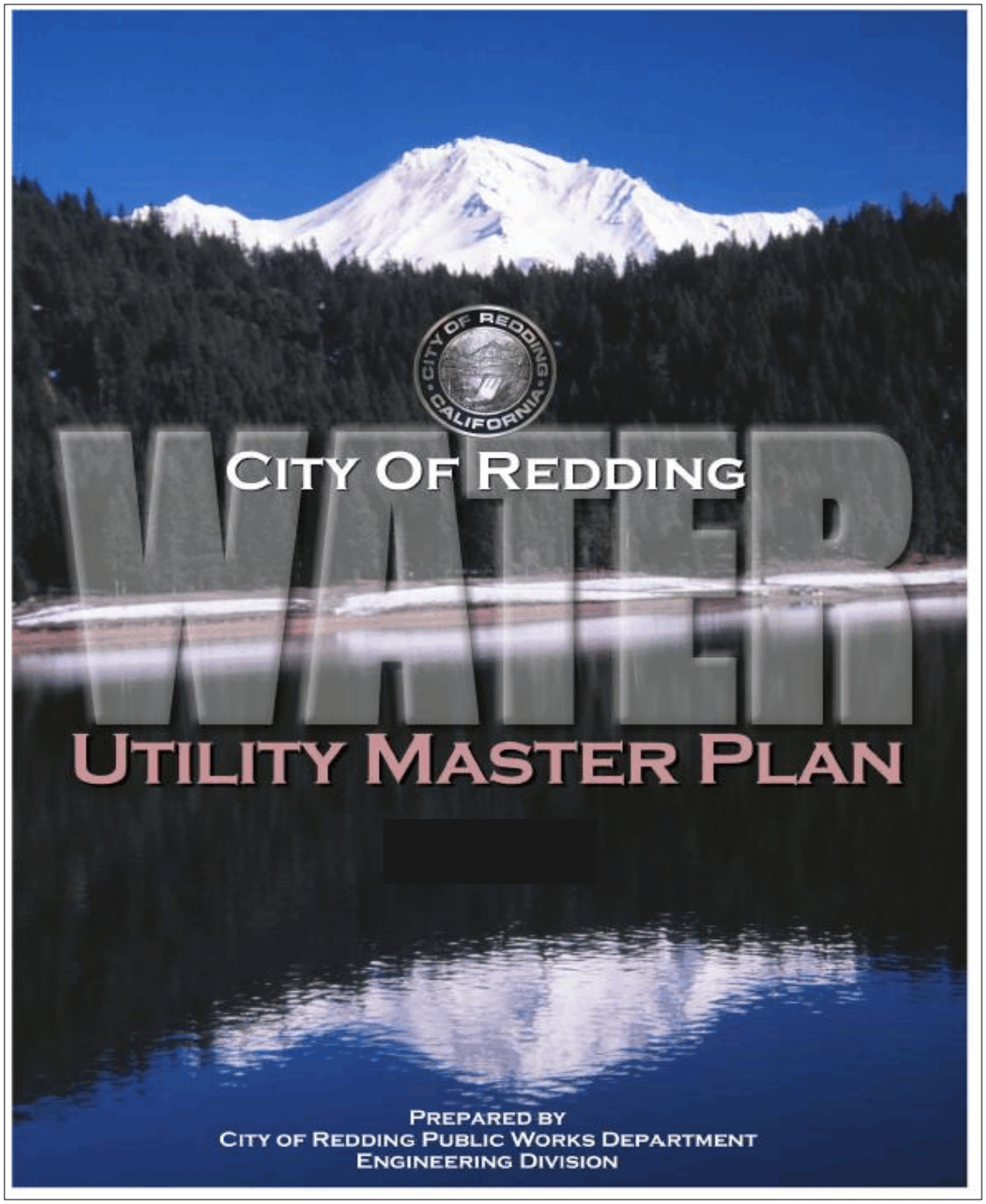
City of Redding
Water Utility Master Plan
Update 2016



Executive Summary

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1.0 INTRODUCTION

The formal City of Redding water supply effort started in 1886 with a Shasta County Board of supervisors granting a franchise for distribution of water in the City of Redding to S.P. Fillman. In 1887 the City of Redding incorporated and the franchise was sold by Grant Deed to the Redding Water Company. Major construction milestones include construction of a pumping facility to pump water from the Sacramento River to an open reservoir on Foothill drive where the existing Foothill Water Treatment Plant is located. Construction of Pump Station 1 in 1937 along with chemical treatment facilities. Significnt Pump Station and treatment plant improvements in 1959 including a two and seven million gallon reservoirs. Numerous small improvements were constructed over the subesequent decades along with annexations of the Cascade and Enterprise districts and acquisition of Buckeye County Water District water system. The latest large scale improvement was increasing the treatment capacity of Buckeye Water Treatment plant to 14 mgd in 2006.

The Water Master Plan Update 2016 presents a review of the City's water system and provides specific planning direction for the system through 2035, including water demands, required water supply, capital improvements needed for planned growth in the City, and evaluation of rate and fee impacts. For long-term planning purposes, the Water Master Plan also evaluates total water demand and supply requirements under the City's projected ultimate buildout condition. The latest City of Redding Water Master Plan was completed in June 2012 (Water Utility Master Plan 2012).

2.0 SCOPE AND PURPOSE OF WATER MASTER PLAN

The 2000 Water Master Plan provided an evaluation and assessment of the utility requirements for operations, capital improvements, funding, and water supply during a period of time where the Redding area was experiencing rapid growth which was projected to continue. The 2012 effort has scaled back the growth expectation to account for economic changes that have occurred in the last few years leading up to that effort.

The City of Redding Water Master Plan 2016 presents an updated evaluation and assessment of the current state of the City's water system, and provides a framework for addressing water system operations, capital improvements and funding, water supply. The scope of work for the Water Master Plan 2016 included the

following primary tasks:

- Evaluation of City of Redding Water Supply
- Evaluation of the existing water system facilities
- Water system demand evaluation for current and forecast planning horizons
- Hydraulic analysis of the existing and future water system
- Capital improvement plan (CIP)
- Capital funding evaluation

3.0 OVERVIEW OF WATER SUPPLY

The City of Redding uses both surface-water and groundwater supplies. The surface-water supply is governed under two separate contracts with the Bureau of Reclamation and one with Anderson Cottonwood Irrigation District (ACID). Water is diverted from either the penstocks dropping from Whiskeytown Lake to Spring Creek tributary of Keswick Lake or the Sacramento River at PS1. The City also has two groups of ground water wells: the Enterprise wells and the Cascade wells. On average, the City gets approximately 69 percent of its total annual supply from surface water and 31 percent from groundwater. Surface water is used seasonally throughout the year and groundwater is used minimally in the winter but peaks along with surface-water use in the summer.

4.0 OVERVIEW OF EXISTING WATER TREATMENT AND DISTRIBUTION SYSTEM

The City of Redding's existing water system service area is shown on Figure ES-1. The system infrastructure includes two Water Treatment Plants (WTP), 17 groundwater wells, approximately 2.93 million feet (555 miles) of conveyance and distribution pipelines, ten pump stations and twelve reservoirs providing a total of 33.5 million gallons (MG) of storage. In 2015, the City water system had an average of 29,022 connections serving a population of approximately 91,053 people. The 2015 average daily demand is approximately 18.9 million gallons per day (mgd), with maximum-day demand (MDD) of 41.6 mgd. It is important to note that 2015 was the second year of an emergency drought declaration by the Governor resulting in statewide mandatory conservation. It is not reasonable to expect that in a non-drought year or a year where there are no supply curtailments conservation would continue at the same level. A location map of all key system facilities is located in the back of Chapter 2; Figures 2-3A and 2-3B.

The City's two surface-water treatment plants are the Foothill WTP and the Buckeye WTP. The City also has two groups of groundwater wells: the twelve Enterprise wells, which supply most of the City's groundwater, and the five Cascade wells, which constitute a relatively minor supply. The City's water system is divided into six primary pressure zones: Foothill, Hill 900, Cascade, Enterprise, Hilltop-Dana, and Buckeye. Small sub-zones exist for Mary Lake and Summit City. Locations of WTPs and pressure zone boundaries can be seen in Figure ES-1.

5.0 WATER SYSTEM FACILITIES EVALUATION

The water system facilities evaluation focused on the general material condition, operations, capacity and reliability, and improvements needed to meet future water demands. The facilities evaluation was conducted in November 2010, followed by review of the findings and recommendations. Since that time, some of the recommended improvements or repairs have been completed, and the need for others has been re-evaluated by City staff in terms of revising timing to coincide with other capital improvements, budget constraints, or other influencing factors. The map in Appendix A illustrates the proposed capital improvements in the City's

six pressure zones. Following is a summary of key findings and recommendations for each type of facility. See Chapter 5 and Appendix B for detailed findings and recommendations.

5.1 Foothill Water Treatment Plant

The Foothill WTP provides roughly half of the City's average-day and maximum-day supply. The plant provides primary and/or secondary supply to all six pressure zones. The plant's raw water source is the Sacramento River via Pump Station No.1 (PS-1). A major expansion of the plant was completed in 1981, bringing its design capacity to 24 mgd. However, at maximum surface loading rates for the filters the treatment plant capacity is 44 mgd with all filters in service, or firm capacity of 34 mgd with only three of four filters in service.

The 1989 Water Master Plan recommended that the Foothill WTP be expanded to 42 mgd by 2001 to meet anticipated supply requirements. The 2000 Water Master Plan revised projections for location and magnitude of growth in the City and found that the expansion is not required until well after 2010. Therefor the recommended improvements for the 2012 Water Master Plan focused on peak-day operating capacity and reliability, and to address regulatory compliance issues.

In 2010 the City hired a Pace Engineering to perform an evaluation of the Foothill WTP and to prepare a facilities plan for recommended improvements. The Facilities Plan for City of Redding Foothill Water Treatment Plant was completed in May 2011. The plan outlined approximately $4.9 million in immediate recommended improvements followed by an additional $6.2 million to be completed by 2020. The plan included the following primary recommendations for Foothill WTP:

- Upgrades to controls and power supply
- Maintenance on the 6 MG reservoir
- Construction of filter improvements
- Construction of new filter backwash improvements
- Pump upgrades for PS-2 (PS-2 supplies water to Hill 900 pressure zone by filling the Hill 900 reservoirs)
- Install Clearwell Baffling
- Construction of five flocculator basins if classic direct filtration is required

As of 2016 the remaining projects are the Clearwell Baffling and construction of flocculator basins.

5.2 Groundwater Wells

The City currently has 17 groundwater wells, five in the Cascade well field and 12 in the Enterprise well field. Well supply represents approximately 30% of the City's total annual water demand. The 12 Enterprise wells have a combined peak pumping capacity of 21 mgd, and provide 95 percent of the City's groundwater supply. In 2015, the annual supply from the Enterprise wells was 7,525 acre-feet (ac-ft). Recent reduction in the allowable levels of arsenic in drinking water has resulted in two wells, EW11 and EW13, being placed on reserve pending investigation of treatment or replacement alternatives.

Evaluation of supply vs demand shows that the inactive wells are not required for current demands but will either need to have treatment, modification or be replaced by 2020. Each of the Enterprise wells has chlorine injection at the well head for disinfection. All Enterprise wells, except EW-3A and EW-4, have

orthopolyphosphate injection to control iron and manganese, which contribute to taste and odor problems. Additional longer-term development of future Enterprise wells is discussed in Water System Evaluation Supply section, Section 5.2.

In 2008 the Water City hired Water Works Engineers LLC. to evaluate well head treatment alternatives to address the Arsenicand Manganese levels. Results of that analysis were recommendations for construction of approximately $13 million in well head treatment facilities. The 2012 Master Plan effort recommended further investigation of the feasibility, cost/benifit and risk associated with abandoning the wells with higher concentrations of these elements and constructing new wells. The current strategy to address well water quality issues includes construction of well head treatment at EW12, the highest producing well, to use in combination with other wells to blend and dilute constituent levels to below their respective MCLs.

The five Cascade Wells provide approximately 5 percent of the City's annual groundwater supply and have a combined capacity of 0.7 mgd. Annual yield in 2010 was 520 ac-ft. The wells supply only the southern end of the Cascade Zone, providing about 20 percent of the zone supply during peak-demand days. Cascade Well 5 is maintained as a standby backup water source and is not operated on a regular basis.

5.3 Pump Stations

The City's water system has eleven pump stations, used for raw water supply, conveyance of treated water between pressure zones, as emergency back-up sources, or to increase pressure to higher elevation areas. All pump stations, except PS-1, are in relatively good functioning condition, have adequate capacity, and should not require major improvements before 2035. A general recommendation for all pump stations is for the Utility to begin regular pump-efficiency testing.

PS-1 supplies raw water to the Foothill WTP. The pump station is located on the south bank of the Sacramento River, along the Sacramento River Trail approximately 0.25-miles upstream of the Lake Redding Bridge. PS-1 is the primary delivery source of raw Sacramento River water to the Foothill WTP as as such is a critical component of the City water supply chain. The pump station building and intake structure were constructed in 1937. The existing pumps, which were all installed between 1967 and 1987, have a firm capacity of 29 mgd. PS-1 is scheduled for replacement because of three different deficiencies:

- Concerns that the intake will not meet long term state and federal criteria regarding protection of endangered fish species. Modified fish screens were installed at PS-1 in 2006 and are being monitored for effectiveness under a waiver from NOAA Fisheries to continue operating the facility.

- The intake also has limited capacity during low river flows due to the shallow river depth at the location of the intake when the Anderson-Cottonwood Irrigation District diversion dam flashboards are not in place. This situation makes the City dependent on Anderson-Cottonwood Irrigation District (which typically has flashboards installed only from April to November) to achieve required pumping capacity.

- The Water Master Plan 2000 also identified the pump station as being located in an area of high seismic liquefaction potential and recommended that the structure be evaluated for its ability to withstand damage during a design earthquake.

5.4 Reservoirs

The City's water system currently has 12 reservoirs totaling 33.5 MG of storage (including the 0.8 MG Buckeye backwash reservoir). Each storage reservoir typically serves one primary pressure zone, and may also provide secondary or back-up storage to adjacent pressure zones. The following observations and

recommendations are provided for storage reservoirs:

Foothill Zone – The Foothill Zone has adequate storage through all planning horizons in this Master Plan. However, as identified in the Foothill WTP Facilities Plan, baffling is recommended for the 6-MG reservoir at Foothill WTP to provide reliable disinfection at higher filter rates above 3.5 gpm.

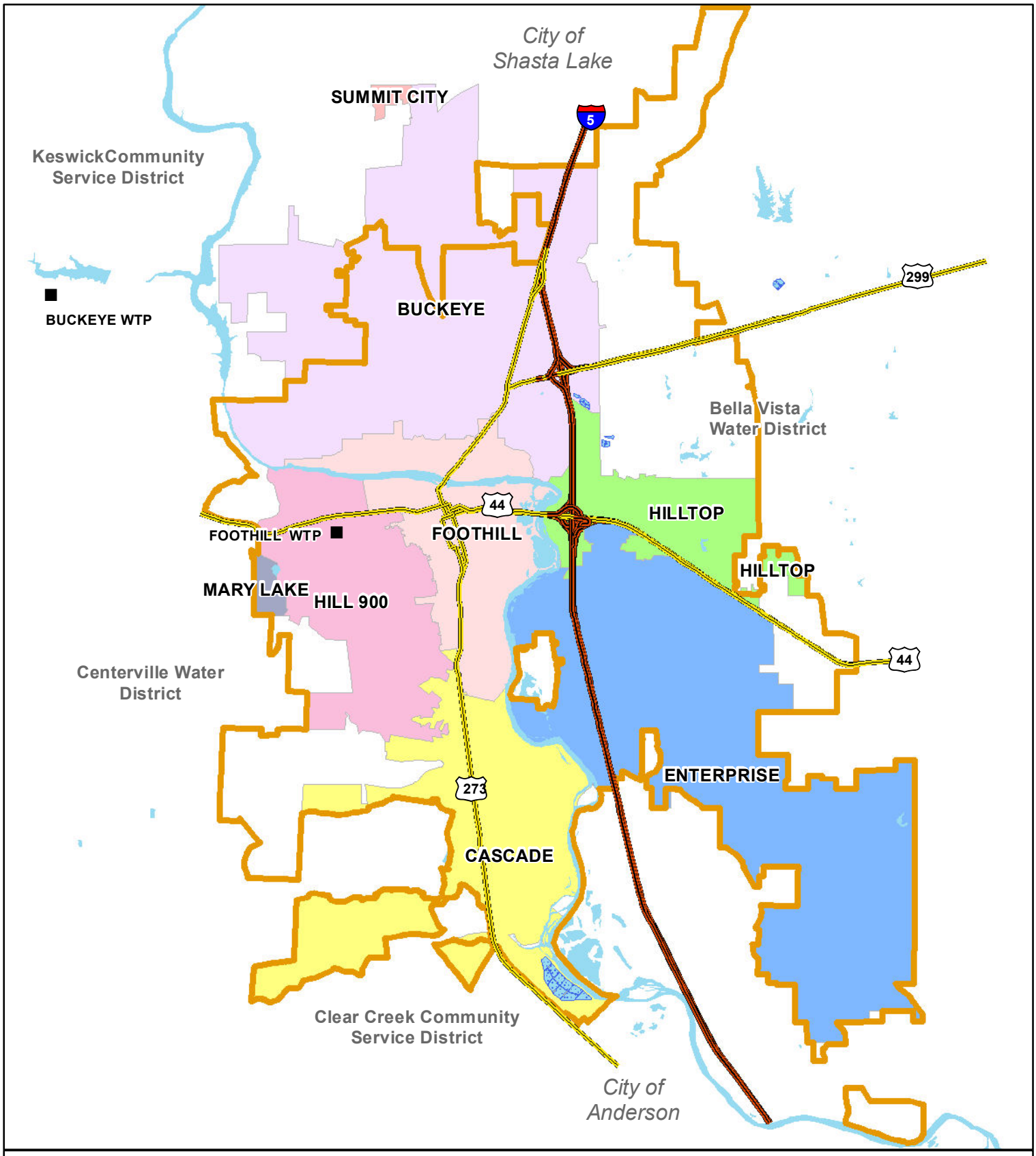
Hill 900 Zone – The Hill 900 Zone is in need of additional storage to meet standard storage criteria for the combination of Equalization, Fire Service and Emergency Storage. New 3.0 MG storage facility has been identified as necessary under existing conditions.

Buckeye Zone – Buckeye Zone storage also does not meet the criteria for desired combination of storage volumes under current demands. The utility has already identified and purchased land for construction of the new reservoir in the Buckeye Pressure Zone. The prior Master Plan identified replacement of the 0.2MG reservoir at the northern end of the pressure zone prior to construction of a new facility. Analysis of the distribution system requirements to serve the new, and larger, replacement reservoir discovered that substantial pipe improvements would also be required to take advantage of increased storage at that location. Construction of a new 3.5MG Buckeye Reservoir is recommended by 2020.

Enterprise Zone – Additional storage is necessary in the Enterprise Pressure Zone by ultimate build-out (UBO) of the pressure zone. However, due to lack of suitable locations with adequate elevation for gravity supply from the storage reservoirs, additional flexibility in operations of the City-wide distribution system may provide an alternative to additioal reservoir capacity. Further investigation of storage requirements in this zone is recommended as growth projection numbers are refined.

Additional consideration was given to account for reservoir age and ultimate replacement of old reservoirs. Given an expected lifespan is 75 years the first reservoir to exceed its lifespan is the Buckeye 0.2 mg reservoir in 2024. By that time the recommended new Buckeye Reservoir should have been constructed and the 0.2 mg reservoir can be decommissioned. Table ES-1 lists the reservoirs, their expiration dates and recommended replacement time frames.

Enterprise Reservoirs 1 and 2



TREATMENT PLANT
CITY BOUNDARY

PRESSURE ZONE
BUCKEYE
CASCADE
ENTERPRISE
FOOTHILL
HILL 900
HILLTOP
SUMMIT CITY
MARY LAKE

N
W
E
S

0 0.5 1 2 3 Miles

Figure ES-1
City of Redding
Water Service Area

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October 1, 2012

Table ES-1 Reservoir Age and Replacement Recommendations

Reservoir	Size, MG	Construction Date	Age	Remaining Lifespan	Expiration Date	Recommended Replacement Date
Buckeye 1	0.2	1949	63	12	2024	Decommission
Hill 900-1	2	1959	53	22	2034	2030
Cascade	1	1964	48	27	2039	2035
Enterprise 1	3.5	1968	44	31	2043	2040
Buckeye 2	2	1978	34	41	2053	2050
Redding Ranchettes	2	1982	30	45	2057	2055
Hill 900-2	2	1984	28	47	2059	2055
Enterprise 2	6	1986	26	49	2061	2060
Buckeye Backwash	0.8	1995	17	58	2070	2065
Buckeye 3	4	2002	10	65	2077	2075
Foothill	6	1980	32	43	2055	2050
Foothill	4	2006	6	69	2081	2080

5.5 Water Distribution Piping

The City's water distribution system includes approximately 2.93 million feet (555 miles) of conveyance and distribution pipe ranging in size from 2- to 48-inches in diameter. Over ninety percent of the piping consists of four pipe materials: Asbestos cement (31 percent), polyvinylchloride (33 percent), ductile iron (14 percent), and cast iron (13 percent). The remaining approximately 10 percent consists primarily of steel or galvanized steel pipe.

The City's cast iron piping is typically 50-80 years old or older, and has the highest percentage of pipe failures. This is significant given that cast iron pipe still makes up approximately 13 percent of the City's distribution system, with most of this piping ranging in size from 6- to 16-inches in diameter.

The City's current piping specifications require ductile iron pipe for all pipe 12-inch diameter or larger, and allow either PVC C900 or ductile iron for piping smaller than 12-inch diameter. These specifications ensure that consistent high-quality piping is installed, with good corrosion resistance and long-term service performance.

Numerous projects are listed in the plan for replacement of pipe based on criteria for maximum allowable velocity to meet demands. If water velocity in the pipes exceeds recommended limits it results in shortened pipe lifespan due to the increased erosion of the pipe interior. The largest component of these projects is a series of projects in Lake Boulevard from Oasis Road to Hilltop Drive. The 2000 Water Master Plan proposed a large diameter pipe in Oasis Road from Lake Boulevard east across I-5 to the Dry Gulch Creek area to provide large amounts of water supply across the northern contract boundary. As a result of renegotiations of various water contracts the City may now utilize water from Buckeye Treatment plant at any location in the City service area and conveyance has become necessary to support conveyance of that supply south and east to Enterprise Pressure Zone. This change resulted in elimination of most of the proposed large diameter pipe in Oasis Road and replacement of an already aging, high velocity and problematic cast iron pipe in Lake Boulevard with a large diameter new water main.

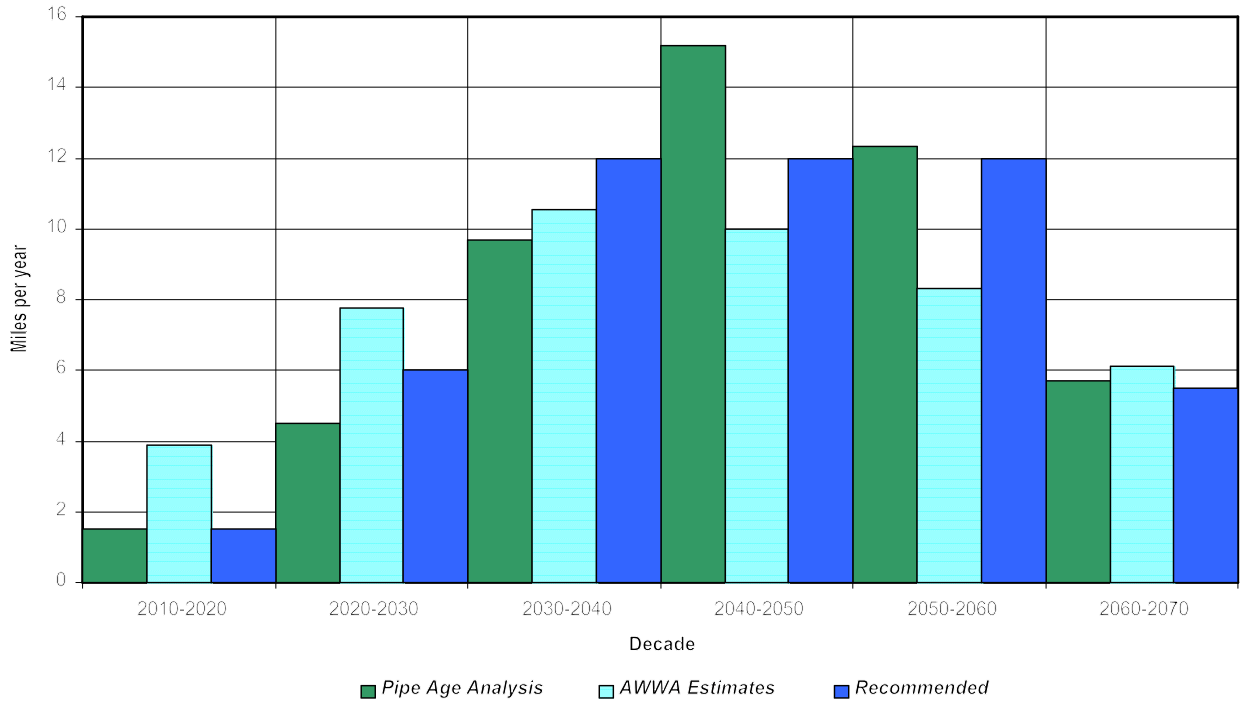
5.6 Pipe Replacement Program

The water system has approximately 100,000 feet of old cast iron water mains larger than 10-inches in diameter. It is recommended that the City develop a prioritized water main replacement effort, focusing on the larger cast iron and older steel mains and those with high velocities, targeting approximately 20,000 feet of the highest priority pipe for replacement by 2020. This will require replacement of 2,000 feet of mains per year. Other factors may also influence prioritization such as pipes located in streets with high truck traffic volumes and concurrent land development or other Capital Projects.

Approximately 3 percent (95,073 feet or 18.0 miles) of the distribution system is 4-inch diameter pipe. The pipe size information currently available indicates substantial length of pipes smaller than 4-inches in diameter, however no indication in the database was given as to whether these are service connections or antiquated local pipe networks. It is recommended that the utility develop a prioritized water main replacement effort to eliminate substandard diameter pipes beginning with those that can be identified as supplying fire hydrants. The replacement program should also consider existing service problems such as low pressure, piping repair history, fire service limitations, and coordination with other capital improvements such as street repairs.

Evaluation of the age of the City's pipe inventory relative to expected lifespan indicates the need for an increasing schedule of pipe replacement peaking in the decade between 2040 and 2050 at approximately 15 miles of replacement per year. AWWA estimates the percent of ageing water distribution systems nationwide show a similar trend, peaking at approximately 10.5 miles of expiring pipe per year from 2030-2040. It is recommended that the City implement a replacement schedule that will distribute the peak replacement period over a larger time frame. Figure ES-2 shows the results of the pipe age analysis, AWWA estimates and the recommended replacement schedule.

Figure ES-2 Pipe Replacement Schedule



5.7 Fire-fighting Water Service

The water distribution system was evaluated for its ability to provide fire-fighting water service throughout the service area. The location, flow, and duration of each fire service analysis were provided by the City of Redding Fire Department, derived from the current California Fire Code. Improvements under the existing condition were only identified in the area between Hilltop drive and Canby Lane in the Mistletoe Drive area.

Fire flows were also analyzed at several other locations throughout the City corresponding to the highest predicted demand for each pressure zone. Analysis was then conducted to determine if conveyance improvements necessary and already recommended to resolve high velocities were also adequate to maintain fire flow supply at future planning horizons. In most cases the high velocity driven projects provided adequate conveyance capacity to offset any predicted impact to fire flows due to increased development. There are a limited number of projects where conveyance improvements were triggered by fire flow volumes. All such projects were assigned a higher priority during the project ranking process.

6.0 EXISTING AND FUTURE WATER DEMANDS

Existing water demands and recent trends in the growth and types (commercial/industrial, single family residential or multiple family residential) of water use were analyzed to develop the existing condition analysis. This information was combined with City growth projections and land use planning data to forecast future water demands for 2020, 2025, 2035 and maximum project buildout of the City water service area. The City's water service area will reach buildout in approximately 2145 to 2155 at the current growth rate forecast. Water demands were also evaluated separately for each of the six pressure zones.

During 2015, the Average Daily Demand (ADD) and Maximum Daily Demand (MDD) were 23.0 mgd and 48.9 mgd, respectively. The relative mix of customer types (residential, commercial, industrial) and the percentage of total water use by each customer group has remained fairly constant over the last decade. Residential and commercial water service connections make up 87 percent and 10 percent of the connections, and represent 71 percent and 25 percent of the total water demand, respectively. The remaining 5 percent of the water demands are for a mix of public facilities, industrial, and irrigation users. Key factors related to existing and future water demands include the following:

- The City-wide average water use is 209 gallons per person per day (GPCD) in 2015 and 229 GPCD average over the last five years.
- The average ratio of population per water service connection has remained relatively constant at 3.2 persons per connection.
- The City has an average of 2.365 persons per household.
- The City-wide ratio of MDD/ADD is 2.2.

City-wide growth rates were obtained from Itron Inc. through contract with Redding Electric Utility. Geographic distribution of the population growth was determined utilizing the 2005 Shasta County Regional Transportation Demand Model data.

Additional factors affecting water use and demand include:

- Conservation efforts - Conservation efforts are being required by the State of California by year 2020 with interem goals to achieve in 2015. The Draft Urban Water Management Plan provides water management guidance towards achieving the goals. However, success of the effort is uncertain and as such not addressed in this plan.

- Green Building Code - The California Green Building Code requires multiple meters for each connection, one for indoor use and a separate meter for outdoor use for certain commercial and residential conditions.

- California Fire Code - The California Fire code has recently required that all residences have indoor fire sprinklers. The amount of water required from the indoor fire sprinkler system may require installation of larger water meters. The impact of installation of larger water meters may increase water utilization per connection in areas where larger water meters are installed.

Table ES-2 summarizes projected growth in water demands for the water service area throughout buildout.

Table ES-2 City of Redding Water Service Area – Growth and Water Demand Projections

Year	Service Area Population	Average Connections	Annual Demand (ac-ft)	ADD	MDD
1990	66160	20805	20300	18.1	39.9
1995	72250	22720	22200	19.8	43.6
2000	79020	24849	23900	21.3	44.5
2005	86289	27135	30992	27.7	48.6
2010	89565	28165	25818	23.0	48.9
2015	91053	28813	21270	19.0	40.1
2020	93194	29306	24520	21.9	46.4
2025	94897	29842	24968	22.3	47.3
2035	98915	31105	26060	23.2	49.3
UBO	163300	51031	46779	40.0	90.0

7.0 WATER SUPPLY REQUIREMENTS

The City will need to develop new water supply and treatment capacity to meet growing water demands, as shown above. The City's existing water supplies and specific steps required to develop additional water for the 2020, 2025 and 2035 planning horizons are summarized below. Figure ES-3 shows annual water supply relative to annual demand including a 10% margin of safety for annual variability in demand. Figure ES-4 shows peak day treatment capacity relative to peak daily demand for each planning horizon. Both supply and treatment capacity depend on construction of the recommended improvements. In the near term (2015-2035), two additional wells will need to be constructed or EW-11 and EW-13 will need to be put back into service.

Beyond 2035 major water system infrastructure will be necessary to support UBO demands including new water rights, new wells, and new treatment capacity. Strategies for filling those needs are discussed in Chapter 5, Water System Evaluation.

8.0 CAPITAL IMPROVEMENT PLAN

The Water Master Plan 2012 identifies specific capital improvements to the water supply, treatment, and distribution system needed to meet both replacement- and expansion-related needs between 2010 and 2030. Detailed breakdown of the CIP by project, year and benefit category is provided in Chapter 6, Water System Capital Improvement Plan. Table ES-3 summarizes the major capital improvements recommended between 2015 and 2035. Table ES-3 is a summary of the larger projects for general discussion of the magnitude of the budget and project schedule.

The new CIP shows that low growth rate projections resulted in a plan where 93.5% of the project budget is rate funded, either maintenance or capital replacement, with 6.5% identified as impact fee funded supporting new capacity or new pipe construction. One of the largest components of the new CIP is the expanding Pipe Replacement Program between 2020 and 2035 increasing the amount of pipe being replaced by approximately 1.0 mile per year in order to keep up with pipes reaching the end of their expected lifespan.

Figure ES-3 Water Supply and Demand

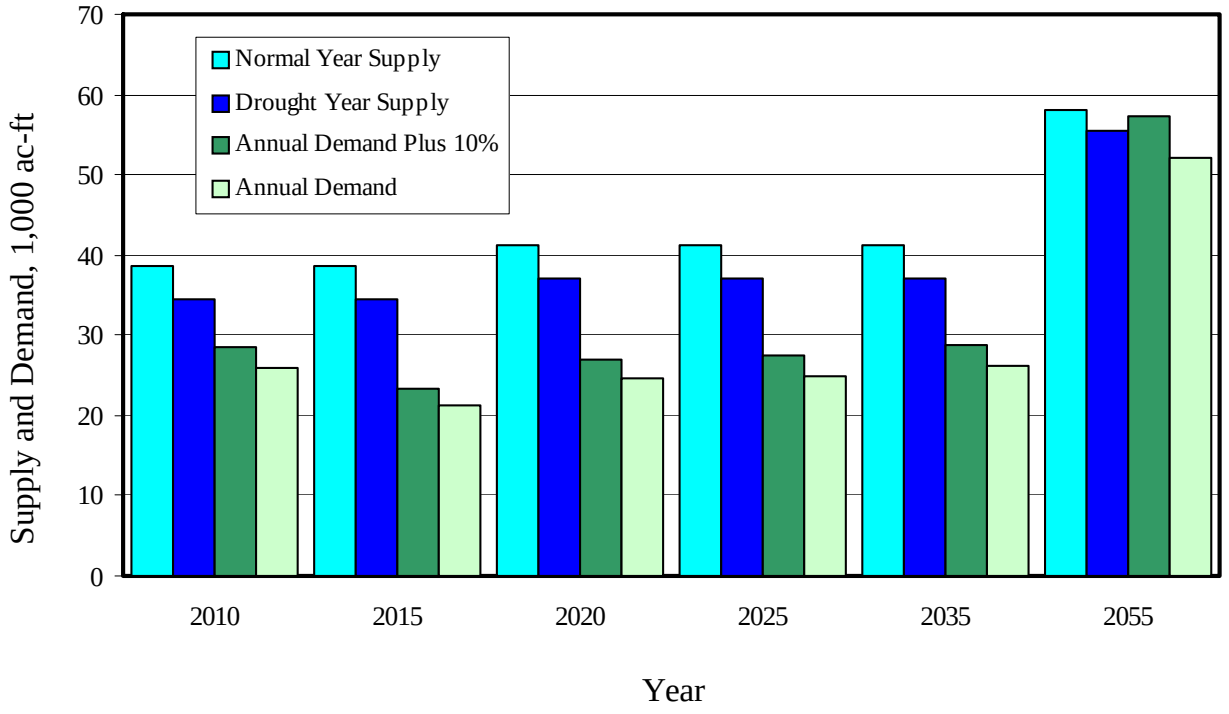
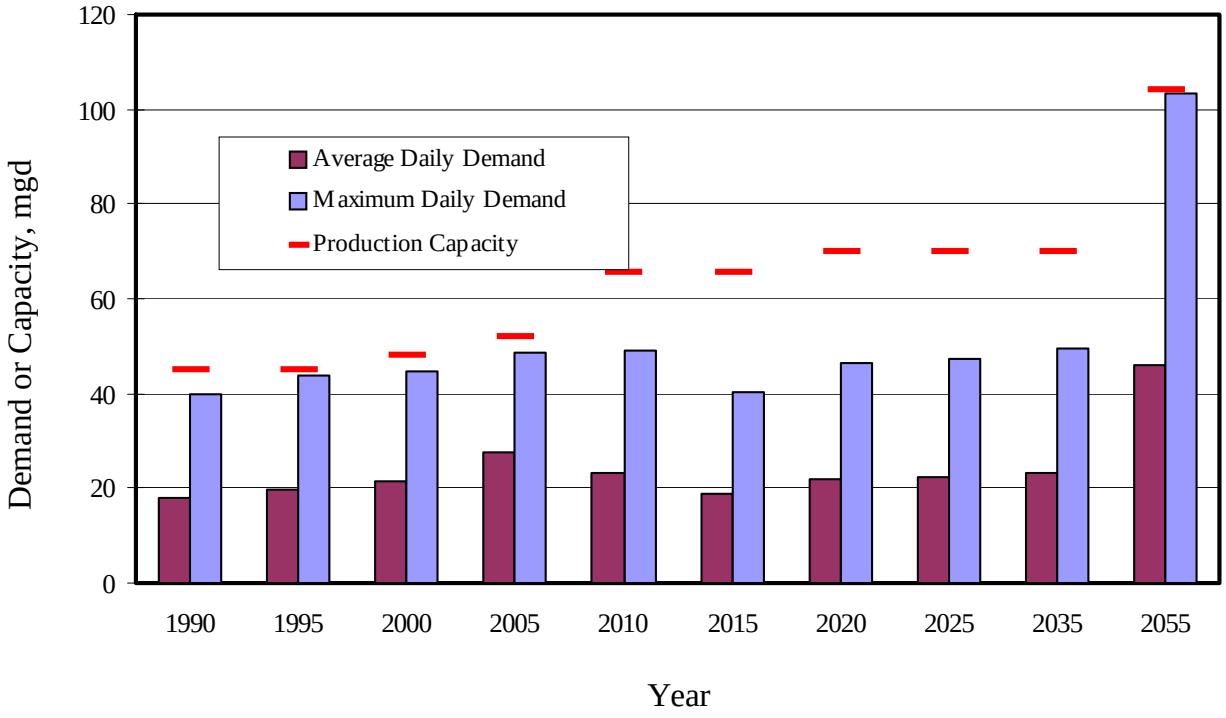


Figure ES-4 Water Treatment Capacity



Pump Station 1

Table ES-3 Major Replacement and Expansion Capital Expenditures

Fiscal Year	*Project*	*Rate Cost*	*Expansion Cost*	*Total Cost*
2016-2017	- Foothill WTP Improvements	$2,800,000		$2,800,000
	- Buckeye WTP Improvements	$105,000		$105,000
	- Well Head Treatment EW12	$2,555,420		$2,555,420
	- Pipe Replacement Program	$1,058,000		$1,058,000
	- Pump House 1 Relocation Enviro	$750,000		$750,000
	- Enterprise Reservoir Repair	$100,000		$100,000
	Sub Total:	$7,368,420		$7,368,420
2017-2018	- Foothill WTP Improvements	$824,800		$824,800
	- Pipe Replacement Program	$1,831,575		$1,831,575
	- Cypress Booster Pump	$1,269,477		$1,269,477
	- Buckeye WTP Improvements	$108,255		$108,255
	- 20" Westside Road at Canyon Creek	$102,912	$91,262	$194,174
	- 24" Lake Blvd Oasis to Northpoint (CONV-04)	$2,090,048	$522,512	$2,612,560
	- Cascade Tank Maintenance	$400,000		$400,000
	Sub Total:	$6,627,067	$613,774	$7,240,841
2018-2019	- Foothill WTP Improvements	$850,369		$850,369
	- Buckeye WTP Improvements	$108,255		$108,255
	- Pipe Replacement Program	$1,888,354		$1,888,354
	- 24" Lake Blvd Oasis to Northpoint (CONV-04)	$2,167,069	$541,767	$2,708,836
	Sub Total:	$5,014,047	$541,767	$5,555,814
2019-2020	- Foothill WTP Improvements	$876,730		$876,730
	- Buckeye WTP Improvements	$115,071		$115,071
	- Pipe Replacement Program	$1,946,893		$1,946,893
	Sub Total:	$2,938,694		$2,938,694
2020-2021	- Foothill WTP Improvements	$903,909		$903,909
	- Buckeye WTP Improvements	$118,638		$118,638
	- Pipe Replacement Program	$2,007,246		$2,007,246
	- New Hill 900 Reservoir	$1,605,870		$1,605,870
	20" Lake Blvd, Northpoint to Masonic	$303,562	$123,990	$427,552
	Sub Total:	$4,939,225	$123,990	$5,063,215
2021-2022	- Foothill WTP Improvements	$931,930		$931,930

	- Buckeye WTP Improvements	$122,316		$122,316
	- Pipe Replacement Program	$3,849,804		$3,849,804
	- New Hill 900 Reservoir	$1,605,870		$1,605,870
	- 20" Oasis - UPRR to Beltline	$821,308	$205,327	$1,026,635
	- Construct Blending Pipeline EW13 to EW14	$2,377,278		$2,377,278
	16" Lake Blvd - Masonic to Hilltop	$171,046	$477,059	$648,105
	Sub Total:	$9,879,552	$682,386	$10,561,938
2022-2023	- Foothill WTP Improvements	$960,820		$960,820
	- Buckeye WTP Improvements	$126,108		$126,108
	- Pipe Replacement Program	$5,588,608		$5,588,608
	- 20" Oasis - Calexico to A6-V1	$460,481	$347,381	$807,862
	- Pump Station 1 Relocation	$8,832,000		$8,832,000
	- 20" Beltline - Oasis to Mtn Lakes	$411,411	$137,137	$548,548
	Sub Total:	$16,379,428	$484,518	$16,863,946
2023-2024	- Foothill WTP Improvements	$990,605		$990,605
	- Buckeye WTP Improvements	$130,017		$130,017
	- Pipe Replacement Program	$7,450,492		$7,450,492
	- Well Head Treatment at EW14	$2,017,845		$2,017,845
	- Pump Station 1 Relocation	$8,832,000		$8,832,000
	- Construct New Well	$2,119,328		$2,119,328
	Sub Total:	$21,540,287		$21,540,287
2024-2025	- Foothill WTP Improvements	$1,021,314		$1,021,314
	- Buckeye WTP Improvements	$138,203		$138,203
	- Pipe Replacement Program	$9,442,174		$9,442,174
	- Pump Station 1 Relocation	$4,074,325		$4,074,325
	- Well Head Treatment at EW14	$2,017,845		$2,017,845
	Sub Total:	$16,693,861		$16,693,861
2025-2026	- Foothill WTP Improvements	$1,059,001		$1,059,001
	- Buckeye WTP Improvements	$138,203		$138,203
	- Pipe Replacement Program	$11,590,698		$11,590,698
	- Construct Blending Pipe from EW12 to EW14	$2,856,150		$2,856,150
	- Pump Station 1 Relocation	$2,347,762		$2,347,762
	Sub Total:	$17,991,814		$17,991,814

2026-2027	- Foothill WTP Improvements	$1,098,078		$1,098,078
	- Buckeye WTP Improvements	$142,487		$142,487
	- Pipe Replacement Program	$13,843,450		$13,843,450
	- New Buckeye Reservoir at Herbscenta	$489,392	$1,468,178	$1,957,570
	- 30" Buckeye Res to Quartz Hill	$274,897	$824,691	$1,099,589
	- 24" Quartz Hill to Keswick Dam Blvd	$401,327	$1,203,983	$1,605,310
	Sub Total:	$16,249,631	$3,496,852	$19,746,484
2027-2028	- Foothill WTP Improvements	$1,138,597		$1,138,597
	- Buckeye WTP Improvements	$146,904		$146,904
	- Pipe Replacement Program	$16,268,176		$16,268,176
	- New Buckeye Reservoir at Herbscenta	$489,392	$1,468,178	$1,957,570
	Sub Total:	$18,043,069	$1,468,178	$19,511,247
2028-2029	- Foothill WTP Improvements	$1,180,611		$1,180,611
	- Buckeye WTP Improvements	$151,458		$151,458
	- Pipe Replacement Program	$18,852,998		$18,852,998
	- 16" Twin View - 8-V24 to Oasis Center	$1,674,645	$717,705	$2,392,350
	Sub Total:	$21,859,712	$717,705	$22,577,417
2029-2030	- Foothill WTP Improvements	$1,224,175		$1,224,175
	- Buckeye WTP Improvements	$156,154		$156,154
	- Pipe Replacement Program	$21,606,430		$21,606,430
	Sub Total:	$22,986,759		$22,986,759
	TOTAL:	$188,511,566	$8,129,171	$196,640,737

9.0 IMPACTS OF THE CIP ON FINANCES

A high level analysis of the recommended CIP to projected water utility rate and impact fee revenue was performed. It is noted that a more detailed analysis will be provided in a pending 2016 utility rate program update. The 2016 Master Plan Update analysis included the following assumptions:

- Master Plan Growth Rate Projections. Details of the Master Plan Growth Rate Projections can be found in Appendix D, Demand Forecasting Methods. Annual growth rates range from 0.38 to 0.43% per year.

- CCI escalation of cost of all projects. Cost estimates were prepared in 2011 dollars then escalated by an annual increase of 3.69% to the year the project is scheduled for completion. This results in a doubling of project costs approximately every 20 years. So the last year of projects listed in Table ES-3, totaling $22,987,000, thirteen years in the future, would be approximately $14,352,000 in 2016 dollars.

- Impact fees increasing at an annual rate of 3.69% starting in 2012-13 to match the CCI.

- Rates increased by the blended CCI/CPI index of 3.08% per year starting in 2012-13.

- There are additional Utility budget divisions that set aside various components of the budget for specific purposes if examined in a high enough level of detail. For instance there is an account for rolling stock with interest on the balance that is a line item on revenue. In this document all such accounts were re-combined into either fee or rate accounts for the purpose of identifying potential overall budget challenges.

- Non-capital expenses were also incorporated into the financial analysis.

A short summary of the findings of the financial analysis prepared with this Master Plan are as follows:

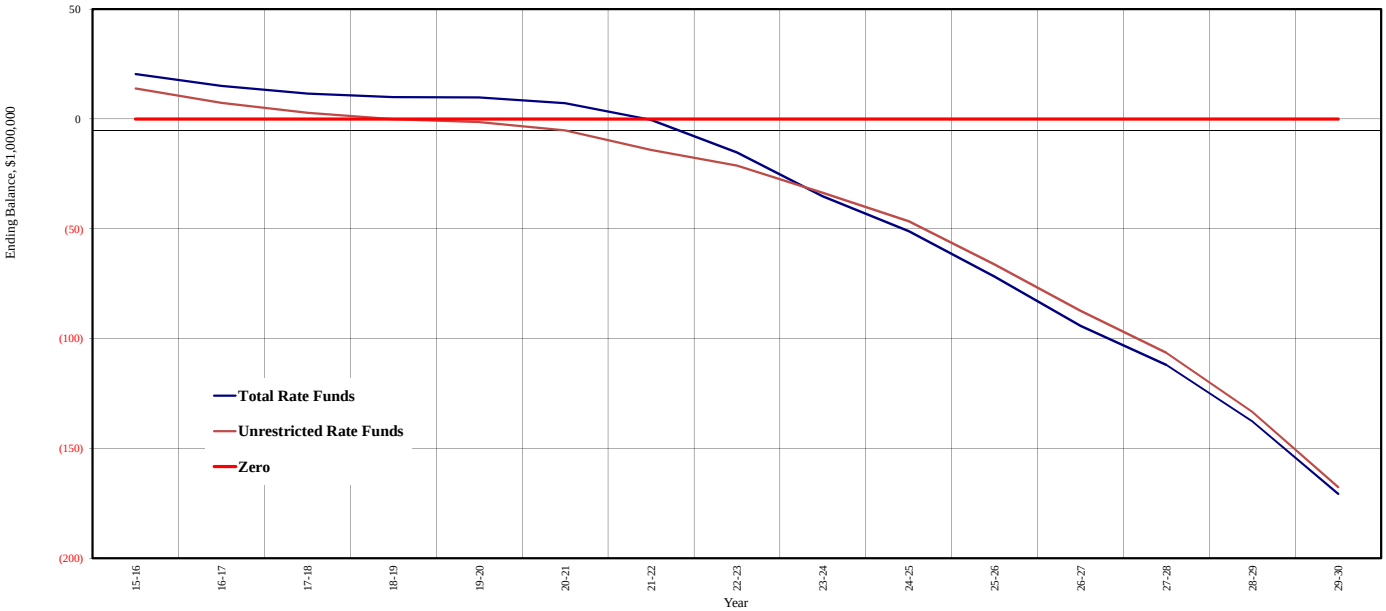
1. Under current fee schedule, the utility has funds to support the growth related component of projects. It is important to note that the lack of current impact fee related projects forecast that far in the future does not necessarily indicate that none will be necessary. It is recommended that periodic revision of this document re-evaluate those needs at regular intervals to verify need, or lack thereof, for more growth related projects. This impact fee deficit can be covered by rate payer revenue. However, in doing so;

2. Under the current rate schedule, the Utility will run out of unrestricted rate funding in fiscal year 2018-19.

3. Risks associated with maintaining the current fee and rate schedule are:
   - Pipe replacement schedule will not keep up with expiring pipe resulting in an increase in water main failure.
   - Treatment plant improvements may not keep up with the regulatory requirements resulting in loss of service to customers.
   - Storage for emergencies may become deficient as existing reservoirs expire.

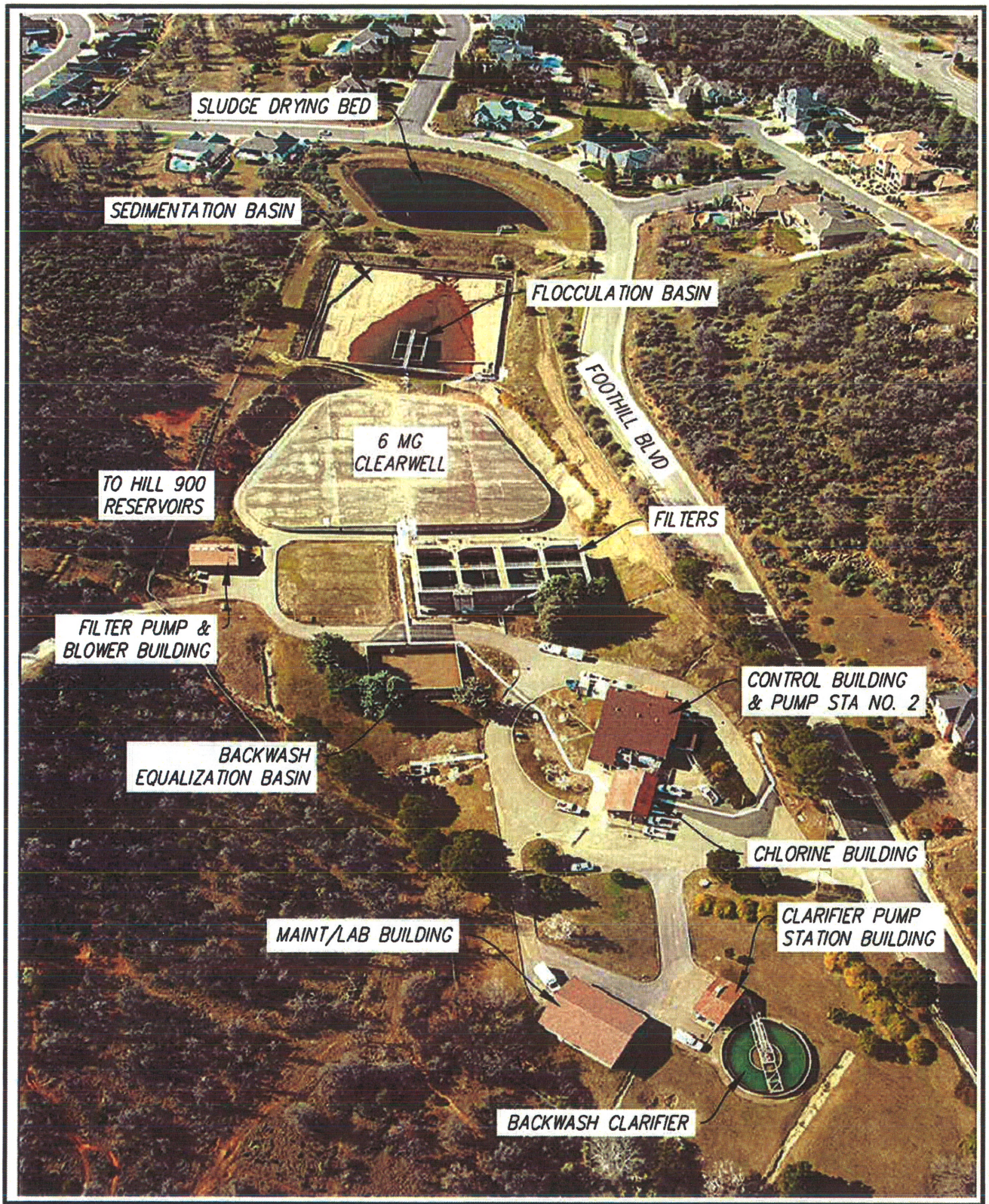
4. The high level analysis revealed that if rates alone are used to keep the Utility balance from dropping below zero, annual increases will need to be implemented between 6% and 8% starting with 8% in 2017-18. Figure ES-5 shows the end of year balance for each account under the assumptions listed above. Note that this analysis does not include a reserve.

Figure 7-2 Baseline Scenario



Rate Increase:	7.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Buckeye 4 MG Reservoir



DATE			
05/11	PACE ENGINEERING REDDING, CALIFORNIA	CITY OF REDDING FOOTHILL WATER TREATMENT PLANT FACILITIES PLAN EXISTING FWTP AERIAL	FIGURE 1 JOB # 21.10

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File Name: M:\Land Projects\0021.10 Foothill WTP Facilities Plan\Dwg\AERIAL.dwg, Layout: AERIAL

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Reference Documents

City of Redding Water Master Plan 2000
City of Redding Water Utility Master Plan 2012
DPH Public Water System Annual Inspection Report for City of Redding, September 2010
City of Redding General Plan 2000
City of Redding Subdivision Ordinance (Redding Municipal Code Title 17)
City of Redding Zoning Ordinance (Redding Municipal Code Title 18)
Shasta County Regional Transportation Planning Agency - Traffic Model

AC	asbestos cement pipe
ac-ft	acre-feet
ADD	average-day demand
AWWA	American Water Work Association
C	concentration
CAD	computer-aided drafting
CCP	concrete cylinder pipe
CI	cast iron
CIP	capital improvement plan
CT	chlorine concentration times modal contact time
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CW	Cascade Well
D/DBP	disinfectants/disinfection byproducts
DBP	disinfection byproducts
DEM	digital elevation model
DI	ductile iron
DPA	design, permitting, and project administration costs
DPH	Department of Public Health
DTM	digital terrain model
EPA	U.S. Environmental Protection Agency
EW	Enterprise Well
FAC	Federal Advisory Committee
FY	fiscal year
GALV	galvanized steel
GIS	geographic information system
gpcd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
gpd/conn	gallons per day per connection
HAA	haloacetic acids
hp	horsepower
HE	household equivalent
HGL	hydraulic grade level
IDS	initial distribution system
IESWTR	interim enhanced surface water treatment rule
ISO	Insurance Services Office
LF	linear feet
LRAA	locational running annual average
LT2ESWTR	long-term 2 enhanced surface water treatment rule

M&I	municipal and industrial
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MDD	maximum-day demand
MG	million gallons
mgd	million gallons per day
mL	milliliter
MPN	most probable number
MSL	mean sea level
n/a	not available
NPSH	net-positive suction head
NTU	nephelometric turbidity unit
O&M	operations and maintenance
PDD	peak-day demand
PLAS	plastic (non-PVC) pipe
PPB	parts per billion
ppc	person per connection
pph	person per household
PRV	pressure-reducing valve
PS	pump station
psi	pounds per square inch
PVC	polyvinyl chloride
PWL	pumping water level
Reclamation	U.S. Bureau of Reclamation
SCADA	supervisory control and data acquisition
STL	steel
Sub	submersible vertical turbine
SWTR	surface water treatment rule
T	time
TDH	total dynamic head
TOC	total organic carbon
TTHMs	total trihalomethanes
UBO	ultimate build-out
ug/l	micrograms per liter
UV	ultraviolet
VFD	variable frequency drive
VT	vertical turbine
WMP	water master plan
WSA	water service area
WSP	welded steel pipe
WTP	water treatment plant

CHAPTER 1

Introduction and Overview
Water Utility Master Plan Update 2016

1.1 PURPOSE

The Water Master Plan includes detailed hydraulic modeling, water system operations evaluation and capital improvement recommendations for the water system through year 2030. A cost of service study will be performed by an independent team based on results of this report. The Plan also addresses the City's long-term water demands, supply alternatives, and major capital improvements through buildout of the City's water service area.

The Water Master Plan is a "planning level" document and as such has inherent uncertainties which are unacceptable for final design purposes. It is imperative that prior to the design of any significant infrastructure that the design process be initiated with a scoping effort including detailed, design level analysis to refine or confirm the results contained in this document.

1.2 SCOPE

The scope of work for the Water Master Plan includes the following primary tasks:

Data Collection and Evaluation Review of Existing System Water system facility and operations information were collected for all major components of the water system. This included distribution piping, pump stations, reservoirs, water treatment plants, and groundwater supply wells. The City's Geographic Information System (GIS) data for the water system was collected, reviewed, and updated. Field investigations of most major facilities were conducted to evaluate general material conditions and typical operating conditions. Current and historical water production, distribution, and demand data were collected and reviewed.

Digital Elevation Model (DEM) A DEM was created with the WMP 2000 to provide coordinates and elevations for all points within the City water system. Elevations for each component of the water system was then determined by overlaying the GIS water system network onto the DEM, providing a three-dimensional representation of the water system. This existing DEM data remains relevant and is utilized and updated where necessary with the WMP 2016 update.

Hydraulic Modeling of Water System A computer model of the City's water distribution system was developed with the WMP 2000 to simulate detailed daily and hourly operations of the water system. Prior to system modeling for the WMP 2012, all pipe sizes and locations used in the model were verified and updated as needed using current GIS information and as-built drawings from new development and public projects occurring over the past decade. The updated hydraulic model was then used to evaluate operations of the existing system and determine needed future improvements such as pipelines and storage reservoirs. Additional review and revision of the hydraulic model and operations parameters occurs on an ongoing basis and was reviewed for completeness and accuracy prior to the 2016 revision effort.

Development Demand Customer demand was developed by analysis of water demands for each pressure zone and distributed across each model network zone uniformly following diurnal patterns. The highest 100

water users were identified, located and their demands were applied according to their quantity, use pattern, and location.

Development of Future Water Demand Projections Future water demand for each of the City's six pressure zones was developed for 2015, 2020, and 2030 using land use projections from the current Regional Traffic Planning Model and information from Redding Electric Utilities consultant, Economic Sciences Corporation. The Ultimate Buildout (UBO) scenario demand projections were obtained from allowable land use density projections under the current General Plan and Zoning Ordinance. The demand projections for planning horizon were then used to determine needed water supply and distribution system improvements.

Long-term Water Supply Evaluation Alternatives for increased future water supply were evaluated according to projected water demands. Recommendations are made for specific actions to develop supply through 2030, and long-term planning recommendations are made to address buildout water supply requirements.

Water System Capital Improvements Specific capital improvements are scheduled through 2030, including costs and year of completion, as necessary to meet increased water demands in the City. Anticipated long-term capital improvements beyond 2030 were projected to forecast potential planning efforts necessary to support their construction.

Financial Analysis A brief financial overview through 2030 is provided as an order of magnitude evaluation of potential budget deficit or excess. A cost of service study prepared by an independent consultant will follow the Master Plan effort to provide detailed recommendations on utility funding.

1.3 RECENT DEVELOPMENTS

Following development of the Water Utility Master Plan 2012 water utility planning efforts have been presented with several new challenges and changes. The most publicized of these is the three year drought from 2013 through 2015 and the regulatory reaction to water shortages in different regions of the State. In addition to the drought issues population forecasts continue to show declining growth. Environmental interest influences on water use are also escalating as non-governmental groups attempt to shift water use to support claims that municipal/industrial and agricultural uses are causing violations of the Endangered Species Act.

Documentation of water supply resources in the Water Utility Master Plan 2012 included consideration and planning for curtailment of diversions from both Spring Creek Conduit (Buckeye Contract) and the Sacramento River (Redding Contract) according to the terms of each contract. However, both contracts include language that can increase curtailment (reduce diversion amounts) in the event that the Governor of the state declares an emergency. If that happens the amount of curtailment is unpredictable. In early 2014 the Governor declared a statewide drought emergency and the resulting Bureau curtailment of water diversion was as much as 100% at one point.

In addition to a new understanding of the magnitude of possible curtailments during a drought, growth projections in terms of population have been drastically declining. In the 2000 Water Master Plan population growth averaged 1.7% per year between 2005 and 2035. By the 2012 MP effort the average from 2010 to 2030 dropped to 1.0% per year and the latest estimates obtained in 2015 only reflect 0.4% per year through 2035. Figure 1-1 presents a comparison of the three growth projection efforts.

The utility is also presented with uncertainty in regards to water rights obligations from the Bureau of Reclamation. In 2004-2005 the Bureau of Reclamation renewed contracts for Project Water from the CVP for settlement contractors for as much as another 40 years based on a Biological Opinion (BiOp) prepared by the Bureau with concurrence from Fish and Wildlife Service. The reasoning for the BiOp claiming that renewal of the contracts would not likely adversely affect the Delta Smelt was subsequently invalidated. A new BiOp was issued in 2008 which found that renewal of the contracts would jeopardize the Delta Smelt and adversely modify its critical habitat. The litigation then changed direction to an argument regarding whether or not the Bureau had discretion in renewing the contracts. A procedural history of that is as follows:

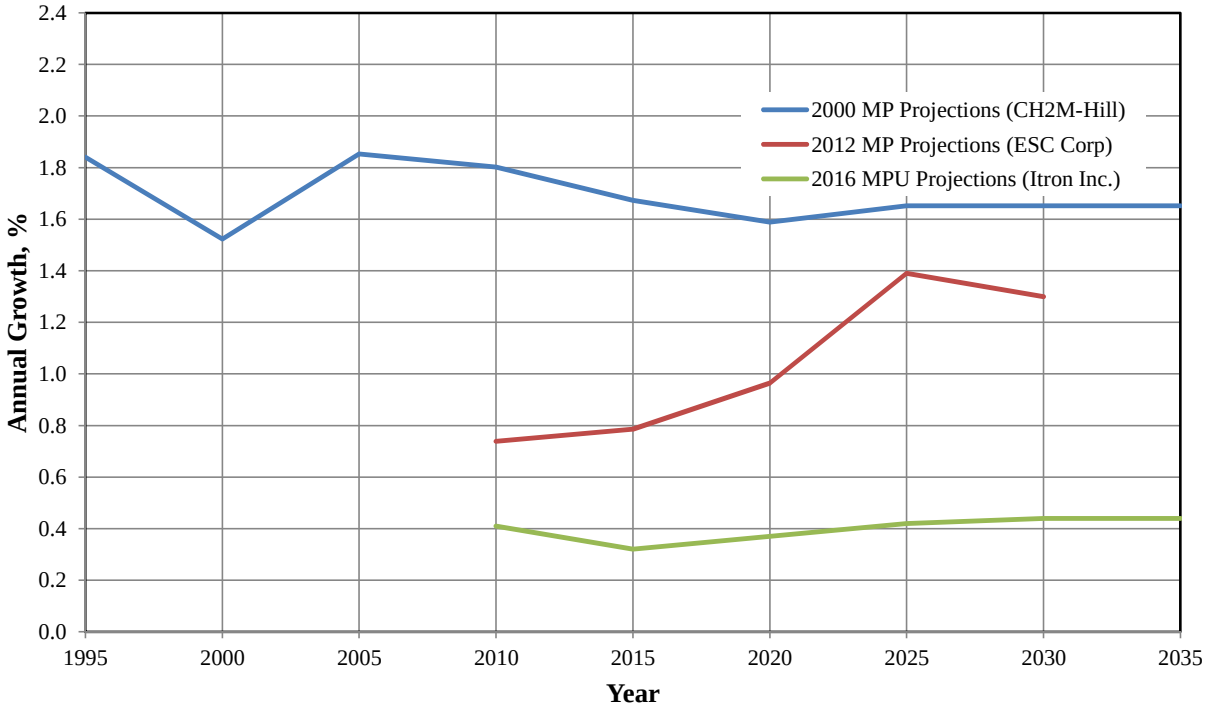
2008: Plaintiffs (NRDC et al.) filed a Third Amended Complaint in on-going litigation begun in 2004.
2009: decision by U.S. District Court for the Eastern District of California.
- Affirmed the USBR's position: Sec. 7 consultation is not triggered due to inadequate discretion
- NRDC appealed.

2012: 9th Circuit court of appeals panel affirmed the decision.
NRDC moved for an en blanc hearing (full 11-judge panel of 9th Circuit Court).
- Issue heard en blanc and reversed the prior decision 11-0
- Remanded back to U.S. District Court

The current status of the issue is that it is pending hearing by the Federal Supreme Court.

Of note in this process is that these contentious contracts were the result of extensive litigation and negotiation in the 1950s culminating in a settlement between the USBR and water rights holders that were impacted by operations of the newly constructed CVP facilities, specifically Shasta and Keswick Dams. Should the NRDC be successful in invalidating the existing contracts nobody knows the extent to which the pre-1964 litigation would return.

Figure 1-1 Growth Projections



Photograph Courtasy of Shasta Historical Society

Foothill Reservoirs - Replaced in 2006

BUCKEYE WATER TREATMENT PLANT

Water Utility Master Plan Update 2016

CHAPTER 2

Water System Facilities and Operations

2.1 OVERVIEW OF CITY WATER SYSTEM

The City of Redding's existing water system includes two treatment plants, 17 groundwater wells and Sacramento River and Whiskeytown Lake surface water resources for supply, approximately 2.95 million feet (558.5 miles) of conveyance and distribution pipelines, eleven pump stations, and twelve reservoirs. The overall water system and its primary features and facilities is mapped in Figure 2-3 (located at the back of this chapter) and Appendix A-1. The City's water system is licensed with the California Department of Public Health under System Number #4510005.

The City provides water service within the area shown on Figure 2-1, referred to in this study as the Water Service Area (WSA). The WSA does not match the City's corporate boundary exactly, as some parts of the City are served by neighboring water systems such as the Bella Vista Water District and Centerville Community Services District. The WSA also includes areas located outside the city limits in the Buckeye area. In 2015, the City's water system had an average of 28,999 service connections and a WSA population of approximately 90,700 people.

The WSA and overall water system have grown steadily since 1941 when the City's original water system incorporated with the old California Water Service Company system. This was followed by annexations of several special water districts. Major annexations included the Buckeye County Water System in 1967 and the Cascade and Enterprise special districts in 1977.

The water system is divided into six primary pressure zones for supply and distribution operations. Collectively the combination of all pressure zones represents the entire WSA. General statistics for the pressure zones are provided in Table 2-1. Figure 2-1 shows pressure zone boundaries and adjacent water service districts. Figure 2-2 provides a schematic profile of the City water system, showing the relative elevations of each water source and the interaction of the various pump stations and reservoirs.

The City has two surface-water treatments plants: Foothill WTP, which is supplied from Sacramento River via the Pump Station No. 1 (PS-1) diversion, and Buckeye WTP, which is supplied from Whiskeytown Lake via the Spring Creek Conduit. The City also has two groups of groundwater wells: twelve Enterprise wells, which supply most of the City's groundwater, and five Cascade wells, which are a relatively minor supply. Under normal operations, Foothill WTP supplies water to the Foothill Zone, Hill 900 Zone, Cascade Zone, Enterprise Zone, Hilltop-Dana Zone, and Buckeye Zone. Buckeye WTP supplies water to the Buckeye Zone, Hilltop-Dana Zone, and Foothill Zone. Enterprise wells supply the Enterprise, Cascade, and Hilltop-Dana zones. Cascade wells supply only the southern portion of the Cascade Zone.

2.1.1 Foothill Zone

The Foothill WTP is the regular supply for the Foothill Zone. Water from the Foothill WTP is transferred via gravity or pump stations to the Hill 900 Zone (via PS-2), Cascade Zone (gravity feed), Enterprise Zone (gravity feed), and Buckeye Zone (PS-3 and PS-4).

2.1.2 Hill 900 Zone / Mary Lake Booster Subzone

The Hill 900 Zone receives all of its supply from the Foothill WTP via PS-2. A secondary emergency supply can be provided via the El Reno Pump Station, which can convey water from the Cascade Zone into the southern end of the Hill 900 Zone. The Hill 900 Zone makes no regular transfers of water to other primary zones. However, within the Hill 900 zone there is a small isolated distribution network pressurized by the

Mary Lake Booster Pump. Mary Lake Booster Pump is set to maintain pressure at the higher elevations of Hill 900 pressure zone. When the Booster Pump is in operation, two check valves close downstream to prevent recirculation of water back through the pumps essentially creating a temporary new pressure zone.

2.1.3 Cascade Zone

The Cascade Zone is supplied from both the Foothill WTP via the Railroad Avenue vault and the Enterprise well field via the South Bonnyview pipeline and PS-6. During low demands, most of the supply comes from the Foothill Zone connection; and during high demands, both the Foothill and South Bonnyview supplies are needed. The Cascade Zone makes no regular transfers of water to other zones, with the minor exception of the El Reno Booster Pump to the Hill 900 Zone for emergency transfers.

2.1.4 Enterprise Zone

The Enterprise Zone is supplied from both the Foothill WTP via the Cypress Avenue cross- town main and the Enterprise wells. During low-demand periods, most of the supply comes from the Foothill WTP because of lower net supply costs. During heavy demands, the Enterprise Zone uses water from both the Foothill WTP supply and the Enterprise wells. Water is conveyed from the Enterprise Zone into both the Cascade Zone (via South Bonnyview), and the Hilltop-Dana Zone (via PS-5 and Goodwater PS).

2.1.5 Hilltop-Dana Zone

The Hilltop-Dana Zone's primary supply is the Foothill WTP, via the Cypress main and the Enterprise Zone. During heavy-demand periods, the Palisades pressure-reducing valves (PRV) can supply water from the Buckeye Zone into the Hilltop-Dana Zone to supplement the PS-5 supply. Emergency supply can be provided from the Enterprise Zone via the Goodwater Booster Pump station. The Hilltop-Dana Zone makes no regular transfers of water to other zones.

2.1.6 Buckeye Zone / Summit City Subzone

The Buckeye Zone's primary supply is the Buckeye WTP via the 30-inch Buckeye main. During heavy demands, PS-3 and PS-4 can be used to supply the Buckeye Zone with water from the Foothill WTP. Water is conveyed from the Buckeye Zone into the Hilltop-Dana Zone, as described above, and can also be conveyed into the Foothill Zone in an emergency via a PRV bypass at PS-3 and PS-4. Bureau of Reclamation contract water serving the Buckeye Zone also serves a small pressure zone located generally north of Walker Mine Road called the Summit City Pressure Zone (SCPZ). Water serving SCPZ is purchased by the City as part of the Buckeye Contract with the Bureau, but treated and delivered to customers by the City of Shasta Lake under a Water Delivery Agreement with the City of Redding. Water serving SCPZ originates at Shasta Dam and is transferred by way of the 6-inch Toyon main pipeline. Water delivery to SCPZ by City of Shasta Lake is tracked by a 4-inch compound meter located at 12984 Beltline Road. For the purpose of this Master Plan, SCPZ is treated as a subzone of the Buckeye Zone since they share Buckeye Contract water and are otherwise interconnected.

Table 2-1 Pressure Zone Statistics

Pressure Zone	Service Area (Acres)	Main Water Source(s)	Storage Capacity (MG)	Number of Connections
Enterprise	8783	Enterprise	9.5	8,729
Buckeye / Summit Cty	8263	BWTP, PS 3	6.2	5,050
Hill 900 / Mary Lake	3426	PS 2	4.0	4,701
Foothill	3334	FWTP	10.0	4,200
Cascade	4690	Cascade	3.0	3,413
Hilltop Dana	2148	PS 5 &	0.0	2,906
System Total	*30,644*		*32.7*	*28,999*

2.2 SURFACE-WATER TREATMENT FACILITIES

2.2.1 Foothill Water Treatment Plant

The Foothill WTP is located on Foothill Boulevard on the west side of the City. The facility was initially constructed in 1920, with one sedimentation basin and one open storage reservoir. The plant experienced modest upgrades in stages through the 1940s. In 1959 a major expansion was completed that included a concrete-lined flocculation/sedimentation basin, a concrete-lined reservoir, a building that houses controls and chemical feed systems, and development of PS-2 for supply to the Hill 900 pressure zone. The last major facility upgrades occurred 1981 when improvements were made to increase capacity and treatment operations, including filtration works and a covered storage reservoir. Following the 1981 expansion the plant's capacity was rated at 24 million gallons per day (mgd) with a planned future expansion to 42 mgd.

The Sacramento River is the water source for the Foothill WTP. PS-1, located near the southern trailhead of the Sacramento River Trail, pumps raw water to the plant through two transmission pipelines. Both pipes are 30-inch diameter ductile iron (DI), with the first pipeline constructed in 1976 and the second completed in 2010.

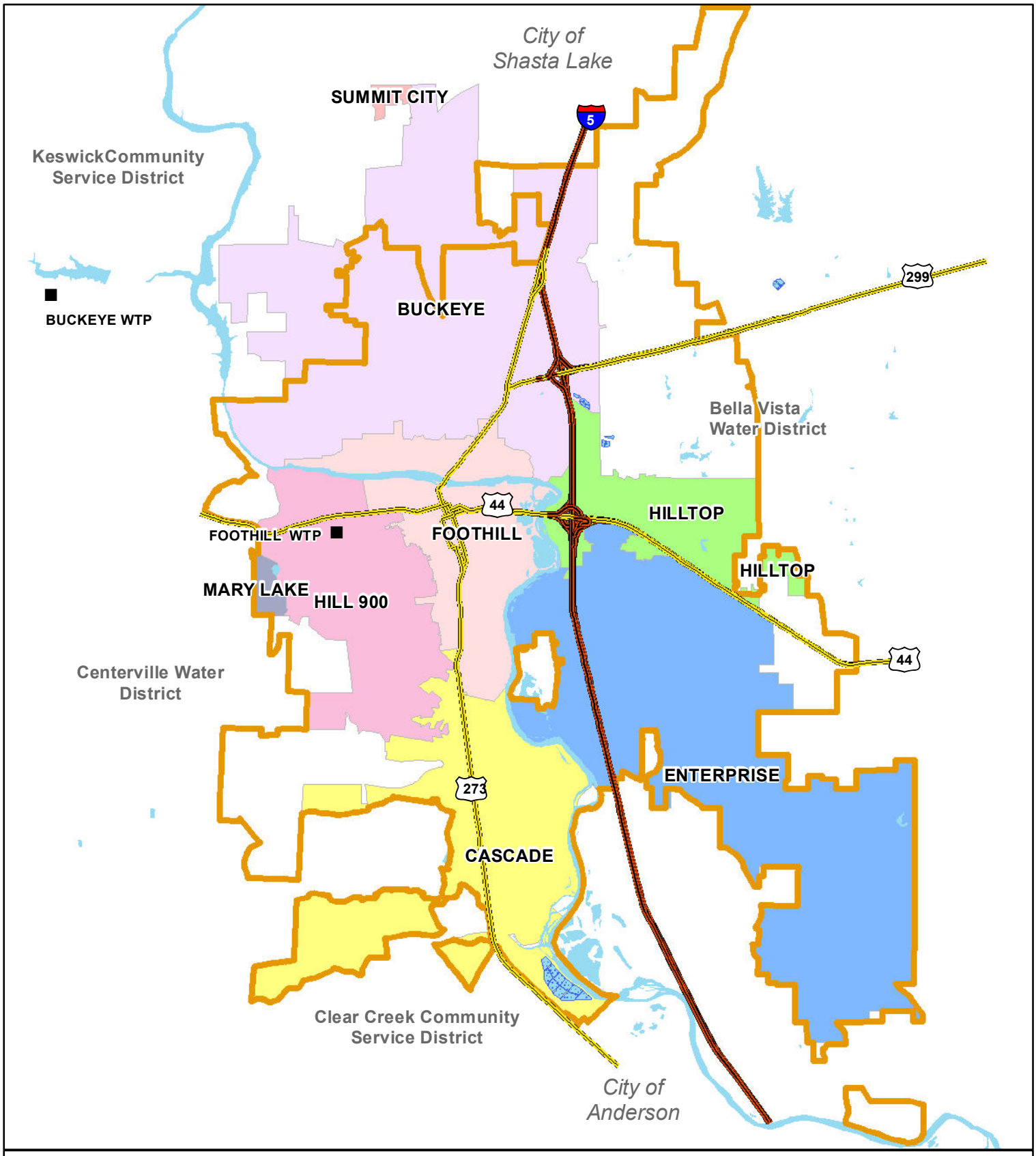
The plant's treatment systems include a flocculation sedimentation basin; a filtration system with filters and an air scour and backwash system housed in a pump and blower building; backwash wastewater handling facilities including an equalization basin, a clarifier, and a return pump station; a sludge drying bed; a control building housing controls, several chemical feed systems and PS-2; and a chlorine building housing the disinfection materials and equipment.

At the time of the 1981 expansion, the treatment facilities were designed to meet the requirements of the State of California Department of Health Services and federal drinking water regulations. However, California Waterworks Standards as administered by California Department of Public Health (CDPH) allows a higher surface loading rate than has been used historically at the treatment plant. At the allowable filter surface loading rate, the plant's firm capacity is 36 mgd, making the limiting factor the firm capacity of PS-1 which is 29 mgd.

2.2.2 Buckeye Water Treatment Plant

The Buckeye WTP, located on Benson Drive to the northwest of the City, was built in 1993. The plant was designed with an initial capacity of 7 mgd and was expanded to 14 mgd in 2008. The ultimate capacity of the treatment plant is planned to be as high as 28 mgd. The treatment plant's source water comes from the 17-foot diameter Spring Creek Conduit which draws raw water from Whiskeytown Lake, located approximately 3 miles west of the treatment plant. A 36-inch raw water pipe taps into the Spring Creek Conduit and feeds the plant.

The treatment system at Buckeye WTP currently includes a rapid mixing chamber; flocculation basins; sedimentation basins; a filtration system including filters and an air scour and backwash system; backwash wastewater handling facilities including a washwater recovery basin and sludge drying beds; and a control building housing controls, several chemical feed systems, and other miscellaneous systems. The plant is unmanned most of the time. Typically, the key processes are monitored and controlled from the Foothill WTP.



TREATMENT PLANT
CITY BOUNDARY

PRESSURE ZONE
BUCKEYE
CASCADE
ENTERPRISE
FOOTHILL
HILL 900
HILLTOP
SUMMIT CITY
MARY LAKE

N
W
E
S

0 0.5 1 2 3 Miles

Figure 2-1
City of Redding
Water Service Area

P:\RMU\ESRI\MasterPlan\Water_ServiceArea_8x11-2.mxd

October 1, 2012

2.3 GROUNDWATER SUPPLY FACILITIES

The City currently has 17 groundwater wells (16 active; 1 standby): 12 in the Enterprise Pressure Zone, located mainly north and west of the Redding Municipal Airport, and five in the Cascade Pressure Zone, located in the southeast corner of the zone near the Sacramento River. The 12 Enterprise wells provide approximately 30 percent of the City's total annual water supply. Well locations are shown on Figure 2-3. Table 2-2 lists information on each well.

Table 2-2 Groundwater Well Data

Well No.	Date	Depth (ft)	Casing (in)	Depth to Perf. (ft)	Elev. of Well Head (ft)	Typical Capacity (gpm)	Typical Summer Static W.L. (ft)	Typical Summer PWL (ft)	Typical Summer Draw (ft)	Specific Capacity (gpm/ft)	Typical Discharge Pressure (psi)	Pump HP / Type
Enterprise												
EW-3A	1983	496	16	244	526	460	151	245	94	4.9	80	100 / Sub
EW-4		500	16	120	522	365	177	233	56	6.5	112	150 / VT
EW-6A	1983	510	12	215	522	600	110	168	58	10.3	126	80 / Sub
EW-7	1968	600	16	200	515	1400	190	265	75	18.7	40	250 / Sub
EW-8	1980	395	15	150	792	1364	104	117	13	105	103	200 / VT
EW-9	1986	505	16	180	501	1575	109	132	23	68	120	250 / VT
EW-10	1986	525	16	210	514	1350	125	167	42	32	80	150 / VT
EW-11	1989	510	10	200	503	1350	140	170	30	45	110	200 / VT
EW-12	2002	500	16	240	502	2570	117	180	63	40.7	110	350/VT
EW-13	2002	500	16	240	498	1500	80	150	30	50		250/VT
EW-14	2006	410	16	260	500	1800	117	238	121	15	113	250/VT
EW-23	2007	410	16	270	500	1740	125	VFD	-	-	125	350/VT
Cascade												
CW-1	1961	172	10	70	440	180	26	73	47	3.8	112	30 / Sub
CW-5 *	1964	358	16	115	477	100	55	88	33	3.0	115	20/VT
CW-6	1967	712	12	68	439	97	101	125	24	4	126	25 / VT
CW-8	1970	200	12	80	439	144	45	100	55	2.6	110	40 / VT
CW-9	1973	170	12	115	439	83	27	43	16	5.2	126	20 / VT

* CW-5 is used only as a standby well

MSL = mean sea level NGVD-29
gpm = gallons per minute
PWL = pumping water level
psi = pounds per square inch

Sub = Submersable Turbine
VT = Vertical Turbine
Draw = Drawdown

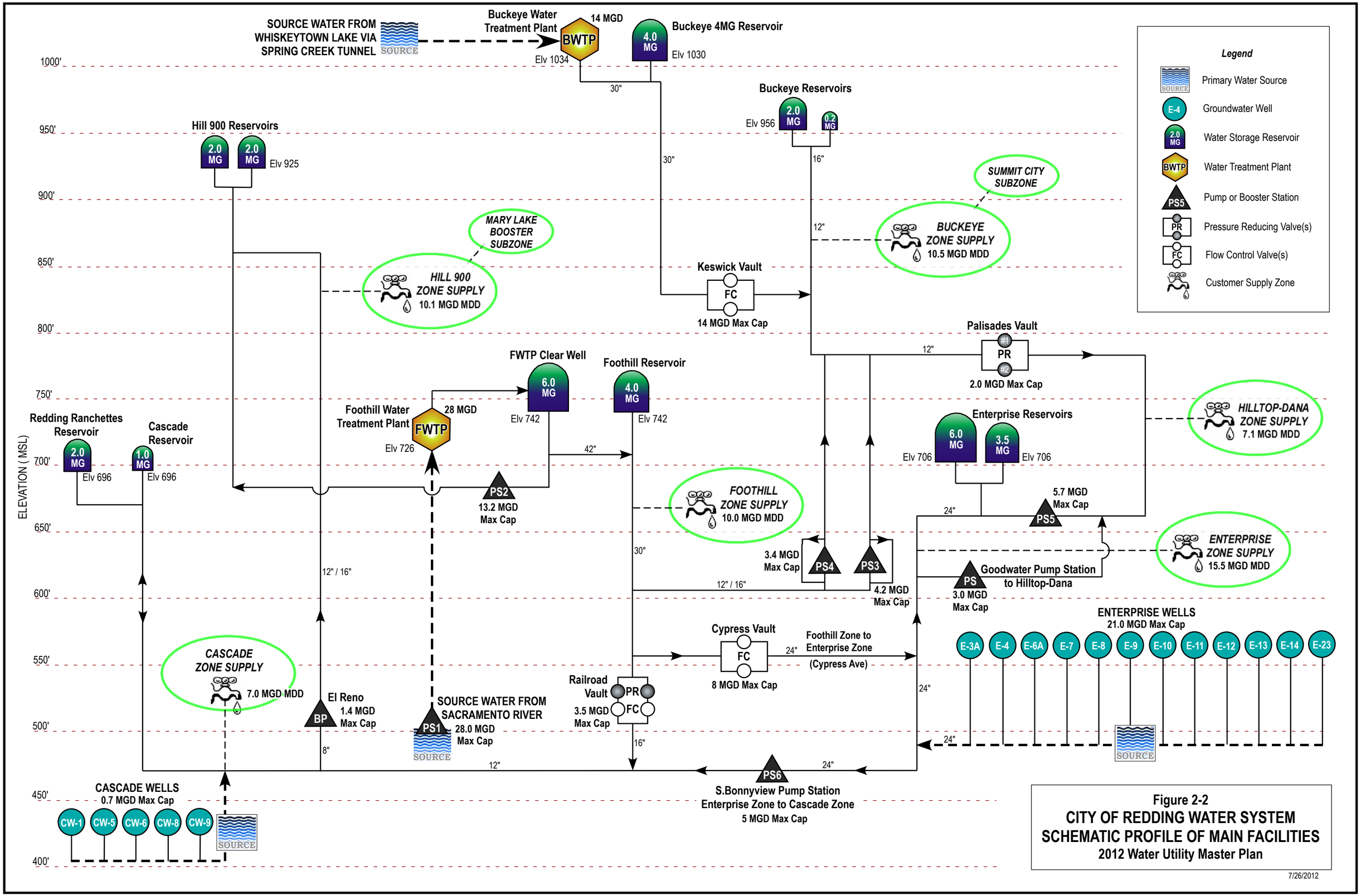


Figure 2-2
CITY OF REDDING WATER SYSTEM
SCHEMATIC PROFILE OF MAIN FACILITIES
2012 Water Utility Master Plan

2.3.1 Enterprise Wells

The 12 Enterprise wells provide approximately 95 percent of the City's groundwater supply and have a combined pumping capacity of approximately 19 mgd (excluding EW-11 and 13). Annual yield in 2015 was approximately 7,525 ac-ft. The wells vary substantially in their flow rates and annual yield, as shown in Table 2-2. The older wells (EW-3A, EW-4, EW-6A, EW-7) are located in lower yielding areas of the aquifer, and the newer wells (EW-12 through EW-23) are located farther south in the higher-yielding area of the aquifer.

The water quality from the Enterprise wells is generally considered good, but requires a certain amount of special treatment. Chlorination is provided at each well head. Enterprise wells, except EW-3A and EW-4, have orthopolyphosphate injection to reduce iron and manganese, to improve taste and odor problems. The City also has an annual water main flushing program that helps prevent water quality in the mains supplied from the Enterprise wells.

During low-demand periods, typically one or two of the larger wells (EW-8 through EW-23) are operated automatically to maintain water levels in the Enterprise reservoirs. During maximum-demand periods, all wells are typically running and set to manual control to prevent any well from being turned off automatically because of potential problems with the communication signals used to provide the supervisory control and data acquisition (SCADA) link.

On January 22, 2001 the U.S. EPA established the mcl AT 0.010 MG/l (10 µg/L) (40 CFR 141.62(b)(16)). The Rule became effective on March 23, 2001. The Rule established that the 0.01 mg/L MCL was enforceable as of January 23, 2006, and that the clarifications to compliance and new source contaminant monitoring regulations became enforceable on January 22, 2004 (40 CFR 141.6(j) & (k)).

Arsenic levels exceed the MCL of 0.01 mg/L in EW-12 and manganese levels exceed the SMCL of 0.050 mg/L. The arsenic and manganese levels in EW-12 are over double the MCL/SMCL levels. The oxidation of soluble manganese in the groundwater to manganese dioxide results in a black or dark brown colloidal solid that deposits within the water distribution system and is noticeable at the point of use for community residents. In 2014/15 Waterworks Engineers was contracted to investigate the possibility and feasibility of implementing well head treatment at EW-12.

Wells EW-11 and EW-13 show arsenic concentrations near or exceeding the maximum allowable contaminant level of 10 ppb. In 2008 the City contracted with Water Works Engineers to investigate alternatives for addressing the arsenic issue in these wells. The final study issued in July 2008 recommended several projects to dilute and treat arsenic, iron and manganese concentrations. Further details of these projects and this issue are covered in Chapter 5. EWs 11 and 13 are currently on backup “standby” status for emergency use only.

Pursuant to recommendations of the Enterprise Zone Well Operations and Treatment Alternatives Analysis performed by Waterworks Engineers in July 2008 well head treatment is being designed for Enterprise Well 12. EW12 is the highest producing well in the current city well inventory but approaching MCL levels for arsenic and manganese. The strategy behind well head treatment at this location includes the ability to utilize EW12 water that is free of these constituents to blend down water from other wells and allow them to increase production. This would not only put EW12 into full service but add capacity in two other wells.

2.3.2 Cascade Wells

The five Cascade Zone wells typically provide less than 4 percent of the City's annual groundwater supply, and have a combined pumping capacity of approximately 0.73 mgd. Annual yield in 2015 was 560 ac-ft. The water from the Cascade wells is generally of good quality. The Cascade wells do not have chlorine injection at the wells because water quality testing shows sufficient chlorine residual in the system resulting

from blending the well water with the supply from the Foothill WTP. The wells are run on manual control only.

2.4 CONVEYANCE AND DISTRIBUTION PIPING

2.4.1 Summary of Distribution System Piping

As of 2015, the City's water distribution system includes approximately 2,942,250 linear feet (558 miles) of conveyance and distribution pipe ranging in size from 1-inch to 48-inch. Table 2-4 summarizes the existing distribution system pipe by size, material, and linear feet. The information in the table is summarized from the City's GIS water pipe database. The following general observations are made from this information:

1. There are 8 pipe material types, with approximately 91 percent of the piping consisting of the four most common pipe materials: PVC (34 percent), AC (29 percent), DI (17 percent), and CI (11 percent). The remaining 9 percent of piping consists of a mix of CCP, Steel (WSP, GALV, STL) and unknown pipe material.

2. Distribution of pipe sizes is as follows: 4-inch and smaller (7 percent), 6-inch and 8-inch (69 percent), 10-inch to 16-inch (19 percent), 18-inch to 24-inch (3.1 percent), and larger than 24-inch (2.2 percent). Most of the City's piping consists of materials with good corrosion and service properties (AC, PVC, DI). The City's current piping specifications require DI for all pipe 12-inch or larger, and allow either PVC C900 or DI for piping smaller than 12-inch.

3. There are approximately 108,465 feet of steel pipe, ranging from 4-inch to 30-inch, with most of this in the 4-inch to 8-inch range. The sections of larger steel pipe typically have corrosion protection from a combination of linings, coatings, and cathodic protection.

4. The existing AC pipe is primarily used in 6-, 8-, and 12-inch lines, with smaller amounts of 4-inch pipes. AC pipe is no longer used in new distribution system construction.

5. Approximately 7.3 percent (213,487 feet or 40 miles) of the main distribution piping is small size (4-inch or smaller). This smaller piping is located primarily in older areas of the City and areas where the City annexed existing community water systems such as Buckeye and Cascade. The City’s current construction standards require minimum main distribution pipe size of 6-inches and greater.

Table 2.3 provides annual statistics on recorded distribution service problems dating back to 1993.

Table 2-3 Distribution System Problems Summary 1995 to 2015

Year	Number of Connections	Main and Service Breaks; Water Outages	Low/High Pressure	Taste/Odor Complaints
1995	22720	n/a	69	85
1996	23426	619	110	97
1997	23609	659	97	123
1998	23901	312	119	74
1999	24051	454	130	85
2000	24849	346	102	29
2001	25259	343	98	25
2002	25796	396	130	100
2003	26278	412	158	48
2004	26575	443	134	50
2005	27135	426	197	43
2006	27682	404	131	66
2007	27906	617	152	10
2008	27973	454	151	50
2009	28123	209	84	19
2010	28212	164	110	34
2011	28224	119	107	31
2012	28322	79	250	65
2013	28468	323	125	194
2014	29727	244	212	32
2015	29022	124	197	71

Table 2-4 Water System Pipe Inventory (Feet)

Dia (in)	*Pipe Type* AC	CI	DI	PVC	STL	Other/Un	*Totals (ft)*	*Percent*
1	398	98	61	3529	15873	45046	65005	2.2
2	162	15916	815	19907	571	26231	63602	2.2
3	5349	-	270	5470	13	223	11325	0.4
4	21842	1851	742	36145	9634	3341	73555	2.5
6	503933	155567	57052	314557	50457	19174	1100740	37.4
8	218368	48633	42825	588201	16853	449	917691	31.1
10	4480	4329	1702	7601	1481	-	19593	0.7
12	107340	84429	210491	17273	564	2371	422470	14.4
16	4233	6321	91397	-	10	3678	108939	3.7
18	1348	122	11390	-	11555	3269	27684	0.9
20	-	-	1146	-	189	8489	9824	0.3
24	-	146	43470	-	278	15235	59130	2.0
30	-	-	29412	-	916	24354	54682	1.9
36	-	-	6101	-	70	2562	8733	0.3
42	-	-	1231	-	-	-	1231	0.0
48	-	-	419	-	-	-	419	0.0
Totals (ft)	867453	317401	498524	992683	108465	157724	2942250	
Percent	29.5	10.8	16.9	33.7	3.7	5.4		
							557.2 (miles)	

AC asbestos cement pipe
CI cast iron
DI ductile iron
PVC polyvinyl chloride
STL steel

2.5 PUMP STATIONS

The City's water system has ten pump stations, used for raw water supply, conveyance of treated water between pressure zones, as emergency back-up sources, or to increase pressure for higher elevation areas. Table 2-5 lists basic information for each of the pump stations. A brief description of each pump station and its operation is presented below.

Table 2-5 Pump Station Information

Pump Station	Pump Unit No.	Horsepower (hp)	Rated TDH	Rated Capacity	Year Installed	Maximum Capacity(1) (mgd)	Firm Capacity(2) (mgd)	Backup Power
1	1,2	500	320	5200	1987	32.3	28.9	Dual Feeds
	4	400	285	4200	1967			
	5,6	700	305	7000	1981			
2	1,2	150	200	2300	1959	10.3	7.7	Dual Feeds
	3,4	150	200	2300 ea	1978			
3	1,2,3,4	75	300	800 ea	1968	4.2	3.4	Yes
4	1,2,3	75	300	800 ea	1985	3.4	3.0	None
5	1,2,3,4	40	102	1000 ea	1993	5.7	4.3	None
S. Bonnyview	1	40	25	3,500	1994	5	n/a	None
Mary Lake	1	40	102	1000	2000	4.6	1.4	None
	2	75	96	2100	2004			
El Reno	1	75	209	1000	1995	1.4	n/a	None
Mercy	1	20	350	200	1979	0.29	n/a	None
Goodwater	1	125	125	3010	2003	4.32	n/a	None

TDH total dynamic head
n/a not available
(1) Maximum capacity is the pumping capacity with all installed pump units running together.
(2) Firm capacity is the pumping capacity with the largest pump unit out of operation for maintanance or emergency repairs and the remaining pump units running together.

2.5.1 Pump Station No. 1

PS-1 is a critical water supply facility providing raw water supply to the Foothill WTP, which in turn supplies approximately 65 percent and 55 percent of the City's water supply during average and peak-day demands, respectively. PS-1 is located on the south bank of Sacramento River, approximately 1,500 feet upstream from the Diestelhorst and Lake Redding Bridges. Access to the facility is from the Sacramento River Trail. The pump station building and intake structure were built in 1937.

PS-1 has five pumps that are operated automatically in a set sequence indicated by water levels in Foothill WTP's 6-million gallon (MG) reservoir. The most recent pump test, conducted in 2010, indicates PS-1's firm capacity is 28.9 mgd, which is sufficient to support the Foothill WTP at its current firm capacity of 26 mgd and up to a maximum capacity of 28 mgd.

PS-1 diverts water from the Sacramento River at a location where populations of anadromous (salmon and steelhead trout) fish populations have been identified. Beginning with the Central Valley Project Improvement Act of 1992 and continuing with the CALFED program, increasing federal and state resource agency efforts have been aimed at protecting and improving the anadromous fish populations and habitat of the Sacramento River and other major California river systems. Installing modern fish screens at river diversions such as PS-1 has been a major component of that effort. Fish screens were installed at PS-1 in 2005 under a design variance granted by NOAA Fisheries in effort to reduce potential for fish loss. But the screens depart from standard criteria under

certain specific river and operating conditions. As a result, pumping from the river at PS-1 will require further screening improvements and/or additional regulatory approvals. This issue is discussed further in Chapter 5.

2.5.2 Pump Station No. 2

PS-2 is located at the Foothill WTP site, and is used to deliver treated water into the Hill 900 Zone. Flow from PS-2 goes both directly into the Hill 900 Zone distribution system and into the Hill 900 reservoirs located adjacent to the Foothill WTP. PS-2 is the primary water supply into the Hill 900 Zone, with a relatively minor back-up supply provided by the El Reno Booster Pump during MDD conditions. PS-2 has four pumps controlled by the water level in the Hill 900 reservoir.

2.5.3 Pump Station No. 3

PS-3 is located on the west side of Market Street, adjacent to the City of Redding electrical substation and Sulfur Creek. PS-3 is used to supply water from the Foothill Zone into the Buckeye Zone. PS-3 provides both back-up supply and regular MDD supply to the Buckeye Zone when Buckeye Zone demands exceed the capacity of the Buckeye WTP. Under average-day demand (ADD) conditions, PS-3 does not normally operate. The four pumps operate sequentially during high demands, depending on water level in the Buckeye Zone's 2-MG reservoir.

2.5.4 Pump Station No. 4

PS-4 is located on Benton Drive, near the intersection with Riverpark Drive. PS-4 was built from the PS-3 design plans and has the same features and performance. Prior to the Buckeye WTP coming online in 1995, PS-4 was operated similar to PS-3 and used regularly to provide supply from the Foothill Zone, into the Buckeye Zone. Following completion of the Buckeye WTP expansion to 14 mgd in 2008, PS-4 is no longer required to run on a regular basis. PS-4 can provide emergency back-up supply to the Buckeye Zone if necessary because of problems at either the Buckeye WTP or PS-3. Each of the units in PS-4 operate at acceptable efficiency ranges in accordance with the pump design and actual operating conditions.

2.5.5 Pump Station No. 5

PS-5 was relocated in 1993 to its present location adjacent to the Enterprise reservoirs. PS-5 is the primary water supply into the Hilltop-Dana Zone, pumping from the Enterprise reservoirs into the Hilltop-Dana Zone distribution system. The only other supply to the Hilltop-Dana Zone comes from the Palisades PRV connections via Buckeye Zone, which is used during MDD conditions. Since the Hilltop-Dana Zone has no regular gravity-feed source besides the Palisades PRVs, PS-5 operates 24 hours per day, pumping into a closed system with no storage available to equalize supply and demands within the zone. Four variable-speed pumps provide a high degree of flow and head combinations to allow efficient operation under this conditions. The pumps operate sequentially to maintain a target minimum system pressure of 60 pounds psi in the adjacent distribution system piping. Each of the units in PS-5 operate at acceptable efficiency ranges in accordance with the pump design and actual operating conditions.

2.5.6 Pump Station No. 6 - South Bonnyview Pump Station

The South Bonnyview Pump Station (PS-6) is located on South Bonnyview Road, west of the Sacramento River. PS-6 delivers water from the Enterprise Zone to the Cascade Zone. Under average demand conditions, the pump is not needed to boost the flows from the Enterprise Zone. PS-6 is installed in parallel with a regular "gravity-flow" pipeline. Under average demand conditions PS-6 does not operate, and water flows from the Enterprise Zone to the Cascade Zone as determined by the overall hydraulic grades in the zones. Under heavier demand conditions, PS-6 is used to increase flows and is set to operate according to water level in the Redding Ranchettes Reservoir. Because there is only a single installed pump, in the case of a pump failure, the flow rate is limited to the gravity-flow condition until a backup bump is installed. PS-6 operates at an acceptable efficiency

range in accordance with the pump design and actual operating conditions.

2.5.7 El Reno Pump Station

The El Reno Booster Pump Station is located between El Reno Lane and Riviera Drive. The pump is used to deliver flow from the Cascade Zone into the southern end of the Hill 900 Zone, and only operates under emergency backup and fire flow support conditions. The pump is set to turn on/off as indicated by the discharge pressures. The distribution piping serving this area from the northern end of the Hill 900 Zone has been significantly improved since the larger pump was installed, including the installation of a 16-inch main from Placer Street to Country Heights. Analysis of the current operating conditions in the Hill 900 Zone indicates that the El Reno Booster Pump is no longer needed under regular operating conditions, including during MDD. While the pump provides less than 4 percent of MDD for the Hill 900 Zone, it remains useful to support fire flows at the south end of the Zone.

2.5.8 Mary Lake Booster Pump Station

The City installed the Mary Lake Booster pump station to increase pressures in the higher elevations of Hill 900 Zone. The station was upgraded in 2002 with a second pump and check valves located at critical downstream locations to prevent recirculation of water back through the pump. The pumps are variable speed, running continuously to maintain downstream pressure at 60 psi.

2.5.9 Mercy Hospital Booster Pump

The Mercy Hospital Booster Pump is located east of the hospital off of West Street. The pump is intended to provide emergency back-up supply to Mercy Medical Center, which is normally supplied from multiple feeds off of the Hill 900 Zone distribution piping. The pump station lacks a back-up power supply, which reduces its reliability as an emergency supply.

2.5.10 Goodwater Booster Pump Station

The Goodwater Booster Pump Station is located on the north side of Goodwater Avenue across from the intersection with Velia Street. The pump was constructed in 2003 to provide additional pressure and flow to the remote east end of the Hilltop-Dana Zone for emergencies.

2.5.11 Southern Pacific Pump Station

The Southern Pacific Pump Station is located on the opposite side of the Sacramento River from the PS-1 intake, under elevated railroad tracks, and is used solely to pump raw river water to irrigate a golf course. Water rights for this pump station are covered under the City's Sacramento River Contract with the Bureau of Reclamation. The facility is leased to the City by Union Pacific Railroad and maintained and operated under contract from the Golf Course property owner.

2.6 STORAGE RESERVOIRS

2.6.1 Background

The City's water system currently has 12 reservoirs and a total of 32.7 MGs of storage. City water systems require storage reservoirs for three basic purposes: equalization of supply and demand flows, fire service supply, and emergency supply. Table 2-6 lists the individual reservoirs and key information for each.

Table 2-6 Water Storage Reservoirs

Reservoir	Total Capacity (MG)	Min/Max Operations Elevation, ft	Invert Elevation, ft	Year Constructed	Material/Type	Primary Service Zone
Foothill WTP	6	743/726	721	1920 / 1981	Concrete, buried	Foothill/Cascade/Enterprise
Foothill	4	738/727	717	2006	Steel, above ground	Foothill/Cascade/Enterprise
Hill 900-1	2	925/911	890	1959	Concrete, above ground	Hill 900/Foothill
Hill 900-2	2	925/911	890	1984	Steel, above ground	Hill 900/Foothill
Cascade	1	692/676	660.6	1964	Steel, above ground	Cascade
Redding Ranchettes	2	692/676	660.7	1982	Steel, above ground	Cascade
Enterprise 1	3.5	706/685	663.5	1968	Steel, above ground	Enterprise/Hilltop Dana
Enterprise 2	6	706/685	663.5	1986	Steel, above ground	Enterprise/Hilltop Dana
Buckeye 1	0.2	956/943	933.6	1949	Steel, above ground	Buckeye/Hilltop Dana
Buckeye 2	2	956/943	922	1978	Steel, above ground	Buckeye/Hilltop Dana
Buckeye 3	4	1034/1024	1000	2002	Steel, above ground	Buckeye/Hilltop Dana
Buckeye-Backwash	0.8			1995	Steel, above ground	Buckeye/Hilltop Dana

Elevation in ft above msl on NGVD-29

2.6.2 Foothill Zone Storage

The Foothill Zone storage is provided by the Foothill WTP 6-MG clearwell and the new 4MG Foothill reservoir constructed in 2006. Secondary storage is provided by the Hill 900 Zone reservoirs, which can gravity feed into various areas of the Foothill Zone if necessary. The Foothill Zone has adequate storage through at least 2030. Each of the reservoirs generally have effective drain and fill patterns under MDD conditions. The Foothill 6-MG clearwell provides the supply to the plant's backwash pumps and the suction head of PS-2. If the water level in the clearwell is below 35 percent, the backwash pumps cannot operate, which in turn lowers the filter capacity. This may require shutting down the plant because of poor effluent water quality and filter plugging.

2.6.3 Hill 900 Zone Storage

Hill 900 Zone storage is provided by Hill 900 reservoirs 1 and 2. No other storage sources can gravity feed into the Hill 900 Zone. Both of the reservoirs have effective drain and fill patterns under the full range of annual demand conditions. Up to 4.3 MG of additional storage may be required for the Hill 900 Zone under buildout conditions. Alternatives for this new storage include eventually replacing the older 2 MG-reservoir with a 3-MG reservoir and investigating a new reservoir at a suitable location to the west or southwest.

2.6.4 Cascade Zone Storage

The Cascade Zone storage is provided by the Cascade Reservoir and the Redding Ranchettes Reservoir. Back-up storage can be provided by the Foothill Zone. The Cascade Zone has adequate storage through at least 2030. The most significant existing challenge with storage in the Cascade Zone is the performance of the Cascade Reservoir. The reservoir's elevation is too low relative to the hydraulic grade in the zone under normal operating pressures. The reservoir has an altitude valve to control inflow and allow outflow. The reservoir can still contribute to both fire service and emergency service once the system pressures are low enough to allow draining. At times the City manually lowers settings on the Ranchettes reservoirs to allow Cascade Reservoir to cycle. This helps prevent stagnation and water quality problems during the portion of the year when zone demands are not high enough to cause turnover of the stored water.

2.6.5 Enterprise Zone Storage

Enterprise Zone storage is provided by the Enterprise reservoirs 1 and 2. Secondary storage can be provided by the Foothill Zone via the Cypress Street main. The Enterprise Zone has adequate storage through 2030 but will

need an additional 2.5 MG under buildout conditions. Both of the reservoirs have effective drain and fill patterns under the full range of annual demand conditions.

2.6.6 Hilltop-Dana Zone Storage

The Hilltop-Dana Zone shares storage with the Enterprise Zone because PS-5, the primary supply for the Hilltop-Dana Zone, is supplied from the Enterprise reservoirs. PS-5 uses variable-speed pumps that take the place of equalization storage in matching supply rates to demand. Fire service and emergency storage are provide from the Enterprise reservoirs. Secondary storage can be provided from the Buckeye reservoirs via the Palisades PRVs. Several check-valve inter-ties from the Enterprise Zone into the Hilltop-Dana Zone can provide fire service and emergency back-up supply under a low pressure condition in the Hilltop-Dana Zone. As a result of the multiple supply and storage sources the Hilltop-Dana Zone has adequate storage to meet buildout condition requirements.

2.6.7 Buckeye Zone Storage

Buckeye Zone storage is provided mainly by the Buckeye reservoirs 1, 2, and 3; small additional storage capacity is provided by the 86,000 gallon Buckeye backwash. Reservoir 3 (4MG) was completed in 2002 for needed secondary storage and supported the expansion of the Buckeye WTP from 7-mgd to 14-mgd capacity in 2008. The Buckeye Zone has adequate storage to meet current conditions but will need additional storage by 2020 increasing to an additional 16.8 MG need by buildout of the pressure zone.

2.7 PRESSURE-REDUCING STATIONS

The City water distribution system has 11 PRV stations that are used to provide regular and/or back-up flow from a higher pressure source main into a lower pressure service area. The PRVs allow flow from a higher pressure area of the system into a lower pressure area determined by a set downstream pressure. Following expansion of the Buckeye WTP, PRV stations were constructed at both PS3 and PS4 to allow transfer of water from Buckeye Zone into Foothill Zone. Table 2-7 lists the existing PRV stations and basic information for each.

2.8 INTER-AGENCY CONNECTIONS

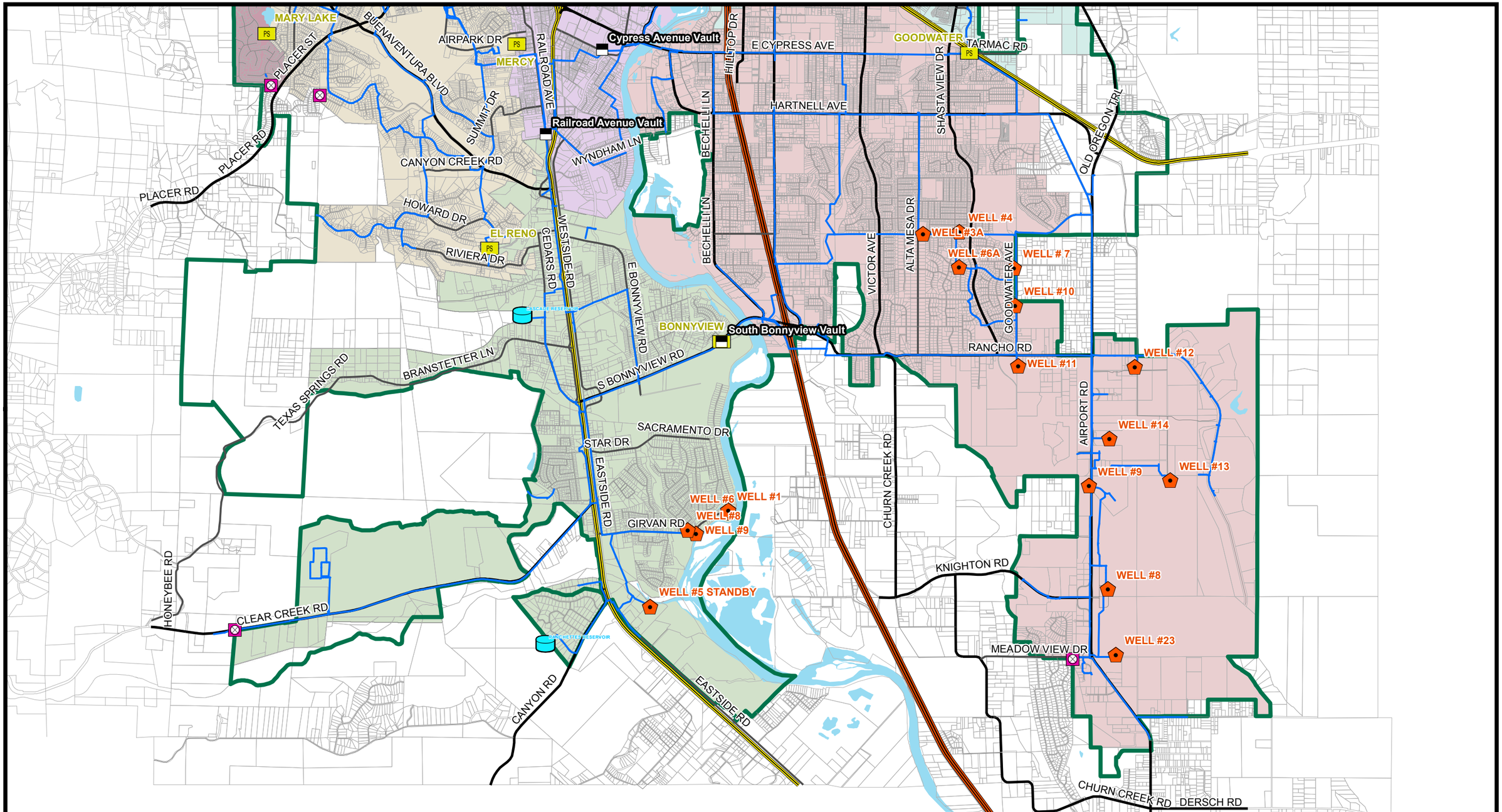
The City of Redding has service inter-ties with several neighboring water systems, mainly for emergency use. These inter-ties can provide back-up supply to local areas of the City. Additionally, Redding provides water to approximately 20 customers in the vicinity of Summit City outside the City of Shasta Lake with water supply purchased from Shasta Lake. Table 2-8 lists the existing inter-tie connections and basic information for each.

Table 2-7 Pressure Reducing Stations

Station No./Name	Location	Zone from/to	Elevation	Zone HGL: from/to (ft)	Typical Pressure (psi) Upstream to Downstream	Downstream Pressure (psi) Setting to Open	Test-Pressure (psi) at Open	Normal Positions ADD/MDD
Linden Ave	Linden Ave	Hlll 900/Foothill	584	925/738	105/65	40	55	CL/CL
Palisades No. 1	Hilltop Dr @ Palisades	Buckeye/Hilltop-	680	956/790	120/60	55 (No.1)	45	CL/OP
						45 (No.2)	40	
Palisades No. 2	River Bend Rd	Buckeye/Hilltop-	609	956/790	150/85	75 (No.1)	75	CL/OP
						70 (No.2)	65	
Cypress Ave	Park Marina Drive sup	Foothill/Foothill	468	743/738	115/115	57	60	CL/CL
Constitution Way	Constitution Way	Buckeye/Buckeye	668	922/813	110	63	60	CL/CL
Meadowview Drive	Meadowview Dr	Enterprise/Ent	488	765/687	120	86	83	CL/CL
Railroad Ave East	Railroad Ave sup vault	Foothill/Foothill	513	743/738	94/92	55	52	CL/CL
Railroad Ave Main	Railroad Ave sup vault	Foothill/Cascade	513	743/692	100/97	63	62	OP/OP
Market Street @ Fell	Market St @ Fell	Foothill/Foothill	513	743/738	100/97	65	60	CL/CL
Redcliff	Redcliff/Bechelli	Hilltop/Enterprise	570	809/705	103/55	48	55	CL/CL
PS-3	Sulphur Cr Rd	Buckeye/Foothill	522	875/600	100/140			
PS-4	Benton Dr	Buckeye/Foothill	524	875/600	100/140			

Table 2-8 Inter-Agency Connection Data

Water System	Inter-tie Location	Size	Pressure Zone
City of Shasta Lake	Walker Mine Road	6-inch	Buckeye
City of Anderson	Meadowview Road	8-inch	Enterprise
Bella Vista Water District	Canby Road	12-inch	Hilltop-Dana
Bella Vista Water District	Old Alturas - Abernathy	6-inch	Hilltop-Dana
Bella Vista Water District	Edgewood Drive	8-inch	Hilltop-Dana
Centerville CSD	Record Lane	8-inch	Hill 900
Centerville CSD	Rainier Dr	6-inch	Hill 900
Centerville CSD	Clear Creek Road	12-inch	Cascade
Shasta CSD			



Inter-Tie
Regulating Valve
Pump
Well
Treatment Plant
Water Storage Tank
Water Line > 8"

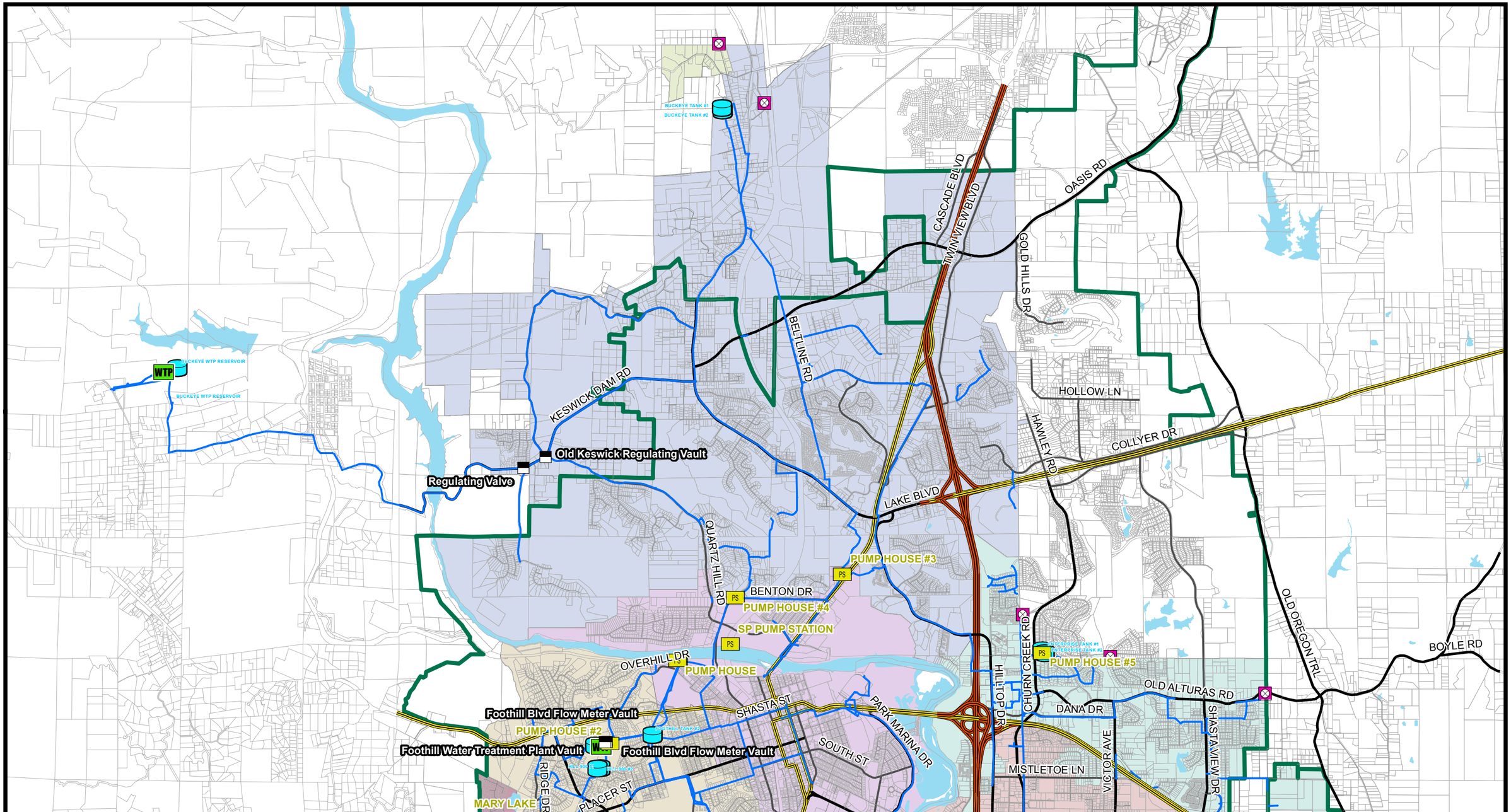
Roads
FWY
HWY
Arterial
Collector
Local
City Limits

Pressure Zone
Buckeye
Cascade
Enterprise
Mary Lake
Foothill
Hill 900
Hilltop
Summit City

0 1 2 4 Miles

Figure 2-3B
City of Redding (South)
Exisiting Facilities

October 13, 2011



Inter-Tie
Regulating Valve
Pump
Well
Treatment Plant
Water Storage Tank
Water Line > 8"

Roads
FWY
HWY
Arterial
Collector
Local
City Limits

Pressure Zone
Buckeye
Cascade
Enterprise
Mary Lake
Foothill
Hill 900
Hilltop
Summit City

0 1 2 4 Miles

Figure 2-3A
City of Redding (North)
Exisiting Facilities

October 13, 2011

PUMP STATION No.1

CHAPTER 3
Water System Demands

3.1 INTRODUCTION

As part of Water Master Plan 2016 update, existing water demands and recent trends in the growth and types of water use were analyzed. This information was then combined with growth projections and the City's land use planning data to forecast future water demands for the following planning horizons: 2020, 2025, 2035 and maximum projected buildout of the City water service area. Water demands are considered geographically for each pressure zone and on a systemwide basis. Demands are also evaluated seasonally for average- and peak-day total use, and for average hourly demand trends (diurnal patterns). The total annual water demand is used for long-term water supply planning, in terms of total acre-feet (ac-ft) per year consumed from both surface and groundwater sources. The ADDs, MDDs, and diurnal trends are used for facility planning including the capacity and locations of water treatment plant and well fields, conveyance and distribution piping, storage facilities, and pump stations.

3.2 CURRENT WATER DEMANDS

As of 2010, the City's WSA had an average of 28,500 service connections serving a WSA population of approximately 90,700 persons. In 2015, the WSA had an ADD of 19.0 mgd and an MDD of 31.8 mgd. The number of service connections and WSA population have grown at an average rate of 1.14 percent between 2000 and 2015 (see Table 3-1). The decade and a half from 2000 to 2015 was a period of mixed growth for the City. From 2000 to 2006 overall growth and new development were robust. This was followed by a significant slowdown in growth through the remainder of the decade as the affects of the national economic recession were felt locally.

The water system customer-connection types include single family homes, multi family housing units, commercial users, industrial users, government and public facilities such as offices and schools, and large irrigation users such as golf courses. Table 3-2 shows the average daily use per connection type derived from 1994 through 2015 billing data. Percentage of water usage is plotted in Figure 3.1. Analysis of the number of customers of each type and water use data show that the relative mix of customer types, as well as the percentage of total water use by each customer type, has remained fairly constant. Residential and commercial service connections (roughly 87 percent and 10 percent of the total connections, respectively) account for most of the annual water demand (71 percent and 25 percent, respectively) .

The average WSA per capita water demand is approximately 247 gallons per capita per day (gpcd), derived from utility billing data from 2006 through 2015. The average ratio of WSA population to the total number of service connections, or "persons per connection" (ppc), has remained relatively constant at 3.2 ppc. City Planning Department data for housing units and the Redding Urban Area population show a similar steady trend of approximately 2.36 persons per household (pph).

3.2.1 Pressure-zone Demands

Each of the City's six primary pressure zones has differences in terms of land use, growth rates, and other factors that influence the total water demands and the seasonal and daily patterns within each zone. These differences determine decisions regarding major water system facilities such as pump stations, pipelines, and storage reservoirs. For these reasons it is important to consider water demands for each pressure zone as well as the total system. Table 3-3 summarizes key water demand data for each pressure zone using 1999 and 2015 data. Water demand within each zone was determined from monthly meter readings.

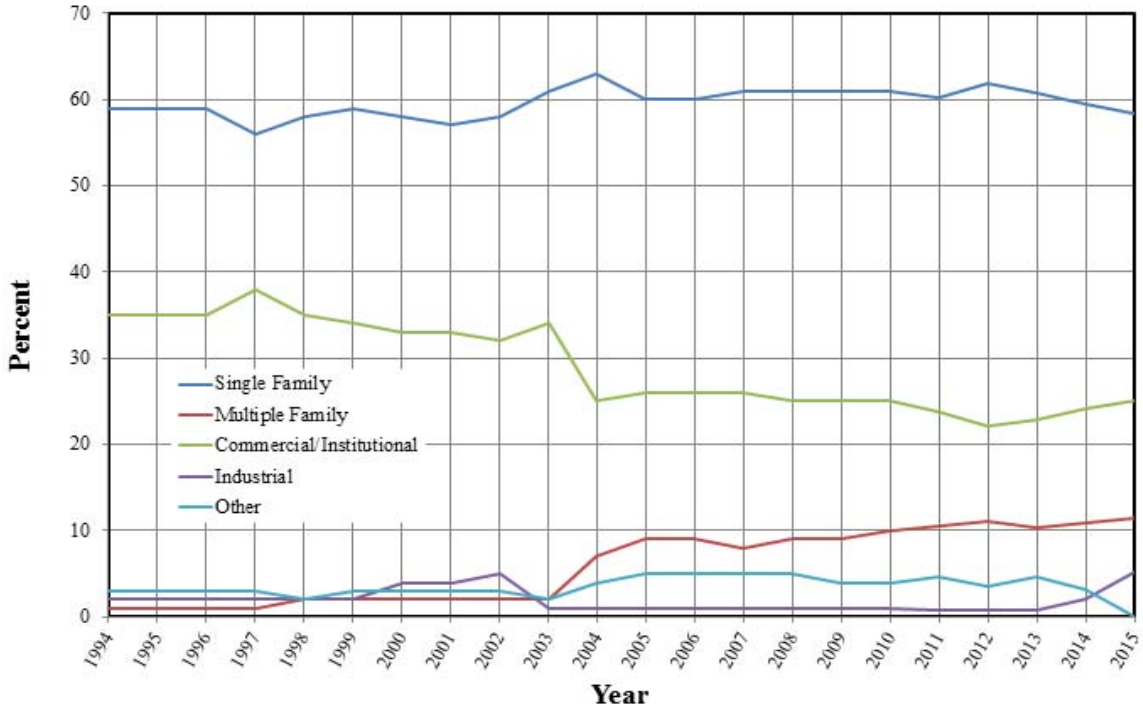
Table 3-1 Water System Service Area Population and Water Use Growth 1990 to 2015

Year	Number of Service Connections	Average Population	Annual Supply (ac-ft)	Average Demand per Capita (gpd)	Average Daily Demand per Connection	Max Daily Demand per Connection	Seasonal Peaking Factor
1990	20805	66160	19049	257	817	n/a	n/a
1991	22021	70027	22076	281	895	n/a	n/a
1992	22338	71035	21136	265	842	n/a	n/a
1993	21734	69114	20154	260	828	n/a	n/a
1994	23,610	78,266	21,289	243	805	n/a	n/a
1995	23,469	75,766	20,750	244	787	n/a	n/a
1996	24,182	76,567	21,728	253	800	n/a	n/a
1997	24,381	77,248	22,967	265	845	n/a	n/a
1998	24,674	78,084	20,024	228	724	n/a	n/a
1999	24,840	78,427	28,954	239	1040	1810	1.74
2000	24,858	79,593	23,076	258	826	1790	2.17
2001	25,259	85,000	25,355	266	896	1864	2.08
2002	25,796	86,300	26,472	274	916	1896	2.07
2003	26,278	87,300	25,452	260	864	1913	2.21
2004	26,584	85,703	28,670	298	960	1863	1.94
2005	27,219	88,459	25,070	253	822	1791	2.18
2006	27,682	89,973	26,375	262	850	1895	2.23
2007	27,906	90,045	26,889	267	860	1792	2.08
2008	27,973	90,491	27,145	267	864	1734	2.01
2009	28,123	90,898	24,947	245	792	1666	2.10
2010	28,212	91,561	22,957	224	726	1736	2.39
2011	28,224	90, 250	24,474	242	774	1539	2.07
2012	28,322	90,200	26,944	265	847	1639	1.94
2013	28,568	90,848	29,849	293	933	1735	1.86
2014	29,727	91,207	24,542	240	737	1350	1.83
2015	29,022	91,053	21270	209	652	1094	1.68

n/a Data not available

Data for 1990 through 1993 obtained from prior master plan efforts. Data for 1994 through 2014 from DWR form 38 reporting. In 2014 the City transferred record keeping to a private utility billing consultant. As a result some data is no longer being recorded and some data is difficult to obtain. In any case, as observed by the total number of service connections between 2014 and 2015, the current data is no longer consistent with the prior data set.

Figure 3-1 Percentage of Water Usage



Note: Variations in usage trends beginning in 2003 are the result of changes in data collection and utility billing record keeping methods by the Utility.

Table 3-2 Water Use History by Customer Type

Connections

Type	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
SFR	18643	18878	19178	19357	19666	19756	19766	19758	19836	21553	21786	22359	22667	22843	22927	22987	23021	23022	23111	23149	23306	23714
MF	456	457	570	582	598	611	620	621	627	695	1532	1067	1680	1696	1743	1844	1905	2005	2016	2066	2332	2170
C/I	3837	3485	3831	3833	3814	3824	3497	3497	3497	3795	2793	2790	2844	2835	2825	2809	2782	2690	2699	2743	3525	2833
Ind	464	431	384	393	380	431	765	1171	1611	137	1139	141	145	151	165	169	169	169	164	162	190	395
Lnd	0	0	0	0	0	0	0	0	0	0	15	0	9	9	0	0	0					
Other	195	199	202	198	200	198	192	196	208	87	283	313	337	372	313	314	335	338	311	347	374	2
Ag	15	19	17	18	16	20	18	16	17	11	3	0	0	0	0	0	0					

Delivery, MG

Type	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
SFR	4069	3967	4144	4226	3815	5592	4406	4718	4998	5027	5918	4883	5196	5314	5376	4984	4565	4369	4936	5134	4321	3615
MF	83	93	98	97	101	155	158	161	163	190	617	737	733	732	762	733	759	764	887	874	796	708
C/I	2445	2383	2505	2823	2307	3234	2520	2764	2747	2860	2379	2089	2206	2247	2190	2001	1836	1726	1772	1934	1752	1552
Ind	155	142	134	134	134	197	316	341	445	67	63	48	52	59	65	59	56	57	64	66	144	322
Lnd	5	5	5	5	5	6	8	8	10	6	6	5	7	7	31	0	0	0	33	34	22	
Other	184	170	193	199	163	251	209	269	262	143	358	407	400	412	422	353	264	340	287	395	228	0

Delivery/Connection/Day, gallons

Type	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
SFR	598	576	590	598	531	775	609	654	690	639	742	598	628	637	641	594	543	520	584	608	508	418
MF	501	559	472	456	463	695	695	710	712	749	1080	1893	1196	1168	1194	1089	1091	1045	1202	1158	935	894
C/I	1746	1873	1787	2018	1657	2317	1969	2165	2152	2065	2327	2051	2125	2172	2118	1951	1808	1758	1793	1932	1362	1501
Ind	914	903	953	934	966	1253	1129	798	757	1349	152	937	991	1070	1068	951	914	924	1064	1124	2081	2232
Lnd	0	0	0	0	0	0	0	0	0	0	1068	0	1984	1984	0	0	0	0	0	0	0	0
Other	2591	2346	2613	2755	2232	3467	2972	3757	3446	4504	3460	3559	3253	3031	3686	3082	2161	2752	2525	3115	1668	118

Percent of Total Delivery

Type	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
SFR	59	59	59	56	58	59	58	57	58	61	63	60	60	61	61	61	61	60	62	61	59	58
MF	1	1	1	1	2	2	2	2	2	2	7	9	9	8	9	9	10	11	11	10	11	11
C/I	35	35	35	38	35	34	33	33	32	34	25	26	26	26	25	25	25	24	22	23	24	25
Ind	2	2	2	2	2	2	4	4	5	1	1	1	1	1	1	1	1	1	1	1	2	5
Lnd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	3	3	3	3	2	3	3	3	3	2	4	5	5	5	5	4	4	5	4	5	3	0

SFR- Single Family Residence MF- Multiple Family Residence C/1 - Comercial/Institutional Ind- Industrial Lnd -Landscaping

Table 3-3 Pressure-zone Service Connections and Water Demands

Zone	- 1999 - No. of Connections	- 1999 - % of Total	- 2010 - No. of Connections	- 2010 - % of Total	- 2010 - % (a) Growth	- 2010 - ADD (mgd)	- 2010 - MDD (mgd)	- 2010 - ADD/ Connection (gpd)	- 2010 - MDD/ Connection (gpd)	- 2010 - Seasonal Peaking Factor	- 2010 - Hourly Peak Factor	- 2010 - Max Peak Factor
Buckeye	4287	17	5008	18	19	3.75	8.38	749	1673	2.2	1.54	3.4
Cascade	2960	12	3339	12	10	2.50	5.59	749	1674	2.2	1.54	3.4
Enterprise	7342	30	8719	31	36	6.94	15.32	796	1757	2.2	1.54	3.4
Foothill	4303	17	4469	16	4	3.30	6.93	738	1551	2.1	1.54	3.2
Hilltop-Dana	1902	8	2458	9	15	2.19	4.75	891	1932	2.2	1.21	2.6
Hill 900	3915	16	4539	16	16	3.50	8.02	771	1767	2.3	1.54	3.5
*Total***s**	**24709**		**28532**									

Zone	- 2015 - No. of Connections	- 2015 - % of Total	- 2015 - % (a) Growth	- 2015 - ADD (mgd)	- 2015 - MDD (mgd)	- 2015 - ADD/ Connection (gpd)	- 2015 - MDD/ Connection (gpd)	- 2015 - Seasonal Peaking Factor	- 2015 - Hourly Peak Factor	- 2015 - Max Peak Factor
Buckeye	5048	17	0.16	3.32	7.61	658	1508	2.3	1.54	3.5
Cascade	3398	12	0.35	2.37	5.76	698	1695	2.4	1.54	3.7
Enterprise	8755	30	0.08	6.22	12.09	711	1380	0.9	1.54	3.0
Foothill	4209	15	-1.16	2.83	8.11	673	1927	2.9	1.54	4.4
Hilltop-	2890	10	3.52	1.33	2.52	460	871	1.9	1.21	2.3
Hill 900	4506	16	0.74	2.97	5.35	631	1137	1.8	1.54	2.8
*Total***s**	29006				Average:	638	1420			

a) Percentage of city-wide growth occurring in each zone

3.2.2 Fire Service Demands

The City water distribution system was evaluated for its capacity to provide required fire fighting service flows at various locations throughout the service area. The required fire service flows are dictated by California Fire Code (CFC) requirements which depend on building size and construction materials to determine the magnitude and duration of water supply required for fire suppression efforts. The AWWA has also issued its own standards for fire flows, presented in AWWA M31 Distribution System Requirements for Fire Protection. The Water Master Plan 2016 used CFC flows and locations of the largest demands to analyze fire flows which included MDDs as the base condition.

Fire flow requirements can often be the controlling factor in the sizing of pipelines and other distribution system infrastructure. As new development occurs between now and future planning horizons, the City will need to determine what sizes of water mains to install to serve these areas, assuming that fire flows are the controlling factor. Evaluation of fire service flows is included in the following system evaluation section, Chapter 5.

The 2013 California Residential Building Code requires installation of fire sprinklers in all new residences. Fire sprinklers alone will not change water demands, but their operation will require larger water meter connections. Informal studies have been performed by the City to determine the potential impact of widespread increases in meter diameter. Results of those efforts indicate that neighborhoods with larger diameter meters in support of required fire sprinklers may result in 10% to 12% higher water usage relative to similar non-sprinklered residential neighborhoods.

3.3 PEAKING FACTORS AND DIURNAL PATTERNS

The City's seasonal and daily patterns of water demand determine the required total supply and the maximum capacity required for supply, treatment, and distribution facilities. City water system operations data was analyzed to determine peaking factors and diurnal water demand patterns on a Citywide basis.

Total daily water use data from 2006 through 2010 was evaluated to determine the average MDD peaking factor (MDD/ADD). The 1989 Water Master Plan used an MDD peaking factor of 2.3, but also cites data showing that the average Citywide MDD peaking factor between 1980 and 1988 was 2.18. Between 1995 and 1999, the MDD/ADD peaking factors ranged from 1.81 to 2.11. The Water Master Plan 2000 used a MDD peaking factor of 2.2. Table 3-4 shows peaking factors for each pressure zone used in the Water Master Plan 2000 and those developed for the current effort. The City-wide MDD/ADD peaking factor used for the Water Master Plan 2016 is 2.2.

Diurnal patterns for City-wide water demands were developed in the Water Master Plan 2000 using hourly operations data for average-day and maximum-day conditions respectively. Figure 3-1 shows the resulting typical average-day and maximum-day diurnal water use patterns for the City. In general, each of the zones has an average-day and maximum-day diurnal pattern very similar to that derived from Citywide operations data. The Hilltop-Dana Zone is the only exception, and has a much flatter daily demand pattern as shown on Figure 3-2. For hydraulic modeling purposes, each zone's MDD was determined using the ADD and the 2010 peaking factors. The Citywide diurnal patterns were then used for the extended-period simulation modeling for all zones except Hilltop-Dana Zone.

Using an MDD/ADD peaking factor of 2.2 and the hourly diurnal peaking factor (maximum hour to maximum average daily demand) of 1.54, the Citywide peak-hour demand peaking factor is approximately 3.39.

Table 3-4 Pressure Zone Peaking Factors

Zone	1997	1998	1999	2010	2015
Buckeye	2.06	2.53	2.44	2.23	2.30
Cascade	2.43	2.81	2.44	2.24	2.40
Enterprise	2.18	2.91	2.38	2.21	1.95
Foothill	1.75	1.75	2.09	2.10	2.89
Hilltop-Dana	1.90	2.46	1.55	2.17	1.89
Hill 900	1.98	2.60	2.21	2.29	1.81

Figure 3-2 City-wide Diurnal Demand Pattern

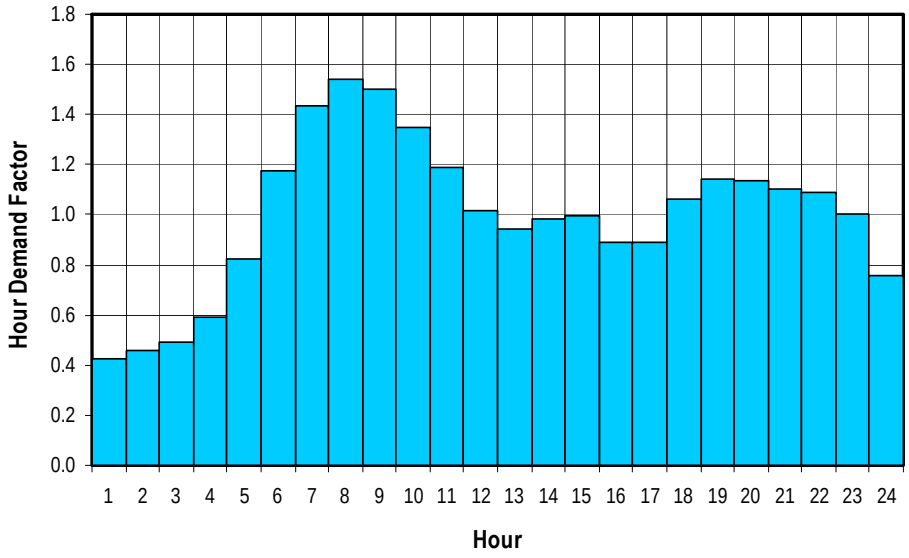
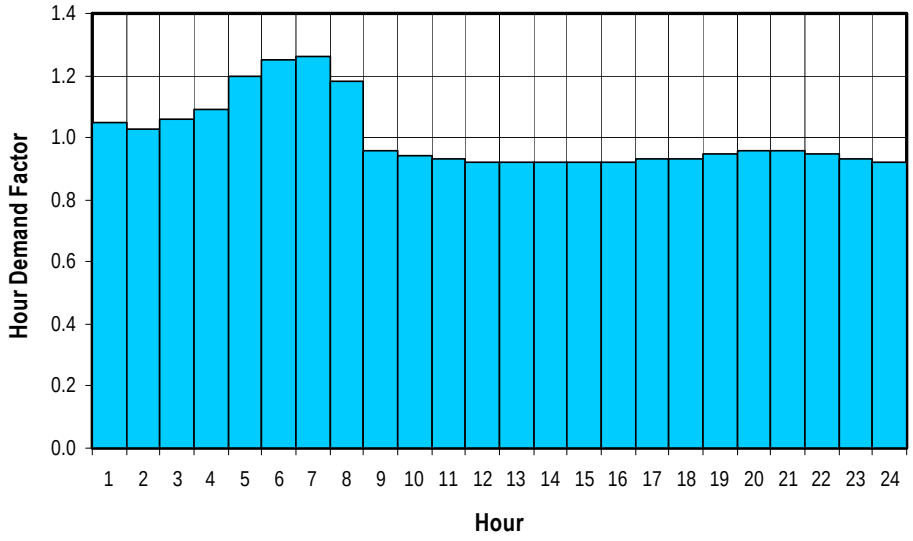


Figure 3-3 Hilltop/Dana Diurnal Demand Pattern



3.4 FUTURE WATER DEMANDS

3.4.1 Methodology Overview

Future water demands for the WSA were projected for the period from 2015 to full buildout. Planning horizons include years 2015 (current conditions), 2020, 2025, 2035 and ultimate buildout. Future water demands were estimated using the Shasta County Regional Transportation Planning Agency (RTPA) model. That effort included a detailed examination of the development potential of every parcel within the planning area. For each parcel development dates were assigned and population added to each planning horizon corresponding to the new development occurring since the prior planning horizon. The Traffic Area Zone population information used in the RTPA model was then geographically assigned to each pressure zone utilizing GIS tools for each planning horizon. Ultimate development population numbers were developed using GIS tools to relate General Plan development densities, for each parcel, to pressure zones.

Future water demands are estimated using a "single coefficient" water demand model, which is based on population growth and the average per capita and per connection water use. The future water demand is estimated using projected values of the City population to determine the number of water service connections and future water demand, using current average per capita and per service connection water use. The City has had a relatively constant proportional mix of both service connection types and total water use by user type, which supports this method of demand projection.

The demand estimates for each horizon utilize this information to relate population to the total number of service connections, total Citywide water demand, and the number of connections and total water demand within each pressure zone. The demand estimates for each planning horizon include the following: total annual Citywide water demand, average daily total water demand, peak-day total water demand, and peak-hour total water demand. For each pressure zone, the demand estimate includes the average daily demand, peak-day demand, and peak-hour demand. The projected total City water demand is based on population growth and average per capita water demand. Table 3-5 summarizes the demand projection information.

The following are key parameters and planning assumptions that influence the future water demand projections.

- The City water system at buildout is assumed to serve the area shown on Figure 2-1, which includes the area within the WSA, specified in Reclamation water service contracts, and land outside the WSA but within the City's primary growth boundary as defined in the 2000 General Plan, which are not already included in an adjacent service area. No regular supply to neighboring water service areas is included in the City's demands.

- The 2000 General Plan data along with detailed projection of development potential for each parcel was used in the RTPA model to develop population projection within the Redding Urban Area. Buildout population projection was obtained from general plan and zoning ordinance development density maps.

- The long-term growth rate for water service connections approximates overall population growth. In other words, population and housing growth are proxy measures for growth of all water user types (residential, commercial, public, etc.).

- The average pph remains steady at 2.36 pph per the General Plan. The ratio of population to water service connections remains constant at 3.2 ppc.

- Average daily per capita water demand is 223 gallons per person per day (average of the last 5-years of daily demand data).

- The ratio of MDD to ADD, Citywide, is 2.2.

Growth in the Redding Urban Area (planning area) from 2015 to 2035 is projected to vary between 0.29 percent and 0.43 percent per year, resulting in a Redding Urban Area population of approximately 99,000 in 2035. The 2035 WSA population will be approximately 98,000. Although the Redding WSA does not include Bella Vista Water District connections or population it does serve area outside the City Limits in the Buckeye area and the WSA population includes transient population that commutes into the city from surrounding areas. The fact that the two estimates are similar in magnitude is coincidental.

The buildout population within the WSA will be approximately 163,300, with a total population of approximately 201,000 in the Redding Urban Area. These population estimates are based on the Redding General Plan land use and total resultant housing units based on average development density. Assuming an average annual growth rate 0.043 beyond 2035 results in an estimated buildout date of approximately 2150 to 2160.

Table 3-5 Demand Projection Summary

Year	Service Area Population	Average Connections	Annual Usage (ac-ft)	ADD (mgd)	MDD (mgd) (a)
1990	66160	20805	20300	18.1	39.9
1995	72250	22720	22200	19.8	43.6
2000	79020	24849	23900	21.3	44.5
2005	86289	27135	30992	27.7	48.6
2010	89565	28165	25818	23.0	48.9
2011	89752	28224	22270	19.9	43.4
2012	90064	28322	24484	21.8	46.4
2013	90523	28468	25804	23.0	49.6
2014	91053	29727	22292	19.9	40.1
2015 (c)	91053	29813	21270	19.0	31.8
2020 (b)	93194	29306	24520	21.9	46.4
2025 (b)	94897	29842	24968	22.3	47.3
2035 (b)	98915	31105	26060	23.2	49.3
UBO	163300	51031	46779	41.1	87.5

(a) Data from Production Logs.
(b) Planning horizon estimates have a large degree of uncertainty due to the developing conservation requirements, curtailments, and the nature of population projections. Demands were forecast based on the average demand per connection observed in 2010 through 2014.
‘(c) Service area population number methodology changed resulting in a data mismatch in 2015.

3.4.2 Pressure Zone Water Demands-2015 to Buildout

For planning horizons 2020, 2025, and 2035 each pressure zone demand is estimated according to the service connections per zone and each zone average daily demand per service connection. The growth in service connections is based on the City's projection of new housing units for each traffic zone for the period 2015 to 2020, from 2020 to 2025, and from 2025 to 2035. The traffic zone housing units were then aggregated by pressure zone. The increase in housing units is used to forecast population and service connection growth in each pressure zone determined by the average pph and ppc. The increase in water demand was then determined by the increase in population and the associated connections. Average and maximum daily water consumption for each connection was based on City-wide meter reading records from 2008 through 2010. Consumption per connection differed in each pressure zone as shown in Table 3-6 and was assumed to remain constant as demands were forecast into the future scenarios.

3.4.3 Mandated Conservation

The California Water Conservation Act of 2009 stipulates explicit methods for calculating gross and per capita water use. The City's base historic per capita use rate (baseline use) is a 10-year per capita daily average for the years 1999-2008. Mandatory conservation targets for 2015 and 2020 are 90% (252 gpcd) and 80% (224 gpcd) of baseline respectively. The 2015 interim target was met however 2015 was the third year of a drought that provoked an emergency conservation proclamation from the state Governor. In that year the citizens of the City of Redding conserved between 25 and 30 percent relative to 2013 demands. The mandate for the 80% conservation for 2020 and beyond remains in place along with a plan of action to achieve the goal (City of Redding Urban Water Management Plan 2015). The community has shown that it can meet the 2020 goal but whether the customers continue to conserve during a year where rainfall is normal has yet to be seen lending significant uncertainty to the forecast of water demands into the future.

Table 3-6 Pressure Zone Demands

		- Pressure Zone -						
		Buckeye	**Cascade**	**Enterprise**	**Foothill**	**Hilltop-Dana**	**Hill 900**	**Average/ Total**
	ADD per Connection	751	769	840	752	573	797	747
Year	MDD/ADD PF	2.5	2.5	2.1	3.2	5	2.1	2.9
2010	Connections	5008	3339	8712	4469	2458	4539	28532
	ADD (mgd)	3.75	2.50	6.94	3.30	2.19	3.50	22
	MDD (mgd)	8.34	5.59	15.32	6.93	4.75	8.02	49
2015	Connections	5050	3413	8729	4200	3906	4701	28999
	ADD (mgd)	3.31	2.39	6.20	2.81	1.33	2.96	3.2
	MDD (mgd)	7.61	5.76	12.09	8.11	2.52	5.35	6.9
2020	Connections	5131	3468	8869	4267	2952	4776	29463
	ADD (mgd)	3.85	2.67	7.45	3.21	1.69	3.81	3.8
	MDD (mgd)	8.59	5.95	16.61	7.16	3.77	8.49	8.4
2025	Connections	5225	3531	9031	4345	3007	4864	30002
	ADD (mgd)	3.92	2.72	7.59	3.27	1.72	3.88	3.8
	MDD (mgd)	8.75	6.06	16.92	7.29	3.84	8.64	8.6
2035	Connections	5466	3681	9413	4529	3134	5070	31273
	ADD (mgd)	4.09	2.83	7.91	3.41	1.80	4.04	4.0
	MDD (mgd)	9.12	6.31	17.63	7.60	4.00	9.01	8.9
UBO	Connections	14134	7199	14428	5186	5178	5949	52074
	ADD (mgd)	10.59	5.39	11.48	3.83	4.61	4.59	40
	MDD (mgd)	23.61	12.02	25.61	8.53	10.29	10.23	90

Additional information and detail on demands and forecasting methodology can be found in Appendix D, Demand Forecasting Methods.

FOOTHILL WATER TREATMENT PLANT

Water Utility Master Plan Update 2016

CHAPTER 4

Water Supplies

4.1 BACKGROUND

The City of Redding uses both surface-water and groundwater supplies. The surface-water supply is governed under two separate contracts with the Bureau of Reclamation and one with Anderson Cottonwood Irrigation District (ACID). Water is diverted from either the penstocks dropping from Whiskeytown Lake to Spring Creek tributary of Keswick Lake or the Sacramento River at PS1. The City also has two groups of ground water wells: the Enterprise wells and the Cascade wells. On average, the City gets approximately 69 percent of its total annual supply from surface water and 31 percent from groundwater. Surface water is used seasonally throughout the year and groundwater is used minimally in the winter but peaks along with surface-water use in the summer.

4.2 SURFACE-WATER SUPPLY

4.2.1 Sacramento River Supply

In 1966, the City entered into long-term supply Contract No. 14-006-200-2871A (Sacramento River Contract) with Reclamation, with an initial term from April 1964 to March 31, 2004. The Sacramento River Contract, one of a group of Reclamation supply contracts generally referred to as "Settlement Contracts," was intended to resolve legal water rights conflicts that arose between pre-1914 water rights holders along the Sacramento River and Reclamation following completion of the Central Valley Project (CVP). On June 7, 2005, City Council approved by Resolution No. 2005-69 which authorized the mayor to sign the Redding Settlement Contract No. 14-06-200-2871-A-R-1, which extended the previous contract for another forty (40) years, until March 31, 2045. The contract did not include any additional quantity of water.

The Sacramento River Contract supply is allocated into two classifications - Base and Project supply. The Base supply of 17,850 ac-feet per year has no associated cost. The Project supply (3,150 ac-feet) has a varying cost made up of two components: the Municipal and Industrial (M&I) Rate charge and the CVP Restoration charge. In 2016, the charges are $26.88/ac-ft and $20.41/ac-ft, respectively, for a total cost of $47.39/ac-ft for the Project supply portion of the Sacramento River supply. The City must pay the M&I rate for its annual allocation of Project supply used during the months of June, July, August and September, and incurs the CVP Restoration charge for the full quantity diverted.

The Base and Project components of the supply of the Sacramento River Contract, are up to the maximum total supply limit of 21,000 ac-ft (17,850 ac-ft Base; 3,150 ac-ft Project). The maximum diversion rate allowed under the Sacramento River Contract is 75 cubic feet per second. The supply is limited to M&I and domestic uses within the geographic limits specified in the Sacramento River Contract. Figure A-1 shows the City's total Water Service Area boundary. In 2008 Reclamation approved an inclusion action for both the Sacramento River Contract and Buckeye Contract to allow water made available under each contract to be conveyed through the integrated City-wide water system. Water use for other purposes or in areas outside of the area-of-use boundary must be approved by Reclamation.

The Sacramento River Contract supply can be reduced up to 25 percent of the average quantity taken by the City during the period April 1st through October 31st of the last 3 proceeding non-Critical Years as

determined from those Years' record of actual measurement is declared for Shasta Reservoir. A critical-year designation is made when existing supply and projected river inflows are at or below certain trigger points that limit CVP's ability to meet the current system demands. From 1964 to present, the supply has only been reduced by 25 percent under this condition five times, in 1977, 1992, 1994, 2014 and 2015. However, under the terms of CVPIA, future cutbacks are forecast to be more frequent and more severe because of increasing demands on the CVP overall and requirements for allocation of CVP yield to environmental water uses. At times in 2014 and 2015 Bureau Deliveries were curtailed in excess of the 25% under a clause in the contracts that grants broader curtailment ability when the Governor declares an emergency. In April 2016 the Bureau announced that agencies would receive 100% of their allocations (M&I or Agricultural) North of the Delta.

Under the forecast long-term average conditions, the Sacramento River Contract cutbacks would be as follows: no reductions in supply in 3 out of 4 years; 17-percent reduction in supply in 1 out of 4 years on average (total supply 17,430 ac-ft); and 25-percent reduction in supply in 1 out of 10 years on average based on the language of Constraints On The Availability Of Water within the contract.

In 2005 the National Resource Defense Council, et al. brought suit against the Bureau of Reclamation and Sacramento River Settlement Contractors over renewal of the Sacramento River Settlement Contracts under the federal Endangered Species Act ("ESA") and Administrative Procedure Act ("APA"). Plaintiffs claim that renewing the contracts without re-visiting the United States Fish and Wildlife Service consultation violates the ESA in not considering impacts to the delta smelt. After many years in the court system the case is now in front of the Federal Supreme court and is pending action at that level. Reversal of the contract renewals could start a legal battle that would last for years if not decades leaving the future of the contracts and historical use of the Sacramento River Water in question.

In 2016 the same group of litigants filed suit against the California Water Resources Control board claiming that diversions from the Sacramento River and Sacramento River/San Joaquin River Delta allowed during the drought of 2014 and 2015 were also discretionary actions that violated the ESA protection of Winter Run Chinook Salmon in the Sacramento River. This further casts into question the ability to rely on established water rights from the Sacramento River.

4.2.2 Buckeye Contract Supply

Contract No. 14-06-200-5272A (Buckeye Contract) originated from the City's annexation of the old Buckeye County Water District, which was formed in 1951 and eventually dissolved in 1967. In 1971, the City entered into the original Buckeye Contract with Reclamation, which assigned the Buckeye Service Area to the City and made available CVP supply to the City to serve the Buckeye area. Amendments to the Buckeye Contract were made in 1990 and 1994. The 1994 amended Buckeye Contract governs the supply to the City's Buckeye WTP, which came online in 1995.

City Staff entered into negotiation with the Bureau regarding the Buckeye Contract in December 1999. On May 18, 2004, the City Council approved Resolution No. 2004-81 approving the Draft Contracts allowing the Bureau to post the Contracts for public review and comment prior to completion of the environmental documentation. On March 15, 2005, City Council approved Resolution No. 2005-40 authorizing the mayor to sign the Buckeye Water Contract No. 14-06-200-5272A-LTR1, which extended the contract for another forty (40) years ending February 28, 2045. The contract did not include any additional water, but remained at 6,140 acre-feet of Project Water.

The supply may be diverted from the CVP's Spring Creek Conduit into the City's Buckeye WTP and/or at the City's PS-1 intake. The supply is for M&I use only within the COR service area shown on Figure A-1.

The Project supply cost includes a basic M&I rate (or cost of service charge), a foregone power charge if the water is diverted at the Buckeye WTP, and a CVPIA Restoration Fund charge. These charges have varied year to year since 1995. The foregone power charge compensates Reclamation for the power generation revenue they forego when the City diverts the supply to the Buckeye WTP upstream of the Spring Creek Power Plant and the Keswick Dam generating plant, which reduces each plant's net power generation. If the Buckeye supply is diverted at the PS-1 intake downstream of Keswick Dam, no foregone power charge is included. Table 4-1 summarizes the 2016 charges for the Buckeye supply.

4.2.3 ACID Contract Supply

In March 2011, the City Council approved an agreement with ACID for the annual purchase of up to four thousand (4,000) acre-feet of water. The additional capacity is needed to meet long-term population growth and to account for water shortage cutbacks in any given Critical Year in our contracts with the United States Bureau of Reclamation (USBR) due to drought conditions. The City needs to secure between 5,000 acre-feet and 10,000 acre-feet of new surface water supply to meet projected water system demands between 2015 and City build-out in approximately 2140.

Table 4-1 Summary of 2015 Buckeye Contract Supply Charges

		Tiered Pricing	
Charges	Buckeye Diversion* 4,916 AF ($/ac-ft)	80% 612 AF ($/ac-ft)	90% 612 AF ($/ac-ft)
M&I Rate	26.88	27.67	28.47
Foregone Power Charges**	13.01	13.01	13.01
CVPIA Restoration Charge	20.41	20.41	20.41
Total	60.30	61.09	61.89

* Buckeye diversion only includes charges for Spring Creek Conduit water from Whiskeytown and no longer applies PS-1 diversion rate.

** On December 18, 2009, the City Council approved Resolution No. 2009-197, to establish a Contract Amendment No. 2 with Western Area Power Administration (WAPA) for foregone Centeral Valley Project (CVP) power loss by water diverted from the Spring Creek Conduit for the 14 MG Buckeye Water Treatment Plant (BWTP). The original contract, No. 92-SAO-18001, was approved and signed by WAPA and the City on June 22, 1992 and would expire on December 31, 2009. The cost of the foregone power per acre foot of water diverted to the BWTP at that time was $11.90. The new negotiated contract will extend Contract No. 92-SAO-18001 until December 31, 2024. Compensation for the foregone power will be referred to as the Monthly Energy Compensation Charge. The cost of the foregone power per acre foot of water diverted to the BWTP with the new contract will average from $15.0 to $29.00. The foregone power charges for 2015 were very low as due to transfer of alternate water source. Prior years have seen charges in excess of $30.00 per acre ft.

4.3 GROUNDWATER SUPPLY

The City has two groundwater supply sources, the Enterprise well field and the Cascade well field. Details on the individual wells are provided in Table 2-2, and locations are shown on Figure A-1. The Enterprise well field provides most of the City's groundwater, while the Cascade wells provide a relatively minor local supply to the southern end of the Cascade area only. Groundwater supply makes up approximately 31 percent of the City's current annual average supply.

4.3.1 Enterprise Wells

The twelve existing Enterprise wells have a total pumping capacity of approximately 19 mgd. The wells are used seasonally, and only operate at or near peak capacity during the summer season maximum demand periods. Table 4-2 summarizes the monthly total production from the Enterprise wells from 2011 to 2016.

The typical pumping rates and annual yield per well vary widely, with the newer wells (EW-12, EW-13, EW-14, and EW-23), which are larger and located in higher yielding areas of the aquifer, providing up to 2.5 mgd on average.

It is anticipated that expansion of the Enterprise well field will take place over the next 10 to 20 years as water demands increase with continued growth in the City. To assess the ability of future groundwater pumping to meet City water supply needs, this plan used a detailed regional groundwater model that was developed as part of the Shasta County Water Master Plan. The model was used to evaluate the forecast pumping levels required to meet the City's buildout water supply. See Section 5.2 for discussion of forecast supply requirements. Future pumping scenarios included normal-year average annual pumping of 18,000 ac-ft per year, drought-year annual pumping of 25,000 ac-ft, and sustained 30-day maximum pumping rates during the drought-year condition. The model results indicate that the regional impacts of this level of future groundwater pumping are minimal. Seasonal drawdown levels for both new and existing City of Redding wells vary from 20 to 40 feet, with full recovery when the wells are turned off.

4.3.2 Cascade Wells

The City currently operates four of the original nine wells in the Cascade area with one additional well available on standby. The other four Cascade wells have all been abandoned because of a combination of low yield and water quality problems; the shallow infiltration gallery Westwood Manor wells are considered under influence of surface water and would require filtration treatment. The four operating wells have a total pumping capacity of approximately 0.76 mgd. The wells are now used all year. Table 4-3 summarizes the monthly production from the Cascade wells from 2011 to 2016. The four wells provide a relatively small contribution to the City-wide water supply.

4.4 EMERGENCY SUPPLY CONNECTIONS

The City of Redding has emergency service inter-ties with several neighboring water systems. These inter-ties provide back-up supply to local areas of the City. Examples of the service provided by these inter-ties include the recent failure of the Bella Vista Water District's main pump station because of transformer problems, during which the City provided limited supply to areas of the Bella Vista Water District system; and the emergency shutdown in 2000 of the City's Foothill WTP, during which time the Centerville Community Services District inter-tie was used to supply the Hill 900 Zone. The existing inter-ties do not have adequate capacity to provide significant supply on a regular basis. Table 2-8 lists the inter-ties.

Table 4-2 Monthly Pumping from Enterprise Wells (MG)

	2011	2012	2013	2014	2015	2016	Average
January	129.9	152.1	110.0	90.1	161.0	106.3	124.9
February	70.0	67.3	65.4	91.5	159.2	100.2	92.3
March	98.3	135.9	107.7	202.2	226.9	142.7	152.3
April	141.2	151.1	153.4	262.0	244.9		190.5
May	153.9	332.2	256.5	368.1	264.5		275.0
June	200.2	375.3	316.7	358.6	257.0		301.6
July	369.9	403.3	353.3	339.1	254.1		344.0
August	350.1	400.7	346.6	256.0	250.6		320.8
September	298.3	310.3	288.0	221.8	211.4		265.9
October	145.0	247.3	207.6	200.5	180.5		196.2
November	137.9	112.8	128.0	105.3	131.8		123.2
December	165.4	112.8	98.6	158.5	110.0		129.1
*Totals**	2260.1	2801.0	2431.7	2653.8	2451.9		2515.7

Table 4-3 Monthly Pumping from Cascade Wells (MG)

	2011	2012	2013	2014	2015	2016	Average
January	11.6	3.8	3.4	6.4	0	17.0	7.0
February	10.1	3.6	3.1	2.6	0	15.7	5.9
March	11.1	3.8	3.4	3.9	0	16.5	6.5
April	7.9	3.5	6.4	3.8	0	0	4.3
May	6.4	6.3	7.9	3.9	0	0	4.9
June	6.2	7.3	10.5	0.4	0	0	4.9
July	6.4	7.4	7.7	0	1.7	0	4.7
August	6.5	4.6	7.5	0	14.3	0	6.6
September	6.1	3.4	7.1	0	17.0	0	6.7
October	6.1	3.5	7.2	0	18.0	0	7.0
November	6.7	3.3	6.8	0	17.0	0	6.8
December	4.5	3.3	6.8	0	16.9	0	6.3
*Totals**	89.7	53.9	77.8	21.0	84.8		71.4

* Totals provided for years with complete data.

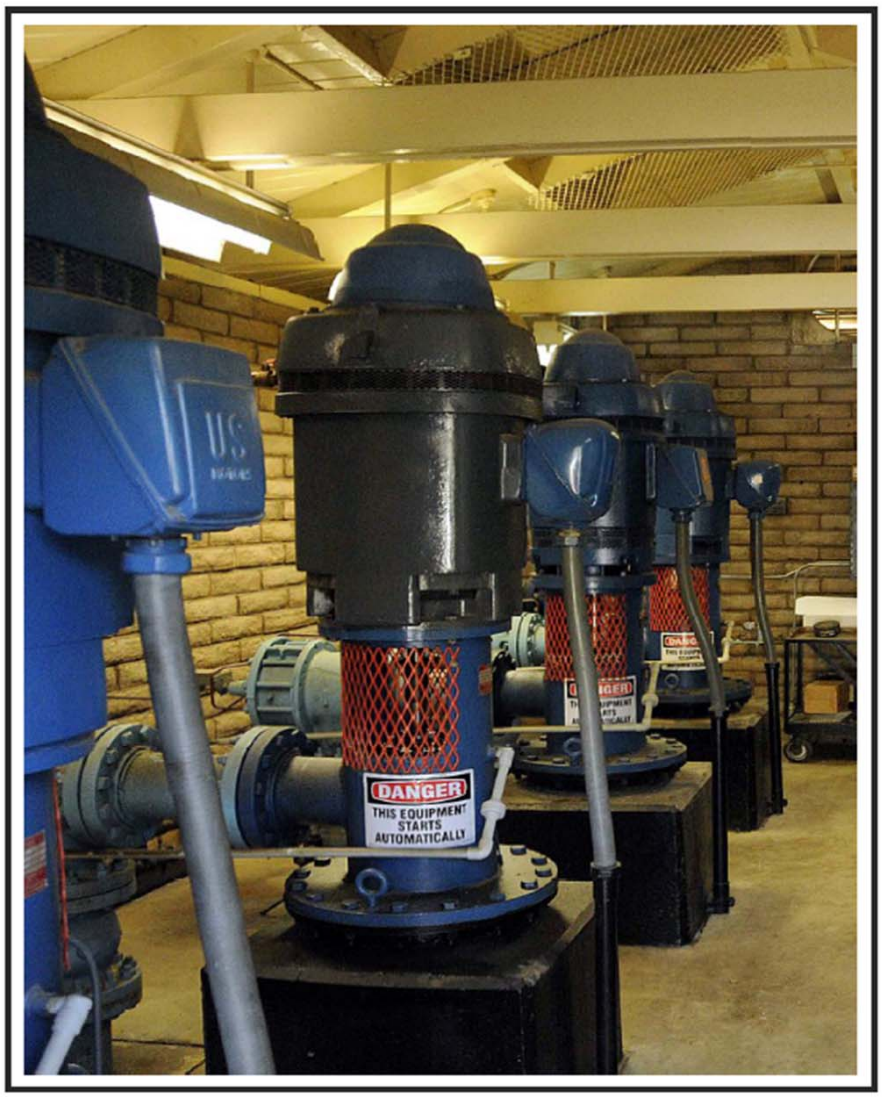
4.5 SUMMARY OF PRESSURE-ZONE SUPPLY SOURCES AND COST

The ability of the City water system to supply each pressure zone from each of the four main supplies is restricted by the locations of the water supply facilities, the wide geographic extent of the service area, topographic relief, and the capacity of the primary distribution facilities. Therefore, each of the six pressure zones generally receives supply from one primary source and one secondary source, according to the most economical supply alternative. The unit cost of supply to each pressure zone, depending on the source and conveyance route, varies widely. Table 4-4 lists average unit supply costs in 2015 for each zone according to source and conveyance route.

Table 4-4 Pressure Zone Supply Costs

Zone	Supply/Conveyance	Power/ Chemical ($/ac-ft)	Source Cost ($/ac-ft)	Total Cost ($/ac-ft)	Total Cost ($/MG)	Notes
Foothill	Foothill WTP	86.94	47.39	134.33	437.75	Average cost per ac ft combined base and project 2010
	Buckeye PS-3 to Foothill	0	129.71	129.71	422.69	
	Buckeye PS-4 to Foothill	0	129.71	129.71	422.69	
Hill 900	Foothill WTP/PS-2	20.36	134.33	154.69	504.09	
	El Reno	68.00	134.33	202.33	659.34	
Cascade	Railroad Ave from Foothill	0	164.99	164.99	537.66	Gravity from Foothill WTP
	S. Bonnyiew from Ent Wells	2.65	128.49	131.14	427.35	Gravity feed or pump from Enterprise Wells
	Cascade Wells	185.20	0	185.20	603.52	
Enterprise	Cypress from Foothill WTP	0	134.33	134.33	437.75	Gravity from Foothill WTP
	Enterprise Wells	128.49	0	128.49	418.72	
Hilltop	Foothill Cypress PS-5 Cypress-	55.47	134.33	189.80	618.51	Assumes Foothill WTP Supply via Cypress
	Ent Wells PS-5	55.47	128.49	183.96	599.48	Assumes Enterprise Well Supply
	Foothill, PS-3, Palisades	95.08	129.71	224.79	732.53	
	Buckeye, Palisades	0	129.71	129.71	422.69	Gravity from Buckeye
Buckeye	Buckeye WTP	95.08	34.63	129.71	422.69	
	Foothill PS-3 to Buckeye	95.08	134.33	229.41	747.59	Peak demand source to Buckeye
	Foothill PS-4to Buckeye	133.58	134.33	267.91	873.05	Peak demand source to Buckeye, normally off

Enterprise Water Towers - Decommissioned and demolished in 1996



PUMP STATION No.3

CHAPTER 5

Water System Evaluation

5.1 BACKGROUND

The City of Redding water system evaluation includes analysis of all major aspects of providing water to the customer. The effort starts with evaluation of water supply including location and ability to transfer between pressure zones and impacts to facilities from such transfers. Following water supply evaluation is the water treatment evaluation to determine the ability to treat the water supply at each planning horizon. The last part of the evaluation is evaluation of the water distribution system to convey water to each pressure zone and meet the different demands within each zone. Each portion of the evaluation is included below along with recommendations for improvements necessary to meet the projected demands. A summary and tabulation of all recommended improvements is included at the end of the chapter.

The evaluation and analysis contained herein assumes development follows the projections described in Appendix D from a combination of Itron Inc. and Shasta County RTPA efforts. The effort is considered the best available projection of growth potential for different areas within the overall planning boundary. This document outlines the City of Redding intent, based on that best available projection, to locate projects that will supply those projected demands. However, since all such planning efforts carry some amount of uncertainty, should development occur earlier than projected or in areas not projected for growth, improvements necessary to obtain services from the City of Redding distribution system shall be constructed and paid for by the developer of the project and may or may not be eligible for reimbursement from the City of Redding or future land development projects that may benefit from said improvements. Such improvements may include not only those necessary to extend supply to the project but also improvements required within and to the existing distribution and/or treatment systems. To mitigate this uncertainty it is recommended that the Master Plan be updated on relatively frequent intervals.

5.2 SUPPLY

5.2.1 Supply Planning Methodology and Assumptions

A range of supply alternatives were evaluated for each planning horizon (2015, 2020, 2025, 2035 and buildout). Basic assumptions regarding supply and treatment capacity development were reviewed with City staff to ensure that a sound basis for the supply alternatives evaluation and a standard process of evaluation followed for each supply alternative. Key assumptions and evaluation steps are summarized below.

1. The City's existing Reclamation supply contracts will be remain at the current contract's total annual supply levels. Price and other conditions may change.
2. Existing and future WTPs will have a peak capacity that allows efficient use of the total water supply available to the facility. Assuming the plants generally operate year-round and follow an operating pattern similar to the annual water demand pattern, treatment plant capacity should be approximately 2.2 times the average supply. For example, if 7,000 ac-ft per year supply is available (or an average of 6.2 mgd), then the associated WTP should be sized for 2.2*6.2 = 13.6 mgd.
3. Groundwater wells will operate at the historic average from 2008 to 2010 about 50 percent of the time. This results in an annual supply of approximately 50 percent of the installed maximum pumping

capacity. For example, if the Enterprise wells have a total pumping capacity of 19 mgd, then the average annual supply is approximately 10,600 ac-ft. New Enterprise area wells will be similar to EW-14, with average capacity of 2.5 mgd.

4. Evaluation factors for new supply and treatment facilities included construction and implementation factors (time, cost, complexity, secondary impacts); Reclamation contract issues (quantity, price, reliability, area of use, point of diversion); and general issues such as operations flexibility to serve multiple areas of the City.

5. A screening-level analysis was done for each alternative including discussion with City staff of the above factors and a pressure zone-level mass balance to evaluate impacts on major existing facilities such as pump stations and conveyance mains.

6. Drought year cuts are determined as a reduction of 25% of the average total water use between April 1 and October 31 from 2008 through 2010. This was calculated and determined to be 2,552 acre feet.

7. The analysis accounts for recent legislation mandating conservation or reduction in demand thereby reducing necessity of supply. Details of measures utilized to encourage conservation and the community conservation performance is published in the City of Redding 2015 Urban Water Management Plan.

Table 5-1 Water Supply Analysis (ac-ft)

	2020		2025		2030		2035		UBO	
Source	Normal	Droug	Normal	Drough	Norm	Droug	Normal	Droug	Normal	Droug
Foothill	21000	18465	21000	18465	21000	18465	21000	18465	21000	18465
Buckeye	6140	4605	6140	4605	6140	4605	6140	4605	6140	4605
ACID	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
Enterprise Wells	10600	10600	10600	10600	10600	10600	10600	10600	10600	10600
Cascade Wells (a)	405	405	405	405	405	405	405	405	405	405
Total	42145	38075	42145	38075	42145	38075	42145	38075	42145	38075
Average Demand	26039	26039	26504	26504	27068	27068	27663	27663	46779	46779
Excess(+) /Deficit(-)	16106	12036	15641	11571	15077	11007	14482	10412	-4634	-8704
% Excess/Deficit	38	32	37	30	36	29	34	27	-11	-23
% Ex/Def (c)	32	24	31	22	29	21	27	19	-23	-37

(a) Well production was calculated based on 50% of total capacity excluding EW-11 and EW-13

(b) Current Average annual demand was estimated from customer service data from 2008 through 2010

(c) ACID is agricultural water supply which is more subject to curtailment and therefore less reliable. This row reflects the percentages excess or deficit without the ACID contract water.

5.2.2 Existing Supply (2015)

The existing condition water supply demands include annual average of approximately 25,818 acre-feet, with a maximum daily demand of 49 mgd. Table 5-1 summarizes the water supply/demand balance for the conditions for all planning horizons. The City's water supply is adequate to meet existing demands in both normal and drought years.

5.2.3 Future Supplies

As shown in Table 5-1, in all planning horizons through 2035 existing water supply is adequate to meet demand under both full-service contract and standard Bureau curtailment with or without the ACID transfer with a minimum of 19% excess available.

5.2.4 Supply - Service Area Buildout Planning Horizon

The term "buildout" or "ultimate buildout (UBO)" refers to the planning condition under which the maximum level of development and population has been reached using the long-term land use plan for the City. Utilizing Itron Inc. growth rates through 2030, and assuming a similar long-term annual average growth rate of between 0.41 percent and 0.43 percent from 2030 through buildout, the WSA should reach buildout in approximately 2145. A much higher level of uncertainty is inherent in the water supply planning for buildout of the City WSA, relative to the 2020, 2025 and 2035 time frames. The recent 10-year period from 2000 to 2010 is a good example of the level of change that can occur. The City has seen both periods of rapid growth followed by stagnation and slow growth.

Major factors that are likely to influence long-term supply requirements and specific alternatives and decisions include the following:

1. The influence on water levels and yield in the groundwater basins from long-term development, including the annual quantity and patterns of pumping, and development of the groundwater basin resources by other water suppliers.
2. The location, rate, and types of development and growth that occur both within the WSA and in neighboring cities and presently unincorporated county areas.
3. City agreements with adjacent water suppliers involving either supply from or to the City.
4. Long term or periodic climate changes altering water supply.

Although the City cannot answer these questions with certainty now, careful consideration of the actions and policies that are enacted over the next 10 to 15 years can help ensure that the City has the maximum flexibility and supply reliability to address these uncertainties.

5.2.5 Supply Delivery Needs - Groundwater Wells

Although wells are called for in this plan to fulfill supply needs for future growth at different planning horizons it is recognized that the location of the majority of wells on the opposite side of the distribution network from the treatment plants may also satisfy a distribution need. The evaluation strategy used in this plan addressed supply needs prior to distribution needs so construction of a well to meet supply deficiencies may have offset needs for some distribution pipe projects. No alternatives analysis was performed to determine what, if any, distribution pipes would be necessary in the absence of the additional wells.

5.2.6 Supply Delivery Needs - Pump Station 1

Pumping Efficiency PS-1 is located on the Sacramento River upstream of the ACID diversion strucuture. The diverstion structure is operated with flashboards installed between April and November which increases the depth of the pool used to supply PS-1. Between November and April when the flashboards are removed the

draw pool for PS-1 is too shallow to operate the pumps at high enough speeds to run efficiently resulting in an excessive use of power. Increasing the pump speed to improve efficiency of the motors would cause cavitation.

Seismic Stability Based on the City's General Plan seismic hazard map, the pump station building and intake structure are located in an area of high seismic liquefaction potential, and should be evaluated for its ability to withstand critical damage during a design earthquake.

Noise Operation of PS-1 has resulted in complaints from nearby homeowners regarding noise levels.

Operation The expansion building for PS-1 lacks adequate workspace around the pumps and other equipment to meet current workplace standards.

Environmental Concerns The primary delivery source of raw Sacramento River "contract" water to the Foothill WTP is Pump Station 1(PS-1). Thus, PS-1 is a critical component of the City water supply chain. The City has been working with state and federal resource agencies for many years to reduce impacts from PS-1 river pumping to state and federal listed salmon in the Sacramento River. The City's pumping agreement with the Bureau of Reclamation is subject to the Central Valley Project Improvement Act (CVPIA) which includes fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation, municipal and industrial water use, and power generation. The CVPIA states that the Department of Interior will "assist the State of California in efforts to develop and implement measures to avoid losses of juvenile anadromous fish resulting from unscreened or inadequately screened diversions on the Sacramento and San Joaquin Rivers, their tributaries, the Sacramento-San Joaquin Delta, and the Suisun Marsh." The Department of Interior has implemented this responsibility through the Anadromous Fish Screening Program (AFSP) administered by the USFWS.

In addition to the restoration goals of the CVPIA, the CALFED Bay-Delta Program provides for development, implementation, and oversight of a long-term comprehensive plan to restore ecosystem health and improve water management for beneficial uses of the Bay-Delta system. The goal for ecosystem quality is to improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species. To accomplish this goal, CALFED developed the Ecosystem Restoration Program Plan (ERPP). The Sacramento River is identified in the ERPP as an important ecological unit of the North Sacramento Valley Ecological zone. The ERPP recognizes the importance of improving salmon spawning and juvenile survival within upstream tributaries of the Bay-Delta. To that end, the CALFED Program recognizes the need to improve diversions with fish-friendly screens and other habitat improvements that contribute to a greater overall population of salmon.

Prior to the mid-1990's, the National Oceanic and Atmospheric Administration-Fisheries (NOAA Fisheries) estimates that up to 10 million anadromous salmonid fry were lost annually from diversions occurring along the Sacramento River. Between 1994 and 2004, 19 fish screening projects were completed within the Central Valley Project service area; 13 occurred within the Sacramento River. These projects contribute to the overall restoration of anadromous fisheries within the Sacramento River System by protecting juvenile fish from entrainment at screened diversions.

In 1998, Anderson-Cottonwood Irrigation District (ACID), the USFWS, and several other natural resource management agencies began the ACID Fish Passage Improvement Project, a cooperative project identified by the CVPIA and supported by CALFED. The project substantially improved anadromous fish passage at the ACID diversion dam by adding fish screens, fish ladders, and a fish viewing facility at the north bank fish ladder in Caldwell Park. Biological monitoring conducted since the project was completed in 2001 has shown a substantial increase in salmon passage and spawning upstream of the dam, which is where the City's pump station is located.

Because of the improvements made at the ACID facility, it became necessary for the City's pump station to complete similar works to prevent entrainment of salmon and other small fish. In August 2000, the City entered into an agreement with the Bureau of Reclamation for funding facility modifications. In July 2001, the City solicited competitive bids to conduct an engineering feasibility study of upgrades to PS-1, including

state of the art fish protection, which resulted in a report entitled Draft Feasibility Study for the City of Redding Pump House No. 1 Fish Protection Project. Five conceptual project alternatives for modification of the PS-1 facility were analyzed.

Upon completion of the study, the City determined that available funding was insufficient to construct a new pumping facility or even to complete many of the recommended modifications to the existing facility meeting the 1997 joint NOAA-Fisheries and California Department of Fish and Game (CDFG) fish screen criteria. Therefore, the City was directed by NOAA Fisheries to pursue an interim retrofit solution for screening until a new screened pumping plant could be funded and built. In 2005, NOAA Fisheries issued a waiver to the City allowing certain aspects of the interim fish screens' performance to depart from standard criteria under certain specific river and operating conditions.

The screens were installed at the facility in mid 2006 under the temporary operating authority provided by the waiver. The waiver allows the plant to operate until 2015 at which time the pump house would have to be replaced or retrofitted with screens meeting the NOAA-Fisheries and DFG screen criteria. Monitoring of the screens, however, indicate that fish may not be adversely affected to the extent predicted, and that the screens may be performing in a satisfactory manner. As a result, the City began discussions with NOAA-Fisheries in 2010 regarding a waiver extension which would allow continued monitoring. If monitoring data, combined with specific operating procedures, shows that the facility does not adversely affect salmon, then with NOAA-Fisheries and DFG approval, the pumping plant may continue to be used in its current configuration and location.

5.2.9 Impacts of New Water Conservation Regulation

In November 2009, California Senate Bill SB-X7-7 (Steinberg) was enacted requiring that all water suppliers increase water use efficiency. The City of Redding, along with other large urban water suppliers in California, will be required to comply with the bill which calls for a statewide 20 percent reduction in per capita water consumption by the year 2020. The legislation requires incremental progress towards the goal by showing a per capita reduction in water use by at least 10% by December 31, 2015. Some highlights of the legislation include:

- Each urban retail water supplier shall develop water use targets and an interim water use target by July 1, 2011.
- An urban retail water supplier shall include in its water management plan the baseline daily per capita water use, water use target, interim water use target, and compliance daily per capita water use.
- The Department of Water Resources shall adopt regulations for implementation of the provisions relating to process water.
- A Commercial, Institutional, Industrial (CII) task force is to be established that will develop and implement urban best management practices for statewide water savings.
- Effective 2016, urban retail water suppliers who do not meet the water conservation requirements established by this bill are not eligible for state water grants or loans.

Targets were calculated per the 10 and 20% reductions strictly on current average per capita water use. The current master plan CIP shows an extensive list of projects for the existing demand scenario with only a handful of projects called for as a result of need to satisfy fire flows or development between 2015 and 2020. Analysis of the water utility production and billing showed that the City met the interim conservation goal for 2015 and appears to be on track for meeting the 2020 goal.

5.2.10 Summary Recommendations for Water Supply Development

The City will need to take specific actions in a timely manner to provide the required supply increases on a schedule that avoids potential deficit conditions in the future. Because of the many uncertainties affecting supply and capacity improvements shown beyond 2020, recommended improvements are conceptual only. The following listed water supply actions and/or improvements are recommended for each planning periods:

Years 2015 to 2020

1. Complete planning process and environmental documentation for relocation of PS-1.

2. In the 2012 Master Plan it was recommended that an investigation of treatment or other process for improving water quality and returning EW-11 and EW-13 to operation. The investigation was performed and resulted in a change in strategy to pursue well head treatment at EW-12 and utilize that well production and a blending plan to mitigate potential high levels of constituents in adjacent wells. Construction of well head treatment at EW-12 is proceeding and expected to be complete within the 2015-2020 planning time frame.

3. The City should review its current planning policies and regulations to ensure protection of the groundwater resources. Key factors to consider include water quality protection from surface contaminants such as industrial wastes, agricultural activities, or land application of sewage sludge; development of groundwater adjacent to the City's well field by other parties; and actions by Shasta County, state and/or federal agencies that may result in exporting Redding Basin groundwater supplies.

4. The City should formulate a consistent long-term policy regarding current and future supply arrangements with neighboring water agencies to ensure the City has adequate supply to meet City water needs and its obligations under such arrangements. The City should evaluate such agreements according to the net economic and financial benefits of such arrangements and the required capital improvements to the City's water system.

Years 2020 to 2025

1. Given Reclamation's position on quantity increases during contract renewal, the City should begin evaluating transfer opportunities within the Redding Basin that would make available non-Project surface-water supplies.

2. Construct necessary improvements to or relocate PS-1.

Years 2025 to 2035

1. Consider construction of two new Enterprise Wells.

2. Investigate long-term transfer arrangements that secure a minimum of 10,000 annual ac-ft of new surface-water supply. Although these supplies may not be needed immediately, the time frame for planning and constructing facilities to use this supply to meet growth in demands requires that the supply be secured at least 5 to 10 years before it is needed. The amount of new supply is based on having sufficient flexibility in using all or a portion of this supply to address future uncertainties such as compensating for drought- year cutbacks, having to dedicate a portion of the supply to other users in exchange for diversion flexibility, possible additional supply arrangements with neighboring water agencies, and variations in groundwater pumping.

3. Take preliminary steps to identify and secure suitable land for future water treatment plant sites as indicated by the specific features of the new surface-water supplies.

5.3 TREATMENT

5.3.1 Treatment Facility Evaluations

Foothill Water Treatment Plant In April of 2011 PACE Civil Inc. completed a facilities plan for Foothill WTP. The goal of this effort was to provide a course of action for necessary maintenance and upgrade improvements for continued operations and expansion of the treatment plant to meet future demands. The results of the evaluation indicate that many improvements should be made to enhance process performance, reliability, and operability. The Foothill WTP Facilities Plan is included by reference in this 2016 WMP. A summary of treatment needs and recommendations for the Foothill WTP is provided in Appendix B.

Buckeye Water Treatment Plant As part of WMP 2000, CH2M Hill conducted a multi-disciplinary evaluation of selected systems and features of the Buckeye WTP. The evaluation identified various improvements to enhance process performance, reliability, operability of the facility. Improvements intended to stabilize process performance and/or increase the capacity of the treatment plant to meet peak demand periods were prioritized. Most of the improvements identified in the WMP 2000 were completed, including the construction of a new 4 MG steel-storage reservoir in 2002. See Appendix B for the remaining WMP 2000 evaluation findings, along with an update on current facility conditions and needs.

5.3.2 Impacts of New Water Treatment Regulations

The U.S. Environmental Protection Agency (EPA) intends to promulgate several new regulations during the next few years. In general, these regulations involve more stringent standards for microbial pathogens and disinfection byproducts in surface waters. These regulations and potential impacts to the City's water treatment systems are discussed below.

Revisions to Total Coliform Rule (RTCR) The 1996 amendments to the Safe Drinking Water Act [Section 1412(b)(9)] require the Administrator to review and revise, as appropriate, each national primary drinking water regulation not less often than every 6 years. The latest proposed revisions to the Total Coliform Rule (RTCR) were published in the Federal Register on July 14, 2010. The revisions include increased monitoring for coliform and expanded followup monitoring should a sample exceed the Maximum Contaminant Limit (MCL). Historic records show that the City has not had a coliform problem and complance with the revised rule should be readily achievable for the cost of the additional monitoring. Should there be samples that exceed the MCL the tiers of additional monitoring required are expected to require approximately 70 additional employee hours for Level 1 assessment, 120 hours for a non-acute Level 2 assessment, and 130 hours for acute Level 2 assessment. It is not possible to forecast the potential cost for corrective action without specific knowledge of the cause. The final RTCR is schedled for promulgation in 2012.

Perchlorate In December of 2005 the EPA established a official reference dose (RfD) of 0.0007 mg/kg/day of perchlorate. A reference dose is a scientific estimate of a daily exposure level that is not expected to cause adverse health effects in humans. The reference dose, which assumes total intake from both water and food sources, is appropriate and protective for all populations, including the most sensitive subgroups. The reference dose includes a 10-fold level of protection factor to cover variability and life stages including fetuses and neonates. The EPA's new RFD translates to a Drinking Water Equivalent Level (DWEL) of 24.5 ppb.

Based on this information the 2008 decision not to regulate perchlorate has been reversed. In Feburary, 2011 the EPA published intent to regulate perchlorate in the Federal Register. This initiates the process of determining the regulatory level. The EPA intends to publish a proposed national primary drinking water regulation within the next 24-months. Samples collected from the City's water system that were tested for percholrate all fell below the reporting level of 4 ppb. Unless the new regulation implements a limit below the current reporting level requirement the new regulation is not likely to impact the utility.

Lead and Copper Revisions Beginning in 2004, EPA conducted a wide-ranging review of implementation of the Lead and Coper Rule (LCR) to determine if there is a national problem related to elevated lead levels.

As a result of the review the EPA identified seven targeted rule changes and implemented short-term regulatory revisions and clarifications promulgated in October 2007 to strengthen the existing LCR. The EPA also identified several regulatory changes to be considered as part of a more comprehensive revision pending additional data collection, research, analysis, and stakeholder involvement. The Lead and Copper Long Term Revisions addresses the remaining regulatory revisions which are expected to be completed in the 2013/2014 time frame.

Information on expected changes or revisions is limited at this time. However, there is some evidence to believe that the revisions will focus on lead service line replacement, sample site criteria, corrosion control and consecutive water systems.

The City monitoring data history shows that no action levels have ever been exceeded for either copper or lead. As a result the City is currently under reduced monitoring requirements for both lead and copper. Compliance with the proposed revisions is not expected to occur with no new improvements.

Groups of Contaminants In an effort to speed up the regulatory process the EPA is attempting to address drinking water contaminants as groups, rather than the traditional approach of individual contaminant regulation. In February 2, 2011, U.S. EPA announced that it would move forward with efforts to regulate, as a single group, up to 16 carcinogenic volatile organic compounds (VOC's)in drinking water. The VOCs would be the first group of drinking water contaminants to be addressed as a single group under the Agency's new "Drinking Water Strategy" announced in March 2010.

Current regulations include eight VOC compounds so within the next 2 to 2.5 years the EPA will determine how many, if any, additional compounds of the suggested 16 will become formally regulated. In addition the VOC group is one of three groups expected to become regulated as the program continues to develop.

Additional compound groups under consideration include nitrosamines, disinfection byproducts from chlorination, perfluoronated compounds, organophosphates, carbamates, triazines, chloroacetanilides, and cyanotoxins.

The exact number of additional compounds that will be regulated is not available so it is difficult if not impossible to project what impact the new regulations will have on the Utility. It is likely that the least that will be required is additional monitoring of new compounds.

Inorganic Contaminants - Floride In January 2011 the federal Department of Health Services recommended that the U.S. EPA impose tougher standards on naturally-occurring fluoride in drinking water. The HSS recommendation follows a government study showing that about 2 out of 5 adolescents have tooth streaking or spottiness because of excessive fluoride. In addition the EPA released two new reviews of research on fluoride, one that showed that prolonged, high intake of fluoride can increase the risk of brittle bones, fractures and crippling bone abnormalities. Since 1962 the fluoridated water standard has been set at a range of 0.7 ppm for warmer climates, where water consumption is higher, to 1.2 ppm in cooler regions. The new proposed limit would be set at 0.7 ppm for all areas. Based on historic analytical results it is likely that the City of Redding will be able to comply with the lower limit. Additional monitoring requirements, if any, will be determined when the EPA formally adopts new regulations.

Floride Introduction Section 14.08.245 of the Redding Municipal Code addresses restriction of non-essential additives into the City's water supply. It indicates that any such additive must meet two requirements:

1. The substance must have been specifically approved by the US Food and Drug Administration for safety and effectiveness with a margin of safety that is protective for all adverse health and cosmetic effects at all ranges of unrestricted consumption; and

2. The substance, at maximum use levels, must contain no contaminants at concentrations that exceed U.S. Maximum Contaminant Level Goals or California Public Health Goals, whichever is more protective.

Although not ruled out as a possible issue to address in the future, it is unlikely that this issue will impact the Utility in the foreseeable future.

5.3.3 Treatment Capacity

Evaluation of water treatment capacity in terms of total water production was performed to determine if and when improvements may be necessary to meet existing or future demands. To some extent treatment capacity and storage capacity need to be analyzed simultaneously to determine the optimum cost benefit ratio between increasing treatment capacity to meet peak day (or hour) needs versus construction of new storage facilities to handle peak demands.

The current water production capacity including treatment plants and wells is 65.7 mgd. Average daily demand is approximately 22 mgd in 2010 which is projected to increase to 46.5 mgd at WSA buildout. No improvements are necessary to meet average day water demands at any planning horizon. Peak day demand in 2015 is 31.8 according to production records. However, 2015 was the third year of drought and declared an emergency by the State governor resulting in unusually high conservation rates. Water consumption in 2014 was also lower than expected because of drought and conservation efforts. For the purpose of this analysis it was deemed conservative to project future demand based on population growth on top of the average demand from 2010 through 2014. This would reflect some level of ongoing conservation but not at the level expected during an emergency proclamation from the governor's office. This results in a peak day demand in 2013 of only 49.3 MGD, slightly less than was recorded in the last unconstrained year (2013), see Table 3-5. Although current production capacity still exceeds 49 mgd, well head treatment at EW-12 and construction of two new wells is recommended for water supply efficiency, which will increase peak day capacity to 70.1 mgd in 2035. Table 5-2 summarizes peak day demand/capacity data. Additionally, Table 5-2 shows that with the addition of well capacity called for in the previous chapter by 2035 additional treatment capacity is not called for until UBO. In order to meet peak day treatment capacity at UBO requires additional well supply or water rights and treatment capacity.

With the additional capacity represented by the above recommended well improvements on line supply/treatment will fall short of daily maximum demand in UBO by 2%. In order to preserve the 10% excess capacity required by the Drinking Water division of the California Water Resources Control Board. the City will need to develop 11 mgd more mgd of treatment capacity (including water rights) or new wells by UBO. Because of the unknown effectiveness and impact of State mandated water conservation efforts combined with the inherent uncertainty involved in a UBO forecast, no recommendations are made at this time for improvements to meet this UBO daily demand. It is recommended that the City re-evaluate the need in another ten years to revise the evaluation and determine if improvements are recommended at that time.

Table 5-2 Water Treatment Capacity - peak daily delivery (mgd)

Source	2015	2020	2025(a)	2035(a)	UBO(b)
Foothill WTP	32	32	32	32	32
Buckeye WTP	14	14	14	14	14
Enterprise Wells	19	19	23.4	23.4	39.9
Cascade Wells	0.73	0.73	0.73	0.73	0.73
Total	65.7	65.7	70.1	70.1	88.0
Peak Day	49	51	52	54	90
Excess(+)/Defici	16.7	14.7	18.1	16.1	-2.0
%	25	22	26	23	-2

(a) 2025 assumes well head treatment at EW-12

(b) assumes additional 18,000 AF supply at Enterprise Wells

5.3.4 Treatment Recommendations

Recommendations for expansion of water treatment capacity are limited to being an option for increasing peak daily supply some time between 2035 and ultimate development. The location of this facility and acquisition of water rights are relatively large issues and will need attention well in advance of plans to construct any such facility. Treatment of Enterprise well 12 for Arsenic and or Iron and Manganese is proceeding and will likely be complete by 2020.

Water treatment plant recommendations are addressed in the Foothill Water Treatment Plant facilities plan as mentioned above. The Buckeye Water Treatment plant expansion was relatively recent and considered adequate to maintain treatment capacity with routine maintenance unless additional regulatory issues require modification or revision of the process.

5.4 STORAGE

Storage requirements are created by four different types of conditions: production deficit, equalization, fire demand, and emergency. Each category is analyzed independently and considered in combination with the others. Each storage reservoir typically serves one primary pressure zone, and may also have the ability to provide secondary or back-up storage to adjacent pressure zones, depending on the relative elevation difference between the zones. For this reason, storage is evaluated separately for each pressure zone. The following section explains how storage requirements were evaluated in this plan, summarizes existing reservoir features, and evaluates the adequacy of existing storage for each pressure zone.

5.4.1 Production Deficit Storage

Production deficit storage and equalization storage are similar except that the goal of deficit storage is to balance cost of construction of treatment facilities vs storage. For this analysis, hourly diurnal demand patterns were applied to the peak day demand value to arrive at an hourly demand volume for the city and each pressure zone. If the demand exceeded the ability to produce water a storage need was recorded for that hour. Storage need was then integrated over time until production exceeded demand to arrive at the storage volume required. Table 5-3 summarizes results of this analysis for each pressure zone and city-wide, including various alternative analysis scenarios.

Buckeye Pressure Zone Three alternatives were analyzed for Buckeye Pressure zone.

Alt 1: The first alternative assumed that both Foothill and Buckeye treatment plants are operating. Water is being pumped at both PS-3 and PS-4 into Buckeye and no diversion is being done at Palisades PRVs.

Alt 2: Buckeye Pressure zone was also analyzed for supply from Buckeye WTP alone with no Foothill water and no diversion through Palisades PRVs.

Alt 3: The last Buckeye PZ alternative assumes Buckeye WTP is off line and all supply arrives through PS-3 and PS-4, no diversion through palisades. In all planning time frames daily demand exceeds pumping capacity so eventually storage will be depleted regardless of how much is constructed. As such results are expressed in terms of hours of storage available before storage is exhausted.

Cascade Pressure Zone Two alternatives were analyzed for Cascade pressure zone. The City is currently undertaking a project to increase capacity to deliver water from Foothill pressure zone to Cascade through the Railroad Avenue Vault. The analysis performed for this document does not include the new expected capacity.

Alt 1: Assumes 4.3 mgd supply at both South Bonnyview and Railroad Avenue Vault and 0.73 mgd supply from Cascade Wells.

Alt 2: Assumes one or the other supply is out of service. Since both South Bonnyview and Railroad Avenue Vault were assumed to have the same capacity the analysis would have the same results if either was removed from service.

Hill 900 Pressure Zone Two alternatives were analyzed for Hill 900 pressure zone.

Alt 1: Supply from PS-2 at 10.3 mgd. No supply from El Reno.

Alt 2: Supply from El Reno at 1.4 mgd. PS-2 out of service.

Hilltop/Dana Pressure Zone Hilltop/Dana pressure zone was analyzed independently assuming the supply from Enterprise is out of service. Only the 2.9 mgd from Buckeye through Palisades was used for supply.

Enterprise & Hilltop Pressure Zone Enterprise and Hilltop/Dana pressure zones both utilize Enterprise Reservoirs for gravity storage so it is appropriate to perform analysis of both pressure zones simultaneously. In addition, with supply available to the two pressure zones from Foothill, Buckeye and Enterprise Wells the number of different possible analysis is very large. Three different alternatives were analyzed based on general applicability. The City of Redding has recently completed modifications to the Palisades PRV settings to optimize the ability to transfer of water from Buckeye into Hilltop Dana. Such modifications were not completed in time to include in the current analysis. Table 5-3 summarizes results of this analysis.

Alt 1: Assumes 2.9 mgd transfer from Buckeye through Palisades, 7.2 mgd from Foothill at Cypress and 23.1 mgd supply from Enterprise Wells.

Alt 2: Assumes 2.9 mgd transfer from Buckeye through Palisades, no supply from Foothill and 23.1 mgd from Enterprise Wells.

Alt 3: Assumes supply of 23.1 mgd from Enterprise Wells only.

Foothill Pressure Zone Three alternatives were analyzed for Foothill Pressure zone.

Alt 1: Foothill WTP operating at 32 mgd. No transfers to Enterprise, HDZ, Buckeye or Cascade. Storage includes the 6 MG clearwell.

Alt 2: Foothill WTP not operating, no transfers out of the PZ and supply assumed to be 2.9 mgd at both PH-3 and PH-4 gravity valves. Storage includes the 6 MG clearwell.

Alt 3: Alt 2 with storage only from the 4 MG reservoir.

City Wide Analysis The City-wide analysis utilizes all supply applying peak day demands and diurnal patterns.

5.4.2 Equalization Storage

Equalization storage has no set standards, as each water system is different in terms of supply and demand. This study used daily operations data from recent typical ADD and MDD conditions to determine representative hourly demand patterns for each pressure zone, as well as for the entire water system. These demand patterns were then used with the steady supply rates to each zone to determine the required

equalization storage. Table 5-7 shows equalization storage requirements for each pressure zone for each planning horizon.

5.4.3 Fire Service Storage

Fire service storage is necessary to ensure adequate water supply is available to meet fire flow demands. Minimum fire flow standards are specified in Appendix-B of the California Fire Code (CFC). The City Fire Department uses CFC fire flow requirements as the "design standard" for the water system supporting the construction of new development. Table 5-5 lists the maximum fire flow demand for each pressure zone.

Table 5-3 Production Deficit Storage Requirements (MG)

		Planning Horizon				
Pressure		2015	2020	2025	2035	UBO
Buckeye	Alt 1	0	0	0	0.12	4.81
	Alt 2	0	0	0.15	1.80	~14 hrs
	Alt 3*	~70 hrs	~ 56 hrs	~ 38 hrs	~ 19 hrs	~ 10 hrs
Cascade	Alt 1*	0	0	0	0	~ 21 hrs
	Alt 2*	> 96 hrs	> 96 hrs	~ 66 hrs	~ 46 hrs	~ 11 hrs
Enterprise &	Alt 1*	0	0	0	0	0.77
	Alt 2*	0.28	0.38	0.47	0.64	~21 hrs
	Alt 3*	0.76	1.18	1.04	1.33	~ 17 hrs
Hilltop Dana *		> 96 hrs	> 96 hrs	>96 hrs	>96 hrs	~ 32 hrs
Foothill	Alt 1	0	0	0	0	0
	Alt 2*	> 96 hrs	> 96 hrs	> 96 hrs	> 96 hrs	> 84 hrs
	Alt 3*	~ 80 hrs	~ 64 hrs	~ 58 hrs	~ 47 hrs	~ 30 hrs
Hill 900	Alt 1*	0.23	0.34	0.38	0.50	0.99
	Alt 2*	~ 14 hrs	~ 14 hrs	~ 13 hrs	~ 12 hrs	~ 11 hrs
City Wide		0.93	1.42	0.93	1.41	8.65

* Daily zone demand exceeds supply. Results expressed in terms of hours before storage is depleted.

Table 5-4 Equalization Storage (MG)

	Planning Horizon				
Pressure	2015	2020	2025	2035	UBO
Buckeye	0.85	0.88	0.89	0.89	n/a
Cascade	0.59	0.62	0.62	0.64	1.22
Enterprise	1.56	1.69	1.72	1.80	n/a
Foothill	0.83	0.73	0.74	0.77	0.87
Hilltop-Dana	0.22	0.18	0.18	0.19	0.48
Hill 900	0.82	0.86	0.88	0.92	1.04
City Wide	4.99	5.20	5.30	5.50	9.17

n/a Demand exceeded supply capability for the pressure zone in this planning horizon. Transfers from other zones are required.

Table 5-5 Maximum Fire Flow By Pressure Zone

Zone	Project	Demand, gpm	Duration, hr	Volume, MG
Foothill	Liberty St Office	3500	3	0.63
Hill 900	Shasta	2500	2	0.3
Cascade	East Side Rd	6000	4	1.44
Enterprise	Bechelli Ln	6000	4	1.44
Hilltop	Mt Shasta Mall	5000	4	1.2
Buckeye	Oasis Center	5000	4	1.2

5.4.4 Emergency Storage

Emergency storage is used to provide water supply under emergency conditions that disrupt the normal water system supply or distribution system operations. Examples of emergency situations include major pipeline breaks, pump station damage (fire, mechanical failure, lightning strike), power outages, water treatment plant failures (mechanical problems, seismic damage, etc.), and source water contamination caused by winter storms or hazardous material spills.

No fixed standards are set for emergency storage volumes. As described in AWWA M32: "The amount of emergency storage included within a water distribution system is an owner option based on an assessment of risk and the desired degree of system dependability. An assessment must be made of the type and nature of emergency conditions, including frequency, intensity, and duration. In general, a vulnerability analysis should be used to determine emergency storage requirements."

For this WMP 2010, a range of potential emergency conditions were considered for each pressure zone, and general assumptions were made regarding the length of interruption of service, likely back-up sources, and alternative supply options. Each zone's emergency storage requirement is generally expressed as a portion of a MDD or an ADD condition, i.e., storage equal to 12 hours of MDD.

Required storage is the total of Equalization Storage, Fire Service Storage and Emergency Storage. Table 5-7 shows storage requirement components and totals for each pressure zone for each planning horizon.

5.4.5 Storage - Current and Future Needs

Hill 900 Storage - Current Need Current emergency storage recommendations trigger the need for additional storage in the Hill 900 Pressure Zone. Since the zone has no secondary gravity supply, planning for construction of a new storage facility is recommended. Current emergency storage allows for approximately 8.5 hours of supply before depletion. Under buildout condition the pressure zone will require an additional approximately 4.5 mg of storage.

Additional storage could also be achieved along with energy cost savings if the Hill 900 pressure zone could be connected to the Buckeye zone. Two alternatives have been suggested for this approach, either crossing the Sacramento River at a location near where Buenaventura Boulevard is planned to cross the river or along the south side of the Sacramento River along the River Trail alignment. The City should investigate the feasibility of this alternative to take advantage of the potential to gravity feed the Hill 900 zone thereby eliminating the need for PS2.

Buckeye Zone Storage - Current Need The Buckeye Zone has an existing 1.1 MG storage shortfall, increasing to 1.65 and 2.13 by 2020 and 2030 respectively. Prior master plan efforts recommended demolition of the

existing 0.2-MG reservoir and replacing it with a 2-MG reservoir. The current analysis of distribution infrastructure covered in Section 5.5 indicates that maintaining storage at this location will require significant conveyance infrastructure in addition to construction of the larger reservoir. Under buildout conditions, up to 17 MG of additional storage will also be required. Alternatives include expanding the existing site, adding one or two new reservoirs on Hill 933 and/or Hill 903 north of Herbscenta Lane, and a new reservoir at the Buckeye WTP site. The City has already secured the needed property on Hill 933 and Hill 930. Detailed analysis of storage and conveyance alternatives revealed that the Hill 933 and 930 locations are the preferred locations for construction of new reservoirs. It is recommended that the City proceed to plan for a new 3.0 MG storage reservoir at either Hill 933 or 930 which will provide adequate storage in the Buckeye Zone through 2030.

Enterprise Zone Storage - Future Need Up to an additional 2.5 MG of storage may be required for the Enterprise Zone under build-out conditions. A major factor for siting this future storage is the lack of suitable sites that have the elevation needed for ground-level storage with gravity flow into the distribution system. Essentially, there are no sites, other than the location of the existing reservoirs, that could be used for future ground-level storage reservoirs. This limitation is somewhat offset by the relatively flexible supply to Enterprise Zone, which includes the Enterprise wells, the Cypress Avenue main, the Palisades PRVs, and emergency supply from the Bella Vista Water District inter-tie. Because most of the buildout storage requirement is indicated by emergency storage requirements, the City could take steps to increase the reliability of one or more of these sources to offset the reduced emergency storage. Long-term alternatives for new storage capacity in the Enterprise Zone include eventually replacing the older 3.5-MG No. 1 reservoir with a larger reservoir, or a new ground-level or buried storage reservoir with a booster pump station and emergency power backup.

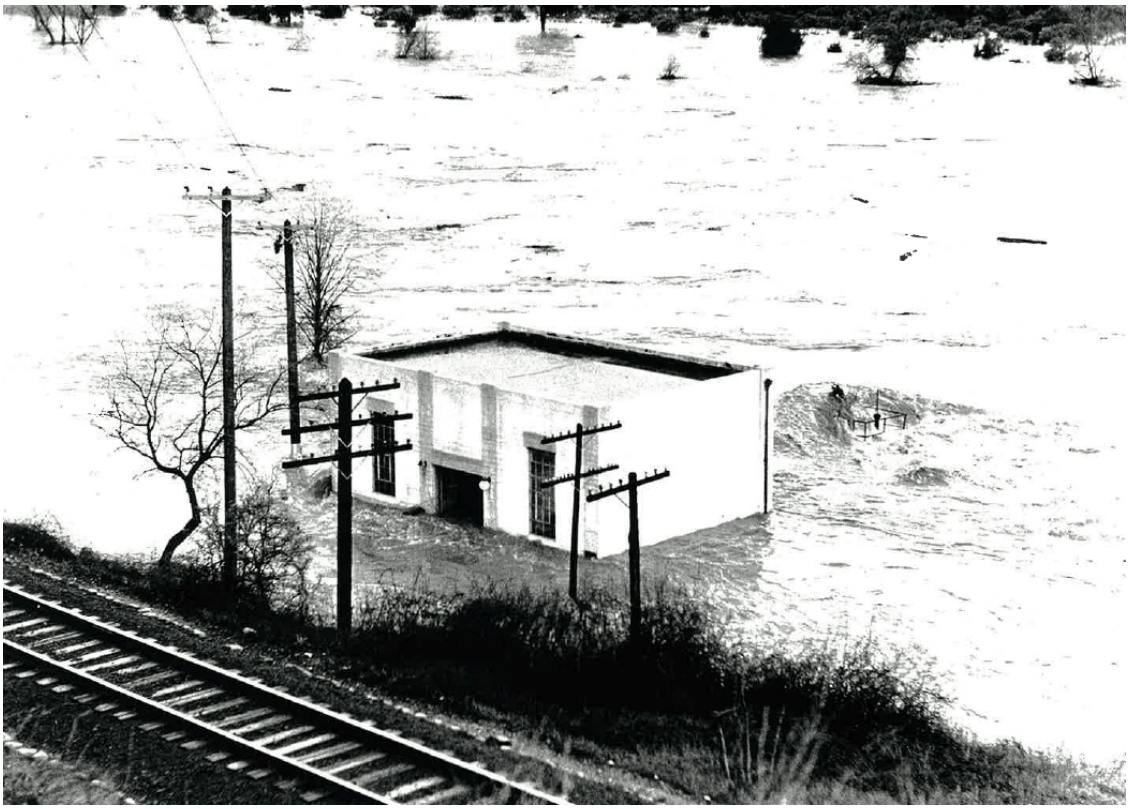
5.4.6 Storage - Recommendations

Analysis of storage presented in Tables 5-6 through 5-8 and the prior discussions indicate that additional storage needs to be planned for both Hill 900 and Buckeye Pressure zones in the relatively near future. Hill 900 Presure zone is currently showing only 9 hours of emergency storage without ability to depend on other pressure zones for storage supply. The only secondary supply for the zone is through El Reno pump station which is not large enough to support the zone demands. It is therefore recommended that the City initiate investigation of alternatives for reservoir location or potential connection between Hill 900 zone and Buckeye Pressure zone with the intent to provide additional storage by 2020.

Increased demands on Buckeye Pressure zone will result in the need for additional storage by the 2030 planning Horzon where the duration of emergency storage drops to 12 hours. The City has already acquired property for locating a new reservoir at Herbscenta Lane. Construction of this facility should occur prior to or shortly after decommissioning of the City's oldest reservoir, the 0.2 MG Buckeye Reservoir at Williamson Road.

Table 5-6 Emergency Storage Duration, hr.

Pressure Zone	Planning Horzon				
	2015	2020	2025	2035	UBO
Buckeye	15	14	12	8	4
Cascade	53	53	50	38	25
Enterprise	28	27	27	26	15
Foothill	32	30	29	28	26
Hilltop-Dana	>72	>72	>72	69	35
Hill 900	9	9	9	8	7



Photograph Courtasy of Shasta Historical Society

Pump Station Number 1 in 1940 Flood

Table 5-7 Pressure Zone Storage Requirements, MG

	Zone	Equalization Storage	Fire Service Storage	Emergency Storage(d)	Required Storage)	Total Existing Storage	Excess
2015	Buckeye	0.85	1.20	4.17	6.88	6.20	-0.02
	Cascade (c)	0.59	1.44	2.88	5.24	13.00	8.09
	Enterprise(b)	1.56	1.44	6.04	11.88	19.50	10.46
	Foothill	0.83	0.63	4.05	5.36	10.00	4.49
	Hilltop Dana	0.22	1.20	1.26	3.97	15.70	13.02
	Hill 900	0.82	0.30	2.67	5.77	4.00	0.21
2020	Buckeye	0.88	1.20	4.29	7.46	6.20	-0.17
	Cascade (c)	0.62	1.44	2.98	5.27	13.00	7.96
	Enterprise(b)	1.69	1.44	8.30	12.32	19.50	8.07
	Foothill	0.73	0.63	3.58	5.71	10.00	5.06
	Hilltop Dana	0.18	1.20	1.88	4.15	15.70	12.44
	Hill 900	0.86	0.30	4.24	5.83	4.00	-1.4
2025	Buckeye	0.89	1.20	4.37	8.16	6.20	-0.26
	Cascade (c)	0.62	1.44	3.03	5.57	13.00	7.91
	Enterprise(b)	1.72	1.44	8.46	12.53	19.50	7.88
	Foothill	0.74	0.63	3.64	5.73	10.00	4.99
	Hilltop Dana	0.18	1.20	1.92	4.24	15.70	12.40
	Hill 900	0.88	0.30	4.32	6.16	4.00	-1.5
2035	Buckeye	0.89	1.20	4.56	13.23	6.20	-0.45
	Cascade (c)	0.64	1.44	3.16	6.63	13.00	7.76
	Enterprise(b)	1.80	1.44	8.81	12.79	19.50	7.45
	Foothill	0.77	0.63	3.80	6.02	10.00	4.80
	Hilltop Dana	0.19	1.20	2.00	4.43	15.70	12.31
	Hill 900	0.92	0.30	4.50	6.58	4.00	-1.72
UBO	Buckeye	12.60	1.20	13.68	27.48	6.20	-21.28
	Cascade (c)	1.22	1.44	6.96	9.62	13.00	3.38
	Enterprise(b)	2.61	1.44	14.84	18.89	19.50	0.61
	Foothill	0.87	0.63	4.94	6.44	10.00	3.56
	Hilltop Dana	0.48	1.20	5.52	7.20	15.70	8.50
	Hill 900	1.04	0.30	5.93	7.27	4.00	-3.27

a) Hilltop Dana Zone has the ability to obtain gravity supply from Buckeye Zone via Palisades PRV and Enterprise Reservoirs

b) Enterprise Zone has the ability to obtain gravity supply from Foothill Zone via Cypress Main

c) Cascade can draw on Foothill Storage via Railroad Avenue Vault

d) Based on 12-hour peak day demand

5.5 DISTRIBUTION

The evaluation of water system piping included an inventory of the existing piping network, review of maintenance and repair activities with City operations staff, and hydraulic modeling of the distribution system. The piping inventory provides a snapshot of what the current pipe network looks like today in terms of pipe sizes, age, and materials. The review of maintenance and repair activities provided a measure of the basic material state and reliability of the piping, highlighted the most common problems and whether the problems are growing worse or improving, and noted where there are patterns in terms of pipe type, locations, etc. The hydraulic modeling determined the basic hydraulic performance of the system in terms of velocity, headloss rates, and the system's ability to provide the necessary flows and pressures. Findings and recommendations from the piping inventory and evaluation are presented below.

5.5.1 Distribution - Current Needs

Evaluation of the existing distribution system consisted of running a 48-hour extended period simulation using the InfoWater computer model. Details of the model and calibration of the model are presented in Appendix C. Following the analysis the pipe network was examined for pipes with maximum flow velocities exceeding 6 feet per second (fps) under maximum day demands. Velocities exceeding 6 fps will result in excessive head loss and shorten the pipe lifespan. These pipes were then investigated for potential replacement. Conveyance projects are identified with a project tag “CONV” followed by a unique project number for ranking and listing purposes. The following locations are where improvements are recommended:

Beltline/Oasis/Lake Boulevard Three distribution projects are currently needed in the vicinity of Beltline/Oasis/Lake Boulevard, as are depicted in Figure 5.1. These projects include:

- (CONV-1) Beltline Road from Oasis Road to Mountain Lakes Boulevard is currently approximately 1013 feet of 12" diameter pipe. Analysis reflects that it needs to be a 16" diameter pipe under current conditions and 20" at ultimate development.
- (CONV-2 & CONV-3) Oasis Road from Calexico Drive to Beltline Road is currently approximately 3700 feet of 8" diameter pipe including a railroad crossing. Analysis indicates a need for 16" diameter pipe under current conditions and 20" diameter pipe at ultimate development.
- (CONV-4) Lake Boulevard from Oasis Road to Northpoint Drive is currently approximately 9090 feet of 12" diameter cast iron pipe. Analysis reflects that the pipe needs to be 16" diameter existing conditions and 24" diameter at ultimate development.

Hilltop to Churn Creek (CONV-8) The Hilltop to Churn Creek connection crosses pressure zone boundaries requiring a check valve. This improvement is called for to assist with water availability for fire flow support along the Hilltop Drive corridor. There is no existing pipe at this location. The analysis is calling for approximately 250 feet of 8" diameter pipe with a check valve as depicted in Figure 5.4.

Cypress Booster Pump (CONV-18) In 2015 the drought emergency proclamation and Bureau curtailments brought to the Utilities attention the need to be able to move more water across town between Foothill and Enterprise Pressure zones. If curtailments are severe enough water will need to be pumped from the Enterprise well field west to Foothill then to other zones. If water quality issues continue to be a challenge in the Enterprise Well field and to provide reliability of water supply to the Enterprise Pressure zone the booster pump facility should also be able to pump east from Foothill to Enterprise Pressure Zones.

5.5.2 Distribution - 2020 Planning Horizon

Westside Road at Canyon Creek (CONV-12) Analysis of the distribution system for the 2015 planning horizon also discovered that the pipe on Westside Road Bridge over Canyon Creek exceeds standards. The existing pipe is approximately 365 feet of 12" diameter pipe. Analysis reflects that it will need to be 20" in diameter at ultimate development. In 2014 the Westside Bridge over Canyon Creek qualified for replacement and CONV-12 was put on hold until such time as the pipe can be designed with the new bridge.

5.5.3 Distribution - 2025 Planning Horizon

Twin View Boulevard (CONV-13) Additional capacity needed to assist with fire flows and potential development related demands at Oasis Road near I-5 has generated the recommendation for increased capacity in Twin View Boulevard. The 2000 Water Master Plan identified a 12" diameter improvement from the Hawley Road extension back to Twin View Boulevard then parallel to the existing pipe to Oasis Road. This would require two pipes crossing the new Twin View Bridge over Churn Creek. Analysis of numerous alternatives for additional supply to this location found that a more efficient project would be to replace the existing pipe in Twin View with a single 16" diameter pipe for a distance of approximately 5,630 feet as depicted in Figure 5.7. In late 2015 plans for significant commercial development near the intersection of Oasis Road and Interstate 5 stalled indefinitely temporarily eliminating the need for this improvement. The project remains on the schedule for the possibility that the project or a similar project will move forward. The location is deemed imminently developable.

Buckeye Reservoir and Conveyance Improvements (CONV-14, -15, -16) By the 2025 Planning Horizon growth in Buckeye Pressure zone will have increased demand to the extent that conveyance to and from the existing Buckeye Reservoirs at Williamson Drive becomes inadequate. Three alternatives were analyzed to evaluate the necessary infrastructure to reduce pipe velocity to meet design standards. Alternative 1 consisted of replacing the 0.2 MG reservoir with a 3 MG reservoir and approximately 12000 feet of 12" diameter pipe in Lake Boulevard with 24" diameter pipe. Alternative 2 was similar to Alternative 1 except the pipe improvement was replacing approximately 9660 feet of 12" diameter pipe in Beltline Drive and Lake Boulevard north of Oasis Road. Alternative 3 includes construction of a new 3 MG reservoir at a location suggested in the 2000 WMP at Herbscenta Lane along with approximately 1485 feet of 30" diameter pipe from the reservoir location to Quartz Hill Road and 3270 feet of 18" diameter pipe from Quartz Hill Road to Keswick Dam Boulevard. Evaluation of the alternatives readily revealed that Alternative 3 is the preferable alternative. The storage location is significantly closer to the center of demand. Figure 5.8 shows the location/extent of the three alternatives.

5.5.4 Distribution - 2035 Planning Horizon

Lake Boulevard to Hilltop By 2015 the hydraulic analysis shows that increased demands and transfer of water from Buckeye to Hilltop Dana Pressure zone will call for increased conveyance capacity. The existing pipe network analysis indicates that increased pipe sizes are necessary from Lake Boulevard down to PS-3, crossing HWY 273 and up to Hilltop Drive. However, analysis and evaluation of the project and immediately available alternatives indicates that a preferable alternative would be to extend the Lake Boulevard pipe to cross HWY 273 and tie into both pipes on Hilltop Drive as shown by Alt 2 in Figure 5.5. The project consists of approximately 700 feet of 20" diameter pipe in Lake Boulevard from Northpoint drive to Masonic Drive (CONV-9) and 1220 feet of 16" diameter pipe from Masonic Drive to the East pipe in Hilltop Drive (CONV-10).

Twin View Boulevard Phase II (CONV-17) Increased demand in the Buckeye Pressure zone also requires continuing effort to assist with fire flow support in the northern part of the pressure zone. To achieve this it is recommended that the new 16" pipe in Twin View be extended approximately 650 feet under I-5 to Caterpillar Road. Figure 5.9 shows the location and extent of the project. Alternate alignment has been proposed for this project suggesting that it may be considerably less expensive to route the project further south on Twin View Boulevard and under I-5 at the overpass.

Figure 5-1 Beltline/Oasis/Lake Boulevard Projects

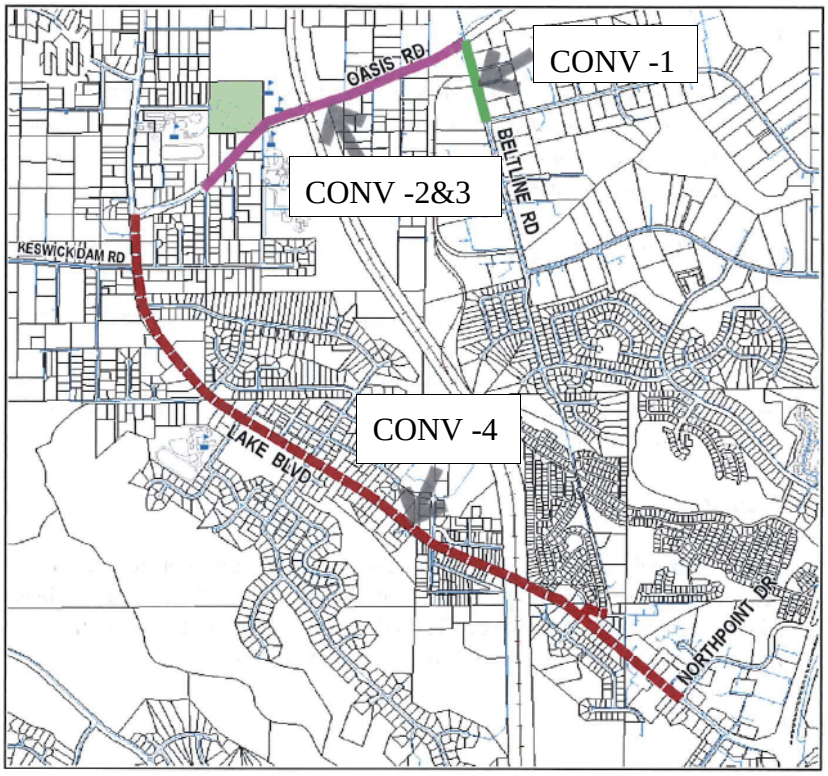


Figure 5-2 Hill 900 to Buenaventura Project

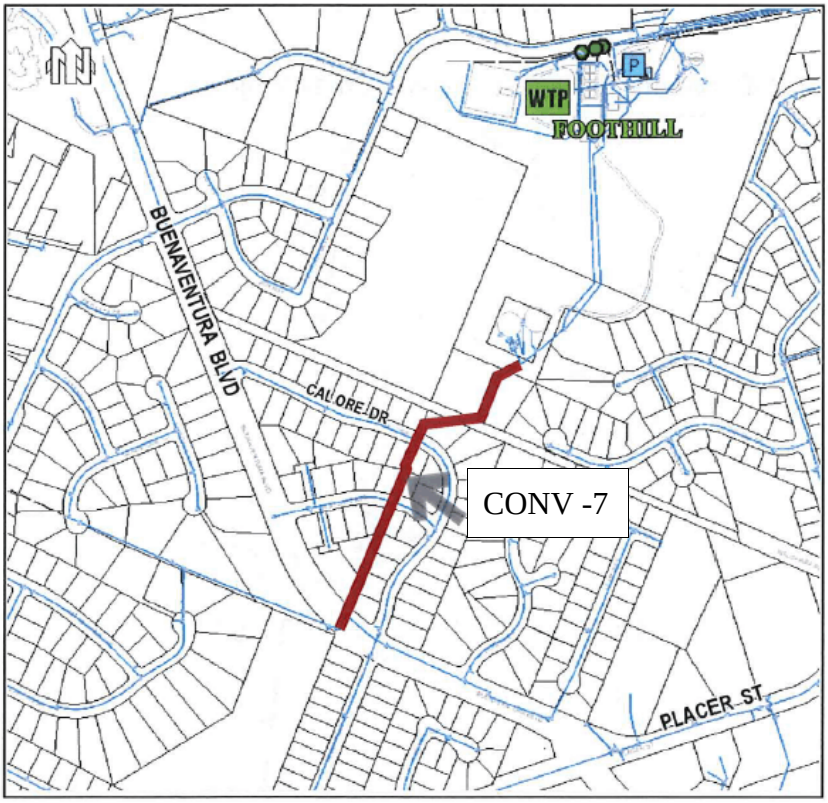


Figure 5-3 Lake Boulevard to Hilltop Project

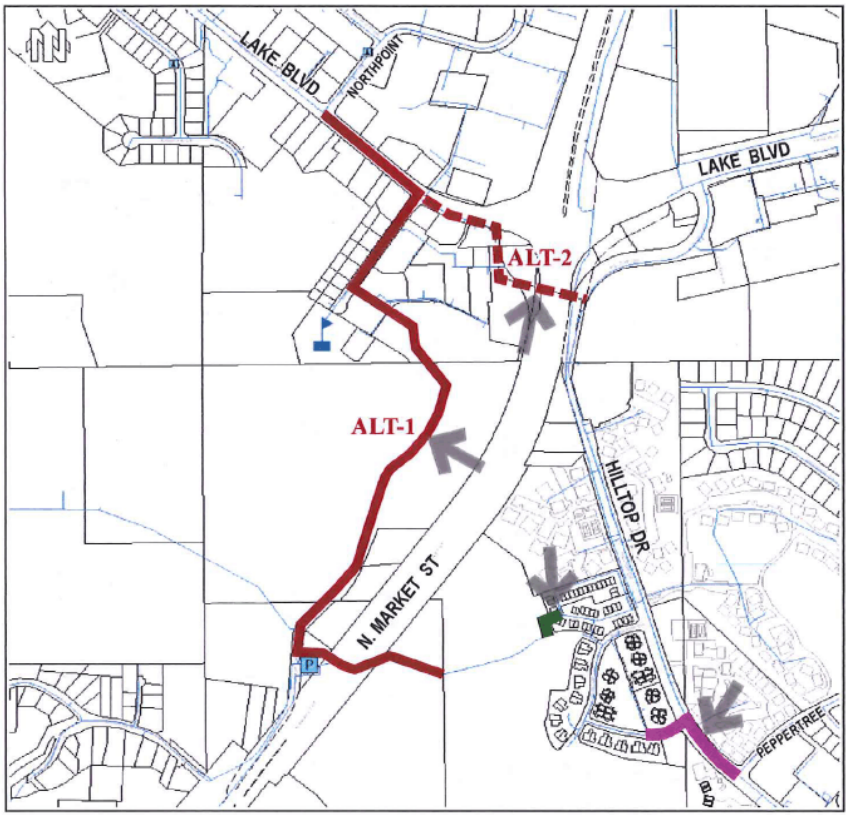


Figure 5-4 Hilltop to Churn Creek Project

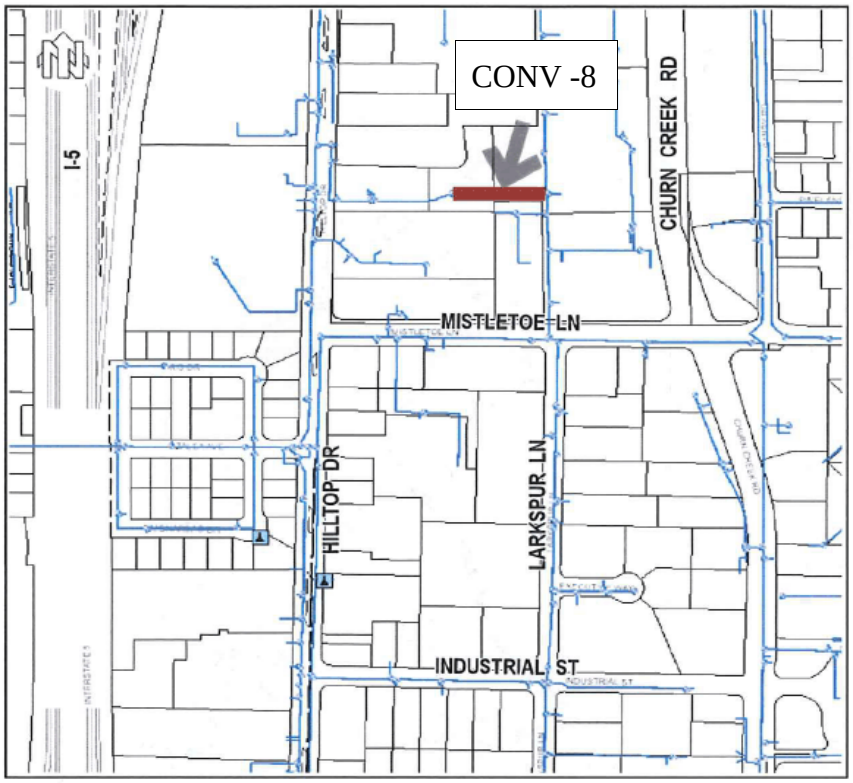


Figure 5-5 Twin View Boulevard Project Phase 1

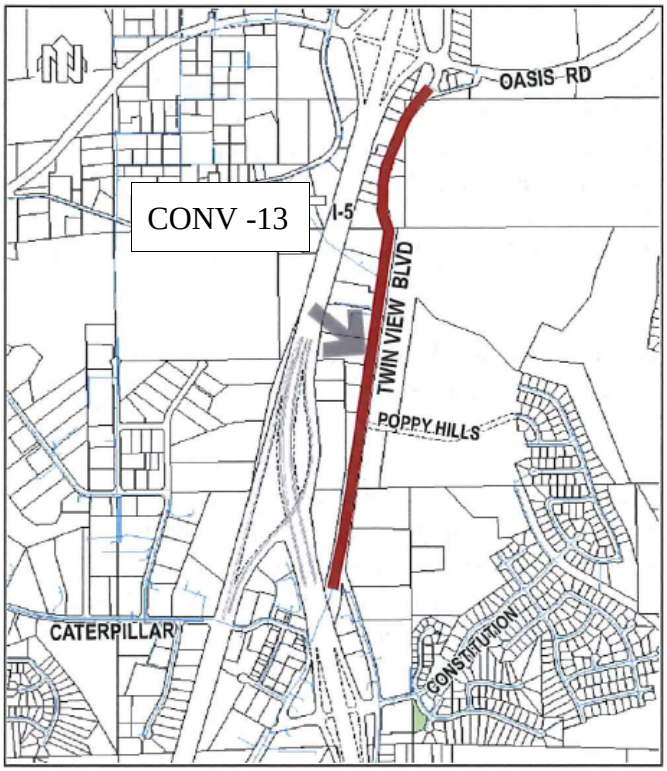


Figure 5-6 Buckeye Tank and Conveyance Projects

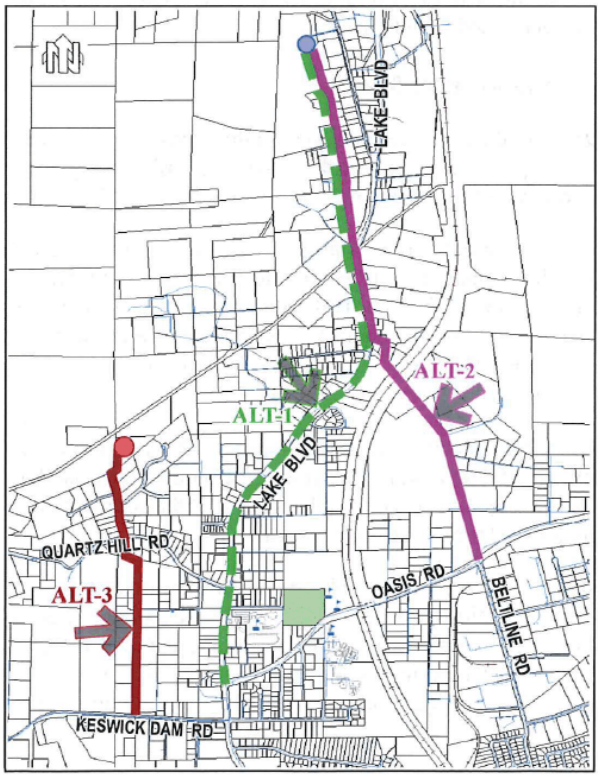
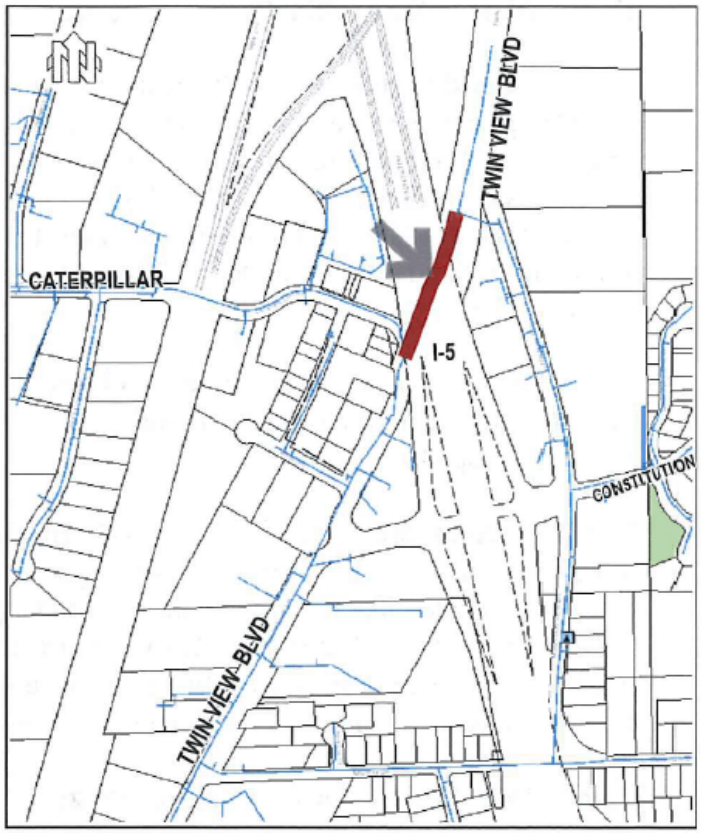


Figure 5-7 Conceptual Twin View Boulevard Phase 2 Project



5.5.5 Distribution - UBO Planning Horizon

The ultimate development demands were deemed too speculative and uncertain to proceed with the extensive effort of identifying all the distribution infrastructure necessary to meet standards. Recommended pipe sizes for infrastructure requirements in earlier planning horizons were obtained from the UBO analysis but no independent project list was generated with this effort.

5.5.6 Distribution Line Maintenance and Repair

Repair activities from 1995 to 2015 were reviewed as part of this study. Table 2-3 lists observations regarding water main breaks and other reported problems with the water distribution system. The average cost for a water main repair in 2015 was $1,587, and the average cost for a service line repair was $1,688.

The CI and steel mains are the most common source of main breaks, due to material properties, age, and corrosion factors. The CI mains are typically old and brittle, with cracks starting at the bell and propagating from there until the pipe fails. The steel piping typically has tape-wrap coatings that degrade, allowing corrosion to set in. City crews typically install an anode with all steel pipe repair sleeves to prevent corrosion of the sleeve. AC pipe is the next most common source of breaks, typically caused by splits or cracks, and can be costly to dispose of.

No CCP pipe breaks were recorded between 1976 and 1989. Similarly, DI and PVC C900 breaks are very rare; for example only one DI line break was recorded between 1976 and 1989. The service history of the DI and PVC C900 supports the City's continued practice of specifying these pipe materials for all new water piping.

The City's distribution system has never had a formal corrosion investigation. However, information collected over the years from repairs on piping indicates that the system has few areas of aggressive corrosion problems. Current practices such as installing anodes on steel repair sleeves, and specifications requiring installation of only PVC C900 and DI piping (with polyethylene bagging where needed) should ensure that corrosion remains a minimal or decreasing problem as the older pipe materials are replaced.

Service Line Repairs The City’s primary tipe of service line is copper. Prior to 1976, copper piping was used for service lines. From 1977 through 1986, the City switched to polybutylene service lines, similar to many water systems throughout the country, because of material cost savings over copper piping. Polybutylene connections began to exhibit a pattern of failing soon after they were put into widespread service. Approximately 6,500 polybutylene service lines were installed between 1977 and 1986. The City has implemented and completed a replacement program for all known polybutylene service lines. Occasionally one is uncovered and scheduled for replacement.

Pipe Evaluations The City's current piping specifications require DI for all pipe 12-inch or larger, and allow either PVC C900 or DI for piping smaller than 12-inch. The City should continue this practice to ensure consistent high-quality piping is installed with good corrosion resistance and long-term service performance.

The CI pipe is relatively old, a significant amount is greater than 50 years old and the source of a high percentage of pipe failures, typically from longitudinal cracking at the pipe bell. The remaining CI pipe will likely continue this pattern of failure, particularly during seismic events, pressure surges, or other actions that cause high mechanical stress. This pattern of CI pipe failure is significant given that CI pipe still makes up approximately 13 percent of the City's distribution system, with most of this piping ranging from 6- to 16-inches in diameter.

Pipe Age Analysis Approximately 20% of the distribution system is of unknown pipe type. Of the 80% where age data was available the oldest pipes were found to be less than 60 years old. Given the age of the utility it is likely that a significant number of older pipes exist in the network. It is reasonable to assume that many of the pipes comprising the 20% unknown age are older. Figure 5-8A shows the distribution of pipe age in the COR distribution system. Figures 5-8B through H show the age distribution of different pipe materials.

The following recommendations are suggested regarding pipe age, type and size:

1. The City should conduct a detailed inventory and evaluation of the older steel and CI mains, focusing on the larger mains (12-inch and larger) and those that are critical links in the distribution system. The result of this evaluation should be a prioritized pipe replacement program that is based on past repair records, pipe age, size, location and failure consequence, and coordination with other water system improvements.
2. The City needs to begin replacement before critical degradation of reliability and service occurs. The distribution system includes approximately 103,700 feet of CI mains and 81,600 feet of steel mains larger than 10-inch. According to the results of the recommended inventory and evaluation process, the main replacement work should focus on the 20,000 feet of large mains that are deemed the highest priority, replacing approximately 2,000 feet of the most critical mains each year for 10 years.
3. The City should begin replacing approximately 2,000 feet per year of substandard-sized pipe. This replacement program should be phased and prioritized using existing service problems such as low pressure, piping repair history, fire service limitations, and coordination with other capital improvements such as street repairs.
4. The City should continue migrating its record keeping process to the Cartegraph database and assure that data collection for each pipe failure includes date, location, size, type of material, and description of failure mechanism (if possible).
5. The City should investigate the condition and inventory of steel pipe corrosion protection systems currently in place and develop a plan for inspection, evaluation and maintenance.
6. Evaluate implementation of a standard utilizing HDPE for service connections instead of copper.
7. Expand the budget for pipe replacement such that between 2020 and 2030 the average total pipe replacement is 6 miles per year.
8. Plan for additional pipe replacement program expansion to an average of 12 miles per year from 2030 through 2060.

5.5.7 Pump Station Needs

Water distribution needs related to pump stations are as follows:

Energy Costs Energy costs for the pumping of water, both from the pump stations and the groundwater wells, represents a major operating expense for the City. In fiscal year 2009-2010, the City water utility spent approximately $1,575,000 on energy costs. The City currently does not schedule regular efficiency and pump testing for each pump station, which is needed to ensure the pump stations are operating at the maximum practical efficiency and do not have mechanical problems that may be reducing operating efficiency.

Pump Station 1 Deficiencies noted during the field inspection included fence repairs for security of the facility. Standard maintenance of cosmetic aspects may need to be improved. Based on the City's General Plan seismic hazard map, the pump station building and intake structure are located in an area of high seismic liquefaction potential, and should be evaluated for its ability to withstand critical damage during a design earthquake. At low river flows the pump station does not have adequate suction head without the backwater provided by leaving in several layers of flashboards at the Anderson-Cottonwood Irrigation District diversion dam. The existing intake fish screen does not meet current state and federal criteria and may need to be replaced. Homes near the pump station have complained occasionally to the City about the motor noise from the pump station. However, a study of noise levels from PS-1 was conducted in 1994 concluding that facility noise levels were below the daytime and nighttime standards established in the Noise Element of the General Plan.

Pump Station 2 Upgrades to PS-2 are recommended in the Foothill WTP facilities plan. These improvements include replacing the impellers on the pumps to attain greater pumping capacity.

Pump Stations 3 and 4 PS-3 and PS-4 will not need any substantial improvements because Buckeye WTP expansion provides adequate water supply to meet demands in the Buckeye Pressure Zone. They are maintained for emergency facilities and redundant supply facilities to the Buckeye Pressure zone for periods of time when the treatment plant is inoperable.

Pump Station 5 PS-5 will not need any major improvements before 2035. At 2030, PS-5 will be operating near its maximum capacity, and the remaining Hilltop-Dana Zone supply will be provided from the Palisades PRVs. The Palisades PRVs are currently being upgraded to improve flow capacity to supplement PS-5 supply. In addition Goodwater booster pump station is also available to supplement supply to the Hilltop-Dana zone. Distribution system check valves and PS5 bypass valve also provide assistance in supply to the Hilltop- Dana zone.

Pump Station 6 PS-6 (South Bonnyview) will not require major improvements before 2035. Improvements to Railroad Avenue Vault are currently being planned to improve conveyance of water from Foothill Pressure Zone to Cascade Pressure zone to accommodate potential future increases in demand.

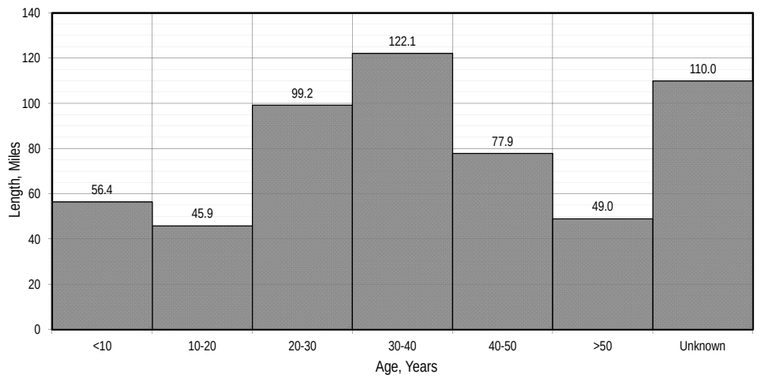
Goodwater Booster Pump Goodwater BP will not require major improvements before 2035. The stations primary purpose is to provide additional emergency supply from Enterprise to Hilltop/Dana Pressure zone in case of dramatic pressure drops in HDZ.

Future Booster Pumps The need for additional booster pumps for the ultimate buildout hydraulic analysis is speculative. The scenario depends on increases in water sources without a significant level of confidence where the sources would be located. The analysis assumes a new water treatment plant located west of the current Foothill WTP location. It also assumes dramatic expansion of the Enterprise Well Field. The 2000 Water Master Plan effort speculated that booster pumps would be called for to push water from Foothill Pressure zone to both Enterprise and Cascade Pressure zones at Cypress and Railroad Avenue Vault respectively. It also indicated that increasing Buckeye WTP to 21mgd would create a need for a 1,000-hp pump station at the Buckeye WTP or along Keswick Road upstream of the Quartz Hill vault.

Photo Courtasy of Shasta Historical Society

Redding Water Company Office

Figure 5-8A - Distribution Pipe Age
All Pipe Materials - Total 560 Miles



Figue 5-8D - Cast Iron Pipe Age
Total 64 Miles

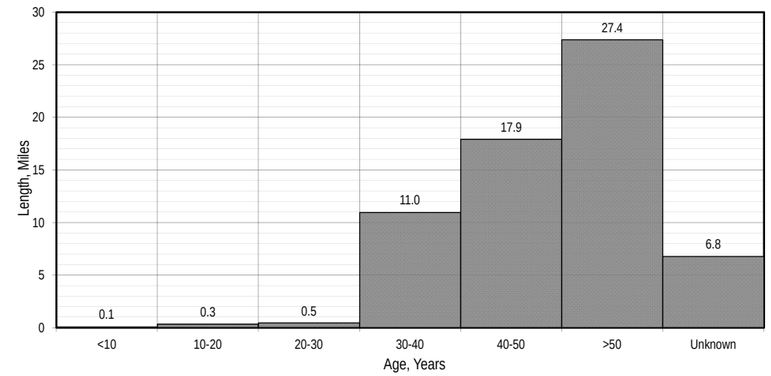


Figure 5-8G - Concrete Lined Steel Pipe Age
Total 14 Miles

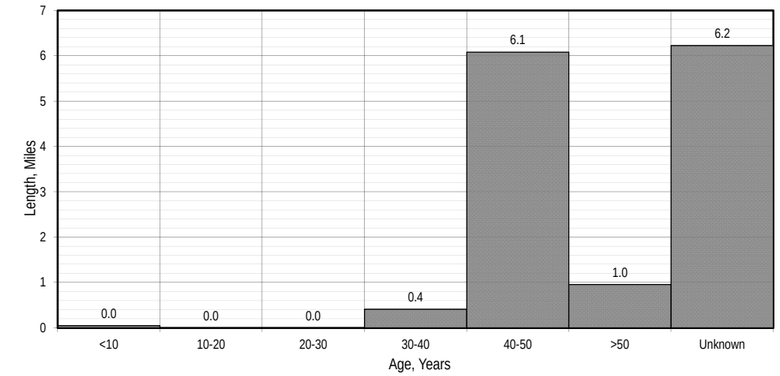


Figure 5-8B - AC Pipe Age
Total 167 Miles

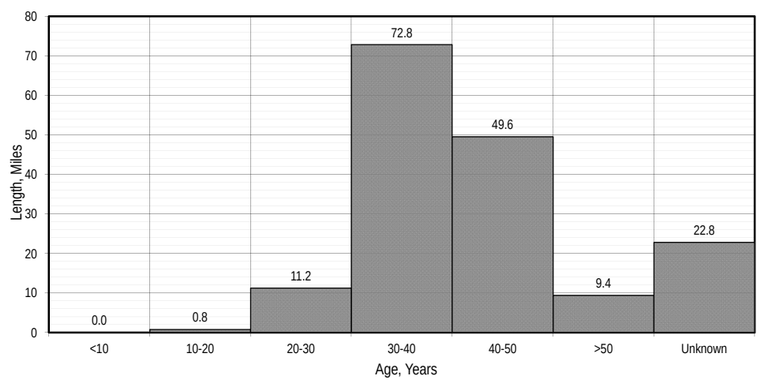


Figure 5-8E - C900 Pipe Age
Total 173 Miles

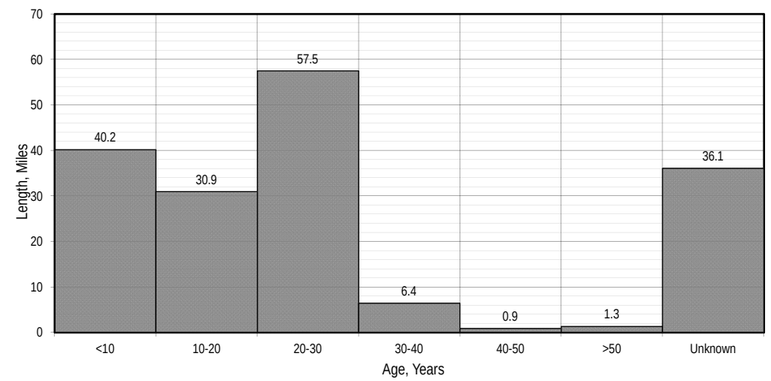


Figure 5-8H - Steel Pipe Age
Total 19 Miles

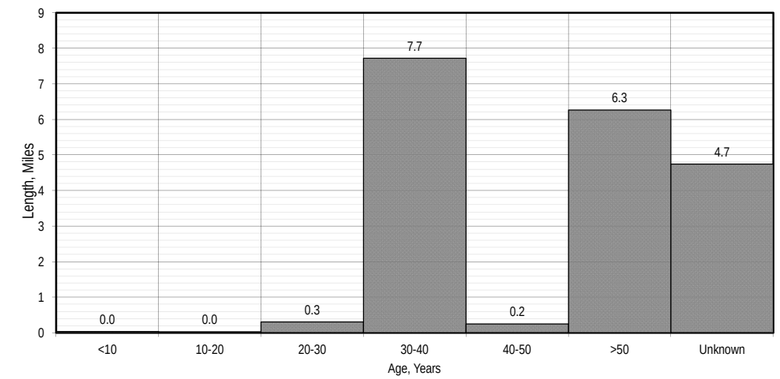


Figure 5-8C - Ductile Iron Pipe Age
Total 90 Miles

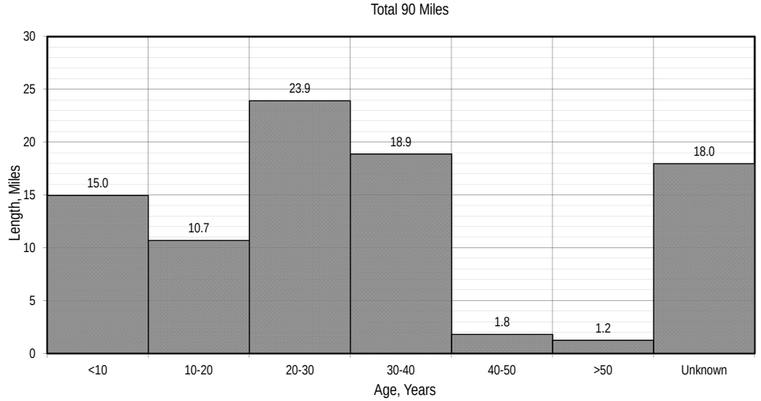


Figure 5-8F - PVC Pipe Age
Total 12 Miles

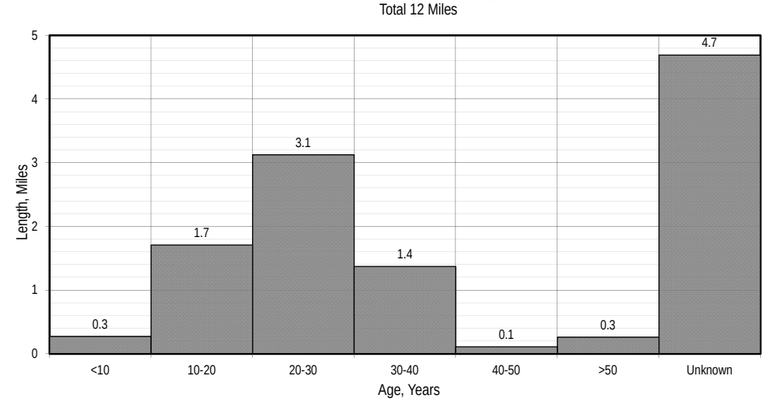


Figure 5-8
CITY OF REDDING WATER SYSTEM
PIPE AGE ANALYSIS
2016 Water Utility Master Plan Update

5.6 FIRE SERVICE DEMANDS

Fire Service Demand evaluation was performed by determining the largest fire service demand within each pressure zone according to the CFC requirements. Analysis was performed to determine if there was adequate water availability to meet the requirements and if not what infrastructure would be necessary to meet the requirements. Table 5-8 shows Fire Flow Service performance measured under the 2015 MDD.

Table 5-8 Fire Flow Service Evaluation 2015 MDD

Pressure Zone	Location	Building Type	Fire Flow (gpm)	Duration (hrs)	*Flow (gpm)*	*Duration (hr)*	Notes
Foothill	Liberty Street	Office Building	3,500	3	>4,000	>4	
Hill 900	Shasta Learning	School	2,500	2	>2,800	>3	(1)
Cascade	East Side Rd	Wood Products	6,000	4	>10,000	>5	
Cascade	Westwood Ln	Shopping Center	5,000	4	>7,000	>4	
Enterprise	Bechelli Ln	Shopping Center	6,000	4	>6,500	>4	
Hilltop Dana	Hilltop Drive	Hotel	5,000	4	>6,500	>4	(2)
Buckeye	Caterpillar Ln	Industrial	4,000	3	>4,000	>3	

(1) Shasta Learning Center requires re-construction or re-activation of the water pipe between Shasta High School and Shasta Learning Center previously abandoned by the School District in order to meet fire flow requirements.

(2) Hilltop Drive Hotel fire flow requirements call for construction of Project CONV-08 to meet the existing needs.

In addition to analysis of water supply for the largest demand locations analysis was performed for areas where significant large scale development has been approved. The following locations were evaluated, each with an assumed fire flow requirement commensurate with the expected use and projected building size during MDD conditions. The conclusions and recommendations below are preliminary, and a new analysis should be done when more detailed information regarding specific development proposals is available.

Lake Boulevard at Market Street - Several undeveloped parcels zoned for commercial are located on the east side of this intersection. Fire flows to this area are not adequate to support large commercial construction with the existing 6-inch and 8-inch piping. New development requiring flow in excess of 2,500-gpm will require installing, at minimum, Project CONV-10 the 16" diameter pipe from Lake Boulevard to Hilltop Drive and modifications to PS-3 to turn on automatically at low pressures, which will boost emergency flows to this area during a fire.

Oasis Road at Interstate 5 - This area is zoned for regional commercial development, similar in scale to the Dana Drive commercial area. Analysis of the water supply system by COR staff and PACE Inc on behalf of Bella Vista Water District determined that most of the fire flow needs for this location can be met by a new emergency supply connection between the COR and Bella Vista Water district at or near the intersection of Oasis Road and Gold Hills Drive. There are several projects being recommended that will ultimately make the need for the emergency connection obsolete. These projects include CONV-04, CONV-09, CONV-10, CONV-13, and CONV-17 on Table 6.1. Future local piping in this area used to serve specific developments should include 12-inch or larger transmission mains to provide fire flow support.

South Bonnyview Road West of Sacramento River - A large parcel of undeveloped land along the south side of South Bonnyview Road is located in this area. The existing 18-inch piping along South Bonnyview can provide adequate fire flows. However, depending on the nature of the development, the minimum piping size in the area should be either 12-inch if a single pipe is used, or 8-inch if there are multiple looped pipe feeds.

5.6.1 Future Fire Service Demands

Evaluation of fire flow supply was performed for future planning horizons to determine necessary infrastructure to avoid degradation of emergency support as future demands are applied. All future scenarios are predicated on construction of the recommended improvements for the prior planning time frame(s). For instance, the 2025 fire service evaluation includes all recommended projects from existing needs, projects recommended for construction between 2015 and 2020, and those recommended for construction between 2020 and 2025. The analysis found that in most cases projects called for to alleviate high velocity issues in pipes at various locations throughout the system more than adequately offset any potential negative impact on fire service flows from additional demands applied to the distribution system. The most pronounced example of this is the increase in fire flow supply in the Buckeye zone from just greater than 4,000 gpm to over 12,000 gpm between 2015 and 2035. Table 5-9 shows the system fire flow capacity at selected locations at future planning horizons under MDD scenarios.

Table 5-9 Fire Flow Service Evaluation Future Planning Horizons MDD Scenario

				Results					
				2020		2025		2035	
Pressure Zone	Location	Fire Flow (gpm)	Duration (hrs)	*Flow (gpm)*	*Duration (hr)*	*Flow*	*Duration*	*Flow*	*Duration (hr)*
Foothill	Liberty Street	3,500	3	>5,000	>4	>5,000	>4	>5,000	>4
Hill 900	Eureka Way	2,500	2	>3,000	>3	>3,000	>3	>3,000	>3
Cascade	East Side Rd	6,000	4	>12,000	>5	>12,000	>5	>11,500	>5
Cascade	Westwood Ln	5,000	4	>7,500	>4	>7,000	>4	>7,000	>4
Enterprise	Bechelli Ln	6,000	4	>7,000	>4	>7,000	>4	>8,000	>4
Hilltop Dana	Hilltop Drive	5,000	4	>7,000	>4	>7,000	>4	>7,000	>4
Buckeye	Caterpillar Ln	4,000	3	>12,000	>3	>11,500	>3	>10,500	>3

ENTERPRISE RESERVOIRS

Water Utility Master Plan Update 2016

CHAPTER 6

Water System Capital Improvement Plan

6.1 INTRODUCTION

Numerous water system improvements are required over the next 10 years, primarily to repair and replace the City's many aging water system components and to a lesser degree increase capacity to accommodate growth. The capital improvements have been determined using the full range of information and analysis from the facilities inspections, water service and facility performance criteria, population and water demand projections, and detailed hydraulic modeling. Recommended projects resulting from the evaluation process are listed along with the rankings in the specific facility evaluations provided in Appendix B.

6.2 PROJECT CLASSIFICATION AND COST ESTIMATES

Order-of-magnitude, or planning level, cost estimates were prepared for each water system capital item. The cost estimates presented were made without benefit of detailed engineering data. The estimates are based on cost curves, bid tabs for recent City projects, and preliminary estimated quantities for major facility components. The final cost of each project and the resulting budget impacts will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedules, and other variables. Therefore the final project costs will vary from those presented here, and each project must be evaluated in greater detail prior to making specific financing decisions or establishing project budgets. A cost estimate report is included in Appendix E, which was prepared by the engineering consulting firm Willdan Inc.

To prioritize the recommended modifications and improvements, each facility is ranked to assess the relative value of improvements with respect to overall plant performance, compliance with regulatory requirements, cost of operation, ease of operation, and other various factors. Specifically, improvements were evaluated against the following criteria: process, reliability, operability, constructability, regulatory considerations, relative cost, and risk. Issues considered under each criteria are summarized in Table 6-1.

Once the projects were ranked for each criteria a value was assigned to each criteria category from 1 to 6 representing the Utility priority for each criteria. This provides a mechanism for projects that are required for regulatory compliance or with high potential risk to attain a higher score. Project criteria ranking scores were then multiplied by the criteria values and summed for each project to attain a project score. Projects were then sorted by overall score to attain a prioritized list for each Master Plan project time frame. The ranking scale and criteria values are presented in Table 6-2.

Tables 6-3, 6-4, and 6-5 identify the capital improvements, ranking, scoring, reason for the projects and recommended improvement.

Table 6-1 Ranking Criteria

Criteria	Issues Considered
Reliability	- Can it be counted on? - Level of redundancy
Operability	- Complexity of operation - Maintenance requirements - Staffing requirements - History of technology - Does it work?
Constructability	- Complexity/ease of construction - Space requirements - Environmental constraints - Political considerations
Regulatory	- Current or pending regulatory requirements dictate undertaking the project
Relative Cost	- Less than $100k - $100k to $500k - Greater than $500k
Risk	- Risk of significant fiscal repercussions if project is deferred or not completed.

Table 6-2 Ranking Scale

Property	Value	Points		
		0	1	2
Process	2	Insignificant	Limited	Significant
Reliability	5	Insignificant	Limited	Significant
Operability	3	Insignificant	Limited	Significant
Constructability	2	Difficult	Limited	Easy
Regulatory	6	Not	Limited	Required
Relative Cost	4	High	Intermediate	Low
Risk	3	Low	Intermediate	High

Table 6-3 Facility Improvements 2016-2020

						Project Property Category							Value Score Product							
Tag No.	Facility Type	Facility Name	Identified Projects	Recommendation	Reason	Process	Reliability	Operability	Constructability	Regulatory	Relative Cost	Risk	Process	Reliability	Operability	Constructability	Regulatory	Relative Cost	Risk	Total Score
EW11-01	Well	Enterprise Well 11	Roof tiles are falling off	Repair	Reliability/Longevity	0	2	1	2	0	2	1	0	10	3	4	0	8	3	28
CONV-08	Distribution System	Pipe Network	8" Hilltop to Alley near Oxford Suites with CV (250 ft)	Construct	FF 2015	2	0	2	1	1	1	2	4	0	6	2	6	4	6	28
EWT-08	Construct Well Head Treatr	Construct	Water Quality/Regulatory	Construct	Capacity/Water Quality	1	0	1	2	2	1	0	2	0	3	4	12	4	0	25
CONV-18	Distribution System	Pipe Network	Booster Pump Station at Cypress Avenue Bridge	Construct	Reliability	1	2	1	2	0	1	0	2	10	3	4	0	4	0	23
EW14-02 *	Well	Enterprise Well 14	Roof access hatches need slip resistant surface and or roof ladder	Install	Safety	0	0	2	2	0	2	1	0	0	6	4	0	8	3	21
EW11-02 *	Well	Enterprise Well 11	Needs ventilation above motor	Install vent	Longevity	0	1	0	2	0	2	1	0	5	0	4	0	8	3	20
EW12-01 *	Well	Enterprise Well 12	Needs ventilation above motor	Install vent	Longevity	0	1	0	2	0	2	1	0	5	0	4	0	8	3	20
FH-01 **	Treatment Plant	Foothill WTP	Upgrade PLC control system wiring & associated equipment, 2015	Upgrade	Reliability	2	1	1	2	0	0	1	4	5	3	4	0	0	3	19
FH-02 **	Treatment Plant	Foothill WTP	Distribute facility power loads between two 1200 KV circuits, 2015	Construct	Reliability	2	2	0	1	0	0	1	4	10	0	2	0	0	3	19
CONV-11	Distribution System	Pipe Network	16" Hilltop from F8-V36 to Peppertree (1170 ft)	Construct	Capacity 2020	2	1	0	1	0	1	1	4	5	0	2	0	4	3	18
CONV-12	Distribution System	Pipe Network	20" Railroad Avenue at Canyon Hollow Creek (370 ft)	Construct	Capacity 2020	2	0	0	1	0	2	1	4	0	0	2	0	8	3	17
EW11-03 *	Well	Enterprise Well 11	Remove unused wiring or tie up or clean up wiring	Remove or clean up	Safety	0	0	1	2	0	2	0	0	0	3	4	0	8	0	15
EW12-02 *	Well	Enterprise Well 12	Needs exterior lighting at equipment	Install lighting	Safety	0	0	1	2	0	2	0	0	0	3	4	0	8	0	15
EW14-04 *	Well	Enterprise Well 14	Needs outdoor lighting on equipment.	Install lighting	Safety	0	0	1	2	0	2	0	0	0	3	4	0	8	0	15
CONV-07	Distribution System	Pipe Network	24" Hill 900 to Buenaventura	Construct	Capacity 2015	2	1	0	1	0	1	0	4	5	0	2	0	4	0	15
EW12-05	Well	Enterprise Well 12	Needs magnetic flow meter	Install meter	Operations	1	0	1	2	0	1	0	2	0	3	4	0	4	0	13
EW13-04	Well	Enterprise Well 13	Needs magnetic flow meter	Install meter	Operations	1	0	1	2	0	1	0	2	0	3	4	0	4	0	13
EW14-05	Well	Enterprise Well 14	Needs magnetic flow meter	Install	Operations	1	0	1	2	0	1	0	2	0	3	4	0	4	0	13
CONV-05	Distribution System	Pipe Network	16" Hilltop at Ridgecrest	Construct	Capacity 2015	2	0	0	1	0	1	1	4	0	0	2	0	4	3	13
CONV-04	Distribution System	Pipe Network	24" Lake Boulevard from Oasis Road to Northpoint Drive (9090 ft)	Construct	Capacity 2015	2	1	0	0	0	0	1	4	5	0	0	0	0	3	12
CONV-13	Distribution System	Pipe Network	16" Twin View from B8-V24 to Oasis Center North (5630 ft)	Construct	FF 2020	2	0	1	1	0	0	1	4	0	3	2	0	0	3	12
EW13-02 *	Well	Enterprise Well 13	Concrete at valve stand is spalling	Investigate/repair	Longevity	0	1	0	1	0	1	0	0	5	0	2	0	4	0	11
CONV-01	Distribution System	Pipe Network	20" Beltline Rd from Oasis to Mtn Lakes (1013 ft)	Construct	Capacity 2015	2	0	0	1	0	1	0	4	0	0	2	0	4	0	10
CONV-02	Distribution System	Pipe Network	20" Oasis Road from UPRR at A6-V1 to Beltline Road (1225 ft)	Construct	Capacity 2015	2	0	0	1	0	1	0	4	0	0	2	0	4	0	10
CONV-03	Distribution System	Pipe Network	20" Oasis Road from Calexico Drive to A6-V1 (1600 ft)	Construct	Capacity 2015	2	0	0	1	0	1	0	4	0	0	2	0	4	0	10

* Project was deemed a maintenance or repair project and transferred to the annual budget for those costs and will not show up as a line item in subsequent tables.
** Project eliminated from the planning effort as it is already under construction.

Table 6-4 Facility Improvements 2020-2025

						Project Property Category							Value Score Product							
Tag No.	Facility Type	Facility Name	Identified Projects	Recommendation	Reason	Process	Reliability	Operability	Constructability	Regulatory	Relative Cost	Risk	Process	Reliability	Operability	Constructability	Regulatory	Relative Cost	Risk	Total Score
CONV-15	Distribution System	Pipe Network	30" New Buckeye Tank to Quartz Hill Rd (3275 ft)	Construct	Capacity 2020	2	1	1	1	0	1	2	4	5	3	2	0	4	6	24
CONV-16	Distribution System	Pipe Network	24" Quartz Hill to Keswick Dam Boulevard (1485 ft)	Construct	Capacity 2020	2	1	1	1	0	1	2	4	5	3	2	0	4	6	24
PS1-06	Surface Supply	Foothill WTP	Pump Station Relocation	Replacement	Capacity, Environmental	0	1	1	0	2	0	1	0	5	3	0	12	0	3	23
FH-13	Treatment Plant	Foothill WTP	Construct five flocculator basins if classic direct filtration system is required, 2025	Construct	Regulatory, Capacity	1	1	0	1	1	2	0	2	5	0	2	6	8	0	23
W-01	Well Supply	Enterprise Wells	Construct New Well, 2025	Construct	Supply	0	1	0	2	1	1	1	0	5	0	4	6	4	3	22
CONV-14	Distribution System	Pipe Network	New Buckeye Tank 3.5 MG at Herbscenta	Construct	Capacity 2020	2	1	1	1	0	0	2	4	5	3	2	0	0	6	20
S-01	Storage	Hill 900 Storage	New 3.0 MG reservoir in Hill 900 Before 2025	Construct	Operations	1	1	1	0	0	0	1	2	5	3	0	0	0	3	13
EWT-02.2	Well Treatment	Enterprise Wells	Construct Blending pipeline for EW-13 and EW-14 if necessary	Construct	Water Quality/Regulatory	2	0	0	1	1	0	0	4	0	0	2	6	0	0	12
EWT-03	Well Treatment	Enterprise Wells	Install oxidation/filtration treatment system at EW-14 to remove manganese	Construct	Water Quality/Regulatory	0	0	0	1	1	0	0	0	0	0	2	6	0	0	8

Table 6-5 Facility Improvements 2025-2035

						Project Property Category							Value Score Product							
Tag No.	Facility Type	Facility Name	Identified Projects	Recommendation	Reason	Process	Reliability	Operability	Constructability	Regulatory	Relative Cost	Risk	Process	Reliability	Operability	Constructability	Regulatory	Relative Cost	Risk	Total Score
CONV-09	Distribution System	Pipe Network	20" Lake Boulevard from Northpoint to Masonic (1220 ft)	Construct	Capacity & FF 2020	2	1	1	1	1	1	1	4	5	3	2	6	4	3	27
W-02	Well Supply	Enterprise Wells	Construct New Well, 2030	Construct	Supply	0	1	0	2	1	1	1	0	5	0	4	6	4	3	22
CONV-10	Distribution System	Pipe Network	16" Masonic to Hilltop	Construct	Capacity & FF 2020	2	1	1	0	1	0	1	4	5	3	0	6	0	3	21
CONV-17	Distribution System	Pipe Network	16" Caterpillar to Twin View under I-5 (650 ft J&B)	Construct	FF 2020	2	1	1	0	0	0	1	4	5	3	0	0	0	3	15
EWT-05	Well	Well Treatment	Construct pipeline from EW-12 to EW-14 to blend	Construct	Water Quality/Regulatory	0	0	0	1	1	0	0	0	0	0	2	6	0	0	8
EWT-06	Well	Well Treatment	Expand treatment at EW-14 to treat flows from EW-12	Construct	Water Quality/Regulatory	0	0	0	1	1	0	0	0	0	0	2	6	0	0	8
EWT-07	Well	Well Treatment	Install centralized oxidation/filtration treatment system at EW-11 and pipelines from EW-7 and EW-10	Construct	Water Quality/Regulatory	0	0	0	1	1	0	0	0	0	0	2	6	0	0	8

6.3 PROJECT SUMMARY

The Capital Improvement plan project listing is limited to planning horizons between 2010 and 2030. Projects recommended to meet demands or conditions beyond 2030 will be considered in more detail in subsequent studies. Attempting to refine or delineate projects 20 or more years in the future was deemed to be less than productive due to the level of uncertainty regarding growth and regulatory requirements. However, the exception to this is in the pipe replacement program element where the City needs to plan for replacement of pipes that were constructed during the growth boom of the 60's and 70's which will peak at approximately 15 miles of pipe per year reaching the end of its lifespan in 2040-2050.

6.3.1 Supply and Treatment Capacity

The City currently meets the projected demands with adequate margin of safety until the 2020 planning horizon. By 2030 the required margin of safety can be achieved by re-activating Enterprise Wells 11 and 13 through treatment or potentially blocking the zones that are causing contamination or construct two new wells. Locations of future wells were outlined in the 2000 Water Master Plan based on an extensive study of the Enterprise Groundwater Aquifer. No changes in proposed locations are recommended with this study. Therefore the locations in the Water Master Plan 2000 remain valid and are grandfathered into this study and should be planned for in the future. No additional demand driven water supply improvements are projected until between 2030 and UBO. In addition, under the State of California mandate for water conservation additional demands may be considerably offset by water conservation efforts.

Improvements currently under way and planned for the Foothill Water Treatment Plant, as indicated in the recent Foothill WTP Facilities Plan, combined with the recent Buckeye WTP upgrade will provide adequate treatment capacity through 2030. The total Foothill WTP upgrade costs are projected to be $11,074,000 between now and 2020.

6.3.2 Pump Stations

Evaluation of the Pump Stations capacity and condition found that due to recent contract changes in how the City is allowed to use water from the different sources and improvements in ability to move water around the City many of the pump stations are now primarily backup systems.

Pump Station 1 on the Sacramento River is scheduled for replacement in 2021-2022.

Pump Station 2, located at Foothill WTP is currently being upgraded with new impellers. In additon the Utility will be evaluating a strategy or obtaining water from Buckeye Pressure Zone to supply Hill 900 thereby removing PS-2 from service except during high demands and as a backup supply source.

El Reno Pump station is planned for upgrade in 2017-18. Although not identified as a capacity need, the Utility deems it an important emergency backup supply for the lower portion of Hill 900 Pressure Zone. Since the Master Plan does not contain criteria for redundant supply thresholds El Reno PS did not get listed in the project listing but will be included in the CIP and Financial Plan.

6.3.3. Piping

Conveyance and distribution piping improvements are required under two circumstances: new pipes for expansion of services, and replacement of existing pipes because of age and reliability or substandard sizing.

There are two criteria for requiring replacement or upgrade of an existing pipe. The first is excessive velocity. If the velocity in a pipe is excessive it results in shorter pipe lifespan, potentially increased pumping costs, and potential inadequate supply downstream.

Analysis of aging pipe reflects a need for a much larger pipe replacement program. Historic record reflects that the City has been replacing approximately 7,900 feet of pipe per year. This will need to be significantly increased to keep up with pipe reaching the end of its expected lifespan.

Pipe replacement should be prioritized as follows:

<u>2010-2020</u>

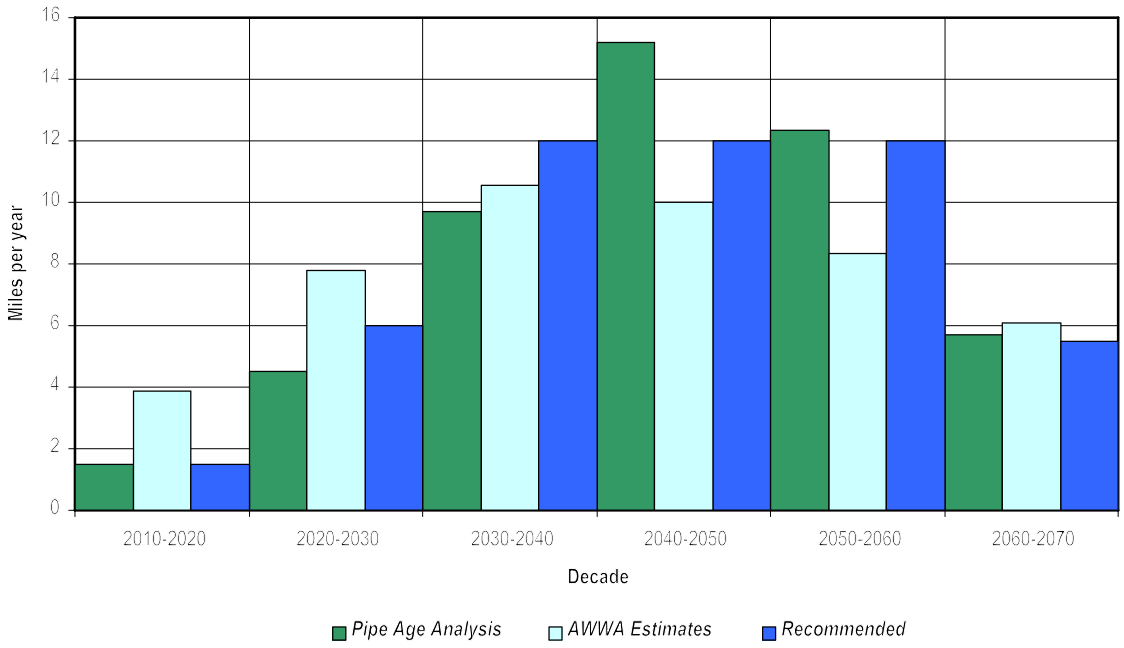
1. Large Diameter Steel and Cast Iron Pipes: 2,000 feet per year for the most critical pipes.
2. Substandard size pipe: 2,000 feet per year.
3. Approximately 4,000 feet of the oldest pipes.

<u>2020-2030</u>

Increase the pipe replacement program by an additional mile per year starting in 2021/22 through 2029/30. That will put the annual replacement project at approximately 10.5 miles in 2029/30. Beyond 2029/30 replacement will need to occur at an average of 12 miles per year for three decades.

It should be noted that this program still does not keep up with the expiring pipe that was constructed in the 1960s and '70s. The program achieves a slight advantage by getting slightly ahead of the pipe age curve in 2030-2040. It falls behind in the decade of 2040-2050 and catches up in 2050-2060. Figure 6-1 reflects the pipe age analysis, AWWA analysis and the recommended pipe replacement schedule.

Figure 6-1 Pipe Replacement Schedule



Most of the major pipe projects are the result of expansion of the Buckeye Water Treatment Plant and a change in strategy for water usage. When the 2000 Water Master Plan was developed the water treated at the Buckeye WTP could only be used in the Buckeye Pressure Zone. Between 2000 and now the water contracts have been amended to allow use of that water anywhere within the City's distribution system. Therefore major infrastructure called for in the 2000 WMP along the northern boundary of Buckeye Pressure Zone conveying water to the Eastern side of the Zone has been replaced with improvements to convey the water south and east through Lake Boulevard and Hilltop Drive. This will serve to help with pipe replacement in Lake Boulevard (which is primarily older cast iron pipe) and provide redundancy in supply to Hilltop Dana, Enterprise, and Foothill Pressure Zones. Projects have then also been identified to assure that infrastructure necessary to provide supply to the north eastern corner of the Buckeye Pressure Zone has been scheduled.

6.3.4 Reservoir Replacement

The new Buckeye Reservoir is scheduled in lieu of replacing the oldest reservoir in service, the Buckeye 0.2 mg reservoir, which is approaching the end of it's expected lifespan. In addition, without the new reservoir, use of the existing Buckeye reservoirs requires replacement of several thousand feet of pipe between Keswick Dam Boulevard/Oasis Road and the existing reservoir location. Thus there are reservoir replacement funds, and pipe replacement savings associated with construction in the new location in addition to the fact that the Utility already obtained the property for construction. Construction of the new reservoir is recommended prior to 2020 to allow decommissioning of the 0.2 MG reservoir prior to reaching the end of it's expected lifespan.

The next reservoir reaching the end of its expected lifespan is Hill 900-1 in 2034 and is recommended for replacement in 2015 due to the existing need for additional storage in the pressure zone. Replacement of reservoirs thereafter will follow approximately every 5-10 years. Table 6-6 shows reservoir age and recommended replacement schedule.

Table 6-6 Reservoir Age and Replacement Recommendations

Reservoir	Size, mg	Construction Date	Age	Remaining Lifespan	Expiration Date	Recommended Replacement Date
Buckeye 1	0.2	1949	63	12	2024	Decommission
Hill 900-1	2	1959	53	22	2034	2030
Cascade	1	1964	48	27	2039	2035
Enterprise 1	3.5	1968	44	31	2043	2040
Buckeye 2	2	1978	34	41	2053	2048
Foothill WTP	6	1980	32	43	2055	2053
Redding Ranchettes	2	1982	30	45	2057	2055
Hill 900-2	2	1984	28	47	2059	2055
Enterprise 2	6	1986	26	49	2061	2060
Buckeye Backwash	0.8	1995	17	58	2070	2065
Buckeye 3	4	2002	10	65	2077	2075
Foothill	4	2006	6	69	2081	2080

6.4 PROJECT FUNDING

Project funding arises from two primary sources. The first is utility rates charged per customer for obtaining the water and maintenance and operation of the treatment plants and distribution system. The second is impact fees to provide infrastructure to support future demands or growth of the treatment and distribution systems.

Rate Funded Improvements Improvements funded by rates are those arising from deterioration of the system, age of the system, and those associated with code or regulatory changes. For instance, regulations may require treatment of well water for manganese. Manganese is a secondary contaminant which means the maximum allowable contaminant level thresholds are set to preserve aesthetic qualities not health concerns. If Manganese removal becomes mandatory then necessary improvements would be funded by rate payers.

Impact Fee Improvements Improvements funded by impact fees are those supporting new development or extending service to new areas in support of future development. Other fee related categories of projects are oversizing of replacement pipes for new or future demands, increasing the capacity of treatment plants, and increasing the amount of supply. New wells or expansion of the treatment plants to accommodate increased demands are fee related improvements. New pipes that are parallel to meet increased or forecast demands, or to serve new areas are fee related projects as well.

Hybrid Funded Projects Many projects fall into a hybrid funding category where multiple reasons exist generating the need for the project. For example a reservoir being called for to replace an existing reservoir may be oversized to meet future needs. Many pipes fall into this category as they may be old enough to need replacement but future forecast demands are calling for a larger diameter pipe. Numerous different methodologies are available for dividing the cost between such projects. The strategy used in this plan for pipe construction was to minimize adding new pipes to the system to the extent possible. Therefore parallel pipes are not recommended. If a pipe is not adequate it is replaced and the rate/fee split is determined by the cost of replacement in kind being borne by the rates and the difference in cost to attain UBO needs is borne by the fees.

Ad-Hoc Caviat Projects In 2003 the City of Redding, at the direction of Council, formed an Ad Hoc Citizens committee to study underground infrastructure development impact fees. The committee recommendations were: 1) That connection fees be raised on a 3-step program, beginning January 1, 2004, to raise sufficient fees to fund 75 percent of the identified growth-related improvements. 2) That rates be raised a sufficient amount to maintain a 25 percent share of growth-related capital improvements by rate payers. 3) That funding for first phase of the Stillwater Business Park be funded by rates.

6.5 PROJECT TIMING

All capacity related projects (pipes, reservoirs, wells, treatment plants) were scheduled to be completed prior to the planning horizon where they were deemed necessary. Maintenance related projects such as leaking roofs, fence repairs, lighting needs, etc. were scheduled according to their ranking and as budget allows. Water Treatment Plant improvements were scheduled according to the recommendations of the Foothill WTP Facilities Plan. The first two planning periods are five year increments. Projects called for to resolve existing conditions and needed by 2015 were placed in the first 5-year time frame and prioritized according to their rank. Subsequent projects were scheduled in their respective time frames in similar manner.

There are several larger projects that fell in time frames that created excessive budget problems. Some of these projects were advanced or delayed in order to better match budget constraints. Each of these projects and the

potential ramifications of the schedule change are discussed below.

Replacement of approximately 9100 feet of pipe in Lake Blvd - CONV-04 This is needed by 2015 to alleviate excessive velocities, age and material concerns. The pipe is being oversized to reduce velocity to an acceptable level, meet future demands, and allow conveyance of water from Buckeye WTP to Foothill and Hilltop Dana Pressure zones. Project implementation is divided between two years, 2015-16 and 2016-17, and will be phased for construction to help minimize disruptions to Lake Boulevard and to spread the cost over time. The risk associated with delay of the project is accepting the limit on ability to transfer water from Buckeye to the other pressure zones and decreased lifespan of a facility that is already old and has maintenance problems.

Replacement of 1225 feet of 8-inch diameter pipe in Oasis Rd from Beltline Rd to the Railroad - CONV-02 This pipe replacement project is one of three (CONV-01, -02, and -03) needed to alleviate velocities that exceed recommended maximum, maintain fire flow support at Mountain Lakes Industrial Park, and support the movement of water from Buckeye WTP southeast to Foothill and Hilltop Dana Pressure zones and east to the northeast corner of the Buckeye Pressure Zone. The project is needed by 2015 but is rescheduled for 2017-18. Risks associated with delaying the project include reduction in lifespan of the facility due to velocities that exceed recommended maximum, limiting the ability to convey water from Buckeye WTP to Foothill and Hilltop Dana Pressure zones, continued reliance on Bella Vista for fire flow support to the northeast corner of Buckeye Pressure zone and potential for not meeting fire flow requirements in Mountain Lakes Industrial Park should demand increase.

Replacement of 1600 feet of 8-inch diameter pipe in Oasis Rd from the Railroad to Calexico Dr - CONV-03 The project is needed by 2015 but delayed until 2018-2019. See CONV-2 for description of risks associated with delay of the project.

Replacement of 1010 feet of 12-inch diameter pipe in Mountain Lakes Boulevard from Oasis Road to Caterpillar Road - CONV-01 The project was originally needed by 2015 but delayed until 2019-2020. See CONV-2 for description of risks associated with delay of the project.

Construction of Five Flocculator Basins - FH-13 This project is called for in anticpation of regulatory requirements. The original construction date of 2016-17 was delayed to 2023-24. Risks associated with the delay are the potential that regulatory requirements may require direct filtration earlier than the projected construction data and the project may need to be moved to an earlier date necessitating delay of other projects.

Table 6-7 Facility Improvements 2015-2020

Tag No.	Facility Type	Facility Name	Identified Projects	Recommendation	Reason	Cost Estimate	Total Score	Funding Split Rates, %	Funding Split Fees, %	Amounts Rates	Amounts Fees
EW11-01	Well	Enterprise Well 11	Roof tiles are falling off	Repair	Reliability/Longevity	$21,523	28	100		$21,523	
CONV-08	Distribution System	Pipe Network	8" Hilltop to Alley near Oxford Suites with CV (250 ft)	Construct	FF 2010	$130,214	28	100		$130,214	
EWT-08	Construct Well Head Treatment at EW-12	Construct	Water Quality/Regulatory	Construct	Capacity/Water Quality	$1,710,000	25	100		$1,710,000	
CONV-18	Distribution System	Pipe Network	Booster Pump Station at Cypress Avenue Bridge	Construct	Reliability	$871,680	23	100		$871,680	
CONV-11	Distribution System	Pipe Network	16" Hilltop from F8-V36 to Peppertree (1170 ft)	Construct	Capacity 2015	$490,723	18	71	29	$350,824	$142,310
CONV-12	Distribution System	Pipe Network	20" Railroad Avenue at Canyon Hollow Creek (370 ft)	Construct	Capacity 2015	$267,961	17	53	47	$142,555	$125,406
CONV-07	Distribution System	Pipe Network	24" Hill 900 to Buenaventura	Construct	Capacity 2010	$751,151	15	53	47	$397,037	$354,114
EW12-05	Well	Enterprise Well 12	Needs magnetic flow meter	Install meter	Operations	$80,000	13	100		$80,000	
EW13-04	Well	Enterprise Well 13	Needs magnetic flow meter	Install meter	Operations	$80,000	13	100		$80,000	
EW14-05	Well	Enterprise Well 14	Needs magnetic flow meter	Install	Operations	$80,000	13	100		$80,000	
CONV-05	Distribution System	Pipe Network	16" Hilltop at Ridgecrest	Construct	Capacity 2010	$60,264	13	59	41	$35,513	$24,751
CONV-04	Distribution System	Pipe Network	24" Lake Boulevard from Oasis Road to Northpoint Drive (9090 ft)	Construct	Capacity 2010	$4,863,111	12	50	50	$2,431,555	$2,431,555
CONV-01	Distribution System	Pipe Network	20" Beltline Rd from Oasis to Mtn Lakes (1013 ft)	Construct	Capacity 2010	$473,505	10	75	25	$355,129	$118,376
CONV-02	Distribution System	Pipe Network	20" Oasis Road from UPRR at A6-V1 to Beltline Road (1225 ft)	Construct	Capacity 2010	$888,898	10	27	73	$237,829	$651,069
CONV-03	Distribution System	Pipe Network	20" Oasis Road from Calexico Drive to A6-V1 (1600 ft)	Construct	Capacity 2010	$697,344	10	57	43	$398,482	$298,862
					Total:	$11,466,373				$7,322,340	$4,146,443

Table 6-8 Facility Improvements 2016-2020

Tag No.	Facility Type	Facility Name	Identified Projects	Recommendation	Reason	Cost Estimate	Total Score	Funding Split Rates, %	Funding Split Fees, %	Amounts Rates	Amounts Fees
CONV-15	Distribution System	Pipe Network	30" New Buckeye Tank to Quartz Hill Rd (3275 ft)	Construct	Capacity 2025	$1,863,888	24	25	75	$465,972	$1,397,916
CONV-16	Distribution System	Pipe Network	24" Quartz Hill to Keswick Dam Boulevard (1485 ft)	Construct	Capacity 2025	$818,948	24	25	75	$204,737	$614,211
EWT-02.3	Well Treatment	Enterprise Wells	Block problem zones in wells to decrease concentrations	Construct	Water Quality/Regulatory	$105,462	24		100		$105,462
FH-13	Treatment Plant	Foothill WTP	Construct five flocculator basins if classic direct filtration system is required, 2020	Construct	Regulatory, Capacity	$6,203,991	23	100		$6,203,991	
PS1-06	Pump Station	Pump Station 1	Pump Station Relocation	Replacement *	Capacity, Environmental	$19,009,071	23	100		$19,009,071	
W-01	Well Supply	Enterprise Wells	Construct new Well	Construct	Supply	$1,476,474	22	100		$1,476,474	
CONV-14	Distribution System	Pipe Network	New Buckeye Tank 3.5 MG at Herbscenta	Construct	Capacity 2025	$3,387,713	20	25	75	$846,928	$2,540,784
S-01	Storage	Hill 900 Storage	New 3.0 MG reservoir in Hill 900 Before 2020	Construct	Operations	$3,100,381	13	100		$3,100,381	
CONV-13	Distribution System	Pipe Network	16" Twin View from B8-V24 to Oasis Center North (5630 ft)	Construct	FF 2025	$2,161,980	12	25	75	$540,495	$1,621,485
EWT-02.2	Well Treatment	Enterprise Wells	Construct Blending pipeline for EW-13 and EW-14 if necessary	Construct	Water Quality/Regulatory	$1,914,467	12	100		$1,914,467	
EWT-03	Well Treatment	Enterprise Wells	Install oxidation/filtration treatment system at EW-14 to remove manganese	Construct	Water Quality/Regulatory	$3,022,899	8	100		$3,022,899	
					Total:	$43,065,274				$36,785,415	$6,279,859

* PS1 Fees are colleced independently of standard rate fees

Table 6-9 Facility Improvements 2025-2035

Tag No.	Facility Type	Facility Name	Identified Projects	Recommendation	Reason	Cost Estimate	Total Score	Funding Split Rates, %	Funding Split Fees, %	Amounts Rates	Amounts Fees
CONV-09	Distribution System	Pipe Network	20" Lake Boulevard from Northpoint to Masonic (1220 ft)	Construct	Capacity & FF 2030	$322,000	27	71	29	$228,000	$94,000
W-02	Well Supply	Enterprise Wells	Construct New Well	Construct	Supply	$1,476,474	22	100		$1,476,474	
CONV-10	Distribution System	Pipe Network	16" Masonic to Hilltop	Construct	Capacity & FF 2030	$453,000	21	25	75	$113,250	$339,750
CONV-17	Distribution System	Pipe Network	16" Caterpillar to Twin View under I-5 (650 ft J&B)	Construct	FF 2030	$610,000	15	25	75	$152,500	$457,500
EWT-05	Well	Well Treatment	Construct pipeline from EW-12 to EW-14 to blend	Construct	Water Quality/Regulatory	1,849,000	8	100		$1,849,000	
EWT-06	Well	Well Treatment	Expand treatment at EW-14 to treat flows from EW-12	Construct	Water Quality/Regulatory	2,030,000	8	100		$2,030,000	
EWT-07	Well	Well Treatment	Install centralized oxidation/filtration treatment system at EW-11 and pipelines from EW-7 and EW-10	Construct	Water Quality/Regulatory	4,942,000	8	100		$4,942,000	
						$11,682,474				$10,791,224	$891,250

CASCADE WELL No.8

CHAPTER 7

Impact of the Capital Improvement Plan

7.1 BACKGROUND

In this chapter the impacts of this new 10-, and 20-year CIP on existing water rates were evaluated to determine what changes may be required to the current rates. The following discussion summarizes the impacts of the CIP on utility finances, reviews the methodology and details for service charge and connection fee evaluations. Recommendations will follow as the product of a cost of service study that will be prepared under contract by a consultant based on the findings of this Master Plan.

The current fee and rate schedules are the result rate, fee and cost of service study performed under contract by NBS Corp. NBS is also currently under contract to provide a new study and recommendations for a new rate structure for the City of Redding Water Utility.

7.2 GENERAL ANALYSIS

The following general financial evaluation provides a framework for integrating the CIP projects into the financial analysis.

Analysis of the finances included the following assumptions:

- Master Plan Growth Rate Projections. Details of the Master Plan Growth Rate Projections can be found in Appendix D, Demand Forecasting Methods. Annual growth rates range from 0.29 to .43% per year.

- CCI escalation of cost of all projects. Cost estimates were prepared in 2011 dollars then escalated by an annual increase of 3.69% to the year the project is scheduled for completion. This results in a doubling of project costs approximately every 20 years.

- Impact fees increasing at an annual rate of 3.69% starting in 2012-13 to match the CCI.

- The utility finances include additional budget divisions that set aside various components of the budget for specific purposes if examined in a high enough level of detail. For instance there is an account for rolling stock with interest on the balance that is a line item on revenue. In this document all such accounts were re-combined into either fee or rate accounts for the purpose of identifying potential overall budget challenges.

Analysis included three different scenarios:

1. Baseline analysis includes only increases in impact fees and rates that have already been approved.

2. Scenario 1 includes inflation increases in rates where currently they only exist in impact fee schedules.

3. Scenario 2 includes inflation increases fees, inflation increases to rates and additional increases in rates required to keep year end balances equal to or above the desired reserve amounts.

7.3 SUMMARY OF FINDINGS

Although the current rate study will ultimately make recommendations to resolve the deficit issue, in order to gain an order of magnitude understanding of the budget gap a general analysis was performed to determine what increases in rates might be necessary to fund the utility. Two approaches were examined in this effort to attempt to help mitigate and understand the magnitude of the budget gap, eliminating or delaying projects, and raising the rate schedule.

Unfortunately, the analysis to determine the required projects to maintain the level of service was performed with budget constraint as a criteria so if a project is not necessary it was not listed. After evaluation of the risks associated, numerous projects were delayed beyond the recommended planning horizon. Details and discussion of the risks of delay of projects are discussed in Chapter 6: Capital Improvement Plan. However, delay of a project does not necessarily alter the budget deficit other than to help prevent unusually large demands on revenue in a single or couple years.

A second analysis was performed to determine the additional increases in fees and rates necessary to fund the utility.

Tables 7-1 through 7-4 show the basic balance accounting for the Utility through 2029-30.

A short summary of the findings of the financial analysis prepared with this Master Plan Update are as follows:

<u>Baseline Scenario</u>

1. Under current fee schedule and project cost sharing, the Utility will not need to increase impact fees at this time. It is important to note that the lack of forecast impact fee related projects does not indicate that none will be necessary, particularly if development rates increase. It is recommended that periodic revision of this document re-evaluate those needs at regular intervals to verify need, or lack thereof, for more growth related projects.

2. Under the current rate schedule, the Utility will run out of unrestricted rate funds in fiscal

year 2017-18 and all rate funding by 2021-22.

Scenario 1

1. As shown in the Baseline Scenario, impact fees do not require adjustment at this time.

2. Adding inflation increases to the rate at the blended CCI/CPI rate of 3.08% per year only keeps the Utility rate account from dropping below zero for one to two more years to fiscal year 2020-21 for unrestricted rates and 2022-23 for total rate funding.

Scenario 3

1. No change was implemented to the impact fee structure.

2. An initial increase of 5% in addition to inflation followed by increases of 3.5 to 4.0% per year every year in addition to inflation appear to provide the utility with adequate funding to maintain the desired reserve and implement the recommended CIP.

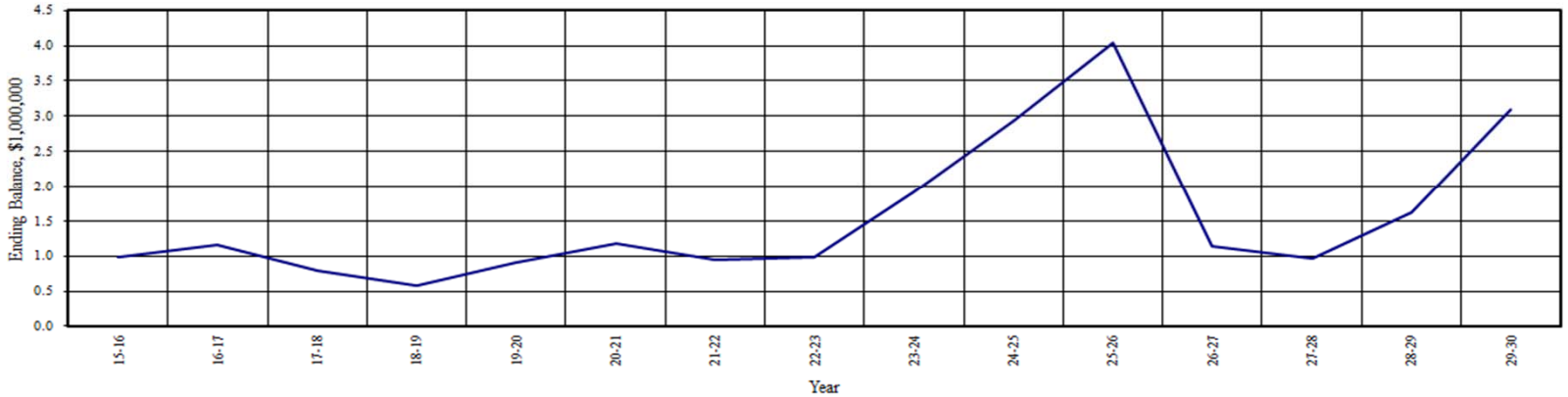
Results of the fee analysis are presented in Table 7-1. Figure 7-1 provides a graphical representation of the impact fee account budget analysis.

Results of the rate analysis are presented in Tables 7-2 through 7-4 and Figures 7-2 through 7-4. Table 7-5 shows a schedule of increases that are projected to provide adequate revenue to meet the utility needs and desired reserve through 2028-29. Additional increases may need to occur in the future to maintain the desired reserve beyond 2028-29.

Table 7-1 CIP Impact on Fees

	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30
Connection Fee (effective Jan 1)	5,807	6,021	6,243	6,474	6,712	6,960	7,217	7,483	7,759	8,046	8,343	8,650	8,970	9,301	9,644
Beginning Balance	518,558	978,734	1,161,684	799,969	570,852	902,578	1,172,252	945,410	975,619	1,917,295	2,936,979	4,039,252	1,133,817	963,490	1,621,751
Revenue															
Connection Fees	991,662	817,880	737,347	779,413	832,110	894,176	951,504	1,013,508	1,081,905	1,164,259	1,251,330	1,352,006	1,412,247	1,517,788	1,638,719
Expected Savings	4,213	7,374	22,661	19,976	3,838	7,677	24,822	18,742	4,337	4,471	4,610	131,673	48,946	26,583	5,209
Transfer from Rates	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Revenue	995,876	825,254	760,009	799,389	835,948	901,853	976,327	1,032,250	1,086,242	1,168,731	1,255,940	1,483,679	1,461,193	1,544,372	1,643,928
Expenditures															
Capital Improvements	140,435	245,805	755,380	665,867	127,947	255,903	827,408	624,736	144,565	149,047	153,667	4,389,113	1,631,520	886,111	173,627
Debt Service	395,264	396,499	366,344	362,639	376,276	376,276	375,761	377,305	0	0	0	0	0	0	0
Total Expenditures	535,699	642,304	1,121,724	1,028,506	504,222	632,179	1,203,169	1,002,041	144,565	149,047	153,667	4,389,113	1,631,520	886,111	173,627
Ending Balance	978,734	1,161,684	799,969	570,852	902,578	1,172,252	945,410	975,619	1,917,295	2,936,979	4,039,252	1,133,817	963,490	1,621,751	3,092,052
Assumptions															
Increase in Hes	103	110	116	119	123	127	130	134	138	142	146	151	156	162	168
Construction Cost Index Increase, %	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69

Figure 7-1 Baseline Scenario End of year Impact Fee Account



Increase:	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69

Table 7-2 - CIP Impact on Rates, Baseline Scenario, $

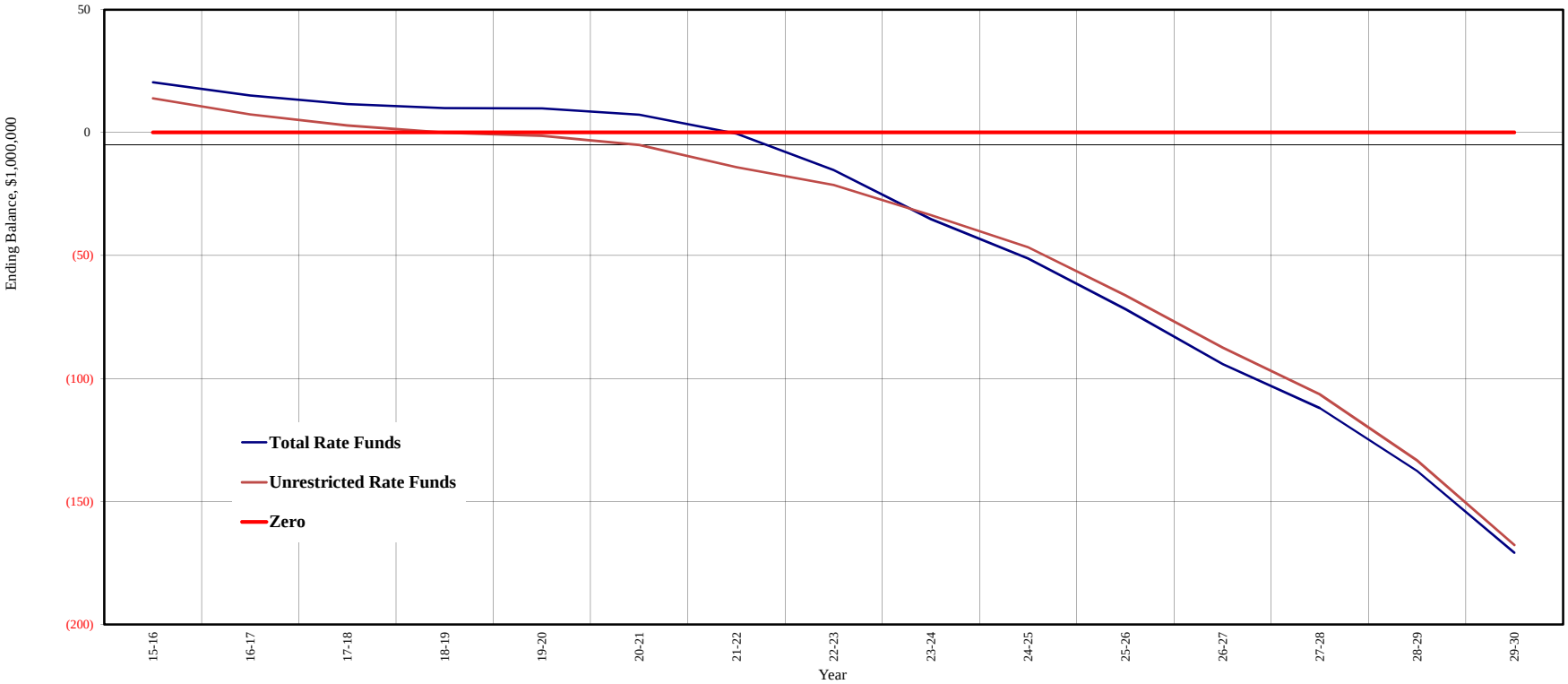
	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30
Beginning Balance	18,687,181	13,920,567	7,388,856	2,791,331	(86,008)	(1,385,888)	(5,165,713)	(14,042,334)	(21,273,729)	(33,628,178)	(46,650,030)	(66,245,087)	(87,426,535)	(106,493,645)	(133,308,318)
Revenue															
Rate Revenue	15,443,838	18,649,331	19,345,098	19,376,675	19,429,840	19,502,946	19,550,154	19,541,690	19,454,453	19,311,659	19,217,633	19,071,597	18,909,516	18,802,140	18,610,801
Expected Savings @ 1.5% Pers/O&M	0	155,119	164,356	168,604	175,215	180,492	185,176	189,984	194,919	199,984	205,184	210,521	215,999	221,623	227,395
Expected Savings @ 3% Capital	0	295,349	235,853	170,860	105,646	169,527	314,659	248,849	400,901	402,031	586,920	615,491	528,783	748,342	959,993
Rolling Stock Asset/Sales & Acct Interest	30,442	17,376	15,425	11,758	11,608	11,400	11,699	3,088	4,140	5,057	5,905	4,601	6,348	8,115	9,902
Total Unrestricted Revenue	15,474,280	19,117,175	19,760,733	19,727,898	19,722,309	19,864,365	20,061,688	19,983,611	20,054,413	19,918,731	20,015,641	19,902,211	19,660,647	19,780,220	19,808,091
Expenses															
O&M *	13,710,458	15,254,920	16,000,924	16,417,831	16,995,731	17,488,368	17,945,223	18,414,157	18,895,494	19,389,566	19,896,713	20,417,286	20,951,645	21,500,158	22,063,206
Debt Service	372,836	374,001	345,556	342,061	354,924	354,924	354,439	355,895	0	0	0	0	0	0	0
Capital Expenses (Rates)	5,982,600	9,844,965	7,861,778	5,695,344	3,521,533	5,650,897	10,488,647	8,294,953	13,363,368	13,401,017	19,563,984	20,516,372	17,626,112	24,944,734	31,999,771
Transfer to Rolling Stock Acct	175,000	175,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Transfer to Fee Acct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Expenditures	20,240,894	25,648,886	24,358,259	22,605,236	21,022,189	23,644,190	28,938,309	27,215,006	32,408,862	32,940,583	39,610,698	41,083,659	38,727,757	46,594,893	54,212,977
Ending Balance Unrestricted Rate Acct:	13,920,567	7,388,856	2,791,331	(86,008)	(1,385,888)	(5,165,713)	(14,042,334)	(21,273,729)	(33,628,178)	(46,650,030)	(66,245,087)	(87,426,535)	(106,493,645)	(133,308,318)	(167,713,204)
Restricted Revenue															
Pump House 1 Revenue **	987,241	1,156,314	1,189,273	1,193,075	1,196,993	1,201,027	1,205,176	1,209,429	1,213,811	1,218,321	1,222,974	1,227,781	1,232,755	1,237,910	1,243,271
Restricted Expenses															
Pump House 1 Expenses	1,500,000							8,832,000	8,832,000	4,074,325	2,347,762	2,446,221			
Pump House 1 Acct	6,982,773	8,139,086	9,328,360	10,521,435	11,718,427	12,919,454	14,124,630	6,502,059	(1,116,130)	(3,972,133)	(5,096,922)	(6,315,362)	(5,082,607)	(3,844,696)	(2,601,425)
Beginning Balance Including PH1 Acct	25,669,954	20,390,580	15,015,183	11,606,931	9,922,667	9,819,780	7,240,982	(430,463)	(15,284,429)	(35,257,067)	(51,134,923)	(71,854,768)	(94,254,656)	(112,089,011)	(137,665,774)
Ending Balance Using PH1 Revenue	20,390,580	15,015,183	11,606,931	9,922,667	9,819,780	7,240,982	(430,463)	(15,284,429)	(35,257,067)	(51,134,923)	(71,854,768)	(94,254,656)	(112,089,011)	(137,665,774)	(170,827,388)

* O&M includes Personnel, O&M Expenses, Interdepartmental Expenses

** Pump House 1 Revenue is collected as an independent line item on utility bills.

Assumptions:															
Annual Increase in Hes	103	110	116	119	123	127	130	134	138	142	146	151	156	162	168
CCI/CPI Rate Adjustment, %	3.08	3.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additonal Rate Increase, %	3.92	3.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Rate Increase, %	**7.00**	**7.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Figure 7-2 Baseline Scenario, $



Rate Increase:	7.00%	7.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 7-3 - CIP Impact on Rates, Scenario 1 Inflation, $

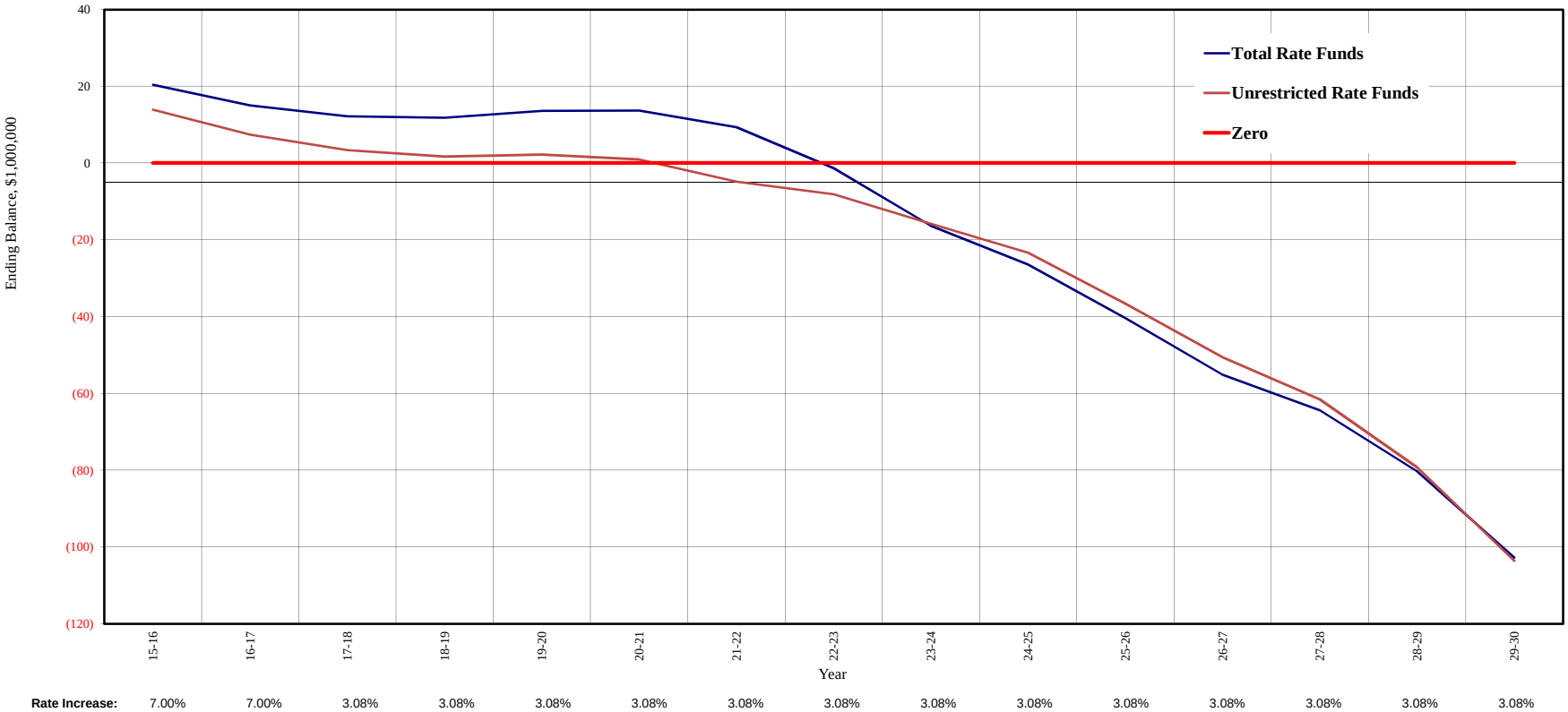
	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30
Beginning Balance	18,687,181	13,920,567	7,388,856	3,367,767	1,671,724	2,187,655	889,090	(4,808,556)	(8,129,648)	(15,807,342)	(23,349,341)	(36,623,155)	(50,601,936)	(61,543,072)	(79,264,628)
Revenue															
Rate Revenue	15,443,838	18,649,331	19,921,535	20,557,971	21,245,650	21,984,206	22,729,129	23,451,993	24,131,208	24,791,513	25,538,875	26,274,264	27,035,490	27,895,257	28,717,066
Expected Savings @ 1.5% Pers/O&M	0	155,119	164,356	168,604	175,215	180,492	185,176	189,984	194,919	199,984	205,184	210,521	215,999	221,623	227,395
Expected Savings @ 3% Capital	0	295,349	235,853	170,860	105,646	169,527	314,659	248,849	400,901	402,031	586,920	615,491	528,783	748,342	959,993
Rolling Stock Asset/Sales & Acct Interest	30,442	17,376	15,425	11,758	11,608	11,400	11,699	3,088	4,140	5,057	5,905	4,601	6,348	8,115	9,902
Total Unrestricted Revenue	15,474,280	19,117,175	20,337,169	20,909,194	21,538,119	22,345,625	23,240,663	23,893,914	24,731,168	25,398,584	26,336,884	27,104,878	27,786,621	28,873,337	29,914,356
Expenses															
O&M *	13,710,458	15,254,920	16,000,924	16,417,831	16,995,731	17,488,368	17,945,223	18,414,157	18,895,494	19,389,566	19,896,713	20,417,286	20,951,645	21,500,158	22,063,206
Debt Service	372,836	374,001	345,556	342,061	354,924	354,924	354,439	355,895	0	0	0	0	0	0	0
Capital Expenses (Rates)	5,982,600	9,844,965	7,861,778	5,695,344	3,521,533	5,650,897	10,488,647	8,294,953	13,363,368	13,401,017	19,563,984	20,516,372	17,626,112	24,944,734	31,999,771
Transfer to Rolling Stock Acct	175,000	175,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Transfer to Fee Acct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Expenditures	20,240,894	25,648,886	24,358,259	22,605,236	21,022,189	23,644,190	28,938,309	27,215,006	32,408,862	32,940,583	39,610,698	41,083,659	38,727,757	46,594,893	54,212,977
Ending Balance Unrestricted Rate Acct:	13,920,567	7,388,856	3,367,767	1,671,724	2,187,655	889,090	(4,808,556)	(8,129,648)	(15,807,342)	(23,349,341)	(36,623,155)	(50,601,936)	(61,543,072)	(79,264,628)	(103,563,249)
Restricted Revenue															
Pump House 1 Revenue **	987,241	1,156,314	1,225,903	1,267,700	1,311,036	1,355,971	1,402,564	1,450,865	1,500,970	1,552,949	1,606,893	1,662,895	1,721,057	1,781,485	1,844,307
Restricted Expenses															
Pump House 1 Expenses	1,500,000							8,832,000	8,832,000	4,074,325	2,347,762	2,446,221			
Pump House 1 Acct	6,982,773	8,139,086	9,364,989	10,632,689	11,943,726	13,299,696	14,702,260	7,321,125	(9,906)	(2,531,282)	(3,272,151)	(4,055,477)	(2,334,419)	(552,935)	1,291,372
Beginning Balance Including PH1 Acct	25,669,954	20,390,580	15,015,183	12,219,997	11,791,654	13,618,621	13,676,027	9,380,945	(1,321,283)	(16,330,007)	(26,393,382)	(40,408,066)	(55,170,172)	(64,390,251)	(80,330,322)
Ending Balance Using PH1 Revenue	20,390,580	15,015,183	12,219,997	11,791,654	13,618,621	13,676,027	9,380,945	(1,321,283)	(16,330,007)	(26,393,382)	(40,408,066)	(55,170,172)	(64,390,251)	(80,330,322)	(102,784,636)

* O&M includes Personnel, O&M Expenses, Interdepartmental Expenses

** Pump House 1 Revenue is collected as an independent line item on utility bills.

Assumptions:															
Annual Increase in Hes	103	110	116	119	123	127	130	134	138	142	146	151	156	162	168
CCI/CPI Rate Adjustment, %	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08
Additonal Rate Increase, %	3.92	3.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Rate Increase, %	**7.00**	**7.00**	**3.08**	**3.08**	**3.08**	**3.08**	**3.08**	**3.08**	**3.08**	**3.08**	**3.08**	**3.08**	**3.08**	**3.08**	**3.08**

Figure 7-3 Scenario 1, Inflation, $



Rate Increase:	7.00%	7.00%	3.08%	3.08%	3.08%	3.08%	3.08%	3.08%	3.08%	3.08%	3.08%	3.08%	3.08%	3.08%	3.08%

Table 7-4 - CIP Impact on Rates, Scenario 2 Inflation Plus, $

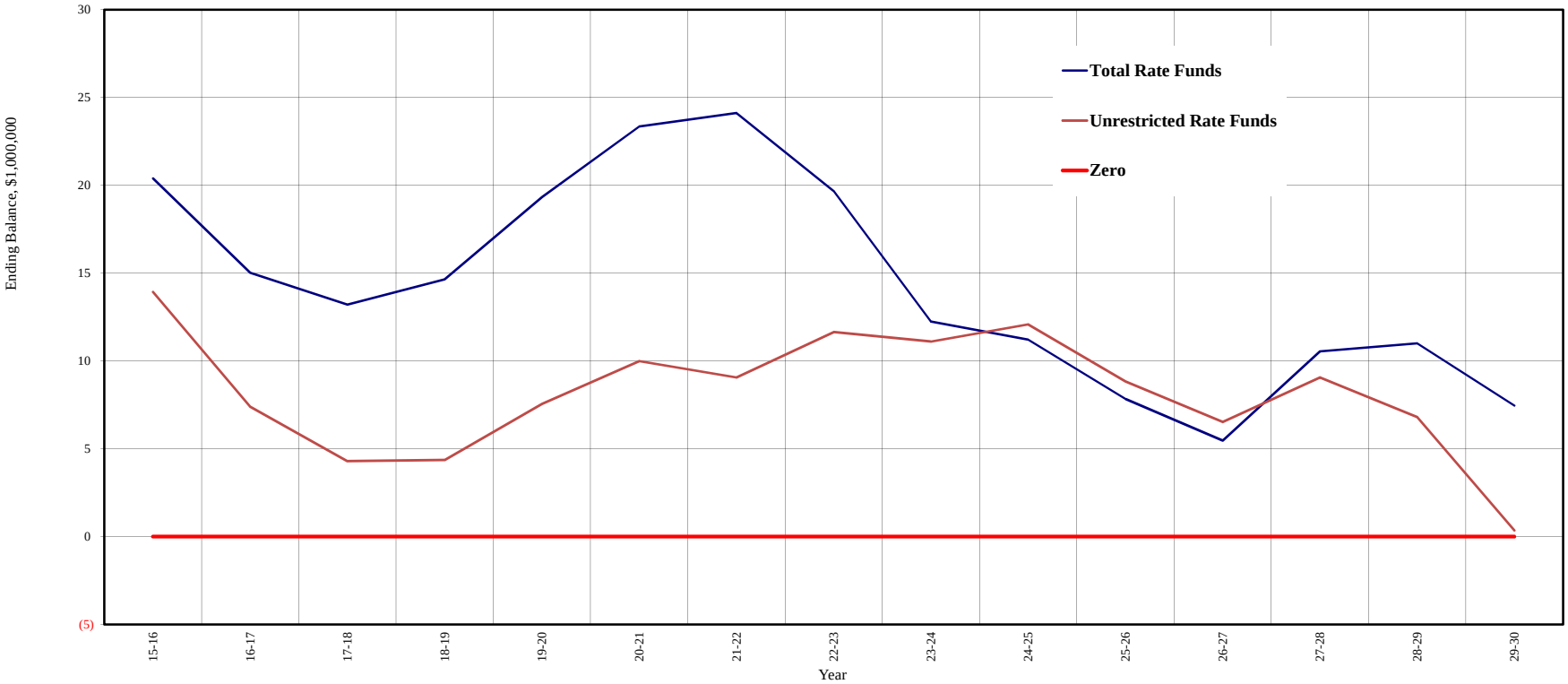
	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30
Beginning Balance	18,687,181	13,920,567	7,388,856	4,288,568	4,350,656	7,558,862	9,992,185	9,055,404	11,629,663	11,096,209	12,071,246	8,821,512	6,519,310	9,064,840	6,810,774
Revenue															
Rate Revenue	15,443,838	18,649,331	20,842,335	22,316,102	23,937,926	25,716,093	27,489,994	29,347,345	31,275,448	33,308,548	35,562,956	37,950,843	40,522,156	43,362,747	46,564,741
Expected Savings @ 1.5% Pers/O&M	0	155,119	164,356	168,604	175,215	180,492	185,176	189,984	194,919	199,984	205,184	210,521	215,999	221,623	227,395
Expected Savings @ 3% Capital	0	295,349	235,853	170,860	105,646	169,527	314,659	248,849	400,901	402,031	586,920	615,491	528,783	748,342	959,993
Rolling Stock Asset/Sales & Acct Interest	30,442	17,376	15,425	11,758	11,608	11,400	11,699	3,088	4,140	5,057	5,905	4,601	6,348	8,115	9,902
Total Unrestricted Revenue	15,474,280	19,117,175	21,257,970	22,667,324	24,230,395	26,077,512	28,001,528	29,789,265	31,875,408	33,915,620	36,360,964	38,781,457	41,273,287	44,340,827	47,762,031
Expenses															
O&M *	13,710,458	15,254,920	16,000,924	16,417,831	16,995,731	17,488,368	17,945,223	18,414,157	18,895,494	19,389,566	19,896,713	20,417,286	20,951,645	21,500,158	22,063,206
Debt Service	372,836	374,001	345,556	342,061	354,924	354,924	354,439	355,895	0	0	0	0	0	0	0
Capital Expenses (Rates)	5,982,600	9,844,965	7,861,778	5,695,344	3,521,533	5,650,897	10,488,647	8,294,953	13,363,368	13,401,017	19,563,984	20,516,372	17,626,112	24,944,734	31,999,771
Transfer to Rolling Stock Acct	175,000	175,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Transfer to Fee Acct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Expenditures	20,240,894	25,648,886	24,358,259	22,605,236	21,022,189	23,644,190	28,938,309	27,215,006	32,408,862	32,940,583	39,610,698	41,083,659	38,727,757	46,594,893	54,212,977
Ending Balance Unrestricted Rate Acct:	13,920,567	7,388,856	4,288,568	4,350,656	7,558,862	9,992,185	9,055,404	11,629,663	11,096,209	12,071,246	8,821,512	6,519,310	9,064,840	6,810,774	359,828
Restricted Revenue															
Pump House 1 Revenue **	987,241	1,156,314	1,284,415	1,378,718	1,480,072	1,589,014	1,698,147	1,814,908	1,939,880	2,073,650	2,216,870	2,370,247	2,534,540	2,710,573	2,912,874
Restricted Expenses															
Pump House 1 Expenses	1,500,000							8,832,000	8,832,000	4,074,325	2,347,762	2,446,221			
Pump House 1 Acct	6,982,773	8,139,086	9,423,501	10,802,219	12,282,291	13,871,305	15,569,452	8,552,360	1,660,241	(340,435)	(471,327)	(547,301)	1,987,239	4,697,812	7,610,686
Beginning Balance Including PH1 Acct	25,669,954	20,390,580	15,015,183	13,199,310	14,640,115	19,328,394	23,350,730	24,112,096	19,669,264	12,243,691	11,218,052	7,837,426	5,459,250	10,539,320	10,995,828
Ending Balance Using PH1 Revenue	20,390,580	15,015,183	13,199,310	14,640,115	19,328,394	23,350,730	24,112,096	19,669,264	12,243,691	11,218,052	7,837,426	5,459,250	10,539,320	10,995,828	7,457,755

* O&M includes Personnel, O&M Expenses, Interdepartmental Expenses

** Pump House 1 Revenue is collected as an independent line item on utility bills.

Assumptions:															
Annual Increase in Hes	103	110	116	119	123	127	130	134	138	142	146	151	156	162	168
CCI/CPI Rate Adjustment, %	3.08	3.08	8.00	7.00	7.00	7.00	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	7.00
Additonal Rate Increase, %	3.92	3.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Rate Increase, %	**7.00**	**7.00**	**8.00**	**7.00**	**7.00**	**7.00**	**6.50**	**6.50**	**6.50**	**6.50**	**6.50**	**6.50**	**6.50**	**6.50**	**7.00**

Figure 7-4 Scenario 2, Inflation Plus, $



Rate Increase:	7.00%	7.00%	8.00%	7.00%	7.00%	7.00%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	7.00%

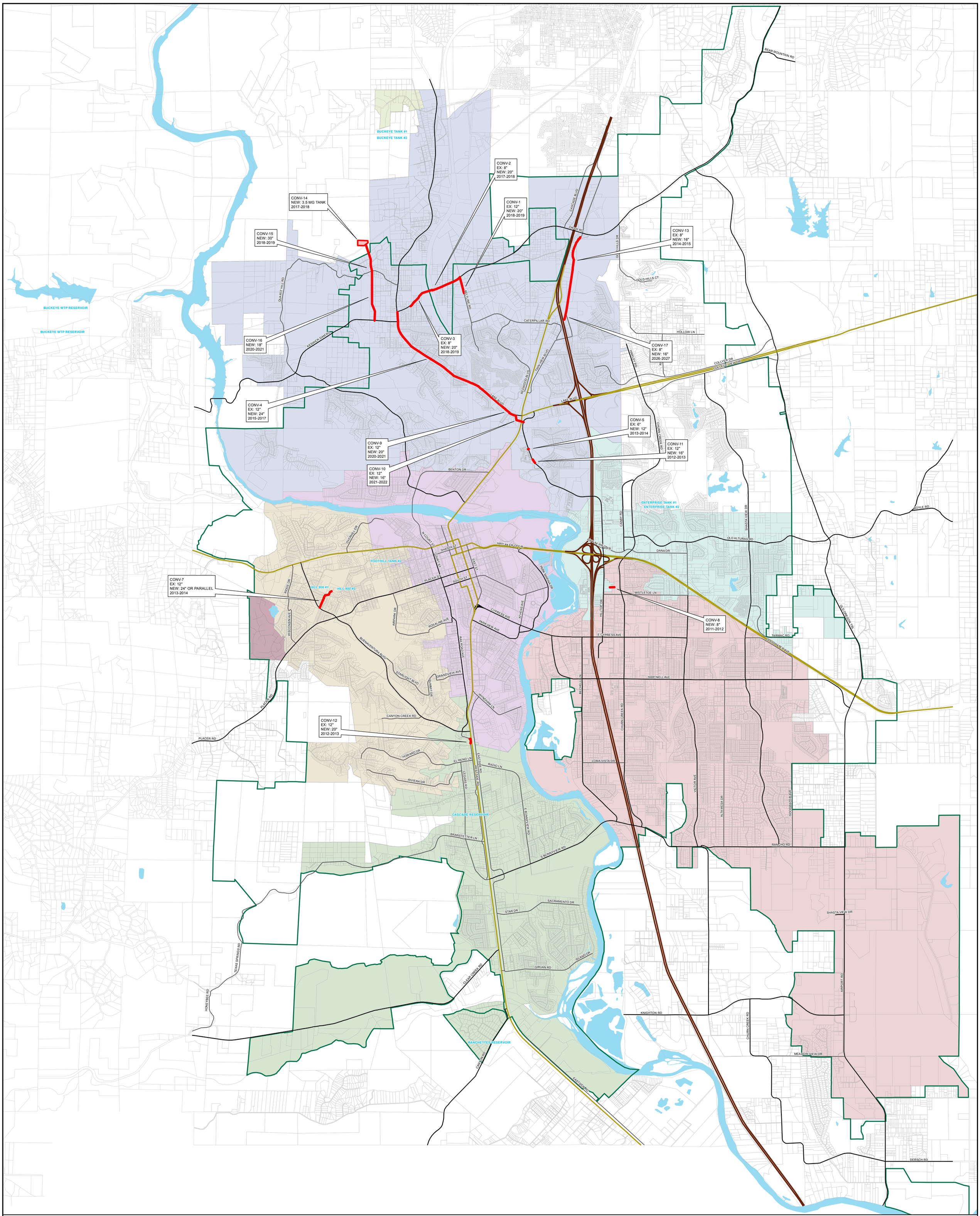
Table 7-5 Rate Increase Analysis Schedule

Year	CCI/CPI %	Additional Increase %	Total %
2016-17	3.08	3.92	7.00
2017-18	3.08	4.92	8.00
2018-19	3.08	3.92	7.00
2019-20	3.08	3.92	7.00
2020-21	3.08	3.92	7.00
2021-22	3.08	3.42	6.50
2022-23	3.08	3.42	6.50
2024-25	3.08	3.42	6.50
2025-26	3.08	3.42	6.50

Year	CCI/CPI %	Additional Increase %	Total %
2026-27	3.08	3.42	6.50
2027-28	3.08	3.42	6.50
2028-29	3.08	3.42	6.50
2029-30	3.08	3.92	7.00

APPENDIX A

Large Scale Map



Inter-Tie
Regulating Valve
Pump
Well
Treatment Plant
Water Storage Tank
Water Line > 8"

Roads
FWY
HWY
Arterial
Collector
Local
City Limits

Proposed Improvement

Pressure Zone
Buckeye
Cascade
Enterprise
Mary Lake
Foothill
Hill 900
Hilltop
Summit City

N
W E
S

0 4,000 8,000 16,000 Feet

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Appendix A
City of Redding
Water System Recommended Projects

Aug. 27, 2012

APPENDIX B

Water System Facility Evaluations

Water Utility Master Plan 2012

APPENDIX B

Water Facility Evaluations

Index Page

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2.0 Pump Station Evaluations B-3
3.0 Groundwater Well Evaluations B-13
4.0 Storage Tank Evaluations..... B-29
5.0 Foothill WTP Projects from Facilities Plan..... B-29

1.0 PURPOSE AND APPROACH

In November 2010, the City of Redding performed evaluations of selected existing facilities and systems associated with its water distribution system infrastructure. The effort was a multidiciplinary evaluation of the City's processes, facilities, structures, equipment, and other related components of these facilities. The goal of this effort was to form a prioritized list of system components that need replacing, upgrading, expanding, and/or modifying. Water treatment facilities and reservoirs and Pump Station 2 were addressed independently from this effort. Goodwater Booster Pump station is relatively new and is considered to be in excellent condition and therefore not included in this effort. Recommendations for those facilities will be added in the project evaluation section. Recommendations for the Foothill WTP are from the Facility Plan completed by PACE Civil Inc.

Due to the time frame necessary to complete this portion of the work, the evaluation was performed without developing detailed engineering concepts. The evaluation consisted of engineers and operators touring selected pump stations and wells to assess their condition. The evaluation included structural, electrical and site civil evaluations in addition to operational aspects. Utility operations staff allowed visual inspections of each facility by the engineering team and provided input on operational needs.

1.1 Approach

The approach taken in the facility evaluations was to briefly describe each facility, identify its major components, evaluate the condition of the facility, and assign a numerical ranking for suggested improvements. When appropriate, a table of pertinent design criteria is shown relating to features of the particular facility. Following this table (when present) is a table indicating observations made by the engineers or input received from City staff relating to what aspects of the facilities need to be improved. Where appropriate, photographs are included to show specific aspects or the overall facility layout under evaluation. From the inspections improvements or modifications were recommended and listed. Many of the recommendations fall below the threshold of project that would trigger a master plan type project and are listed separately as maintenance related activities.

Specific facilities that were evaluated are listed in Table B-1. Recommended projects are listed along with the rankings in the following specific facility evaluation sections.

Table B-1 Facilities and Systems Assessed in Facility Evaluations

Type of Facility	Specific Facility
Pump Station	- Pump Station 1 - Pump Station 3 - Pump Station 4 - Pump Station 5 - El Reno Booster Pump Station - Mary Lake Booster Pump Station - Mercy Hospital Booster Pump Station
Groundwater Source Wells	Enterprise Wells - Well E-3A - Well E-4 - Well E-6A - Well E-7 - Well E-8 - Well E-9 - Well E-10 - Well E-11 - Well E-12 - Well E-13 - Well E-14 - Well E-23 Cascade Wells - Well C-1 - Well C-5 - Well C-6 - Well C-8 - Well C-9

2.0 Pump Station Evaluations

The City's water system has eleven pump stations, used for raw water supply, conveyance of treated water between pressure zones, as emergency back-up sources, or to increase pressure for higher elevation areas. A brief description of each pump station and its operation is presented below.

2.1 Pump Station No. 1

The Sacramento River serves as the raw water source for the Foothill WTP. Pump Station No. 1 is located approximately 1500 feet upstream of Diestlehorst Bridge on the South bank of the Sacramento River. Raw water enters the pump station wetwells through rotating fish screens on a pier in the river. The raw water is then pumped through two separate transmission pipelines to the Foothill Water Treatment Plant.

The pump station was constructed in stages beginning in the late 1930s. The pump station was upgraded in 1987 by replacing three pumps. Fish screens improvements were completed in 2004. Switch control updates were completed in 2008.

Design Criteria

Item	*Description*
Number of Pumps	5
Size of Pumps, hp	1@400 2@500 2@700
Pump Station Capacity	32 mgd total (firm)
Pump TDH, ft	310
Pump Type	Vertical Turbine
Debris Screens	Self-cleaning cylindrical screens
Pump Control	Storage Level in 6-MG reservoir at plant site

Engineers and/or City staff made the following observations regarding Pump Station 1.

Tag No.	*Item*	*Recommendation*	*Purpose*
PS1-01	Communications with Foothill Water Treatment Plant	Replace	Continued Operation
PS1-02	No Backup Power	Install Backup Power	Reliability
PS1-03	Improve lighting in PS1 expansion structure	Construct new lighting	Operation Security
PS1-04	Fence needs Repair	Repair	Security

PS1-05	Fish Screen Improvements	Potential Repair/Replacement	Environmental
PS1-06	Relocate Pump Station 1	Construct	Environmental

Additional smaller items associated with the evaluation of Pump Station 1 included: Eaves need paint, Skim coat (lath) peeling off, roof gutters need repair.

Photo 1: Pump Station 1 South Exterior

Photo 2: Pump Station 1 Expansion Building

Photo 3: Pump Station 1 - West Fence

2.2 Pump Station 3

Pump Station No. 3 is located west of North Market Street (SHR 273) immediately north of Sulphur Creek. The station is designed to pump water from the Foothill Pressure zone to the Buckeye Zone. The pump station has been operating since the late 1960s and has recently been modified to include valves that allow water to move from the Buckeye Zone into the Foothill Zone as needed.

Design Criteria

Item	*Description*
Number of Pumps	4
Size of Pumps, hp	75 each
Pump Station Capacity, gpm	800 each
Pump TDH, ft	300
Pump Type	Vertical Turbine
Pump Control	Level in Buckeye Reservoir

Engineers and/or City staff made the following observations regarding Pump Station 3.

Tag No.	*Item*	*Recommendation*	*Purpose*
PS3-01	Roof deck rotted at swamp cooler	Replace	Longevity
PS3-02	No exterior light	Add light	Security
PS3-03	Electrical to swamp cooler not weatherproof	Replace	Reliability
PS3-04	Interior lighting is inadequate	Add light	Operation

PS3-05	Communications need updating from copper wire to fiberoptic	Upgrade	Reliability
PS3-06	Controls need to be updated to current standards	Upgrade	Operation
PS3-07	Swamp Cooler AC is not compatible with modern solid state controls or electrical equipment	Replace	Longevity

Additional maintenance activities identified include cleaning and painting the swamp cooler stand and minor pavement repair at entrance.

Photo 4: Pump Station 3 Exterior

Photo 5: Pump Station 3 Interior

2.3 Pump Station No. 4

Pump Station No. 4 is located on Benton Drive near the Lake Redding Golf Course and pumps water from the Foothill Zone to the Buckeye Zone. The pump station was constructed in 1983.

Design Criteria

Item	*Description*
Number of Pumps	3
Size of Pumps, hp	75 each
Pump Station Capacity, gpm	800 each
Pump TDH, ft	300
Pump Type	Vertical Turbine
Pump Control	Level in Buckeye Reservoir

Engineers and/or City staff made the following observations regarding Pump Station 4.

Tag No.	*Item*	*Recommendation*	*Purpose*
PS4-01	Communications are by copper wire and need to be converted to fiberoptic	Upgrade	Reliability
PS4-02	Controls need to be updated to current standards	Upgrade	Operations
PS4-03	Interior lighting is inadequate	Add light	Operations
PS4-04	Swamp Cooler AC is not compatible with modern solid state controls or electrical equipment	Replace	Longevity

Photo 6: Pump Station 4 Exterior

2.4 Pump Station No. 5

Pump Station No.5 was relocated to the Enterprise Reservoir location off of Churn Creek Road near Browning Lane in 1993. A fourth pump was added in 1997. The pump station pressurized the Hilltop Dana pressure zone.

Design Criteria

Item	*Description*
Number of Pumps	4
Size of Pumps, hp	75 (each)
Pump Station Capacity, gpm	4,500
Pump TDH, ft	184
Pump Type	Vertical Turbine
Pump Control	Auto - SCADA to Foothill WTP

Engineers and/or City staff made the following observations regarding Pump Station 5.

Tag No.	*Item*	*Recommendation*	*Purpose*
PS5-01	Swamp Cooler AC is not compatible with modern solid state controls or electrical equipment	Replace	Longevity

Additional maintenance related items that were observed in the evaluation were that the eaves need painting and the swamp cooler stand needs replacing.

Photo 7: Pump Station 5 Exterior

Photo 8: Pump Station 5 Interior

2.5 El Reno Pump Station

Constructed in 1994, the El Reno booster pump station is located on El Reno Lane and pumps water from the Cascade Pressure Zone to the Hill 900 zone.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	75
Pump Station Capacity, gpm	900
Pump Type	Horizontal Centrifugal Jacuzzi
Pump Control	Auto

Engineers and/or City staff made the following observations regarding El Reno Booster Pump Station.

Tag No.	*Item*	*Recommendation*	*Purpose*
ELR-01	Roof Leaks	Replace Roof	Reliability/ Longevity
ELR-02	Controls need to be updated to current standards	Upgrade	Operations
ELR-03	Interior lighting is inadequate	Add light	Operations

Photo 9: El Reno Booster Pump Station

2.6 Mary Lake Booster Pump Station

Constructed in 2000 and expanded in 2004 to include an additional pump and control logic Mary Lake Booster Pump Station is located on Lakeside Drive west of Ridge Drive.

Design Criteria

Item	*Description*
Number of Pumps	2
Size of Pumps, hp	1@40 1@75
Pump Station Capacity, gpm	1,000 and 2100
Pump Type	Horizontal Centrifugal Pumps
Pump Control	Downstream pressure

Engineers and/or City staff made the following observations regarding Mary Lake Booster Pump Station. The only items noticed with Mary Lake Booster Pump Station were that there were pipes that were not painted and that some of the original construction was very poor quality.

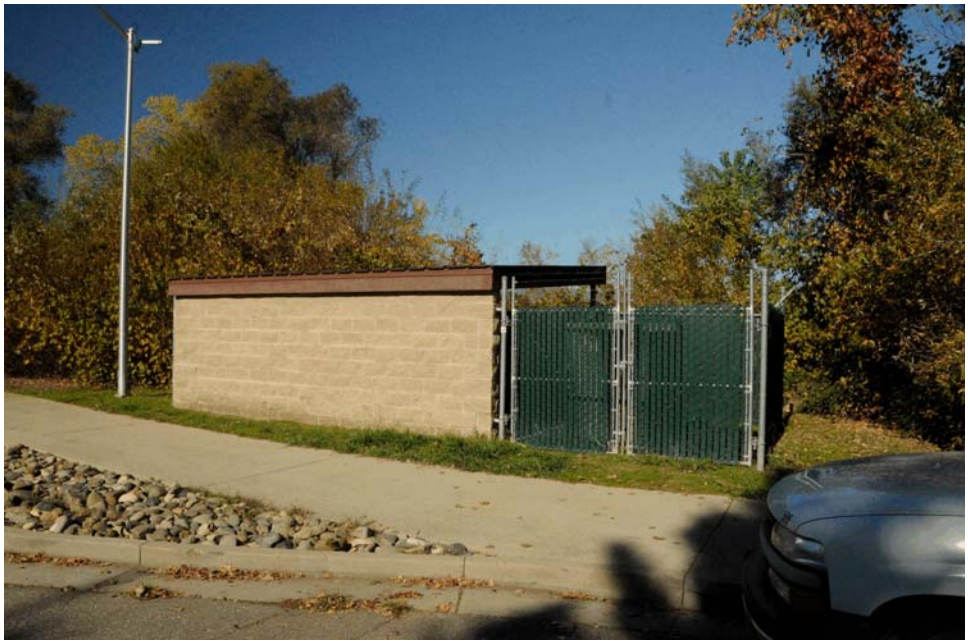

Photo 10: Mary Lake Booster Pump Station Exterior

Photo 11: Mary Lake Booster Pump Station Interior

2.7 Mercy Hospital Booster Pump Station

The Mercy Hospital Booster Pump is located east of the hospital off of West Street. It is designed to supply emergency water supply to Mercy Hospital.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	10
Pump Station Capacity, gpm	200
Pump Type	Century
Pump Control	Manual

Engineers and/or City staff made the following observations regarding Mercy Hospital Booster Pump Station.

Tag No.	*Item*	*Recommendation*	*Purpose*
MHB-01	Service Drop is too low	Raise Electrical Service	Operations

3.0 GROUNDWATER WELL EVALUATIONS

The City's inventory of wells are old and showing signs of wear. General housekeeping and maintenance is needed. If process or mechanical improvements are indicated for a particular well, electrical upgrades should be performed concurrently to modernize the system.

3.1 Enterprise Well No.3A

Enterprise Well No. 3A is located on Alta Mesa Drive at Galaxy Way and was installed in 1983.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	100
Pump Station Capacity, gpm	460
Pump TDH, ft	460
Pump Type	Submersible
Pump Control	Auto and Manual

Engineers and/or City staff made the following observations regarding Enterprise Well No. 3A

Tag No.	*Item*	*Recommendation*	*Purpose*
EW3-01	Roof leaks/dry rot at roof opening	Replace Roof	Reliability/ Longevity
EW3-02	Improper working clearance at Master Control Cabinet.	Reconfigure/Redesign /Reconstruct	Operations

3.2 Enterprise Well No. 4

Enterprise Well No. 4 is located off Castlewood Road.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	60
Pump Station Capacity, gpm	365
Pump TDH, ft	473
Pump Type	Submersible
Pump Control	Auto and Manual

Engineers and/or City staff made the following observations regarding Enterprise Well No. 4

Tag No.	*Item*	*Recommendation*	*Purpose*
EW4-01	Controls need to be updated to current standards	Upgrade	Operations
EW4-02	Improper working clearance at Master Control Cabinet.	Reconfigure/Redesign /Reconstruct	Operations

Additional maintenance activities noted during the evaluation were that the structure facia boards require repair and or replacement and the structure needs paint.

3.3 Enterprise Well No. 6A

Enterprise Well No. 6A was constructed in 1983 on Western Oak Drive near Brittany Drive. The well is normally only operated during the summer.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	75
Pump Station Capacity, gpm	600
Pump TDH, ft	487
Pump Type	Submersible
Control	Automatic

Engineers and/or City staff made the following observations regarding Enterprise Well No. 6A

Tag No.	*Item*	*Recommendation*	*Purpose*
EW6-01	Improper bonding of pull section on left side of service main.	Replace lug and connect to enclosure with machine screw.	Operations
EW6-02	Main Service needs replacing	Replace	Reliability Operations
EW6-03	Need in use receptacle cover for outlets a pump and next to well	Replace	Operations
EW6-04	Controls need to be updated to current standards	Upgrade	Operations
EW6-05	Improper working clearance at Master Control Cabinet.	Reconfigure/Redesign /Reconstruct	Operations

Additional maintenance activities noted during the evaluation were that the structure facia boards need repair or replacement.

3.4 Enterprise Well No. 7

Enterprise Well No. 7 is located on Goodwater Avenue near Freeman Way.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	200
Pump Station Capacity, gpm	1,200
Pump TDH, ft	450
Pump Type	Submersible
Control	Automatic - VFD

Engineers and/or City staff made the following observations regarding Enterprise Well No. 7

Tag No.	*Item*	*Recommendation*	*Purpose*
EW7-01	Controls need to be updated to current standards	Upgrade	Operations
EW7-02	Interior lighting is inadequate	Add light	Operations
EW7-03	Inadequate working space at equipment	Reconfigure/Redesign /Reconstruct	Operations

Additional maintenance activities noted during the evaluation were that the structure facia boards need repair or replacement.

3.5 Enterprise Well No. 8

Enterprise Well No. 8 is located at the Redding Municipal Airport. The well was constructed in the late 1970s and redeveloped in 1998. This is the only well in the system that runs all year.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	200
Pump Station Capacity, gpm	1,050
Pump TDH, ft	345

Pump Type	Vertical Turbine
Control	Automatic

Engineers and/or City staff made the following observations regarding Enterprise Well No. 8

Tag No.	*Item*	*Recommendation*	*Purpose*
EW8-01	Interior lighting is inadequate	Add light	Operations

3.6 Enterprise Well No. 9

Enterprise Well No. 9 was constructed in 1986 and is located on Airport Road.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	250
Pump Station Capacity, gpm	1,750
Pump TDH, ft	380
Pump Type	Vertical Turbine

Engineers and/or City staff made the following observations regarding Enterprise Well No. 9

Tag No.	*Item*	*Recommendation*	*Purpose*
EW9-01	Excessive roof leak	Replace	Reliability/Longevity
EW9-02	Interior lighting is inadequate	Add light	Operations

3.7 Enterprise Well No. 10

Enterprise Well No. 10 was constructed in 1986 on Goodwater Avenue. The well pump facility was currently undergoing rehabilitation during the 2010 Master Plan evaluations.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	150
Pump Station Capacity, gpm	960
Pump TDH, ft	380
Pump Type	Vertical Turbine

Engineers and/or City staff made the following observations regarding Enterprise Well No. 10

Tag No.	*Item*	*Recommendation*	*Purpose*
EW10-01	Roof leaks	Replace	Reliability/Long evity
EW10-02	Needs flow meter	Install Mag Meter	Operations
EW10-03	Interior lighting is inadequate	Add light	Operations

3.8 Enterprise Well No. 11

Enterprise Well No. 11 is located on Goodwater Avenue near Rancho Road. The well is operated mostly in the summer months from May to October.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	200
Pump Station Capacity, gpm	1400
Pump TDH, ft	380
Pump Type	Vertical Turbine

Engineers and/or City staff made the following observations regarding Enterprise Well No. 11

Tag No.	*Item*	*Recommendation*	*Purpose*
EW11-01	Roof tiles are falling off	Repair	Reliability/Longevity
EW11-02	Needs ventilation above motor	Install vent	Longevity
EW11-03	Remove unused wiring or tie up or clean up wiring	Remove or clean up	Operations
EW11-04	Communications need to be migrated from the Copper Tone Telemetry to Ethernet Radio	Upgrade	Reliability
EW11-05	Interior lighting is inadequate	Add light	Operations
EW11-06	Master Control panel needs repairing or replacing.	Repair or replace	Operations

Additional maintenance activities noted during the evaluation were that the structure facia boards need painting.

3.9 Enterprise Well No. 12

Enterprise Well No. 12 was constructed in 2002 on Old Oregon Trail north of Nordona Lane.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	350
Pump Station Capacity, gpm	2570
Pump TDH, ft	540
Pump Type	Vertical Turbine

Engineers and/or City staff made the following observations regarding Enterprise Well No. 12

Tag No.	*Item*	*Recommendation*	*Purpose*
EW12-01	Needs ventilation above motor	Install vent	Longevity
EW12-02	Needs exterior lighting at equipment	Install lighting	Operations
EW12-03	Controls need to be updated to current standards	Upgrade	Operations

EW12-04	Interior lighting is inadequate	Add light	Operations
EW12-05	Needs magnetic flow meter	Install meter	Operations

Additional maintenance activities noted during the evaluation were that the swamp cooler stand needs cleaning and painting.

3.10 Enterprise Well No. 13

Enterprise Well No. 13 was constructed in 2002 near the southern terminus of Old Oregon Trail.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	250
Pump Station Capacity, gpm	1830
Pump TDH, ft	487
Pump Type	Vertical Turbine

Engineers and/or City staff made the following observations regarding Enterprise Well No. 13

Tag No.	*Item*	*Recommendation*	*Purpose*
EW13-01	Pump seal leaking	Repair	Operations
EW13-02	Concrete at valve stand is spalling	Investigate/repair	Longevity
EW13-03	Conductors at Master Control contactor show signs of excessive heat and corrosion.	Upgrade	Operations
EW13-04	Needs magnetic flow meter	Install meter	Operations
EW13-05	Controls need to be updated to current standards	Upgrade	Operations

Additional maintenance activities noted during the evaluation were that the swamp cooler stand needs cleaning and painting. It was also noted that the plug cord for the roof ventilation fan needs replacing.

3.11 Enterprise Well No. 14

Enterprise Well No. 14 was constructed in 2006 east of Airport Road north of the intersection with Shasta View Drive.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	350
Pump Station Capacity, gpm	1740
Pump TDH, ft	520
Pump Type	Vertical Turbine

Engineers and/or City staff made the following observations regarding Enterprise Well No. 14

Tag No.	*Item*	*Recommendation*	*Purpose*
EW14-01	Swamp cooler float has malfunctioned	Repair	Reliability
EW14-02	Roof access hatches need slip resistant surface and or roof ladder	Install	Operations
EW14-03	Conductors at Master Control contactor show signs of excessive heat and corrosion.	Upgrade	Operations
EW14-04	Needs outdoor lighting on equipment.	Install lighting	Security
EW14-05	Needs magnetic flow meter	Install	Operations

3.12 Enterprise Well No. 23

Enterprise Well No. 23 was constructed in 2007 on Meadowview Drive east of Airport Road.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	350
Pump Station Capacity, gpm	1740
Pump TDH, ft	560
Pump Type	Vertical Turbine

Engineers and/or City staff made the following observations regarding Enterprise Well No. 23

Tag No.	*Item*	*Recommendation*	*Purpose*
EW14-05	Needs magnetic flow meter	Install	Operations

3.13 Cascade Well No. 1

Cascade Well No. 1 is located on Island Drive near Riverside Drive. The well is currently being operated all year.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	30
Pump Station Capacity, gpm	180
Pump TDH, ft	375
Pump Type	Submersible
Control	Manual

Engineers and/or City staff made the following observations regarding Cascade Well No. 1

Tag No.	*Item*	*Recommendation*	*Purpose*
CW1-01	Backer board for equipment needs replacing.	Replace	Operations
CW1-02	Disconnects and panels not bonded together	Bond	Operations
CW1-03	Communications need to be upgraded to radio to CCWWTP.	Upgrade	Operations

Photo 12: Cascade Well 1

Photo 13: Cascade Well 1 Enclosure

3.14 Cascade Well No. 6

Cascade Well No. 6 was constructed in 1967 and is located next to Cascade Well No. 1 on Island Drive at Riverside Drive. The well runs continuously all year.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	15
Pump Station Capacity, gpm	97
Pump TDH, ft	400
Pump Type	Vertical Turbine
Control	Manual

Engineers and/or City staff made the following observations regarding Cascade Well No. 6

Tag No.	*Item*	*Recommendation*	*Purpose*
CW6-01	Communications need to be upgraded to radio to CCWWTP.	Upgrade	Operations
CW6-02	Equipment needs to be upgraded and mounted in a large cabinet or building	Upgrade	Operations

Photo 14: Cascade Well 6 Enclosure

Photo 15: Cascade Well 6

3.15 Cascade Well No. 8

Cascade Well No. 8 was constructed in 1970 on Creekside Avenue near Girvan Road. The well runs continuously all year.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	40
Pump Station Capacity, gpm	144
Pump TDH, ft	235
Pump Type	Vertical Turbine
Control	Manual

Engineers and/or City staff made the following observations regarding Cascade Well No. 8

Tag No.	*Item*	*Recommendation*	*Purpose*
CW8-01	Fence is rotting and falling apart	Replace	Security
CW8-02	Electrical cabinets are mounted on fence that is falling apart. Need to bond all electrical cabinets.	Repair	Operations
CW8-03	Communications need to be upgraded to radio to CCWWTP.	Upgrade	Operations
CW8-04	Equipment needs to be upgraded and mounted in a large cabinet or building	Upgrade	Operations

Photo 16: Cascade Well 8 Enclosure

Photo 17: Cascade Well 8

3.16 Cascade Well No. 9

Cascade Well No. 9 was constructed in 1974 on Girvan Road across from Cascade Well No. 8. The well is run continuously all year.

Design Criteria

Item	*Description*
Number of Pumps	1
Size of Pumps, hp	20
Pump Station Capacity, gpm	83
Pump TDH, ft	370
Pump Type	Vertical Turbine
Control	Manual

No observations were made recommending improvements.

Photo 18: Cascade Well 9 Enclosure

Photo 19: Cascade Well 9

4.0 STORAGE TANK EVALUATIONS

In 2004 the City of Redding asked PACE Civil Inc. for an evaluation of Foothill 1.5 MG tanks and the Enterprise 3.5 MG tank for coating repair. Foothill 1.5 MG tanks were replaced by a single 4MG tank in 2006. As an addendum to that work PACE was asked to evaluate replacement of the 3.5 MG tank. Replacement appears to have been suggested based on recommendations of the 2000 Water Master Plan that the pressure zone would need an additional 4 MG storage by buildout. In a memo from Waterworks Engineers dated 3/17/2011 a summary of reservoir inspections for twelve City of Redding water storage reservoirs. Recommendations from the inspections were:

Tag No.	*Item*	*Recommendation*	*Purpose*
SR-01	As soon as possible sand blast and recoat and replace the manway gaskets on Enterprise 3.5 MG tank.	Repair	Longevity
SR-02	Demolish or replace Buckeye 0.2 MG tank due to size and deteriorated condition.	Demo or Replace	Obsolete

Other minor projects included cleaning, painting, repairing access cages and ladders, and minor sandblasting.

5.0 FOOTHILL WTP

In the fall of 2010 PACE Engineering was contracted to perform a facilities plan to evaluate Foothill Water Treatment Plant. The purpose of the effort was to provide a prioritized list of projects for inclusion in this Master Plan. The Facilities Plan "Facilities Plan for City of Redding Foothill Water Treatment Plant" is therefore included in this document by reference.

Projects recommended in that effort are:

Tag No.	*Item*	*Recommendation*	*Purpose*
FH-01	Upgrade PLC control system wiring & associated equipment	Upgrade	Reliability
FH-02	Distribute facility power loads between two 1200 KV circuits	Construct	Reliability
FH-03	Replace polyurethane seam and grout blocks for 6 MG Reservoir	Repair	Maintenance, Longevity
FH-04	Install filter-to-waste system	Construct	Regulatory
FH-05	Install individual filter rate of flow measurement and control	Construct	Operations
FH-06	Modify streaming current controller to automatically control coagulant dosing system	Construct	Operations

FH-07	Construct second backwash equalization basin	Construct	Operations
FH-08	Construct second backwash recycle clarifier	Construct	Operations
FH-09	Add backwash recycle pump	Construct	Operations
FH-10	Upgrade impellers in all four pumps at Pump Station No. 2 & add surge anticipator valve	Upgrade	Capacity
FH-11	Install Clearwell Baffling	Install	Capacity
FH-12	Conduct in-line filtration pilot studies at 6 GPM/SF summer & 3 GPM/SF winter conditions	Perform	Regulatory, Capacity
FH-13	Construct five flocculator basins if classic direct filtration system is required	Construct	Regulatory, Capacity

APPENDIX C

Hydraulic Modeling for the Water Utility Master Plan 2012

Water Utility Master Plan 2012

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Hydraulic Modeling for the Water Utility Master Plan 2012

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1.0 PURPOSE AND SCOPE

This appendix presents a general overview of the hydraulic model software, data sources, modeling methodology, and documentation of results. The primary purpose of the hydraulic model is to simulate the operation and performance of the water system under existing and future conditions. The information presented in this appendix includes:

- Model Software
- Model Compilation and Calibration Overview
- Water System Infrastructure and Model Components
- Modeling Scenarios and Results
- Potential Future actions and refinements

2.0 MODEL SOFTWARE

The City of Redding (COR) hydraulic model was initially developed by CH2M-Hill for the Water Master Plan 2000 using MWH-Soft's H2ONET software. At that time the City purchased a 10,000-pipe capacity license for the software as part of the Master Plan development. The H2ONET software was a software extension to the Autodesk AUTOCAD design platform with import and export capabilities for GIS formats. At the conclusion of the Water Master Plan 2000 effort the model was transferred to the City of Redding for routine use in analysis of the water supply system.

In preparation for the Water Master Plan 2010 effort the H2ONET software was upgraded to MWH-Soft's InfoWater software which utilizes ESRI ArcView plaform and is directly compatible with the City's GIS databases. MWH-Soft has now changed it's name to Innovize so the current model system utilizes Innovize InfoWater running on an ESRI ArcView platform.

Compatibility with the City of Redding GIS databases will allow model updates to occur more frequently and expediently.

3.0 MODEL COMPILATION AND CALIBRATION OVERVIEW

The following steps were involved in building and initial calibration of the hydraulic model in 1999 and 2000:

1. Building the pipe network. The pipe network was originally built by CH2M-Hill using City GIS department data reviewed and corrected for basic information such as pipe connectivity, locations, sizes, materials, age, etc.

2. CH2M-Hill developed a digital elevation model (DEM) utilizing U.S. Geological Survey (USGS) topographic mapping. Then "draped" the pipe and node network over the DEM to assign elevations to all the pipe junctions or nodes.

3. Pipe Hazen-Williams C values were calculated for existing pipes according to age, material, and diameter. These calculations were made using regression equations derived from Darcy-Weisbach friction factor values, which were then converted to Hazen-Williams C values.

4. All major flow control valves, pressure-reducing stations, and check valves were input using City data sheets for each facility and City atlas sheets for each location.

5. All booster pumps, wells, and reservoirs were input using City facility data and drawings.

6. Daily operations data from 1997 through 1999 were collected and analyzed. The operations data were used to determine total daily water demand, daily demands per pressure zone, diurnal curves for City and pressure zones (where possible), and hourly/daily operations for each major facility (pump stations, reservoirs, treatment plants, wells).

7. Available operations data for target calibration dates were reviewed to determine if there was a need for additional field data collection. No new data collection was considered necessary given the sufficient amount of hourly and dailgy data available on the target calibration dates.

8. Initial runs of the hydraulic model were reviewed and compared to daily and hourly operations data. Discrepancies between model results and operations data were addressed with model revisions to match operations data.

9. The model was rerun to verify revisions achieved simulation of actual operations.

10. The baseline model was then modified to include peak day and average day scenarios for each planning horizon.

4.0 WATER SYSTEM INFRASTRUCTURE AND MODEL COMPONENTS

The hydraulic model includes components that represent all major system infrastructure. Key design, performance, and operational characteristics of each main feature of the water system are represented. The model components include pipes, nodes, valves (PRVs, isoltation, and flow constrol), reservoirs (tanks), and pump stations.

H2O-Net and its successor InfoWater both have relatively intuitive graphical user interfaces that are used to input all major conponents, and can quickly import or edit bulk data such as pipe diameters and roughness coefficients from other GIS or database sources. This document does not address the detailed steps in creating and inputting data for model components because the information is readily accessible in the MWSoft H2ONET User's Guide or Innovyze on line documentation for the InfoWater model. The following is information specific to the COR model development or characteristics.

4.1 Pipes

Conveyance and distribution piping was input to the model beginning with bulk import of data from City GIS ARCVIEW shape files. This bulk data included key information such as pipe size, material, date of installation, length, and location. The data was corrected and missing items filled. Missing dates of installation were filled in using information from dates of specific subdivision construction. Nodes were added to all pipe intersections using a CH2M-Hill proprietary software tool called LYNX. The complete pipe network was then "skelatized," eliminating all pipes smaller than 6 inches, and service lines. By skelatizing the pipe network, the modeling can run more efficiently and effectively,, and the model can operate within the 10,000-pipe limit of the City's software license.

2010 Update. In 2006 a significant effort was undertaken to update the pipe network to include all new development between 2000 and 2006. This effort covered most of the construction boom of the early 2000's and all public projects up to that date but did not re-calibrate the model. The 2010 effort utilized current GIS database data to confirm pipe size and location for all pipes in the model and to add all new conveyance pipes six-inches in diameter or greater.

The pipe network was then debugged for instances of duplicate pipes or locations where the prior "skelatizing" effort failed to establish a junction connection at pipe intersections. The resulting update pipe network was used for all subsequent analysis.

Friction factors (Hazen-Williams C values) were initially determined using regression equations that were based on pipe material, age, and diameter. New pipes for future planning horizon scenarios were added using the model interface tools on an individual basis. Additional information for each pipe includes size, length, material, minor loss coefficient, date of installation, pressure zone, phase (i.e., future improvement), and features such as check valves or flow totalizers.

4.2 Nodes

Nodes (or junctions) represent a point where two or more pipes join together or at other locations where model information needs to be accessed or added. Nodes are where water system demands are assigned, and where facilities such as pumps, valves, and reservoirs are connected to adjacent pipes. Key information for each node includes its elevation, water demand (or inflow if a supply point), and pressure zone.

As mentioned above, the original model nodes were created using a LYNX tool that automatically generates nodes at pipe junctions. The nodes were assigned elevations by "draping" the nodes over a Digital Elevation Model (DEM) developed from USGS Topography maps.

The process of "draping" uses the underlying DEM as a graphical database from which to assign elevations to the model nodes by correlating the coordinates of a node with the topography data in the DEM. Node water demands were originally assigned using H2ONET's database editing tools and updated using the same tools in the InfoWater modeling environment.

New nodes are added using the Create menu in InfoWater, which allows the user to enter the required information for each new node. New nodes were assigned elevations according to COR two-foot contour aerial topography data generated in 2004. Nodes associated with future development horizon pipe networks were added individually using the InfoWater network editing tools.

4.3 Tanks and Reservoirs

Tanks and reservoirs were created individually in the Base Model using information from the design drawings, facility data sheets, and operational settings. Tanks and reservoirs are two distinct features in InfoWater. Tanks are fixed-volume features that can be drained completely and have variable water surfaces.

Reservoirs are "infinite" water sources in the model, which can provide as much water as the hydraulic conditions will allow and have constant water levels. Reservoirs are used to represent water sources such as rivers or wells. Tanks are used to represent treated water storage available to the distribution system. Key information for tanks and reservoirs includes capacity, geometry (diameter, height), invert elevation, and maximum/minimum operating levels (and initial water level for reservoirs). New tanks and reservoirs are added using the InfoWater system editing tools on an individual basis.

4.4 Valves (Flow Control, PRV, Check)

Water system valves were added individually, except for check valves. Check valves were imported from the City GIS database, with a "tag" identifying each pipe with a check valve. Flow control valves (FCVs) and Pressure Reducing Valves (PRVs) were added using City atlas and data sheets. Key information for each valve type includes: FCVs - size, minor loss coefficitint, maximum flow, on/off control logic based on other facility parameters such as tank levels; PRVs- size, control setting; Check Valves - upstream and downstream flow direction, size, minor loss coefficitne. New valves can be added using the InfoWater system editing tools.

4.5 Groundwater Wells

Groundwater wells are represented using a combination of reservoir and pump features. A "reservoir" is created to represent an infinite water source set at an elevation representing the ground water surface. A pump is then added corresponding to the capacity of each specific facility. Automated operations can be simulated using the pump's on/off control logic which can be triggered by tank levels or system pressures. New wells can be added using InfoWater system editing tools.

4.6 Water Treatment Plants

The City's two water treatment plants, Foothill and Buckeye, were represented in the same manner as ground water wells, with a combination of a reservoir and pump or multiple pumps with the addition of a tank to represent clearwell storage. A flow control valve is used to limit the plant production to the actual treatment capacity. The setting of the control valve can be adjusted by actual control logic such as tank levels.

5.0 WATER DEMANDS

Water demands were analyzed as two different types of demands, normal demands and high use demands. High use demands are demands of the top 100 water users in the City. Normal demands are the typical demands on the system from the majority of connections throughout the system. In addition to the two different types of demands three different magnitudes of demand scenarios were analyzed; Average Daily Demands (ADD), Maximum Daily Demands, and Calibration Day Demands. Once model calibration has occurred separate model scenarios were developed for both ADD and MDD for each planning horizon 2010, 2015, 2020, 2030 and Ultimate Buildout (UBO).

5.1 High User Demands

Water use data was obtained from meter readings for the largest water users in the City. Independent diurnal patterns were developed for the top 100 users according to the type of use for the water. Demands for those users were distributed to the appropriate node or nodes in the model. The total demand for the highest users in each pressure zone was then subtracted from that zones "normal" demand prior to distributing the remainder across all the nodes in that zone. The top 100 user demand was assumed to occur in both the ADD and MDD scenarios but were modified for the Calibration model to eliminate those specific to irrigation use.

5.2 Normal Demands

Water demands were developed per pressure zone by analyzing meter reading data from 2008 thorough 2010. Daily water production data was also analyzed from 2006 through 2010 to determine average daily demand (ADD) and maximum daily demand (MDD). For the calibration model only demands specific to the date of fire flow testing were used. Diurnal curve patterns were developed with the 2000 Water Master Plan and carried forward to the current effort.

5.3 Diurnal Patterns

The initial demand development process for the Water Master Plan 2011 included an attempt to collect data at a level of detail that would have allowed development of new diurnal demand patterns for each pressure zone from hourly production, storage and zone transfer data. Unfortunately the effort discovered that the data to perform that level of detail was not being recorded. After further discussion and consideration staff determined that there was little reason to believe that the diurnal patterns would change significantly between the 2000 Water Master Plan effort and the current effort. The effort was then tabled pending development of a comprehensive SCADA system which would allow that level of detail.

5.4 Projected Demands

Demand projections for future planning horizons were obtained using population forecasts from the Shasta County Regional Transportation Planning Agency (SCRTPA) model data. Details of the population forecasting can be found in Appendix D. ADD and MDD normal demands were multiplied by a factor to account for growth projections for each pressure zone for each planning horizon.

6.0 MODEL CALIBRATION

The basic model calibration strategy for the 2010 Water Master Plan hydraulic model was as follows:

- obtain operations and field data for a specific time frame
- obtain demand data specific to that same time frame
- apply those demands to the model
- apply the operational settings and conditions that are specific to the day field data was collected to the model
- run the model and obtain results from the model
- compare the results to the field data collected

The data threshold used for determining successful calibration was that static pressures needed to be within 5% of the field data and flows needed to be within 10% of the field data.

The first round of field testing occurred in February and April 2010 and the first round of model calibration attempts occurred in Fall/Winter 2010 using demand data from production and operations logs. After numerous attempts and thorough investigation of the model parameters the initial calibration attempt failed to approach the acceptance criteria. As a result further investigation and effort in refining the model inputs was undertaken. The subsequent investigation determined that the production and operation tools used to develop demands for the pressure zones which were then subsequently applied to the computer model were not appropriate data for that application. In addition it was found that some of the field testing was performed at a period of time when one of the two water treatment plants was off line. Finally, records were not obtained for exact operations settings of the system during the time frame the field tests were being performed. This prompted a second round of model calibration following collection of new demand data, operational settings and feild data.

The second round of model calibration occurred in February 2011 and included utilization of demand data

developed from city-wide meter readings, carefully examined and monitored operational settings coinciding with the timing of the field flow testing effort. The second round of model calibration was successful.

6.1 Specific Calibration Information

Model settings were adjusted to match recorded operational settings for the day and time of day each fire flow was recorded in the field. The data was recorded from February 9th to February 11th during regular business hours. Demand data for the model was obtained from the two sources listed above except those users in the top 100 that were associated with irrigation demands were removed and the normal demand data was obtained from February 2010 meter readings. Twenty seven field fire flow tests were performed throughout the City at locations deemed adequate to examine calibration of the model. Of the twenty-seven tests three were outside the parameters required for accurate use of the testing equipment and therefore eliminated from the list used to verify calibration. Two tests included pitot pressure readings that were below recommended accuracy threshold for the testing equipment but were examined along with the rest of the data. Figure C-1 shows the locations of the fire flow tests performed in February 2011. Table C-2 shows results of the field testing effort and model results.

7.0 MODELING SCENARIOS AND RESULTS

The hydraulic model was used to evaluate a wide range of conditions for the City water system. The conditions can be grouped by year (or planning horizon) and demand conditions. Model runs were done under existing conditions (2010), 2015, 2020, 2030 and ultimate system buildout (UBO). For each of these time frames, extended period simulations (EPS) were run for 48 hour periods under ADD and MDD conditions. For existing, 2015, and 2020 conditions, design fire flows were evaluated under MDD conditions. Because of the model's size (over 8,000 pipes) and the use of EPSs, the model output for each run can not reasonably be documented in print. The quantity of data would be enormous. Instead the graphical display and analysis tools in InfoWater were used to evaluate model results and the output data are stored in the program files themselves. Summary documentation of model runs was developed for review and discussion with City staff, useing EXEL tables and graphs created by exporting key information from the model.

The model results were the basis for determining necessary system improvements in an iterative fashion (i.e., new reservoirs, larger pipes, changes in control settings) to address areas of the system that did not meet minimum performance criteria. These improvements formed the basis of the capital improvements planning presented in the Water Master Plan 2010.

8.0 FUTURE ACTIVITIES

It is recommended that the City continue to develop a more comprehensive data collection system and methodology to further refine the calibration of the model. In addition the model platform is fully GIS compatible and therein lies the potential for some kind of update mechanism to be developed to take advantage of other facility mapping efforts such as atlas generation or GIS mapping of new infrastructure. This may eventually eliminate duplicate data entry efforts and duplicate data sets.

9.0 TABLES

Table C-1 Demand Development

			- ADD -			- MDD -			- Peaking Factors -		
Pressure Zone	Number of Connections	Number of Nodes	Total Demand, MG	Demand per Connection, gpm	Demand per Node, gpm	Total Demand MG	Demand per Connection, gpm	Demand per Node, gpm	MDD/ADD	MH/AH	MH/ADD
Buckeye	5008	1774	3.75	0.52	1.47	8.38	1.16	3.28	2.2	1.54	3.44
Cascade	3339	873	2.50	0.52	1.99	5.59	1.16	4.45	2.2	1.54	3.44
Enterprise	8719	2099	6.94	0.55	2.30	15.32	1.22	5.07	2.2	1.54	3.40
Foothill	4469	1112	3.30	0.51	2.06	6.93	1.08	4.33	2.1	1.54	3.23
Hilltop/Dana	2458	819	2.19	0.62	1.86	4.75	1.34	4.03	2.2	1.21	2.62
Hill 900	4539	1040	3.50	0.54	2.34	8.02	1.23	5.36	2.3	1.54	3.53
Total:	28532	7717	22.18			48.99					

Table C-2 Calibration Demands

		- February Demands -	
Pressure Zone	Number of Nodes	Total Demand MG	Demand per Node gpm
Buckeye	1774	1.95	0.76
Cascade	873	1.35	1.07
Enterprise	2099	3.35	1.11
Foothill	1112	1.99	1.24
Hilltop/Dana	819	1.15	0.98
Hill 900	1040	1.55	1.03
Total:	7717	11.34	

Table C-3: Model Field Testing and Calibration Results

		Pressure Readings		Flow Readings				Pressures					Computer Results			
Zone	Address	Atlas Page	Hydrant #	Atlas Page	Hydrant #	Date	Time	Static	Residual	Pitot	Flow at Residual Pressure	Flow @ 20 [1]	Static	% Deviation	gpm @ residual	% Deviation
Hilltop Dana	660 Durango Way	G9	V45	G9	V49	2/9/2011	10:00	60	45	33	1902	3230	63.0	5.0	1950	2.5
	1022 Roseland St	J13	V7	J13	V10	2/9/2011	10:24	75	42	19	1443	1902	74.9	-0.1	1300	-9.9
	1515 Dana Drive	K10	V44	K10	V75	2/9/2011	10:50	95	85	42	2146	6369 [2]				
	Sports Complex	L14	V6	L14	V15	2/9/2011	11:20	90	52	31	1843	2564	90.6	0.7	1775	-3.7
	2139 Sophy	K12	V26	K11	V52	2/9/2011	11:35	95	72	42	2146	4062	96.0	1.1	2025	-5.6
Buckeye	857 Lake Blvd	D6	V22	D6	V21	2/9/2011	1:10	92	70	45	2221	4213	95.6	3.9	2350	5.8
	12814 Williamson Road	NV5	V18	NV5	V13	2/9/2011	1:30	70	42	16	1324	1811	64.4	-8.0	1100	-16.9
	18673 Old Oasis	NZ8	V33	NZ8	V50	2/9/2011	1:45	135	52	28	1752	2089	136.6	1.2	1625	-7.2
	609 Collyer Drive	D9	V68	D9	V72	2/9/2011	2:00	115	60	31	1843	2476	114.8	-0.2	1800	-2.3
	1283 River Ridge Drive	E4	V30	E4	V35	2/9/2011	2:20	120	80	38	2041	3348	125.4	4.5	2125	4.1
Foothill	1508 Benton Drive	G6	V53	G6	V52	2/9/2011	2:35	100	90	46	2246	6902 [2]				
	1371 Butte Street	K6	V110	K6	V110	2/9/2011	3:00	80	50	38	2041	2968	79.4	-0.7	2050	0.4
	2400 Park Marina Drive	L8	V23	L8	V26	2/10/2011	8:20	110	95	56	2478	6520	115.0	4.5	2400	-3.1
	2900 Valentine Lane	O7	V17	O7	V18	2/10/2011	9:05	110	90	50	2341	5274	112.1	1.9	2150	-8.2
Enterprise	2510 Wilson Ave	N12	V69	N12	V61	2/10/2011	10:00	70	60	34	1931	4604 [2]	70.5	0.7	1750	-9.4
	3440 Oak Haven Ct	P11	V81	P11	V80	2/10/2011	10:40	73	59	35	1959	4020	72.6	-0.6	1900	-3.0
	706 Loma Vista	R9	V68	R9	V67	2/10/2011	11:05	75	60	27	1720	3470	72.9	-2.8	1850	7.6
	4210 Brittany Drive	S12	V51	S12	V52	2/10/2011	12:50	80	70	45	2221	5845 [2]				
	2704 Henderson Road	N8	V29	O8	V8	2/10/2011	1:55	97	80	42	2146	4851	99.4	2.5	2250	4.8
Hill 900	1694 Ridge Drive	L2	V4	L2	V3	2/10/2011	2:19	65	50	26	1688	3055	66.7	2.6	1675	-0.8
	2005 Oconnor	N2	V10	V2	V13	2/10/2011	2:36	65	52	28	1752	3426	67.9	4.5	1700	-3.0
	3939 Silver Lace Lane	P6	V49	P6	V46	2/10/2011	2:55	115	72	41	2120	3253	110.3	-4.1	2100	-0.9
	1000 Royal Oaks Dr	J3	V12	J3	V10	2/11/2011	7:55	115	85	43	2171	4046	109.8	-4.5	2000	-7.9
	2485 Howard Drive	R5	V7	R6	V75	2/11/2011	8:25	112	80	44	2196	3885	111.9	-0.1	2350	7.0
Cascade	3199 Sacramento Drive	X8	V17	X9	V1	2/11/2011	8:45	102	75	40	2094	3815	104	2.0	1900	-9.3
	5481 Eastside Road	V7	V22	V7	V21	2/11/2011	9:15	90	75	44	2196	5046	93.3	3.7	1875	-14.6
	5537 Indianwood	T9	V16	T9	V18	2/11/2011	9:30	100	75	40	2094	3924	99.9	-0.1	1950	-6.9
	1120 Branstetter Lane	V5	V2	V5	V1	2/11/2011	9:50	80	42	14	1239	1585	80.8	1.0	975	-21.3

[1] Flow @ 20 shown here is based on a straight line extrapolation given two data points collected in the field and does not reflect real system dynamics. It also does not account for peak day or peak hour.

[2] Hose Monster flow test equipment requires a minimum 10 psi or 20% reduction in pressure between static and flow test conditions for valid results. Results flagged with [2] do not meet this criteria.

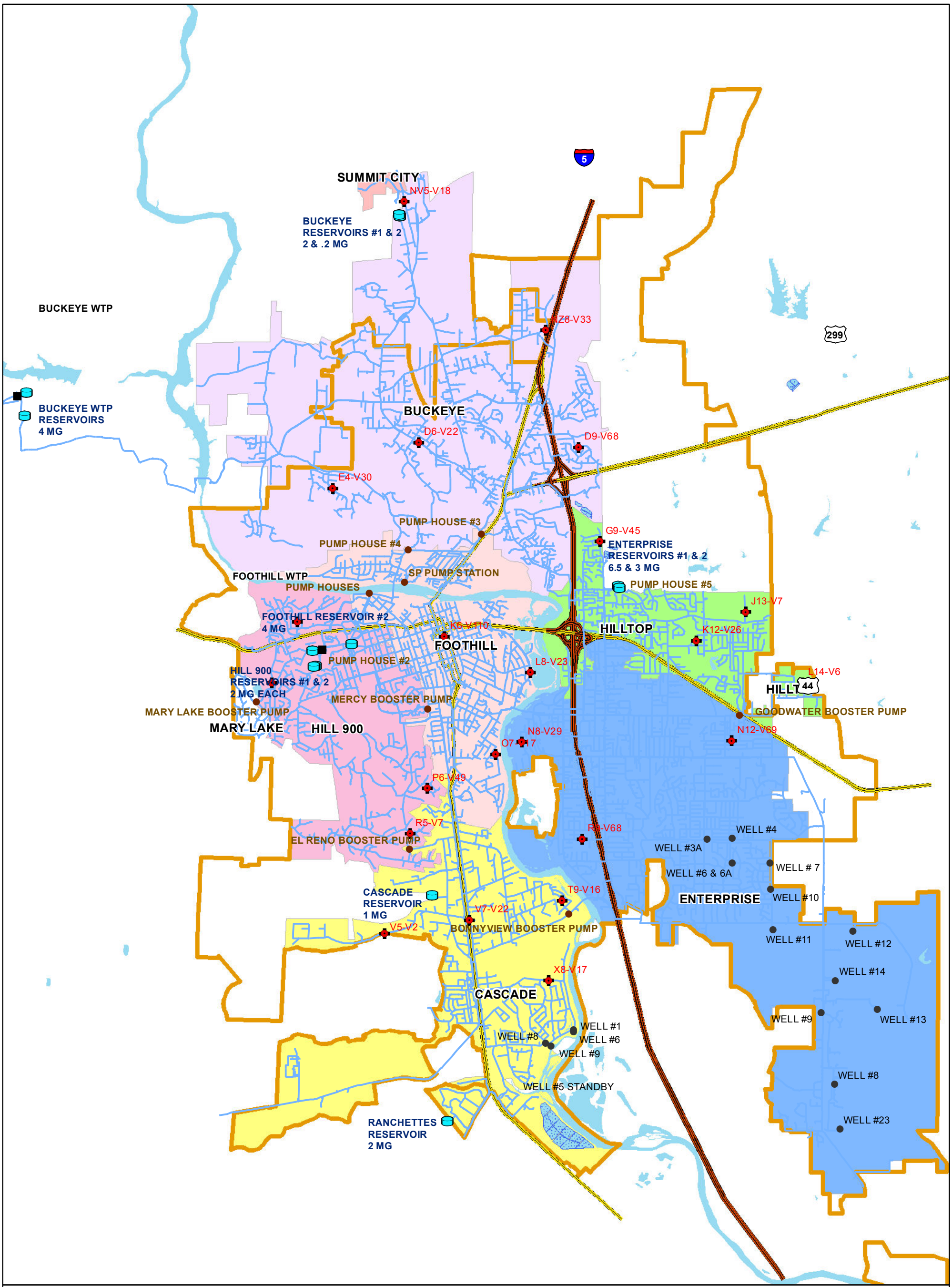

Figure C-1
City of Redding
Water Calibration Points

P:\RMU\ESRI\MasterPlan\Water_ModelCalibration.mxd

July 24, 2012

APPENDIX D

Demand Forecasting Methods

Water Utility Master Plan 2012

APPENDIX D

Demand Forecasting Methods

Index Page

1.0 Purpose D-1
2.0 Water Demand Forecasting D-1
3.0 Tables D-2

Attachment: Shasta RTPA Land Use Forecast Assumptions Technical Memo

1.0 PURPOSE

Population growth and the associated demands on the water system are the key factors in sizing and locating treatment and conveyance systems under the master planning process. Demographic forecasts of population, employment, and housing for the planning areas are used as a basis for projecting land development. The land development projections are then used to determine future water and sewer demands.

This update uses two different methods for projecting future demands. For short term planning horizons (2015, 2020, and 2030) the update uses the land per capita water demands applied to and the growth projection rates. The ultimate build-out condition (UBO) utilized land use densities determined in the General Plan and Zoning ordinance documents and maps to generate an ultimate population forecast.

Growth projection was obtained from a combination of two sources. The Shasta County Regional Transportation Planning Administration Demand Model was accessed to determine geographic distribution of growth. This provided the basis to determine what percent of the city-wide growth occurred in each pressure zone for each planning horizon. Details of the methodology and assumptions used in the RTPA modeling effort are documented in the attached memorandum Subject: Land Use Forecast Assumptions, dated June 4, 2007.

City-wide population growth was obtained from an Economic Sciences Corporation (ESC) analysis performed prior to initiation of the Master Plan effort and subsequently updated with the March 2012 revised projections. A copy of the raw data from ESC is included at the end of this section.

2.0 WATER DEMAND FORECASTING

Water demand forecasting utilized the Traffic Model Traffic Analysis Zones (TAZ) with the population forecasting by summing all the population for each time frame within each pressure zone. Forecast data from TAZ areas that were partially located in a pressure zone was adjusted according to the percent area located within the pressure zone. Similarly data from TAZ areas that fell in multiple pressure zones was divided between pressure zones according the proportion of area in each zone. To account for potential differences in the RTPA forecast for 2010 and actual development customer service information was used to develop demands for the “Existing” (2010) condition.

ESC data was utilized to obtain the percent population growth occurring in each planning period. The RTPA model data was then used to obtain the portion of growth occuring in each pressure zone for each planning

period. 2010 demands, obtained through customer service data, were then increased in each pressure zone in proportion to the percent increase in population in that zone for each planning period.

Ultimate build-out values for the water demands were developed utilizing general plan density values summing all potential development within each pressure zone and converting the values to equivalent population.

Future planning effort recommendations would include utilizing the models ability to geographically assign individual meter reading results to the nearest model junction. This would provide much greater resolution and more accurate method of assigning demands in existing condition scenarios.

3.0 TABLES

Table D-1 Water Service Area Population

Zone	Planning Horizon							
	2010	2015	%	2020	%	2030	%	UBO
Buckeye	15705	17244	9.8	19168	11.2	26934	40.5	44324
Cascade	10471	10545	0.7	11363	7.8	14282	25.7	22576
Enterprise	27343	28230	3.2	28771	1.9	29437	2.3	45245
Foothill	14015	14191	1.3	14271	0.6	15074	5.6	16262
Hilltop Dana	7708	7984	3.6	8227	3.0	8492	3.2	16238
Hill 900	14234	14798	4.0	15676	5.9	16809	7.2	18655
Total WSA	89476	92991	3.9	97475	4.8	111028	13.9	163300
Annual % Growth			0.77		0.95		1.31	

UBO = Ultimate build-out
% = Percentage of population increase

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Dowling Associates, Inc.

Date: June 4, 2007

Memorandum

To: Thomas Hays, Shasta RTPA

cc: Shasta Model Users Group

From: Mike Aronson

Reference: Shasta RTPA Model Update P01114

Subject: Land Use Forecast Assumptions

This memorandum summarizes the land use assumptions for the Shasta County travel model.

Summary

Forecast Process

The land use forecasts for the Shasta County travel model were developed using a combination of:

- Detailed information on individual planned development in each jurisdiction
- Overall growth forecasts for Shasta County from several sources
- Growth forecasts prepared by economists for specific areas (Redding and South County)

The overall forecasts for all of Shasta County and for individual jurisdictions were compiled for each five-year increment between 2005 and 2030.

The actual inputs to the travel modeling process were developed on a parcel basis, starting with the known pipeline development and adding assumed development in other likely areas to match the control totals as closely as possible. In some cases, pipeline development alone would exceed the growth totals, and therefore a slower phasing of development and occupancy would be assumed for certain development areas.

Pipeline Development

The economic consulting firm of Strategic Economics met with planning staff from Shasta County and the cities of Anderson, Redding and Shasta Lake. They prepared comprehensive lists and maps of known "pipeline" development projects in each jurisdiction.

Population Forecasts

Population and housing forecasts to the year 2030 were compiled from the following sources:

- Overall County: California Department of Finance population projections
- Redding: Economic Science Corporation (ESC) projection for the Redding Electric Utility, adjusted for available residential land supply
- Anderson, Cottonwood and South County: Forecasts prepared by Pacific Municipal Consultants (PMC) for South County transportation studies
- Other areas: Historic growth rates from 1990 and 2000 Census, adjusted upwards for areas with known development proposals

The forecasts result in an increase of 48 percent in housing units between 2005 and 2030,

Employment Forecasts

There are no official State of California forecasts of employment by jurisdiction or county. Overall employment forecasts by economic sector were initially based on commercial forecasts prepared by Woods and Poole. These were adjusted upwards to be consistent with the assumed Shasta County population forecasts, which were higher than those assumed by Woods and Poole.

The forecasts result in an increase of 49 percent in total employment between 2005 and 2030.

Residential Projections

Projections for residential growth were documented by Strategic Economics in a memorandum dated November 10, 2005 (Figure 1 and Table 1). These projections were used as the control total targets for residential growth during the parcel-based allocation process. The individual assumptions by jurisdiction and subarea were also noted (Table 2).

Previous Residential Projection

For the 2000 Transportation Model, Economic and Planning Systems (EPS) developed a projection of growth in Shasta County. As is done in this current analysis, EPS compared the historic performance of multiple projections sources before developing the preferred projection for the County. Ultimately, it was determined that the high-migration Economic Sciences Corporation projection for the City of Redding would be the appropriate base for a countywide projection. The projection demonstrated an accurate history of projecting population growth in the City, and was the basis for the City's General Plan update being completed concurrently with the transportation model.

Figure 1: Shasta County Subareas for Residential Projections

Table 1: Shasta County Residential Projection Targets

PROJECTION OF OCCUPIED RESIDENTIAL UNITS BY SUBAREA, SHASTA COUNTY 2005-2030

			2005 base year (DOF occupied housing units)	2010	2015	2020	2025	2030	Estimated Incremental Household Growth	Estimated Percent Household Growth	Net Remaining	Land Capacity (Est. Units)[1]
Projected Units Countywide			68,220	75,158	81,656	88,154	94,652	101,150	32,930	48.3%	32,930	43,962
	Redding at Midpoint Densities, Assume 75% Buildout		34,612	39,109	43,115	46,603	49,587	52,044	17,432	50.4%	15,497	17,432
	Anderson (OmniMeans/PMC)		3,847	5,191	6,531	7,765	8,553	9,193	5,346	139.0%	10,151	5,346
	Shasta Lake		3,786	4,286	4,786	5,286	5,786	6,286	2,500	66.0%	7,651	3,917
	Total Unincorporated County		25,975	26,572	27,224	28,499	30,726	33,626	7,651	29.5%	7,651	17,503
	Urban:	Cottonwood (OmniMeans/PMC)	1,160	1,368	1,614	1,904	2,247	2,651	1,491	128.5%	6,160	1,492
		Other South County (OmniMeans/PMC)	932	1,020	1,104	1,188	1,830	2,482	1,550	166.3%	4,610	444
		Palo Cedro and Southeast of Redding, 70% Buildout	1,562	1,592	1,624	1,715	1,839	2,024	462	29.6%	4,149	924
		Happy Valley (Incl. North Fork)	845	919	998	1,219	1,524	1,977	1,132	134.0%	3,017	2,724
	Rural:	North Central Shasta County (Big Bend, Montgomery	1,240	1,253	1,268	1,308	1,363	1,444	204	16.5%	2,812	----
		East Shasta County (Burney, Fall River, McArthur, C	3,365	3,399	3,436	3,538	3,680	3,889	524	15.6%	2,288	
		Shingletown and Highway 44 Dersch Road Corridor	1,811	1,890	1,974	2,211	2,536	3,020	1,209	66.8%	1,079	5,770
		Other	10,856	10,881	10,908	10,984	11,088	11,242	386	3.6%	693	
		Bella Vista Water/Northeast of Redding	4,204	4,249	4,298	4,433	4,620	4,897	693	16.5%	0	1,095

PROJECTION OF OCCUPIED RESIDENTIAL UNITS BY SUBAREA, SHASTA COUNTY, 5-YEAR INCREMENTS

			2005 base year (DOF occupied housing units)	2005 to 2010	2010 to 2015	2015 to 2020	2020 to 2025	2025 to 2030
Projected Units Countywide			68,220	6,938	6,498	6,498	6,498	6,498
	Redding at Midpoint Densities, Assume 75% Buildout		34,612	4,497	4,006	3,488	2,983	2,458
	Anderson (OmniMeans/PMC)		3,847	1,344	1,340	1,234	788	640
	Shasta Lake		3,786	500	500	500	500	500
	Total Unincorporated County		25,975	597	652	1,276	2,227	2,900
	Urban:	Cottonwood (OmniMeans/PMC)	1,160	208	246	290	343	404
		Other South County (OmniMeans/PMC)	932	88	84	84	642	652
		Palo Cedro and Southeast of Redding, 70% Buildout	1,562	30	32	90	124	185
		Happy Valley (Incl. North Fork)	845	74	79	221	305	453
	Rural:	North Central Shasta County (Big Bend, Montgomery	1,240	13	14	40	55	82
		East Shasta County (Burney, Fall River, McArthur, C	3,365	34	37	103	141	210
		Shingletown and Highway 44 Dersch Road Corridor	1,811	79	84	236	326	484
		Other	10,856	25	27	76	104	155
		Bella Vista Water/Northeast of Redding	4,204	45	48	135	187	277

Source: Strategic Economics, November, 2005

Table 1: Shasta County Residential Projection Targets

PROJECTION OF OCCUPIED RESIDENTIAL UNITS BY SUBAREA, SHASTA COUNTY 2005-2030

			2005 base year (DOF occupied housing units)	2010	2015	2020	2025	2030	Estimated Incremental Household Growth	Estimated Percent Household Growth	Net Remaining	Land Capacity (Est. Units)[1]
Projected Units Countywide			68,220	75,158	81,656	88,154	94,652	101,150	32,930	48.3%	32,930	43,962
	Redding at Midpoint Densities, Assume 75% Buildout		34,612	39,109	43,115	46,603	49,587	52,044	17,432	50.4%	15,497	17,432
	Anderson (OmniMeans/PMC)		3,847	5,191	6,531	7,765	8,553	9,193	5,346	139.0%	10,151	5,346
	Shasta Lake		3,786	4,286	4,786	5,286	5,786	6,286	2,500	66.0%	7,651	3,917
	Total Unincorporated County		25,975	26,572	27,224	28,499	30,726	33,626	7,651	29.5%	7,651	17,503
	Urban:	Cottonwood (OmniMeans/PMC)	1,160	1,368	1,614	1,904	2,247	2,651	1,491	128.5%	6,160	1,492
		Other South County (OmniMeans/PMC)	932	1,020	1,104	1,188	1,830	2,482	1,550	166.3%	4,610	444
		Palo Cedro and Southeast of Redding, 70% Buildout	1,562	1,592	1,624	1,715	1,839	2,024	462	29.6%	4,149	924
		Happy Valley (Incl. North Fork)	845	919	998	1,219	1,524	1,977	1,132	134.0%	3,017	2,724
	Rural:	North Central Shasta County (Big Bend, Montgomery	1,240	1,253	1,268	1,308	1,363	1,444	204	16.5%	2,812	----
		East Shasta County (Burney, Fall River, McArthur, C	3,365	3,399	3,436	3,538	3,680	3,889	524	15.6%	2,288	
		Shingletown and Highway 44 Dersch Road Corridor	1,811	1,890	1,974	2,211	2,536	3,020	1,209	66.8%	1,079	5,770
		Other	10,856	10,881	10,908	10,984	11,088	11,242	386	3.6%	693	
		Bella Vista Water/Northeast of Redding	4,204	4,249	4,298	4,433	4,620	4,897	693	16.5%	0	1,095

PROJECTION OF OCCUPIED RESIDENTIAL UNITS BY SUBAREA, SHASTA COUNTY, 5-YEAR INCREMENTS

			2005 base year (DOF occupied housing units)	2005 to 2010	2010 to 2015	2015 to 2020	2020 to 2025	2025 to 2030
Projected Units Countywide			68,220	6,938	6,498	6,498	6,498	6,498
	Redding at Midpoint Densities, Assume 75% Buildout		34,612	4,497	4,006	3,488	2,983	2,458
	Anderson (OmniMeans/PMC)		3,847	1,344	1,340	1,234	788	640
	Shasta Lake		3,786	500	500	500	500	500
	Total Unincorporated County		25,975	597	652	1,276	2,227	2,900
	Urban:	Cottonwood (OmniMeans/PMC)	1,160	208	246	290	343	404
		Other South County (OmniMeans/PMC)	932	88	84	84	642	652
		Palo Cedro and Southeast of Redding, 70% Buildout	1,562	30	32	90	124	185
		Happy Valley (Incl. North Fork)	845	74	79	221	305	453
	Rural:	North Central Shasta County (Big Bend, Montgomery	1,240	13	14	40	55	82
		East Shasta County (Burney, Fall River, McArthur, C	3,365	34	37	103	141	210
		Shingletown and Highway 44 Dersch Road Corridor	1,811	79	84	236	326	484
		Other	10,856	25	27	76	104	155
		Bella Vista Water/Northeast of Redding	4,204	45	48	135	187	277

Source: Strategic Economics, November, 2005

Table 2: Residential Projections Assumptions

			2005 Base Year Assumptions	Projection Assumptions
Projected Units Countywide			Occupied housing units as reported by the CA Department of Finance	From DoF population projections by age group, worked into households using household formation rates from 2000 U.S. Census
Redding at Midpoint Densities, Assume 75% Buildout TOTAL HOUSEHOLDS			Occupied housing units as reported by the CA Department of Finance	Years 2005-2015 correspond to growth rates from ESC Projection. Growth rate gradually decreases over time from 2015 to 2030, and total estimated incremental growth reflects 75 percent of Redding's land capacity estimate. This number falls short of the E
Anderson (OmniMeans/PMC)			Occupied housing units as reported by the CA Department of Finance	OmniMeans/PMC Memorandum
Shasta Lake			Occupied housing units as reported by the CA Department of Finance	Assumed absorption rate of 100 units/year. This is higher than historic rate of 78 units/year in last 5 years but reflects strong showings in pipeline development, including estimated 1500 units Mountain Gate Meadows
Total Unincorporated County			Occupied housing units as reported by the CA Department of Finance	County net of Cities
	Urban:	Cottonwood (OmniMeans/PMC)	From PMC/OmniMeans Projection for South County	From PMC/OmniMeans Projection for South County
		Other South County (OmniMeans/PMC)	From PMC/OmniMeans Projection for South County	From PMC/OmniMeans Projection for South County
		Palo Cedro and Southeast of Redding, 70% Buildout	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	From 2005-2030, change at double its historic 10 year average annual growth rate from 1990-2000 Census.
		Happy Valley (Incl. North Fork)	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	Control total for 2030 accommodates major pipeline development + 20 percent additional development
	Rural:	North Central Shasta County (Big Bend, Montgomery Creek, Round Mountain)	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	Assumed to develop at 25 year average annual growth rate for the total unincorporated county of 0.61%
		East Shasta County (Burney, Fall River, McArthur, Cassel)	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	Assumed to develop at tract 10 year average annual growth rate from 1990-2000, or 0.58%
		Shingletown and Highway 44 Dersch Road Corridor	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	Assumed to develop at tract10 year average annual growth rate from 1990-2000, or 2.07%
		Other	Total DOF for Uninc county minus all other unincorporated areas	Assumed to develop at tract's 10 year average annual growth rate for the total unincorporated county of 0.14%. Assume this rate because growth in these areas will be the slowest, and more likely to reflect unincorporated rate
		Bella Vista Water/Northeast of Redding	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	Assumed to develop at 25 year average annual growth rate for the total unincorporated county of 0.61%

Source: Strategic Economics, November, 2005

EPS extrapolated the Redding projection to Shasta County by assuming that the City of Redding would continue to capture the same share of the County's population over time. Incorporated areas would continue to grow faster than the unincorporated areas and Redding would continue to grow faster than Anderson and Shasta Lake. The final county projection was adjusted to conform to current and projected population estimates from the State of California. Ultimately there was some concern that this projection did not accurately project growth in other cities and the unincorporated areas of Shasta County; in fact, the EPS projection overestimated the county population and households in the year 2000 when compared with the U.S. Census.

Residential Projections Sources

Several projection series were evaluated and compared based on projected residential growth through 2030. The modeling techniques, historic accuracy, and applicability to the 2000-2030 time frame were considered. Reviews of these projection series follow.

Woods & Poole 2004

Woods & Poole is a national private projection of population by age group and/or housing units. This projection is only available at the countywide level. Woods & Poole is developed through modeling efforts tracking birth, death, and migration rates over time for the entire United States. County population projections are then developed based on sub-county analysis areas "economic areas" as the reference area. Growth in one county is linked to growth in other counties in order to maintain the national projected population. Total population is primarily informed by employment and earnings projections in the Woods & Poole model.

Based on our research, a fairly sizeable portion of the population in Shasta County is not working or is not working in Shasta County, therefore Woods & Poole, which is driven primarily by employment may not be an accurate source of population projections for Shasta County. When compared to the US Census, Woods & Poole underestimated total population growth from 1990 to 2000

Economic Sciences Corporation

Economic Sciences Corporation (ESC) completes a projection of Redding households and population for Redding Electric Utility each year. This projection is not available at the countywide level, and is only available for the City of Redding. Because this projection is based on actual customer records from the Redding Electric Utility, it appears to be the most accurate projection of Redding's population and household trends, at least in the short term.

While this population projection has historically been very accurate and appears accurate in the short term (5-10 years), the model does not take into account the available supply of land when determining its projections. Data from the City of Redding Planning Department indicates that the barring any further annexation, the City of Redding will exhaust its residential land supply by approximately 2015. At this point, much of the additional growth projected for the City of Redding in the ESC projection will likely be diverted into nearby unincorporated areas of the County as well as the City of Anderson.

Economic and Planning Systems

Economic and Planning Systems' (EPS) projection for the previous regional transportation model is based on Economic Sciences Corporation's projection for the City of Redding, and extrapolated to the Countywide level on a proportional population growth basis.

Since EPS used the ESC Redding projection as its base, this projection series has the same limited land supply issue that the ESC Redding projection has. Additionally, the EPS projections also assumed that Redding would continue to attract the largest share of the growth in the County through 2025. For this forecast update, this projection was considered to be a very aggressive estimate as it also fails to take Redding's land supply constraints into consideration.

California Department of Finance

The California Department of Finance (DOF) is the state projection of population by age group, available through the year 2050. There has been some concern that the DOF projection places an emphasis on its projections for major metropolitan areas, resulting in less accurate projections for non-urban areas such as Shasta County. The largest inaccuracies are likely in the method with which the DOF calculates net migration.

Historically, the DOF projections have been the most accurate for the County when compared to the Census. The DOF projections also represent a mid-range scenario; its population projections are higher than Woods & Poole, but lower than the EPS projections.

Preferred Residential Projection

Based on the information available regarding the historical accuracy of the various projection sources, the methodology with which these projections are calculated and information regarding the availability of land in the City of Redding, the following projection sources have been used in the residential projections.

Economic Sciences Corporation

While these projections were deemed to be overly aggressive in the long term, they are very accurate for the City of Redding in the short-term. Therefore, Redding's long-term projections were adjusted downward based on information regarding the availability of land.

Department of Finance

Given the historical accuracy and the DOF's position as a mid-range scenario among all available population projections, the Department of Finance projections for the County were used as the base for the population projections. However, the total county population was adjusted with input from the stakeholders.

Additional Adjustments

The basic residential projections were modified based on input from stakeholders in late 2005, particularly in the following ways:

- Growth rates for Anderson, Cottonwood and South County were made consistent with other land use forecasts prepared for transportation studies in those areas
- Pipeline activity was assumed to phase in over time;

- Historic growth rates were reflected in areas where constant growth is expected to occur;
- Projections were adjusted to accommodate both large scale development projects, such as North Fork, the Vineyards, and Mountain Gate Meadows, as well as some increment of additional development where appropriate.

Employment Projections

The overall employment projection targets are based on growth rates by sector developed by Woods & Poole, adjusted to correspond to the higher rate of population growth assumed for Shasta County (Table 3).

Employment Projections Sources

Several projection series were analyzed for the projection of jobs in Shasta County through 2030. Whereas the residential projection focuses generally on housing unit growth, the employment projection also divides the projected jobs into separate sectors. Generally, jobs are grouped in the following sectoral categories: Manufacturing, Retail, Services, Construction, and Agriculture. Some of the projection series described below provide a general jobs projection, while others provide a sectoral breakdown.

Sources of employment data were compared on a decade-by-decade basis. Unlike the population projections, no one source can be considered a comprehensive, Census-type base for employment projections. Employment projections use varying sectoral categories and collect a variety of data that frequently omits employment in the government sector, or the self-employed. Strategic Economics evaluated each projection series with the following criteria:

- The projection series must include all categories of workers including self-employed and unpaid family members
- The projection series must allow the employment to be spatially located

The sources are compared below.

Woods & Poole

Woods & Poole (W&P) 2004 is a national private projection of jobs by sector. The W&P projection is based on a modified "export base" model incorporating national trends in sectoral growth and decline, and accounting for the effect of employment trends of adjacent areas on each other.

Woods & Poole is considered an excellent source of employment projections, in that it includes employment information for categories of workers not included in other projection series including the self-employed, proprietors, domestic workers, unpaid family workers, railroad workers, and members of the armed forces.

Table 3: Shasta County Employment Projection Targets

Total County	2005	2010	2015	2020	2025	2030
Retail	14,719	15,943	17,121	18,403	19,790	21,300
Service	29,669	33,229	36,798	40,706	44,950	49,531
Government	11,147	11,892	12,588	13,331	14,112	14,924
Other	14,094	14,947	15,673	16,442	17,249	18,087
Total Employment	**69,629**	**76,011**	**82,180**	**88,882**	**96,101**	**103,843**

Anderson + Anderson SOI	2005	2010	2015	2020	2025	2030
Retail	1,183	1,281	1,376	1,479	1,591	1,712
Service	1,403	1,571	1,740	1,925	2,126	2,342
Government	483	515	545	578	611	647
Other	1,713	1,817	1,905	1,998	2,096	2,198
Total Employment	**4,782**	**5,185**	**5,567**	**5,980**	**6,424**	**6,899**

Redding + Redding SOI	2005	2010	2015	2020	2025	2030
Retail	11,417	12,366	13,280	14,275	15,350	16,522
Service	23,748	26,598	29,454	32,582	35,979	39,647
Government	8,069	8,609	9,112	9,650	10,215	10,803
Other	9,156	9,710	10,182	10,681	11,205	11,750
Total Employment	**52,390**	**57,282**	**62,028**	**67,188**	**72,750**	**78,722**

Shasta Lake	2005	2010	2015	2020	2025	2030
Retail	493	534	573	616	663	713
Service	678	759	841	930	1,027	1,132
Government	576	615	651	689	729	771
Other	577	612	641	673	706	740
Total Employment	**2,324**	**2,520**	**2,706**	**2,909**	**3,125**	**3,357**

Cottonwood	2005	2010	2015	2020	2025	2030
Retail	278	301	323	347	373	402
Service	297	333	369	408	451	496
Government	341	364	386	408	432	457
Other	302	321	336	353	370	388
Total Employment	**1,219**	**1,319**	**1,414**	**1,516**	**1,626**	**1,744**

Rural East (Burney, Fall River, McArthur, Cassel)	2005	2010	2015	2020	2025	2030
Retail	484	524	563	605	650	700
Service	977	1,094	1,212	1,341	1,480	1,631
Government	387	413	437	462	490	518
Other	443	470	493	517	543	569
Total Employment	**2,291**	**2,501**	**2,704**	**2,925**	**3,163**	**3,418**

Shasta County Other	2005	2010	2015	2020	2025	2030
Retail	864	936	1,005	1,080	1,162	1,250
Service	2,567	2,875	3,184	3,522	3,889	4,286
Government	1,290	1,376	1,457	1,543	1,633	1,727
Other	1,902	2,017	2,115	2,219	2,328	2,441
Total Employment	**6,623**	**7,204**	**7,761**	**8,364**	**9,012**	**9,704**

Based on Woods & Poole, growth rates adjusted in proportion to population projections

California Employment Development Department

The California Employment Development Department (EDD) provides a projection of employment by industry for Shasta County through 2008, as well as current data. Its projection is based on unemployment and tax data reported to the State. This data is analyzed and projected by a local branch of the EDD, ensuring the greatest projection accuracy of local conditions. The Shasta County Economic Development Corporation (Shasta EDC) uses this local projection for its analysis and policy development.

While the EDD is a considered a fairly reliable projection of employment, it does not include employment information for categories of workers including the self-employed. In addition, current employment data from EDD is available spatially to local governments through a confidentiality agreement, but does not always have accurate place information for its currently reported jobs, making it difficult to accurately locate employment within the county.

InfoUSA

Info USA is a private source of employment data estimated by gathering data from the Yellow Pages, Business White Pages Directory, phone calls, county courthouse, Secretary of State data, business magazines and newspapers, annual reports, 10K's and other SEC filings, new business registrations and incorporations and postal service information.

InfoUSA does not provide a projection of employment, but is a reasonably accurate spatial picture of current employment in Shasta County. For this travel model update, InfoUSA was used as the initial source for 2004 base year employment, with considerable additional consultant effort to fill in and correct the employment information.

Selected Projection Source

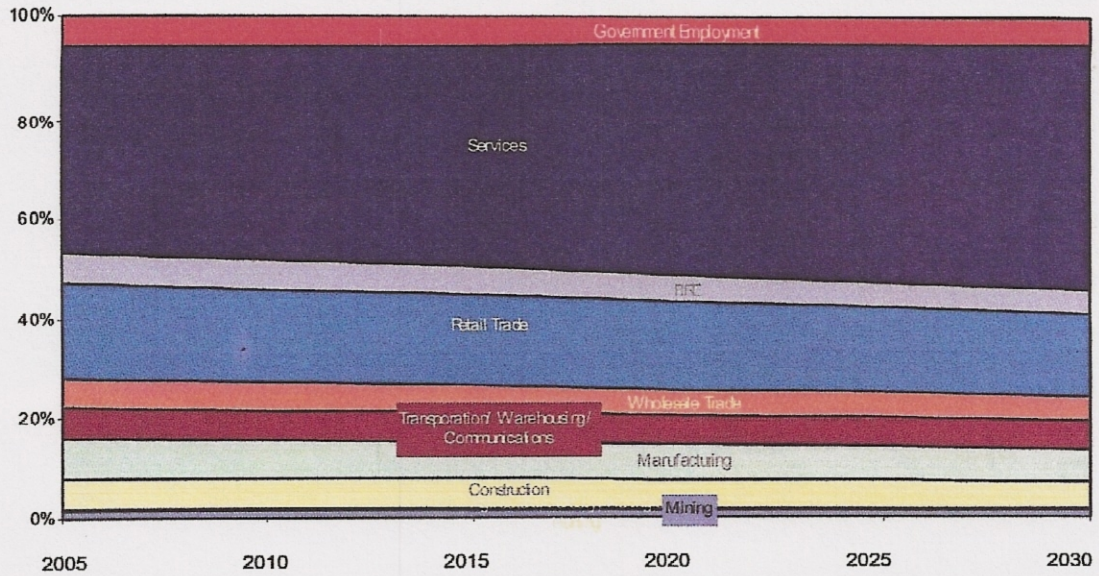
Woods & Poole was used as the projection source because it provides five year increments of employment by sector at the County level, and was determined to be the most comprehensive source of job estimates for the governmental sector and for domestic workers.

Employment Sectors

Figure 2 shows how the employment sectors are projected to shift over time within Shasta County. As anticipated in the previous 2000 EPS Projection, the Services sector is anticipated to become a larger share of total jobs in the County, while Manufacturing and Wholesale Trade become a declining share of total jobs. All sectors are anticipated to increase their total absolute number of jobs.

The 2000 EPS projection anticipated that retail jobs would increase proportionally with residential population growth. This assumption was retained for this employment forecast. The Woods & Poole projections had retail employment increasing by 21 percent between 2005 and 2030, while overall employment would grow by 37 percent. This compares to an assumed housing growth of 48 percent during the same period. For this forecast, retail employment was adjusted to increase by 45 percent, with an overall employment increase of 49 percent between 2005 and 2030.

Figure 2: Shift in Sectors as a Percent of Total Employment, Shasta County 2005-2030



Subarea Allocation

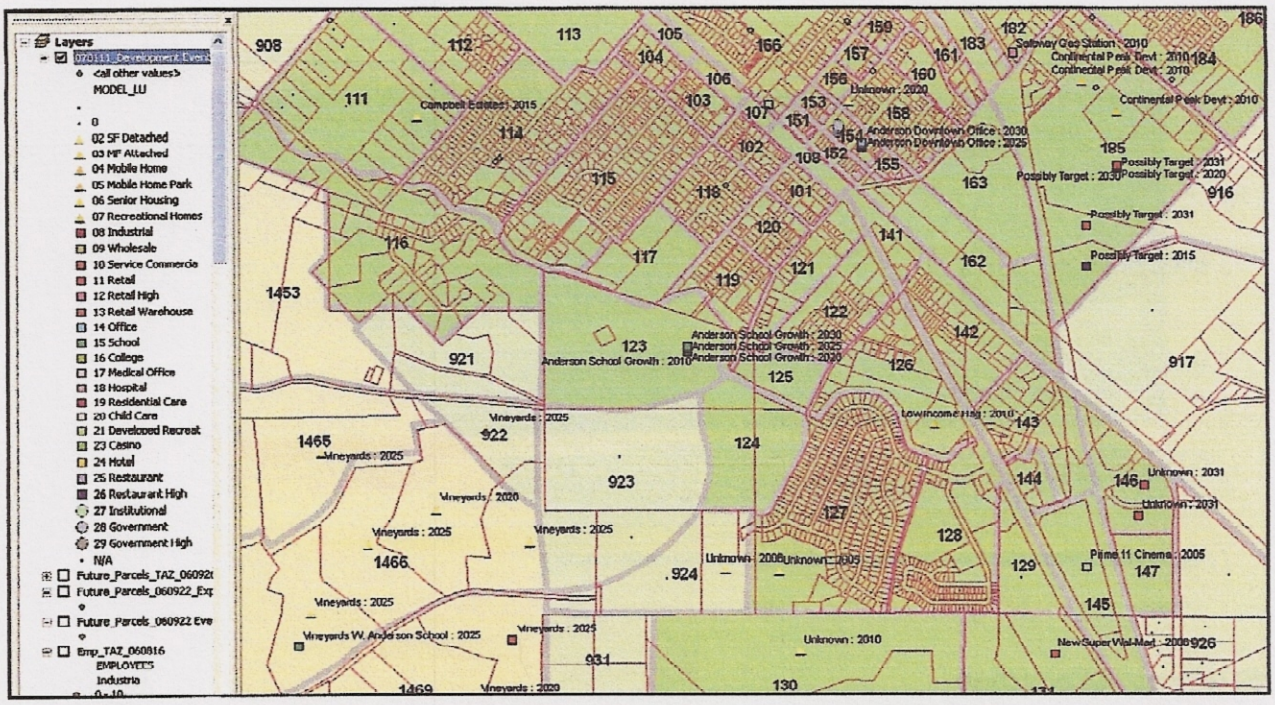
Employment growth was allocated to the Cities and unincorporated county using a proportional formula. In this estimate, Cities maintain their current share of jobs in each of the given sectors. It is expected that land capacity limitations in Anderson and Cottonwood, as well as anticipated large scale development projects such as Oasis Road and Stillwater Business Park will shift a larger share of the projected job growth to Redding, and possibly to Shasta Lake, while Anderson's share of growth decreases. This shift would be most likely to occur in the Manufacturing, Warehousing, and Transportation/ Communications sectors.

Geographic Allocation

Future land uses were allocated to individual parcels and aggregated to the transportation analysis zones (TAZs) used in the Shasta County travel model. A geographic information systems (GIS) process was used to track the various development assumptions (Figure 3).

The initial geographic allocations were based on the pipeline development projects and expected development years provided by each of the jurisdictions. Several major projects, such as Vineyards, provided detailed phasing expectations for residential and non-residential land uses.

Figure 3: Example GIS Land Use Allocation



Locations for additional development beyond pipeline development were assumed based primarily on proximity to other similar development. The City of Redding provided extensive information on zoning and expected likelihood of development for each vacant parcel. In other areas, residential development was assumed to occur near recent development activity (based on 2000 to 2004 building permit data), while non-residential development was assumed to occur near similar existing non-residential uses.

Employment in health services, education and government was projected to grow, but specific development areas were not identified for these uses (with the exception of several new school sites). Therefore, most of the growth in these sectors were assumed to occur in the vicinity of existing concentrations of employment, such as existing medical centers, government offices and school administration sites.

Phased Development Projects

The development years for major projects provided by jurisidictions were adjusted in order to fit within the overall Shasta County growth projections (Table 4). In particular, several development areas are not projected to be fully built out by 2030.

Model Land Use Inputs

Summaries of the final land use totals used in the Shasta County travel model for each five year increment are attached (Table 5) These totals may not exactly match the residential and employment projections targets, as they are based on specific developments and parcels, and were not "smoothed out" to precisely match the control totals.

Table 4: Shasta County Development Phasing Assumptions

Development	Land Use	Units	2005	2010	2015	2020	2025	2030	After 2030	TOTAL	Percent by 2030
Anderson Potential Target Site	Retail	SF	0	0	0	130,000	0	130,000	66,000	326,000	80%
	Fast Food	SF	0	0	2,500	0	0	2,500	0	5,000	100%
City of Redding (7251 Eastside)	Industrial	SF	0	0	0	198,000	0	298,000	496,000	992,000	50%
Clover Creek (3901 Airport)	Office	SF	0	0	72,700	0	0	0	0	72,700	100%
	Retail	SF	0	0	0	72,700	0	0	0	72,700	100%
Cobblestone Business Park	Office	SF	0	187,000	0	0	0	0	0	187,000	100%
Lasata	MF Attached	DU	0	0	150	151	0	0	0	301	100%
Manor Crest (Cottonwood Hills)	SF Detached	DU	0	64	64	0	0	0	0	128	100%
McConnell Land (350 Old Oregon)	SF Detached	DU	0	0	223	1,165	0	0	0	1,388	100%
Mountain Gate Meadows	SF Detached	DU	0	0	0	0	250	500	250	1,000	75%
	MF Attached	DU	0	0	0	250	250	0	0	500	100%
	Service Commercial	SF	0	0	0	100,000	0	0	0	100,000	100%
North Fork	SF Detached	DU	0	47	47	460	314	532	0	1,400	100%
	Retail	SF	0	0	0	0	180,000	290,000	472,000	942,000	50%
	Office	SF	0	0	0	145,000	0	0	0	145,000	100%
	Equestrian Center	Emps	0	0	0	0	10	0	0	10	100%
Oak Ranch Estates	SF Detached	DU	0	66	66	0	0	0	0	132	100%
Oasis Road Specific Plan	SF 1-5 DU/Acre	DU	0	0	6	3	3	0	0	12	100%
	SF 2-3.5 DU/Acre	DU	0	0	16	0	16	0	0	32	100%
	SF 6-10 DU/Acre	DU	0	0	30	30	0	0	0	60	100%
	MF 15 DU/Acre	DU	0	0	593	296	296	0	0	1,185	100%
	MF 18 DU/Acre	DU	0	0	448	280	168	0	0	896	100%
	Regional Commercial	SF	0	188,500	188,500	188,500	377,000	0	1,342,222	2,284,722	41%
	General Commercial	SF	0	0	143,500	143,500	0	143,500	143,500	574,000	75%
	Shopping Center	SF	0	0	0	0	0	113,500	113,500	227,000	50%
	General Office	SF	0	0	0	0	19,800	0	0	19,800	100%
	Limited Office	SF	0	0	13,100	0	0	0	0	13,100	100%
Palo Cedro Silverbridge Oaks	SF Detached	DU	0	0	0	100	200	0	0	300	100%
Palomar Davis Ridge	SF Detached	DU	0	197	197	0	0	0	0	394	100%
	MF Attached	DU	0	56	0	0	0	0	0	56	100%
Park Marina Drive Specific Plan	SF Detached	DU	0	22	0	0	0	0	0	22	100%
	MF Attached	DU	0	0	99	14	10	0	0	123	100%
	Retail	SF	0	0	50,000	39,200	42,500	55,500	0	187,200	100%
	Office	SF	0	0	0	0	42,500	0	0	42,500	100%
	Hotel	SF	0	0	0	55,500	42,500	0	0	98,000	100%
Shasta Gateway Industrial Park	Industrial	SF	0	49,000	49,000	94,000	94,000	94,000	1,590,000	1,970,000	19%
	Office	SF	0	24,500	24,500	24,500	24,500	0	0	98,000	100%
Shastina Ranch	SF Detached	DU	0	328	0	94	0	0	0	422	100%
	School	Emps	0	0	50	0	0	0	0	50	100%
Shingletown Sierra Pacific	SF Detached	DU	0	66	66	0	0	0	0	132	100%

Table 4 (continued): Shasta County Development Phasing Assumptions

Development	Land Use	Units	2005	2010	2015	2020	2025	2030	After 2030	TOTAL	Percent by 2030
Stillwater Business Park	Industrial	SF	0	0	0	224,000	224,000	199,000	3,554,000	4,201,000	15%
	Office	SF	0	0	205,200	563,900	223,600	593,900	510,900	2,097,500	76%
VA Home Property (Knighton)	Industrial	SF	0	365,000	138,000	0	0	132,000	0	635,000	100%
	Office	SF	0	191,800	127,900	0	179,100	0	0	498,800	100%
Vineyards	SF Detached	DU	0	682	422	1,166	1,029	666	330	4,295	92%
	MF Attached	DU	0	0	640	0	287	287	0	1,214	100%
	Retail	SF	0	20,000	0	50,000	20,000	50,000	0	140,000	100%
	Office	SF	0	0	50,000	50,000	0	0	0	100,000	100%
	School	Emps	0	0	0	50	50	0	0	100	100%
Woodridge Lake	Retail	SF	0	0	30,000	30,000	0	0	0	60,000	100%

Table 5: Shasta Model Land Use Inputs

2004 Land Use Summary

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	9,065	3,738	3,737	886	1,220	410	846	3,363
Redding	81,136	33,886	33,848	10,862	22,065	7,492	7,718	48,138
Shasta Lake	9,016	3,711	3,706	493	678	576	577	2,324
Subtotal Incorporated	**99,217**	**41,335**	**41,290**	**12,242**	**23,963**	**8,479**	**9,141**	**53,825**
Unincorporated								
Anderson Sphere	1,841	759	758	297	173	73	867	1,410
Redding Sphere	10,120	3,994	3,987	287	1,640	577	1,438	3,941
Cottonwood	3,479	1,323	1,322	278	297	341	302	1,219
Rural North Central (Big Bend, Montgomery Creek)	293	143	141	12	5	20	0	37
Rural East (Burney, Fall River, McArthur, Cassel)	5,240	2,183	2,166	484	977	387	443	2,291
Rural Shingletown	1,263	628	607	87	88	53	34	262
Rural Vineyards	39	15	15	0	0	0	0	0
Rural Other	41,760	17,371	17,101	765	2,474	1,217	1,868	6,323
Subtotal Unincorporated	**64,035**	**26,416**	**26,097**	**2,209**	**5,653**	**2,668**	**4,953**	**15,483**
TOTAL	**163,252**	**67,751**	**67,388**	**14,451**	**29,616**	**11,147**	**14,094**	**69,308**

Table 5 (continued): Shasta Model Land Use Inputs

Increment 2004 to 2005

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	262	125	125	0	10	0	0	10
Redding	1,602	583	583	268	43	0	0	311
Shasta Lake	131	69	69	0	0	0	0	0
Subtotal Incorporated	**1,996**	**777**	**777**	**268**	**53**	**0**	**0**	**321**
Unincorporated								
Anderson Sphere	0	0	0	0	0	0	0	0
Redding Sphere	27	0	0	0	0	0	0	0
Cottonwood	10	0	0	0	0	0	0	0
Rural North Central (Big Bend, Montgomery Creek)	0	0	0	0	0	0	0	0
Rural East (Burney, Fall River, McArthur, Cassel)	0	0	0	0	0	0	0	0
Rural Shingletown	0	0	0	0	0	0	0	0
Rural Vineyards	0	0	0	0	0	0	0	0
Rural Other	146	60	60	0	0	0	0	0
Subtotal Unincorporated	**182**	**60**	**60**	**0**	**0**	**0**	**0**	**0**
TOTAL	**2,178**	**837**	**837**	**268**	**53**	**0**	**0**	**321**

2005 Land Use Summary

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	9,327	3,863	3,862	886	1,230	410	846	3,373
Redding	82,738	34,469	34,430	11,130	22,108	7,492	7,718	48,449
Shasta Lake	9,147	3,780	3,775	493	678	576	577	2,324
Subtotal Incorporated	**101,213**	**42,112**	**42,067**	**12,510**	**24,016**	**8,479**	**9,141**	**54,146**
Unincorporated								
Anderson Sphere	1,841	759	758	297	173	73	867	1,410
Redding Sphere	10,147	3,994	3,987	287	1,640	577	1,438	3,941
Cottonwood	3,489	1,323	1,322	278	297	341	302	1,219
Rural North Central (Big Bend, Montgomery Creek)	293	143	141	12	5	20	0	37
Rural East (Burney, Fall River, McArthur, Cassel)	5,240	2,183	2,166	484	977	387	443	2,291
Rural Shingletown	1,263	628	607	87	88	53	34	262
Rural Vineyards	39	15	15	0	0	0	0	0
Rural Other	41,906	17,431	17,161	765	2,474	1,217	1,868	6,323
Subtotal Unincorporated	**64,217**	**26,476**	**26,157**	**2,209**	**5,653**	**2,668**	**4,953**	**15,483**
TOTAL	**165,430**	**68,588**	**68,224**	**14,719**	**29,669**	**11,147**	**14,094**	**69,629**

Table 5 (continued): Shasta Model Land Use Inputs

Increment 2005 to 2010

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	2,701	1,328	1,328	354	160	37	103	655
Redding	11,713	4,701	4,701	617	2,954	477	629	4,677
Shasta Lake	1,210	504	504	80	80	37	53	250
Subtotal Incorporated	**15,624**	**6,534**	**6,534**	**1,051**	**3,194**	**551**	**786**	**5,582**
Unincorporated								
Anderson Sphere	28	14	14	0	0	0	0	0
Redding Sphere	49	22	22	0	29	61	0	90
Cottonwood	367	130	130	20	7	43	0	70
Rural North Central (Big Bend, Montgomery Creek)	29	13	13	0	0	0	0	0
Rural East (Burney, Fall River, McArthur, Cassel)	52	32	32	28	202	27	23	280
Rural Shingletown	143	66	66	9	22	0	9	40
Rural Vineyards	0	0	0	0	0	0	0	0
Rural Other	350	142	142	119	84	79	45	326
Subtotal Unincorporated	**1,017**	**419**	**419**	**177**	**343**	**210**	**76**	**806**
TOTAL	**16,641**	**6,953**	**6,953**	**1,228**	**3,537**	**761**	**862**	**6,388**

2010 Land Use Summary

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	12,028	5,192	5,191	1,241	1,390	448	950	4,028
Redding	94,451	39,170	39,132	11,747	25,062	7,969	8,348	53,126
Shasta Lake	10,358	4,284	4,279	573	758	613	630	2,574
Subtotal Incorporated	**116,837**	**48,646**	**48,601**	**13,561**	**27,210**	**9,030**	**9,927**	**59,728**
Unincorporated								
Anderson Sphere	1,869	773	772	297	173	73	867	1,410
Redding Sphere	10,196	4,016	4,009	287	1,668	638	1,438	4,031
Cottonwood	3,856	1,453	1,452	298	304	384	302	1,289
Rural North Central (Big Bend, Montgomery Creek)	322	156	154	12	5	20	0	37
Rural East (Burney, Fall River, McArthur, Cassel)	5,292	2,215	2,198	512	1,179	414	466	2,571
Rural Shingletown	1,406	694	673	97	109	53	43	302
Rural Vineyards	39	15	15	0	0	0	0	0
Rural Other	42,256	17,573	17,303	884	2,557	1,296	1,912	6,649
Subtotal Unincorporated	**65,235**	**26,895**	**26,576**	**2,385**	**5,996**	**2,879**	**5,029**	**16,289**
TOTAL	**182,071**	**75,541**	**75,177**	**15,946**	**33,206**	**11,908**	**14,956**	**76,017**

Table 5 (continued): Shasta Model Land Use Inputs

Increment 2010 to 2015

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	983	472	472	120	114	37	57	328
Redding	10,645	3,994	3,994	952	1,966	449	467	3,834
Shasta Lake	1,372	500	500	0	104	37	53	194
Subtotal Incorporated	**13,000**	**4,966**	**4,966**	**1,072**	**2,184**	**523**	**577**	**4,356**
Unincorporated								
Anderson Sphere	238	89	89	0	0	0	0	0
Redding Sphere	138	56	56	0	711	53	36	800
Cottonwood	608	230	230	0	191	27	10	228
Rural North Central (Big Bend, Montgomery Creek)	0	0	0	0	0	0	0	0
Rural East (Burney, Fall River, McArthur, Cassel)	0	0	0	28	162	27	23	240
Rural Shingletown	143	66	66	63	78	0	9	150
Rural Vineyards	2,151	842	842	0	157	0	8	165
Rural Other	525	232	232	3	102	53	71	230
Subtotal Unincorporated	**3,804**	**1,515**	**1,515**	**95**	**1,400**	**160**	**157**	**1,813**
TOTAL	**16,804**	**6,481**	**6,481**	**1,167**	**3,584**	**684**	**734**	**6,169**

2015 Land Use Summary

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	13,012	5,664	5,663	1,360	1,504	485	1,007	4,356
Redding	105,095	43,164	43,125	12,699	27,029	8,418	8,814	56,960
Shasta Lake	11,730	4,784	4,779	573	861	651	683	2,768
Subtotal Incorporated	**129,837**	**53,612**	**53,567**	**14,633**	**29,394**	**9,553**	**10,504**	**64,084**
Unincorporated								
Anderson Sphere	2,107	862	861	297	173	73	867	1,410
Redding Sphere	10,334	4,072	4,065	287	2,380	691	1,474	4,831
Cottonwood	4,464	1,683	1,682	298	495	412	312	1,517
Rural North Central (Big Bend, Montgomery Creek)	322	156	154	12	5	20	0	37
Rural East (Burney, Fall River, McArthur, Cassel)	5,292	2,215	2,198	540	1,341	441	489	2,811
Rural Shingletown	1,549	760	739	160	187	53	52	452
Rural Vineyards	2,190	857	857	0	157	0	8	165
Rural Other	42,781	17,805	17,534	887	2,659	1,349	1,983	6,879
Subtotal Unincorporated	**69,038**	**28,410**	**28,091**	**2,480**	**7,397**	**3,039**	**5,186**	**18,102**
TOTAL	**198,875**	**82,022**	**81,658**	**17,113**	**36,790**	**12,592**	**15,690**	**82,185**

Table 5 (continued): Shasta Model Land Use Inputs

Increment 2015 to 2020

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	164	80	80	265	118	20	69	472
Redding	8,339	3,480	3,480	827	887	449	24	2,187
Shasta Lake	1,266	490	490	12	136	37	140	324
Subtotal Incorporated	**9,768**	**4,050**	**4,050**	**1,104**	**1,141**	**506**	**232**	**2,983**
Unincorporated								
Anderson Sphere	55	28	28	0	456	0	24	480
Redding Sphere	486	211	211	0	1,797	61	317	2,175
Cottonwood	878	300	300	0	3	27	0	30
Rural North Central (Big Bend, Montgomery Creek)	107	50	50	0	0	0	0	0
Rural East (Burney, Fall River, McArthur, Cassel)	241	100	100	28	162	27	23	240
Rural Shingletown	462	240	240	54	27	0	9	90
Rural Vineyards	2,916	1,166	1,166	90	174	43	8	315
Rural Other	945	352	352	6	173	70	122	371
Subtotal Unincorporated	**6,090**	**2,447**	**2,447**	**178**	**2,790**	**229**	**503**	**3,701**
TOTAL	**15,859**	**6,497**	**6,497**	**1,282**	**3,931**	**735**	**735**	**6,684**

2020 Land Use Summary

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	13,176	5,744	5,743	1,625	1,622	505	1,076	4,828
Redding	113,434	46,644	46,605	13,526	27,916	8,867	8,838	59,147
Shasta Lake	12,995	5,274	5,269	585	997	688	822	3,092
Subtotal Incorporated	**139,605**	**57,662**	**57,617**	**15,737**	**30,535**	**10,059**	**10,736**	**67,067**
Unincorporated								
Anderson Sphere	2,162	890	889	297	629	73	891	1,890
Redding Sphere	10,820	4,283	4,277	287	4,176	752	1,791	7,006
Cottonwood	5,342	1,983	1,982	298	498	439	312	1,547
Rural North Central (Big Bend, Montgomery Creek)	429	206	204	12	5	20	0	37
Rural East (Burney, Fall River, McArthur, Cassel)	5,533	2,315	2,298	568	1,502	468	512	3,051
Rural Shingletown	2,011	1,000	979	215	214	53	61	542
Rural Vineyards	5,106	2,023	2,023	90	331	43	17	480
Rural Other	43,726	18,156	17,886	893	2,832	1,419	2,106	7,250
Subtotal Unincorporated	**75,129**	**30,857**	**30,538**	**2,658**	**10,187**	**3,268**	**5,689**	**21,802**
TOTAL	**214,734**	**88,518**	**88,155**	**18,395**	**40,722**	**13,327**	**16,425**	**88,869**

Table 5 (continued): Shasta Model Land Use Inputs

Increment 2020 to 2025

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	0	0	0	176	21	37	3	236
Redding	6,293	3,006	3,006	1,059	3,170	459	427	5,114
Shasta Lake	1,302	500	500	0	80	37	98	214
Subtotal Incorporated	**7,595**	**3,506**	**3,506**	**1,235**	**3,270**	**533**	**527**	**5,565**
Unincorporated								
Anderson Sphere	359	140	140	0	0	0	0	0
Redding Sphere	616	249	249	0	730	61	261	1,052
Cottonwood	819	340	340	0	3	27	0	30
Rural North Central (Big Bend, Montgomery Creek)	76	50	50	0	0	0	0	0
Rural East (Burney, Fall River, McArthur, Cassel)	298	140	140	28	162	27	23	240
Rural Shingletown	530	240	240	9	22	0	9	40
Rural Vineyards	2,023	778	778	36	4	0	0	40
Rural Other	3,180	1,072	1,072	81	37	122	0	240
Subtotal Unincorporated	**7,902**	**3,009**	**3,009**	**155**	**958**	**238**	**293**	**1,642**
TOTAL	**15,497**	**6,515**	**6,515**	**1,390**	**4,227**	**771**	**819**	**7,208**

2025 Land Use Summary

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	13,176	5,744	5,743	1,801	1,643	542	1,078	5,064
Redding	119,727	49,650	49,611	14,586	31,085	9,326	9,264	64,261
Shasta Lake	14,298	5,774	5,769	585	1,077	725	920	3,307
Subtotal Incorporated	**147,200**	**61,167**	**61,123**	**16,972**	**33,805**	**10,593**	**11,263**	**72,632**
Unincorporated								
Anderson Sphere	2,522	1,030	1,029	297	629	73	891	1,890
Redding Sphere	11,436	4,533	4,526	287	4,907	813	2,051	8,058
Cottonwood	6,161	2,323	2,322	298	501	466	312	1,577
Rural North Central (Big Bend, Montgomery Creek)	505	256	254	12	5	20	0	37
Rural East (Burney, Fall River, McArthur, Cassel)	5,831	2,455	2,438	596	1,664	495	535	3,291
Rural Shingletown	2,541	1,240	1,219	224	235	53	70	582
Rural Vineyards	7,129	2,801	2,801	126	335	43	17	520
Rural Other	46,905	19,228	18,958	974	2,869	1,541	2,106	7,490
Subtotal Unincorporated	**83,031**	**33,866**	**33,547**	**2,813**	**11,145**	**3,505**	**5,982**	**23,445**
TOTAL	**230,231**	**95,033**	**94,670**	**19,785**	**44,949**	**14,098**	**17,245**	**96,077**

Table 5 (continued): Shasta Model Land Use Inputs

Increment 2025 to 2030

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	0	0	0	658	72	37	2	769
Redding	5,946	2,461	2,461	594	2,399	555	412	3,961
Shasta Lake	1,205	500	500	0	3	37	94	134
Subtotal Incorporated	**7,151**	**2,961**	**2,961**	**1,252**	**2,474**	**629**	**507**	**4,863**
Unincorporated								
Anderson Sphere	1,047	467	467	131	15	0	0	145
Redding Sphere	1,524	606	606	0	1,890	61	297	2,249
Cottonwood	1,021	400	400	0	3	27	0	30
Rural North Central (Big Bend, Montgomery Creek)	165	80	80	0	0	0	0	0
Rural East (Burney, Fall River, McArthur, Cassel)	506	210	210	28	162	27	23	240
Rural Shingletown	684	360	360	9	22	0	9	40
Rural Vineyards	2,477	953	953	90	10	0	0	100
Rural Other	1,098	439	439	0	11	79	0	90
Subtotal Unincorporated	**8,522**	**3,514**	**3,514**	**258**	**2,112**	**195**	**329**	**2,894**
TOTAL	**15,673**	**6,475**	**6,475**	**1,511**	**4,586**	**824**	**836**	**7,757**

2030 Land Use Summary

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	13,176	5,744	5,743	2,459	1,715	579	1,080	5,833
Redding	125,673	52,111	52,072	15,180	33,485	9,881	9,677	68,222
Shasta Lake	15,502	6,274	6,269	585	1,079	762	1,014	3,440
Subtotal Incorporated	**154,351**	**64,129**	**64,084**	**18,224**	**36,279**	**11,222**	**11,770**	**77,495**
Unincorporated								
Anderson Sphere	3,569	1,498	1,496	427	644	73	891	2,035
Redding Sphere	12,960	5,138	5,132	287	6,797	875	2,348	10,307
Cottonwood	7,181	2,723	2,722	298	504	493	312	1,607
Rural North Central (Big Bend, Montgomery Creek)	670	336	334	12	5	20	0	37
Rural East (Burney, Fall River, McArthur, Cassel)	6,337	2,665	2,648	624	1,826	523	558	3,531
Rural Shingletown	3,225	1,600	1,579	233	257	53	78	622
Rural Vineyards	9,606	3,754	3,754	216	345	43	17	620
Rural Other	48,004	19,666	19,396	974	2,881	1,620	2,106	7,580
Subtotal Unincorporated	**91,553**	**37,380**	**37,061**	**3,071**	**13,257**	**3,700**	**6,311**	**26,339**
TOTAL	**245,904**	**101,508**	**101,145**	**21,296**	**49,536**	**14,922**	**18,081**	**103,834**

Table 5 (continued): Shasta Model Land Use Inputs

Increment 2005 to 2030

Area	Population	Housing Units	Occupied Units	Employment				
				Retail	Service	Government	Other	TOTAL
Incorporated								
Anderson	3,848	1,880	1,880	1,573	485	169	233	2,460
Redding	42,936	17,642	17,642	4,050	11,377	2,388	1,958	19,774
Shasta Lake	6,355	2,494	2,494	92	401	186	437	1,116
Subtotal Incorporated	**53,139**	**22,017**	**22,017**	**5,714**	**12,263**	**2,743**	**2,629**	**23,349**
Unincorporated								
Anderson Sphere	1,728	739	739	131	470	0	24	625
Redding Sphere	2,814	1,144	1,144	0	5,157	298	910	6,366
Cottonwood	3,693	1,400	1,400	20	206	152	10	388
Rural North Central (Big Bend, Montgomery Creek)	377	193	193	0	0	0	0	0
Rural East (Burney, Fall River, McArthur, Cassel)	1,097	482	482	140	849	136	115	1,240
Rural Shingletown	1,962	972	972	146	170	0	45	360
Rural Vineyards	9,567	3,739	3,739	216	345	43	17	620
Rural Other	6,098	2,235	2,235	210	407	403	238	1,257
Subtotal Unincorporated	**27,335**	**10,904**	**10,904**	**863**	**7,604**	**1,031**	**1,358**	**10,856**
TOTAL	**80,474**	**32,920**	**32,920**	**6,577**	**19,867**	**3,775**	**3,987**	**34,205**

Attachment 3

SHASTA COUNTY TRAVEL DEMAND FORECASTING MODEL MEETINGS:

NUMBER	MEETING	DATE
1.	Steering Committee Model Update Kickoff Meeting	October 8, 2003
2.	Steering Committee Winter Meeting - Initial Requirements	January 9, 2004
3.	SMUG - RFQ coordination and requirements document	March 29, 2004
4.	Travel Model Kickoff Meeting - Schedule/data collection	January 12, 2005
5.	SMUG - Road Network Classification and TAZ revisions	March 29, 2005
6.	SMUG Preliminary Projections and Land Use Allocation Meeting	June 22, 2005
7.	SMUG Preliminary Projections and Land Use Allocation Meeting	June 23, 2005
8.	SMUG - Data Inventory Pipeline Project ID	August 18, 2005
9.	SMUG Projection and Land Use Allocation Meeting #2	September 14, 2005
10.	SMUG Projection and Land Use Allocation Meeting #3&4	September 15, 2005
11.	SMUG Projection and Land Use Allocation Meeting #3	October 20, 2005
12.	SMUG - Base Year validation review	November 10, 2005
13.	SMUG - Project Status - Base Year and data verifications	March 21, 2006
14.	SMUG - Calibration phase one	July 12, 2006
15.	SMUG - Calibration phase two	August 21, 2006
16.	Training - Model Documentation review	September 25/26, 2006
17.	Traffic Model - Output Review, validation and calibration results	November 21, 2006
18.	Forecast Assumptions Agreement by SMUG	January 23, 2007

Attachment 3

Attachment 3-1 Shasta Model User Group (SMUG)		
Name	**Agency**	**Position**
Thomas Hays *	RTPA	Senior Planner
Scott White *	Caltrans	Chief Office of District Planning
Kim Hanagan *	Caltrans	PE System Planning
John Stokes *	City of Anderson	Planning Director
John Abshier *	City of Redding	Traffic Engineer
Kent Manuel	City of Redding	Senior Planner
Jim Coats	City of Redding	GIS Manager
Carla Thompson *	City of Shasta Lake	Development Service Director
Zack Bonnin	County of Shasta	Senior Planner
Dan Little	RTPA	Executive Director
Doug DeMallie	City of Redding	Planning Manager
Al Cathey	County of Shasta	Traffic Engineer
Dennis Daily	City of Shasta Lake	Traffic Engineer
Wayne Gungl	City of Redding	Permit Center Manager
Rich Barchus	City of Anderson	Public Works Director
Kevin Kidd	City of Anderson	Deputy Public Works Director
Dan Kovacich	RTPA	Executive Director
Consultant Support		
Mike Aronson	Dowling Associates Inc	Project Manager
Dena Blazer	Strategic Economics	Project Manger – Land Use
Abby Thorne-Lyman	Strategic Economics	Associate – Land Use
Mark Teague	Pacific Municipal Corp	Planner
Kamesh Vedula	Omni-Means	Traffic Modeler/Engineer
Marcella Nankervis	WILLDAN	Traffic Engineer – City of Shasta Lake

* = Core Group Member

In addition to the 18 consultant lead meetings, approximately 30 meetings were held one on one with jurisdictional subject matter experts to confirm the accuracy and appropriateness of the information provided to the project team.

City of Redding Growth Forecast by ITRON Inc.

CITY OF REDDING
POPULATION FORECAST
2015 FORECAST

Year	Base	High	Low
1982	45,059	45,059	45,059
1983	46,758	46,758	46,758
1984	48,502	48,502	48,502
1985	50,385	50,385	50,385
1986	52,641	52,641	52,641
1987	55,307	55,307	55,307
1988	58,650	58,650	58,650
1989	62,555	62,555	62,555
1990	66,950	66,950	66,950
1991	70,700	70,700	70,700
1992	73,350	73,350	73,350
1993	75,300	75,300	75,300
1994	76,450	76,450	76,450
1995	77,350	77,350	77,350
1996	78,150	78,150	78,150
1997	78,950	78,950	78,950
1998	79,650	79,650	79,650
1999	80,383	80,383	80,383
2000	81,742	81,742	81,742
2001	83,525	83,525	83,525
2002	84,990	84,990	84,990
2003	86,010	86,010	86,010
2004	86,811	86,811	86,811
2005	87,407	87,407	87,407
2006	88,003	88,003	88,003
2007	88,621	88,621	88,621
2008	89,121	89,121	89,121
2009	89,583	89,583	89,583
2010	89,861	89,861	89,861
2011	90,196	90,196	90,196
2012	90,848	90,848	90,848
2013	91,207	91,207	91,207
2014	91,471	91,498	91,429
2015	91,725	91,780	91,642
2016	91,996	92,090	91,855
2017	92,282	92,427	92,064
2018	92,577	92,785	92,265
2019	92,881	93,164	92,456
2020	93,194	93,565	92,639
2021	93,516	93,988	92,811
2022	93,846	94,432	92,974
2023	94,186	94,900	93,127
2024	94,536	95,391	93,271
2025	94,897	95,907	93,406
2026	95,270	96,450	93,534
2027	95,656	97,020	93,655
2028	96,056	97,621	93,770
2029	96,472	98,252	93,880
2030	96,906	98,918	93,988

CITY OF REDDING
POPULATION FORECAST
2015 FORECAST
Percent Change

Year	Base Case	High Growth	Low Growth
1982	6.69	6.69	6.69
1983	3.77	3.77	3.77
1984	3.73	3.73	3.73
1985	3.88	3.88	3.88
1986	4.48	4.48	4.48
1987	5.07	5.07	5.07
1988	6.04	6.04	6.04
1989	6.66	6.66	6.66
1990	7.03	7.03	7.03
1991	5.6	5.6	5.6
1992	3.75	3.75	3.75
1993	2.66	2.66	2.66
1994	1.53	1.53	1.53
1995	1.18	1.18	1.18
1996	1.03	1.03	1.03
1997	1.02	1.02	1.02
1998	0.89	0.89	0.89
1999	1.13	1.13	1.13
2000	1.69	1.69	1.69
2001	2.18	2.18	2.18
2002	1.75	1.75	1.75
2003	1.2	1.2	1.2
2004	0.93	0.93	0.93
2005	0.69	0.69	0.69
2006	0.68	0.68	0.68
2007	0.7	0.7	0.7
2008	0.56	0.56	0.56
2009	0.52	0.52	0.52
2010	0.31	0.31	0.31
2011	0.37	0.37	0.37
2012	0.72	0.72	0.72
2013	0.4	0.4	0.4
2014	0.29	0.32	0.24
2015	0.29	0.32	0.24
2016	0.28	0.31	0.23
2017	0.3	0.34	0.23
2018	0.31	0.37	0.23
2019	0.32	0.39	0.22
2020	0.33	0.41	0.21
2021	0.34	0.43	0.2
2022	0.35	0.45	0.19
2023	0.35	0.47	0.18
2024	0.36	0.5	0.16
2025	0.37	0.52	0.15
2026	0.38	0.54	0.15
2027	0.39	0.57	0.14
2028	0.41	0.59	0.13
2029	0.42	0.62	0.12
2030	0.43	0.65	0.12

APPENDIX E

Cost Estimates

Water Utility Master Plan 2012

CITY OF REDDING

2011 WATER MASTER PLAN
PROJECT COST ANALYSYS

TECHNICAL MEMORANDUM

JANUARY 24, 2012

PREPARED BY:

WILLDAN ENGINEERING
2400 WASHINGTON AVE
SUITE 101
REDDING, CA 96001

The technical memorandum contained herein has been prepared by or under the direction of the following Registered Persons.

REGISTERED CIVIL ENGINEER

January 24, 2012

CITY OF REDDING
2011 WATER MASTER PLAN UPDATE

PROJECT COST ANALYSIS
TECHNICAL MEMORANDUM

INTRODUCTION

This Technical Memorandum presents the project cost analysis summary of the 2011 Water Master Plan projects prepared by Willdan Engineering. Willdan Engineering (Willdan) was retained by the City of Redding to assist in the development of planning level project cost estimates for the various projects proposed in the City's latest Water Master Plan update.

To better define the scope of some of the projects, Willdan met with City staff on site at Enterprise Well No. 23 to discuss the individual projects and see samples of many of the system upgrades being proposed. Willdan also obtained current bid specifications of the preferred system upgrades to better evaluate the costs associated with these projects and compare current market prices.

For each proposed project, cost estimates were developed to the detail appropriate for a conceptual level cost estimate to provide general planning information for project financing and funding discussions. The information presented here is based upon simple line item project descriptions and discussions with City staff and is not intended to be used for the purpose of specific project budgeting.

Line item unit prices were developed utilizing the most current unit costs from City of Redding projects supplemented with cost data from other local agency projects when City of Redding data was unavailable. Simple percentages were used to estimate the costs of preliminary engineering and construction management for each individual project. Where project estimates were available from earlier studies, Willdan applied ENR cost indexes to the previous estimates to update them to current 2011 values. All project costs developed are in 2011 dollars and include a 20 percent contingency fund.

The costs that were developed in this Study should be considered as order-of-magnitude costs for budgeting purposes only. As projects definitions are refined, the project costs should be updated based upon the latest project understanding and scope.

CONCLUSIONS

The cost analyses for the proposed 2011 Water Master Plan projects are included in the attached appendix.

RECOMMENDATIONS

The cost estimates provided in this technical memorandum were based upon discussions with City staff to refine the scope of each project to the greatest extent possible and are accurate as of the date of this memorandum. Due to the current volatility and instability in the construction trades, as further analyses are performed and the project descriptions are further refined, these project costs should be revisited and reevaluated.

APPENDIX

PROJECT COSTS

Well and Pump Station Projects

Project Number	Project Description	Const Cost with 20% Contingency	Year of Estimate	2011 Const Cost	Design Cost	CM Cost	2011 Total Cost	Rounded 2011 Total Cost
PS1-01	Communications with Foothill Water Treatment Plant	$24,000	2011	$24,000	$3,600	$3,600	$31,200	**$32,000**
PS1-02	No Backup Power	$180,000	2011	$180,000	$27,000	$27,000	$234,000	**$234,000**
PS1-03	Improve lighting in PS1 expansion structure	$3,600	2011	$3,600	$540	$540	$4,680	**$5,000**
PS1-04	Fence needs Repair	$14,256	2006	$15,040	$2,256	$2,256	$19,553	**$20,000**
PS1-05	Fish Screen Improvements	$2,400,000	2005	$2,618,852	$392,828	$392,828	$3,404,507	**$3,405,000**
PS3-01	Roof deck rotted at swamp cooler	$16,200	2011	$16,200	$2,430	$2,430	$21,060	**$22,000**
PS3-02	No exterior light	$2,500	2011	$2,500	$375	$375	$3,250	**$4,000**
PS3-03	Electrical to swamp cooler not weatherproof	$1,000	2011	$1,000	$150	$150	$1,300	**$2,000**
PS3-04	Interior lighting is inadequate	$1,900	2011	$1,900	$285	$285	$2,470	**$3,000**
PS3-05	Communications need updating from copper wire to fiber optic	$3,600	2011	$3,600	$540	$540	$4,680	**$5,000**
PS3-06	Controls need to be updated to current standards	$36,000	2011	$36,000	$5,400	$5,400	$46,800	**$47,000**
PS3-07	Swamp Cooler AC is not compatible with modern solid state controls or electrical equipment	$7,200	2011	$7,200	$1,080	$1,080	$9,360	**$10,000**
PS4-01	Communications are by copper wire and need to be converted to fiber optic	$3,600	2011	$3,600	$540	$540	$4,680	**$5,000**
PS4-02	Controls need to be updated to current standards	$36,000	2011	$36,000	$5,400	$5,400	$46,800	**$47,000**
PS4-03	Interior lighting is inadequate	$1,900	2011	$1,900	$285	$285	$2,470	**$3,000**
PS4-04	Swamp Cooler AC is not compatible with modern solid state controls or electrical equipment	$7,200	2011	$7,200	$1,080	$1,080	$9,360	**$10,000**
PS5-01	Swamp Cooler AC is not compatible with modern solid state controls or electrical equipment	$7,200	2011	$7,200	$1,080	$1,080	$9,360	**$10,000**
PH-1	Pump Station Relocation	$11,034,000	2002	$13,587,571	$2,038,136	$2,038,136	$17,663,842	**$17,664,000**

Project Number	Project Description	Const Cost with 20% Contingency	Year of Estimate	2011 Const Cost	Design Cost	CM Cost	2011 Total Cost	Rounded 2011 Total Cost
ELR-01	Roof Leaks	$16,200	2011	$16,200	$2,430	$2,430	$21,060	**$22,000**
ELR-02	Controls need to be updated to current standards	$36,000	2011	$36,000	$5,400	$5,400	$46,800	**$47,000**
ELR-03	Interior lighting is inadequate	$1,100	2011	$1,100	$165	$165	$1,430	**$2,000**
MHB-01	Service Drop is too low	$4,200	2011	$4,200	$630	$630	$5,460	**$6,000**
EW3-01	Roof leaks/dry rot at roof opening	$16,200	2011	$16,200	$2,430	$2,430	$21,060	**$22,000**
EW3-02	Improper working clearance at Master Control Cabinet.	$42,000	2011	$42,000	$6,300	$6,300	$54,600	**$55,000**
EW4-01	Controls need to be updated to current standards	$36,000	2011	$36,000	$5,400	$5,400	$46,800	**$47,000**
EW4-02	Improper working clearance at Master Control Cabinet.	$42,000	2011	$42,000	$6,300	$6,300	$54,600	**$55,000**
EW6-01	Improper bonding of pull section on left side of service main.	$0	2011	$0	$0	$0	$0	**$0**
EW6-02	Main Service needs replacing	$8,400	2011	$8,400	$1,260	$1,260	$10,920	**$11,000**
EW6-03	Need in use receptacle cover for outlets a pump and next to well	$600	2011	$600	$90	$90	$780	**$1,000**
EW6-04	Controls need to be updated to current standards	$36,000	2011	$36,000	$5,400	$5,400	$46,800	**$47,000**
EW6-05	Improper working clearance at Master Control Cabinet.	$42,000	2011	$42,000	$6,300	$6,300	$54,600	**$55,000**
EW7-01	Controls need to be updated to current standards	$36,000	2011	$36,000	$5,400	$5,400	$46,800	**$47,000**
EW7-02	Interior lighting is inadequate	$2,400	2011	$2,400	$360	$360	$3,120	**$4,000**
EW7-03	Inadequate working space at equipment	$48,000	2011	$48,000	$7,200	$7,200	$62,400	**$63,000**
EW8-01	Interior lighting is inadequate	$1,500	2011	$1,500	$225	$225	$1,950	**$2,000**
EW9-01	Excessive roof leak	$16,200	2011	$16,200	$2,430	$2,430	$21,060	**$22,000**
EW9-02	Interior lighting is inadequate	$1,800	2011	$1,800	$270	$270	$2,340	**$3,000**
EW10-01	Roof leaks	$13,500	2011	$13,500	$2,025	$2,025	$17,550	**$18,000**
EW10-02	Needs flow meter	$9,600	2011	$9,600	$1,440	$1,440	$12,480	**$13,000**
EW10-03	Interior lighting is inadequate	$1,800	2011	$1,800	$270	$270	$2,340	**$3,000**
EW11-01	Roof tiles are falling off	$16,200	2011	$16,200	$2,430	$2,430	$21,060	**$22,000**

Project Number	Project Description	Const Cost with 20% Contingency	Year of Estimate	2011 Const Cost	Design Cost	CM Cost	2011 Total Cost	Rounded 2011 Total Cost
EW11-02	Needs ventilation above motor	$4,200	2011	$4,200	$630	$630	$5,460	**$6,000**
EW11-03	Remove unused wiring or tie up or clean up wiring	$8,160	2011	$8,160	$1,224	$1,224	$10,608	**$11,000**
EW11-04	Communications need to be migrated from the Copper Tone Telemetry to Ethernet Radio	$19,200	2011	$19,200	$2,880	$2,880	$24,960	**$25,000**
EW11-05	Interior lighting is inadequate	$1,800	2011	$1,800	$270	$270	$2,340	**$3,000**
EW11-06	Master Control panel needs repairing or replacing.	$36,000	2011	$36,000	$5,400	$5,400	$46,800	**$47,000**
EW12-01	Needs ventilation above motor	$4,200	2011	$4,200	$630	$630	$5,460	**$6,000**
EW12-02	Needs exterior lighting at equipment	$3,000	2011	$3,000	$450	$450	$3,900	**$4,000**
EW12-03	Controls need to be updated to current standards	$36,000	2011	$36,000	$5,400	$5,400	$46,800	**$47,000**
EW12-04	Interior lighting is inadequate	$1,920	2011	$1,920	$288	$288	$2,496	**$3,000**
EW12-05	Needs magnetic flow meter	$14,400	2011	$14,400	$2,160	$2,160	$18,720	**$19,000**
EW13-01	Pump seal leaking	$6,000	2011	$6,000	$900	$900	$7,800	**$8,000**
EW13-02	Concrete at valve stand is spalling	$3,600	2011	$3,600	$540	$540	$4,680	**$5,000**
EW13-03	Conductors at Master Control contactor show signs of excessive heat and corrosion.	$1,800	2011	$1,800	$270	$270	$2,340	**$3,000**
EW13-04	Needs magnetic flow meter	$14,400	2011	$14,400	$2,160	$2,160	$18,720	**$19,000**
EW13-05	Controls need to be updated to current standards	$36,000	2011	$36,000	$5,400	$5,400	$46,800	**$47,000**
EW14-01	Swamp cooler float has malfunctioned	$100	2011	$100	$15	$15	$130	**$1,000**
EW14-02	Roof access hatches need slip resistant surface and or roof ladder	$1,800	2011	$1,800	$270	$270	$2,340	**$3,000**
EW14-03	Conductors at Master Control contactor show signs of excessive heat and corrosion.	$1,800	2011	$1,800	$270	$270	$2,340	**$3,000**
EW14-04	Needs outdoor lighting on equipment.	$3,000	2011	$3,000	$450	$450	$3,900	**$4,000**
EW14-05	Needs magnetic flow meter	$14,400	2011	$14,400	$2,160	$2,160	$18,720	**$19,000**
EW14-05	Needs magnetic flow meter	$14,400	2011	$14,400	$2,160	$2,160	$18,720	**$19,000**

Project Number	Project Description	Const Cost with 20% Contingency	Year of Estimate	2011 Const Cost	Design Cost	CM Cost	2011 Total Cost	Rounded 2011 Total Cost
CW1-01	Backer board for equipment needs replacing.	$1,320	2011	$1,320	$198	$198	$1,716	**$2,000**
CW1-02	Disconnects and panels not bonded together	$0	2011	$0	$0	$0	$0	**$0**
CW1-03	Communications need to be upgraded to radio to CCWWTP.	$19,200	2011	$19,200	$2,880	$2,880	$24,960	**$25,000**
CW6-01	Communications need to be upgraded to radio to CCWWTP.	$19,200	2011	$19,200	$2,880	$2,880	$24,960	**$25,000**
CW6-02	Equipment needs to be upgraded and mounted in a large cabinet or building	$36,000	2011	$36,000	$5,400	$5,400	$46,800	**$47,000**
CW8-01	Fence is rotting and falling apart	$26,400	2006	$27,853	$4,178	$4,178	$36,209	**$37,000**
CW8-02	Electrical cabinets are mounted on fence that is falling apart. Need to bond all electrical cabinets.	$5,400	2011	$5,400	$810	$810	$7,020	**$8,000**
CW8-03	Communications need to be upgraded to radio to CCWWTP.	$19,200	2011	$19,200	$2,880	$2,880	$24,960	**$25,000**
CW8-04	Equipment needs to be upgraded and mounted in a large cabinet or building	$36,000	2011	$36,000	$5,400	$5,400	$46,800	**$47,000**

Conveyance Capacity Projects

Project Number	Project Description	Const Cost with 20% Contingency	Year of Estimate	2011 Const Cost	Design Cost	CM Cost	2011 Total Cost	Rounded 2011 Total Cost
CONV-01	20" Beltline Rd from Oasis to Mtn Lakes (1013 ft)	$338,160	2011	$338,160	$50,724	$50,724	$439,608	**$440,000**
CONV-02	20" Oasis Road from UPRR at A6-V1 to Beltline Road (1225 ft)	$634,710	2011	$634,710	$95,207	$95,207	$825,123	**$826,000**
CONV-03	20" Oasis Road from Calexico Drive to A6-V1 (1600 ft)	$498,240	2011	$498,240	$74,736	$74,736	$647,712	**$648,000**
CONV-04	24" Lake Boulevard from Oasis Road to Northpoint Drive (9090 ft)	$3,475,680	2011	$3,475,680	$521,352	$521,352	$4,518,384	**$4,519,000**
CONV-05	16" Hilltop at Ridgecrest	$42,840	2011	$42,840	$6,426	$6,426	$55,692	**$56,000**
CONV-07	24" Hill 900 to Buenaventura	$536,160	2011	$536,160	$80,424	$80,424	$697,008	**$698,000**
CONV-08	8" Hilltop to Alley near Oxford Suites with CV (250 ft)	$92,400	2011	$92,400	$13,860	$13,860	$120,120	**$121,000**
CONV-09	20" Lake Boulevard from Northpoint to Masonic (1220 ft)	$390,960	2011	$390,960	$58,644	$58,644	$508,248	**$509,000**
CONV-10	16" Masonic to Hilltop	$543,360	2011	$543,360	$81,504	$81,504	$706,368	**$707,000**
CONV-11	16" Hilltop from F8-V36 to Peppertree (1170 ft)	$350,460	2011	$350,460	$52,569	$52,569	$455,598	**$456,000**
CONV-12	20" Railroad Avenue at Canyon Hollow Creek (370 ft)	$191,040	2011	$191,040	$28,656	$28,656	$248,352	**$249,000**
CONV-13	16" Twin View from B8-V24 to Oasis Center North (5630 ft)	$1,545,360	2011	$1,545,360	$231,804	$231,804	$2,008,968	**$2,009,000**
CONV-14	New Buckeye Tank 3.5 MG at Herbscenta	$2,421,006	2011	$2,421,006	$363,151	$363,151	$3,147,308	**$3,148,000**
CONV-15	30" New Buckeye Tank to Quartz Hill Rd (1485 ft)	$677,940	2011	$677,940	$101,691	$101,691	$881,322	**$882,000**
CONV-16	18" Quartz Hill to Keswick Dam Boulevard (3270 ft)	$929,460	2011	$929,460	$139,419	$139,419	$1,208,298	**$1,209,000**
CONV-17	16" Caterpillar to Twin View under I-5 (650 ft J&B)	$1,800,000	2011	$1,800,000	$270,000	$270,000	$2,340,000	**$2,340,000**

Foothill WTP Improvements

Project Number	Project Description	Const Cost with 20% Contingency	Year of Estimate	2011 Const Cost	Design Cost	CM Cost	2011 Total Cost	Rounded 2011 Total Cost
FH-01	Upgrade PLC control system wiring & associated equipment, 2015	$307,700	2011	$307,700	$46,155	$46,155	$400,010	**$400,000**
FH-02	Distribute facility power loads between two 1200 KV circuits, 2015	$360,000	2011	$360,000	$54,000	$54,000	$468,000	**$468,000**
FH-03	Replace polyurethane seam and grout blocks in 6 MG Reservoir, 2015	$138,460	2011	$138,460	$20,769	$20,769	$179,998	**$180,000**
FH-04	Install filter-to-waste system, 2015	$362,308	2011	$362,308	$54,346	$54,346	$471,000	**$471,000**
FH-05	Install individual filter rate of flow measurement and control, 2015	$426,925	2011	$426,925	$64,039	$64,039	$555,003	**$555,000**
FH-06	Modify streaming current controller to automatically control coagulant dosing system, 2015	$30,800	2011	$30,800	$4,620	$4,620	$40,040	**$40,000**
FH-07	Construct second backwash equalization basin, 2015	$779,230	2011	$779,230	$116,885	$116,885	$1,012,999	**$1,013,000**
FH-08	Construct second backwash recycle clarifier, 2015	$1,202,310	2011	$1,202,310	$180,347	$180,347	$1,563,003	**$1,563,000**
FH-09	Add backwash recycle pump, 2015	$23,100	2011	$23,100	$3,465	$3,465	$30,030	**$30,000**
FH-10	Upgrade impellers in all four pumps at Pump Station No. 2 & add surge anticipator valve, 2015	$113,845	2011	$113,845	$17,077	$17,077	$147,999	**$148,000**
FH-11	Install Clearwell Baffling, 2020	$262,000	2011	$262,000	$39,300	$39,300	$340,600	**$341,000**
FH-12	Conduct in-line filtration pilot studies at 6 GPM/SF summer & 3 GPM/SF winter conditions, 2020	$76,920	2011	$76,920	$11,538	$11,538	$99,996	**$100,000**
FH-13	Construct five flocculator basins if classic direct filtration system is required, 2020	$4,434,615	2011	$4,434,615	$665,192	$665,192	$5,765,000	**$5,765,000**

Enterprise Zone Well Operations & Treatment Alternatives Analysis

Project Number	Project Description	Const Cost with 20% Contingency	Year of Estimate	2011 Const Cost	Design Cost	CM Cost	2011 Total Cost	Rounded 2011 Total Cost
EWT-01	Adjust Operations to maximize surface water usage prior to bringing high-concentration wells on line	$150,000	2008	$145,303	$21,795	$21,795	$188,893	**$189,000**
EWT-02	Study feasibility of blending EW-13 and EW-14 to reduce Mn and As concentrations.	$40,000	2011	$40,000	$0	$0	$40,000	**$40,000**
EWT-02.1	Perform well profiling study to determine feasibility of selectively blocking potential problem zones	$15,000	2011	$15,000	$2,250	$2,250	$19,500	**$20,000**
EWT-02.2	Construct Blending pipeline for EW-13 and EW-14 if necessary	$1,412,000	2008	$1,367,782	$205,167	$205,167	$1,778,117	**$1,779,000**
EWT-02.3	Block problem zones in wells to decrease concentrations	$75,000	2011	$75,000	$11,250	$11,250	$97,500	**$98,000**
EWT-03	Install oxidation/filtration treatment system at EW-14 to remove manganese	$2,230,000	2008	$2,160,166	$324,025	$324,025	$2,808,216	**$2,809,000**
EWT-05	Construct pipeline from EW-12 to EW-14 to blend	$1,467,600	2008	$1,421,641	$213,246	$213,246	$1,848,134	**$1,849,000**
EWT-06	Expand treatment at EW-14 to treat flows from EW-12	$1,611,600	2008	$1,561,132	$234,170	$234,170	$2,029,471	**$2,030,000**
EWT-07	Install centralized oxidation/filtration treatment system at EW-11 and pipelines from EW-7 and EW-10	$3,924,000	2008	$3,801,118	$570,168	$570,168	$4,941,453	**$4,942,000**

Storage Projects

Project Number	Project Description	Const Cost with 20% Contingency	Year of Estimate	2011 Const Cost	Design Cost	CM Cost	2011 Total Cost	Rounded 2011 Total Cost
S-01	New 3.0 MG reservoir in Hill 900 Before 2020	$2,100,000	2006	$2,215,557	$332,333	$332,333	$2,880,224	**$2,881,000**

Well Projects

Project Number	Project Description	Const Cost with 20% Contingency	Year of Estimate	2011 Const Cost	Design Cost	CM Cost	2011 Total Cost	Rounded 2011 Total Cost
W-01	Rehabilitate EW11 or construct new Well, 2020	$1,000,000	2006	$1,055,027	$158,254	$158,254	$1,371,535	**$1,372,000**
W-02	Rehabilitate EW13 or construct new Well, 2020	$1,000,000	2006	$1,055,027	$158,254	$158,254	$1,371,535	**$1,372,000**

Grand Total	**$71,885,000**