Appendix B. Water Use Forecast: 2000 to 2020

MINUTE ORDER
CITY COUNCIL MEETING

July 1, 2002
MO. 02-182

CITY CLERK DEPARTMENT
Redwood City

DATE: July 2, 2002

Attention: City Attorney
Public Works Dept.

SUBJECT: **Final Report – Redwood City Water Use Forecast 2000 to 2020;**

Meeting of the Council of the City of Redwood City on July 1, 2002.

Present: Council Member Ruskin, Pierce, Hartnett, Jordan

Absent: Council Member Howard, Vice Mayor Ira and Mayor Claire

The following motion was made, carried and entered on the Minutes:

Hartnett/Pierce Motion to review and accept the Final Report – Redwood City Water Use Forecast 2000 to 2020 prepared by consultant John Whitcomb, PhD; and to set July 15, 2002 as the date of the Public Hearing for the purpose of adopting a resolution amending the Redwood City Urban Water Management Plan;

The motion passed by a unanimous roll call vote by all those present.

Patricia S. Howe

Patricia S. Howe
City Clerk

Redwood City Water Use Forecast 2000 to 2020

Prepared for:

Peter Ingram
Public Works Services Director
City of Redwood City
1400 Broadway
Redwood City CA 94063

Prepared by:

John Whitcomb, PhD
(800) 800-9519

June 20, 2002

Executive Summary

This project develops base water use forecasts for the City of Redwood City (RWC) for the period 2000 to 2020. The forecasts can be used for a variety of water planning activities including:

- Assessing the merits of an expanded recycled water system in Redwood Shores and subsequent proposed phases in other areas
- Updating elements of RWC's Urban Water Management Plan
- Establishing a continuing nexus between water supply planning and RWC's General Plan
- Developing base water use characteristics for potential rates and charges.

The water use forecasts are comprised of seven separate forecasts made for the following user sectors: single family, multiple family, commercial, commercial irrigation, municipal, other, and residential irrigation. The forecasts made for each of these sectors make use of forecasts of key data drivers. The data drivers are number of housing units for the residential sectors, number of employees for the commercial sectors, and population for the other sectors. These data drivers are multiplied by water use coefficients, based on historical water use correlations, to obtain the water use forecasts.

Results are summarized in Exhibits 1 and 2. Holding other factors constant, total water use is expected to increase from 13,170 acre-feet per year (AFY) in 2000 to 15,520 AFY in 2020. This is a 17.8% increase over the 20 years that translates into an annual average 0.82 percent increase. Factoring in passive water conservation from natural replacement of toilets and clothes washers with more efficient technologies decreases the 2020 forecast by 703 AFY to 14,817 AFY. This translates into a 0.59 annual average increase over the 20 years.

Exhibit 1. Base Water Use Forecast in Acre-Feet per Year (AFY)

	Actual	Forecast Year			
Description	**2000**	**2005**	**2010**	**2015**	**2020**
Existing Customers	12,596	12,596	12,596	12,596	12,596
New Customers	0	513	1,386	1,962	2,328
New and Existing Customers	12,596	13,109	13,981	14,558	14,923
Unaccounted for Water	574	524	559	582	597
Total without Conservation	13,170	13,633	14,541	15,140	15,520
Total with Passive Conservation	13,170	13,467	14,191	14,590	14,817

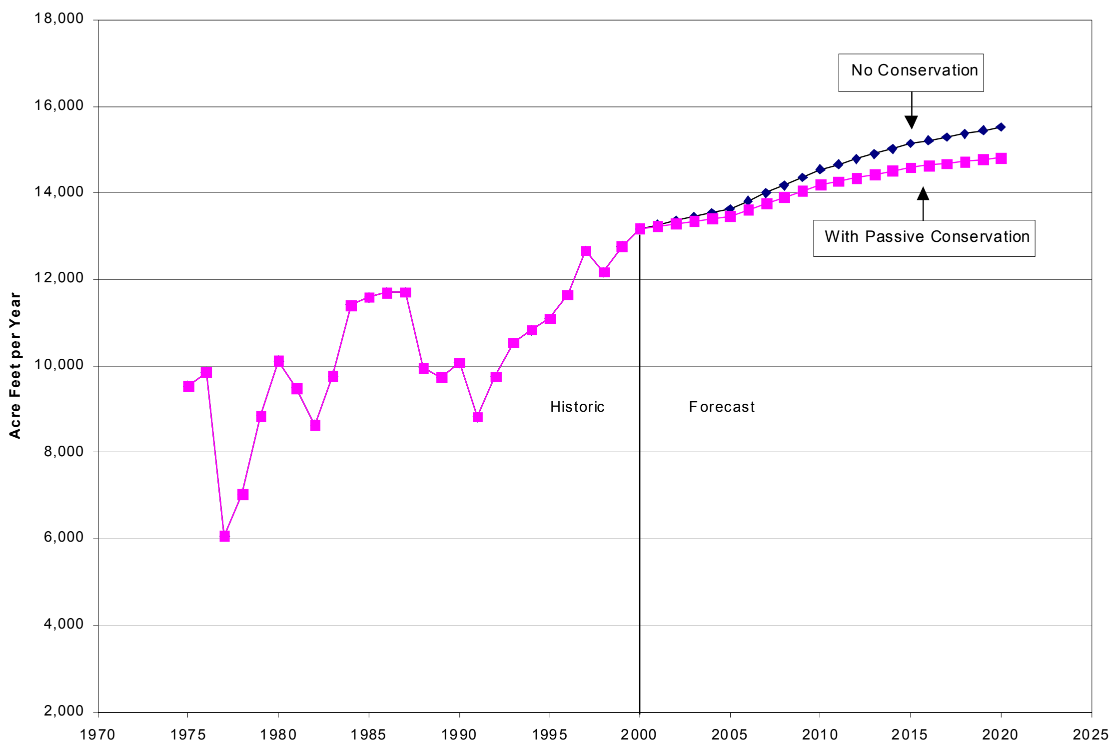
The base water use forecasts do not factor in additional water savings that could be achieved through active water conservation programs. RWC's Urban Water Management Plan addresses potential savings from water conservation "Best Management Practices" (BMPs). The forecasts generated here are used as the base case scenario for that plan.

The 0.59 rate of future growth in water use is less than that experienced by RWC in the past. From 1975 to 2000, the annual average rate of growth was 1.3 percent, largely a result of the significant growth occurring in the Redwood Shores area. RWC is now nearing build-out, with less land available for new development. However, RWC's Community Development Services Department expects significant increases in multiple-family housing via redevelopment in the downtown area and new projects east of Highway 101. From 2000 to 2020, RWC expects a 63.3 percent increase in multiple-family dwelling units. This compares with only a 1.9 percent increase in single-family units over the same period.

The water use forecasts are based on normal local weather conditions. Actual future water use will vary with abnormal temperature and rainfall, but this evaluation suggests that annual water demand only varies by +/- 2 percent because of local weather. This stability is largely a result of stability in local temperatures on an annual basis. Swings in water demand are much more impacted by perceptions of water supply drought in the Hetch Hetchy water system, such as those experienced in 1976/77 and 1991.

This evaluation also explores the issue of water use intensification. Rapid increases in real estate prices and rents can cause some water use customers to use existing space more intensively (e.g., more persons per square foot). Over 1997 to 2000, analysis shows RWC has experienced some water use intensification. However, it is difficult to predict the future trend of intensification. Hence, the forecasts generated here assume that the intensification levels experienced in 2000 will remain constant over our 20-year planning horizon.

Exhibit 2. Base Water Use Forecast



1. Objective and Approach

The objective of the research described in this report is to develop water use forecasts for the City of Redwood City (RWC) for the 20-year period 2000 to 2020. The resulting water use forecasts can assist RWC with a variety of water planning decisions/functions, including supporting the decision-making process underlying construction of water recycling facilities in the Redwood Shores area.

A variety of methods are available to forecast water use. There are pros and cons associated with each, and data availability is often an important selection determinant. Previously, RWC has used simple extrapolation methods for water use forecasting. This approach has minimal data and analytic requirements, but an extrapolation of the past is not necessarily the best predictor of the future.

Because RWC has available several key sources of information regarding future drivers of water use (e.g., housing units and employment), it is logical to make use of this information as is done via the following single variable model:

$$WATER_{s,t} = DRIVER_{s,t} * COEFFICIENT_{s,t}$$

where

$WATER_{s,t}$	= water use of sector s in time t
$DRIVER_{s,t}$	= data driver of sector s in time t
$COEFFICIENT_{s,t}$	= water use per driver coefficient of sector s in time t

In RWC's case there are seven sectors identified in the billing system as follows:

- single family residential
- multiple family residential
- commercial
- commercial Irrigation
- government
- other
- residential irrigation

As described in Section 2, the data drivers are number of housing units for the residential sectors, number of employees for the commercial sectors, and population for the other sectors. Section 3 describes the development of the coefficients that are based on historical water use correlations, as potentially adjusted for weather, water prices, and expected water conservation transformations. Once the data drivers and their associated coefficients are identified, water use forecasts over a 20-year period are developed as described in Section 4. Lastly, Section 5 describes sensitivity analyses of the water use forecasts to underlying assumptions.

2. Water Use Drivers

Data drivers for each water use sector are defined in Exhibit 3.

Exhibit 3. Water Use Drivers by Sector

Water Use Sector	Water Use Driver	Source
Single Family	Number of single family dwelling units	RWC Housing Element, 1999-2006
Multiple Family	Number of multiple family dwelling units	RWC Housing Element, 1999-2006; RWC Planning
Commercial	Number of employees	ABAG
Commercial Irrigation	Number of employees	ABAG
Government	Population	ABAG
Other	Population	ABAG
Residential Irrigation	Number of multiple family dwelling units	RWC Housing Element, 1999-2006; RWC Planning

The values of these data drivers are shown in Appendix A in 5-year increments over the forecast period. These dwelling unit, employee, and population estimates are the best current information available. They can and should be updated as expectations of future circumstances change.

For the single-family residential class, dwelling units are segmented into six categories based on the year the dwelling unit was constructed. Water use patterns are known to vary with vintage based on factors such as water fixture efficiency and size of landscape. We obtained year built by obtaining tax assessor information from San Mateo County and linking this information with the water use billing data via parcel number. We defined the categories, partly, to match the years associated with key plumbing code changes.

For the multiple-family residential class, dwelling units are segmented into three categories based on the number of dwelling units at a site. The categories include homes with 2 to 4, 5 to 25, and over 25 dwelling units. Water use patterns are known to vary with the number of units at a site based on factors relating to demographics and landscaping. We were not able to obtain year built information for each account in this sector.

3. Water Use Coefficients

The water use coefficients are based on analysis of historical water use billing records. The coefficients mirror the water use driver framework. We investigated adjusting the coefficients for weather, water prices, and water conservation technologies. The sections below describe how the coefficients are adjusted for each.

3.1 Weather

In water use forecasting, it is typical to "weather normalize" base year water use. Water use tends to increase with hot, dry weather and decrease with cool, wet weather. Hence, it is important to adjust for abnormal weather patterns in order to establish an unbiased starting point for the forecasts.

We collected monthly rain and daily maximum temperature data from the National Atmospheric and Oceanic Administration for the Redwood City weather station over the period 1948 to date. Our analysis of this data shows that weather during the calendar year 2000 was closer to normal than any other year in the series. This simplifies the weather normalization task as the 2000 water use data are already effectively weather normalized. The annual weather values for 2000 and normal are shown in Exhibit 4.

Exhibit 4. Weather for Year 2000

Description	**2000**	**Normal**
Annual Rain (inches)	19.57	20.21
Annual Average of Daily Max Temperature (ºF)	71.0	71.3

3.2 Water Prices

Changes in water prices are also known to change customers' behavioral decisions regarding water use. Following the first law in economic demand theory, as the real price of a commodity increases, the quantity demanded by consumers decreases.

A review of RWC water prices shows they have remained relatively stable over recent years after adjusting for inflation. This finding of rate stability again simplifies the analysis as there is no need to make water price adjustments to base year water use. Appendix E contains the 2002 water price schedule.

3.3 Water Conservation Technologies

Water fixtures have tended to become more water efficient over time because of improvements in water conservation technologies. In this study, we specifically account for known water using efficiencies occurring with toilets and clothes washers. These are the two largest end uses of indoor residential water use, making up about half of total use.

Toilet manufactures came out with 1.6 gallon per flush toilets, known as ultra-low flush toilets or ULFTs, in 1989. Toilets before this time used 3.5 gallon per flush or more. In January 1992, a California Plumbing Code change required all new toilets to be ULFTs. Many older, less-efficient toilets were still being sold, however, at this time. A Federal plumbing code change effective January 1994 mandated ULFTs be used in all new construction as part of the Energy Policy Act of 1992. In 1994 the older toilets were no longer manufactured on a national level and ULFT penetration has been increasing since.

Engineering changes have also improved the water and energy efficiency associated with clothes washers. Over the last five years, this efficiency has been associated with horizontal axis washers, although other high-efficiency alternatives are also evolving. A Federal code change has mandated high-efficiency clothes washer be the only product sold by 2007.

Appendix B shows the residential water use coefficients, as well as the estimated penetration rates and water savings associated with ULFTs and high-efficiency clothes washers for the residential sectors. The current penetration rates are estimated from a water conservation baseline penetration study recently completed by East Bay Municipal Water District (2001). Future penetration rates are based on expected natural rates of replacement. RWC could accelerate these replacement rates via water conservation programs and incentives. RWC is currently participating in a high-efficiency washer rebate program through the Bay Area Water Users Association. This acceleration is not factored into the base water use forecasts generated in this study. It is included in sensitivity analyses described in Section 5.

Appendix C shows estimated water savings associated with ULFT installation at commercial sites. It shows the universe of toilets installed at commercial sites within the city as of 1992, along with water savings and penetration rate assumptions.

4. Water Use Forecasts

Water use forecasts are generated for a given year by multiplying the relevant data driver by its water use coefficient. Appendix D shows the results. These forecasts should be interpreted as expected "normal" year forecasts. Weather, pricing, water-use intensification, conservation, and data driver variations can alter these expected values as discussed in the next section.

Water forecasts are developed by sector. They are comprised of sub-forecasts made for:

- existing users as of 2000
- new users after 2000, and
- water conservation occurring from natural replacement of water fixtures.

For existing users, the forecasts assume that the indoor and outdoor water use patterns experienced in 2000 will remain constant, except for the explicit accounting for water conservation occurring from natural replacement of water fixtures. For new single-family customers, the 2000 water use coefficients are used as derived from homes built between 1993-2000 as they are deemed to be the most representative of the future. For the new multiple family customers, we use the coefficients associated with sites with over 25 dwelling units; most if not all new multiple family growth is expected by the RWC Planning Department to be large-scale projects.

In calculating total system water demands, we factor in a 4% increase to reflect unaccounted for water in the distribution system; it equals the difference between the water put into the water distribution system and total billed water use. For the calendar year 2000, this mass balance accounting shows unaccounted for water use equals 4.4%. For the future years, the forecast calculation assumes unaccounted water use will be 4.0%. Having an unaccounted for factor of about 4.0% is relatively good. Comparable water systems typically experience unaccounted water from 5 to 10%.

5. Sensitivity Analysis

This section explores how variations in assumptions can impact the base case point estimates generated in Appendix D. Specifically, we looked at water use intensification and weather variation.

5.1 Water Use Intensification

Increasing residential and commercial space costs can lead to intensification of use at an existing site. Apartments, for example, can see more persons per unit as higher rent costs cause more people to live together to make the rent. Similarly, business owners are financially motivated to put more employees per square foot to manage costs.

We tested the hypothesis of intensification by comparing FY 1997/98 water use to FY 2000/01 water use. We found that water use did increase by about 8 percent on a water use per bill basis for both multiple family and commercial customers. This held true for winter as well as annual water use (weather is not likely to cause this change).

Although this evidence supports water use intensification over the 4-year period, it does not necessarily mean it will continue in the future. In fact, prices in the real estate market have decreased in recent months. Therefore, for the purposes of forecasting, we assume that the intensification levels experienced in 2000 will remain constant over our 20-year planning horizon.

5.2 Weather Variation

RWC's annual water demand only varies by about +/- 2 percent as a result of weather. This conclusion is drawn from analysis of statistical regression models of monthly water purchases as a function of weather between 1975 and 2001. Note weather can significantly impact RWC's water supplies via the Hetch Hetchy water system; shortages in supply can consequently require RWC to take actions to cut water demands (e.g., 1991). Absent supply shortages, however, RWC's annual water demand does not vary greatly because of local weather.

This lack of variability in annual water use is largely a function of the lack of variability in annual temperatures. Over the 1948 to 2001 period, about 70 percent of the time annual average temperature did not vary by more than 1ºF from its average of 70.3ºF and never had a difference greater than 3ºF. Although greater differences are experienced on a month-to-month basis, they tend to average out over the year. This stability creates stability in annual water demand. Exhibit 5 plots temperature against monthly water use over 1975 to 2001. Water use and temperature are highly correlated.

Annual rainfall, in contrast, is much more variable. However, rain tends to fall in the winter and early spring months when temperatures and irrigation demands are relatively low. Hence, rainfall variability does not tend to greatly impact annual water demands. Rainfall has a much bigger impact on water supply (Hetch Hetchy) than demand.

Our model correlating water use with weather was specified to measure the deviations in water use (as shown in Exhibit 5) from deviations in normal temperature and rainfall as follows:

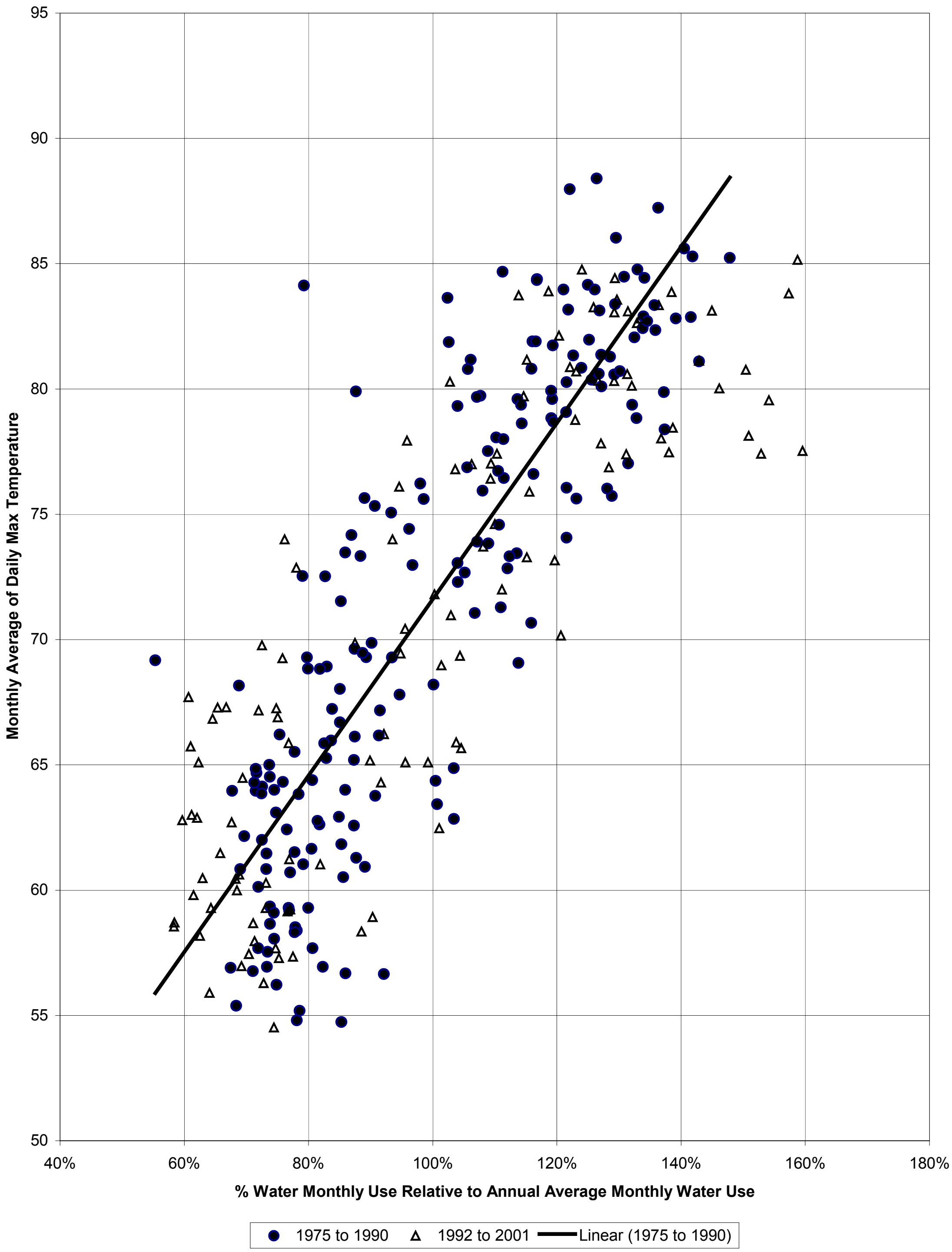
$$WATERt = \sum_{i=1}^{12} \alpha i \times MONTHi,t + \beta 1 \times TEMPDEVt + \beta 2 \times RAINDEVt$$

where,

WATERt	= ratio of water use in month t to a 12-month moving average of *WATERt*
MONTHi,t	= binary variable creating one unique α intercept for each calendar month
TEMPDEVt	= temperature deviation in month t from the average for that month (ºF)
RAINDEVt	= rainfall deviation in month t from the average for that month (inches)
$\alpha i, \beta 1, \beta 2$	= coefficients estimated using least squares regression

After estimating the model, we used actual weather data from 1949 to 2001 to simulate the maximum impacts on annual water use. From this exercise, we determine that water use can be expected to vary +/- 2 percent from weather alone on annual basis.

Exhibit 5. Water Use and Temperature



Appendix A. Water Use Drivers

Description	1950	1960	1970	1980	1990	2000	2005	2010	2015	2020
Population - Service Area						**82,088**	**85,788**	**87,638**	**90,033**	**91,558**
Population - City (1)	25,544	46,290	55,686	54,951	66,072	75,402	78,800	80,500	82,700	84,100
% Change from 2000							4.5%	6.8%	9.7%	11.5%
Population - Outside City (2)	NA	NA	NA	NA	NA	6,686	6,988	7,138	7,333	7,458
% Change from 2000							4.5%	6.8%	9.7%	11.5%
Single Family Accounts/Units - Service Area						**18,365**	**18,520**	**18,598**	**18,669**	**18,714**
% Change from 2000							0.8%	1.3%	1.7%	1.9%
Year Built										
Pre 1960						12,889	12,889	12,889	12,889	12,889
1960-69						1,414	1,414	1,414	1,414	1,414
1970-82						1,604	1,604	1,604	1,604	1,604
1983-92						1,400	1,400	1,400	1,400	1,400
1993-00						1,057	1,057	1,057	1,057	1,057
Post 2000							155	233	304	349
Post 2000 Inside City (3)							45	68	68	68
Post 2000 Outside City (4)							110	165	236	281
Multiple Dwelling Units - Service Area						**11,242**	**12,379**	**15,463**	**17,273**	**18,357**
% Change from 2000							10.1%	37.6%	53.6%	63.3%
Units per Site		% of new								
2-4 Units		0%				2,234	2,234	2,234	2,234	2,234
5-25 Units		0%				5,199	5,199	5,199	5,199	5,199
25+ Units		100%				3,810	4,947	8,031	9,840	10,925
Post 2000 (5) — Total New Dwelling Units							1,137	4,221	6,031	7,115
Development Projects: Downtown Area Plan							491	1,892	2,579	3,410
Marina Shores Village							200	1,065	1,930	1,930
Century 12 Site							0	580	580	580
Accessory Dwelling Units							50	100	150	200
50-feet Wide Duplex lots							32	66	100	134
Rolison Road Site							32	32	32	32
Brewster/Winslow							0	79	160	239
Arguello/Marshall							0	16	33	49
Middlefield Area							0	19	40	59
852-860 Walnut St.							15	5	10	15
Transit Corridors (mixed use district)							50	100	150	200
Franklin Street (Phase 1)							206	206	206	206
885 Woodside Rd. - mixed use							4	4	4	4
150 El Camino - mixed use							7	7	7	7
El Camino/Vera site							50	50	50	50
Total Dwelling Units - Service Area						**29,607**	**30,899**	**34,061**	**35,941**	**37,071**
% Change from 2000							4.4%	15.0%	21.4%	25.2%
Total Employment - City (6)					**41,720**	**52,290**	**55,630**	**56,570**	**57,940**	**59,560**
% Change from 2000							6.4%	8.2%	10.8%	13.9%

(1) Association of Bay Area Governments (ABAG)
(2) For 2000 = 2,352 SF accounts * 2.74 persons plus 93 MF units * 2.6 persons; others years = rate of population growth in RWC
(3) RWC planners estimate maximum of 68 lots available for SF development.
(4) Assumes that outside city growth of SF units is in direct proportion to RWC popluation growth.
(5) MF Dwelling unit forecasts based on projects identified by RWC Planning.
(6) Association of Bay Area Governments (ABAG)

Appendix B. Water Use Coefficients - Residential

Single Family Residential

Year Built	2000	2005	2010	2015	2020
		Forecast Year			
Gallons/Day/Account					
Pre 1960	288.8	285.1	280.8	275.6	271.8
1960-69	292.4	288.8	284.6	279.5	275.8
1970-82	312.9	309.3	305.0	300.0	296.2
1983-92	329.9	325.8	321.1	315.7	311.8
1993-00	254.5	252.7	249.8	245.8	243.1
Post 2000		248.0	246.0	242.8	240.6
ULFT Penetration Rate (1)					
Pre 1960	39%	50%	60%	67%	73%
1960-69	42%	52%	61%	68%	74%
1970-82	42%	52%	61%	68%	74%
1983-92	31%	44%	54%	63%	69%
1993-00	79%	83%	86%	89%	91%
Post 2000		100%	100%	100%	100%
Assumed natural replacement rate of toilets					4.0%
GPCD Water Savings (2)					8.9
High Efficiency Clothes Washers (1)					
Pre 1960	10%	16%	30%	52%	67%
1960-69	10%	16%	30%	52%	67%
1970-82	10%	16%	30%	52%	67%
1983-92	10%	16%	30%	52%	67%
1993-00	10%	16%	30%	52%	67%
Post 2000		20%	33%	54%	68%
Assumed natural replacement rate of washers (3)					7.1%
H-Axis washer % of new sales (4)	10%	20%	50%	100%	100%
GPCD Water Savings (5)					5.6

Multiple Family Residential

Units	2000	2005	2010	2015	2020
		Forecast Year			
Gallons/Day/Dwelling Unit					
2-4 Units	218	215	212	209	207
5-25 Units	183	180	178	175	172
25+ Units	174	173	171	169	167
ULFT Penetration Rate (1)					
2-4 Units	45%	55%	63%	70%	76%
5-25 Units	45%	55%	63%	70%	76%
25+ Units	45%	55%	63%	70%	76%
Assumed natural replacement rate of toilets					4.0%
GPCD Water Savings					8.9
High Efficiency Clothes Washers (1)					
2-4 Units	5%	13%	28%	50%	66%
5-25 Units	5%	13%	28%	50%	66%
25+ Units	5%	13%	28%	50%	66%
Assumed natural replacement rate of washers (3)					7.1%
H-Axis washer % of new sales		25%	50%	100%	100%
GPCD Water Savings (5)					5.6
% of units with clothes washers at site					50%

(1) Based on EBMUD Penetration Study 2001
(2) AWWARF Residential End-Use Study (1999)
(3) Average useful life of toilet is 14 years.
(4) Federal energy efficiency act will mandate high efficiency after 2007.
(5) Result for a 2001 study conducted in Seattle by Aquacraft.

Appendix C. Water Use Coefficients - Commercial

Subgroup	Number of 1992 Toilets (1)	% of Toilets	GPD Savings per ULFT (2)	Total GPD Savings (3)	% of Total Savings
Hotels	1,980	14%	16	31,679	9%
Eating	340	2%	47	15,984	5%
Health	1,679	12%	21	35,266	10%
Offices	4,151	29%	20	83,028	23%
Retail/ Wholesale	3,241	23%	40	129,643	37%
Other	761	5%	18	13,691	4%
Industrial	953	7%	23	21,914	6%
Churches	228	2%	28	6,385	2%
Government	323	2%	25	8,079	2%
Schools: K to 12	431	3%	18	7,760	2%
All Subgroups	14,088	100%		353,429	100%

(1) Based on 1992 U.S. Economic Census data and toilet coefficients (CUWCC, The CII/ULFT Savings Study, 2001).
(2) Based on The CII ULFT Savings Study (CUWCC, 2001). School savings of 18 gpd is assumed.
(3) Equals number of toilets multiplied by GPD savings per ULFT. Total represents potential savings if all 1992 CII toilets are retrofitted with ULFTs. Some of this potential is already realized.

Zip Codes included: 94061 94062 94063 94065

	Forecast Year				
	2000	2005	2010	2015	2020
AF per Year ULFT Incremental Water Savings					
	0	-57	-104	-142	-173
ULFT Penetration Rate					
	22%	36%	48%	58%	65%

Annual natural replacement rate: 4.0%
ULFTs exclusively on market Jan 1, 1994.

Appendix D. Water Use Forecasts

	Total Acre Feet per Year				
	Actual	Forecast Year			
Class Description	**2000**	**2005**	**2010**	**2015**	**2020**
Single Family	**6,014**	**5,983**	**5,916**	**5,830**	**5,765**
Existing Customers	6,014	6,014	6,014	6,014	6,014
New Customers		44	66	87	100
Conservation: Toilets & Washers		-75	-165	-271	-349
Multiple Family	**2,356**	**2,544**	**3,100**	**3,398**	**3,565**
Existing Customers	2,356	2,356	2,356	2,356	2,356
New Customers		222	825	1,178	1,390
Conservation: Toilets & Washers		-34	-81	-137	-182
Commercial	**2,355**	**2,404**	**2,410**	**2,441**	**2,454**
Existing Customers	2,355	2,355	2,355	2,355	2,355
New Customers		106	159	228	272
Conservation: Toilets		-57	-104	-142	-173
Commercial - Irrigation	**1,110**	**1,181**	**1,201**	**1,230**	**1,264**
Existing Customers	1,110	1,110	1,110	1,110	1,110
New Customers		71	91	120	154
Municipal - City	**20**	**20**	**21**	**21**	**22**
Existing Customers	20	20	20	20	20
New Customers		1	1	2	2
Other	**115**	**121**	**123**	**127**	**129**
Existing Customers	115	115	115	115	115
New Customers		5	8	11	13
Residential - Irrigation	**626**	**689**	**861**	**962**	**1,022**
Existing Customers	626	626	626	626	626
New Customers		63	235	336	396
Total					
Existing Customers	12,596	12,596	12,596	12,596	12,596
New Customers	0	513	1,386	1,962	2,328
New and Existing Customers	12,596	13,109	13,981	14,558	14,923
Unaccounted for Water (4.0%)	574	524	559	582	597
Total without Conservation	13,170	13,633	14,541	15,140	15,520
Passive Conservation	0	-166	-350	-550	-704
Total with Passive Conservation	13,170	13,467	14,191	14,590	14,817

Appendix D
CITY OF REDWOOD CITY
WATER RATE SCHEDULE

Effective January 1, 2002

Bi-Monthly Billing	RESIDENTIAL Water Rates		COMMERCIAL Water Rates	Redwood City (1,2,3,4,5)
Bi-Monthly Basic Service Charge	$20.88		**Commercial Monthly Service Charge**	
			5/8 "	$ 9.47
All Residential Accounts pay the same Basic Service Charge in areas 1, 2, 3, 4, 5	(Monthly $10.44)		¾ "	$ 14.21
			1 "	$ 23.68
			1 ½ "	$ 47.35
			2 "	$ 75.76
			3 "	$142.05
			4 "	$236.75
			5"	$473.50
			6"	$473.50
Residential Water Rates			8"	$473.50
0-10 Units (Lifeline)	$ .88		10"	$473.50
11-25 Units	$1.75			
11-50 Units	$2.00		**Commercial**	
11-75 Units	$2.25		**Water Rates**	
76+ Units	$2.50			
			0 -15 Units	$1.75
			0 - 75 Units	$1.80
			75+	$1.80

* Note- Emerald Lake Hills water rates in parity with all others
Sewer Rates = $19.57 per month for a single family dwelling effective January 1, 2002