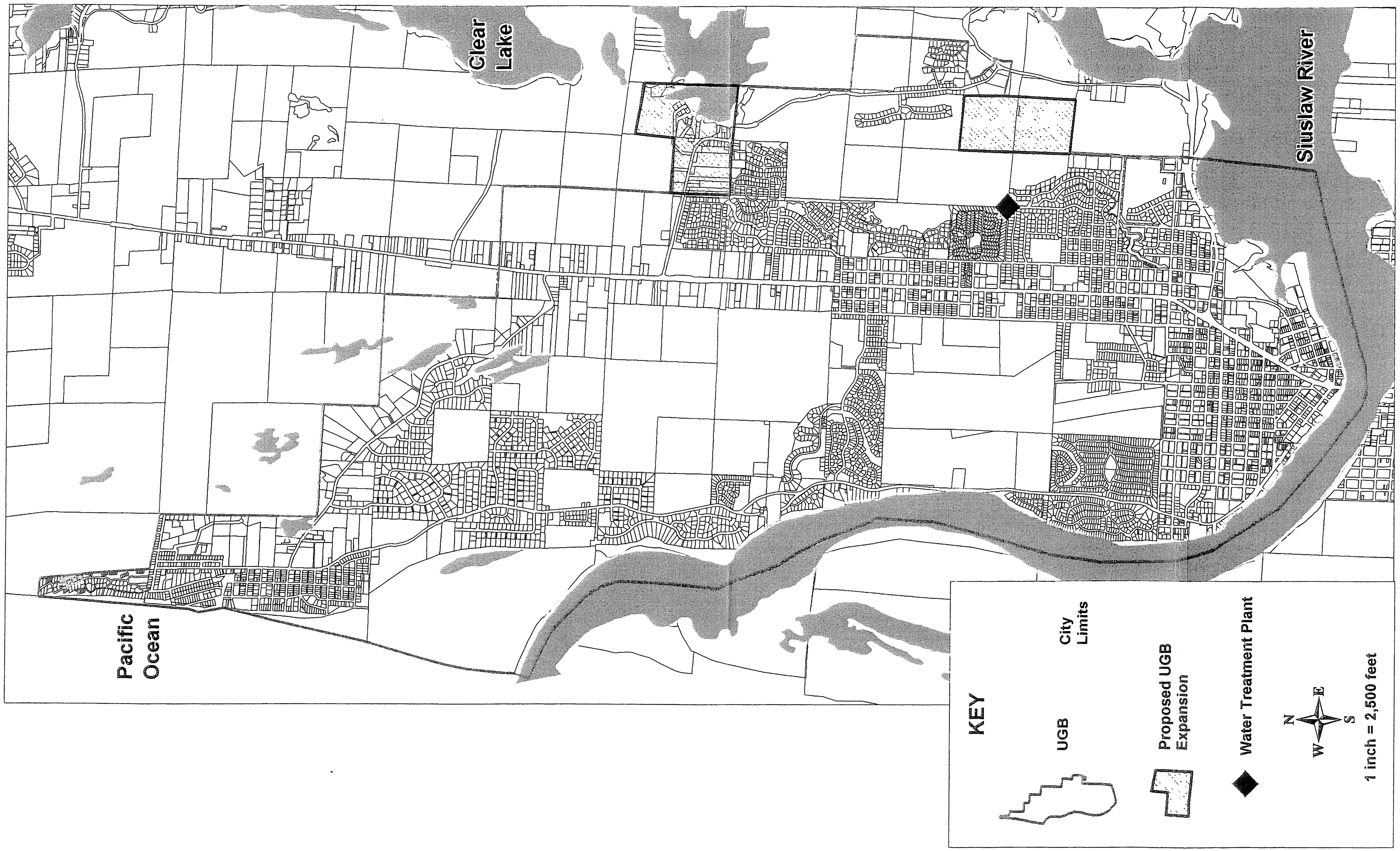

Figure 2-1. Florence Water Study Area

deposits. Location and thickness can be estimated from well drilling records. These deposits may contain soft compressible clay, organic materials, and peat. They have poor supportive properties and could cause settling of heavy structures if foundations were not designed to account for the presence of this material.

Climate

Precipitation, temperature, and other climatic factors will significantly affect both water usage and construction details of potable water facilities. Temperature, cloud cover, and the rate of evaporation highly influence peak water demand. Accumulated rainfall may raise groundwater levels in many areas, particularly in deflation plains, necessitating special foundation design for structures.

General Climatic Conditions. Florence generally has a mild marine climate. The maximum summertime temperature seldom exceeds 95 degrees F. The wintertime temperature seldom drops below 25 degrees F. Summer conditions are often foggy to sunny and cool; winter conditions include frequent heavy rain with occasional strong wind.

Precipitation. The average annual precipitation recorded at Honeyman State Park, about 3 miles south of Florence, is 72.09 inches. Essentially all of the precipitation is in the form of rain; snow rarely exceeds minor flurries. About 70 percent of the rainfall occurs in November through March.

Temperature. The mean and extreme temperatures recorded at Honeyman State Park are summarized in Table 2-1. The mean daily extremes are mild as expected in a marine environment. The absolute extremes are also fairly mild, although wintertime temperatures occasionally fall well below freezing. Freezing temperatures have been experienced in October through April. Although the subfreezing temperatures may persist long enough to freeze water in aboveground facilities, they do not last long enough to be of concern for buried facilities. The highest summertime temperature recorded during the period of record was 99 degrees F.

Other Climatic Factors. Wind speed and direction are not measured and recorded for the Florence area. The nearest coastal location with wind data is North Bend. At that location, the prevailing wind in the wintertime is southeasterly at 7 knots. Evapotranspiration data are available from an agricultural station near Bandon. However, for design of water impoundment facilities, site-specific data such as pan evaporation data should be collected.

Water Resources

Surface water resources are a key element in water resource planning. The Siuslaw River has a mean annual discharge estimated at about 2,400 cubic feet per second (cfs) with minimum flows of under 100 cfs occurring in August and September. The river is currently listed with the Environment Protection Agency as water quality limited for temperature. The river and estuary are heavily used for recreation. Fishing, boating, and other water-based activities provide valued recreation for local residents and seasonal visitors. It is reported that crab and fish are harvested near the treatment plant, and some crab beds are located within a few hundred feet of the plant. The most significant clam beds are reported to be more than one-half mule upstream.

Table 2-1. Florence Area Temperature Summary

	Means[a]			Extremes[a]		Mean number of days[b] Maximum		Minimum	
Month	Daily Max	Daily Min	Monthly	Max	Min	90 or above	32 or below	32 or below	0 or below
Jan	50.3	37.4	43.8	65	14	0	0	8	0
Feb	52.9	38.6	45.8	71	13	0	0	4	0
Mar	55.5	39.5	47.5	78	23	0	0	5	0
Apr	58.6	40.5	49.6	83	29	0	0	2	0
May	62.7	44.0	53.4	85	33	0	0	0	0
Jun	66.0	47.8	56.9	92	36	0	0	0	0
Jul	68.8	50.2	59.5	95	40	0	0	0	0
Aug	69.1	51.0	60.0	91	39	0	0	0	0
Sep	69.3	49.1	59.2	99	32	0	0	0	0
Oct	63.1	45.5	54.3	88	26	0	0	0	0
Nov	54.1	41.6	47.8	69	20	0	0	3	0
Dec	49.9	37.5	43.7	63	9	0	0	5	0
Year	60.1	43.6	51.8	99	9	0	0	27	0

Notes: [a] Temperature mean and extreme data from Honeyman State Park, 1971 through 1990. From Oregon Climate Service.

[b] "Number of days exceeded" data from NOAA Climatological Summary for Reedsport, Oregon, 1951 through 1980.

Several freshwater lakes are found within the Florence area, many of which are used for recreation. Clear Lake, one of the largest, is used as a drinking water source for the Heceta Water District, north of the city. The lake is under consideration as a potable water source for the city as well. The city currently obtains its drinking water from wells. Because the soil is highly permeable in this area, these lakes could be subject to contamination if septic tank drain fields are improperly sited or designed.

SOCIOECONOMIC ENVIRONMENT

Water treatment, distribution, and storage system demand and design capacities are determined by population, land use patterns, and economic growth within the UGB. This section presents population projections based on historical data for the city. Land use information was obtained from Lane Council of Governments (LCOG) land use and zoning maps.

Population

Population projections in this report are based on projections developed by LCOG and the city planning department in the process of updating the comprehensive plan. The comprehensive plan update is currently under development.

The Florence population projections were developed by LCOG using several approaches resulting in a range of projections. The low-end projection was based on the lowest historical growth rate experienced out of the last 5, 15, and 25 years. The lowest annual average growth rate (AAGR) occurred between 1980 and 1995. This rate was 2.3 percent and is assumed as the low-end projection.

The high-end projection is based on the most recent growth rate of Florence. The rate from 1990 to 1995 was 3.7 percent. Although the rate of 3.7 percent is not as high as the rate of 7 percent experienced during the 1970s, it is assumed as the maximum sustainable rate based on the decline of resource-based industries.

The two rates presented above (2.3 percent and 3.7 percent) are the expected minimum and maximum bounds on the AAGR for Florence over the next 20 years as determined by LCOG. The updated comprehensive plan will assume a growth rate between these bounds. City planners expect that the assumed rate will be toward the lower end of the range. For the water facilities plan we will assume a growth rate of 3.5 percent. Our selection of a relatively high rate within the planning range is based on the following observations:

- Demographics. Although population growth in Florence may be limited by the lack of resource-based industries, other factors point toward a continued strong growth rate. Growth in the nearby Eugene-Springfield area is projected to be strong. New industries (computer and electronics-based) have moved into the area reducing the dependence on timber. Growth in the Eugene area will probably result in a substantial increase in tourism in the Florence area. The attendant increases in services in Florence will make the area even more attractive to new residents. Demographics indicate that a large proportion of retired people are moving to Florence and other parts of the Oregon coast. The average age of the population in Florence has been increasing since 1960. This trend will probably continue, particularly as the age of the United States population as a whole increases. Although the increase in retirement-age population results in a lower birthrate, it also provides growth that is relatively independent of the availability of jobs. Influx of more retired people will actually create more jobs.

- Economies of scale. The marginal cost of constructing water supply and treatment facilities with a slightly higher capacity is relatively small. Constructing a unit process with a slightly larger capacity generally does not cost as much per unit capacity. Also, there are many project-wide fixed costs including design, mobilization, and construction management, which are not heavily affected by small changes in system size.
- Uncertainties in projections. Because there are many uncertainties in municipal planning, it is generally advantageous to take a conservative approach in sizing facilities. If the facilities are oversized, they will be adequate for a longer period than the 20-year planning horizon. If they are undersized, capacity problems could develop in the near future.

To determine the design population, the assumed AAGR of 3.5 percent is applied to the current population over the 20-year design period. Also, the service population, which currently includes only residents within the city limits, will expand to include the entire UGB. According to the Center for Population And Census at Portland State University, the 1995 populations for the city and the UGB were 6,185 and 7,590, respectively. The projected populations for each year of the design period are calculated based on these populations and the assumed AAGR of 3.5 percent. These populations are summarized in Table 2-2.

Table 2-2. Florence City and UGB Population Projections

	Population	
Year	City	UGB
1995	6,185	7,590
1996	6,401	7,856
2000	7,346	9,015
2005	8,725	10,706
2010	10,362	12,716
2015	12,307	15,102
2020	14,617	17,937

Note: Shaded area represents actual data from the Center for Population And Census. Unshaded area represents extrapolations based on 3.5 percent AAGR.

The current service population is assumed as 6,401, the estimated city population in the year 1996. The design service population is calculated as 17,937, the estimated entire UGB population for the design year 2020. The service population increase over the design period is 280 percent, or a factor of 2.8.

Land Use

Land use within the Florence UGB is largely determined through the city's comprehensive plan and zoning. Historical development patterns in many cases have simply been reflected by these efforts. For this study, the city's 1988 Comprehensive Plan land use plan categories can be used to reflect general land use distribution throughout the UGB. These categories include residential, commercial, highway area, waterfront, industrial, marine, open space, and public. Figure 2-2 presents the city's current land use plan. The corresponding plan categories reflect the recommended use of those lands, even though the current use may be quite different. For example, residential use of commercially planned land occurs in many instances. For facility planning purposes, the planned use governs the assumptions made in this report. Table 2-3 summarizes the current land use.

Table 2-3. Summary of Current Land Use Areas

Description	Total area, acres	Resid.	Comm.	Indust.	Util/ transp.	Gov't/ schools	Open space
City	3,508	913	125	0	1,012	511	947
Outside city	1,945	700	10	0	291	146	798
Total UGB	5,453	1,613	135	0	1,303	657	1,745

The city is in the process of updating this land use plan (Periodic Review) and may change some of the land use recommendations presented in Figure 2-2. Details are presented in the city's urban growth boundary amendment reports. The significant anticipated changes are discussed below. One area of potential land use change includes about 60 acres near the intersection of Munsel Lake Road and Highway 101 in north Florence. This area is planned and zoned mostly for commercial use, but is being considered for large-scale, regional commercial uses with a planned commercial activity node. This would change the use expectations from small-scale light and heavy commercial uses to large retail and supporting commercial uses such as a hotel and full-service restaurants. Another land use change is anticipated along 9th Street west of Kingwood Street. This area is experiencing professional office and institutional development rather than the planned residential development. The city expects to continue this transition to professional office space, while still encouraging higher density residential uses on the periphery.

Two 80-acre areas are being considered as part of an expanded UGB, as shown on Figure 2-1. One area lies on the southeastern edge of Florence. Currently, the Ocean Dunes Golf Course lies partially within the city and UGB, and partially outside. The Ocean Dunes residential planned unit development lies within city limits, and the golf course developer proposes to expand the UGB to bring the entire Ocean Dunes Golf Course into the UGB, and ultimately city limits. This will increase the residential yield opportunities through the availability of public sewer to this area.

The second area lies on the northeastern edge of Florence, near Munsel Lake. Suburban densities have already been established through property dividing in this area. Including this area in the UGB, and perhaps ultimately within the city, would permit the extension of sanitary sewer service along Munsel Lake Road.

BASIS OF PLANNING

In this section, guidelines for water system performance will be developed. While local and federal regulations establish minimum standards, a community may elect to operate a safer or more conservatively designed system. These guidelines will be used to size improvements. Typical unit costs for some basic water system elements are provided to permit relative cost comparisons for alternatives.

WATER SYSTEM STANDARDS

The function of a water system is to deliver water in adequate quantity and quality at an acceptable pressure from the source of supply to the customers. The water supply system should be capable of meeting all demands without reducing pressure below acceptable limits. This section of the report establishes standards for the level of service to be provided by the water system. These standards are based upon industry standards, operator preference, as well as regulatory requirements.

WATER SYSTEM DEMAND

Annual average per capita demand	188 gpcd
Peak month to annual average peaking factor	1.44
Peak day to annual average peaking factor	1.75
Peak hour to annual average peaking factor	3.50
Fire flow, Q, gpm as a function of population P, thousands	$Q=1020(P)^{1/2}(1-0.01(P)^{1/2})$
Fire flow duration, hours	15
Fire reserve volume, V, mg	$V=(15/24)Q$

Maximum system flow is peak hour or peak day plus fire flow, whichever is greater.

Assume system losses are 10 percent of the total demand

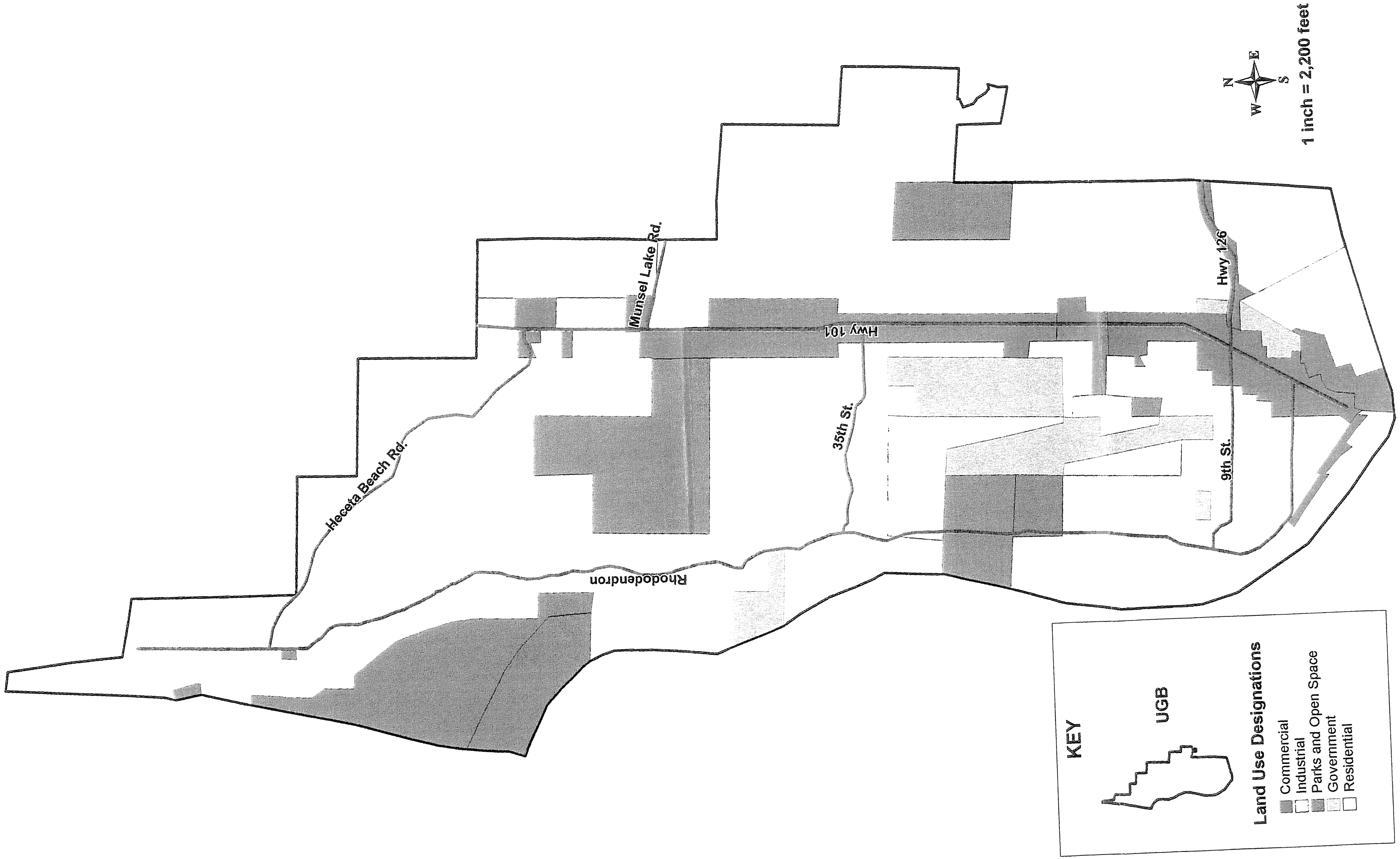

Figure 2-2. Zoning Map of Florence

WATER SYSTEM FACILITIES

Minimum water system pressure at the customers tap during a fire	20 psig
Minimum water system pressure in the water mains	30 psig
Maximum water system pressure	100 psig
Minimum distribution system chlorine residual	0.3 mg/L
Ideal water distribution system velocity	5 to 7 feet per second

Water supply must be capable of meeting peak day demand with 10 percent of the supply capacity out of service.

Peak hourly flow is provided by use of water in storage.

Minimum storage requirement is based on three days of annual average demand plus fire reserve volume.

Users with demands greater than 500 gpm must provide their own storage to meet instantaneous demands.

Require water meters on all connections and annual meter maintenance and calibration.

Practice water conservation and demand management.

WATER SYSTEM UNIT COSTS

To develop viable alternatives, it is necessary to have a basic understanding of the relative costs of water treatment, storage, and distribution systems. The following units costs are order of magnitude only and will be refined during the alternative cost evaluation phase.

Water Supply	200 foot screened well, flow monitoring pump and piping, approximately 200 gpm (0.3 mgd)	$100,000
	Green sand iron removal system with piping and controls, 700 gpm (1.0 mgd)	$1,900,000
Water treatment	Direct pressure filtration with piping and controls, 700 gpm (1.0 mgd)	$1,800,000
Water storage	Ground level concrete reservoir, 2 million gallons or larger, including piping and site work	$ 260,000 per million gallons
Water Distribution	12-inch-diameter water main with valving and site restoration, C900 or ductile iron pipe	$60 per linear foot

CURRENT AND FUTURE WATER REQUIREMENTS

To determine future water demands, it is important to first analyze current water use patterns. Annual average water consumption is evaluated as well as seasonal, daily and hourly variations. Peaking factors are then calculated which can be applied to future usage to predict water usage throughout the planning period.

PEAKING FACTORS

Water usage is characterized on the basis of demand during both average and peak conditions. Four conditions are typically evaluated:

Average Annual Flow	Total annual water use divided by 365. (Flow is typically reported in million gallons per day.)
Maximum Month Flow	Total monthly use divided by the number of days in the month.
Maximum Day Flow	Total daily use for the peak day of the year.
Maximum Hourly Flow	Total hourly use during the hour of maximum consumption.

CURRENT WATER USAGE

Planning for adequate supplies to meet future needs requires analysis of prior water use records. Florence's monthly water use over the past 5 years is provided in Table 2-4. Figure 2-3 is a graphical representation of the same data for 1992 through 1996. The average daily per capita usage is 182 gallons per person per day which compares well with prior studies. It should be noted that the uses shown for 1995 are abnormally high. This may be attributable to an unseasonably hot summer and a major distribution system break.

Table 2-5 shows the average annual, monthly, and maximum day flows for the period for 1992 to 1996. Comparing the maximum monthly flow and the peak day flow to the annual average flow yields peaking factors of 1.44 and 1.75 respectively. Maximum hour peaking factors are not available as Heceta monitors the amount of water sold to Florence on a monthly basis. A peak hour to average annual flow peaking factor of 3.50 was selected. This is the same peaking factor used in the 1992 Water Facilities Plan and is typical for many municipalities.

This data includes all water produced at the Florence wellfield facility and the water sold to the city by Heceta. The flow summary is developed by reading master meters at the Florence wellfield and at the point of the Heceta intertie. Included in this flow is all nonmetered uses such as distribution system leakage, washdown at municipal facilities, fire suppression, sewer or water main flushing, and unauthorized connections.

Figure 2-3. Monthly Average Water Use (1992-96)

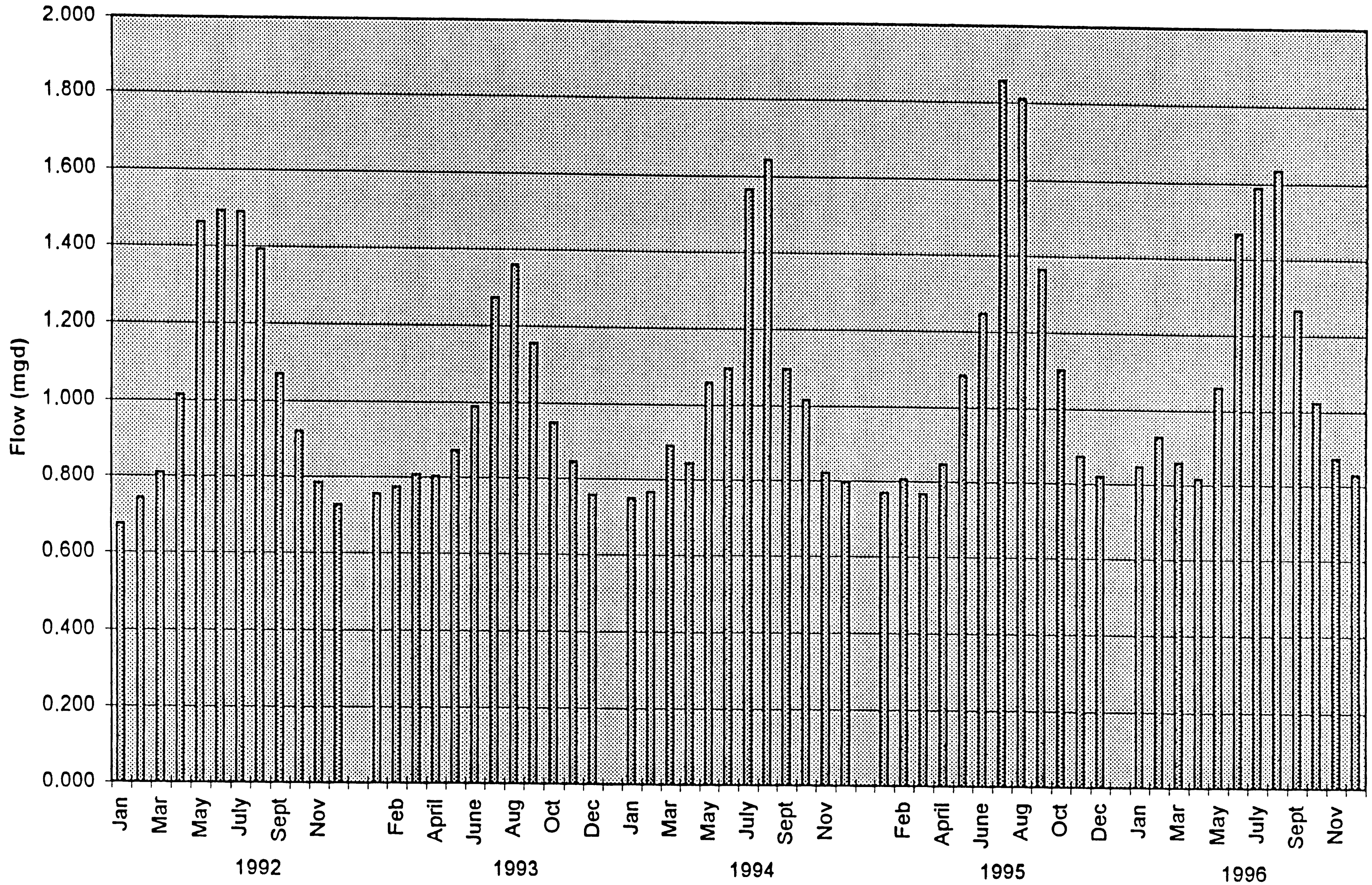

Table 2-4. City of Florence Monthly Average Water Demands (1992-1996) (Million Gallons per Day)

Year	Month	City of Florence Production	From Heceta	Total Consumption by Florence
1992	Jan	0.628	0.045	0.673
	Feb	0.663	0.079	0.742
	Mar	0.723	0.086	0.809
	April	0.737	0.278	1.015
	May	0.948	0.515	1.463
	June	0.786	0.707	1.493
	July	0.908	0.582	1.490
	Aug	0.850	0.541	1.392
	Sept	0.728	0.343	1.071
	Oct	0.796	0.125	0.921
	Nov	0.729	0.056	0.785
	Dec	0.670	0.056	0.726
1993	Jan	0.685	0.070	0.755
	Feb	0.701	0.072	0.774
	Mar	0.742	0.065	0.807
	April	0.740	0.062	0.802
	May	0.800	0.074	0.874
	June	0.828	0.162	0.989
	July	0.820	0.452	1.272
	Aug	0.737	0.622	1.358
	Sept	0.656	0.501	1.157
	Oct	0.673	0.276	0.949
	Nov	0.670	0.175	0.846
	Dec	0.676	0.080	0.756
1994	Jan	0.679	0.069	0.748
	Feb	0.696	0.070	0.766
	Mar	0.660	0.233	0.893
	April	0.689	0.156	0.845
	May	0.597	0.461	1.058
	June	0.453	0.644	1.097
	July	0.753	0.813	1.566
	Aug	0.726	0.917	1.643
	Sept	ND	0.477	0.477
	Oct	0.712	0.304	1.016
	Nov	0.741	0.081	0.822
	Dec	0.719	0.077	0.796
1995	Jan	0.649	0.010	0.027
	Feb	0.701	0.127	0.805
	Mar	0.721	0.070	0.766
	April	0.760	0.088	0.847
	May	0.940	0.144	1.084
	June	1.073	0.176	1.248
	July	1.527	0.327	1.854
	Aug	1.389	0.420	1.809
	Sept	1.236	0.129	1.366
	Oct	1.102	0.0003	1.103
	Nov	0.875	0.0003	0.875
	Dec	0.819	ND	0.819

Year	Month	City of Florence Production	From Heceta	Total Consumption by Florence
1996	Jan	0.848	ND	0.848
	Feb	0.928	ND	0.928
	Mar	0.860	ND	0.860
	April	0.815	ND	0.815
	May	1.060	ND	1.060
	June	1.292	0.1744	1.467
	July	1.235	0.3539	1.588
	Aug	1.212	0.4215	1.633
	Sept	1.068	0.1984	1.267
	Oct	0.949	0.0732	1.023
	Nov	0.836	0.0379	0.874
	Dec	0.616	0.2121	0.828

ND = No flow data was indicated for the month

Table 2-5. City of Florence 1992-1996 Annual Average Water Demands

Year	Service Population	Flow (mgd)	Per Capita Flow (gpcd)	Peak Month Flow (mgd)	Peaking Factor[a]	Peak Day Flow (mgd)	Peaking Factor[a]	Minimum Day Flow (mgd)	Peaking Factor
1992	5,475	1.050	192	1.490	1.42	1.985	1.89	0.348	0.33
1993	5,705	0.946	166	1.358	1.44	1.829	1.93	0.540	0.57
1994	6,005	0.981	163	1.643	1.68	1.755	1.79	0.591	0.60
1995	6,185	1.535	248	1.854	1.21	2.236	1.46	0.139	0.09
1996	6,400	1.101	172	1.633	1.48	1.834	1.67	0.084	0.08
Average			188		1.44		1.75		

Notes:

[a]Peaking factors are the ratio of the maximum monthly flow to average annual flow, the ratio of maximum day to average annual flow, and the ratio of the minimum day to average annual flow.

Unmetered water use accounted for 15.1 percent of all water produced from 1988 to 1990. It is expected that this percentage may be slightly reduced in the future as leaks are repaired and higher quality home service connections are installed. Unmetered water usage is included in the following projections for future water demands.

FUTURE WATER DEMANDS

Using the population projections developed earlier and applying the demand factors shown above, future water use projections can be developed. Table 2-6 shows the projected average annual flow, maximum month flow, and maximum day flow for the entire planning period. The maximum month and maximum day usage for the year 2020 are projected to be 4.86 and 7.0 respectively. When buildout of the entire study area occurs, the approximate maximum month and maximum day usage will be 9.88 and 14.23 respectively.

Table 2-6. City of Florence Projected Water Demands (1997-2020)

Year	Service Population[1]	Avg Annual Flow, mgd[2]	Max Month Flow, mgd	Max Day Flow, mgd[3]	Max Hourly Flow, mgd	Fire Flow, mgd[4]
	Peaking Factor[5]	- →	1.44	1.75	3.50	-
1997	8,131	1.53	2.20	3.54	5.35	1.39
1998	8,415	1.58	2.28	3.65	5.54	1.40
1999	8,710	1.64	2.36	3.75	5.73	1.42
2000	9,015	1.69	2.44	3.86	5.93	1.43
2001	9,330	1.75	2.53	3.97	6.14	1.45
2002	9,657	1.82	2.61	4.09	6.35	1.46
2003	9,995	1.88	2.71	4.21	6.58	1.48
2004	10,344	1.94	2.80	4.33	6.81	1.49
2005	10,706	2.01	2.90	4.46	7.04	1.51
2006	11,081	2.08	3.00	4.60	7.29	1.52
2007	11,469	2.16	3.10	4.73	7.55	1.54
2008	11,870	2.23	3.21	4.88	7.81	1.55
2009	12,286	2.31	3.33	5.02	8.08	1.57
2010	12,716	2.39	3.44	5.17	8.37	1.59
2011	13,161	2.47	3.56	5.33	8.66	1.60
2012	13,622	2.56	3.69	5.49	8.96	1.62
2013	14,098	2.65	3.82	5.66	9.28	1.64
2014	14,592	2.74	3.95	5.84	9.60	1.66
2015	15,102	2.84	4.09	6.01	9.94	1.67
2016	15,631	2.94	4.23	6.20	10.29	1.69
2017	16,178	3.04	4.38	6.39	10.65	1.71
2018	16,744	3.15	4.53	6.59	11.02	1.73
2019	17,330	3.26	4.69	6.79	11.40	1.75
2020	17,937	3.37	4.86	7.01	11.80	1.77

Notes:

1. Service population includes population in both City of Florence and the Florence Urban Growth Boundary.
2. Average annual flow is calculated based on the per capita flow estimated from data for 1992 to 1996 and the projected service population.
3. Maximum day flow includes fire flow for a duration of 15 hours.
4. The instantaneous fire flow is estimated assuming 20% commercial and 80% residential use, where the fire flow for commercial buildings equals 1020*P0.5*(1-0.01*P0.5) with P = population in thousands, and the fire flow for residential buildings equals 500 gpm (Reference: Elements of Water Supply and Wastewater Disposal, 2nd Edition, 1971.)
5. Peaking factors are based on flow data from 1992 to 1996, except for the peak hourly flow peaking factor, which is estimated by averaging the peak hourly flow peaking factors determined for other similar cities along the Oregon coast ("Water Supply Plan Update 1992" by HGE, Inc.).

1. U.S.D.A. Soil Conservation Service. *Soil Survey of Lane County Area, Oregon.* 1987.

2. Schlicker, Herbert G., et al. Environmental Geology of Coastal Lane County, Oregon. 1974.

CHAPTER 3

REGULATORY STANDARDS

Oregon State drinking water requirements are established in Oregon Administrative Rules (OAR) 333-061 Public Water Systems. The OARs are administered by the Oregon Department of Human Resources Division of Health (Division). These rules are based upon the original Environmental Protection Agency (EPA) Safe Drinking Water Act (Act) enacted in 1986 and subsequently revised. The last major revision to the Act was in 1996. In this chapter, the maximum contaminant levels and treatment standards are first summarized for both surface water and groundwater systems. The impact of these regulatory requirements upon future water sources and treatment are discussed next. Finally, process options allowed under current regulations are identified.

RESPONSIBILITIES OF WATER SUPPLIERS [OAR 333-061-0025]

This section defines the requirements for Florence and the Heceta Water District as purveyors of drinking water. Requirements for sampling, reporting, recordkeeping, complaint investigation, and operator training are explained.

MAXIMUM CONTAMINANT LEVELS AND ACTION LEVELS [OAR 333-061-0030]

Maximum contaminant levels (MCLs) have been established for inorganic, organic, and volatile organic contaminates as shown in Tables 3-1, 3-2, and 3-3.

Table 3-1. Inorganic Maximum Contaminant Levels

Contaminant	MCL mg/L	Action Level (mg/L)
Antimony	0.006	
Arsenic	0.05	
Asbestos	7 MFL*	
Barium	2	
Beryllium	0.004	
Cadmium	0.005	
Chromium	0.1	
Copper		1.3
Cyanide	0.2	
Fluoride	4.0	
Lead		0.015
Mercury	0.002	
Nickel	MCL being reevaluated by EPA	
Nitrate (as N)	10	
Nitrite (as N)	1	
Total Nitrate + Nitrite (as N)	10	
Selenium	0.05	
Thallium	0.002	

*MFL = million fibers per liter > 10 um

Table 3-2. Organic Maximum Contaminant Levels

Contaminant	MCL, mg/L
Alachlor	0.002
Atrazine	0.003
Benzo(a)pyrene	0.0002
Carbofuran	0.04
Chlordane	0.002
Dalapon	0.2
Dibromochloropropane	0.0002
Dinoseb	0.007
Dioxin (2, 3, 7, 8-TCDD)	0.00000003
Diquat	0.02
Di (2-ethylhexyl) adipate	0.4
Di(2-ethylhexyl)phthalate	0.006
Endothall	0.1
Endrin	0.002
Ethylene Dibromide	0.00005
Glyphosate	0.7
Heptachlor	0.0004
Heptachor epoxide	0.0002
Hexachlorobenzene	0.001
Hexachlorocyclopentadiene	0.05
Lindane	0.0002
Methoxychlor	0.04
Oxamyl (Vydate)	0.2
Picloram	0.5
Polychlorinated Biphenyls	0.0005
Pentachlorophenol	0.001
Simazine	0.004
Toxaphene	0.003
2,4-D	0.07
2,4,5-TP Silvex	0.05

Table 3-3. Volatile Organic Chemical Maximum Contaminate Levels

Contaminant	MCL, mg/L
Benzene	0.005
Carbon tetrachloride	0.005
Cis-1,2-Dichloroethylene	0.07
Dichloromethane	0.005
Ethylbenzene	0.7
Monochlorobenzene	0.1
0-Dichlorobenzene	0.6
P-Dichlorobenzene	0.075
Styrene	0.1
Tetrachloroethylene (PCE)	0.005
Toluene	1.
Trans-1,2-Dichloroethylene	0.1
Trichloroethylene (TCE)	0.005
Vinyl chloride	0.002
Xylenes (total)	10.
1,1-Dichloroethylene	0.007
1,1,1-Trichloroethane	0.2
1,1,2-Trichloroethane	0.005
1,2-Dichloroethane	0.005
1,2-Dichloropropane	0.005
1,2,4-Trichlorobenzene	0.07

TURBIDITY

The maximum contaminant levels for turbidity for all nonfiltered public water systems using surface water sources or groundwater sources under the direct influence of surface water is 5 NTU unless a specific variance has been granted by the Division.

Water supplies from systems employing conventional filtration treatment must be less than 0.5 NTU for at least 95 percent of all monthly samples and may exceed 1 NTU in no more than 5 percent of monthly samples.

For water systems using slow sand filtration and diatomaceous earth, the turbidity level must be less than 1 NTU in at least 95 percent of the samples taken each month and at no time shall the turbidity exceed 5 NTU.

Systems using other filtration technologies must meet the same turbidity limits as slow sand filtration and diatomaceous earth.

MAXIMUM MICROBIOLOGICAL CONTAMINANT LEVELS

Microbiological contaminant levels are based upon the presence or absence of total coliforms in a sample. For a system which is required to collect 40 or more samples per month, total coliform positive samples shall not exceed 5.0 percent of the samples collected each month. For systems that collect fewer than 40 samples per month, no more than one positive sample is allowed each month.

In the event of a positive sample, the water purveyor must immediately conduct a repeat sampling. If any repeat sampling tests positive for fecal, E. coli or total coliform, these samples constitute a violation and public notification is required.

SECONDARY CONTAMINANT LEVELS

A number of secondary contaminants could adversely affect water quality. Maximum limits for these contaminants are shown in Table 3-4.

Table 3-4. Secondary Contaminant Maximum Levels

Secondary Contaminant	Level, mg/L
Color	15 color units
Corrosivity	Non-corrosive
Foaming agents	0.5
pH	6.5-8.5
Hardness (as $CaCO_3$)	250
Odor	3 threshold odor number
Total dissolved solids (TDS)	500
Aluminum	0.05-0.2
Chloride	250
Copper	1
Fluoride[a,b]	2.0
Iron	0.3
Manganese	0.05
Silver	0.1
Sulfate	250
Zinc	5

[a] Violations of secondary contaminant levels for fluoride require a special public notice. Refer to OAR 333-061-0042(6).

[b] Violations of maximum contaminant levels for fluoride (4.0 mg/L) require public notification as specified in OAR 333-061-0042.

TREATMENT REQUIREMENTS AND PERFORMANCE STANDARDS FOR SURFACE WATER, GROUNDWATER UNDER SURFACE WATER INFLUENCE, AND GROUNDWATER [OAR 333-061-0032]

Beginning January 1, 1992, all surface water systems and groundwater systems under the influence of surface water had to meet a requirement of at least 99.9 percent (3-log) removal and/or inactivation of Giardia lamblia cysts and a 99.99 percent (4-log) removal and/or deactivation of viruses.

The OARs makes a major distinction between filtered and nonfiltered treatment systems.

NONFILTERED SYSTEMS

Systems which do not utilize filtration must also meet a number of special requirements including the following:

1. Source water quality must have fecal coliform levels less than or equal to 20/100 mL or total coliform levels less than or equal to 100/100 mL in at least 90 percent of the measurements over 6 months.
2. Turbidity levels cannot exceed 5 NTU without a variance from the Division.
3. Consistently meet disinfection requirements.
4. Maintain a comprehensive watershed control program which minimizes potential contamination from Giardia and viruses in the source water. The public water system needs to show through ownership or written agreements with landowners within the watershed that it "can control all human activities which may have an adverse impact on the microbiological quality of the source water." The water system needs to submit an annual report to the Division indicating current and future problems and solutions regarding source water quality. The watershed control program must:

   a) Characterize the watershed hydrology and land ownership.

   b) Identify watershed characteristics and activities which might have an adverse effect on water quality.

   c) Monitor occurrences of activities which might have an adverse effect on water quality.

   The water system is also subject to annual inspections of the watershed program. Any water system which does not consistently meet the requirements for a nonfiltered system will be deemed in violation and the Division can require filtration to be installed.

5. Each day a system serves water to a public system, the operator must evaluate the combined chlorine residual and contact time and determine if the values are sufficient to achieve the specified inactivation rates. The disinfection must have redundant components including auxiliary power. In addition, the system must have an automatic shutoff which activates whenever there is less than 0.2 mg/L residual disinfectant in the water. A residual disinfectant concentration cannot be less than 0.2 mg/L for more than 4 hours.

FILTERED SYSTEMS

Water systems using filtration technology are subject to fewer regulations. Approved filtration technology includes:

1. Conventional filtration or direct filtration.
2. Slow sand filtration.
3. Diatomaceous earth filtration.
4. Other filtration technologies that can meet the required turbidity limits.

Disinfection systems for filtered systems must provide a disinfectant residual that cannot fall below 0.2 mg/L for more than 4 hours. Filtered systems must meet the same disinfection requirements as unfiltered systems. A disinfectant residual must be detectable in at least 95 percent of all samples.

GROUNDWATER SYSTEMS

Systems using a groundwater source must provide continuous disinfection where there are consistent violations of the total coliform rule for source quality and when a potential health hazard exists as determined by the Division.

TREATMENT REQUIREMENTS AND PERFORMANCE STANDARDS FOR CORROSION CONTROL [OAR 333-061-0034]

Corrosion control is mandated by the Division to minimize the potential for the release of harmful metals into a public water supply. Medium-sized water systems (serving 3,301 to 50,000 persons) were to conduct initial sampling by July 1, 1992, to determine if corrosion control is necessary. A water system that exceeded the lead or copper action level was required to implement optimal corrosion control. A water system that exceeds the lead or copper action levels must also provide public notice through a public education program.

The Division can require a corrosion control study to evaluate the effectiveness of treatment methods such as:

- Alkalinity and pH adjustment
- Calcium hardness adjustment
- Phosphate or silicate based corrosion inhibitor addition

Source water evaluations shall also be conducted and treatment applied as required. This treatment may include ion exchange, reverse osmosis, lime softening, or coagulation/filtration.

VOLUNTARY WELLHEAD PROTECTION PROGRAM

Protection of Oregon's groundwater resources is the primary goal of the Oregon Wellhead Protection Program. Established under the original EPA Safe Drinking Water Act, this program is jointly administered by the Department of Environmental Quality and the Health Division.

Under this voluntary program, a community identifies the recharge area for its ground water supplies, determines the potential sources of contamination and makes decisions regarding how the groundwater resource will be managed. The DEQ is responsible for the inventory of possible contaminant sources and the Division takes the lead in approving the delineating of the capture zone of the wellfield. The zone of capture is calculated for time periods of 2, 5, and 10 years.

Depending upon the size of the community, the program can be simple desktop evaluation for small communities or may require ground water modeling for larger communities. So far, no community has a fully certified wellhead protection program. Junction City, Coburg, Springfield, Boardman, Medford, and Klamath Falls all have programs under development.

A community can receive the following benefits from a certified wellhead protection program:

1. Reduced regular sampling will be allowed by the Division. Both VOC and SOC sampling can be reduced by 50 percent with an approved.
2. Funding availability may be enhanced by having an approved program. In the future, the State Revolving Fund program and the Oregon Economic Development Department may require wellhead protection programs to qualify for funding.
3. As a planning tool, a program can assist in making decisions regarding locating new developments or facilities in the water service area. Invariably, the potential effects to groundwater are questioned in the public hearing processes.

Given the potentially rapid recharge and the highly transmissive sands in the study area, a wellhead protection program is recommended for Florence's existing wellfield and any future wellfields. These programs can be developed simultaneously so the site specific data can be used for both wellfields. Once a site for a new wellfield is established, preliminary design will include pump testing to evaluate the aquifer. Results of these pump tests will provide valuable input into a delineation model.

Limited funding may be available from the Division by the end of 1997 for program development efforts. Such funding can be reimbursed to the city if the programs are developed prior to the end of the year.

FUTURE REGULATORY IMPACTS

The 1996 revisions to the Safe Drinking Water Act will strongly influence the operation of both existing and future water treatment and distribution systems in Oregon. The Division recently summarized the following changes:

1. Existing standards and rules are unchanged. Monitoring frequencies for some regulated contaminants may be reduced.
2. Future standards are expected to focus on high priority contaminants such as microbial contaminants. The expected schedule for these new regulations are:
   - November 1998 - Stage 1 of Disinfectants and Disinfection By-Products Rule
   - November 2000 - Enhanced Surface Water Treatment Rule

- August 2000 - Radon Rule
- January 2001 - Arsenic Rule
- Prior to May 2002 - Groundwater Disinfection Rule
- May 2002 - Stage 2, D-DBP Rule
- February 2005 - Sulfate Regulations

3. Over the next 6 to 12 months, new and expanded programs will be promulgated by the EPA which include:

   - A state revolving fund (SRF) program for water system construction much like the wastewater SRF program.
   - Notification and consumer confidence reports.
   - Compliance capacity development programs.
   - Assistance programs source water assessment and protection.
   - Monitoring relief linked to source water protection.
   - Operator certification for all community and non-community systems.
   - Technical assistance for small systems.

4. The 1996 revisions are also expected to include significant funding provisions. Nineteen million dollars per year is expected through the year 2003. This money is earmarked for water system construction and implementation of new and existing regulatory programs.

IMPACT OF REGULATIONS

Current and future regulations will highly influence both the near term and long term planning decisions by Florence. Requirements for maximum contaminant levels, turbidity, disinfection, sampling, operations, and monitoring will influence selection of appropriate technology. At present, the city effectively addresses all the maximum contaminant level requirements. In particular, the secondary contaminant limit for iron at 0.3 mg/L will continue to be a major factor when evaluating treatment options.

The current requirements for unfiltered surface water systems apparently will preclude using Clear Lake as a surface water source without filtration. When the Division was asked to interrupt the surface water rule, they referred us to a letter to Heceta Water District dated January 9, 1992, which states filtration will be required. This issue will be discussed in detail later in this facilities plan. The upcoming enhanced surface water treatment rules will likely reduce allowable turbidity from 0.5 NTU to 0.1 NTU. More stringent operational control of such process streams as backwash flows are also expected under the enhanced rules.

The Stage 1 Disinfection By-Product Rules will go into effect by 1998 and add testing requirements for Total Trihalomethanes and Haloacetic Acids. Stage 1 limits will be 80 micrograms per liter and 60 micrograms per liter respectively. It is expected these limits will be reduced to 40 micrograms per liter and 30 micrograms per liter respectively when Stage 2 goes into effect.

PROCESS OPTIONS

A wide range of treatment alternatives will be evaluated during the course of this master planning effort. For ground water, the treatment technologies considered will be determined by the amount of iron or other constituents detected in the water. To treat elevated iron, the current green sand technology will be evaluated. Groundwater that is free from iron or other impurities may be simply disinfected. Disinfection by either chlorine gas or hypochlorite (both vendor-supplied and on-site generated) may be viable options.

For surface water supplies, the Division will permit the city to consider the following treatment options:

- Conventional treatment using flocculation, adsorption, and filtration steps
- Direct pressure filtration
- Slow sand filtration
- Diatomaceous earth
- Millipore filtration such as reverse osmosis

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Beginning January 1, 1992, all surface water systems and groundwater systems under the influence of surface water had to meet a requirement of at least 99.9 percent (3-log) removal and/or inactivation of Giardia lamblia cysts and a 99.99 percent (4-log) removal and/or deactivation of viruses.

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1. Source water quality must have fecal coliform levels less than or equal to 20/100 mL or total coliform levels less than or equal to 100/100 mL in at least 90 percent of the measurements over 6 months.
2. Turbidity levels cannot exceed 5 NTU without a variance from the Division.
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4. Maintain a comprehensive watershed control program which minimizes potential contamination from Giardia and viruses in the source water. The public water system needs to show through ownership or written agreements with landowners within the watershed that it "can control all human activities which may have an adverse impact on the microbiological quality of the source water." The water system needs to submit an annual report to the Division indicating current and future problems and solutions regarding source water quality. The watershed control program must:

   a) Characterize the watershed hydrology and land ownership.

   b) Identify watershed characteristics and activities which might have an adverse effect on water quality.

   c) Monitor occurrences of activities which might have an adverse effect on water quality.

   The water system is also subject to annual inspections of the watershed program. Any water system which does not consistently meet the requirements for a nonfiltered system will be deemed in violation and the Division can require filtration to be installed.

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MAXIMUM MICROBIOLOGICAL CONTAMINANT LEVELS

Microbiological contaminant levels are based upon the presence or absence of total coliforms in a sample. For a system which is required to collect 40 or more samples per month, total coliform positive samples shall not exceed 5.0 percent of the samples collected each month. For systems that collect fewer than 40 samples per month, no more than one positive sample is allowed each month.

In the event of a positive sample, the water purveyor must immediately conduct a repeat sampling. If any repeat sampling tests positive for fecal, E. coli or total coliform, these samples constitute a violation and public notification is required.

SECONDARY CONTAMINANT LEVELS

A number of secondary contaminants could adversely affect water quality. Maximum limits for these contaminants are shown in Table 3-4.

Table 3-4. Secondary Contaminant Maximum Levels

Secondary Contaminant	Level, mg/L
Color	15 color units
Corrosivity	Non-corrosive
Foaming agents	0.5
pH	6.5-8.5
Hardness (as $CaCO_3$)	250
Odor	3 threshold odor number
Total dissolved solids (TDS)	500
Aluminum	0.05-0.2
Chloride	250
Copper	1
Fluoride[a,b]	2.0
Iron	0.3
Manganese	0.05
Silver	0.1
Sulfate	250
Zinc	5

[a] Violations of secondary contaminant levels for fluoride require a special public notice. Refer to OAR 333-061-0042(6).

[b] Violations of maximum contaminant levels for fluoride (4.0 mg/L) require public notification as specified in OAR 333-061-0042.

Table 3-3. Volatile Organic Chemical Maximum Contaminate Levels

Contaminant	MCL, mg/L
Benzene	0.005
Carbon tetrachloride	0.005
Cis-1,2-Dichloroethylene	0.07
Dichloromethane	0.005
Ethylbenzene	0.7
Monochlorobenzene	0.1
0-Dichlorobenzene	0.6
P-Dichlorobenzene	0.075
Styrene	0.1
Tetrachloroethylene (PCE)	0.005
Toluene	1.
Trans-1,2-Dichloroethylene	0.1
Trichloroethylene (TCE)	0.005
Vinyl chloride	0.002
Xylenes (total)	10.
1,1-Dichloroethylene	0.007
1,1,1-Trichloroethane	0.2
1,1,2-Trichloroethane	0.005
1,2-Dichloroethane	0.005
1,2-Dichloropropane	0.005
1,2,4-Trichlorobenzene	0.07

TURBIDITY

The maximum contaminant levels for turbidity for all nonfiltered public water systems using surface water sources or groundwater sources under the direct influence of surface water is 5 NTU unless a specific variance has been granted by the Division.

Water supplies from systems employing conventional filtration treatment must be less than 0.5 NTU for at least 95 percent of all monthly samples and may exceed 1 NTU in no more than 5 percent of monthly samples.

For water systems using slow sand filtration and diatomaceous earth, the turbidity level must be less than 1 NTU in at least 95 percent of the samples taken each month and at no time shall the turbidity exceed 5 NTU.

Systems using other filtration technologies must meet the same turbidity limits as slow sand filtration and diatomaceous earth.

Table 3-2. Organic Maximum Contaminant Levels

Contaminant	MCL, mg/L
Alachlor	0.002
Atrazine	0.003
Benzo(a)pyrene	0.0002
Carbofuran	0.04
Chlordane	0.002
Dalapon	0.2
Dibromochloropropane	0.0002
Dinoseb	0.007
Dioxin (2, 3, 7, 8-TCDD)	0.00000003
Diquat	0.02
Di (2-ethylhexyl) adipate	0.4
Di(2-ethylhexyl)phthalate	0.006
Endothall	0.1
Endrin	0.002
Ethylene Dibromide	0.00005
Glyphosate	0.7
Heptachlor	0.0004
Heptachor epoxide	0.0002
Hexachlorobenzene	0.001
Hexachlorocyclopentadiene	0.05
Lindane	0.0002
Methoxychlor	0.04
Oxamyl (Vydate)	0.2
Picloram	0.5
Polychlorinated Biphenyls	0.0005
Pentachlorophenol	0.001
Simazine	0.004
Toxaphene	0.003
2,4-D	0.07
2,4,5-TP Silvex	0.05

CHAPTER 3

REGULATORY STANDARDS

Oregon State drinking water requirements are established in Oregon Administrative Rules (OAR) 333-061 Public Water Systems. The OARs are administered by the Oregon Department of Human Resources Division of Health (Division). These rules are based upon the original Environmental Protection Agency (EPA) Safe Drinking Water Act (Act) enacted in 1986 and subsequently revised. The last major revision to the Act was in 1996. In this chapter, the maximum contaminant levels and treatment standards are first summarized for both surface water and groundwater systems. The impact of these regulatory requirements upon future water sources and treatment are discussed next. Finally, process options allowed under current regulations are identified.

RESPONSIBILITIES OF WATER SUPPLIERS [OAR 333-061-0025]

This section defines the requirements for Florence and the Heceta Water District as purveyors of drinking water. Requirements for sampling, reporting, recordkeeping, complaint investigation, and operator training are explained.

MAXIMUM CONTAMINANT LEVELS AND ACTION LEVELS [OAR 333-061-0030]

Maximum contaminant levels (MCLs) have been established for inorganic, organic, and volatile organic contaminates as shown in Tables 3-1, 3-2, and 3-3.

Table 3-1. Inorganic Maximum Contaminant Levels

Contaminant	MCL mg/L	Action Level (mg/L)
Antimony	0.006	
Arsenic	0.05	
Asbestos	7 MFL*	
Barium	2	
Beryllium	0.004	
Cadmium	0.005	
Chromium	0.1	
Copper		1.3
Cyanide	0.2	
Fluoride	4.0	
Lead		0.015
Mercury	0.002	
Nickel	MCL being reevaluated by EPA	
Nitrate (as N)	10	
Nitrite (as N)	1	
Total Nitrate + Nitrite (as N)	10	
Selenium	0.05	
Thallium	0.002	

*MFL = million fibers per liter > 10 um

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1. U.S.D.A. Soil Conservation Service. *Soil Survey of Lane County Area, Oregon.* 1987.

2. Schlicker, Herbert G., et al. Environmental Geology of Coastal Lane County, Oregon. 1974.

FUTURE WATER DEMANDS

Using the population projections developed earlier and applying the demand factors shown above, future water use projections can be developed. Table 2-6 shows the projected average annual flow, maximum month flow, and maximum day flow for the entire planning period. The maximum month and maximum day usage for the year 2020 are projected to be 4.86 and 7.0 respectively. When buildout of the entire study area occurs, the approximate maximum month and maximum day usage will be 9.88 and 14.23 respectively.

Table 2-6. City of Florence Projected Water Demands (1997-2020)

Year	Service Population[1]	Avg Annual Flow, mgd[2]	Max Month Flow, mgd	Max Day Flow, mgd[3]	Max Hourly Flow, mgd	Fire Flow, mgd[4]
	Peaking Factor[5] →	-	1.44	1.75	3.50	-
1997	8,131	1.53	2.20	3.54	5.35	1.39
1998	8,415	1.58	2.28	3.65	5.54	1.40
1999	8,710	1.64	2.36	3.75	5.73	1.42
2000	9,015	1.69	2.44	3.86	5.93	1.43
2001	9,330	1.75	2.53	3.97	6.14	1.45
2002	9,657	1.82	2.61	4.09	6.35	1.46
2003	9,995	1.88	2.71	4.21	6.58	1.48
2004	10,344	1.94	2.80	4.33	6.81	1.49
2005	10,706	2.01	2.90	4.46	7.04	1.51
2006	11,081	2.08	3.00	4.60	7.29	1.52
2007	11,469	2.16	3.10	4.73	7.55	1.54
2008	11,870	2.23	3.21	4.88	7.81	1.55
2009	12,286	2.31	3.33	5.02	8.08	1.57
2010	12,716	2.39	3.44	5.17	8.37	1.59
2011	13,161	2.47	3.56	5.33	8.66	1.60
2012	13,622	2.56	3.69	5.49	8.96	1.62
2013	14,098	2.65	3.82	5.66	9.28	1.64
2014	14,592	2.74	3.95	5.84	9.60	1.66
2015	15,102	2.84	4.09	6.01	9.94	1.67
2016	15,631	2.94	4.23	6.20	10.29	1.69
2017	16,178	3.04	4.38	6.39	10.65	1.71
2018	16,744	3.15	4.53	6.59	11.02	1.73
2019	17,330	3.26	4.69	6.79	11.40	1.75
2020	17,937	3.37	4.86	7.01	11.80	1.77

Notes:

1. Service population includes population in both City of Florence and the Florence Urban Growth Boundary.
2. Average annual flow is calculated based on the per capita flow estimated from data for 1992 to 1996 and the projected service population.
3. Maximum day flow includes fire flow for a duration of 15 hours.
4. The instantaneous fire flow is estimated assuming 20% commercial and 80% residential use, where the fire flow for commercial buildings equals 1020*P0.5*(1-0.01*P0.5) with P = population in thousands, and the fire flow for residential buildings equals 500 gpm (Reference: Elements of Water Supply and Wastewater Disposal, 2nd Edition, 1971.)
5. Peaking factors are based on flow data from 1992 to 1996, except for the peak hourly flow peaking factor, which is estimated by averaging the peak hourly flow peaking factors determined for other similar cities along the Oregon coast ("Water Supply Plan Update 1992" by HGE, Inc.).

Year	Month	City of Florence Production	From Heceta	Total Consumption by Florence
1996	Jan	0.848	ND	0.848
	Feb	0.928	ND	0.928
	Mar	0.860	ND	0.860
	April	0.815	ND	0.815
	May	1.060	ND	1.060
	June	1.292	0.1744	1.467
	July	1.235	0.3539	1.588
	Aug	1.212	0.4215	1.633
	Sept	1.068	0.1984	1.267
	Oct	0.949	0.0732	1.023
	Nov	0.836	0.0379	0.874
	Dec	0.616	0.2121	0.828

ND = No flow data was indicated for the month

Table 2-5. City of Florence 1992-1996 Annual Average Water Demands

Year	Service Population	Flow (mgd)	Per Capita Flow (gpcd)	Peak Month Flow (mgd)	Peaking Factor[a]	Peak Day Flow (mgd)	Peaking Factor[a]	Minimum Day Flow (mgd)	Peaking Factor
1992	5,475	1.050	192	1.490	1.42	1.985	1.89	0.348	0.33
1993	5,705	0.946	166	1.358	1.44	1.829	1.93	0.540	0.57
1994	6,005	0.981	163	1.643	1.68	1.755	1.79	0.591	0.60
1995	6,185	1.535	248	1.854	1.21	2.236	1.46	0.139	0.09
1996	6,400	1.101	172	1.633	1.48	1.834	1.67	0.084	0.08
Average			188		1.44		1.75		

Notes:

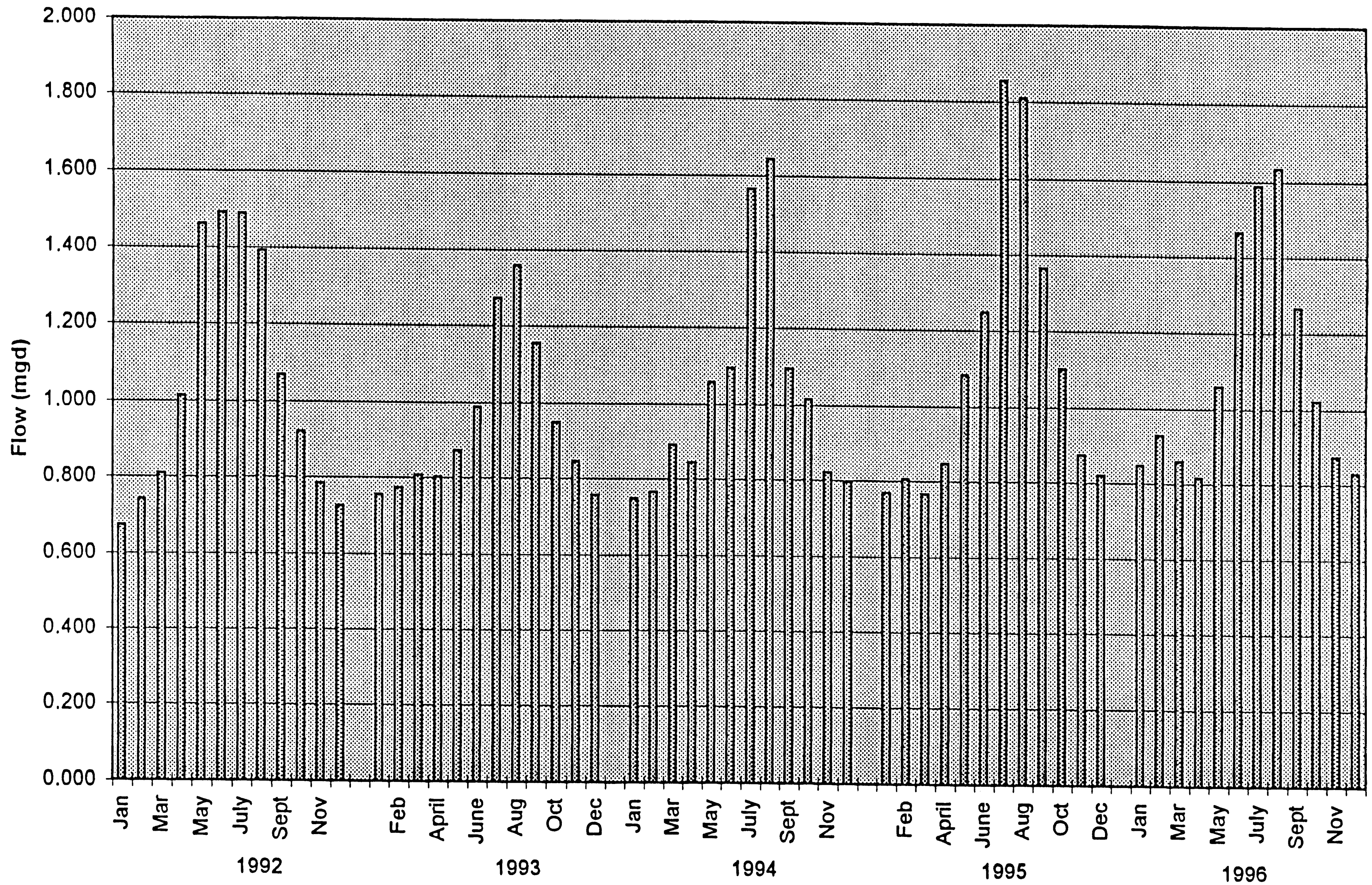
[a]Peaking factors are the ratio of the maximum monthly flow to average annual flow, the ratio of maximum day to average annual flow, and the ratio of the minimum day to average annual flow.

Unmetered water use accounted for 15.1 percent of all water produced from 1988 to 1990. It is expected that this percentage may be slightly reduced in the future as leaks are repaired and higher quality home service connections are installed. Unmetered water usage is included in the following projections for future water demands.

Table 2-4. City of Florence Monthly Average Water Demands (1992-1996) (Million Gallons per Day)

Year	Month	City of Florence Production	From Heceta	Total Consumption by Florence
1992	Jan	0.628	0.045	0.673
	Feb	0.663	0.079	0.742
	Mar	0.723	0.086	0.809
	April	0.737	0.278	1.015
	May	0.948	0.515	1.463
	June	0.786	0.707	1.493
	July	0.908	0.582	1.490
	Aug	0.850	0.541	1.392
	Sept	0.728	0.343	1.071
	Oct	0.796	0.125	0.921
	Nov	0.729	0.056	0.785
	Dec	0.670	0.056	0.726
1993	Jan	0.685	0.070	0.755
	Feb	0.701	0.072	0.774
	Mar	0.742	0.065	0.807
	April	0.740	0.062	0.802
	May	0.800	0.074	0.874
	June	0.828	0.162	0.989
	July	0.820	0.452	1.272
	Aug	0.737	0.622	1.358
	Sept	0.656	0.501	1.157
	Oct	0.673	0.276	0.949
	Nov	0.670	0.175	0.846
	Dec	0.676	0.080	0.756
1994	Jan	0.679	0.069	0.748
	Feb	0.696	0.070	0.766
	Mar	0.660	0.233	0.893
	April	0.689	0.156	0.845
	May	0.597	0.461	1.058
	June	0.453	0.644	1.097
	July	0.753	0.813	1.566
	Aug	0.726	0.917	1.643
	Sept	ND	0.477	0.477
	Oct	0.712	0.304	1.016
	Nov	0.741	0.081	0.822
	Dec	0.719	0.077	0.796
1995	Jan	0.649	0.010	0.027
	Feb	0.701	0.127	0.805
	Mar	0.721	0.070	0.766
	April	0.760	0.088	0.847
	May	0.940	0.144	1.084
	June	1.073	0.176	1.248
	July	1.527	0.327	1.854
	Aug	1.389	0.420	1.809
	Sept	1.236	0.129	1.366
	Oct	1.102	0.0003	1.103
	Nov	0.875	0.0003	0.875
	Dec	0.819	ND	0.819

Figure 2-3. Monthly Average Water Use (1992-96)



WATER SYSTEM FACILITIES

Minimum water system pressure at the customers tap during a fire	20 psig
Minimum water system pressure in the water mains	30 psig
Maximum water system pressure	100 psig
Minimum distribution system chlorine residual	0.3 mg/L
Ideal water distribution system velocity	5 to 7 feet per second

Water supply must be capable of meeting peak day demand with 10 percent of the supply capacity out of service.

Peak hourly flow is provided by use of water in storage.

Minimum storage requirement is based on three days of annual average demand plus fire reserve volume.

Users with demands greater than 500 gpm must provide their own storage to meet instantaneous demands.

Require water meters on all connections and annual meter maintenance and calibration.

Practice water conservation and demand management.

WATER SYSTEM UNIT COSTS

To develop viable alternatives, it is necessary to have a basic understanding of the relative costs of water treatment, storage, and distribution systems. The following units costs are order of magnitude only and will be refined during the alternative cost evaluation phase.

Water Supply	200 foot screened well, flow monitoring pump and piping, approximately 200 gpm (0.3 mgd)	$100,000
	Green sand iron removal system with piping and controls, 700 gpm (1.0 mgd)	$1,900,000
Water treatment	Direct pressure filtration with piping and controls, 700 gpm (1.0 mgd)	$1,800,000
Water storage	Ground level concrete reservoir, 2 million gallons or larger, including piping and site work	$ 260,000 per million gallons
Water Distribution	12-inch-diameter water main with valving and site restoration, C900 or ductile iron pipe	$60 per linear foot

CURRENT AND FUTURE WATER REQUIREMENTS

To determine future water demands, it is important to first analyze current water use patterns. Annual average water consumption is evaluated as well as seasonal, daily and hourly variations. Peaking factors are then calculated which can be applied to future usage to predict water usage throughout the planning period.

PEAKING FACTORS

Water usage is characterized on the basis of demand during both average and peak conditions. Four conditions are typically evaluated:

Average Annual Flow	Total annual water use divided by 365. (Flow is typically reported in million gallons per day.)
Maximum Month Flow	Total monthly use divided by the number of days in the month.
Maximum Day Flow	Total daily use for the peak day of the year.
Maximum Hourly Flow	Total hourly use during the hour of maximum consumption.

CURRENT WATER USAGE

Planning for adequate supplies to meet future needs requires analysis of prior water use records. Florence's monthly water use over the past 5 years is provided in Table 2-4. Figure 2-3 is a graphical representation of the same data for 1992 through 1996. The average daily per capita usage is 182 gallons per person per day which compares well with prior studies. It should be noted that the uses shown for 1995 are abnormally high. This may be attributable to an unseasonably hot summer and a major distribution system break.

Table 2-5 shows the average annual, monthly, and maximum day flows for the period for 1992 to 1996. Comparing the maximum monthly flow and the peak day flow to the annual average flow yields peaking factors of 1.44 and 1.75 respectively. Maximum hour peaking factors are not available as Heceta monitors the amount of water sold to Florence on a monthly basis. A peak hour to average annual flow peaking factor of 3.50 was selected. This is the same peaking factor used in the 1992 Water Facilities Plan and is typical for many municipalities.

This data includes all water produced at the Florence wellfield facility and the water sold to the city by Heceta. The flow summary is developed by reading master meters at the Florence wellfield and at the point of the Heceta intertie. Included in this flow is all nonmetered uses such as distribution system leakage, washdown at municipal facilities, fire suppression, sewer or water main flushing, and unauthorized connections.

CHAPTER 4

ALTERNATIVE DEVELOPMENT

In this chapter, design criteria are presented based upon the evaluation of historical data from the previous chapter. These criteria are then used to develop new water source alternatives. The alternatives evaluated are: an expansion to the existing water treatment facility, an expanded treatment plant on Clear Lake, and a new groundwater source in the northwestern portion of the Urban Growth Boundary (UGB). A distribution analysis follows. The analysis was performed using a computer model to identify current deficiencies and to plan for future distribution system expansions. A storage system analysis concludes this chapter.

DESIGN CRITERIA

The function of a water system is to deliver water in adequate quantity and quality at an acceptable pressure from the source of supply to the customers. The water supply system should be capable of meeting all demands during the period of use without allowing the pressure to fall below acceptable limits. This section of the report establishes standards for the level of service to be provided by the water system. These standards are based upon industry standards, operator preference, as well as regulatory requirements. While local and federal regulations establish minimum standards, a community may elect to operate a safer or more conservatively designed system. The guidelines presented in Table 4-1 will be used to size water system improvements.

WATER SOURCE AND TREATMENT ALTERNATIVE SIZING

Chapter 2 presented the future water requirements for the Florence study area. As established above under Design Criteria, the water source and treatment alternatives must be able to meet the project maximum day demand with 10 percent of the capacity out of service. The sizing requirement for the maximum day source and treatment is then (1.1)(7.0 million gallons per day (mgd)) = 7.7 mgd.

In Chapter 1, it was established that 3.0 mgd is a reasonable capacity to expect from the existing treatment system following optimization and expansion. The Clear Lake Water Source Assessment dated May 21, 1997, showed approximately 2.5 mgd could be withdrawn from Clear Lake during the summer months while limiting drawdown to approximately 1.5 feet. This source assessment is included in Appendix C. The actual acceptable drawdown has yet to be established. This determination will result from negotiations with all interested parties. For the purposes of this study, it is assumed the peak summer capacity of Clear Lake is 2.5 mgd.

Table 4-1. Design Criteria Guidelines

Criteria descriptions	Value
Water demand	
Annual average per capita demand, gpcd	188
Peak month to annual average peaking factor	1.44
Peak day to annual average peaking factor	1.75
Peak hour to annual average peaking factor	3.50
Fire flow, Q, gpm as a function of population P, thousands	$Q=1020(P)^{1/2}(1-0.01(P)^{1/2})$
Fire flow duration, hours	15
Fire reserve volume, V, mg	V=(15/24)Q
Maximum system flow	Greater of peak hour or peak day plus fire flow
System losses in percent of total demand	10
Reserve supply capacity for peak day, percent	10
System pressure	
Minimum pressure at customers tap during a fire, psig	20
Minimum water system pressure in the water mains, psig	30
Maximum water system pressure	100
Storage	
Peak hourly flow is provided by use of water in storage.	
Minimum storage requirement is based on three days of annual average demand plus fire reserve volume.	
Users with demands greater than 500 gpm must provide their own storage to meet instantaneous demands.	
Other	
Minimum distribution system chlorine residual, mg/L	0.3
Preferred water distribution system velocity, feet per second	5 - 7
Require meters on all connections and annual meter maintenance and calibration.	
Practice water conservation and demand management.	

Two options are evaluated to determine the most appropriate combination of water sources and treatment to provide the required 7.7 mgd. These options are summarized in Table 4-2.

Table 4-2. Treatment Capacity Expansion Options

Item	Capacity, mgd	
	Option 1	Option 2
Expanded Florence treatment plant	3.0	3.0
New Clear Lake surface water plant	2.5	–
New groundwater source and treatment	2.2	4.7
Total	7.7	7.7

NEW WATER SOURCE AND TREATMENT ALTERNATIVES

In this section, the three alternatives for providing additional water supplies are described in detail. The alternatives are: expansion and optimization of Florence's existing water treatment facility, development of the Clear Lake surface water supply, and development of a new groundwater supply.

FLORENCE WATER TREATMENT PLANT OPTIMIZATION AND EXPANSION

Chapter 1 includes a discussion of recommended plant improvements to the Florence Water Treatment Plant. It was estimated that the existing facilities could reliably produce 2.5 mgd following optimization. Additional treatment facilities would be required to expand the plant capacity to 3.0 mgd. The improvements and costs associated with plant optimization and expansion are discussed below.

Plant Optimization

Recommendations to increase the capacity and improve operations at the existing City of Florence groundwater treatment plant are discussed in the report and are summarized below. Estimated construction costs are shown for individual items. These improvements are currently under construction.

Horizontal Contact Chamber. Install a bypass line around the horizontal contact chamber to provide maintenance access to this vessel while the plant is operational. Downstream of the horizontal contact chamber, provide flexible chemical injection piping to optimize the sequence of chemical feed injection. Install a perforated diffuser for each injected chemical in the horizontal contact chamber. Estimated cost: $15,000

Filtration. Five potential improvements to the existing filtration system have been identified. These are as follows:

1. Restore the existing filter media to 24 inches of 0.35 millimeters (mm) effective size greensand capped with 12 inches of 1 mm effective size anthracite coal. Estimated cost: $20,000.
2. Rehabilitate filters 1 and 2 with new air scour and backwash piping, media screen, and underdrain systems. Estimated cost: $100,000.
3. Replace the existing pneumatically actuated control valves with electrically actuated units with variable rate opening and closure. Estimated cost: $30,000.
4. Modify the air scour distribution nozzles in filters 3, 4, and 5 by turning the nozzles upward and retrofit the water purge cycle in the air distribution manifold to purge air from the media and the air piping. Alternatively, install fine screens on each air scour nozzle to prevent clogging by media. Estimated cost: $12,000.
5. Install a pressure relief valve on the air scour blower. Estimated cost: $600.

Chemical Feed Systems. Improvements to the chemical feed systems include general improvements to all the systems as well as specific improvements to the chlorine, sodium hydroxide, and sodium carbonate systems. These are summarized below.

General

1. Install carrier water systems to improve chemical dispersion for all chemical feed systems, except for chlorine. Estimated cost: $9,000

2. Install new plant flow meter to flow pace all applied chemicals. Estimated cost: $5,000

Chlorine

1. Install a chlorine analyzer with a low and high chlorine dose alarm. Estimated cost: $5,000

2. Install a second chlorinator for redundancy. Estimated cost: $5,000

Sodium Hydroxide

1. Modify the feed system to permit sodium hydroxide to also be used for final pH adjustment. Estimated cost: $3,000

Sodium Carbonate

1. Convert the system to feed sodium fluoride. Estimated cost: $3,000

2. Install a dust collection system to capture sodium fluoride dust at the point of entry to the feed system. Estimated cost: $5,000

Wash Water Ponds. Install a recovered water pumping station to convey decanted pond supernatant to a new on-site irrigation system. Install new backwash piping from the outlet of the plant at a uniform slope to outlet at the high water level of the washwater ponds. Estimated cost: $15,000

Operations Building and Other Support Facilities. Install a telemetry system to report plant operations data to the city's public works department. Estimated cost: $20,000

Cost Summary of Plant Optimization Project. The estimated costs of the plant optimization improvements described above are summarized in Table 4-3.

Table 4-3. Estimated Plant Optimization Project Costs

Item	Cost, dollars
Construction cost, subtotal	247,600
Contingency, 25 percent	61,900
Subtotal	309,500
Engineering, administration and legal costs, 20 percent	61,900
Total plant optimization project cost	371,400

Plant Expansion

To provide a total of 3.0 mgd treatment capacity at the existing facility, additional wells and greensand filters will be required. Seven existing wells yield approximately 220 gallons per minute (gpm) each for a total of 1,540 gpm (2.2 mgd). Three more wells will be necessary to provide sufficient raw water capacity. These wells will be constructed with approximately the same depth and diameter as the seven existing wells.

Three additional greensand filters are recommended. Prior plant expansions made provisions for three more filters in the existing building. Although only two additional filters may be required for this phase, it would be prudent and cost effective to complete the installation at this time. The third new filter could be considered a standby in the event any unit needs to be removed from service and maintained.

These filters will have an internal configuration similar to the existing filters except air scour outlets will be directed upwards and a water purge to the air scour piping will be provided. In addition, consideration may be given to an alternate underdrain system which utilizes a wedge wire screen media support system in lieu of gravel. The advantage of this system is that additional media depth could be provided for a given height of filter unit. Filter manufacturers have noted a tendency for this type of support screen to clog. This potential problem will be investigated during preliminary design. The costs for the wells, filters, and associated appurtenances are presented in Table 4-4.

Table 4-4. Estimated Costs for Existing Plant Expansion

Item	Cost, dollars
Groundwater wells (3)	200,000
Piping	60,000
Greensand filters (3) with associated control valves	400,000
Electrical and instrumentation	50,000
Construction cost subtotal	710,000
Contingency, 25 percent	177,500
Subtotal	887,500
Engineering, administration, and legal costs, 20 percent	177,500
Total plant expansion project cost	1,065,000

NEW CLEAR LAKE TREATMENT SYSTEM

Regardless of the relative purity of Clear Lake, the necessity of treating the raw water has been decided. The Health Division has clearly mandated some type of surface water treatment. A copy of a letter from the Division discussing this requirement is included in Appendix D.

A new water treatment facility at Clear Lake would be designed to provide a minimum of 2.5 mgd during summer periods. At least 3 mgd would be produced by the facility during winter periods when lake level drawdown is not a concern. The raw water pumps would be equipped with variable frequency drives to allow variable production. Treatment will be required to meet the Surface Water Rules discussed in Chapter 3.

Description of Surface Water Treatment Alternatives

Four treatment alternatives are considered in this evaluation. These include direct filtration, diatomaceous earth filtration, microfiltration, and ultrafiltration. Given the pristine raw water quality of Clear Lake, any of these technologies would meet the requirements of the drinking water standards. The most appropriate choice can therefore be determined by a present worth analysis which considers both the capital and long-term operational cost of each treatment alternative. After selection of the most economical surface water treatment technology, a complete treatment system alternative is developed for a cost comparison to the groundwater source and treatment option. A brief description of each surface water treatment alternative is provided below.

Direct Filtration. The direct filtration process for treatment of surface water consists of three basic unit processes. The first process disperses and rapidly mixes coagulant chemicals with raw water. After mixing, water is conveyed to a flocculation zone where floc particles (destabilized colloidal particles) are allowed to form and coagulate into larger, filterable particles. The final unit process is filtration where floc particles are physically removed. There is more operating experience with this type of treatment system than any other examined for this study. Capital costs are generally low for this type of treatment and there are several reputable vendors that supply direct filtration package plants for this size of application. Control of this type of treatment system requires operator attention to ensure optimization of the coagulant chemical dosage and resultant flocculation reaction. If the flocculation reaction does not properly occur, filtered water quality could be compromised.

Diatomaceous Earth Filtration. Diatomaceous earth (DE) filtration consists of a pressure filter in which the filtration media is a layer of diatomaceous earth. DE is composed of silicate skeletons of diatoms which are mined from open pits. It is injected as a slurry into the raw water stream ahead of the DE filter. This slurry forms a porous DE cake which physically strains particulate matter from the raw water. This technology is generally used for small applications such as swimming pools and the beverage industry. It offers the features of a simple process with reduced risk of system failure, and a process that does not impart any chemicals to the water. Drawbacks of this technology include an increased production of sludge and no ability to remove dissolved organics.

Microfiltration and Ultrafiltration. Both microfiltration and ultrafiltration are relatively new filtration processes that rely on porous membranes to physically strain particles in water. These systems use thin sheets of synthetic organic materials (cellulose acetate, for example) that have very small pore sizes capable of screening protozoan cysts and bacteria. Generally, microfiltration can screen out these harmful organisms while ultrafiltration provides even higher levels of filtration capable of screening out smaller particles, including viruses and colloidal materials.

These membrane filtration processes require high pressures (up to 50 pounds per square inch (psi)) to provide the driving force to pass water through the membranes. These processes offer the advantage of imparting no chemicals to the water and are simple to operate; however, capital costs are generally higher than other filtration processes. Membranes can be backwashed once they show signs of clogging, but after 3 to 5 years they require replacement. Advances in applied technology may yield longer lasting and more cost-effective membranes in the future.

Estimated Costs for Surface Water Treatment Alternatives

Tables 4-5, 4-6, 4-7, and 4-8 provide estimated construction costs for 3 mgd surface water treatment systems using the above technologies. Disinfection using chlorine gas is assumed for all alternatives. A detailed comparison of chlorination options is presented later.

Table 4-5. Estimated Project Costs for New Clear Lake Treatment System Direct Filtration Alternative[a]

Component	Quantity	Unit cost, dollars	Cost, dollars
Screened intake	1	62,000	62,000
Wet well	1	10,000	10,000
Variable speed raw water pumps	3	85,000	255,000
Alum/polymer feed systems	2	15,000	30,000
Microfloc Trident® filtration system[b]	1	405,000	405,000
Finished water pumps	3	80,000	240,000
Chlorination system[c]	2	7,450	14,900
Chlorine scrubber	1	100,000	100,000
Clearwell[d]	1	216,000	216,000
Chemical storage and operations building[e]	1	290,000	290,000
Emergency generator	1	150,000	150,000
Yard piping		106,000	106,000
Subtotal			1,878,900
Electrical and instrumentation, 15 percent			281,835
Piping, 20 percent			375,780
Installed equipment cost, total			2,536,515
Contractor's indirects, 10 percent			253,652
Mobilization and demobilization, 5 percent			126,826
Contingency, 25 percent			634,129
Engineering, administration, legal, 20 percent			507,303
Project cost, total			4,058,000

Notes:

[a] Alternative based on surface water treatment of 3 mgd with raw water turbidity of 1 NTU.

[b] Filtration system includes adsorption clarifier, mixed media gravity filter, chemical feed system controller, process valves, and technical support.

[c] Chlorination system sized for 200 lb/d with compound loop control and vacuum regulator.

[d] Clearwell cost is based on 200,000 gallon capacity.

[e] Building cost based on a 2,900 square foot building with a unit cost of $100 per square foot.

Table 4-6. Estimated Project Costs for New Clear Lake Treatment System Diatomaceous Earth Filtration System[a]

Component	Quantity	Unit cost, dollars	Cost, dollars
Screened intake	1	62,000	62,000
Wet well	1	10,000	10,000
Variable speed vertical turbine pumps	3	141,667	425,000
US Filter DE filtration system[b]	1	945,000	945,000
Finished water pumps	3	80,000	240,000
Chlorination system[c]	2	7,450	14,900
Chlorine scrubber	1	100,000	100,000
Clearwell[d]	1	216,000	216,000
Chemical storage and operations building[e]	1	290,000	290,000
Emergency generator	1	150,000	150,000
Yard piping		147,000	147,000
Subtotal			2,599,900
Electrical and instrumentation, 10 percent			259,990
Piping, 20 percent			519,980
Installed equipment cost, total			3,379,870
Contractor's indirects, 15 percent			506,981
Mobilization and demobilization, 5 percent			168,994
Contingency, 25 percent			844,968
Engineering, administration, legal, 20 percent			675,974
Project cost, total			5,577,000

Notes:

[a] Alternative based on surface water treatment of 3 mgd with raw water turbidity of 1 NTU.

[b] Filtration system includes DE feed system, piping, valves, and controls.

[c] Chlorination system sized for 200 lb/d with compound loop control and vacuum regulator.

[d] Clearwell cost is based on 200,000 gallon capacity.

[e] Building cost based on a 2,900 square foot building with a unit cost of $100 per square foot.

Table 4-7. Estimated Project Costs for New Clear Lake Treatment System Microfiltration System[a]

Component	Quantity	Unit cost, dollars	Cost, dollars
Screened intake	1	62,000	62,000
Wet well	1	10,000	10,000
Variable speed vertical turbine pumps	3	141,667	425,000
Memcor microfiltration system[b]	1	2,250,000	2,250,000
Finished water pumps	3	80,000	240,000
Chlorination system[c]	2	7,450	14,900
Chlorine scrubber	1	100,000	100,000
Clearwell[d]	1	216,000	216,000
Chemical storage and operations building[e]	1	290,000	290,000
Emergency generator	1	150,000	150,000
Yard piping		225,000	225,000
Subtotal			3,982,900
Electrical and instrumentation, 10 percent			398,290
Piping, 20 percent			796,580
Installed equipment cost, total			5,177,770
Contractor's indirects, 15 percent			776,666
Mobilization and demobilization, 5 percent			258,889
Contingency, 25 percent			1,294,443
Engineering, administration, legal, 20 percent			1,035,554
Project cost, total			**8,543,000**

Notes:

[a] Alternative based on surface water treatment of 3 mgd with raw water turbidity of 1 NTU.

[b] Filtration system includes hollow fiber polypropylene membrane modules, backwash and air supply systems, computerized control, and technical support.

[c] Chlorination system sized for 200 lb/d with compound loop control and vacuum regulator.

[d] Clearwell cost is based on 200,000 gallon capacity.

[e] Building cost based on a 2,900 square foot building with a unit cost of $100 per square foot.

Table 4-8. Estimated Project Costs for New Clear Lake Treatment System Ultrafiltration System[a]

Component	Quantity	Unit cost, dollars	Cost, dollars
Screened intake	1	62,000	62,000
Wet well	1	10,000	10,000
Variable speed vertical turbine pumps	3	141,667	425,000
Aquasource ultrafiltration system[b]	1	3,000,000	3,000,000
Finished water pumps	3	80,000	240,000
Chlorination system[c]	2	7,450	14,900
Chlorine scrubber	1	100,000	100,000
Clearwell[d]	1	216,000	216,000
Chemical storage and operations building[e]	1	290,000	290,000
Emergency generator	1	150,000	150,000
Yard piping		270,000	270,000
Subtotal			4,777,900
Electrical and instrumentation, 10 percent			477,790
Piping, 20 percent			955,580
Installed equipment cost, total			6,211,270
Contractor's indirects, 15 percent			931,691
Mobilization and demobilization, 5 percent			310,564
Contingency, 25 percent			1,552,818
Engineering, administration, legal, 20 percent			1,242,254
Project cost, total			**10,249,000**

Notes:

[a] Alternative based on surface water treatment of 3 mgd with raw water turbidity of 1 NTU.

[b] Filtration system includes membrane modules, recirculation pumps, piping and valves, and local controls.

[c] Chlorination system sized for 200 lb/d with compound loop control and vacuum regulator.

[d] Clearwell cost is based on 200,000 gallon capacity.

[e] Building cost based on a 2,900 square foot building with a unit cost of $100 per square foot.

The total capital costs of the four alternatives are summarized in Table 4-9. It is clear from the table that the direct filtration alternative has the lowest capital cost.

Table 4-9. Capital Cost Summary for Surface Water Treatment Alternatives

Treatment alternative	Capital cost, dollars
Direct filtration	4,058,000
Diatomaceous earth filtration	5,577,000
Microfiltration	8,543,000
Ultrafiltration	10,249,000

Table 4-10 shows the annual operations costs for each of these surface water treatment systems. These costs are based on a plant flow of 3 mgd and are expressed in 1997 dollars.

Table 4-10. Annual Costs for Surface Water Treatment Options

		Alternative			
Item	Quantifier	Direct filtration	DE filtration[a]	Microfiltration[b]	Ultrafiltration[c]
Chemical					
Alum	Dosage (mg/L)	10			
	Usage per day (lb/d)	250.2			
	Unit price ($/lb)	0.25			
	Alum cost ($/day)	61.93	0.00	0.00	0.00
Polymer	Dosage (mg/L)	1			
	Usage per day (lb/d)	25.0			
	Unit price ($/solution lb)	2.6			
	Polymer cost ($/day)	65.05	0.00	0.00	0.00
Chlorine[d]	Dosage (mg/L)	3	3	3	3
	Usage per day (lb/d)	75.1	75.1	75.1	75.1
	Unit price ($/ton)	531	531	531	531
	Chlorine cost ($/day)	19.95	19.95	19.95	19.95
Membrane	Cost per 1,000 gal ($)			0.02	0.02
Cleaning[e]	Cleaning chemical ($/day)	0.00	0.00	60.00	60.00
Energy	Feed/finished water pumping[f]				
	kWh for cont. operation	2,901.59		3,799.71	3,799.71
	Unit cost ($/kWh)	0.05		0.05	0.05
	Energy cost ($/day)	145.08		189.99	189.99
Media Replacement[g]	Frequency (years)			5	5
	Cost per 1,000 gal ($)			0.04	0.04
	Media repl. cost ($/day)	0.00		120.00	120.00
Labor	Labor hours	6.0		2.0	2.0
	Labor hourly costs ($/hr)	25.00		25.00	25.00
	Labor costs ($/day)	$150.00		$50.00	$50.00
Maintenance[h]	Cost per day ($/day)	$69.49		$8.22	$8.22
Other O&M[i]	Cost per 1,000 gal		0.25	0.009	0.009
	Other O&M cost ($/day)	0.00	750.00	27.00	27.00
Operating cost $/day, 1997 dollars		511.48	769.95	475.15	475.15
Operating cost $/year, 1997 dollars		186,689.79	281,031.18	173,430.84	173,430.84
Operating cost $/1,000 gal, 1997 dollars		0.17	0.26	0.16	0.16

Notes:

[a] DE filtration O&M costs based on cost data in EPA Publication "Workshop on Emerging Technologies for Drinking Water Treatment Filtration," CERI-87-49, for similar plant capacity.

[b] Microfiltration O&M costs based on costs data indicated in manufacturer literature (Memtec technical bulletin) and literature review.

[c] Ultrafiltration O&M costs assumed to be similar to those for microfiltration.

[d] Chlorine costs for all 4 alternatives are assumed to be the same. The actual dosage requirement may be lower for microfiltration and ultrafiltration. Microfiltration with 0.2 um membranes is capable of higher removal of bacteria and ameboid cysts than direct filtration and DE filtration, while ultrafiltration with 0.01 um membranes is capable of higher bacterial as well as viral removal.

[e] For microfiltration, chemical cleaning of the membranes is periodically performed using an alkaline solution or citric acid.

[f] For direct filtration, the total differential pressure is estimated assuming 20 psi for raw water pumping from Clear Lake, 4 psi pressure drop across gravity filter, and 60 psi for distribution system. For microfiltration and ultrafiltration, the total differential pressure is estimated assuming 20 psi for raw water pumping from Clear Lake, 30 psi pressure drop across filtration system, and 60 psi for distribution system.

[g] Media replacement costs are annual prorated costs for membrane service life of 5 years.

[h] Maintenance costs for direct filtration are estimated as 1 percent of the capital costs.

[i] For DE filtration, the total O&M costs are combined in a single cost per 1,000 gallons. For microfiltration and ultrafiltration, other O&M costs include energy costs for air compressor and clean-in-place water heating.

Since a chlorine residual must be maintained in the distribution system, it is assumed that chlorination will be used for disinfection. Options for providing chlorine include chlorine gas, hypochlorite delivered in bulk, and hypochlorite generated onsite. Table 4-11 shows that gaseous chlorine is the least costly method of adding chlorine for disinfection. The costs for gaseous chlorine include provisions for a chlorine gas scrubber. Chlorination using gaseous chlorine is included in all subsequent alternatives.

Table 4-11. Chlorination System Present Worth Comparison

	20-Year life cycle[a]			
Alternative	Capital cost, dollars	Total annual cost, dollars/year	Net present worth, dollars	$/Mgal treated (at 3 mgd)
Gaseous chlorine	280,000	56,000	548,000	50.96
Sodium hypochlorite (delivered from off site)	69,000	71,000	702,000	65.29
Sodium hypochlorite (on-site generation)	311,000	81,000	792,000	73.71

Notes: [a] Life cycle costs are calculated based on 8 percent interest rate.

Because direct filtration has the lowest cost of the four surface water treatment alternatives, it is selected as the most appropriate method of treatment. Likewise, gaseous chlorine is selected as the lowest cost disinfection alternative. The capital, annual, and present worth costs of the selected Clear Lake surface water treatment system are presented in Table 4-12.

Table 4-12. Capital, Annual, and Present Worth Costs of Direct Filtration System

Capital cost, dollars	Total annual cost, dollars/year[a]	Present worth cost, dollars[b]	Dollars/1,000 gal treated (at 3 mgd flow)
4,058,000	600,000	5,891,000	0.55

Notes: [a] Includes amortization of capital cost.
[b] Present worth based on 8 percent discount rate and 20-year period.

NEW GROUNDWATER SOURCE AND TREATMENT

Based on previous hydrogeological studies, groundwater resources are probably sufficient to meet expected water supply demands. Water quality is generally acceptable with the exception of high iron concentrations. The following sections discuss how a groundwater source is developed and the need to provide groundwater protection. Options for treatment and their associated costs are then presented.

New Groundwater Source

The source of the iron is believed to be solublization of the iron from low pH water created by the breakdown of organic material in the dunal sands. High iron increases water supply costs because of water treatment costs and well redevelopment costs due to increased fouling of the groundwater supply wells. Therefore, the primary factor in selection of new wellfield will be minimizing iron concentrations in the raw water. In addition, new groundwater supply development should occur outside of the hydrologic boundaries of Clear Lake.

Based on groundwater sample results for iron in groundwater, there appears to be a correlation between open dunal sands and reduced concentrations of iron in groundwater. This is consistent with formation of the iron due to breakdown of the organic material. Potential wellfield areas that have reduced iron concentrations and are outside of the hydrologic boundary of Clear Lake include:

- The area west of the junction of Munsel Lake Road and U.S. Highway 101.
- The area west and east of Mercer Lake Road and U.S. Highway 101.

Figure 4-1 shows these areas and how they relate to the recharge of Clear Lake. These areas are discussed in the Water Source Assessment included in Appendix C. Each of the potential well sites would probably have long-term iron concentrations in the range of 0.5 to 1 part per million. The regions from which each of these potential wellfields would draw water, or "capture zones," would be east of U.S. Highway 101 towards Clear Lake. To preserve groundwater quality, the potential wellfield capture zones should be protected from industrial development or other activities that may release contaminants to the subsurface.

New groundwater wells should be specifically designed to minimize iron concentrations and the need for maintenance due to clogging. Results of limited groundwater sampling indicate that iron concentrations may be lower in the upper zone of the aquifer than at depth. This relationship should be further evaluated for confirmation and long-term consistency. The use of zonal sampling techniques or depth-specific sampling during drilling activities can be a useful method to evaluate the vertical distribution of iron concentrations. Well screening can then be avoided in undesirable locations of high iron concentration. If there is an increasing iron concentration gradient with depth, new water supply wells should be screened to draw water from the upper zones of the aquifer. The total depth of the well should be limited to the depth of the dunal sands (approximately 100 to 150 feet below the ground surface). Drilling beyond the depth of the dunal sands is unlikely to yield significant quantities of water and may lead to decreased groundwater quality.

The problem of iron fouling in the well is associated with increased water velocity near the well screen intake and pump impellers. New wells should be cased with high flow stainless steel wire wrap well screen 12 to 16 inches in diameter. Higher groundwater quality can be maintained by using more wells drilled to shallower depths. These wells would probably produce approximately 200 to 250 gpm.

Two groundwater supply systems are developed for comparison. A 2.2 mgd facility would be needed in conjunction with the Clear Lake supply. A 4.7 mgd facility would be needed if the Clear Lake supply were not available. Assuming approximately 220 gpm from each well, 7 wells would be needed to supply a 2.2 mgd facility and 14 wells needed to supply 4.7 mgd. As an initial assumption, 1,000 foot spacing is planned between each well. As well development proceeds, it may be possible to reduce the spacing as the potential for drawdown interference is established. A buffer of 500 feet is assumed around the perimeter of the wellfield to provide a measure of wellhead protection. A total of 150 acres of land is included for the 2.2 mgd wellfield and 300 acres of land included for the 4.7 mgd wellfield.

Wellhead Protection

In development of a new wellfield, it is important to evaluate the potential for contamination by performing a well head protection (WHP) study. This evaluation is an assessment of potential contamination sources in a production well capture zone and focuses on protecting the aquifer within this area. Because groundwater is present at shallow depths (less than 50 feet) and the dunal sands have high permeability, it is likely that an accidental release of contamination at the surface would result in groundwater contamination.

The Oregon Department of Environmental Quality has recently released a WHP guidance manual. This manual documents the voluntary program for WHP in Oregon and how a city may become certified for WHP. Certification can result in less stringent sampling and reporting costs. It is likely that the costs of the WHP would be returned quickly in the savings from reduced sampling. In addition, Florence may apply for a State/Federal Assistance grant for performing the WHP study.

Groundwater Treatment and Costs

Although low iron levels are expected, some degree of iron removal should be anticipated. Greensand iron removal technology is assumed for these alternatives. This is the same technology currently used by the city at their existing water treatment plant. However, since lower iron concentrations are expected, relatively high greensand filter loading rates are assumed. The components and costs of both facilities are shown in Table 4-13.

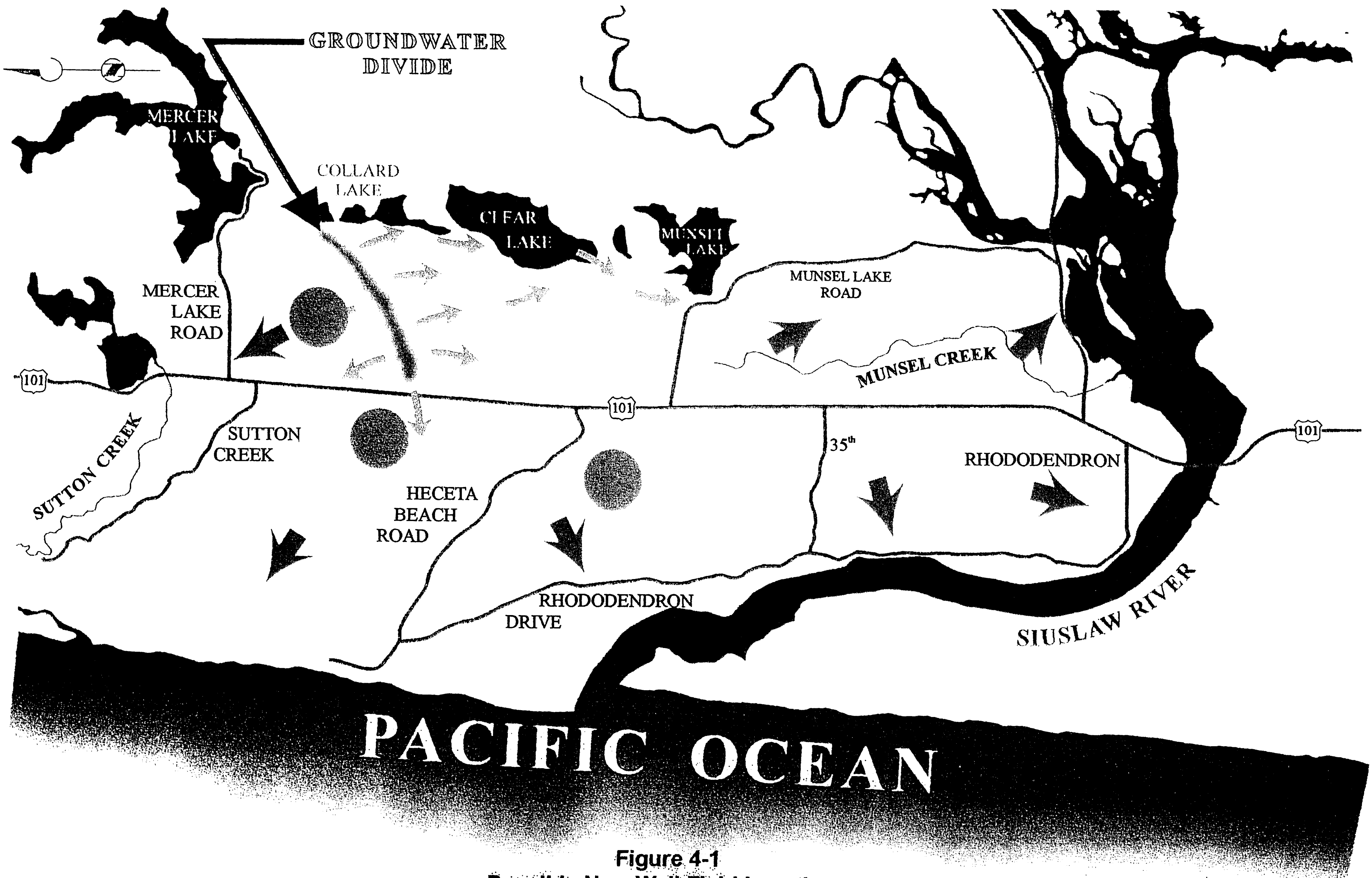


Figure 4-1
Possible New Well Field Locations

Table 4-13. Groundwater Treatment System Capital Costs

Components	Cost, dollars 2.2 mgd	Cost, dollars 4.7 mgd
Wells	490,000	980,000
Greensand filtration[a]	511,500	987,000
Chlorination system[b]	14,900	14,900
Chlorine scrubber	100,000	100,000
Chemical feed systems[c]	60,000	60,000
Clearwell	184,000	336,000
Yard piping	82,000	149,000
Emergency generator[d]	--	200,000
Subtotal	1,442,400	2,826,900
Electrical and instrumentation, 15 percent	216,360	424,035
Piping, 20 percent	288,480	565,380
Installed equipment cost, total	1,947,240	3,816,315
Contractor's Indirects, 10 percent	194,724	381,632
Mobilization and demobilization, 5 percent	97,362	190,816
Contingency, 25 percent	486,810	954,079
Engineering, administration, and legal, 20 percent	389,448	763,263
Subtotal	3,116,000	6,106,000
Land[e]	450,000	900,000
Total project cost	3,566,000	7,006,000

Notes:

[a] Filtration system includes pressure vessels, underdrain and backwash systems, greensand media, process valves, and technical support.

[b] Chlorination system cost is for gaseous chlorine rated at 200 lb/d with vacuum regulator and compound loop control.

[c] Chemical feed systems include those for potassium permanganate, sodium hydroxide, sodium fluoride, and zinc hexametaphosphate.

[d] Emergency generator required for 4.7 mgd option only as emergency source available with Clear Lake supply.

[e] Assumes a land cost of $3,000 per acre.

Table 4-14 shows the estimated present worth costs associated with both a 2.2 mgd and a 4.7 mgd groundwater facility.

Table 4-14. Present Worth Costs for Groundwater Treatment Systems

Treatment capacity, mgd	20-Year Life Cycle[a] Capital cost, dollars	Total annual cost, dollars/yr	Net present worth, dollars	$/1,000 gallons treated (at 3 mgd)
2.2	3,566,000	598,000	5,874,000	0.75
4.7	7,006,000	1,166,000	11,446,000	0.68

Notes: [a] Life cycle costs are calculated based on 8 percent interest rate.

To determine the most cost effective combination of surface and groundwater, the present worth costs of both surface and groundwater treatment are added as shown in Table 4-15.

Table 4-15. Present Worth Cost Comparison of Options

Option	Description	Capital cost, dollars	Total equivalent annual cost, dollars/yr[a]	Present worth cost, dollars[a]
Option 1	Clear Lake surface water--2.5 mgd Groundwater--2.2 mgd	7,624,000	1,198,000	11,765,000
Option 2	Clear Lake surface water--0 Groundwater--4.7 mgd	7,006,000	1,166,000	11,446,000

Notes: [a] Present worth and equivalent annual costs based on 8 percent interest rate over 20 years.

The total present worth costs for both options are between 11 and 12 million dollars. Although the present worth cost for Option 2 is slightly lower, the 3 percent difference between the costs of the two options is not significant. This cost comparison and other noncost criteria will be considered in the following chapter in selection of the recommended alternative.

WATER DISTRIBUTION SYSTEM EVALUATION

In this section, the existing water distribution system is analyzed using a computer model. Deficiencies in the existing system relating to flow and pressure are identified. Future demands within the planning area are also modeled and system improvements are recommended.

ANALYSIS APPROACH

A model called CYBERNET was used to simulate present average day demand and maximum water use conditions developed previously. The system analysis includes the following steps:

- Develop the computer model of the existing transmission system.
- Analyze the ability of the existing system to meet current and future demands.
- Identify water system deficiencies at current and projected levels of development.
- Analyze the ability of an expanded water system to meet future demands.

The program was developed to assess steady state flow and pressure conditions for pressure pipe networks. The program can accommodate varied piping configurations and a wide range of hydraulic components such as pumps, valves, pressure regulating valves, and storage tanks. CYBERNET can also perform an extended period simulation to evaluate fill and draw cycle on storage tanks.