plan (UWMP – Ref. #10). The Agency is using the Draft UWMP as their blueprint for the water supply requirements for their customers through 2030. As the data in the plan will be used by the Agency to establish the District's entitlement limits, the District should acknowledge those limitations by utilizing them in their planning effort.

HISTORICAL WATER USE

Annual water production for the five year study period is shown in Table 5-1. Water produced by District wells represent a declining proportion of the water used within the District during that period. Interestingly, the trend is the opposite of that reported in the *1998 Update* (Ref. #1). The decrease in well production of approximately 40 percent is attributable to decreased use of wells during low demand periods and other operational changes implemented by District operations staff. In FY 2000/01, District wells produced nearly nineteen percent of the District's water supply. However, in FYs 2003/04 and 2004/05 well production was less than twelve percent of total supply. Maximizing well water production remains desirable as it is more economical than purchasing water from the Agency.

Table 5-1
HISTORICAL ANNUAL WATER SUPPLY VOLUMES

Source	Units	2000-01	2001-02	2002-03	2003-04	2004-05
Agency	Million Gal.	933.45	940.38	937.98	1,028.65	950.04
	Acre-Feet	2,865	2,886	2,879	3,157	2,916
Local Wells	Million Gal.	215.43	182.16	167.98	136.44	124.66
	Acre-Feet	661	559	515	419	383
Totals	Million Gal.	1,148.88	1,122.54	1,105.96	1,165.09	1,074.70
	Acre-Feet	3,526	3,445	3,394	3,576	3,298

UNACCOUNTABLE WATER LOSSES

A breakdown of annual water use between metered and unmetered uses is shown in Table 5-2. Water sales during the period ranged from 87 to 90 percent of total water production. Residential water sales have consistently been about 88 percent of total water sales during the period. The unmetered water uses listed in Table 5-2 include the estimated volumes of water used by the fire district for flushing hydrants, fire drills and fire fighting; water used by the District for construction related activities, system maintenance (flushing and cleaning of mains and tanks), promotional and miscellaneous uses, and; water lost due to evaporation, meter losses and theft.

Table 5-2
HISTORICAL ANNUAL WATER USE BREAKDOWN
(Million Gallons)

Type	2000-01	2001-02	2002-03	2003-04	2004-05
Residential Sales	867.63	868.18	879.17	930.36	833.15
Commercial Sales	145.35	125.9	108.07	116.76	106.97
Fire	0.14	0.22	0.12	0.16	0.13
Construction	0.09	0.05	0.07	0.22	0.17
Maintenance (includes repaired leaks)	26.74	25.99	28.54	27.04	21.62
Evaporation	5.74	5.61	5.53	5.83	5.37
Meter Losses	18.81	18.62	18.66	19.77	17.73
Miscellaneous	0.53	0.53	0.53	0.53	0.53
Unaccountable	83.85	77.44	65.27	64.42	89.03
Totals	1,148.88	1,122.54	1,105.96	1,165.09	1,074.70

Unaccountable water loss is the difference between metered production and water exiting the system via metered water sales and unmetered volumes of water utilized for other purposes. Production, the volume of water entering the water system, is metered at the ten aqueduct turnouts and at the District's wells. Unaccountable water loss is attributed to many causes. While leaks in water mains and services are often suspected to be the primary cause, other causes can also be significant contributors. Meters that are old and/or worn tend to read low because the moving parts no longer move as fast as they should and a common phenomenon is for low flows to pass through larger meters without registering. Even new meters are not 100 percent accurate at all flows. Unauthorized water use includes connections to service lines before the meter and the unauthorized taking of water out of hydrants. In 2005, the District replaced over 1,000 old meters, and has launched a phased program to replace all old meters.

Based upon the District's past annual reports for the study period, the amount of unaccountable water has ranged from 5.5 to 8.3 percent with the five year average being 6.8 percent. Unaccountable water loss listed in the 1998 Update averaged over ten percent. The reduction suggests that the District's ongoing efforts to reduce system leaks have been successful. An unaccountable water percentage of seven percent is considered average for water systems comprised of similar distribution system piping and age.

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MONTHLY DEMAND VARIATIONS

Monthly water supply data for the study period is shown in Table 5-3. The listed volumes include water supply from both the Agency aqueduct and District wells. The data shows that July and August have typically been the maximum water use months and winter water use is less than half of summer use. The primary reason for monthly water use variation from one year to the next is due to climatic fluctuations. Peak month water use is important as it is used for forecasting future demands and associated water facility needs.

Table 5-3
HISTORICAL MONTHLY WATER SUPPLY VOLUMES
(Million Gallons)

Month	2000/01	2001/02	2002/03	2003/04	2004/05	Average	% of Tot. Annual
July	139.54	144.46	157.62	146.36	133.67	144.33	12.8
August	134.87	134.20	117.63	131.76	141.25	131.91	11.7
September	119.49	110.87	117.38	138.33	124.79	122.17	10.9
October	100.74	116.70	104.68	111.88	92.28	105.25	9.4
November	65.19	65.64	82.05	60.82	70.33	68.81	6.1
December	62.20	54.32	59.21	58.28	60.73	58.91	5.2
January	66.94	66.22	59.20	55.42	65.24	62.60	5.6
February	55.95	55.48	54.20	52.91	55.42	54.79	4.9
March	67.15	57.07	64.84	79.70	64.38	66.63	5.9
April	86.69	88.87	67.34	85.81	66.42	79.03	7.0
May	120.03	106.89	88.03	104.16	90.45	101.91	9.1
June	130.28	121.99	133.79	139.67	109.72	127.09	11.3
Totals	1,148.88	1,122,54	1,105.96	1,165.09	1,074.70	1,123.44	

UNIT WATER USE

The District's annual reports list the estimated number of customers served each year. The number of customers is listed two ways; the number of active services and estimated population served. Using annual water production data and the customer information, the average day use (AD), average day use during the maximum use month (ADMM) were calculated and are presented in Table 5-4. The ratio of ADMM to AD is also listed.

Table 5-4
HISTORICAL WATER PRODUCTION BREAKDOWN

Parameter	2000/01	2001/02	2002/03	2003/04	2004/05
Annual Volume (MG)	1,148.88	1,122.54	1,105.96	1,165.09	1,074.70
Average Daily (MGD)	3.15	3.08	3.03	3.19	2.94
Maximum Month (MG)	139.54	144.46	157.62	146.36	141.25
Est. Population Served	22,842	22,923	22,958	23,074	23,142
Per Capita Production					
Average Annual (GPD)	138	134	132	138	127
Max. Month (GPD)	197	203	221	205	197
No. Active Connections	6,687	6,685	6,704	6,743	6,771
Per Connection Production					
Average Annual (GPD)	471	460	452	473	435
Max Month (GPD)	673	697	758	700	673
Ratio ADMM to AD	1.43	1.52	1.68	1.48	1.55

Total water use has been generally trending downward during the five year study period although the highest water use occurred in FY 2003/04. Maximum monthly use does not appear to follow any particular trend and is most likely weather dependent. The ratio between average day of the maximum month and the average day ranged from 1.43 to 1.68 during the study period and averaged 1.53. This figure is very similar to that listed in the *1998 Update* (1.50). Average per capita production was 134 gallons per day.

WATER USE BY CLASS

The District's predominant meter class is residential, with over 86 percent of all water sales attributable to residential end uses. The bulk of the remaining water sales are attributable to commercial and institutional uses as there are no industrial users within the District. Water sales records for each meter class were compiled for FY 2004-2005 and are presented in Table 5-5. The table also lists the percentage of total sales by meter class and the ratio of average day sales during the maximum monthly demand (ADMM) to the average day demand for each class.

Table 5-5
METERED USE BY CLASS FOR FY 2004/05

Meter Class	Total (MG)	% of Total	No. of Conn.	ADMM (gpd/conn)	Ave. Day (gpd/conn.)	Ratio ADMM toAD
Single Family	636.90	67.9%	6,177	455	286	1.59
Multi-Family	175.86	18.7%	414[1]	251[2]	189[2]	1.33
Commercial	69.23	7.4%	155	1,665	1,224	1.36
Institutional	31.40	3.3%	30	5,395	2,868	1.88
Irrigation	22.61	2.4%	28	4,769	1,796	2.65
Hydrant	2.54	0.3%	13	1,427	535	2.67
Fire	0.03	0.0%	27	-	3	-
Totals	938.57		6,769			

[1]Serves a total of 2,547 multi-family residential units.
[2]Average use per multi-family residential unit.

The District defines one equivalent single family dwelling unit (ESD) as the average day of a single family residence during the month of maximum use. The ESD is a convenient unit for quantifying existing and projecting future demands and associated facility needs. Currently the District defines an ESD as a demand of 490 gallons per day. In FY 2004/05 the average single family demand during the maximum month was 462 gallons per day. This figure cannot be considered an ESD as the figure includes all single family connections, not just those having 5/8" meters. However, as 5/8" meters constitute 95 percent of all single family meters any resulting error would be minor. Water use in FY 2004/05 was approximately 4.5 percent lower than the average of the five year period. Adjusting for the slightly lower water use to account for the typical yearly variation yields a single family demand during the maximum month of 483 gallons per day. This figure suggests the District's current definition of an ESD continues to be reasonable and appropriate.

WATER USE PROJECTION TO 2030

Projecting water use is dependent upon several factors including future land uses, employment projections, anticipated water conservation and reuse efforts, and historical user trends. Most of these factors were thoroughly analyzed and included in the population projection model developed by Maddaus Water Management and included in their Memorandum to the Sonoma County Water Agency (Ref. #8). Table 5-6 lists the gross and net water demand projections set forth in the Maddaus Memo and estimated unit water demand projections based on the net annual demands.

Table 5-6

WATER DEMAND PROJECTIONS

	Fiscal Year				
	2009/10	**2014/15**	**2019/20**	**2024/25**	**2029/30**
Population	23,359	24,055	24,753	25,109	25,466
No. of Connections	6,917	7,122	7,328	7,434	7,539
Annual Demand (AC-FT)					
Gross Annual Demand	3,953	4,075	4,196	4,259	4,322
Conservation Savings	205	324	409	462	504
Net Annual Demand	3,748	3,751	3,787	3,797	3,818
Net Unit Demands:					
Ave. Day (MGD)	3.35	3.35	3.38	3.39	3.41
ADMM (MGD)	5.4	5.4	5.4	5.4	5.5
Est. Max. Day (MGD)	10.0	10.0	10.1	10.2	10.2

WATER CONSERVATION

Water conservation in the District is mandated by the Restructured Agreement for Water Supply (Ref. #5) between the Agency and the water contractors. Under Section 1.12 of the Agreement, the District is required, under threat of fines, to be a member of the California Urban Water Conservation Council (CUWCC); to sign the "Memorandum of Understanding Regarding Urban Water Conservation in California" maintained by the CUWCC; participate in all of the Best Management Practices (BMPs) for water conservation promulgated by the CUWCC, and; any other conservation measures as may be required of the Sonoma County Water Agency. The District, which has a long history of promoting water conservation efforts, is currently fulfilling their obligations under their Agreement with the Agency and has implemented all 13 BMPs recommended by the CUWCC.

Water conservation efforts are predicted to significantly reduce the District's gross water demands (Refer to Table 5-6 above). The Maddaus Memo estimates that by 2010 the District's water savings due to the various conservation efforts could total 205 acre-feet annually, and increase to 504 acre-feet annually by 2030. The sources of these significant savings include the CUWCC BMPs, impending changes to housing standards and the plumbing code, and other BMPs the District might implement on their own. It is important that the District implement as many BMPs as are practicable as the Agency has assumed significant savings in water demands will be achieved in the future and the anticipated savings are reflected in the annual entitlement limits for the District set forth in the Agency's Draft 2005 UWMP (Ref. #10).

FIRE PROTECTION

Fire protection for the District is provided by the Sonoma Valley Firemed System and by the Glen Ellen Fire Department. The Sonoma Valley and Glen Ellen fire chiefs have indicated that a fire hydrant flows of 2,500 gallons per minute (GPM) should be provided in commercial areas. In residential areas, a fire flow of 1,000 GPM is desirable and a minimum fire flow of 500 GPM should be available everywhere. These flows should be provided for a duration of two hours from one or more hydrants concurrent with a maximum day demand while maintaining a residual pressure of 20 pounds per square inch throughout the distribution system.

Water use from fire fighting or testing fire hydrants is generally estimated and included in the unmetered water category. (Refer to Table 5-2). The District had 27 separate fire line services to commercial and multi-family residences in FY 2004/05. The water flow through these services totaled 30,000 gallons for the entire year, an insignificant amount. Fire flow volumes have been ignored in future demand projections.

CHAPTER 6
PROJECTED SYSTEM REQUIREMENTS

GENERAL

During the five year study period, the ratio of the Average Day of the Maximum Month (ADMM) to Average Day production requirements averaged 1.53. Since peak month demands vary significantly from year to year in response to weather conditions, and available metering data is inadequate to make further refinements, it is recommended that the slightly more conservative unit multiplier of 1.60 be used. It is also recommended that the Maximum Day to Average Day ratio multiplier of 3.0, previously determined for the *1998 Update* (Ref. #1), be used.

Projections of future water needs are presented in Table 5-6. Projected total water demand in FY 2029/30 is 3,818 acre-ft. distributed by 7,540 service connections. The projected average day demand is 3.4 MGD. Using the above unit multipliers, the projected average day demand during the maximum month would be 5.5 MGD and the maximum day demand would be 10.2 MGD.

WATER SUPPLY

<u>Sonoma County Water Agency Entitlement</u>
In May of 1990, the District Board of Directors requested an entitlement increase of 80 percent from the Agency (from 4.7 MGD to 8.5 MGD). This request was based on full build out within the District's Sphere of Influence (from previous Master Plans), an area comprised of approximately 16,600 acres. For approximately 90 percent of the service area, land use was assumed to be in accordance the County's 1989 General Plan Land Use Map. For the remaining area, a single family residential density of 4 units per acre was assumed.

At the present time, maximum monthly purchases from the Agency are limited to 4.9 MGD per the Memorandum of Understanding Regarding Water Transmission System Capacity Allocation During Temporary Impairment (M.O.U. – Ref. #6). The M.O.U. is a voluntary agreement, executed by the Agency and all the water contractors, to reduce water consumption until such time as sufficient improvements to the Agency’s water supply and transmission system can be constructed. Unfortunately, construction of necessary improvements has been delayed by litigation challenging the sufficiency of the associated environmental documentation. A new environmental impact report is currently being prepared, with completion and adoption expected sometime in 2008. The requested entitlement volume of 8.5 MGD is expected to satisfy supply requirements to full buildout (2050) of the District. The process the District followed to establish this entitlement amount is described in the *1998 Update*.

In addition to the maximum monthly entitlement limitation set forth in the M.O.U., water purchases are also restricted to 3,200 acre-feet on an annual basis. The District is currently using more than 3,200 acre-feet annually and has to supplement Agency supply with local groundwater supplies (wells) to satisfy demands. In 2004, the District requested that their annual entitlement be increased by 1,000 acre-feet to 4,200 acre-feet. While the request has not yet been granted, the Agency's Draft 2005 UWMP (Ref. #10) lists projected annual water entitlement to the District in excess of their present entitlement suggesting that the requested increase will eventually be approved. The document shows that by 2030 projected sales to the District will be 3,729 acre-feet, or 529 acre-feet more than currently authorized. This projection will purportedly be incorporated into the next iteration of the Restructured Agreement for Water Supply (Ref. #5), expected sometime after adoption of the new Water Supply and Transmission System EIR. It is anticipated however, that entitlement increases may be granted incrementally as the Agency has pending requests for additional rights to Russian River water that must be approved before significantly increasing deliveries to any of the contractors. The water rights issues are not anticipated to be resolved before 2016. In the interim the District will need to continue to rely on local groundwater to make up the supply shortfall.

District Groundwater Supply
The Agency M.O.U. (Ref. #6) suggests (but does not require) each water contractor work towards developing 40 percent of their water supply needs from local sources during the term of the temporary impairment. Local supplies could also be used to reduce reserve storage requirements. During emergencies all outside water use would be curtailed and demand would diminish to approximately the level of average wintertime demand. Winter water use has averaged approximately 90 gallons per day per capita over the study period. At the current (2005) population of 23,200, wintertime water use is 2.1 MGD and is projected to be 2.26 MGD by 2030. Existing groundwater supplies are unavailable to the higher Glen Ellen and Madrone pressure zones. These zones account for approximately eight percent of District demands. The remaining zones would be able to be served indefinitely during an emergency if local groundwater supplies totaling 2.0 MGD could be developed.

In 1999 the District commissioned Luhdorff & Scalmanini to prepare a groundwater master plan. The 1999 Master Ground Water Plan (L&S Plan – Ref. #11) identified five locations within the District that may be suitable as production well sites. The L&S Plan estimated that a total of 2.57 MGD (1,780 GPM) of groundwater production might be possible from wells located in the District. Using recommended well operation practices described therein, the projected annual well capacity was approximately 1,900 acre-feet, more than sufficient to meet the M.O.U. goals in 2030.

However, B&C Report (Ref. #12) evaluated the feasibility of locating wells on ten sites within the District. They concluded that only three of the ten sites are feasible for development of new wells and only one site (the location of an abandoned well on Verano Avenue) stands out as having real potential. The District is currently developing a well at the Verano Avenue site. Anticipated production capacity is expected to be approximately 200 GPM.

The District's current annual production from local groundwater sources is approximately 400 acre-feet (including production from the Larbre well lease set to expire in 2010). Current operations practice involves utilizing the wells nearly full time during the peak demand season (a period of four to five months) and operating them sparingly the remainder of the year. Adjusting operations practices could increase annual production by approximately fifty percent, to 600 acre-feet. With the addition of the new well on Verano Avenue, the District will have the potential to produce up to 800 acre-feet annually. Another benefit is that water produced from District wells is less expensive to produce than water purchased from the Agency and therefore it is economically advantageous for the District to utilize wells as much as possible. However, further well development at this time will likely be limited due to the pessimistic conclusions in the B&C Report.

One way to increase well production would be to change current operations practices. Ron Foster Sr. of Ground Water Well and Pump, Inc., a local well driller with considerable experience, has suggested that an optimum well operating scheme would involve operating wells daily for approximately 16 to 18 hours rather than for 24 hours. He also suggests that once or twice annually the wells should be rested for several days to two weeks. A similar operating scheme is described in the L&S Plan. The well down-time allows for maintenance and aquifer recovery. Using these operational parameters, wells can typically operate approximately two thirds of the time throughout the year.

STORAGE FACILITIES

General

Total recommended water storage volume is comprised of three elements: equalizing, reserve, and fire storage. The recommended parameters to establish the volume of each element is listed in Table 6-1.

Table 6-1
RECOMMENDED STORAGE PARAMETERS

Equalizing Storage:	25% of Maximum Day Use (without off-peak pumping) 40% of Maximum Day Use (with off-peak pumping)
Reserve Storage:	100% of Average Day Use
Fire Flow Storage:	Commercial - 2,500 GPM for 2 hours Residential - 1,000 GPM (desirable) for 2 hours Residential - 500 GPM (minimum) for 2 hours

Equalizing storage provides water during peak hourly demand periods to reduce water supply capacity requirements. Equalizing storage is replenished at night when demands are low and may include capacity to allow for off-peak pumping to reduce power costs. Each pressure zone should have adequate equalizing storage for the number of users connected in that zone.

Reserve storage is for emergencies. The minimum recommended reserve storage component is a one day supply at average demand rates. Larger reserves may be warranted if unforeseen incidences become more commonplace but can introduce operational problems (stored water becomes stagnant when the turnover rate is relatively low). Reserve storage should be situated in the pressure zone where it is intended to be used. It may be located in a higher pressure zone if provisions are available to return it to the lower zone by gravity. Local well production can be used to offset and/or supplement reserve storage.

Fire flow storage is reserved for fighting fires. Fire flow storage volumes are based upon the flow rates and durations requested by the local fire district. Fire flow storage should be provided in every pressure zone (based upon needs in that zone) or alternatively in a higher pressure zone(s) provided there are provisions to return it to the lower zone by gravity.

District Storage Requirements

Recommended storage requirements for each pressure zone are presented in the report by Brelje & Race entitled, 1999 Water Storage Plan (*1999 Storage Plan* – Ref. #2). Most of the recommendations in that report remain valid but need to be updated to reflect the storage that has been constructed since its preparation.

Storage requirements for the Aqueduct and Trinity Oaks pressure zones (served directly from the SCWA aqueduct without pumping) differ from other zones as equalizing storage is not required, and in some cases fire storage requirements may be reduced as it can be considered to be available in the Agency's tanks. Pumped zones on the other hand, do require equalizing and fire storage reserves. The District's pumped zones are shown on Figure 4.

Table 6-2 lists the projected 2005 storage requirements for each zone as published in the *1999 Storage Plan*. Requirements for the Sonoma Mountain zones have been added. The *1999 Storage Plan* projections were based on the number of projected service connections in each zone and their respective average demands. While the current number of services in each pressure zone was not determined for this report, the *1999 Storage Plan* projection of 6,900 total service connections within the District in 2005 is only two percent over the actual total of 6,780. The small difference in service connections results in storage volume requirements that are slightly conservative, but within an acceptable range of accuracy for each zone.

Table 6-2
STORAGE REQUIREMENTS AND EXISTING CAPACITY

	Volume (1000 Gallons)				
Pressure Zone	**Operating**	**Reserve**	**Fire**	**Total[1]**	**Existing**
Trinity Oaks	0	33	0	33	0
Glen Ellen	152	203	300	655	650
Madrone	174	278	150	602	2,000
Temelec	226	301	300	827	1,200
Sonoma Mountain 4 & 5	16	38	0[2]	54	54
Sobre Vista 2 & 3	29	38	120	187	240
Chestnut 2 & 3	82	109	120	311	320
Donald/Michael	10	13	120	143	200
Aqueduct (Main Zone)	0	2,101	150	2,251	800
Totals	689	3,114	1,260	5,063	5,464

[1]Values (except Sonoma Mountain zones) reproduced from Table 3.5 "Storage Requirements by Zone – 2005", in the 1999 Water Storage Plan (Ref. #2).
[2] Fire storage volume requirement for the Sonoma Mountain Homestead area provided by a private irrigation system**.**

Storage projections for build-out of the District's sphere of influence (2050) are also presented in the *1999 Storage Plan*. The projections assume a build-out total of approximately 9,000 service connections. The projected number of service connections (7,540) is much less for FY 2029/30. A straight-line interpolation between the 2005 storage requirements and the projections for 2050 yield the results for 2030 listed in Table 6-3.

Table 6-3
PROJECTED STORAGE REQUIREMENTS (2030)

	Volume (1000 Gallons)			
Pressure Zone	**Operating**	**Reserve**	**Fire**	**Total**
Trinity Oaks	0	33	0	33
Glen Ellen	167	225	300	692
Madrone	191	300	150	641
Temelec	247	329	300	876
Sonoma Mountain 4 & 5	16	38	0	54
Sobre Vista 2 & 3	29	38	120	187
Chestnut 2 & 3	90	120	120	330
Donald/Michael	11	14	120	145
Aqueduct (Main Zone)	0	2,307	150	2,457
Totals	751	3,404	1,260	5,415

[1]Assumes Sobre Vista water system owners elect to join VOMWD; this is an unlikely occurrence before the end of the planning period.

A comparison of current storage volumes to projected requirements for 2030 suggests a total shortfall of 140,000 gallons. A zone by zone comparison suggests that there is currently a significant storage shortfall in the Aqueduct zone of 1.45 MG and a projected 2030 shortfall of 1.65 MG. The shortfalls are actually 0.6 MG greater due to the lower water levels in the Bolli tanks in the summer months due to high system demands. The actual projected 2030 shortfall is then 2.3 MG. Fortunately storage located upstream in the Madrone and Glen Ellen pressure zones can be transferred into the Aqueduct zone and the deficit is also offset by well production capacity within the Aqueduct pressure zone. The Madrone pressure zone currently has a storage surplus of 1.4 MG decreasing to a projected surplus of approximately 1.35 MG in 2030. This volume is available to the Aqueduct zone thereby decreasing its shortfall to approximately 1.0 MG. Production wells in the Aqueduct pressure zone currently produce the equivalent of approximately 0.42 MGD. Well production is projected to increase to at least 0.61 MGD once the new Verano Well goes online. The storage shortfall will then be approximately 0.4 MG.

The Glen Ellen pressure zone is projected to have a small shortfall of approximately 40,000 gallons in 2030. As there is no local supply in that area, the District should consider increasing storage to accommodate an extended curtailment of the Aqueduct supply. Because storage located in Glen Ellen can also be used in lower zones, locating additional storage facilities there would be an efficient use of resources.

The Trinity Oaks pressure zone has approximately 50 connections and is served directly from the Agency aqueduct. A standby well, capable of producing about 50 gpm, is located in the zone. There is presently no storage in the zone as the existing redwood storage tank has been removed from service. The tank originally was used in conjunction with well and hydro-pneumatic booster pumps, but was no longer needed after switching to Agency pressure. The District has several alternatives to providing reserve storage in this zone. Assuming the District is willing to utilize the well, it would be an acceptable alternative to storage, provided, it was equipped to operate on a portable emergency generator. Another alternative would be to have an ongoing service contract with a water hauler that would truck in water during service outages. A third alternative would be to construct a 3,600 LF pipeline between Glen Ellen and Trinity Oaks, allowing access to storage reserves in Glen Ellen. The first two alternatives would be more economical than a new pipeline considering there are so few customers in the zone.

BOOSTER PUMPS

Two pumps, each capable of pumping the maximum day demand should be available at each booster pump station for reliability. At locations where more than one booster pump station serves a pressure zone, the combined pumping capacity should be at least the maximum day demand with the largest single pump out of service. Pumped pressure zones are shown on Figure 4.

Currently the District pumps from the Agency aqueduct into the Glen Ellen pressure zone to keep the tanks in that zone full. Similarly, a new booster pumping station is under construction at Agua Caliente Road that following completion will keep the 2.0 M gallon Hanna tank fuller during high demand periods. Booster stations are an option for sustaining the desired hydraulic grade line in any pressure zone. Pressures in the Aqueduct pressure zone is, at times, lower than desired. If the Water Agency does not complete additional segments of the parallel aqueduct this situation is likely to become more prevalent as demands in the District and City of Sonoma continue to increase. Booster pumping is less desirable than completing the additional parallel aqueduct segments for several reasons: 1) water withdrawn from the Agency aqueduct using pumps reduces flows to the Sonoma tanks making less water available to the City of Sonoma; 2) pumping is costly and increases the cost of purchased water; 3) the capital and maintenance costs associated with developing and maintaining booster stations is considerable, 4) booster pumping does not provide the same level of redundancy as parallel aqueducts would, and; 5) the District may still be obligated to help fund the construction of the parallel segments of the aqueduct at a later date regardless.

Figure 4 – PUMPED ZONES ****

DISTRIBUTION NETWORK

General

Evaluation of the District's extensive and complicated water distribution system was accomplished using sophisticated hydraulic modeling software. Typical system deficiencies, including low pressure, high pipeline velocity, inadequate networking, and inadequate fire flow capacity were fully analyzed using the modeling program. Scenarios modeled included average and maximum demand situations for current and future demand conditions.

A computer model of the District's water system was created and analyzed for the *1998 Update*. For this report, the original model was converted to run with new software and updated to reflect all improvements completed since 1998, including those made to the Agency's Sonoma aqueduct and associated facilities. Recommended improvements to District facilities were identified during the numerous hydraulic analyses that were performed. Review of pipe type and age and network redundancy resulted in additional recommended improvements.

Hydraulic Model

The revised model includes all of the Aqueduct, Madrone, Temelec, and Glen Ellen pressure zones and the Water Agency's gravity flow portion of the Sonoma Aqueduct system between the Oakmont/Los Guillicos and Sonoma tanks. (Refer to Exhibit III in Appendix B.) The Eldridge booster pump station was not included in the model as the pumps are rarely used. District booster pump stations to higher zones were included in the model. (Refer to Figure 4.) Other than the demand created by the booster pump stations, higher zones operate independently from Zone 1, and therefore were not included in the model. The model also did not include the Trinity Oaks area since it operates independently with its own Agency aqueduct turnout.

The original steady state model only analyzed system hydraulics at a specific instance in time and under a specific set of boundary conditions. Due to increased demands, the steady state model was no longer stable and obtaining meaningful results was difficult. To generate results and stabilize the model, diurnal demand curves for daily time of use fluctuations were created for the various user classes (i.e. residential, commercial, and irrigation) and the model was converted from a steady state model to an extended time period simulation (EPS) model covering a five day time period. The EPS model is comparable to the modeling performed by the Water Agency for their aqueduct system, and provides meaningful results showing how facilities respond over long time periods.

The steady state model was useful for determining fire flow capabilities and identifying low pressure areas and high velocity pipes. The EPS model is capable of producing graphical results similar to SCADA trends over the selected time period, such as changes in tank levels, pressure fluctuations at any user-selected node, booster pumping flow rates, pump starts and stops, and Agency turnout flows. Evaluation of the EPS model results provides a better understanding of system performance under stressful demand conditions. Selected samples of graphical results are included in Appendix B.

Model Calibration & Expected Accuracy

Hydraulic models should be re-calibrated about every five years or more often if there are major changes to the water system. Since it has been nearly ten years since the original calibration, a calibration of the updated model was performed.

Calibrating large models is a slow, trial and error process. A well calibrated model should produce results within five percent of field measured conditions (95 percent accurate). A successful calibration was eventually achieved for the revised model. Results were mixed however, with highly accurate calibration achieved in many areas and borderline acceptable results in four areas (the Temelec area, the area north of Serres Road, the older area around Bartlett Avenue, and an area around Donald Avenue near Michael Drive). Closed valves were suspected to be the reason for the calibration problems in these areas but District staff conducted a field investigation and found all valves open. A plausible explanation for the borderline results in these areas could not be identified. It was especially puzzling considering model results for several other areas were extremely accurate. Based on the overall calibration results it can be assumed that model results of system pressures are within 3 psi of actual, pipeline velocities are within 5 percent of actual, and EPS results should be accurate for five days, and possibly longer. Results from very long EPS runs will be inaccurate at a specified time, but they are useful for determining tank level and pressure trends (See results in Appendix B). The five day simulations provide conservative results as periods of extremely high demands typically do not last more than a few days.

Existing System Analyses

Following model calibration, demand scenarios were created to approximate average day, average day of the peak month, and maximum day demand conditions. The differing demand conditions were run with existing network conditions and the results examined in order to identify current deficiencies in pressure, flow, pipe velocity, etc. Through a trial and error process of additional modeling, appropriate improvements were identified to satisfy the maximum day demand conditions.

EPS model runs were used to identify the adequacy of the Agency's aqueduct system, and whether system pressure, flow, and tank levels in the District would be able to recover each day. For the EPS simulations, tanks were assumed to be about 80 percent full at the beginning of the run period and all wells and booster pumps to higher zones (modeled as simple demands) were modeled as "on."

Fire flow scenarios were run with both the steady state and EPS models. The fire flow scenarios checked whether recommended fire flows would be available at selected locations, about 65 in all. Locations were selected that are evenly spread around the water system in order to assess fire flow availability throughout.

System deficiencies identified during the various model runs are listed in Table 6-4. Listed information includes the nature and location of the deficiency, and the recommended improvement to correct it. In some isolated low pressure areas the problem is due to the terrain and there may not be any reasonable solution.

Table 6-4
SUMMARY OF HYDRAULIC MODEL RESULTS

Project ID	Map No.	Deficiency	Recommended Improvement
1	18-K	Low Fire Flow; Low Pressure Area	Extension and loop connection from Robin Drive to Warm Springs Road (380 LF - 8").
2	18-K	Low Fire Flow; Low Pressure Area	Parallel main in Warm Springs Road from Saddle Road to new looped main (570 LF - 8").
3	22-M	Emergency Transfer; Water Quality	Modify Eldridge PSV to include 2-inch combination PSV/PRV and 6" PRV in parallel.
4[1]	23-N	Flow to Hanna Tank; Low Fire Flow	Parallel main in Madrone Road from Agency turnout to Maplewood Drive (980 LF - 8").
5	26-O	Low Pressure Area; Low Fire Flow; High P/L Velocity	Parallel main in Agua Caliente Road from Agency turnout to Vailetti Drive (1,600 LF - 8").
6	26-P	Low Pressure Area	Main extension in Park Avenue from Park Avenue well to Elev. 150 +/- (1,050 LF - 6"); Transfer ±30 services to new Zone 2 main.

[1] New Agua Caliente Booster Pump Station No. 2 is intended to aid filling of Hanna Tank. Project ID. #4 would also fill the tank and help increase fire flows to low flow areas. The District may wish to consider constructing the parallel main in the future as it would add additional benefits over the pump station, with reduced operating expenses.

Model runs conducted after incorporation of the recommended improvements of Table 6-4 indicate that the average day and average day of the maximum month demand conditions could be satisfied with only minor dips in storage tank levels and system pressures after five days, and even longer periods. Under maximum demand conditions the five day extended period simulations indicate that storage tanks would struggle to recover and pressures would begin to drop severely by the end of the five day period. Shorter periods of extremely high demands would be less of a problem. Construction of one or two of the Agencies planned parallel aqueduct segments would alleviate these problems entirely.

<u>Future System Analyses (2030)</u>
The future system was analyzed in a similar fashion as the existing system. All recommended improvements were included in the model along with updated demands. The model was run under all demand conditions (average, average of maximum month and maximum day demands) and results analyzed to identify any additional system deficiencies. No additional system deficiencies were identified. However the EPS model indicated that the hydraulic grade line (system pressure) would dip severely and rapidly under average day of maximum month demand conditions resulting in empty tanks, low pressures and inadequate fire flows across the entire District. All District tanks and the Sonoma tank emptied completely before the end of the five day simulation. The model demonstrated that these problems could only be mitigated by increasing local source capacity (new wells) or by constructing at least two of the planned four additional parallel aqueduct segments. The

last two segments were determined to provide minimal improvement to system pressures or flows under 2030 demands, but may be necessary eventually.

CHAPTER 7
MASTER WATER PLAN

GENERAL

The Master Water Plan (Plan) contains recommendations and cost estimates that may be used to develop an on-going capital improvement program (CIP). The Plan identifies improvements to supply, storage, booster pumping, valves and piping, and other operational aspects required to satisfy recognized reliability and water quality standards for all District customers through the end of the planning period (2030). The Plan shows the sizes and locations of recommended improvements and identifies a logical order for their implementation. For those improvements that are primarily to improve system reliability, the order that they are made is not critical. The hydraulic model was instrumental in revealing system deficiencies. Several of the pipeline replacement projects listed in the *1998 Update* have not yet been completed and are recommended again herein.

SUPPLY

Agency Aqueduct

The primary supply source for the District is the Agency's Sonoma Aqueduct. Demands along the Sonoma Aqueduct were approaching its hydraulic capacity until the recent construction of the parallel segment between the Eldridge tanks and Madrone Road. The parallel segment has improved deliveries to and pressures in the northern areas of the Aqueduct pressure zone and in the Madrone pressure zone. However, the improvements to service will diminish as the District and City of Sonoma demands continue to increase.

The hydraulic model indicates that if two of the planned parallel aqueduct segments are constructed, deliveries and pressures from the existing turnouts would be adequate to satisfy District demands to the end of the planning period (2030). Specifically, the 26,000 LF segment of 24-inch diameter pipe from the Los Guillicos tank to the turnout at Trinity Oaks and the 17,000 LF segment of 20-inch diameter pipe from Madrone Road to the turnout at Railroad and Verano Avenues. The District will need to participate with the City of Sonoma and the Agency in the funding and construction of these facilities within the next ten to fifteen years unless additional local supply sources are developed.

While the remaining two planned segments would provide only minor service improvements within the District, they would considerably improve delivery system redundancy and reliability. Details of the planned parallel pipeline segments are listed in Table 7-1, adapted from tables in the Water Agency's Water Supply and Transmission System Project EIR (WSTS EIR – Ref. #13).

Table 7-1
SONOMA AQUEDUCT PARALLEL PIPELINE

Segment	Length	Diameter	Cost[1]
1[2]	8,500 LF	20	$ 2.80 M
2	26,000 LF	24	7.05 M
3	7,000 LF	24	2.45 M
4	17,000 LF	20	4.45 M
5	7,200 LF	20	2.20 M
		Total Project Cost	$18.95 M
		Total District Share	$10.90 M

[1]Costs from Table 1B of the Water Agency's 1998 Water Supply and Transmission System Project EIR, Appendix H and updated to 2001 costs in the 2001 WSTSP Financial Plan. Listed costs include planning, engineering, inspection and construction.
[2]The 8,500 LF segment from Eldridge Tanks to Madrone Road completed in 2006.

Hydraulic modeling indicates that unless new local supply sources are developed and/or improvements made to the Sonoma Aqueduct before 2030 severe pressure and fire flow deficiencies will occur within the District during the peak demand season as water levels in District and Agency storage tanks fall, and potentially drain completely during high demand periods. Operating pressures in a number of localized areas would drop below 20 psi, the minimum allowed under State Department of Health requirements.

District Wells
Luhdorff & Scalmanini investigated the potential of developing additional groundwater sources in the District. Their report (Ref. #11) indicates that several new wells could be developed on the valley floor within the Aqueduct pressure zone and that their expected capacity would be between 100 and 400 GPM each, with likely yields around 300 GPM. The valley floor would be the ideal location for new wells as they could take advantage of the existing, well networked piping system and would be located directly in the zone with the highest demands and least volume of reserve storage. Other well locations identified include the areas within the Sonoma Volcanic soil types, with lower expected yields of between 50 and 200 GPM. The more recent B&C Report (Ref. #13) is much more pessimistic regarding the potential to develop local groundwater supplies within the District.

The District has begun developing the new Verano well with an expected yield of 200 GPM, but has no current plans for developing additional wells due to the findings in the B&C Report. Despite the inherent challenges of finding suitable well sites, it is recommended that the District continue their test well program until either the desired peak production capacity of 2.0 MGD is achieved or the potential well options identified in the B&C Report have been exhausted. Construction of the recommended parallel Agency aqueduct segments could be postponed if additional local groundwater supply were developed.

STORAGE

Storage recommendations in the *1998 Update* were superseded by those in the 1999 Water Storage Plan (Ref. #2) due to changes in the underlying assumptions regarding local groundwater availability and the period of time the Agency supply might be unavailable during an emergency. The *1999 Storage Plan* assumed that considerable local groundwater supplies (1.8 MGD by 2005 and 2.5 MGD by 2050) could be developed and assumed only a single day of emergency reserve capacity (from wells and storage) was necessary. The *1999 Storage Plan* also established storage needs for each pressure zone based on the average day demands of the zone, rather than the average for the entire District, as zonal demands vary widely.

The storage recommendations in this report are an update of the more thorough analysis performed for the *1999 Storage Plan*. However, as well production capacity is currently not expected to exceed 800 acre-feet the recommended reserve storage capacity for each pressure zone has been revised. One day of reserve storage continues to be the recommended volume, a recognized standard of both Title 22 of the California Administrative Code and the American Water Works Association. Development of additional reserve storage is encouraged since well capacity will be insufficient to sustain minimum needs and service outages longer than one day have occurred in the past. Additional reserve storage would also allow peak demands to be withdrawn from District tanks thereby reducing demand on Agency supply facilities.

Storage in Agency tanks may be available to the District during an extended service outage although the Agency does not guarantee delivery during emergencies. As a result, Agency storage was ignored when determining recommended reserve storage volumes.

Table 7-2 lists the recommended locations and volumes of storage facilities the District should add during the planning period. Recommended storage volumes could be reduced if additional groundwater supplies were developed. The capacities of the proposed tanks are based on the projected number of customers served and whether reserve storage is also being provided for other pressure zones.

New tanks will be required for future customers in areas targeted for new development. The Cavedale Road and Moon Mountain areas are likely areas where new development may occur. The terrain in these areas suggest that service be extended from pressure zones 2 and 3, respectively, but their distance from the upper pressure zones will dictate the creation of separate pressure zones with their own storage. The Cavedale Road tank site is a prime location for placement of additional storage reserves. It is recommended that the District construct as large a tank as the future site can accommodate (up to 1.0 MG). If additional reserve storage is not provided at the site, the volume of the Cavedale tank would only need to be 0.2 MG to serve a projected 60 to 80 new customers.

TABLE 7-2
RECOMMENDED STORAGE IMPROVEMENTS

Name	Existing Volume	Proposed Volume	Notes
Glen Ellen #2	-0-	Up to 0.5 MG	Key location for additional reserve storage. Supplements storage for current customers, and increases overall system reliability and flexibility.
Cavedale	-0-	Up to 1.0 MG	Key location for additional reserve storage. Supplements storage for current customers, and increases overall system reliability and flexibility.
Moon Mountain	-0-	0.16 MG	Storage for future customers. Increases system reliability and flexibility.

Storage will only need to be provided for the Cavedale area when additional development in that area occurs. The area could be served from the Aqueduct pressure zone or, following some piping modifications, be incorporated into the Madrone pressure zone with its slightly higher hydraulic gradient (supplied by the Madrone and Hanna turnouts). Switching the Cavedale area to the Madrone pressure zone could be accomplished at any time and would eliminate one of the worst low pressure areas of the District (Serres Road area). A new booster pump station at the future Cavedale tank site would supply water to the Moon Mountain tank. The Moon Mountain tank will similarly only be necessary should future development occur.

District tanks will eventually require replacement as they age beyond their useful design life. All but one of the District's older tanks have been replaced during the past several years. No replacements are recommended at this time. The only old tank still in service is the 90-year old lower Sobre Vista tank, a 30 thousand gallon concrete tank with a wood cover. The tank is still in fair condition and being concrete, is likely to remain so for some time. The condition of the cover structure should be inspected annually for rot and will need to be replaced every 15 years or so. The tank interior should be inspected annually as well. Should signs of significant deterioration appear, consideration should be given to replacing it with a new tank of similar volume.

BOOSTER PUMP STATIONS

No booster pump station improvements are recommended at this time. The Saddle booster pump station was previously recommended to be eliminated and that recommendation remains valid. One future booster pump station, to serve the Moon Mountain area, may be required after additional development in that area. The anticipated booster pump station configuration is presented in Table 7-3. The Moon Mountain booster pump station would supply the portion of the Upper Northeast Valley area located above the main service zone. The pump station would be constructed at the future anticipated Cavedale tank site and would supply the (future) Moon Mountain tank. The facility would include two pumps, each capable of delivering the maximum day water demand for the roughly 90 projected customers in the zone. The second pump would serve as a standby unit.

The developer would be installing and supplying this pump station if and when service is requested. The developer's engineer would spec the size of the pumps at that time.

Table 7-3
Booster Pump Station Improvements

Name	Booster Pumps	Function
Moon Mountain	2 @ 100 gpm	Supply for upper zone

WATER MAIN REPLACEMENTS AND ADDITIONS

A number of water main replacements recommended in the *1998 Update* still remain to be completed. Most are included in the District's current 5-year CIP, therefore, are included herein and assigned the highest priority (1). Pipeline replacements are listed in Table 7-4 along with their estimated current (2006) costs. The listed costs include allowances for planning, design and construction but do not reflect site specific impacts such as terrain, number of service connections, etc. Most replacement projects are needed because existing mains are undersized by current standards (less than 4-inches in diameter) and/or comprised of old steel pipe that is corroding and approaching its useful life. Some main replacements recommended previously in the *1998 Update* are to improve fire protection in localized areas.

The recent hydraulic modeling effort indicates that construction of several new water mains would improve pressure and fire flows, reduce high line velocities and provide more reliable service (with redundant piping) in several areas. These recommended distribution system improvements are listed in Table 6-4 and again in Tables 7-4, 7-5 and 7-6 with their estimated costs (also shown graphically on Exhibit II at the end of this report). The recommended replacement and parallel mains have been assigned a priority (1, 2 or 3) depending upon their relative benefit to the distribution system. While the benefits of each project would be substantial, existing service levels would not deteriorate further if they were not constructed as each project targets an existing system deficiency.

Completing all main replacements and new main installations in about 15 years would maintain acceptable levels of service. Based on this criterion, Priority 1 distribution system improvements should be scheduled for construction in the initial five years, Priority 2 improvements should be constructed in the next five year period, and the remainder during the last five.

Table 7-4
PRIORITY 1 DISTRIBUTION SYSTEM IMPROVEMENTS

SYSTEM MAP NO.	LOCATION	EX. PIPING	NEW PIPING	PROJECT COST[1]
15-M	Adine Court Easement	1 1/4"	340' - 2"	$ 37,000
16-M	Trinity Road Easement	1 1/4"	570' - 2"	62,000
18-K	Robin Dr.- Warm Springs Road Ext.		380' - 8"	100,000
18-L	Gibson Street	1 1/2"	420' - 6"	62,000
18-L	Riddle Road Esmt.	2"	200' – 4"	24,000
19-L	Carmel Avenue	1" to 3"	1190' - 8" 730' – 2"	296,000
22-M	Eldridge PSV Modifications			75,000
23-N	Brookview Drive	1 1/2"	140' - 2"	15,000
25 L/26L	Sobre Vista (Near Lake Josephine)	4"	550' – 6"	82,000
26-Q	Woodland & Cragmont Drive	2" and 4"	640'- 4" 290'-2"	109,000
27-P	Balsam	2"	710' - 6"	105,000
27-P	Monterey West	2"	370' – 6"	55,000
27-Q	Monterey East	2"	240' - 2"	26,000
27-Q	Las Lomas Road	2"	710' - 2"	77,000
28-Q	East Thomson Ave.	1" and 2"	330' - 6"	49,000
28/29-Q	Mulford Lane	2"	300' - 2"	32,000
29-P	Academy Lane	1-1/2" and 4"	370' - 6" 420' – 2"	100,000
29-P/Q	Fairview Lane	2"	950' - 2"	103,000
29-Q	Lomita Avenue	2"	200' - 6"	30,000
29-Q	Manzanita Road	4"	1070' - 6"	159,000
30-O	Laurel Avenue	1 1/2" and 2"	360' - 2"	39,000
30-P	Railroad Avenue	2" and 4"	410' - 6"	61,000
30-Q	Indian Lane. (AKA Robbin Lane)	2"	250" - 6"	37,000
30/31-P	Bay Street	4" and 6"	1390' - 6"	206,000
31-P	Center Avenue	2"	240' – 6"	36,000
31-P	Walnut Avenue	1"	530' - 6"	79,000
31-P	Penny Lane	1" and 2"	500' - 6"	74,000
31-P	Oak Street	2" and 4"	650' - 6"	97,000
31-P	Walnut Avenue	1-1/2" and 4"	500' - 6"	74,000
			TOTAL PRIORITY 1:	**$2,324,000**

1. Project costs include design, construction and construction inspection.

Table 7-5
PRIORITY 2 DISTRIBUTION SYSTEM IMPROVEMENTS

SYSTEM MAP NO.	LOCATION	EX. PIPING	NEW PIPING	PROJECT COST[1]
18-K	Warm Springs Road (Parallel Main)		570’ - 8"	$104,000
26-O	Agua Caliente Road (Parallel Main)		1600’ - 8"	292,000
			TOTAL PRIORITY 2:	**$396,000**

1. Project costs include design, construction and construction inspection.

Table 7-6
PRIORITY 3 DISTRIBUTION SYSTEM IMPROVEMENTS

SYSTEM MAP NO.	LOCATION	EX. PIPING	NEW PIPING	PROJECT COST[1]
26-P	Park Avenue (Main Extension)		1050’ - 6"	$156,000
23-N	Madrone Road. (Parallel Main)		980’ - 8"	179,000
			TOTAL PRIORITY 3:	**$335,000**
			TOTAL All REPLACEMENTS AND NEW MAINS:	**$3,055,000**

1. Project costs include design, construction and construction inspection.

MONITORING/CONTROLS

The central monitoring system for all District tanks, pumps and wells, installed as recommended in the *1998 Update*, has been recently expanded to include monitoring of several Agency facilities. Consideration should be given to future monitoring of flows and pressures at each Agency turnout and at District-operated pressure regulating valves, and remote operational control of isolation valves at several of the Agency’s turnouts. Having the ability to monitor flows and pressures on a continuous basis would allow peak demand periods to be accurately analyzed thereby aiding in system planning efforts (such as model calibrations). Hydraulic modeling indicated that once the additional improvements to the Agency’s aqueduct system are completed, many District tanks will remain full most of the year. Having the ability to remotely close valves at several of the turnouts would allow for adequate turnover in the District’s water tanks. As these improvements are not mandatory, no specific time frame for their implementation is provided.

SUMMARY OF COSTS

Parallel Aqueduct

Project cost estimates for each of the future parallel aqueduct segments are listed in Table 7-1 of the Agency's Water Supply and Transmission System EIR (and were updated in the 2001 WSTSP Financial Plan). The listed District share was determined by formulas set forth in the Agency's Restructured Agreement for Water Supply (Ref. #5). Only Segments 2 and 4 are required prior to the end of the present planning period (2030). The information is repeated in Table 7-7 herein. The 2001 costs have been adjusted to current (2006) dollars by assuming an annual inflation rate of 5% over the period.

Table 7-7
PARALLEL AGENCY AQUEDUCT COSTS

Segment No.	Length	Diameter	2001 Cost	Current Cost
2	26,000 LF	24	7.05 M	9.5 M
4	17,000 LF	20	4.45 M	6.0 M
		Total Cost	**$11.5 M**	**$ 15.5 M**
	Estimated District Share		**$ 6.6 M**	**$ 8.9 M**

District Wells

While the District may not pursue additional well capacity beyond the new well currently under construction, the pursuit of additional local supply sources should be considered. Additional groundwater supplies may be able to be developed at the other feasible sites identified in the B&C Report or at other sites identified in the future. The current construction budget for the Verano well is approximately $630,000. The Verano well is located on District-owned property whereas easements or fee property would probably need to be purchased for others. A reasonable budget allowance that would provide for all costs associated with development of future wells would be $1.5M (includes planning, right-of-way acquisition, environmental documentation, design, exploratory program, and construction).

Storage Facilities

One additional storage facility will be needed in the near term, located in the Glen Ellen pressure zone, and would satisfy the slight storage shortfall and provide needed reserves. The storage tank would have a capacity of 0.5 MG and be ideally located on the east side of the area, somewhere in the vicinity of Mound Avenue. Approximately a half acre of land would be necessary to accommodate a flat bottom reservoir. Extensive landscaping and screening measures would likely be necessary based on the experience with the recently completed Hill Road tank.

Steel prices have been volatile recently and increased substantially during the past few years. Coatings are also becoming increasingly expensive and these trends are expected to continue. Table 7-8 lists the estimated costs for a new welded steel tank in the Glen Ellen area.

Table 7-8
GLEN ELLEN TANK COST ESTIMATE

Item		Est. Cost
Environmental Documentation		$50,000
Design & Specifications		100,000
Property Acquisition		280,000
Construction		
Site Work		50,000
Foundation		30,000
0.5 MG Steel Tank		500,000
Tank Coatings		190,000
Site Piping		40,000
Site Paving		40,000
Landscaping		30,000
Fencing		20,000
Mobilization/De-mobilization/Other		50,000
	Construction Subtotal:	$950,000
Inspections		100,000
	Subtotal	$1,480,000
15% Contingency		220,000
	Total Cost	$1,700,000

The need for storage in the Cavedale and Moon Mountain areas will become necessary when and if development occurs in those areas. The costs of these tanks and the booster pumping facilities will be covered by developers or through connection fees. However, should the District elect to add additional storage capacity in the Cavedale tank as recommended, the costs of upsizing would be the District's responsibility. An estimate of $2 to $3 dollars per gallon added would be appropriate. Therefore, for an added capacity of 800,000 gallons, the District should expect to contribute approximately $2 M.

Booster Pump Stations

No new booster pumping facilities are recommended at this time.

Distribution Network

Estimated costs of each recommended distribution network improvement are listed in Tables 7-5 through 7-7. A summary of the estimated costs by "priority" are presented in Table 7-9.

Table 7-9
SUMMARY OF DISTRIBUTION SYSTEM IMPROVEMENT COSTS

Priority 1 Distribution System Improvements:		$2,324,000
Priority 2 Distribution System Improvements:		396,000
Priority 3 Distribution System Improvements:		335,000
	TOTAL:	$3,055,000

The combined cost of all recommended improvements, including the District's share of two parallel Agency aqueduct segments is $13.7 M. Each well the District elects to construct will increase the total by approximately $1.5 M. Facilities for future customers should be financed with connection fees or paid for by development interests, with elective added volume paid for by District capital improvement funds.

APPENDIX A
HYDRAULIC MODEL

APPENDIX A - HYDRAULIC MODEL

GENERAL

Hydraulic modeling provides a means of assessing strengths and weaknesses within a complicated water system. Models indicate areas of excessively high or low pressure and allow evaluation of possible solutions; perform fire flow analyses; simulate facilities such as regulating valves, pressure sustaining valves, pumps, check valves and more; help determine pumping schedules; and provide a planning and design tool for future facilities.

As a part of the Master Water Plan, the model of the Valley of the Moon Water System was used to determine if adequate fire protection would be available from both residential and commercial area hydrants during maximum day demand conditions, to determine how Agency and District tanks will recover during long periods of high demands, to determine the piping improvements necessary to provide minimum fire flow volumes, and to assess piping improvements which would benefit the overall hydraulic performance of the network.

MODEL CONSTRUCTION

A hydraulic model was created for the previous 1998 *Update*. The information in the existing model was used as the basis for the current modeling efforts. The old model was updated to include all piping and facility improvements constructed in the interim, and entirely new, updated demands were assigned to each node.

DEMAND ALLOCATION

A demand analysis of the District water system was performed to determine the average day demands for single family residential, multi-family residential, commercial, institutional, and irrigation connections within each of the District's meter reading routes. The demand analysis used water production totals and metered sales data for the past five years. Large meter service connections were evaluated individually using their metered sales data. The average day demands were allocated to each model node by meter reading route along with a small additional demand to account for overall system losses.

The average day demands for each demand class were determined and assigned to nodes uniformly in each meter reading route. (Within the software, each node may be assigned up to 10 differing demand types). Extended time period simulations (EPS) also utilized diurnal demand curves that adjust demands based on the time of day. Diurnal curves for residential, commercial and irrigation classes of demands were created based on typical use patterns. After demands were assigned to the nodes, the model was calibrated to ensure accuracy.

CALIBRATION

Model calibration ensures that model predictions fairly accurately match real water system conditions. Accurate calibration of a model takes substantial time and effort. Piping networks experience pressure losses due to friction that are proportional to fluid velocity and the roughness of the pipe wall (there are minor losses due to bends, pipe diameter changes, obstructions, etc.) Losses are typically accounted for by the use of a frictional loss coefficient, which may vary with pipe material and age. Published values for frictional losses are used initially, and adjusted through a trial and error process during calibration until the model results match closely with field measured conditions.

The District model was calibrated by performing flow tests at numerous fire hydrants throughout the distribution system. During the tests, the time was recorded and later compared to SCADA data in order to determine tank levels, pump and well status, etc. ("boundary conditions") at the specific time hydrants were being flowed.

To calibrate, boundary conditions in the model were set to match those recorded for each of the flow tests, estimated demands were applied to the nodes, and the model run and checked to see if the model predictions for flow would match the measured flows and residual pressures. Where inconsistencies resulted, adjustments to model frictional coefficients or other parameters were made until model results matched closely with the field measurements.

Through a trial and error process, the model was calibrated with eventual satisfactory results.

MODELING RESULTS

A number of scenarios were created and modeled in order to determine any existing or expected system deficiencies. Two types of models were used: steady state models which look at a single instance in time, and extended time period type simulations (EPS) which look at the water system over a long period of time. In this case, the EPS models used a five day time period. Steady state models are useful for determining locations with high line velocities and low fire flows. EPS models are useful for determining areas of low pressure, the duration of low pressure events, and the robustness of the network during extended high demand periods. The scenarios included varying demands between average day, average day of the maximum month, and maximum day demands. Also, the scenarios included current demands and demands projected for 2030. The complete list of scenarios modeled is shown in Table A-1 below.

Table A-1
Hydraulic Model Scenarios

Run Name	No	System Modeled	Demands	Model Type
BASE		Base Network Model (Used as basis for all other models)		
Exist	1	Existing	Average Day	Steady state
	2	Existing	Maximum Day	Steady state
Improved	1	Improved	Average Day	Steady State
	2	Improved	Maximum Day	Steady State
MastPlan	1	Improved + Parallel Aqueduct	Average Day	Steady State
	2	Improved + Parallel Aqueduct	Maximum Day	Steady State
ExistEPS	1	Existing	Average Day	EPS
	1.1	Improved	Average Day	EPS
	1.2	Improved + Parallel Aqueduct	Average Day	EPS
	2	Existing	Maximum Day	EPS
	2.1	Improved	Maximum Day	EPS
	2.2	Improved + Parallel Aqueduct	Maximum Day	EPS
	3	Existing	ADMM	EPS
	3.1	Improved	ADMM	EPS
	3.2	Improved + Parallel Aqueduct	ADMM	EPS
MastPlanEPS	1	Improved + Parallel Aqueduct	Average Day	EPS
	2	Improved + Parallel Aqueduct	Maximum Day	EPS
	3	Improved + Parallel Aqueduct	ADMM	EPS

The existing system models included all District facilities and pipes within the distribution system, and pipe improvements currently under construction. Modeling results indicated that most areas are already well networked with adequate pressure and fire flow capabilities, especially under average demand conditions. The recent piping and storage improvements have considerably improved the robustness of the water system. There remain two specific areas that continue to be problematic for fire flow and pressure, plus the higher elevations along transition zones between zone one and two also experience low pressures during particularly high demand periods.

In the Aqueduct zone, fire flows are above 500 GPM everywhere, but below 1000 GPM in the area of El Portola Drive near Hwy. 12. Pressures in this area dip below 40 psi regularly, and below 30 psi occasionally. Piping improvements have been identified to improve fire flows but the physical elevations of the area preclude improving pressures by piping improvements alone. A change to the future Cavedale Road pressure zone or additional parallel piping to connect the area to the Madrone pressure zone would be necessary to alleviate low pressure problems.

In the Glen Ellen pressure zone, the lack of a looped piping network in the Lakeside Drive area contributes to low pressures and low fire flows. Fire flows are below 500 GPM in some locations. To alleviate low pressure during high demand periods, and to increase fire flows to over 1000 GPM under maximum demand conditions, the completion of a piping loop over the local creek and a parallel pipe to the turnoff to Saddle tank would be necessary.

Additional improvements noted include:

- A parallel main in Park Avenue from the upper pressure zone. Transferring a number of the services over to the parallel main would provide those services with the higher pressure of the upper zone.
- A parallel main from the Madrone Road turnout to the intersection of Maplewood Drive would reduce head losses, increasing the hydraulic grade of the zone, and help to keep Hanna tank full without pumping.
- Eldridge pressure reducing station should be modified to include a small combination pressure sustaining/reducing valve and a larger pressure reducing valve. The small valve will allow for a steady, but small transfer of water from the Glen Ellen PZ to the Madrone PZ, reducing any water quality concerns for the long transmission main. The larger valve will allow for considerable transfers to occur in emergency situations, or during a fire.

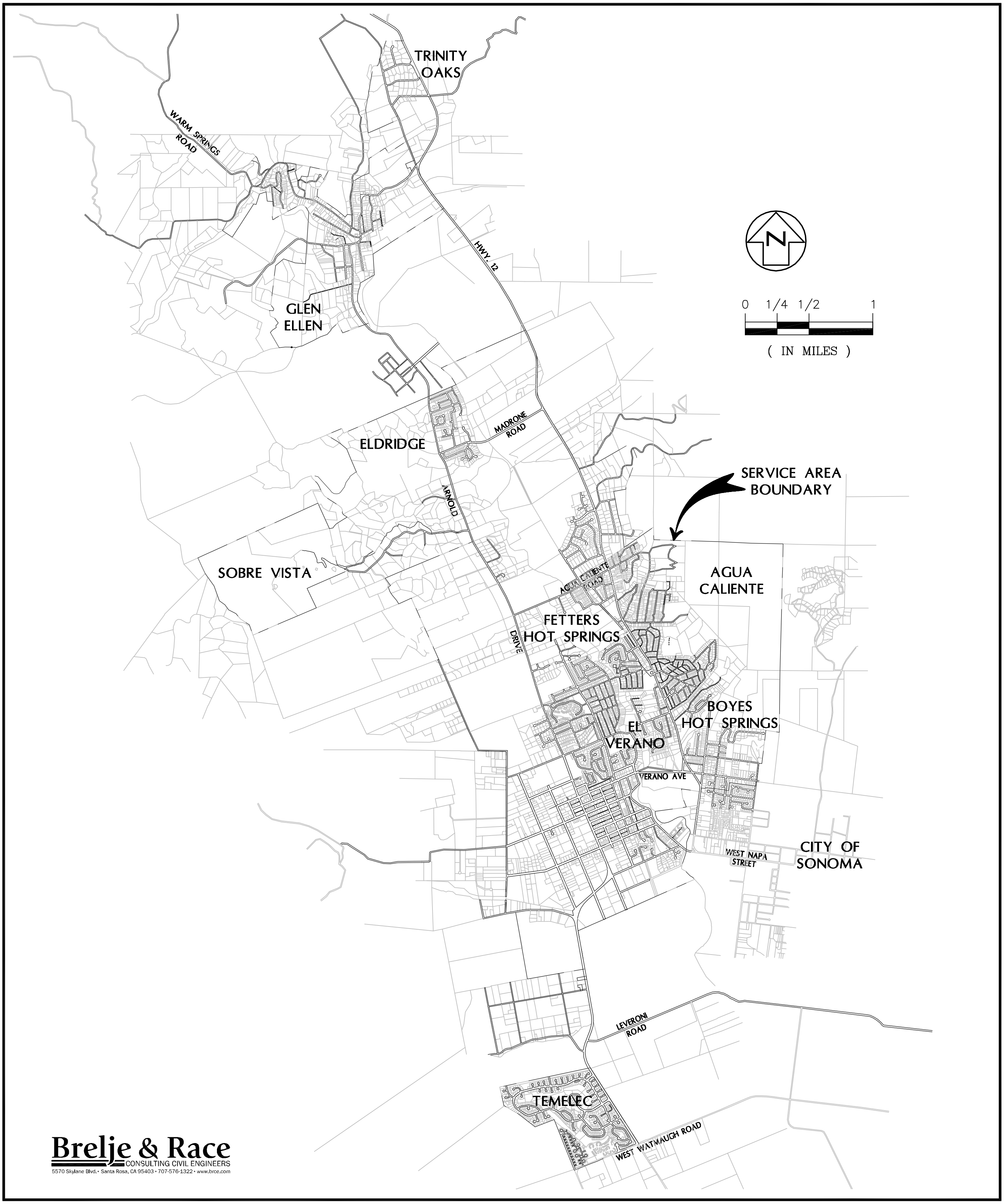
The improved system models indicated that with the piping improvements noted above, fire flows will all be 1000 GPM or greater during maximum day demand conditions.

The Master Plan models include demands based upon projections for 2030, all recommended piping improvements, and two additional segments of the planned four segments of the Agency's parallel aqueduct. The Master Plan models were useful in determining that the parallel segments would be required in order to keep tank levels full, or near full during extended high demand periods. Without the parallel segments, Agency and District tanks will empty rapidly under maximum demands, and fairly rapidly under ADMM demands.

MODEL RESULTS DOCUMENTATION

Graphic and tabular modeling results are provided for selected modeling scenarios in the accompanying, but separately bound Appendix B. The results provided demonstrate how each particular improvement will benefit the distribution system. Explanations are provided for each scenario.

APPENDIX B
HYDRAULIC MODEL



SERVICE AREA MAP

FIGURE 1

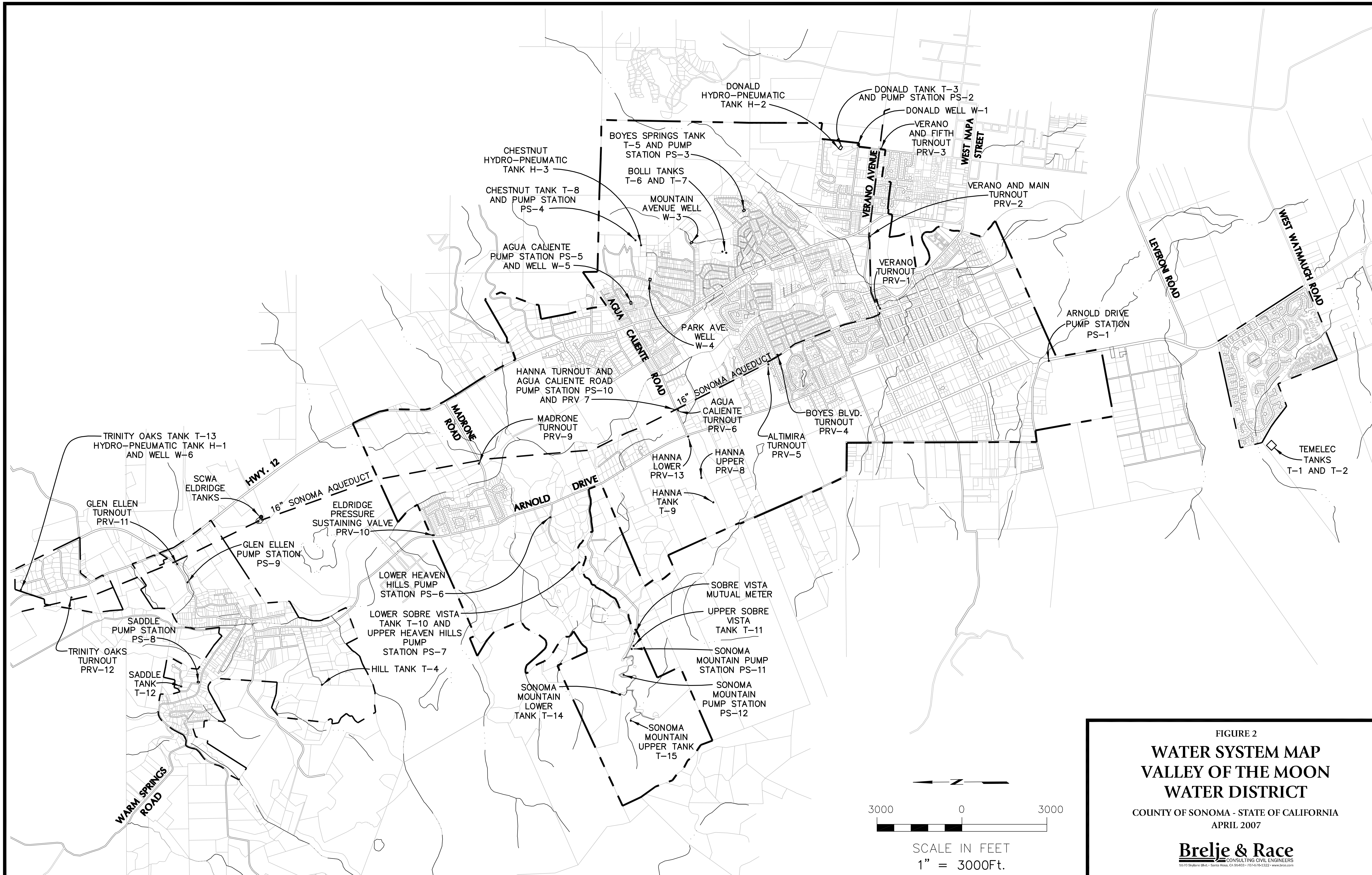


FIGURE 2

WATER SYSTEM MAP
VALLEY OF THE MOON
WATER DISTRICT

COUNTY OF SONOMA - STATE OF CALIFORNIA
APRIL 2007

Brelje & Race
CONSULTING CIVIL ENGINEERS

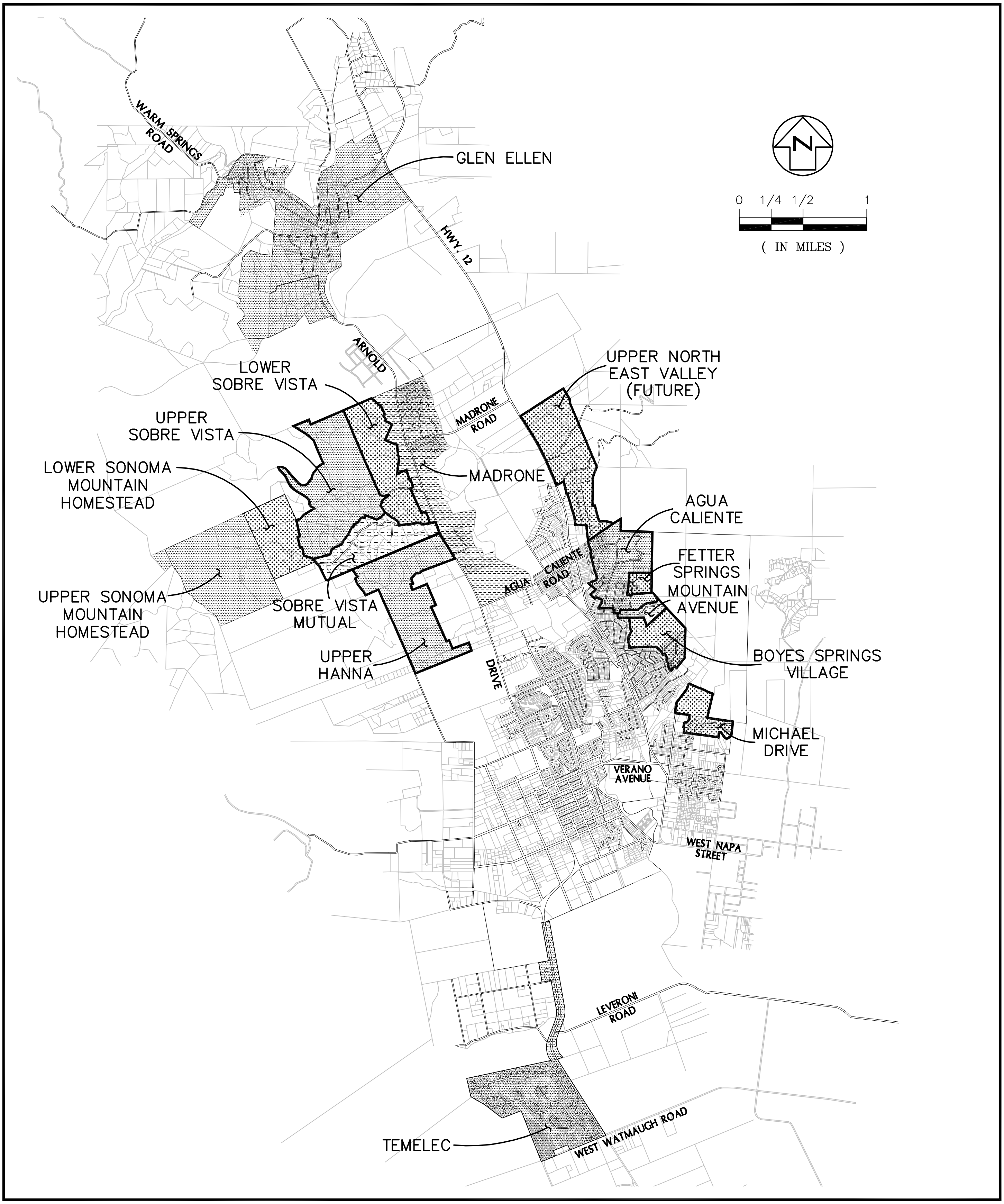
FIGURE -- 3

SPHERE OF INFLUENCE MAP
VALLEY OF THE MOON
WATER DISTRICT

COUNTY OF SONOMA - STATE OF CALIFORNIA
APRIL 2007

Brelje & Race
CONSULTING CIVIL ENGINEERS

04-12-07 kiflizghi \1674\dwg\1674 FIG 3.DWG XREF: 1674 DESIGN FAC.DWG TAB: LAYOUT1 VIEW: PS1



PUMPED ZONES

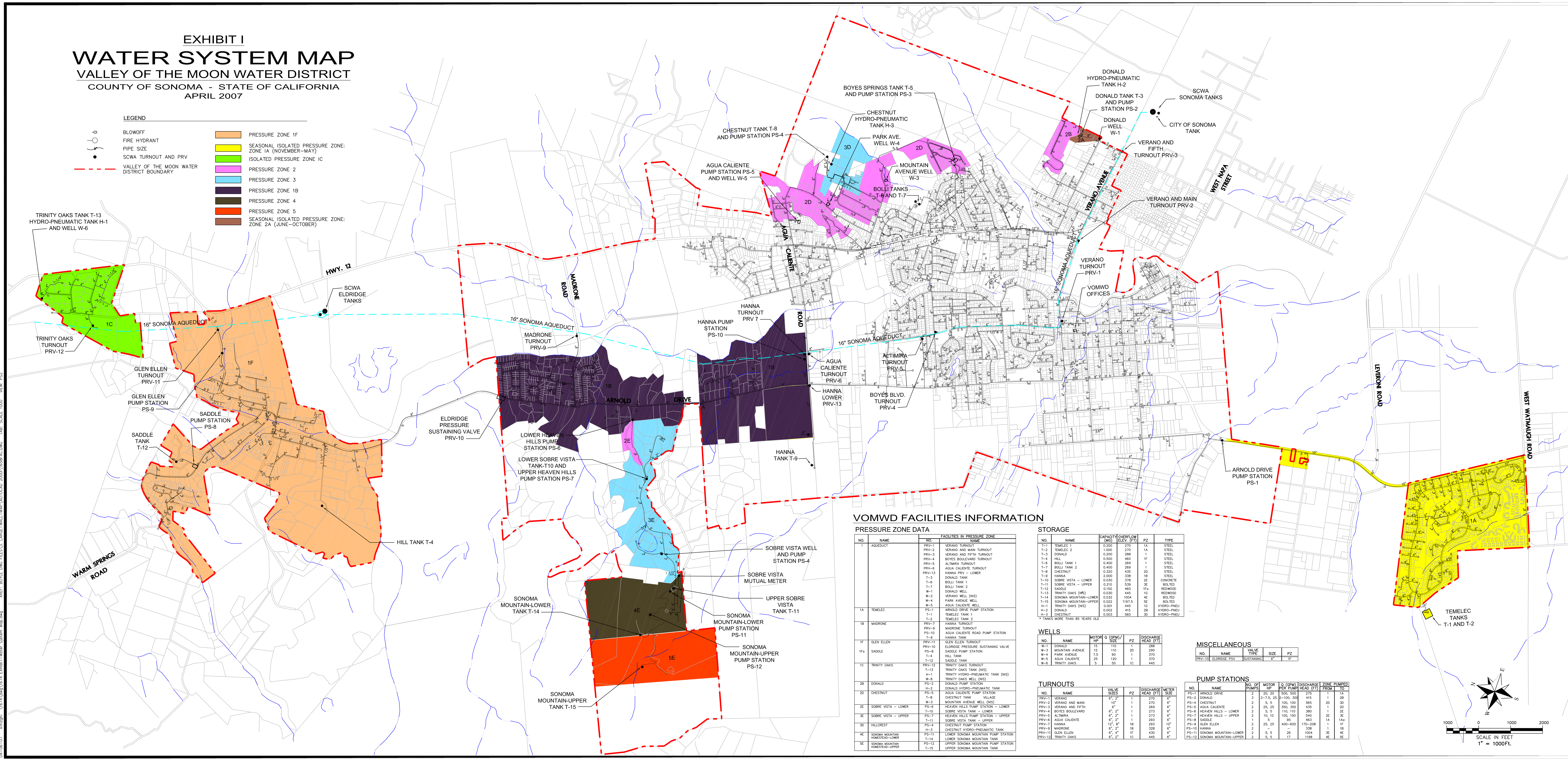
FIGURE 4

EXHIBIT I

WATER SYSTEM MAP

VALLEY OF THE MOON WATER DISTRICT

COUNTY OF SONOMA - STATE OF CALIFORNIA
APRIL 2007



VOMWD FACILITIES INFORMATION

PRESSURE ZONE DATA

NO.	NAME	FACILITIES IN PRESSURE ZONE NO.	FACILITIES IN PRESSURE ZONE NAME
1	AQUEDUCT	PRV–1	VERANO TURNOUT
		PRV–2	VERANO AND MAIN TURNOUT
		PRV–3	VERANO AND FIFTH TURNOUT
		PRV–4	BOYES BOULEVARD TURNOUT
		PRV–5	ALTIMIRA TURNOUT
		PRV–6	AGUA CALIENTE TURNOUT
		PRV–13	HANNA PRV – LOWER
		T–3	DONALD TANK
		T–6	BOLLI TANK 1
		T–7	BOLLI TANK 2
		W–1	DONALD WELL
		W–2	VERANO WELL (NIS)
		W–4	PARK AVENUE WELL
		W–5	AGUA CALIENTE WELL
1A	TEMELEC	PS–1	ARNOLD DRIVE PUMP STATION
		T–1	TEMELEC TANK 1
		T–2	TEMELEC TANK 2
1B	MADRONE	PRV–7	HANNA TURNOUT
		PRV–9	MADRONE TURNOUT
		PS–10	AGUA CALIENTE ROAD PUMP STATION
		T–9	HANNA TANK
1F	GLEN ELLEN	PRV–11	GLEN ELLEN TURNOUT
		PRV–10	ELDRIDGE PRESSURE SUSTAINING VALVE
1Fa	SADDLE	PS–8	SADDLE PUMP STATION
		T–4	HILL TANK
		T–12	SADDLE TANK
1C	TRINITY OAKS	PRV–12	TRINITY OAKS TURNOUT
		T–13	TRINITY OAKS TANK (NIS)
		H–1	TRINITY HYDRO–PNEUMATIC TANK (NIS)
		W–6	TRINITY OAKS WELL (NIS)
2B	DONALD	PS–2	DONALD PUMP STATION
		H–2	DONALD HYDRO–PNEUMATIC TANK
2D	CHESTNUT	PS–5	AGUA CALIENTE PUMP STATION
		T–8	CHESTNUT TANK VILLAGE
		W–3	MOUNTAIN AVENUE WELL (NIS)
2E	SOBRE VISTA – LOWER	PS–6	HEAVEN HILLS PUMP STATION – LOWER
		T–10	SOBRE VISTA TANK – LOWER
3E	SOBRE VISTA – UPPER	PS–7	HEAVEN HILLS PUMP STATION – UPPER
		T–11	SOBRE VISTA TANK – UPPER
3D	HILLCREST	PS–4	CHESTNUT PUMP STATION
		H–3	CHESTNUT HYDRO–PNEUMATIC TANK
4E	SONOMA MOUNTAIN HOMESTEAD–LOWER	PS–11	LOWER SONOMA MOUNTAIN PUMP STATION
		T–14	LOWER SONOMA MOUNTAIN TANK
5E	SONOMA MOUNTAIN HOMESTEAD–UPPER	PS–12	UPPER SONOMA MOUNTAIN PUMP STATION
		T–15	UPPER SONOMA MOUNTAIN TANK

STORAGE

NO.	NAME	CAPACITY (MG)	OVERFLOW ELEV. (FT)	PZ	TYPE
T–1	TEMELEC 1	0.200	270	1A	STEEL
T–2	TEMELEC 2	1.000	270	1A	STEEL
T–3	DONALD	0.200	288	1	STEEL
T–4	HILL	0.500	460	1F	STEEL
T–6	BOLLI TANK 1	0.400	269	1	STEEL
T–7	BOLLI TANK 2	0.400	269	1	STEEL
T–8	CHESTNUT	0.320	435	2D	STEEL
T–9	HANNA	2.000	338	1B	STEEL
T–10	SOBRE VISTA – LOWER	0.030	378	2E	CONCRETE
T–11	SOBRE VISTA – UPPER	0.210	539	3E	BOLTED
T–12	SADDLE	0.150	460	1Fa	REDWOOD
T–13	TRINITY OAKS (NIS)*	0.030	445	1G	REDWOOD
T–14	SONOMA MOUNTAIN–LOWER	0.032	1004	4E	BOLTED
T–15	SONOMA MOUNTAIN–UPPER	0.022	1197.5	5E	BOLTED
H–1	TRINITY OAKS (NIS)	0.001	445	1G	HYDRO–PNEU
H–2	DONALD	0.002	415	2B	HYDRO–PNEU
H–3	CHESTNUT	0.003	560	3D	HYDRO–PNEU

* TANKS MORE THAN 85 YEARS OLD

WELLS

NO.	NAME	MOTOR HP	Q (GPM)/ SIZE	PZ	DISCHARGE HEAD (FT)
W–1	DONALD	15	110	1	288
W–3	MOUNTAIN AVENUE	15	110	2D	290
W–4	PARK AVENUE	7.5	90	1	370
W–5	AGUA CALIENTE	25	120	1	370
W–6	TRINITY OAKS	5	50	1C	445

MISCELLANEOUS

NO.	NAME	VALVE TYPE	SIZE	PZ
PRV–10	ELDRIDGE PSV	SUSTAINING	6"	1F

TURNOUTS

NO.	NAME	VALVE SIZES	PZ	DISCHARGE HEAD (FT)	METER SIZE
PRV–1	VERANO	6", 2"	1	270	6"
PRV–2	VERANO AND MAIN	10"	1	270	6"
PRV–3	VERANO AND FIFTH	6"	1	269	6"
PRV–4	BOYES BOULEVARD	6", 2"	1	273	6"
PRV–5	ALTIMIRA	6", 2"	1	273	6"
PRV–6	AGUA CALIENTE	6", 2"	1	293	6"
PRV–7	HANNA	12", 8"	1B	293	10"
PRV–9	MADRONE	6", 2"	1B	328	6"
PRV–11	GLEN ELLEN	6", 4"	1F	430	6"
PRV–12	TRINITY OAKS	6", 2"	1C	445	6"

PUMP STATIONS

NO.	NAME	NO. OF PUMPS	MOTOR HP	Q (GPM) PER PUMP	DISCHARGE HEAD (FT)	ZONE PUMPED FROM	ZONE PUMPED TO
PS–1	ARNOLD DRIVE	2	20, 20	500, 500	275	1	1A
PS–2	DONALD	3	2–7.5, 25	2–100, 300	415	1	2B
PS–4	CHESTNUT	2	5, 5	100, 100	565	2D	3D
PS–5	AGUA CALIENTE	2	25, 25	350, 350	435	1	2D
PS–6	HEAVEN HILLS – LOWER	2	5, 5	110, 110	380	1	2E
PS–7	HEAVEN HILLS – UPPER	2	10, 10	100, 100	540	2E	3E
PS–8	SADDLE	1	5	95	463	1A	1Aa
PS–9	GLEN ELLEN	2	25, 25	400–600	170–208	1	1F
PS–10	HANNA	2	–	–	338	1	1B
PS–11	SONOMA MOUNTAIN–LOWER	2	5, 5	26	1004	3E	4E
PS–12	SONOMA MOUNTAIN–UPPER	2	5, 5	17	1198	4E	5E


EXHIBIT II
WATER MASTER PLAN
VALLEY OF THE MOON WATER DISTRICT
SONOMA COUNTY - CALIFORNIA
MAY 2007
NORTH
SCALE: 1"=1000'
LEGEND
6"
WATER MAIN REPLACEMENTS
8"
WATER MAIN ADDITIONS
AIR RELEASE VALVE
BLOWOFF
FIRE HYDRANT
8"
PIPE SIZE
REDUCER/PIPE CHANGE
SCWA TURNOUT AND PRV
VALLEY OF THE MOON WATER DISTRICT BOUNDARY
SOBRE VISTA TANK 2 0.13 MG
CAVEDALE TANK 1.0 MG
MOON MOUNTAIN TANK 0.16 MG
MOUND TANK 0.5 MG
HILL TANK 0.5MG
ARNOLD DRIVE PUMP STATION PS-1
TEMELEC TANKS T-1 AND T-2
Brelje & Race
CONSULTING CIVIL ENGINEERS