GROUNDWATER SUPPLY & WATER STORAGE INVESTIGATION

Prepared for

the City of Menlo Park, California

Barrett Consulting Group

SAN MATEO COUNTY
ENVIRONMENTAL HEALTH

JUL 03 1991

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GROUNDWATER SUPPLY
AND
WATER SYSTEM STORAGE INVESTIGATION

Prepared For

THE CITY OF MENLO PARK
SAN MATEO COUNTY, CALIFORNIA

CITY COUNCIL

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Jack H. Morris, Mayor Pro-Tem
Gerald R. Grant, Council Member
Calvin M. Jones, Council Member
Ted I. Sorensen, Council Member

AUGUST, 1989

BARRETT CONSULTING GROUP INC.
3000 Alpine Road
Menlo Park, CA 94028

Barrett Consulting Group

3000 Alpine Road
Menlo Park, CA 94025
415 854-7090
Fax: 415 854-7724

August 2, 1989

The Honorable City Council
City of Menlo Park
City Hall
Laurel and Mielke Drive
Menlo Park, CA 94025

Dear Council Members:

In accordance with our Agreement dated March 16, 1989, we submit herewith a "Groundwater Supply and System Storage Investigation".

This report summarizes our investigations and findings dealing with the City's water system. Conclusions and recommendations are presented in Chapter II.

We wish to acknowledge Phillip G. Harris, Consulting Engineer and William C. Ellis, Consultant in Groundwater and Geology, for their contributions to this report.

It has been a pleasure working with members of your Staff and we wish to thank them for their assistance in providing much of the information that was necessary in the preparation of this report. In particular, we thank Mr. Lauren Mercer, Director of Public Works, for his assistance during the course of our investigation.

Respectfully submitted,

BARRETT CONSULTING GROUP

Frank H. Barrett, Jr.
President
FHB:nbm

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (CONT'D)

CHAPTER I

INTRODUCTION

BACKGROUND

The City of Menlo Park retained Barrett Consulting Group to perform an investigation of possible groundwater supplies and storage facilities for the City's water system. Currently, the City purchases all water from the San Francisco Water Department (SFWD). The purpose of this report is to investigate various storage and supply options that will improve the reliability of the Menlo Park water system.

SCOPE OF WORK

Barrett Consulting Group was directed to prepare an engineering report to include the following items:

- Basic data and background information including hydrogeologic data, well reports, historical aquifer extraction and water quality data.
- Estimate of water demands and storage requirements that includes annual average, monthly, peak daily, and peak hourly flow rates.
- Evaluation of supply and storage components of existing systems with skeletal hydraulic modeling using data developed for the 1974, Barrett Consulting Group's water system analysis.
- Hydrogeologic investigation delineating aquifer sources underlying the City and assessing the feasibility of developing supply wells.
- Evaluation of the need for additional storage and alternative supplies for all systems.
- A final report presenting the results of the study, recommended improvements and a proposed course of action.

CHAPTER II

CONCLUSIONS AND RECOMMENDATIONS

The Menlo Park water system is comprised of five zones. These zones are grouped into three subsystems; Zones 1, 4, and 5 comprise one subsystem, Zone 3, the Sharon Heights area, is another and Zone 2, Bohannon Industrial Park, is the third subsystem (see Figure 2-1).

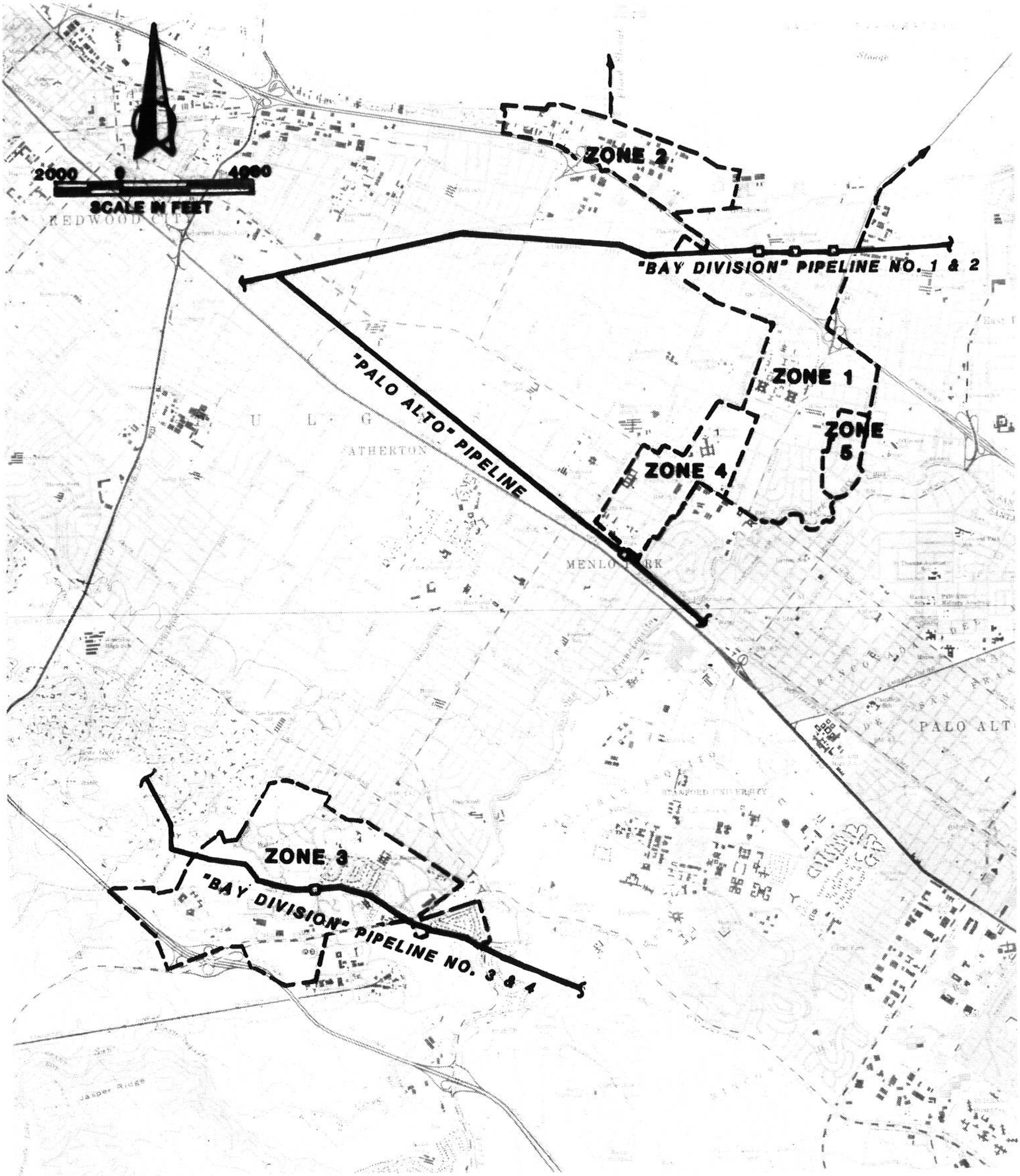
The hydraulic adequacy of a water system is determined by the system's ability to meet normal domestic, commercial and industrial requirements as well as to provide the flows and pressures needed for fire fighting purposes. The accepted criteria for evaluating the needs of a water system for fire fighting are those established by the Insurance Services Office (ISO). The standards require that the system must be capable of supplying the maximum daily demand plus the required fire flow while maintaining a residual pressure of 20 psi throughout the system to ensure adequate service is provided throughout the system. In most systems, fire flows determine the size of major system components.

The fire fighting capability of the Zone 1, 4 and 5 system is considerably diminished if either the Palo Alto pipeline or the Bay Division pipelines are out of service. The maximum fire flow that can be sustained at St. Patricks Seminary with only the Palo Alto pipeline in service, is approximately 2,800 gpm. Fire flow at the Veterans Administration Hospital would be limited to about 1,800 gpm. If only Bay Division Pipelines 1 and 2 are in service, the maximum sustainable fire flows at St. Patricks Seminary and the Veterans Administration Hospital is estimated to be 1,800 gpm and 3,000 gpm, respectively. The ISO recommended fire flow at St. Patricks Seminary is 4,500 gpm and at the Veterans Administration Hospital is 5,000 gpm.

Zone 3 provides acceptable system performance for all fire flow situations modeled except for a fire at Sand Hill Circle with the reservoir as the only source in service. In this case, the system will support a 4,000 gpm fire flow where 5,000 gpm is required.

To calculate an emergency reserve, it is important to define the operating conditions. A volume equal to one maximum day's demand is commonly used. The total storage requirements for the system as a whole will range from roughly 15 to 32 mg, respectively, for a one-day and three-day emergency reserve based on current water demands.

About seven million gallons (mg) of storage and/or local supply capacity is needed to meet fire protection and one-day emergency



LEGEND

– – – MENLO PARK WATER DEPARTMENT ZONE BOUNDARIES

—o— SAN FRANCISCO WATER DEPARTMENT PIPELINE & SUPPLY METER

FIGURE 2-1

LOCATION MAP

reserve requirements in the Zone 1, 4 and 5 system. The Zone 2 system requires about 2.5 mg of storage. Neither of these systems currently has storage. Therefore, they must depend entirely on the SFWD supply to meet emergency requirements.

The volume of storage needed to meet the fire protection and one-day emergency reserve requirements for Zone 3 is 8 mg. Since there is an existing 2 mg reservoir within this system, the additional storage needed is 6 mg.

It is recommended that the City construct improvements to provide the storage volume needed to satisfy the one-day emergency storage requirement. This includes 10 mg of storage to serve Zones 1, 4, and 5 and Zone 2 and 6 mg to serve Zone 3. Wells should be used to supplement the emergency storage and to provide a sustained supply in the event of a prolonged outage. The cost of constructing the necessary storage is estimated to be $10,790,000. Three production wells are estimated to cost $1,125,000.

Because of the relatively flat topography in and around Zones 1, 4 and 5, either elevated storage or storage at ground level must be provided. Elevated tanks are rarely constructed in California because of seismic concerns and the high costs of constructing these structures to meet seismic requirements.

Steel tanks, concrete tanks and concrete reservoirs, both above and below grade, are all viable options for ground level storage depending upon service life, maintenance, reliability and construction cost.

Inasmuch as any of the three types of storage discussed will perform satisfactorily, the decision on which type of tank/reservoir to use can be based on siting considerations including aesthetics and multiple uses of the site.

Many alternative locations were investigated to determine suitable sites for additional storage. Water system hydraulics, public ownership of land, fire flow requirements, and aesthetics were several considerations. The possibility of multiple use of a site was also taken into account.

It is recommended that the City construct storage facilities for Zone 1, 4 and 5 at the Veterans Administration Hospital, Burgess Park, and a third site, possibly a joint facility on the Raychem property. This latter parcel could also serve Zone 2. A second water storage tank next to the existing Sand Hill reservoir, and a joint use tank on Stanford property near the radio telescope are the recommended locations to serve Zone 3.

Unlike the Zones 1, 4 and 5 and Zone 2 systems, there is no existing emergency connection between California Water Service Company facilities and Zone 3 nor is there any alternative emergency supply source. Constructing an interconnection may prove beneficial to both systems allowing stored water in either system to be delivered to the other in an emergency.

It is recommended that the City construct a connection to the California Water Service Bear Gulch District system along Avy Drive between Altschul Avenue and Deanna Drive. Because the two systems operate at different pressures, the interconnection will require a booster pump/pressure regulating station. The cost of constructing this interconnection is estimated to be $435,000.

It is also recommended that the City enter into a formal agreement with SLAC to use their 12-inch loop line that connects to the Zone 3 subsystem. This will provide an alternate route between the reservoir and Zone 3.

Geology and groundwater beneath the general Menlo Park area have never been investigated in significant detail. Data to indicate deeper subsurface conditions and maximum productivity are very limited. The total amount of groundwater pumped from the basin in the Menlo Park area each year is unknown, but is apparently less than basin yield capabilities, based on knowledge of local well development and indicated basin storage levels.

Data is not currently available on which to make an assessment of safe or perennial basin yield. Nevertheless, it appears that additional wells can be developed without adversely impacting the basin. This would be contingent on the proper location and operation of new wells, and the limiting of such development to prudent levels determined as more data and basin response to development are obtained.

The western part of Zone 1, Zone 4, Zone 5 and an area extending north and west of Zone 4 comprise the apparent most desirable area for well development. Properly located and designed wells could yield between 800 gpm and 1,200 gpm. Wells operated by Stanford University and the City of Palo Alto are located just across San Francisquito Creek from the City of Menlo Park. Should new City wells be developed in this area, the potential for mutual pumping interference should be evaluated.

It is recommended that the City undertake a test well drilling program to assist in determining the location of suitable production wells. The test wells should be located in the vicinity of the new storage facilities. This program is estimated to cost between $30,000 and $45,000.

In the development of this program, preliminary project cost estimates were prepared. Because of the increasing cost of construction, Summer, 1989, was used as the base level on which the cost estimates would be developed.

Because of the high costs of implementing this program, it is recommended that the City develop a long range financing plan as soon as possible. This should be done to provide a capital reserve to be used to fund this program.

TABLE 2-1

PRIORITIZED LISTING OF RECOMMENDATIONS

Type of Improvement (1)	Location	Total Project Cost
Develop Long-range Financing Plan	---	---
Test Well Program (Three Wells)	VA Hospital Burgess Park Undetermined	$ 45,000
Formalize Emergency Water System Inter-Connection Agreement with SLAC	---	---
Interconnection with Cal Water Service Co System. Improvements to include Booster Pump Station, Pressure Regulating Station, Standby (emergency) Generator, & Piping	Avy Drive between Altschul Ave and Deanna Drive	435,000
Tank (4mg), Booster Pump Station, Standby (emergency) Generator, Well & Piping	VA Hospital	2,890,000
Tank (2mg), Booster Pump Station, Standby (emergency) Generator, & Well	Burgess Park	1,970,000
Tank (3mg)	Sand Hill Reservoir	1,700,000
Reservoir (4 mg), Booster Pump Station, Standby (emergency) Generator & Well	Undetermined - To Be Located in Zones 1,2,4 or 5	3,655,000
Reservoir (3 mg), & Piping	Stanford University	1,700,000
Totals - All Improvements		$12,395,000

NOTES: 1) Cost basis is 1989
2) Costs include allowance for engineering, contingencies, and administration.

TABLE 2-2

PRIORITIZED LIST OF RECOMMENDATIONS
FUNDING OPTION ONE - REVENUE BONDS

Type of Improvement (1)	Location	Total Project Cost	Annual Debt Service (2)	Annual O & M Cost (3)	Total Annual Cost	Cost/Unit of Water Sold (4)
Develop Long-Range Financing Plan		N/A				
Test Well Program (6)	VA Hospital/Burgess Park	$45,000				
Formalize Agreement with SLAC		N/A				
BPS, PRS, SG & Piping (6)	CWSC Interconnection	$435,000		$10,200	$10,200	
Tank (4mg), BPS, SG, Well & Piping	VA Hospital	$2,891,000	$305,495	$17,200	$322,695	$.16
Tank (2mg), BPS, SG, Well & Piping	Burgess Park	$1,968,000	$207,960	$15,300	$223,260	$.11
Tank (3mg)	Sand Hill Reservoir	$1,700,000	$179,641	$2,000	$181,641	$.09
Tank (4mg), BPS, SG, Well & Piping	East Side - Undesignated	$3,656,000	$386,333	$17,000	$403,333	$.20
Reservoir (3mg) & Piping	Stanford University	$1,700,000	$179,641	$2,000	$181,641	$.09
Totals - All Improvements		$12,395,000	$1,259,070	$63,700	$1,322,770	$.66

(1) BPS - Booster Pump Station
SG - Standby (emergency) Generator
PRS - Pressure Regulating Station
(2) Based on an interest rate of 8.5 percent and a term of 20 years.
(3) Includes operating and maintenance labor, power, fuel and supplies.
(4) Based on annual water sales of 2 million units.
(5) Cost basis 1989 (San Francisco ENR CCI = 5800)
(6) Financed from existing CIP fund.

TABLE 2-3

PRIORITIZED LIST OF RECOMMENDATIONS
FUNDING OPTION TWO - TEN YEAR "PAY AS YOU GO"

Year	Available Funds (2)	Type of Improvement (1)	Location	Project Cost (3)	Carryover
1990	$1,660,000				$1,660,000
1991	$3,320,000	Tank (4mg), BPS, SG, Well & Piping	VA Hospital	$2,773,890 $413,438	$132,673
1992	$1,792,673				$1,792,673
1993	$3,452,673	Tank (2mg), BPS, SG Well and Piping	Burgess Park	$1,936,301 $455,815	$1,060,556
1994	$2,720,556	Tank (3mg)	Sand Hill Reservoir	$2,169,679	$550,878
1995	$2,210,878				$2,210,878
1996	$3,870,878				$3,870,878
1997	$5,530,878	Tank (4mg), BPS, SG Well and Piping	East Side - Undesignated	$4,847,531 $554,046	$129,300
1998	$1,789,300				$1,789,300
1999	$3,449,300	Reservoir (3mg) & Piping	Stanford University	$2,769,121	$680,180

(1) BPS - Booster Pump Station
SG - Standby (emergency) Generator
PRS - Pressure Regulating Station
(2) Based on annual water sales of 2 million units and cost per unit of $0.83
(3) Cost basis 1989 plus 5% inflation per year

TABLE 2-4

PRIORITIZED LIST OF RECOMMENDATIONS
FUNDING OPTION THREE - FIFTEEN YEAR "PAY AS YOU GO"

Year	Available Funds (2)	Type of Improvement (1)	Location	Project Cost (3)	$1,989 Cost	Carryover
1990	$1,300,000					$1,300,000
1991	$2,600,000					$2,600,000
1992	$3,900,000	Tank (4mg), BPS, SG,	VA Hospital	$2,912,585	$2,516,000	
		Well & Piping		$434,109	$375,000	$553,306
1993	$1,853,306					$1,853,306
1994	$3,153,306					$3,153,306
1995	$4,453,306	Tank (2mg), BPS, SG,	Burgess Park	$2,134,772	$1,593,000	
		Well & Piping		$502,536	$375,000	$1,815,998
1996	$3,115,998					$3,115,998
1997	$4,415,998	Tank (3mg)	Sand Hill Reservoir	$2,511,674	$1,700,000	$1,904,324
1998	$3,204,324					$3,204,324
1999	$4,504,324					$4,504,324
2000	$5,804,324					$5,804,324
2001	$7,104,324					$7,104,324
2002	$8,404,324	Tank (4mg), BPS, SG	East Side -	$6,186,815	$3,281,000	
		Well & Piping	Undesignated	$707,118	$375,000	$1,510,390
2003	$2,810,390					$2,810,390
2004	$4,110,390	Reservoir (3mg) & Piping	Stanford University	$3,534,178	$1,700,000	$576,212

(1) BPS - Booster Pump Station
SG - Standby (emergency) Generator
PRS - Pressure Regulating Station
(2) Based on annual water sales of 2 million units and cost per unit of $0.65
(3) Cost basis 1989 plus 5% inflation per year

CHAPTER III

WATER DEMANDS AND STORAGE REQUIREMENTS

OVERVIEW

It is necessary to summarize current water use data and then project future water demands in order to evaluate the adequacy of the existing water system. This data is also needed to develop and evaluate various storage schemes and alternative supply sources, including groundwater. Of particular significance are projections made for current and future maximum day demands in each of the subsystems that comprise the Menlo Park system.

Water demands and storage requirements are summarized in three tables included in this chapter. These tables show average, maximum monthly, maximum daily and maximum hourly demand projections. These projections are made for the Zones 1, 4 and 5, Zone 2 and Zone 3 systems, for 1989, for the year 2005 and for a maximum development scenario. Fire demands and storage requirements are also shown in these tables.

HISTORICAL WATER USE

System water use was investigated twice previously by Barrett Consulting Group. The first investigation, entitled "Water System Analysis and Financing Plan" was completed in May of 1974. At that time, using 1971-72 data, there were approximately 3,450 metered connections. Water sales were approximately 1,760,000 units per year. This report also included a detailed analysis of water use by meter size and projected the maximum monthly, maximum daily and maximum hourly demands. The maximum monthly demand (e.g., average day in maximum month) at that time, based on actual sales data, was 1.31 times the average annual demand.

Water use data and demand projections were updated in January of 1985 when the "Water System Rate Update Study" was prepared for the City. This work was done to equitably allocate costs to customers based on meter size. Data for 1983-84 was compared with data from the 1971-72 period. The number of customers had increased to 3,770 from 3,450. Water sales were approximately 1,946,000 units in 1983-84 - an increase of about 11 percent.

Table 3-1 is an update of a table included in the 1985 report that shows water use by month for 1977 through 1987. Data for 1985, 1986 and 1987 have been added to the original table. Note that water sales (i.e., use) for 1986 and 1987 have averaged about 1,927,000 units per year. Data for 1988 is not representative because of drought-related conservation and thus is not shown. Based on Table 3-1, it appears that 2 million units per year is a reasonable estimate of current usage in a normal year.

TABLE 3-1

ANNUAL WATER SALES BY YEAR

Sales (Units)

Month	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1979-87 Average	Percent of Avg.	1986-87 Average	Percent of Avg.
January	97,962	68,227	82,307	89,509	103,777	88,757	106,003	107,998	102,176	102,666	95,331	97,614	63.86%	98,999	61.65%
February	95,020	74,239	89,609	100,288	95,582	93,386	100,555	115,964	119,188	101,940	102,948	102,162	66.84%	102,444	63.79%
March	83,847	77,587	85,389	99,978	92,778	102,319	105,024	127,784	131,388	102,944	109,711	106,368	69.59%	106,328	66.21%
April	99,341	84,186	105,860	127,459	114,582	107,814	126,645	162,041	152,471	134,705	161,504	132,565	86.72%	148,105	92.22%
May	104,681	113,405	129,481	156,904	169,897	179,703	142,709	196,740	195,661	172,121	191,973	170,577	111.59%	182,047	113.36%
June	114,823	176,078	184,674	179,330	199,662	199,598	197,848	232,909	228,215	224,684	216,040	206,996	135.42%	220,362	137.22%
July	132,770	193,461	188,440	194,143	221,853	189,863	206,318	232,007	241,266	224,996	230,224	214,346	140.23%	227,610	141.73%
August	141,915	184,094	194,734	211,065	195,909	218,176	196,672	226,125	241,753	231,933	226,343	215,857	141.22%	229,138	142.68%
September	123,876	165,348	194,853	182,079	191,389	185,075	201,725	216,012	192,349	202,203	206,202	196,876	128.80%	204,203	127.16%
October	90,521	150,093	148,005	163,978	154,768	141,898	166,398	171,175	171,167	160,211	178,955	161,839	105.88%	169,583	105.60%
November	82,707	119,953	102,423	143,611	114,315	122,618	126,033	124,098	131,372	148,241	112,526	125,026	81.79%	130,384	81.19%
December	70,954	89,309	93,329	111,032	90,155	94,755	105,878	115,398	110,139	113,688	102,110	104,054	68.07%	107,899	67.19%
Total	1,238,417	1,495,980	1,599,104	1,759,376	1,744,667	1,723,962	1,781,808	2,028,251	2,017,145	1,920,332	1,933,867	1,834,279	100.00%	1,927,100	100.00%

WATER DEMAND VARIATIONS

Table 3-1 also indicates that the maximum monthly water usage has been increasing. In 1974, it was found that the ratio of maximum monthly demand to average demand was 1.31. Table 3-1 shows that the maximum monthly demand ratio in August for the 1979 through 1987 period had increased to 1.41. Looking only at data for 1986 and 1987, revealed that the maximum monthly demand ratio had increased to 1.43 for the two most recent non-drought years.

Examination of water use data for Zone 3 (Sharon Heights) indicated that much of the increase in the maximum monthly demand is attributable to irrigation in this zone. The maximum monthly demand ratio for Zone 3 is roughly 1.65. Subtracting Sharon Heights usage from the total use in the system indicates that the maximum monthly demand ratio for the remainder of the Menlo Park system is about 1.35.

Table 3-2 is a summary of the demand ratios used in this study.

TABLE 3-2

MENLO PARK WATER DEMAND RATIOS

Demand	Expressed as a Ratio To Average Annual Demand	
	Zone 3	Other Zones
Average Annual Demand	1.00	1.00
Maximum Monthly Demand	1.65	1.35
Maximum Daily Demand	2.40	2.00
Maximum Hourly Demand	4.80	4.00

Projected Water Demands by Zone

Table 3-3 shows annual water sales by zone for 1986 and 1987-the two most recent years with representative water usage. The last column in the table is an estimate of water sales, or use, by zone assuming an annual sales of 2 million units. These estimates use the percentages derived from the average of 1986-87 sales data. Note that the system comprising Zone 1, 4 and 5 uses approximately 44 percent of the total. Zones 2 and 3 use 18 and 38 percent, respectively. These estimates of annual water use were used to develop water demand and storage requirement projections for modeling purposes and for analyzing storage and supply alternatives.

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TABLE 3-3

ANNUAL WATER SALES BY ZONE

	Sales (Units)				
	1986	1987	1986-87 Average	Percent of Total	Current Estimate (1)
Zone 1	613,809	578,616	596,213	30.94%	619,400
Zone 4	185,028	216,360	200,694	10.41%	208,000
Zone 5	57,443	49,991	53,717	2.79%	55,800
Subtotal - Zones 1,4 & 5	856,280	844,967	850,624	44.14%	883,200
Zone 2	353,563	348,560	351,062	18.22%	364,400
Zone 3	710,489	740,339	725,414	37.64%	752,400
Total - All Zones	1,920,332	1,933,867	1,927,100	100.00%	2,000,000

(1) Used to develop water demand and storage requirement projections.

FIRE PROTECTION REQUIREMENTS

A water system's ability to meet the flow and pressure requirements for fire fighting is the most stringent test of its capacity. The accepted criteria for evaluating the needs of a water system for fire fighting are those established by the Insurance Services Office (ISO). These criteria are included in their 1980 revision to the publication "Rating Schedule for Municipal Fire Protection". The standards require that the system must supply the maximum daily demand plus the required fire flow in all developed parts of the service area while maintaining a minimum residual pressure of 20 psi. In the 1974 and 1975 work done for the City by Barrett Consulting Group, several structures, located at key points in the system, were selected for fire simulations which were done using a computerized hydraulic model. Those fires that stressed the system the most were re-evaluated during this study.

For the Zones 1, 4 and 5 system, fires at St. Patricks Seminary and at the Veterans Administration Hospital place the most stringent demands on the system. If the system can meet the fire demands at these two locations, other fire demands can easily be met. For St. Patricks, the required fire flow is 4,500 gpm, for a duration of four hours. For the Veterans Administration Hospital, the fire demand is 5,000 gpm, also for a four hour duration.

Discussions with the Bohannon Management Group, who operate the industrial park (Zone 2), indicated that all structures in that complex were sprinklered. Fire demands will thus not exceed 3,000 gpm (three hour duration). The Zone 2 system was not modeled.

For Zone 3, the largest potential fires are at the Sand Hill Circle Office Park complex, the Sharon Heights Shopping Center and at SLAC. The Sand Hill Circle complex which is unsprinklered, imposes a 5,500 gpm demand (four hour duration) - by far the largest in the zone. Fire demands at the Sharon Heights Shopping Center (2,500 gpm for a three hour duration) and at SLAC are lower.

SUMMARY OF WATER DEMANDS AND STORAGE REQUIREMENTS

Table 3-4 is a summary of current (1989) system water demands and storage requirements developed from the data described previously in this chapter. The table shows demands and storage requirements for the Zones 1, 4 and 5, Zone 2 and Zone 3 systems and the totals for the entire Menlo Park water system.

Annual demands, in units, are those previously shown in Table 3-3. Annual demands are also expressed in millions of gallons.

TABLE 3-4

WATER DEMANDS AND STORAGE REQUIREMENTS - 1989

Item	Zones 1, 4 & 5	Zone 2	Zone 3	Totals All Zones
Demands/Flow Requirements				
Annual Demand (units)	883,200	364,400	752,400	2,000,000
" " (mg)	660.63	272.57	562.80	1,496.00
Average Daily Demand Ratio	1.00	1.00	1.00	
" " " (mgd)	1.81	.75	1.54	4.10
" " " (gpm)	1,256	518	1,070	2,844
Max. Monthly Demand Ratio	1.35	1.35	1.65	
" " " (mgd)	2.44	1.01	2.54	6.00
" " " (gpm)	1,696	700	1,766	4,161
Max. Daily Demand Ratio	2.00	2.00	2.40	
" " " (mgd)	3.62	1.49	3.70	8.81
" " " (gpm)	2,512	1,037	2,568	6,117
Max. Hourly Demand Ratio	4.00	4.00	4.80	
" " " (gpm)	5,024	2,073	5,136	12,234
Max. Fire Demand (gpm)	5,000	3,000	5,500	
Duration (hours)	4	3	4	
Max. Day Plus Fire Demand (gpm)	7,512	4,037	8,068	
Storage Requirements - 1 Day Emergency Storage				
Equalizing Storage (mg) (1)	.90	.37	.93	2.20
Fire Protection (mg) (2)	1.20	.54	1.32	3.06
Emergency Reserve (mg) (3)	3.62	1.49	3.70	8.81
Total Storage (mg)	5.72	2.41	5.95	14.08
Storage Requirements - 3 Days Emergency Storage				
Equalizing Storage (mg) (1)	.90	.37	.93	2.20
Fire Protection (mg) (2)	1.20	.54	1.32	3.06
Emergency Reserve (mg) (4)	10.86	4.48	11.10	26.44
Total Storage (mg)	12.96	5.39	13.35	31.71

(1) Calculated as 25 percent of the maximum daily demand.
(2) Calculated as the maximum fire demand times the required duration.
(3) Equal to the maximum daily demand.
(4) Equal to three times the maximum daily demand.

Average, maximum monthly, maximum daily and maximum hourly demands are shown expressed in million gallons per day (mgd) and gallons per minute (gpm) units. The maximum monthly, maximum daily and maximum hourly demands were estimated using the ratios shown in Table 3-2.

The maximum hourly demand is of particular significance when evaluating the adequacy of supply facilities. The maximum hourly demand must be met from supply, supplemented by storage, if available. Note that the current maximum daily demand and maximum hourly demand for the entire system are approximately 6,100 gpm and 12,200 gpm, respectively.

The fire demands shown in Table 3-4 and the required durations, in hours, are for the largest fires in each system. For the Zones 1, 4 and 5, system, a fire at the Veterans Administration Hospital is the most severe test. For Zone 3, the Sand Hill Circle office complex is the worst potential fire. For Zone 3, a 3,000 gpm non-specific fire demand is included.

The volume needed for distribution storage usually includes three components; equalizing storage, fire protection storage and an emergency reserve. Equalizing storage is storage needed to meet peaks in demand greater than the average daily demand. Ideally, the source facilities produce water at a rate equal to the average daily demand on a 24-hour basis. Storage is used to meet peak demands and is then replenished during those times of the day when system demand is less than the average. Equalizing storage is commonly calculated as 25 percent of the maximum daily demand.

The volume allotted for fire protection is the maximum fire flow, in gpm, sustained for the specified duration shown in Table 3-4. This is a "worse case" scenario which assumes that the supply facilities will not be operating to supplement flows. Table 3-4 shows that storage requirements for fire protection range from 0.54 million gallons (mg) in Zone 2 to 1.32 mg in Zone 3. Total fire protection storage requirements are 3.66 mg. As neither the Zones 1, 4 and 5 system nor the Zone 2 system now have system storage, fire fighting demands must be met entirely from the SFWD supply.

The Zone 3 reservoir, which has a capacity of 2.0 mg, is marginally adequate to meet both equalizing storage and fire protection requirements in this zone.

The volume of water needed for an emergency reserve cannot be calculated with accuracy unless the conditions for which it is needed can be defined. This is difficult, if not impossible, to do. A volume equal to one maximum day's demand is commonly used. Table 3-4 shows storage requirements for a one day emergency supply and for a three day supply. Normal demands in an emergency will probably be far less than the maximum daily demand. The impact of water losses from main breakage must be considered, however. The storage requirement for the system as a whole will be about 14 and 32 mg, respectively, for a one-day and three-day emergency reserve.

The City is now in the process of updating its Comprehensive Plan. Projections of water demands and storage requirements were also made for the year 2005 based on a preliminary City map showing projected increases in dwelling units and in commercial-industrial square footage. Tabls 3-5 shows the water demand and storage projections for the year 2005.

The demands shown in Table 3-5 should be considered upper limits. Water conservation, the gradual conversion to ultra low flush toilets and the pricing policies of the San Francisco Water Department will probably tend to minimize increases in water use. Also, the areas under irrigation in new or add-on units will likely be less than for existing dwellings.

Table 3-5 is probably the best guide for City water system planning purposes. This table shows that water purchases may increase to 2,500,000 units - an increase of about 25 percent. For 2005, the average daily and maximum daily demands may be 5.2 mgd and 11.3 mgd, respectively. Total system storage requirements increase to 17 mg and 40 mg, respectively, for the one-day and three-day emergency supply scenarios.

TABLE 3-5

WATER DEMANDS AND STORAGE REQUIREMENTS - 2005

Item	Zones 1, 4 & 5	Zone 2	Zone 3	Totals All Zones
Demands/Flow Requirements				
Annual Demand (units)	1,015,680	408,128	1,113,552	2,537,360
" " (mg)	759.73	305.28	832.94	1,897.95
Average Daily Demand Ratio	1.00	1.00	1.00	
" " " (mgd)	2.08	.84	2.28	5.20
" " " (gpm)	1,445	580	1,584	3,609
Max. Monthly Demand Ratio	1.35	1.35	1.65	
" " " (mgd)	2.81	1.13	3.77	7.70
" " " (gpm)	1,950	784	2,613	5,347
Max. Daily Demand Ratio	2.00	2.00	2.40	
" " " (mgd)	4.16	1.67	5.48	11.31
" " " (gpm)	2,889	1,161	3,801	7,851
Max. Hourly Demand Ratio	4.00	4.00	4.80	
" " " (gpm)	5,778	2,322	7,602	15,702
Max. Fire Demand (gpm)	5,000	3,000	5,500	
Duration (hours)	4	3	4	
Max. Day Plus Fire Demand (gpm)	7,889	4,161	9,301	
Storage Requirements - 1 Day Emergency Storage				
Equalizing Storage (mg) (1)	1.04	.42	1.37	2.83
Fire Protection (mg) (2)	1.20	.54	1.32	3.06
Emergency Reserve (mg) (3)	4.16	1.67	5.48	11.31
Total Storage (mg)	6.40	2.63	8.17	17.20
Storage Requirements - 3 Days Emergency Storage				
Equalizing Storage (mg) (1)	1.04	.42	1.37	2.83
Fire Protection (mg) (2)	1.20	.54	1.32	3.06
Emergency Reserve (mg) (4)	12.49	5.02	16.43	33.94
Total Storage (mg)	14.73	5.98	19.12	39.83

(1) Calculated as 25 percent of the maximum daily demand.
(2) Calculated as the maximum fire demand times the required duration.
(3) Equal to the maximum daily demand.
(4) Equal to three times the maximum daily demand.

CHAPTER IV

HYDRAULIC EVALUATION OF EXISTING SYSTEMS

OVERVIEW

Computerized hydraulic models are valuable tools for determining the strengths and weaknesses of water systems. Both the Zone 1, 4 and 5 system and the Zone 3 system were modeled previously by Barrett Consulting Group. The Zone 1, 4 and 5 system was modeled as part of the 1974 study, utilizing a mainframe computer. The findings of the modeling effort resulted in a phased capital improvement program that has since eliminated nearly all of the piping deficiencies in that system. The data from the original modeling effort in Zones 1, 4 and 5, along with the changes made since that work was done, have been incorporated into a new model that can be run on an IBM AT, or compatible, microcomputer.

The Zone 3, Sharon Heights, system was modeled by Barrett Consulting Group in 1982. No significant piping deficiencies were found at that time. The data from the 1982 modeling effort was also input to IBM AT compatible software. The City now has, as a result of this investigation, models of two principal systems that can be conveniently rerun in the future on the City's equipment.

The approach used for designing model "runs" was first to model the maximum daily demand, and then to run the two worst fires in each system as determined from Insurance Services Office (ISO) recommendations. This was done with the SFWD sources and the reservoir (Zone 3 only) in operation. The models were then rerun with one or more sources or the reservoir out of service.

The Zone 2, (Bohannon Industrial Park), system was not modeled. It is served from SFWD Meter B1, located at Ivy Drive near Hill Avenue. Water is delivered to Zone 2 through a 12-inch main. No pressure regulation is provided at the meter. Therefore, a pressure of 120 to 130 psi is maintained in this line. A 3,000 gpm flow rate is easily achieved under these conditions. Adequate pressure is available for servicing sprinkler systems.

ZONES 1, 4 AND 5 SYSTEM

Table 4-1 summarizes the results of hydraulic analyses run on the Zones 1, 4 and 5 system. The table shows the model run designation and its description, the source(s) of water and the pressures at key locations ("nodes"). The intersections of pipelines are called nodes. Figure 4-1 is a skeletal map of the Zones 1, 4 and 5 system showing all pipes and those nodes referenced in the table. The sources for the Zones 1, 4 and 5 system are all connections to SFWD's pipelines. Node 1 is located on SFWD's Palo Alto pipeline near El Camino Real. Nodes

TABLE 4-1

SUMMARY OF HYDRAULIC ANALYSES - ZONES 1, 4 & 5

Model Run - Description	Source Flow (gpm)				Node 36		Node 55		Node 56		Node 87		Node 15		Node 59		Node 60		Node 103	
	Node 1	Node 117	Node 119	Total	HGL	psi	HGL	psi	HGL	psi	HGL	psi	HGL	psi	HGL	psi	HGL	psi	HGL	psi
All Sources Operating																				
MPZ145-01 Max. Day	1,041	1,165	299	2,505	208	70	209	67	208	71	210	68	208	80	208	76	208	78	208	78
MPZ145-02 Fire at St. Patricks (4500 gpm)	4,187	2,162	656	7,005	176	56	180	55	171	55	202	65	193	73	184	65	190	71	189	70
MPZ145-03 Fire at VA Hospital (5000 gpm)	3,138	3,288	1,079	7,505	176	56	187	58	174	56	210	68	159	59	157	53	155	55	155	55
Palo Alto Pipeline Only																				
MPZ145-11 Max. Day	2,505	0	0	2,505	189	62	196	61	188	62	210	68	172	65	179	63	173	63	174	64
MPZ145-12 Fire at St. Patricks (4500 gpm)	7,005	0	0	7,005	(19)	(29)	10	(19)	(27)	(31)	94	18	(37)	(26)	(30)	(27)	(36)	(27)	(35)	(27)
MPZ145-14 Fire at St. Patricks (2800 gpm)	5,305	0	0	5,305	97	21	117	27	93	21	168	50	80	25	87	23	81	24	82	24
MPZ145-13 Fire at VA Hospital (5000 gpm)	7,505	0	0	7,505	(137)	(80)	(67)	(53)	(147)	(83)	67	7	(348)	(161)	(281)	(136)	(344)	(160)	(338)	(158)
MPZ145-15 Fire at VA Hospital (1800 gpm)	4,305	0	0	4,305	132	37	155	44	129	36	199	63	69	20	91	25	71	19	73	20
Bay Division Pipelines 1 & 2 Only																				
MPZ145-21 Max. Day	0	1,933	572	2,505	187	61	187	57	187	62	186	58	197	76	192	69	196	73	195	73
MPZ145-22 Fire at St. Patricks (4500 gpm)	0	5,210	1,795	7,005	(145)	(83)	(154)	(90)	(145)	(82)	(163)	(93)	65	18	(40)	(32)	40	6	28	1
MPZ145-24 Fire at St. Patricks (1800 gpm)	0	3,246	1,059	4,305	99	22	96	18	99	23	93	17	161	60	128	41	153	54	149	53
MPZ145-23 Fire at VA Hospital (5000 gpm)	0	5,571	1,934	7,505	(1)	(21)	(2)	(24)	(1)	(20)	(3)	(24)	42	8	3	(13)	22	(2)	17	(4)
MPZ145-25 Fire at VA Hospital (3000 gpm)	0	4,116	1,389	5,505	97	22	97	18	97	23	96	19	124	44	101	30	113	37	110	36

Node 1 - SFWD Meter B-4
Node 117 - SFWD Meter B-2
Node 119 - SFWD Meter B-3
Fire at St. Patricks Seminary - Nodes 36, 55, 56 & 87
Fire at Veterans Administration Hospital - Nodes 15, 59, 60 & 103

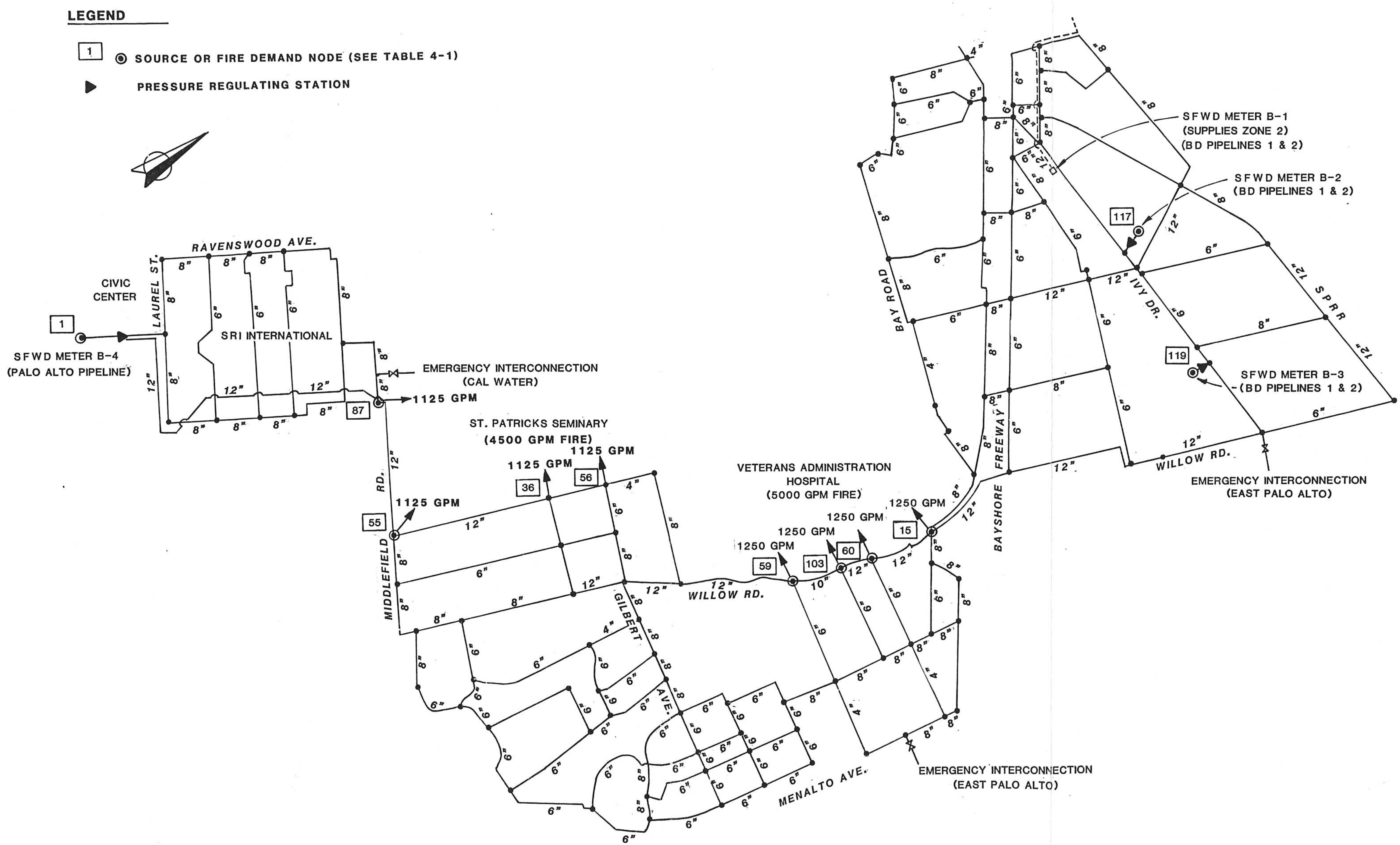


FIGURE 4-1

ZONES 1, 4, AND 5 SYSTEM PIPING NETWORK

117 and 119 are connections to SFWD's Bay Division Pipeline Nos.1 and 2 that are located east of the Bayshore Freeway along Ivy Drive. These are called Meters B2 and B3. Pressures are regulated down to avoid overpressuring the system.

The table also shows pressures at key nodes adjacent to St. Patricks Seminary and the Veterans Administration Hospital. Nodes 36, 55, 56 and 87 are the approximate locations of hydrants that would be used to fight a fire at St. Patricks. The assumption was made that an equal quantity of water, 1,125 gpm, would be withdrawn at each node. Nodes 15, 59, 60 and 103 are the supply nodes to meet a Veterans Administration Hospital fire, each contributing an assumed 1,250 gpm.

The adequacy of the distribution system and the supply under a specific fire condition is gauged by the residual pressure available at or near the nodes supplying the water used to fight the fire. The ISO requires that a 20 psi residual be maintained at all points. This requirement ensures that the system remains pressurized so that contaminants cannot enter it. The columns labelled "psi" in the table indicate system performance under a particular fire flow condition. The columns entitled "HGL" show the elevation that the water would rise to, in feet, in a standpipe at that location - a useful engineering concept for evaluating the results.

The model was run under three source conditions, namely, 1) all sources operating, 2) only the Palo Alto pipeline operating (Node 1), and 3) only Bay Division Pipeline Nos. 1 and 2 operating (Nodes 117 and 119).

The table shows that the system functions adequately for either a fire at St. Patricks, or a fire at the Veterans Hospital, providing that all sources are operating.

The fire fighting capability of the system is considerably diminished if either the Palo Alto pipeline or the Bay Division pipelines are out of service. Table 4-1 shows that the maximum fire flow that can be sustained at St. Patricks with only the Palo Alto pipeline in service, is about 2,800 gpm. Fire flow at the Veterans Hospital would be limited to about 1,800 gpm.

If only Bay Division Pipeline Nos. 1 and 2 are in service, the maximum sustainable fire flows at St. Patricks and the Veterans Hospital will be 1,800 gpm and 3,000 gpm, respectively.

ZONE 3 (SHARON HEIGHTS) SYSTEM

Table 4-2 is a summary of the hydraulic analyses run on the Zone 3 system. Figure 4-2 is a skeletal map of the Zone 3 system. The nomenclature and features shown are identical to that shown on Table 4-1 and Figure 4-1. Node 1 is the 2 mg Sand Hill

Reservoir. Node 101 is the meter on SFWD's Bay Division Pipeline Nos. 3 and 4. Nodes 9 and 10 are takeoff points for 1,250 gpm fire flows at the Sharon Heights Shopping Center. Nodes 76, 77 and 78 are 1,833 gpm flows at the Sand Hill Circle office complex.

The approach used for analyzing the Zone 3 system was similar to that employed for Zones 1, 4 and 5. The system was first tested under maximum day and fire flow conditions with both sources operating. Next, the system was tested with only the reservoir in service. Then the reservoir was removed from the system so that the entire supply was obtained from the SFWD connection.

Table 4-2 shows acceptable system performance for all situations modeled except for a fire at Sand Hill Circle with only the reservoir in service. The system will only support a 4,000 gpm fire flow under these circumstances.

TABLE 4-2

SUMMARY OF HYDRAULIC ANALYSES - ZONE 3

Model Run - Description	Source Flow (gpm)			Node 9		Node 10		Node 76		Node 77		Node 78	
	Node 1	Node 101	Total	HGL	psi	HGL	psi	HGL	psi	HGL	psi	HGL	psi
Both Sources Operating													
MPZ3-01 Max. Day	(1,075)	3,638	2,563	495	133	495	137	491	94	491	80	491	92
MPZ3-02 Fire at Shopping Center (2500 gpm)	1,282	3,781	5,063	471	122	469	125	481	89	481	75	481	88
MPZ3-03 Fire at Sandhill Circle (5500 gpm)	3,508	4,555	8,063	455	115	455	120	419	63	421	50	416	60
Reservoir Only													
MPZ3-11 Max. Day	2,563	0	2,563	463	119	463	123	466	83	466	69	466	81
MPZ3-12 Fire at Shopping Center (2500 gpm)	5,063	0	5,063	388	86	385	89	412	59	414	46	413	58
MPZ3-13 Fire at Sandhill Circle (5500 gpm)	8,063	0	8,063	301	49	301	53	280	2	283	(10)	278	0
MPZ3-14 Fire at Sandhill Circle (4000 gpm)	6,563	0	6,563	359	74	359	114	350	32	351	19	348	30
Bay Division Pipelines 3 & 4 Only													
MPZ3-21 Max. Day	0	2,563	2,563	567	164	567	168	566	126	566	112	566	125
MPZ3-22 Fire at Shopping Center (2500 gpm)	0	5,063	5,063	444	111	442	114	452	77	452	63	452	75
MPZ3-23 Fire at Sandhill Circle (5500 gpm)	0	8,063	8,063	442	110	442	114	385	48	385	34	381	45

Node 1 - Reservoir
Node 101 SFWD Meter
Fire at Sharon Heights Shopping Center - Nodes 9 & 10
Fire at Sandhill Circle Office Park - Nodes 76, 77 & 78

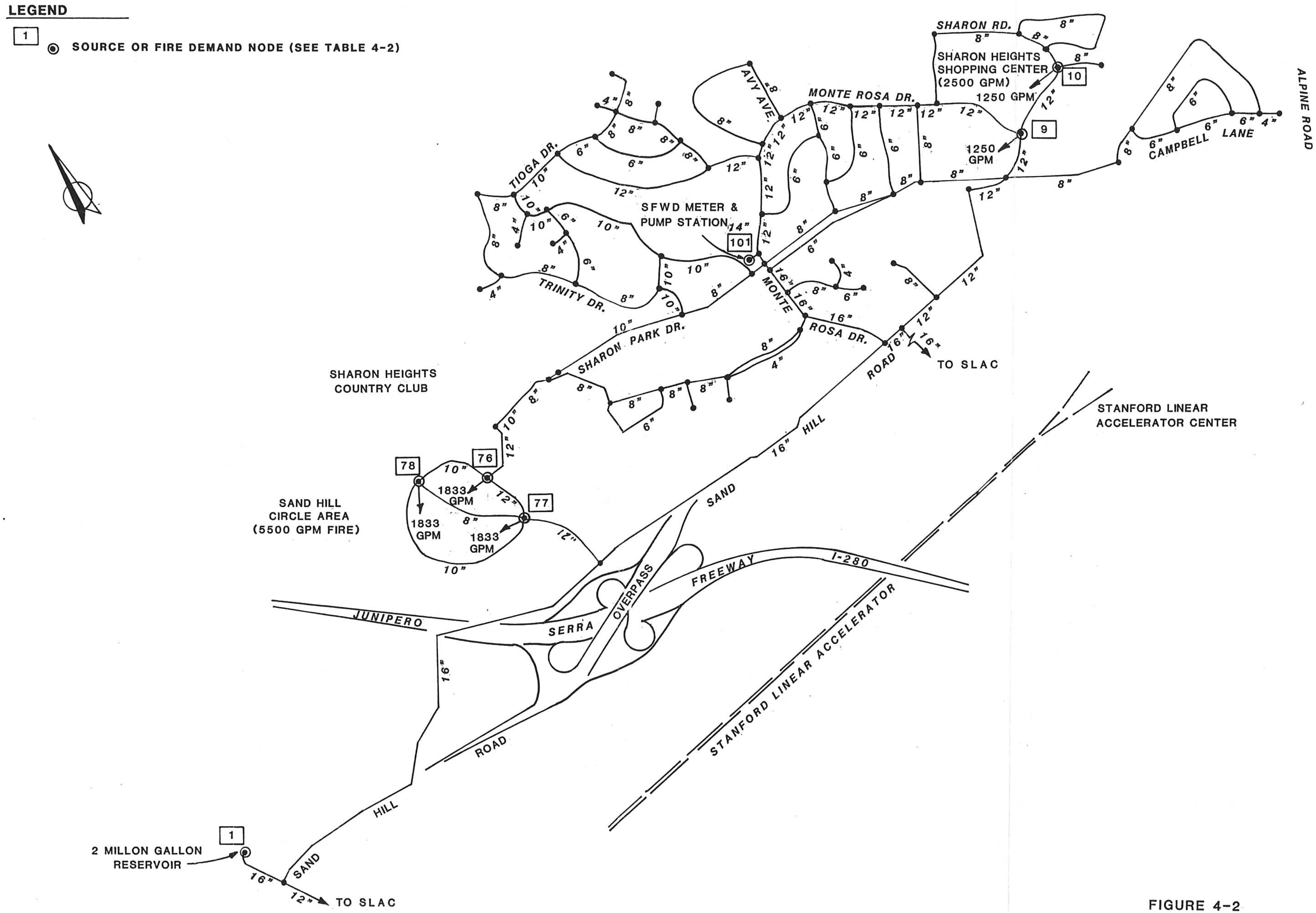


FIGURE 4-2
ZONE 3 SYSTEM PIPING NETWORK

CHAPTER V

HYDROGEOLOGIC CONDITIONS
AND
WELL PROSPECTS

BACKGROUND

Purpose and Scope

The City of Menlo Park is considering the possibility of developing a supplemental municipal water supply from wells located within the City or its immediate environs. Therefore, an investigation has been conducted to establish groundwater conditions and occurrence in this general area, to determine prospects for public supply wells in the various parts of the area, and to outline the best approach in developing wells for City supply. This report summarizes the results of this investigation and recommends steps to be taken to pursue the desired development.

Available Data

Geology and groundwater beneath the general Menlo Park area have been investigated as part of several studies of the San Francisquito Creek alluvial fan. However, this area did not have the large well development to supply commercial agricultural water requirements as occurred southward throughout most of the Santa Clara Valley. Even so, a number of smaller, relatively shallow wells have been installed to serve single residential needs, primarily irrigation. Therefore, data to indicate deeper subsurface conditions and maximum productivity are very limited.

Primary sources of information on local groundwater include: the California Department of Water Resources, by way of Water Well Drillers Reports; and the U.S. Geological Survey (USGS), which has conducted several limited water investigations of the region and is currently compiling detailed records on geological and geotechnical data, particularly on underlying bedrock occurrence. San Mateo County has essentially no groundwater record or monitoring system in this area, although the County Department of Environmental Health keeps certain limited groundwater quality information. The USGS investigations are being supported by the City of Menlo Park and the study described in this report has utilized basic data developed by that agency and made available to the City.

Overall, the assessment of groundwater conditions and potential for City well development has been accomplished by interpretation of the limited data for the Menlo Park area, plus data and knowledge of conditions immediately south in Palo Alto and other basin areas.

GROUNDWATER CONDITIONS

Geologic Setting

Unconsolidated waterbearing sediments were deposited on top of consolidated bedrock materials by the ancestral San Francisquito Creek flowing in the same general area and direction as at present. The alluvial fan deposits of varying beds of sand, silt, clay and gravel were thereby built up, ranging from a thin edge along the foothills to more than 600 feet in thickness east and northward, beneath the Menlo Park area. These materials are waterbearing and constitute the primary area groundwater source. Underlying bedrock deepens bayward under Menlo Park, but rises beneath the eastern part of the area reducing the thickness of overlying alluvium. Outcrops of consolidated rocks occur in the foothills on the west, as delineated on Figure 5-1. In addition to these hydrogeologic units, semi-consolidated rock materials, primarily the Santa Clara formation, underlie groundwater basin deposits along parts of the western edge of the Menlo Park area, as shown on Figure 5-1.

Cross-sections A-A' and B-B', Figures 5-2 and 5-3, respectively, show the basic relationship between bedrock and alluvial fan sediments across the Menlo Park area, and the approximate position of these materials.

The existence of a fault is apparent along the western area margin (Cross-section A-A') from geologic observation, well logs, and gravity mapping by the USGS. This fault appears to drastically offset the buried bedrock surface and corresponding depths of overlying alluvial deposits and other probable fault, referred to as the Belmont Hills fault, may pass through the area (Figure 5-1). These faults are thought to offset the underlying bedrock, however, possible effects on basin hydrogeologic conditions, if any, have not been determined.

Groundwater Occurrence

The unconsolidated alluvial fan materials laid down by the ancestral San Francisquito Creek extend for several miles both north and south of the creek and contain the groundwater resource available to the Menlo Park area. These sands, silts, clays and gravels contain groundwater within the interstices between soil grains. During deposition of these sediments, the area was inundated several times by the ancestral San Francisco Bay leaving thick clay beds and clay-rich zones within the more permeable sedimentary sequence. The alluvial basin is saturated below shallow depths down to underlying bedrock and constitutes an extension of the Santa Clara Valley groundwater basin to the south. The consolidated rocks in the hill areas to the west, which extend at depth below the groundwater basin form both the western and lower limits of the basin.

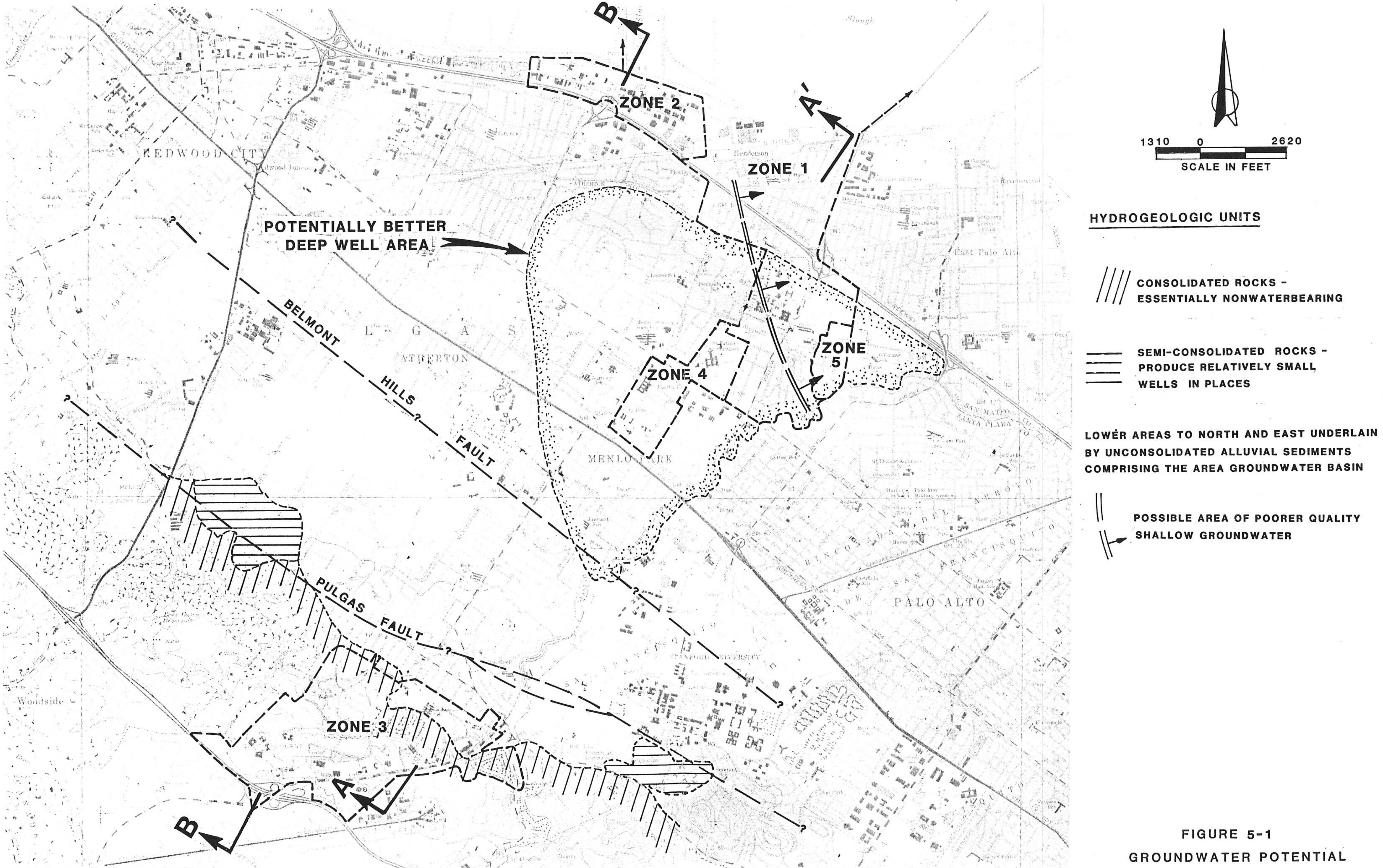


FIGURE 5-1
GROUNDWATER POTENTIAL

FIGURE 5-2
HYDROGEOLOGIC CROSS SECTION A-A'

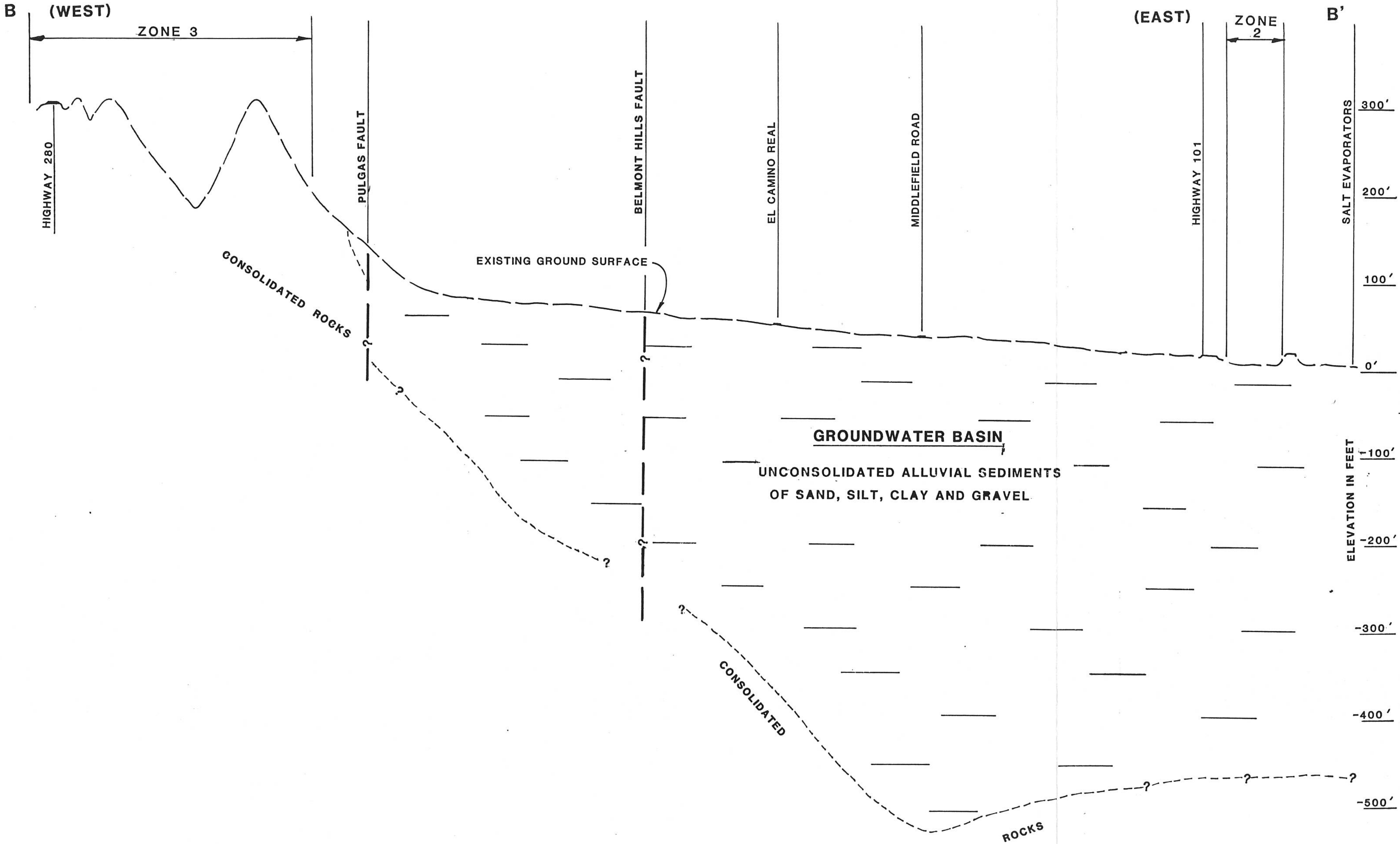


FIGURE 5-3

HYDROGEOLOGIC CROSS SECTION B-B'

The semi-consolidated Santa Clara Formation crops out in the foothill region southwest of the City of Menlo Park, as shown on Figure 5-1. This geologic unit is capable of supplying small wells, usually at a maximum yield of 100 gallons per minute, or less. The Santa Clara formation underlies the alluvial fan deposits in the Menlo Park area to an unknown extent. Although this formation is considerably tighter than sediments of the main alluvial basin, its materials are difficult to differentiate in drilling logs. Regardless of its extent in this area, this formation cannot be considered an aquifer for development of City supply wells.

Within the groundwater basin, the sedimentary strata commonly occur in zones of more pervious sand and gravel materials, separated by zones of less pervious fine-grained clays and silts. Such tighter zones tend to confine groundwater below them under artesian pressure and, in places, support perched or semi-perched groundwater above them. Due to these conditions, groundwater in the Menlo Park area occurs in both shallow and deeper aquifer units. Deeper aquifer units are more productive and capable of supplying large wells. Aquifers are recharged from surface sources, principally percolation of stream flows in the western part of the area. San Francisquito Creek is a major source of groundwater recharge to the area.

Depth to groundwater level in local wells is usually relatively shallow, static levels often being within 20 to 50 feet of the ground surface. When wells are pumped, the static levels drop to depths determined by both the rate of extraction and the permeability of aquifer materials tapped. Groundwater moves within this area essentially from higher areas of recharge northward toward the Bay, however, the flow pattern is commonly disrupted in the vicinity of heavily pumped wells.

Area Wells

The Menlo Park area has only a relatively small number of larger wells pumping several hundred gallons per minute, or more. These are limited to public supply wells such as the O'Conner Tract Cooperative Water Company in the eastern portion of the City, Menlo College, and the Federal Government at the Veterans Administration Hospital and the U.S. Geological Survey complexes. Only a small number of wells were drilled through the complete thickness of basin alluvium to bedrock, and most extend only several hundred feet below ground level to obtain the supply required. California Water Service, which serves a large part of the City, has no wells in the area. The City of Palo Alto has several large wells just south of the Menlo Park southern boundary (San Francisquito Creek). Numerous smaller wells exist at private residences for watering of gardens. These are uniformly shallow, usually less than 100 feet in depth, and are pumped only 10 to 50 gallons per minute on a seasonal basis.

The total amount of groundwater pumped from the basin in the Menlo Park area each year is not known, but is apparently less than basin yield capabilities, based on observations of local well development and indicated basin storage levels. Data are not currently available on which to make an assessment of the maximum quantity of groundwater which could be extracted safely from the area. Nevertheless, it appears that significant additional well development could be implemented without adversely impacting the basin. Optimum development would be contingent on proper location and operation of new wells, and limiting new well development to prudent levels determined as more data and basin response to initial development are obtained.

Water Quality

Few chemical analyses of well water are readily available for this area. However, the quality of deeper groundwater in Menlo Park is indicated to be basically acceptable for drinking compared to State and Federal standards. However, local groundwater commonly contains excessive concentrations of manganese and/or iron and new developments should expect this problem. General mineral concentrations may increase somewhat in certain areas north of Highway 101. There is no present evidence of Bay water intrusion into deeper aquifers in this area, however, certain wells, either through deteriorated casings, or improperly screened and/or sealed bores, may admit shallow groundwater of poor quality into the wells which mixes with water from deeper zones.

Over an area near the Bay, mostly in Palo Alto south of Embarcadero Road, shallow groundwater within 40 to 60 feet of the surface is of poor-to-very poor mineral quality and unsuitable for most uses. This fringe of poor quality shallow water may extend northward past Willow Road; Figure 5-1 shows an area of Menlo Park which may be so affected. With additional data, this area may prove to be larger, or smaller, than depicted here. Fortunately, where this condition exists, deeper aquifers are naturally protected by heavy clay zones, or aquicludes. Therefore, it is critical that new wells be designed to tap only deeper aquifer zones and to tightly seal out all shallow zone groundwater which could be a threat to water quality.

NEW WELL PROSPECTS

General

In conjunction with the water storage and hydraulic investigations for the City of Menlo Park, this study has evaluated areas for hydrogeologic conditions and suitability for well development. Groundwater conditions vary markedly between certain parts of the City, clearly limiting potential new well development. Study and interpretation of available well logs, production rates, bedrock depths, and other data resulted in delineation of a geographical area in the Menlo Park area which appears to be move favorable for large capacity well development than other areas north of San Francisquito Creek. The area thus delineated is shown on Figure 5-1 and is suggested for planning any new well developments for City water supply. Boundaries of this area are not absolute and should be considered as fairly broad transition zones. Within this area, well prospects should be more favorable and outside the area, prospects should be less favorable. This is not to say that certain sites outside the more favorable area might not produce acceptable wells for City supply, or conversely, that certain sites within the area could not be less productive than expected. Nevertheless, this interpretation represents the sum total of analyses possible with data available from all sources and is considered valid for present planning purposes.

Well potential in the City is discussed below with respect to water system pressure zones, and areas at large.

Zone 3 - Sharon Heights

As shown on Figure 5-1, the Zone 3 area is underlain by consolidated rocks, or bedrock, and is totally outside the Menlo Park area groundwater basin. Although small wells might be obtained in places in that vicinity, production would be solely from fractures in the rock, or from sandstone materials. Well discharges of more than perhaps 10 to 30 gallons per minute would not be expected. Although not outcropping in the immediate vicinity, the Santa Clara Formation may occur beneath basin alluvium deposits below the Zone 3 boundary. If present, this unit could conceivably produce wells, although the individual well yields to be expected would not be feasible for substantial water needs. It is therefore not believed feasible to develop groundwater supplies within the Zone 3 area, or even in the adjacent basin area for some distance to the north and east.

Zone 2 - Bohannon Industrial Park

This area is capable of supply well development, although it does not lie in the indicated best local area for wells (Figure 5-1). Records are available for two deep wells drilled in the eastern part of this area by the Bear Gulch Water Company, one in 1924 and the other assumed to be of equivalent vintage. Each well encountered bedrock at a depth near 400 feet. This investigation found no information on yield of these wells, their construction or performance, and they have long since been abandoned.

It is concluded that an acceptable well could be constructed in Zone 2, particularly along the southeastern margin, with some possible reservations. In this location in the basin alluvial fan sedimentation sequence, the average sand size is finer and there is a lower incidence of gravel, as suggested by the old recorded well logs. Thus, well design must reflect this condition which, in turn, would restrict well capacity. There is no evidence that additional groundwater extractions at this location near the Bay would induce Bay water to intrude into the deeper source aquifers. Even so, this is a question that must be kept in mind and, if new wells are developed there, aquifer monitoring should be installed to give early-warning in the event that intrusion should occur.

Wells drilled in this area should encounter bedrock at about the same depth as the old wells noted, around 400 feet, or possibly somewhat deeper. Special care must be taken to seal off shallow waters to a depth of at least 200 feet, and also to employ well design parameters to ensure sand-free water production.

Zones 1, 4 and 5

As shown on Figure 5-1, Zones 4 and 5, and the western part of Zone 1 overlie the projected most favorable area for well development. Palo Alto wells at several locations opposite these zones across San Francisquito Creek are large producers. Bedrock depths in this area should be near the deepest in the area, probably 600 to 700 feet. On the other hand, eastward from this vicinity, bedrock is indicated to rise to much shallower depths (see Cross-section A-A').

Despite the potential for encountering atypical conditions at any point in the basin, properly located and designed wells in the zonal areas noted could be capable of yielding at production rates of 800 to 1200 gpm, although the optimum operating capacity may be lower. It is important to provide adequate distance between new wells and existing wells in this area to minimize the possibility of mutual interference between wells.

The Stanford and Palo Alto Faults, indicated to pass through parts of this area, are not known to influence groundwater; however, they should be further evaluated for possible hydrogeologic impact on the movement of groundwater.

Other City Areas

A fairly large favorable area for deep well development exists mainly northeast, north and west of Zone 4 (Figure 5-1). Some of this area lies marginal to San Francisquito Creek, and that location may actually overlie the most favorable portion of the Creek fan within Menlo Park. However, wells of Stanford University and the City of Palo Alto are located just across the creek. Should new City wells be desired in this area, the potential for mutual pumping interference should be evaluated. Nevertheless, this part of the area should not be ignored in planning for new wells.

NEW WELL DEVELOPMENT

Location

As previously discussed, new storage facilities for the City water distribution system are recommended at sites in the southwestern part of the Veterans Administration property on Willow Road, and in Burgess Park. Water system efficiency would be enhanced if new well facilities were sited close to major storage units. Inasmuch as these storage sites are situated within the indicated more favorable well area delineated on Figure 5-1, properly designed and constructed supply wells installed at these locations would be expected to yield at substantial rates.

Test Holes

At any sites selected for new City development, production well construction should be preceded by drilling and logging of a test hole at or very near the intended wells. Such holes should follow the same basic approach, consisting of the following elements:

1. Drill a mud-rotary hole approximately 9 inches in diameter through the entire alluvial fan deposits of the groundwater basin to underlying bedrock; total depth could vary as much as several hundred feet, depending on site; depth of a test hole (and followup well) at the Veterans Administration site would probably be in the range of 600 to 650 feet; at the Burgess Park site, depth would probably be in the same order, or perhaps slightly deeper;

2. Collect drill-cutting samples at 10-foot intervals and at formational changes; geologically log the hole;

3. On completion, run an electric log of the hole to delineate the relative permeability of the subsurface material penetrated by the bore.

4. Select various drilling samples for grain-size analysis by a soils laboratory;

5. Design production well based on analyses and interpretations of the geological and electric logs, and aquifer grain-size distribution; individual parameters specified for each well include depth intervals to be screened, screen type and slot size, and filter-pack grain size.

Production Wells

It is not expected that new wells at the Veterans Administration and Burgess Park sites would be significantly affected by mutual pumping interferences with neighboring wells. The current well use at the Veterans Administration is understood to be relatively minor. If the City were to take over operation of the Veterans Administration well and integrate it into the City system for either regular, or standby use, both the City and Veterans Administration water use efficiencies might be enhanced. Similar City use of a well at the U.S. Geological Survey on Middlefield Road might also be considered.

Recommended new well design criteria would be subject to test hole data, as noted above. However, basic elements would tentatively consist of:

1. Drilling a 24-inch (approximate) diameter hole to bedrock, using the reverse-rotary drilling method;

2. Casing well with 14-inch diameter steel casing; screen well with 14-inch wrapped-wire (shaped wire) stainless steel screen;

3. Backfilling annulus between screen and well bore with specially selected filter-pack material;

4. Placing a surface sanitary seal in annulus between bore and casing to approximately 200 feet below ground surface;

5. After construction, developing well by bailing, swabbing, air-jetting, and/or pumping, as judged appropriate;

6. After development, pump-testing well for a minimal period of 72 hours; test data collected would determine optimum operating parameters.

Cost

Costs for drilling and logging an exploratory test hole, or to construct a new production well, will vary with depth which, in turn, varies with the thickness of alluvial sediments at a given site within the area. However, on an overall basis the cost of a test hole, sampled and electric-logged, should be on the order of $10,000. An adequate production well would be expected to cost in the range of $75,000. Neither of these estimates include the costs of right-of-way, well pumping equipment, or engineering.

CHAPTER VI

EVALUATION OF STORAGE AND SUPPLY ALTERNATIVES

OVERVIEW

The purpose of this chapter is to describe and evaluate various storage and supply options that will improve the reliability of the Menlo Park water system. It should be recognized, however, that the evaluation process is, in large measure, subjective and that risk can never be completely defined or eliminated, especially from earthquake hazards.

The approach used to evaluate storage and supply alternatives was as follows:

1. Develop various scenarios that could cause interruptions to supply. These include natural disasters such as an earthquake or landslide, failures from corrosion, and construction-related interruptions.

2. Evaluate, in a general sense, the reliability of the SFWD Hetch-Hetchy supply. Planned future improvements were considered.

3. Determine what other nearby water purveyors that use SFWD water do to maximize reliability.

4. Identify and develop storage and supply alternatives applicable to the three subsystems in the Menlo Park system.

5. Develop costs for the most promising alternatives.

The alternatives considered included:

1. Storage - Both elevated and at-grade steel tanks were investigated. Above grade and buried prestressed concrete tanks and cast-in-place concrete reservoirs were also investigated. Various sites in the Zones 1, 4 and 5 system and Zone 3 system were considered. Where needed, booster pumping facilities were included in each scheme.

2. Interconnections with other purveyors - Because Menlo Park is now connected to California Water Service Company's facilities and the East Palo Alto system in the Zone 1, 4 and 5 system, attention was directed toward obtaining a connec-

tion with the California Water Service Company for Zone 3.

3. Alternative supplies - The current groundwater supply investigation is the principal focus of this alternative.

SUPPLY INTERRUPTION SCENARIOS

Supply interruptions can be categorized as; (1) localized, (often short-term) interruptions, or (2) general, extended outages. Localized interruptions could include (1) a break in a SFWD pipeline (one only), (2) scheduled maintenance of SFWD facilities, (3) a malfunction of pumping equipment or the standby generator at the SFWD connection in Zone 3, (4) a construction accident, (5) acts of vandalism, and (6) a major pipeline break in the Menlo Park system caused by earth movement or corrosion. There are undoubtedly situations other than those listed that could cause localized interruptions in service. These interruptions will last only a few hours. When damage will take longer to repair, temporary measures can be taken to restore service while repairs are made.

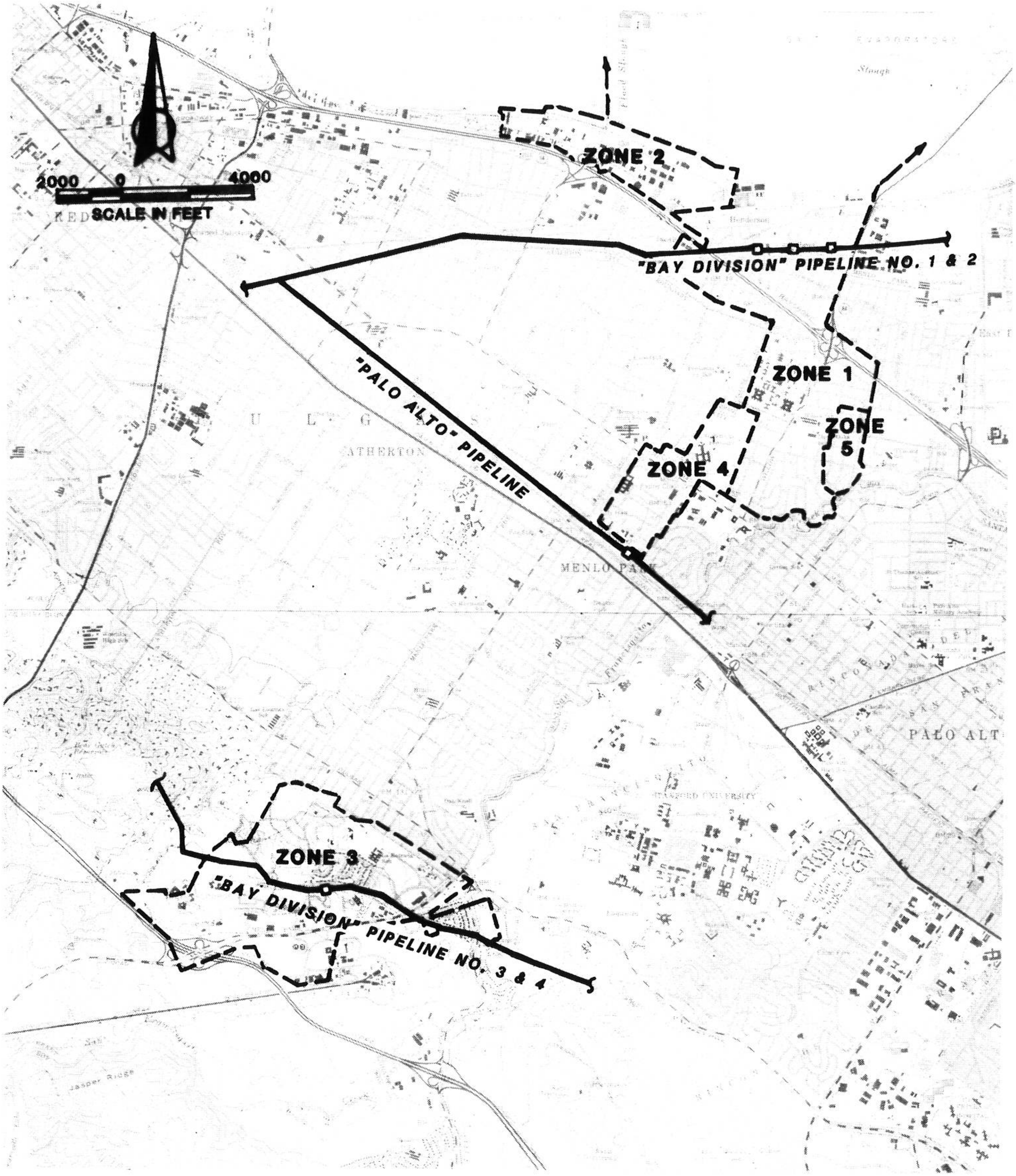
The most likely cause of a general, long-term outage would be an earthquake. Other events having major impact might include a non-seismic related structural failure of a dam, transmission pipe or tunnel in SFWD's Hetch-Hetchy system. Sabotage by terrorists cannot be overlooked. Such an act could take many forms including destruction of a major pipeline or dam or the introduction of a toxic substance into the water supply.

Mitigating the effects of either localized or general interruptions requires advance planning. Storage, duplicate supply and transmission facilities and other physical improvements that provide redundancy in the system, are important. Having a detailed emergency operation plan in place is equally as important.

EVALUATION OF SFWD SUPPLY RELIABILITY AND CAPACITY

A meeting with Mr. Norman Lougee, Manager of Resources and Planning for the SFWD, was held on April 17, 1989, to discuss the reliability of SFWD's Hetch-Hetchy system. A secondary purpose for the meeting was to obtain recommendations for improving the reliability of the Menlo Park system in the event of a Hetch-Hetchy outage.

The physical components of and operating procedures for the Hetch-Hetchy system were discussed insofar as they impact water deliveries to Menlo Park. The Zone 3 system is served by SFWD's Bay Division Pipeline Nos. 3 and 4 as shown on Figure 6-1. If a disruption of the Hetch-Hetchy supply to the east should occur,



LEGEND

MENLO PARK WATER DEPARTMENT ZONE BOUNDARIES

SAN FRANCISCO WATER DEPARTMENT PIPELINE & SUPPLY METER

FIGURE 6-1
SAN FRANCISCO WATER DEPARTMENT SUPPLY CONNECTIONS

these lines can be valved off east of the Stanford tunnel. The tunnel is located near the radar telescope on Stanford property just east of Freeway 280 between Alpine and Page Mill Roads. Mr. Lougee mentioned that Stanford University had considered constructing a reservoir at this location to supplement their supply in the event of such an outage. He believes that a reservoir at this location will improve Menlo Park system reliability because the reservoir could be backfed from the Peninsula facilities of SFWD if the Hetch-Hetchy supply were interrupted.

The need for storage in the lower zones was discussed. He mentioned that peaking off the Hetch-Hetchy facilities may, in the future, be subject to a rate surcharge or be prohibited altogether when SFWD's pipelines approach or exceed capacity.

Mr. Lougee described SFWD's current program to improve system capacity and reliability. They are currently increasing the capacity of the San Andreas Water Treatment Plant in Millbrae from 80 mgd to 180 mgd. This work will be completed by 1992. These improvements will allow treated water to be backfed from the San Andreas plant to Peninsula users. This scheme uses the balancing reservoir adjacent to the Pulgas Water Temple for storage and hydraulic control. SFWD will then have the capability of backfeeding both Bay Division Pipeline Nos. 1 and 2 and the Palo Alto Pipeline to serve the Menlo Park Zones 1, 4 and 5 system and Bay Division Pipeline Nos. 3 and 4, which serve Zone 3.

The volume of raw water in storage in the SFWD system in Alameda and San Mateo Counties is extensive. If undamaged or lightly damaged in a natural disaster, these supplies alone could sustain San Francisco and San Mateo County and South Bay customers for a considerable length of time. This could be the scenario if an earthquake in the Central Valley damaged Hetch-Hetchy storage or transmission facilities.

Calavaras and other East Bay reservoirs have a combined capacity of about 45 billion gallons. Crystal Springs and San Andreas Reservoirs hold about 26.5 billion gallons. The combined treatment capacity of the Sunol water treatment plant (Alameda County) and the newly expanded San Andreas plant will be 340 mgd, versus a current average daily demand for all users of about 270 mgd.

If the assumption is made that the local reservoirs are half full when disaster strikes and the demand is 270 mgd, the local supply can maintain service for over eight months.

If it is assumed that the SFWD system is isolated at the Stanford Tunnel and thus only Crystal Springs and San Andreas Reservoirs are available for use (assumed half full), service to San Francisco and San Mateo Counties could be maintained for over four months.

SURVEY OF LOCAL WATER PURVEYOR

The following local water purveyors, who rely on the SFWD for supply, either totally or in part, were contacted (e.g., only those that responded are listed):

California Water Service Company (Bear Gulch District)
Stanford University
City of Palo Alto
Belmont County Water District
Estero Municipal Improvement District (Foster City)

Each of these parties was asked the following questions:

1. What is your average annual (or daily) water demand?

2. What is your maximum daily demand?

3. How much (what percentage) of your demand is met from SFWD?

4. What are your alternative sources, if any?

5. How many connections to the SFWD supply do you have?

6. How much distribution storage do you have?

7. Do you have any current plans to add storage or otherwise improve the reliability of your supply?

The survey results are shown in Table 6-1. Distribution storage is shown as a percentage of the maximum daily demand. These percentages may be compared with the recommended storage requirements for Menlo Park shown previously in Tables 3-4 and 3-5.

SYSTEM ALTERNATIVES FOR ZONES 1, 4 AND 5

Storage and/or Supplemental Supply Requirements

Based on Table 3-5, about seven million gallons (mg) of storage and/or local supply capacity is needed to meet the equalizing and fire protection requirements and provide a one-day emergency reserve in the Zone 1, 4, and 5 system. If the emergency reserve is increased to three days, the storage/local supply requirement will increase to about 15 million gallons. It is recommended that capacity equivalent to at least the 1-day supply, 7 mg, be provided entirely from storage. Wells, if properly located and

TABLE 6-1

LOCAL WATER PURVEYOR STORAGE SURVEY - SUMMARY

Water Purveyor	Average Daily Demand (mgd)(1)	Max. Daily Demand (mgd)(1)	Present Storage Volume (mg)	Storage Percentage (Max. Day Basis)	Planned Storage Additions (mg)	Connection To SFWD Facilities (Number)	Normal Percentage Of Supply from SFWD	Alternate Sources Presently Available?
Menlo Park, City of	4.1	8.8	2.0	23%	(2)	5	100%	No
California WSC - Bear Gulch	11.6	19.3	9.5	49%	None	8	85%	Yes (3)
Stanford University	2.0	3.0	2.5	83%	7.0	3	100%	Yes (4)
Palo Alto, City of	17.0	29.0	11.0	38%	None	4	100%	Yes (4)
Redwood City, City of	9.8	20.0	16.6	83%	9.0	13	100%	No
Belmont County Water District	5.0	10.0	11.5	115%	0.5	2	100%	No
Estero MID (Foster City)	6.0	12.5	8.0	64%	8.0	1	100%	No

(1) In most instances, demands represent the purveyor's best estimates based on 1986 or 1987 (pre-drought) use.

(2) This study recommends 4 mg of additional storage (first phase) and a total of 16 mg, ultimately, to meet peaking and fire demands and to provide a 1-day emergency reserve.

(3) Storage volume shown does not include 215 mg of raw water storage in Bear Gulch Reservoir which is served by a 5 mgd capacity water treatment plant.

(4) Wells

equipped with standby generators, may be used to provide all, or a part of, any additional emergency reserve. This assumes that groundwater supply(s) of adequate capacity can be found. Wells offer the advantage of providing a sustained supply in the event of a prolonged outage. Wells may be somewhat more susceptible to damage than tanks in an earthquake, however.

Types of Storage

Because of the relatively flat topography of the Zones 1, 4 and 5 system, elevated storage or pumped storage at, or below, ground level must be provided.

Elevated tanks are rarely constructed in California because of seismic concerns and the costs for constructing these structures to meet current seismic code requirements. A 2 million gallon elevated tank, for example, will cost over $4 million to construct. For comparison, a 2 million gallon steel tank at grade, including a booster pump station and standby generator, will cost about $1.1 million. Environmental (aesthetic) concerns are another major drawback of elevated tanks. For these reasons, elevated tanks are not recommended for Menlo Park.

Steel tanks, prestressed circular concrete tanks and cast-in-place concrete reservoirs may be viable choices for storage depending upon siting requirements, aesthetics and budget. Steel tanks are the least costly on a first cost basis, can be made seismically-resistant and are durable, providing they are recoated regularly. Aesthetics, and the need for periodic coating, are the principal drawbacks of steel tanks. The cost for coating a steel tank may approach one-fourth of the first cost of the tank structure. Coating is usually required every 8 to 15 years.

Another alternative is a circular prestressed concrete tank. These tanks may be built above grade, below grade or partially above grade. They can be designed to meet all seismic requirements and, in some instances, when installed below grade in parks, have been used as tennis courts or playing fields. The first cost of these structures is higher than steel tanks but periodic coating is not required, thus reducing maintenance costs. They often compare favorably with steel tanks on a present worth basis when the cost of coating steel tanks is included.

A third alternative is a cast-in-place rectangular or square concrete reservoir. These structures may also be built partially or completely below grade. They can also be designed to resist seismic forces. Like prestressed concrete tanks, a cast-in-place concrete reservoir can accommodate multiple uses of the site. Tennis courts, playgrounds and ball fields can be built over them. This type of storage is usually the most expensive of the three types considered. The concrete reservoir can be built on irregularly shaped sites because the dimensions are not fixed. The costs for constructing a cast-in-place concrete reservoir is about twice as high as for a steel tank. Prestressed concrete tank costs fall between steel tanks and concrete reservoirs. Concrete tanks or reservoirs with non-load bearing roofing systems will cost less than those with load-bearing (buried or multiple) roofs. Booster pumping and standby generator costs were developed independently.

Because any of the three types of storage discussed will perform satisfactorily, the decision as to which type of tank/reservoir is best suited for a particular site must be based on other considerations that will include aesthetics, costs, and other needed uses of the site.

Location Alternatives

The hydraulic analyses described in Chapter 4 showed the weaknesses of the Zones 1, 4, and 5 system in fire fighting situations when the supply is obtained from only one source. When either the Palo Alto pipeline or Bay Division Pipeline Nos. 1 and 2 were taken out of service, fire flows were reduced to the 2,000 to 3,000 gpm range. For this reason, a central location for storage, such as the Veterans Administration Hospital or St. Patricks Seminary, is the most desirable potential storage. Alternative locations for storage facilities are shown on Figure 6-2. The Veterans Administration (VA) Hospital is an ideal location for a centrally located storage facility. Preliminary discussions with VA Hospital engineering staff have been held regarding this alternative. The concept of a below grade, joint-use storage facility is attractive to them.

Various potential storage locations on the east side of Zone 1 were also investigated. Potential sites include (1) Kelly Park, (2) Flood Park, (3) the Belle Haven schoolgrounds, (4) a small park located at Hamilton Avenue and Ivy Drive, and (5) a vacant city-owned strip bounded by the Southern Pacific Railroad right-of-way, Chilco Street and Terminal Avenue. This latter parcel was eliminated from further consideration because of the City's desire to reserve this site for housing. Locations in the Bohannon Industrial Park may also be advantageous inasmuch as such a site could also meet peaking and emergency demands of the Zone 2 system.

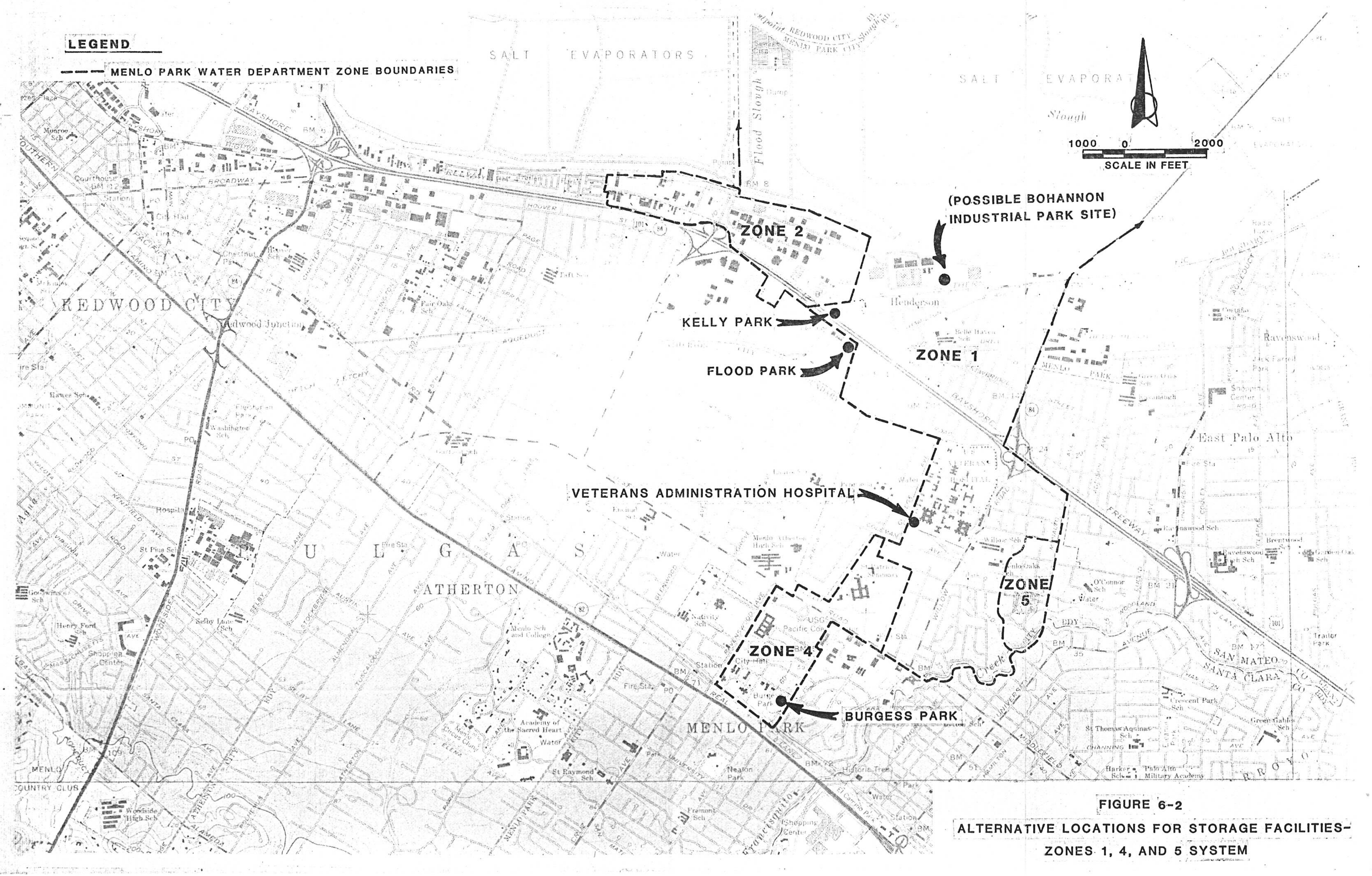


FIGURE 6-2
ALTERNATIVE LOCATIONS FOR STORAGE FACILITIES-
ZONES 1, 4, AND 5 SYSTEM

The best location on the west side of Zone 1, 4 and 5 system is Burgess Park. To avoid removing recreational facilities from service, a reservoir built at this location must be below grade.

SYSTEM ALTERNATIVES FOR ZONE 2

Based on Tables 3-4 and 3-5, approximately 2.6 mg and 6.0 mg, respectively, of storage is needed to provide a one-day and three-day emergency reserve in Zone 2. Wells may be used to supplement storage if groundwater is available in sufficient quantities.

Locations in Zone 2 were not investigated in detail although the concept was discussed with Mr. Scott Bohannon, Vice President of Bohannon Development Company.

SYSTEM ALTERNATIVES FOR ZONE 3

Storage and Supplemental Supply Requirements

Based on Table 3-5, approximately 8 mg of storage and/or local supply capability is needed to meet requirements in Zone 3 with a one-day emergency reserve. If a three-day reserve is provided, the volume in storage increases to 19 mg.

Interconnection with California Water Service Facilities

Unlike the Zones 1, 4 and 5 and Zone 2 systems, there are no existing connections to California Water Service Company facilities in Zone 3 nor to any other emergency supply. Constructing an interconnection may prove beneficial to both systems allowing stored water in either system to be delivered to the other in an emergency. Examination of system maps furnished by Mr. Clay Scofield, Manager of California Water Service Company's Bear Gulch District, indicated that the best location for such a connection would be on Avy Drive between Altschul Avenue and Deanna Drive. A schematic of the proposed connection is shown on Figure 6-3.

Because the two systems operate at different pressures, the interconnection will require a booster pumping-pressure regulating station. The Bear Gulch system in this vicinity operates at the pressure available from SFWD's pipelines (approximate hydraulic grade line, or HGL, of 319 feet).

In Zone 3, on the other hand, the SFWD supply is boosted to the Sand Hill tank at an elevation of 486 feet. This provides adequate pressure to serve the higher elevations in this zone. Therefore, the booster pumps at the Bear Gulch connection must be

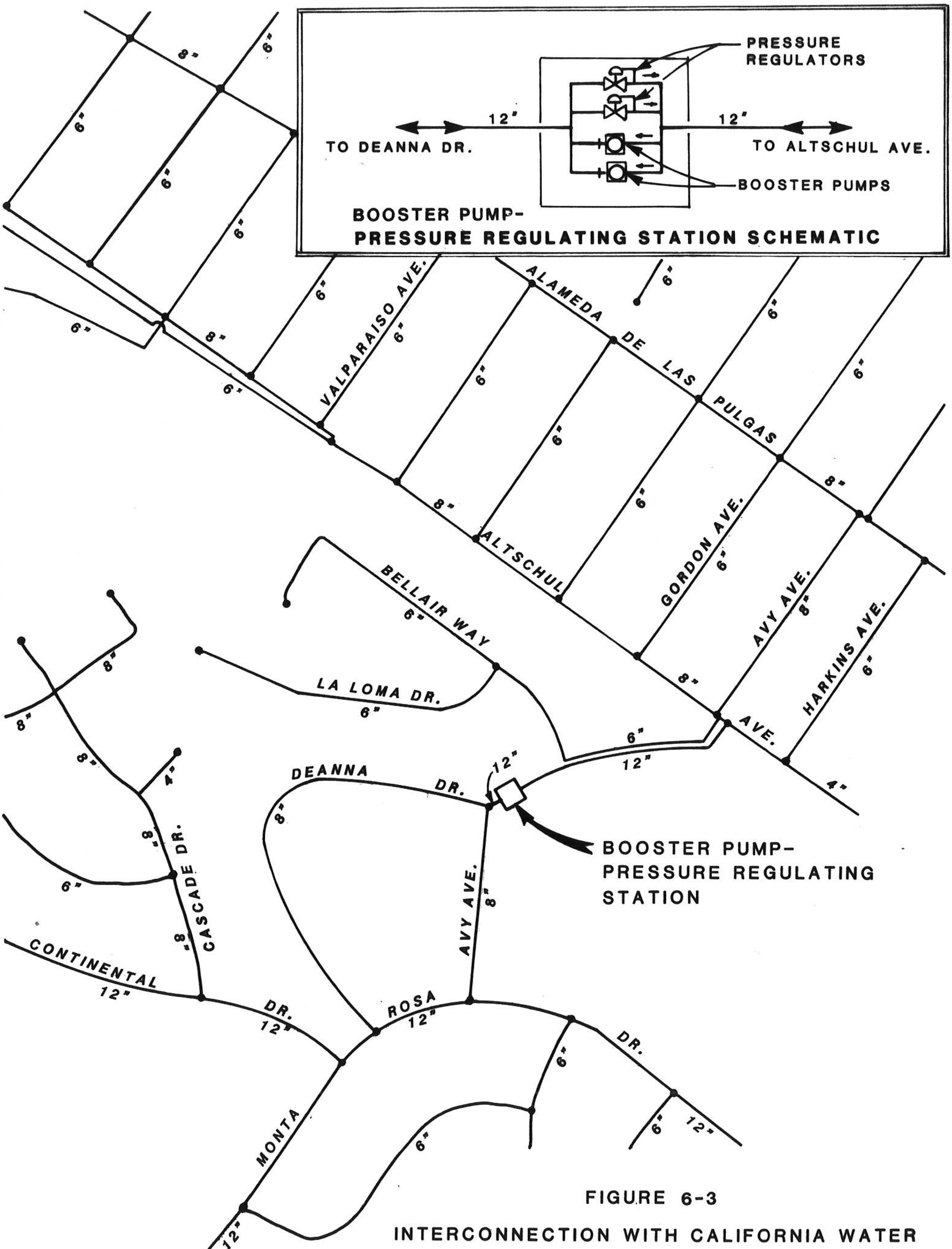


FIGURE 6-3

INTERCONNECTION WITH CALIFORNIA WATER SERVICE COMPANY FACILITIES-ZONE 3 SYSTEM sized for the same approximate lift as the booster pumps at the SFWD connections. Design capacity will be less - approximately 2,500 gpm - as dictated by the piping and supply limitations of the two systems at the points of connection.

Delivering water from Zone 3 into the Bear Gulch system will require pressure regulators in parallel with the booster pumps as shown on Figure 6-3.

A 12-inch main has been extended from Altschul Avenue to Deanna Drive along Avy Avenue instead of using the existing 6-inch main. This has been done to avoid causing local low pressures in the Bear Gulch system when the connection is in operation.

Storage Location Alternatives

Alternatives investigated for additional storage to serve Zone 3 included (1) a tank or reservoir adjacent to the existing reservoir, (2) a tank at Sharon Park, (3) a tank at Stanford Hills Park, (4) a joint storage project with Stanford University located on Stanford property southeast of the Zone 3 service area, and (5) emergency raw water storage from Felt or Searsville Lakes. The location of these alternative sites are shown on Figure 6-4.

Constructing a second tank or reservoir adjacent to the existing Sand Hill reservoir is the simplest and least expensive means for increasing storage in Zone 3. The site can easily accommodate a second tank/reservoir and does not pose a threat to, or interfere with, other uses of the site. Being at the same elevation, a new tank/reservoir would operate in tandem with the existing reservoir. The principal disadvantage of providing all the system storage at this site is the lack of piping "redundancy". One 16-inch pipe serves as the inlet and outlet. Constructing a second pipe to follow a different alignment is the preferred method of improving reliability, albeit an expensive one. Another approach may be to enter into a formal agreement with SLAC to use their 12-inch loop line that connects to the Zone 3 system at two locations on opposite sides of Interstate 280 (see Figure 4-2 in Chapter 4 for these locations).

Both Sharon Park and Stanford Hills Park are possible storage tank locations that lie within the Zone 3 service area. Both will require booster pumping facilities with standby generators. To retain the character of the parks and to avoid losing recreational space, a tank, or tanks, should be buried. Of these two locations, site consideration appears to favor Stanford Hills Park.

Stanford University utilities personnel have had a 7 mg reservoir designed for eight years but have been unable to obtain funding from the University to construct it because of the 20 percent

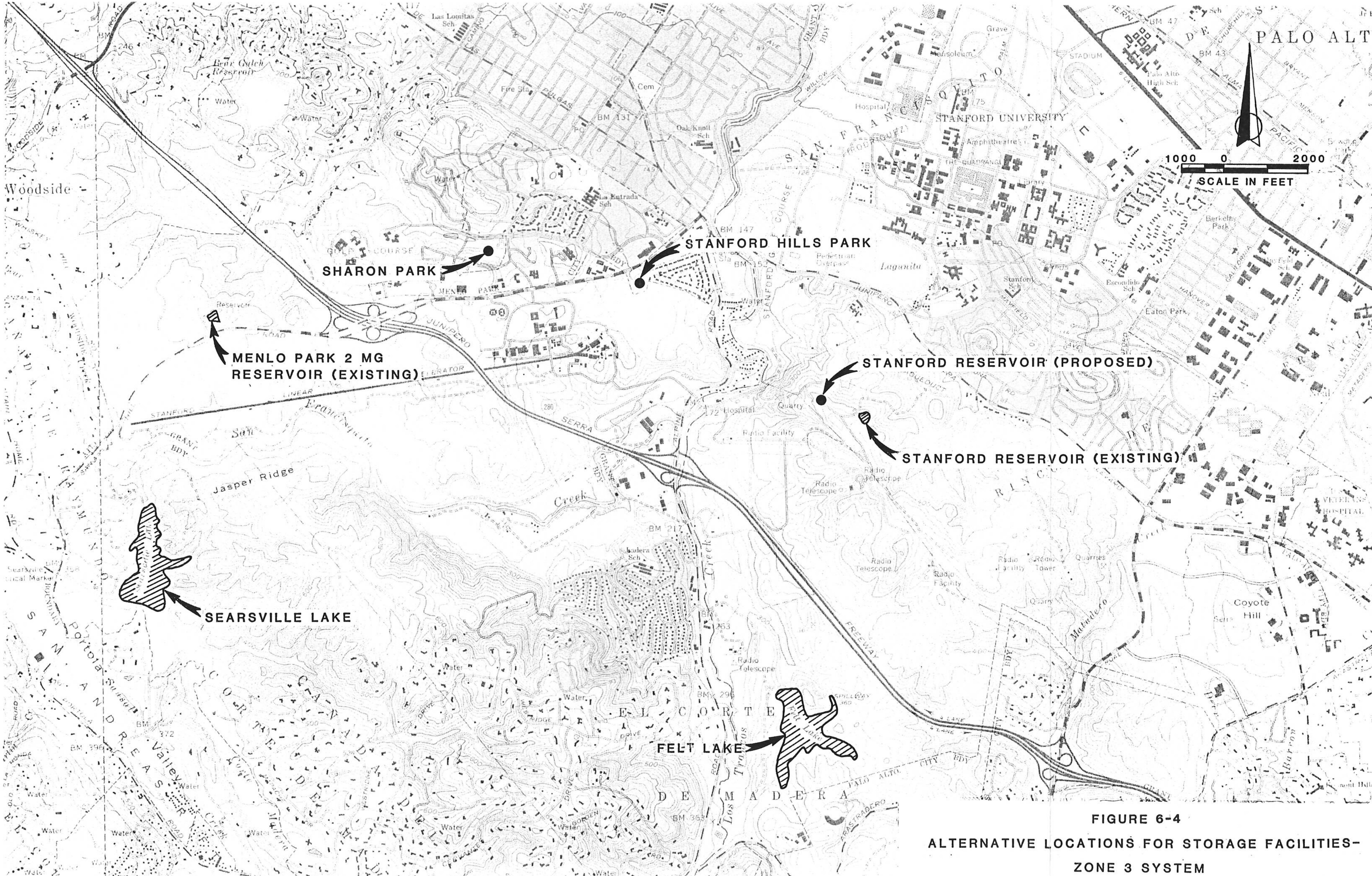


FIGURE 6-4

ALTERNATIVE LOCATIONS FOR STORAGE FACILITIES-

ZONE 3 SYSTEM

rate increase needed to pay for the facility. The University has a 2.5 mg reservoir nearby that is currently the only potable water storage in their system. Discussions with Ms. Cheryl Jenson, Director of Mechanical Utilities, indicated that staff would be interested in exploring a joint-use facility with Menlo Park (and possibly with California Water Service Company). The elevation of the reservoir would be about 412 feet - too low to serve Zone 3 without pumping. It appears that constructing a main to tie into the Bear Gulch District's main on Alpine Road is the least costly means of connecting to the Zone 3 system. The proposed Bear Gulch - Zone 3 interconnection could be used to deliver Stanford reservoir water to Zone 3. The water would be "wheeled" through the Bear Gulch system. All connections would be metered so that all parties are fairly compensated for water transfers across system boundaries.

Use of raw water from Felt and/or Searsville Lakes was also discussed with Cheryl Jensen. The Stanford irrigation systems can only use excess water from Searsville Lake as a result of its conversion to a biological research facility. Since conversion, Searsville has silted heavily, greatly reducing its storage capacity and usefulness for water supply.

Felt Lake, on the other hand, is the principal source of irrigation water for the Stanford campus and the golf course. Stanford currently uses about one-half of the 937 acre-foot capacity of the lake each year. It is unlikely that this water would be available to Menlo Park for emergency usage. In any case, complete treatment would be needed to render this supply potable. The cost for constructing and maintaining a water treatment plant to treat Felt Lake water for emergency use only is prohibitive.

RECOMMENDATIONS

Table 6-2 presents a cost summary of recommended storage (and system) improvements that will greatly enhance the reliability of the Menlo Park water system. This table lists three projects each for the Zones 1, 4 and 5 (includes Zone 2) and Zone 3 systems. Constructing all improvements will provide the storage volume needed to satisfy the one-day emergency storage requirement shown in Table 3-5 for the year 2005.

The storage volumes required are as follows:

Veterans Administration Hospital	4 mg
East Side (undesignated location)	4 mg
Burgess Park	2 mg
Total Zones 1, 4 and 5 (includes Zone 2)	**10 mg**

TABLE 6-2

STORAGE IMPROVEMENT COST SUMMARY

Type of Improvement (1)	Location	Priority	Total Project Cost	Annual Debt Service (2)	Annual O & M Cost (3)	Total Annual Cost	Cost/Unit of Water Sold (4)
Zones 1,2,3 & 4							
Tank (4mg), BPS, SG & Piping	VA Hospital	A	$2,516,000	$265,868	$12,200	$278,068	$.14
Reservoir (4mg), BPS & SG	East Side - Undesignated	B	$3,281,000	$346,706	$12,000	$358,706	$.18
Tank (2mg), BPS & SG	Burgess Park	C	$1,593,000	$168,334	$10,300	$178,634	$.09
Totals - Zones 1,2 3 &4			$7,390,000	$780,909	$34,500	$815,409	$.41
Zone 3							
BPS, PRS, SG & Piping	CWSC Interconnection	A	$435,000	$45,967	$10,200	$56,167	$.03
Tank (3mg)	Sand Hill Reservoir	B	$1,700,000	$179,641	$2,000	$181,641	$.09
Reservoir (3mg) & Piping	Stanford University	C	$1,700,000	$179,641	$2,000	$181,641	$.09
Totals - Zone 3			$3,835,000	$405,248	$14,200	$419,448	$.21
Totals - All Improvements			$11,225,000	$1,186,157	$48,700	$1,234,857	$.62
Totals - Priority A Only			$2,951,000	$311,835	$22,400	$334,235	$.17
Totals - Priority B Only			$4,981,000	$526,347	$14,000	$540,347	$.27
Totals - Priority C Only			$3,293,000	$347,975	$12,300	$360,275	$.18

(1) BPS - Booster Pump Station
SG - Standby (emergency) Generator
PRS - Pressure Regulating Station
(2) Based on an interest rate of 8.5 percent and a term of 20 years.
(3) Includes operating and maintenance labor, power, fuel and supplies.
(4) Based on annual water sales of 2 million units.
(5) Cost basis is 1989 (San Francisco ENR CCI = 5800)

Sand Hill Reservoir Site - New Tank	3 mg
Sand Hill Reservoir Site - Existing Reservoir	2 mg
Stanford Reservoir (Joint-use)	3 mg
Total	**8 mg**

The proposed Zone 3 interconnection with Bear Gulch District facilities, while not storage per se, is the means by which Stanford Reservoir water may be delivered to Zone 3. This connection is an important reliability enhancement for both the City's Zone 3 system for Bear Gulch.

Because of the high costs, these improvements have been prioritized. The table shows that the highest, "A" priority has been given to the Zones 1, 4 and 5 tank and supporting pump station at the Veterans Administration Hospital and to the Bear Gulch District interconnection in Zone 3. The combined project cost for the "A" priority facilities is about $3 million as compared with a total project cost for all recommended storage improvements of over $11 million.

To put these costs into perspective, they have been reduced to a cost per unit of water sold basis assuming current, non-drought yearly sales of 2 million units. Table 6-2 shows that the added cost per unit of Priority "A" and for all recommended improvements will be $0.17 and $0.62, respectively.