2016 Water Master Plan

City of Waterford

Public Services Department
101, E Street
Waterford, California 95386

April, 2016

CITY OF WATERFORD

WATER MASTER PLAN

2016

FINAL DRAFT

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1.0 INTRODUCTION

In October, 2006, the City of Waterford ("City") adopted its 2025 General Plan ("GP"). The GP is a comprehensive, long-range guide to the City's future, which directs the physical growth and conservation of resources within the city and its sphere of influence ("SOI"). In the GP Preface, the City makes the following statement regarding its intention for the future:

> *"The City of Waterford, a community of around 8,000 people, took a look at the future and saw a community that could double, triple or even quadruple its population in the next 20 to 30 years based on the experience of other small communities in the region. That is where the "vision" began. The City decided to take charge of its growth; be in the position to tell the development community where, when and most importantly, how growth and development will occur.*
>
> *Thus began the City's "Waterford Vision 2025 General Plan" update program in 2004. The City's leaders, its Planning Commission and City Council, challenged its administrator, planner engineer and other City officials to look far into the future. To develop a plan of what the City could look like with a population of 30,000 people; what would the City need to support this population?*
>
> *The concept of "new-urbanism" was found to be a basic design principal that could solve many of the City's existing problems and achieve the City's long-term goals. These goals include the development of a "sustainable" community, a community that has a balance of job creating opportunities and vibrant commercial districts with "livable" neighborhoods. The city is relatively isolated from the major growth centers of the Central Valley; the City's planning concept is to capitalize and "celebrate" this isolation.*
>
> *The "Waterford Vision 2025 General Plan" recognizes that residential development is a necessary component of growth and will occur (is occurring) at the early phases of "City Building". The plan, however, recognizes that it must accommodate business and industry to improve the quality of life for residents of the city in the future; a future that includes increasing energy costs, global warming, and changes in the region's demographics and basic economic structure over the next few decades."*

The importance of securing and maintaining a reliable supply of water to achieve the goals and objectives envisioned in the City's GP cannot be understated. Unlike other utilities, a source of water must be available, as it cannot be engineered or created. California, and specifically the Central Valley, is headed into an unfamiliar and disconcerting water future. There are clear signs that a "business as usual" approach to water will not be an adequate planning tool. For the first time in its history, groundwater is being regulated by the State, senior water rights holder diversions are being restricted, and turf on commercial developments is outlawed. Assuming hydrologic models are correct, water planning and programs will become more challenging over time. Without a feasible strategic water plan, the City may not realize build-out of its General Plan.

Any public water supply program should achieve three (3) primary objectives:

- ❖ Be reliable and sustainable, and sufficiently robust in anticipation of periods of drought and other possible source water restrictions;
- ❖ Be healthy and of high quality, meet federal and state drinking water regulations for maximum contaminants, including esthetic properties so it is pleasant to drink; and
- ❖ Be affordable, both for rate payers and developers.

In the arid west, reliability has, and will be, an increasingly important objective of the water program. The main reason: there is simply not enough water to supply the needs of the State of California. Some of this supply-demand gap is drive by geography (75% of the water supply is in northern parts of the state, and 75% of the demands are farther south). It is further exasperated due to the nature of precipitation in California, where unstable precipitation cycles are the norm, alternating between periods of floods and droughts. Statewide, groundwater is being pumped at rates that far exceed recharge, so its current rate of use in unsustainable. Adding climate change predictions to this condition makes the water supply picture more troubling. Communities that ignore these signs will struggle to maintain their current way of life, let alone have potential to grow.

The greatest threat to the City's water program at this time is reliability. The City relies solely on local groundwater for its supply, so essentially has all of its "water supply eggs in one basket." Most communities recognize that this is both dangerous and limits future options for growth. The solution is to develop multiple source waters, normally consisting of some combination of groundwater, one or more surface water supplies, and incorporation of recycled wastewater into the program. Water conservation is also viewed by most proactively thinking communities as another inexpensive and easily obtainable "source," since it can directly reduce the source supplies needed to meet demands.

Quality is of concern for obvious reasons, although as a society we have forgotten how critical this objective is, now that we have nearly eliminated waterborne diseases over the past 100 years with improvements in water and wastewater sanitation systems. In the early 20th century, it was common that many thousands of deaths would occur from typhoid, cholera, and other infectious diseases caused by poor quality drinking water. Today, we have little concern of these threats due to modern treatment and national drinking water and wastewater regulations. However, vigilance of microbial threats continues to occupy our daily water operations activities in form of flushing, testing, and reporting.

Yet both reliability and quality objectives also need to be balanced with affordability. Communities cannot implement solutions that make the cost of water too expensive for its residents. A water program needs to find the point whereby all of these factors, quality, reliability, and cost of service, are all satisfied. None of the three objectives may be completely met, but al should receive "passing grades" and be addressed sufficiently.

1.2 BACKGROUND

Historically, Waterford was home to a ferry that provided north-south travel across the Tuolumne River. Later, the city was located along a railroad corridor serving the surrounding ranch land. Waterford, now, is located at the rural cross roads of the east-west trending State Highway 132 (Yosemite Boulevard) and the north south roadway system connecting Oakdale with the City of Merced (home of U.C. Merced).

With its location along the Tuolumne River, Waterford is a gateway to the recreation areas in the foothills of the Sierra and beyond. Farming, recreation and, of course, “bedrooms” form the basis of Waterford’s economy. Given traditional patterns of rural growth, adjacent to major metropolitan centers, Waterford was destined to be a bedroom community for the Modesto urban center. This was not the “vision” of Waterford’s residents and leaders, however.

The City's Water Program is addressed specifically in the Public Facilities Element of the 2025 GP ("GP"). This element of the GP addresses existing water supply conditions in Waterford, as well as future water supply conditions and concerns under potential growth scenarios. Specifically, it identifies broad goals and policies associated with the City's Water Program and Supply. Some of these goals include water conservation, sustainability, climate change, water quality, and water supply reliability.

After many years of effort and coordination, the City of Waterford (“City”) purchased the Waterford and Hickman Water Service Areas from the City of Modesto (“Modesto”) in July, 2015. This purchase gives the City more control over the quality of its utilities and services, and ability to manage revenues generated by the water enterprise. Previously, revenues were collected from City ratepayers, but not fully reinvested in the Waterford water system and infrastructure. As a result, the State of California Department of Drinking Water (“DDW”) issued several deficiency notices to Modesto that the system required upgrades and corrections. As owners of the service areas, the City is confident it can improve its water supply program while ensuring revenues are reinvested for the benefit of its ratepayers.

Recent State DWR activities are clear signs that change is on the water horizon, and Waterford will be impacted, perhaps greatly. The first is mandatory water conservation. In the past 8 years, there have been numerous water conservation laws and codes enacted that the City must address. The end result is that Waterford will be required to reduce its pre-2010 water use by approximately 20%. The second issue concerns groundwater sustainability. Communities with declining groundwater tables either need to self-regulate by developing sustainable groundwater management plans, or be subject to state adjudication, whereby the state dictates how much each agency/well owner can pump. The net result of this legislation is that Waterford may not be able to increase its groundwater use in the future.

1.3 PURPOSE

The purpose of a Water Master Plan (WMP) can be multi-functional, addressing issues such as the current state of the water system, system deficiencies, and future capital improvements. A potentially greater benefit of a WMP is the strategic planning aspect, especially for communities located in arid climates like California where water resources are limited. Specifically, the WMP provides the following:

- A review and inclusion of the 2025 GP policies and directives, State of California Division of Water Resources and Water Board mandatory permit and water code requirements, and other pending laws or directives that may impact water planning.
- An analysis of present demands and a projection of future demands based on expected expansion and recommended water conservation practices through 2070.
- A discussion of the local groundwater status, the need for a sustainable groundwater program, and the role of local groundwater to meet future demands.
- A review of the local groundwater quality, and probability of future groundwater treatment necessity.
- Review and analysis of source water options other than groundwater.
- Identify areas and potential for non-potable water use.
- A water conservation plan and implementation strategy with cost-benefit analysis of recommended conservation strategies.
- An analysis of the City's water production capacity and ability to meet present and projected future demands.
- An analysis of the water system's ability to meet MDD, Peak Hour Demands, and emergency fire flows, including those high fire demand locations as determined by the local fire authority.
- An analysis of the City's water distribution system, identification of deficiencies, and recommendations for mitigation.
- A Capital Improvement Plan with associated costs and phasing plan.

Section 2 System Description

2.0 INTRODUCTION

The City of Waterford is located at the base of the foothills of the Sierra Nevada Mountains in eastern Stanislaus County, California, approximately 15 miles east of Modesto, 16 miles northeast of Turlock, 32 miles southeast of Manteca, and 10 miles south of Oakdale. Other smaller cities surrounding Waterford include Empire (9 miles west), Hughson (9 miles southwest), Riverbank (17 miles northwest), and La Grange (19 miles east). The City is located on the northeast side of Stanislaus County, on the Tuolumne River, at the intersections of Highway 132 and the Oakdale Waterford Highway.

Waterford is a community with a rich agricultural heritage. It is among many diverse communities in the Central Valley of California that was established through the hard work and dedication of many individuals committed to a common vision of prosperity and opportunity. It is proud of its provincial setting and strong sense of community. The City was formally founded on 1969 though the town had been used as a Southern Pacific Railroad station since 1890, shortly after the founding of the town of Empire in 1859. The town was established on higher ground above fording operations closer to the river (which is rumored to be the source of the name). This "higher ground" section is present day downtown Waterford and is where the City's expansion began.

2.1 CITY OF WATERFORD WATER FACILITIES

The City operates and maintains three (3) separate service areas; River Pointe, Waterford, and Hickman (see Figure 2.1). The Waterford and Hickman systems were acquired by Modesto in the mid 1990's as part of the Del Este Water Company purchase. Del Este owned several water service areas in addition to Waterford and Hickman, including water systems in Turlock, Modesto, Ceres, and unincorporated Stanislaus County. In 2015, the City of Waterford acquired the Waterford and Hickman systems from Modesto. The service areas are hydraulically independent, and there are no emergency interconnections between any two systems. Consolidating the Waterford and River Pointe systems is evident as their boundaries are contiguous and both are within the City of Waterford boundaries. Joining the Hickman system with Waterford is less apparent, due to the geographical separation, and Waterford has no plans to annex Hickman.

A. River Pointe The River Pointe service area is a new development (2004) with approximately 330 metered residential customers, and buildout capacity of approximately 350 total connections. The water system consists of two (2) wells, a water treatment facility for removal of manganese, two (2) 100,000 gallon storage tanks, and booster pumps. The service area elevations range from approximately 140' to 100'. Similar development is anticipated to the east (south of Highway 132) in the future according to the City's GP. The water production capacity of the River Pointe system exceeds the service area demands. The potential capacity of the River Pointe water production system is discussed in section 2.6.

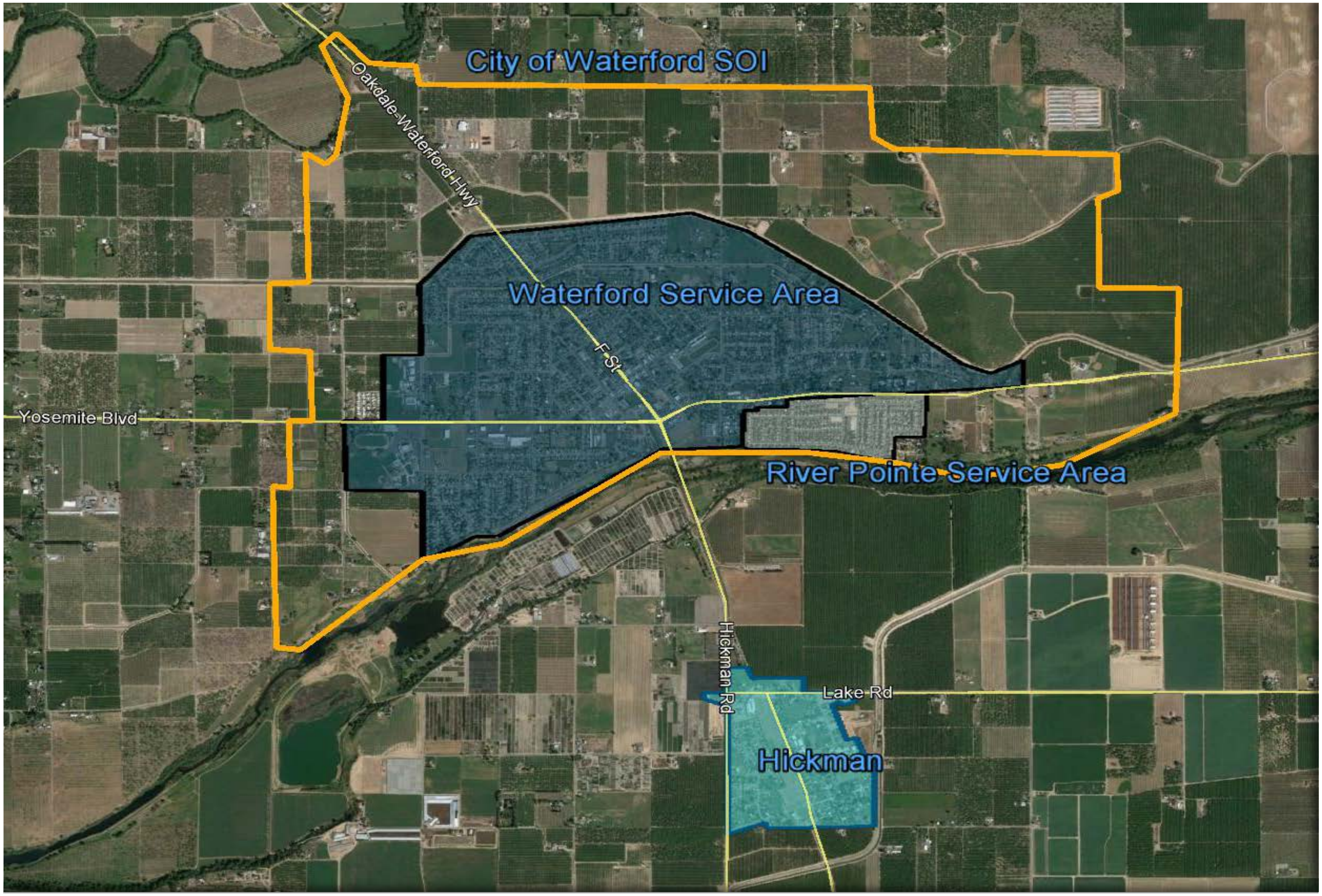

Figure 2.1 Water Service Areas

B. Waterford The Waterford service area is an older water system, with facilities dating back to at least 1945. The system provides water for both residential and commercial development. The Waterford system has six (6) wells, and approximately 91,000 feet of distribution pipe. Wells and distribution pipelines are of various size, age, and materials, and some wells and pipes are in need of replacement. The City has approximately 2260 service connections. A comprehensive water meter installation program began in 2005, and was completed in late 2014, in accordance with state water code. [1]Ground elevations across the City range from approximately 140' to 185'. Due to minimal elevation change, the City currently only has a single pressure zone. The City currently has no storage. Figure 2.2 shows the location of existing/proposed City production and storage (inclusive of River Pointe), booster pump stations, and proposed pressure zone boundaries.

Figure 2.2 Water Facility Locations

Source water is from local groundwater aquifers, exclusively, as the City does not currently use surface water. The City owns and operates six (6) water production wells, with an additional two (2) in the River Pointe system. The total production capacity for the systems are 2,875 gpm and 1,800 gpm, respectively.

[1]AB 2572 (2004) requires urban water suppliers, as defined, on or before January 1, 2025, to install water meters on all municipal and industrial water service connections that are located in its service area.

Characteristics of each well, in all both the Waterford and River Pointe systems, and total and net production are provided in Table 2.1.

Table 2.1 Summary of City of Waterford Groundwater Wells, Including River Pointe

Well	Type	Year Built	Depth (ft)	Pump Replaced	Current Efficiency (%) [a]	Flow (gpm)
242	Production	1985	295	2008	58	305
244	Production	1949	259	2007	47	488
245	Production	1965	300	2003	69	377
286	Production	1985	311	Prior to 2003	54	520
302	Production	1991	237	Prior to 2003	72	730
303	Production	1991	276	2005	62	455
River Pointe #1	Production	2004	382	Never	63	750
River Pointe #2	Production	2004	400	Never	63	800
Total Well Production						4,425
	Total Net Well Production (Per State Water Code Requirements)					3,625

a. Based on testing conducted in September and October of 2015.

Several of the City wells are past their expected useful life (approximately 50 years), including Wells 244 and 245. Both of these wells will likely have to be retired within the next 20 years, and Well 244 will likely be retired in less than ten (10) years, given that it has high levels of manganese. In addition, all of the wells are operating at efficiencies significantly below optimum (i.e. eye of the pump curve). Well pumps should be expected to have efficiencies of at least 70%. None of the Waterford wells appear to be operating at this minimum, and some are excessively low. Poor efficiency can be due to a number of reasons, including age, dropping water tables due to overdrawing of the aquifer, well screen encrustation or obstruction, and pump bowl damage from sand wear. The low efficiencies are an indication that the pumps are not producing as much water as they are capable of, and the cost of pumping water is higher than necessary. Each well should be evaluated by removing pumping equipment for inspection, and performing a video inspection of the well. Depending on the outcome of the inspection, pumps should be rebuilt or replaced, and wells may require rehabilitation.

C. Hickman The Hickman water service area includes approximately 185 service connections, with a population of approximately 430 persons. Most of Hickman is residential, though there are approximately 11 commercial connections, including an elementary school. The Hickman system has two (2) wells, with a combined production of approximately 600 gpm. One well is equipped with GAC treatment for taste and odor control. The Hickman has no storage. The source capacity of the Hickman system is inadequate to meet required demands, and required significant capital improvements. Production of one (W272) is too low to meet maximum day system demands if the highest producer is out of service, and fire suppression is not available even if both wells are functioning.

Table 2.2 Summary of Hickman Groundwater Wells

Well	Type	Year Built	Depth (ft)	Pump Replaced	Current Efficiency (%) [a]	Flow (gpm)
272	Production	1961	332	2008	43	146
309	Production	1993	292	2007	46	440
Total Well Production						586
	Total Net Well Production (Per State Water Code Requirements)					146

2.2 WATER QUALITY ANALYSIS

There are a number of regulations throughout Federal, State, County, and local levels that collectively help to protect the quality of drinking water in the United States. The primary Federal Drinking Water Standards, created and enforced by the EPA, are part of the Safe Water Drinking Act (SWDA), originally passed in 1974 and then amended in 1986 and 1996. This act regulates the quality of drinking water and sources, including as surface water and groundwater, serving 25 people or more. The SWDA helps to ensure that levels of both naturally occurring and man-made contaminants remain at low enough levels such that no threat is present to the consumer. These levels, referred to as "maximum contaminant levels" or MCL's, are set using a method that balances health risk with cost.

SDWA Drinking Water Standards include both primary and secondary MCL's. Primary contaminants are considered a health risk to the consumer and are enforceable as established by the EPA. Primary standards may be acute (immediate health concern) or chronic (health concern due to extended of exposure). Secondary contaminants are those that cause aesthetic concerns and damage to infrastructure (i.e. water distribution systems, home water heaters, plumbing fixtures, etc.), but are not of any health concern to the consumer. Examples of this include contaminants such as manganese, which can alter the color and odor of the water, but are of no concern to the consumer in terms of health. Secondary contaminants have set MCLs, but are not enforceable at the Federal level. Some states, counties, and localities have made certain secondary MCLs enforceable.

States have ability to alter MCL's below the Federal SWDA standards, making them more stringent that Federal SDWA Standards, but not less stringent. The agency responsible for the State level regulations in California is known as the California Water Board, Department of Drinking Water (DDW). DDW establishes MCL's for primary and secondary contaminants, most of which are taken directly from the SWDA Standards. The responsibility, to regulate and enforce drinking water standards, fall to state, county, and local government programs.

Groundwater has contamination risks that may include:

- Naturally occurring contaminants (such as metals naturally present in the soils).
- Man-made contaminants, based on local activity (i.e. farming, industrial waste creation, etc.).
- Proximity to brackish water sources (salt water proximity).

Locally, groundwater contamination is predominantly due to agricultural practices, or salts and metals found in the soil. Common contaminants on the east side of Stanislaus County include total salts, nitrates (byproduct of fertilizer), DBCP (soil treatment), arsenic, manganese, TCP, and iron. Microbial contamination is rare in groundwater sources, and typically only occurs due to poor well construction.

City water quality data was analyzed during the years 2008-2015 (See Appendix E). The data analysis spanned a variety of chemicals including metals, nitrates, bacteriological, organics (i.e. pesticides), and others. As expected, contaminants of concern found in City water quality tests included those common in other local groundwater basins in Stanislaus, San Joaquin, and Tuolumne Counties. Although tests indicated the presence of several contaminants, the concentrations did not exceed MCL's for contaminants other than DBCP and manganese.

DBCP: Water quality data for Well 303 beginning showing concentrations of dibromochloropropane (DBCP) in 2005. DBCP is an organic-based soil fumigant, which was commonly associated with agrarian activities in the Central Valley. DBCP travels through the soil, transported by applied water or precipitation, until it reaches the water table. Generally, DBCP remains near the top of the water table, and does not continue into deeper aquifers. By 2007, concentrations of DBCP required treatment using granular activated carbon (GAC). Well 303 is equipped with two (2) GAC vessels for DBCP removal. Although nitrate is not elevated in Well 303 water, it accumulates on the GAC bed, thus high concentrations of nitrate are also of concern at this facility. GAC reduces DBCP concentrations to approximately half the MCL.

Manganese: In 1995, Well 244 was equipped with GAC treatment for taste and odor control. Water quality data shows that as early as 2004, manganese concentrations were exceeding the secondary standard for drinking water, of 50 ug/l. [2]The results shown below indicate that Well No. 244 produces water that exceeds the secondary drinking water standard for manganese (50 ug/L).

Section 64449, Title 22, California Code of Regulations (CCR), requires quarterly monitoring for manganese to determine compliance with the MCL of 50 ug/L based on the average of four quarters monitoring. The City of Modesto tested Well 244 for four consecutive quarters (between 7/27/11 and 4/25/12) to determine compliance with the manganese MCL. The well was tested for manganese before and after GAC treatment. The results are summarized below. The quarterly manganese average for the raw water was 73.75 ug/L, and it was 26 ug/L for the treated water. Although the GAC treatment does seem to remove manganese, it is not the intended purpose and sufficient data was not collected to determine if GAC would sufficiently

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[2] A secondary drinking water standard is typically for aesthetic nuisances, such as staining of plumbing fixtures, laundry, or taste, odor, etc.

reduce manganese over the long term. Thus, DDW did not accept GAC as an adequate form of manganese treatment.

Table 2.3 Well 244 Manganese Concentration (Untreated)

Sample Date	Raw Water Manganese Results (ug/L)
4/12/07	81
8/25/09	77
1/27/2010	130
9/15/2010	80
7/27/11	100
10/26/11	80
1/25/12	73
4/25/12	74
5/23/12	68

Table 2.4 Well 244 Manganese Concentration (Treated)

Sample Date	Treated Water Manganese Results (ug/L)
1/27/10	92
9/15/10	46
7/27/11	84
10/26/11	0.0
1/25/12	0.0
4/25/12	20

In June 2014, DDW issued a citation (No. 03-10-14C-005) to the City of Modesto after quarterly monitoring confirming that Well 244 in Waterford water system had exceeded the secondary drinking water standard for manganese. In the citation, Modesto was required to install a treatment system to remove manganese from the well or pursue a manganese waiver with public consent. Modesto did not pursue a waiver and indicated it would evaluate various treatment mechanisms to remove manganese from the well. DDW required Modesto to install treatment by July, 2015. DDW stated that if treatment was not installed by said date, Modesto would need to change the status of Well 244 to standby until a treatment system for the removal of manganese and a permit was secured from DDW.

Nitrate: A common groundwater contaminant in the Central Valley is nitrate. Nitrate is a primary contaminant, since it can have acute health impacts, particularly for newborns and infants. Generally, the source of nitrate is from applied fertilizers in agrarian activities. Nitrates often elevate slowly over time. Water agencies that use groundwater should regularly track the nitrate concentrations in their wells to determine that need for future treatment, since upon exceeding the MCL, use of the well must be discontinued immediately. Nitrate data for Waterford wells were collected and plotted, as shown in the following graphs.

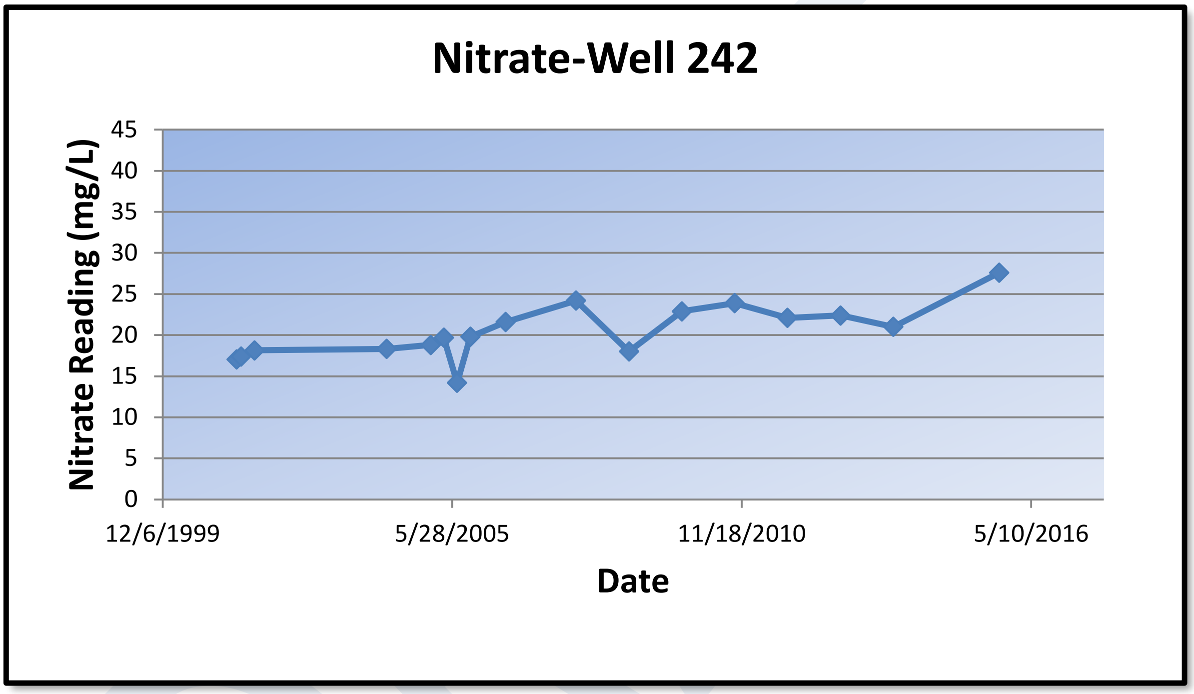

Figure 2.3 - Well 242 Historical Nitrate Concentrations

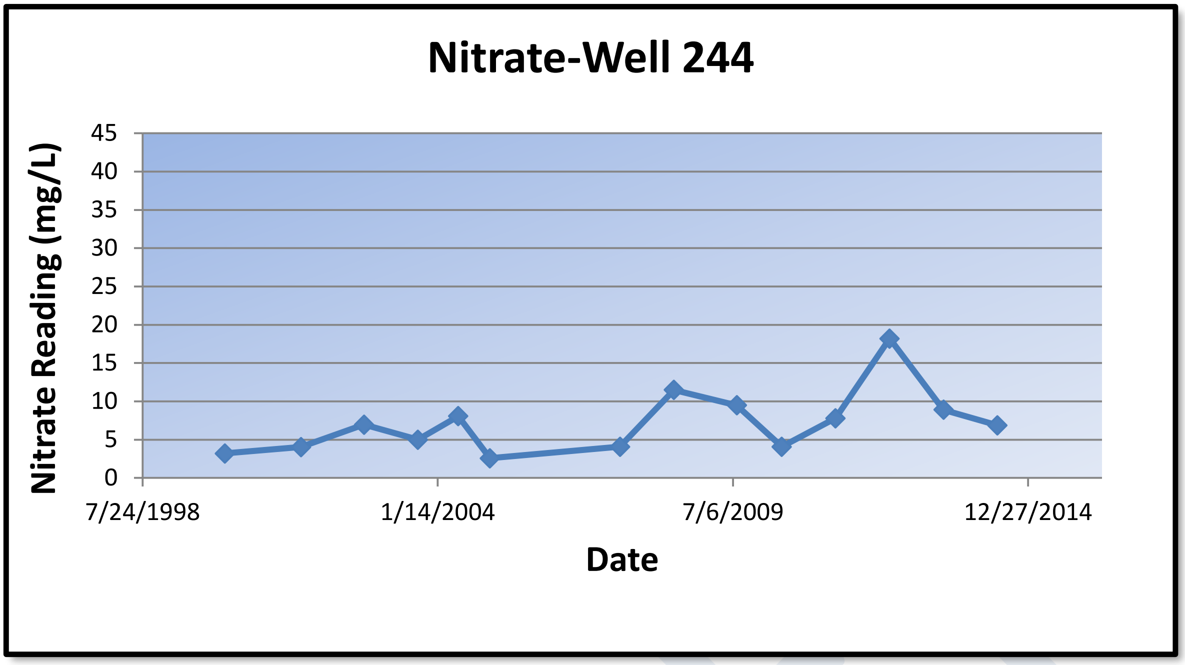

Figure 2.4 - Well 244 Historical Nitrate Concentrations

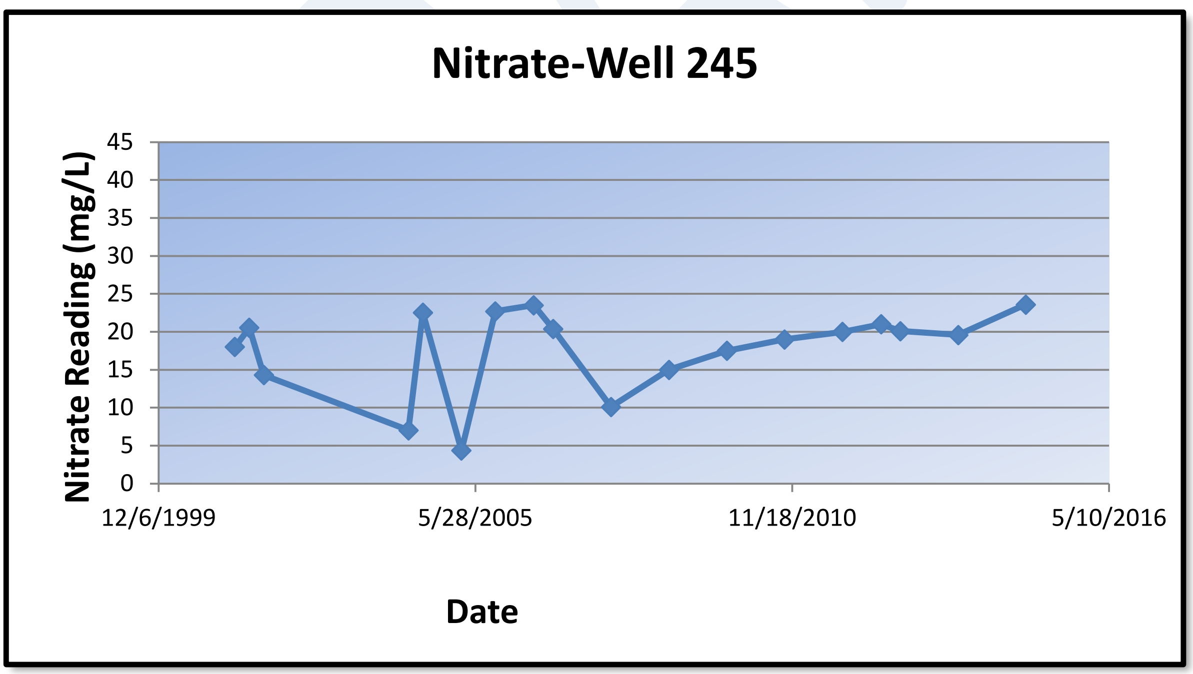

Figure 2.5 - Well 245 Historical Nitrate Concentrations

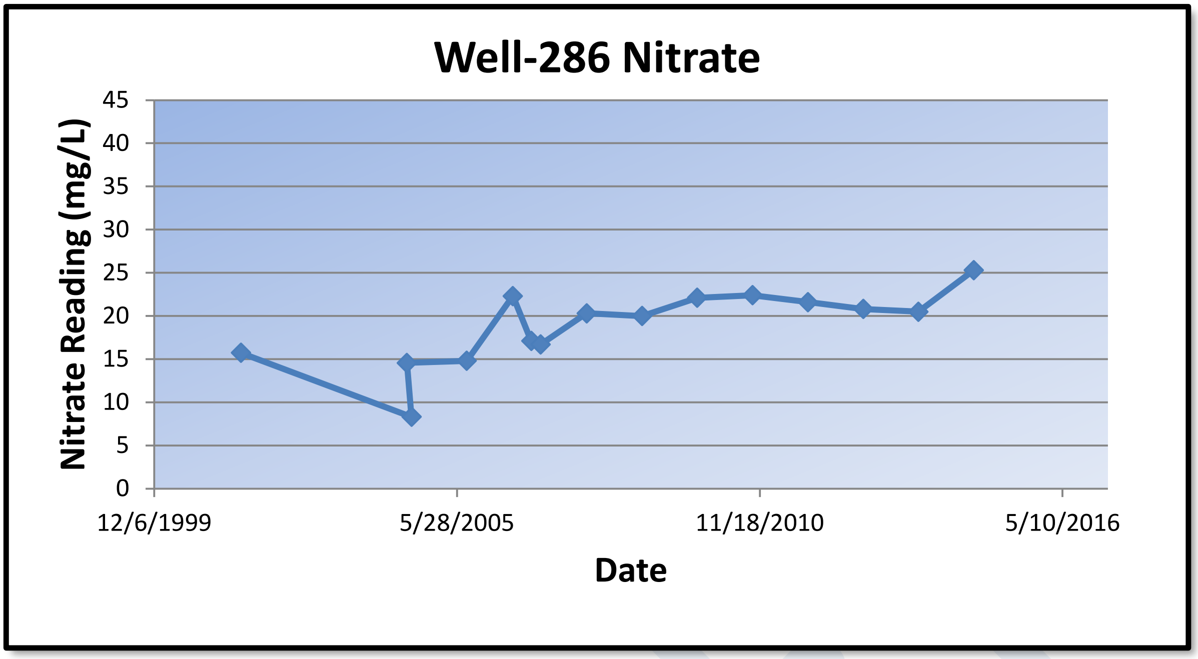

Figure 2.6 - Well 286 Historical Nitrate Concentrations

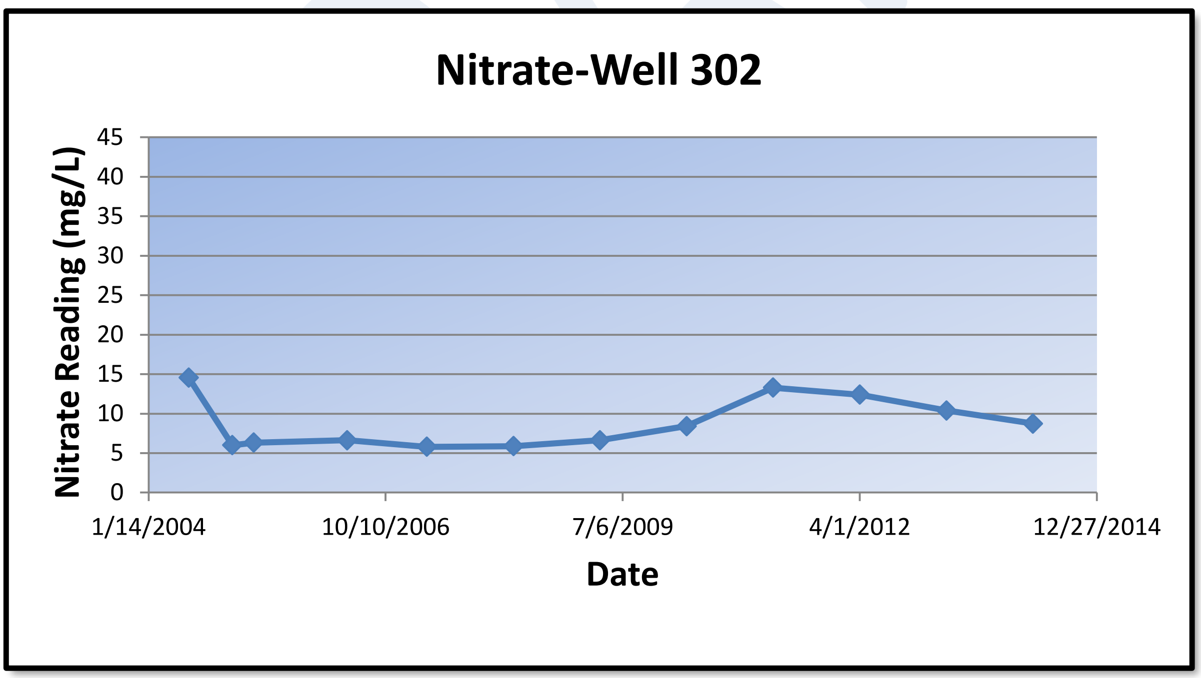

Figure 2.7 - Well 302 Historical Nitrate Concentrations

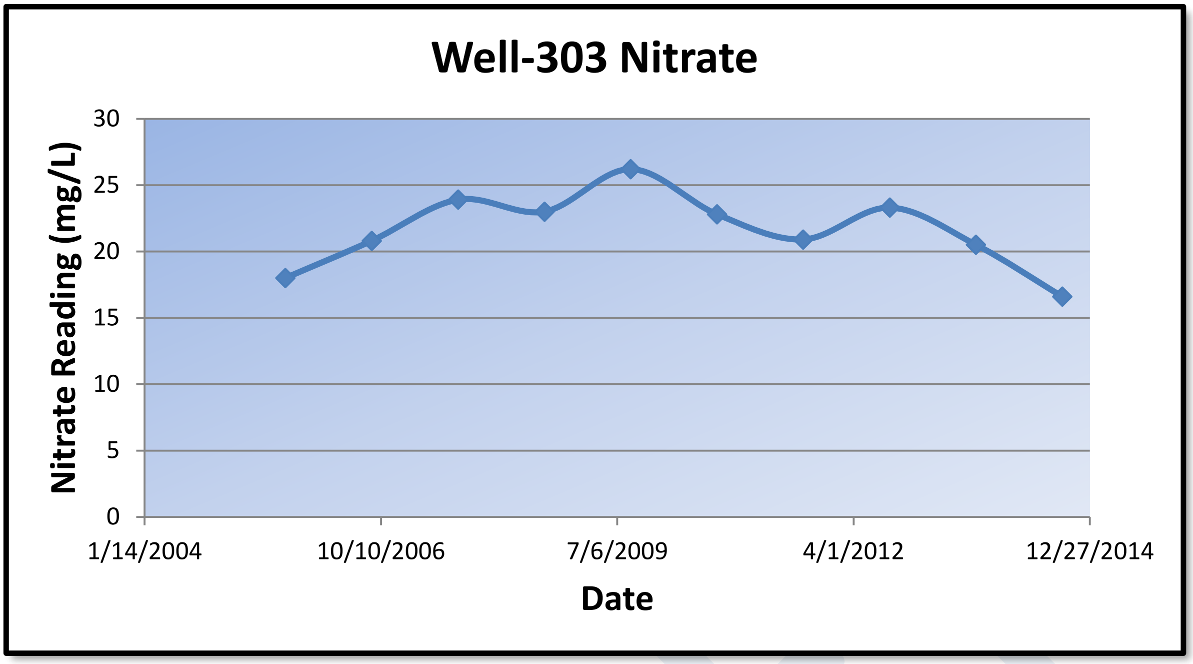

Figure 2.8 - Well 303 Historical Nitrate Concentrations

None of the readings in any of the wells were at or above the nitrate MCL of 45 mg/l. If nitrate levels are below the MCL in the data, but are trending upward with time, this suggests not only that a violation could be possible in the future, but that something is causing the increasing nitrate readings that could be mitigated in future planning. For example, since nitrate is generally a contaminant that typically stays near the top of the water table, constructing wells to take water from deeper zones could avoid the need for treatment. Wells 242, 245, and 286 all showed minor upward trends, as can be seen in the figures, though no readings surpass 35 mg/L, and all show slow increases in nitrate concentration. However, upward trends could be a sign of future contaminant issues. Regular nitrate analysis of all wells is encouraged in the future to allow sufficient time for an appropriate mitigation plan. In addition, wells 242 and 245 are in need of replacement due to age. New wells could be constructed to draw water from deeper zones, thereby avoiding nitrate and other surface contaminants, such as DBCP.

Most of the water quality data available for the analysis was collected infrequently. Potential upward trends and contamination issues are difficult or impossible to identify without regular testing. Due to this, an increase in frequency of testing for the following contaminants is recommended, even if not required by DDW:

- Chromium XI
- Gross Alpha
- Nitrates
- Manganese
- DBCP

2.3 WATER TREATMENT FACILITIES

In general, the water quality for Waterford is good, with no major water quality concerns. Groundwater is less susceptible to contamination than surface water sources, though it can have various metals and agricultural run-off byproducts requiring treatment before use as a drinking water supply. The City has three (3) water treatment facilities to remove contaminants as discussed in the previous section.

Both Well 244 and Well 303 have GAC treatment, although for different contaminants. GAC units work to remove contaminants from the influent by adsorbing contaminants to the carbon in the media. Well 244 is equipped with a single vessel, Well 303 is equipped with a pair of vessels that works in parallel. The unit at Well 244 was installed for aesthetic purposes, removing various contaminants that cause taste and odor issues in the water. Though not a direct health concern, the taste and odor was of sufficient levels to justify treatment. The GAC vessels at Well 303 were installed to remove DBCP, a primary chronic contaminant that does pose a health risk to water customers. The GAC vessels also had the unintended but beneficial effect of lowering nitrate levels in the effluent. However, nitrate can build up on the GAC media and, after enough time, create what is commonly referred to as "nitrate break through", whereby nitrate can slough away from the filter causing spikes when the well is cycled. The well is equipped with a nitrate monitoring system, automatically shutting off the well if nitrate levels approach the MCL.

Nitrate break through issues, in tandem with build-up of other contaminants, can be solved by frequent backwashing of the GAC units. Backwashing not only prevents such spikes in the effluent, it also cleans the carbon, allowing for more absorptive capabilities, increasing the efficiency of the treatment provided by the GAC unit. This lengthens the effective life of the media, however, even with frequent backwashing, the carbon does need occasional replacement. The carbon has to either be fully replaced with new carbon or has to be replaced by a combination of new carbon and fire-cleansed carbon, which is typically done on site of the vendor that supplies the media (Calgon Carbon, in the case of Waterford).

With the exception of the GAC units, the only treatment Waterford requires is chlorination of the water, to provide disinfection and residual disinfectant, as per state standards. The City currently requires no additional treatment to fulfill State standards or lower the levels of any contaminants known or monitored for.

2.4 AGING INFRASTRUCTURE

Much of the Downtown area has aging steel pipe that near its useful life. The City of Modesto began replacing sections of the older pipe, and the City will need to continue this effort until all of the aging steel pipe is replaced. Other deficiencies associated with the Downtown area include undersized pipes, lack of fire hydrants and improper locations/spacing, and pipes in alleys that do not meet state health standards due to proximity of sewer pipes. Approximately 31,829 l.f. of pipe, new fire hydrants and services should be replaced in the near-term (next 10 years), as it is expected some of these pipes will soon reach a point of failure.

Appendix F includes an exhibit of where older pipes are located and need to be replaced. A worksheet provided in Appendix F itemizes the location, length, and cost estimate for pipe the pipe replacement. Most of these pipes have been in service 60 years or more, and will eventually become more costly to maintain than replace. One concern of operating old pipes is the risk of catastrophic failure, whereby a pipe break causes severe damage to streets, private properties, etc. The area and quantity of pipe identified for replacement may be greater than shown, as records of City water infrastructure is not complete.

In addition to the aging infrastructure and the insufficient size, some of the mains are currently in alleyways, presenting further need for replacement. A significant problem with water mains in the alleys is access. The work area is restricted, cluttered with overhead utilities, and unpaved surfaces. This poses a safety threat to workers (tight working spaces, low hanging main lines and service drops, etc.), and leaks have greater potential do damage to private property. Damage to private properties, should they occur, due to faulty water pipes, may be the responsibility of the City. The placement of water meter boxes is often on a case-by-case basis, and most boxes are subject to traffic loads and continuous flooding (due to poor drainage in alleys). If water mains are located in the street, there are more equipment options for excavation and repair, overhead power is limited, and leaks can flow into the gutter. In addition, a paved surface makes for a safer and sturdier surface to work from.

New water mains could be relocated in the streets that front the houses. The difficulty with placing mains in front streets is that services must be either relocated to the front of the house, or ran from the street through the lot to the back of the house and connected to the existing service in the alley or behind the house. The costs associated for relocation of mains in the streets have been incorporated in the pipe replacement program (Appendix F). These costs assume water mains will be replace in advance of, or in coordination with, street improvement work (i.e. resurfacing, patching, repairs), so the cost of replacing asphalt is significantly reduced. New water meter boxes could be located in sidewalk landscaping or in front yards. This alternative requires that City crews or contractors work on private properties that have no existing easements for that purpose. All options require extensive planning and individual coordination with each property owner.

Fire Suppression and Hydrant Locations The downtown area is lacking in the number, spacing, and location of fire hydrants. Since water mains follow the alleys, hydrants are primarily located where alleys intersect with streets, where they exist. This is a poor location for fire hydrants since fires are typically fought from the front of the structure. The current location of the hydrants is in a “blind” spot for fire fighters, and exceeds the maximum spacing standard. Placing the hydrants at the street intersections will meet spacing standards and enhance the City’s ability to fight structure fires.

Placing fire hydrants at street intersections requires that water mains be placed in the streets, or that dedicated dead-end fire hydrant mains be constructed from the alley to the street intersections (if mains remain in the alley). Potential problems are associated with this design, including the absence of services on the fire hydrant mains, creating numerous "pockets" of stagnant water and an increase in the risk of contamination. If dead-end fire hydrant runs are installed, the City will be required to increase contamination testing and fire hydrant flushing. The design is also less reliable since mains feeding the hydrants are not "looped". Due to the increase in operations and maintenance, potential health issues, and a less reliable fire suppression system, this design (extending dead-end hydrant mains to street intersections), was not considered viable.

Groundwater Wells Two (2) of the City's wells are past their useful life (50 years) and need to be replaced before they fail. One of these wells (W244) is offline due to manganese, and is only available for use during an emergency (i.e. fire). These wells represent 30% of the total production capacity. The time required to replace a well is about 2 years (design, test hole, drilling, site improvements, etc.), hence waiting until a well fails is not recommended as the City could be left without adequate supply for an extended period. New wells may provide more capacity than the existing wells, so a 1:1 replacement may not be required. However, at least one (1) and possibly two (2) new wells should be planned in the near future. Conservation measures can extend the time allowed between present day and new well construction (see section 5). Well 244 can be kept as a means of fire emergency supply and may possibly be used for non-potable water use, such as irrigation.

2.5 SOURCE WATER PRODUCTION CAPACITY

The production capacity requirement is adequate, due to the recent permit adjustment from DDW. Currently, the City is required by DDW to have sufficient capacity to meet peak hour demands. The system capacity does not provide adequate fire suppression capacity during a high demand period, in accordance with typical waterworks standards. However, by joining River Pointe and Waterford service areas, all capacity requirements are meet. A detailed discussion regarding capacity is provided herein.

River Pointe Water Supply System Capacity The River Pointe water supply system (two wells and treatment facility) is the youngest infrastructure owned by the City. The River Pointe wells were constructed based on a modern design, including corrosion resistant perforated screens, gravel envelop, and deep sanitary seals. Wells associated with the Waterford system are of an older design, generally cable-tool construction with open bottom, which normally produce higher amounts of sand. Hence, the River Pointe facilities are expected to remain an important part of the City's water production through the planning period.

River Pointe water supply system and is supplied by two (2) wells with pumping capacity of approximately 750 -800 gpm each. Both wells require treatment for manganese, so the total production is currently limited to the capacity of the treatment vessel. The River Pointe System also has 200,000 gallons of ground-level storage capacity, with booster pumps of combined total rate of 2,500 gpm. The current operational sequence of the system is as follows:

(1) When the storage tank reaches a set low level, one of the well pumps is started.
(2) Water from the well is pumped through a pressure filter vessel for treatment, and discharged into the storage tank.
(3) When the distribution system pressures reach a set low pressure, boosters are started to pump water from the storage tank into the water distribution system.

With consolidation of the River Pointe and Waterford systems, surplus capacity in the River Pointe system could be used outside of the River Pointe service area. Increasing existing system capacity can be less costly than constructing new facilities. Often wells have greater production capacity than can be used, and the well pumps are sized for the demands, but not necessarily maximum output. As part of the system evaluation, the capacity of the River Pointe water supply system was reviewed to determine if the capacity could be increased. Because the sequence is serial, each part of the system was checked for maximum capacity and possible expansion.

The options for increasing production from the River Pointe water supply facilities may include:

- Larger Pumps in the Wells – If the wells are capable of yielding more water than is currently being pumped, larger pumps could be installed in the wells to gain additional production.
- Additional Treatment Capacity - Adding treatment capacity for (i) greater well production, and/or (ii) pumping both wells at the same time.
- Add Booster Pump Capacity – Additional capacity could be gained by adding an additional booster pump.

Well Capacity - The first step required evaluating the wells to determine if additional production could be gained by increasing the size of the well pumps. Table 2.4 provides information necessary for evaluating the production capacity of the River Pointe wells.

Table 2.5 River Pointe Well Data

Well	Total Depth	Highest Screen	Specific Capacity	Standing Water Level	Current Pumping Water Level	Potential Pumping Rate
R.P. Well #1	372’	156’	11.5	75’	161’	750 gpm [3]
R.P. Well #2	408’	186’	14.7	72’	140’	1,400 gpm

[3] This well is limited to approximately 750 gpm pumping capacity due to high well screens. Pumping in excess of approximately 750 gallons may cause damage to the pump due to cascading water and cavitation.

Column 3, *Specific Capacity*, is an indication of the wells ability to yield water, a quotient of well production (gpm) divided by pumping drawdown (ft). A lower number indicates a higher cost to produce water because the pumping water level is low (deep). Specific capacity values of 0-10 gpm/ft are poor, 10- 20 gpm/ft are marginal. In the Central Valley, it is normal to find wells with specific capacities of 30 – 60 gpm/ft. Although the River Pointe wells have higher production than other wells, they are not the most economical to operate.

According to the data, River Pointe Well #1 is currently being over pumped, since the pumping water level is lower than the top screens. This creates a condition called “cascading water”, whereby air becomes entrained in the water and creates cavitation resulting in excessive pump wear. This condition can be corrected by reducing the pumping rate, and is assumed to have a maximum pumping rate of 750 gpm. River Pointe Well #2 has the ability to increase its capacity to approximately 1,400 gpm.

Filter Capacity - River Pointe treatment consists of a single, multi-chambered steel pressure vessel, with sand and anthracite media. The multi-chamber feature allows each “cell” to be backwashed with the product water from the other three (3) chambers. This eliminates the need for a reserve of backwashing supply water, or from taking water from the distribution system to backwash the filter. The existing iron/manganese sand filter has dimensions of 40’ long x 8’ wide (diameter). At 1,000 gpm, the filter loading rate is approximately 3.1 gpm/ft^2. Allowable loading rates of an oxidation/filtration sand filter for removal of iron/manganese of this design can reach 5 gpm/ft^2, or higher. At 5 gpm/ft^2, the River Pointe filter has a treatment capacity of approximately 1,600 gpm. Hence, surplus filter capacity remains available.

Booster Pumps - The River Pointe system currently has three (3) booster pumps that lift treated water from the water storage tanks into the distribution system. The booster pumps create necessary pressure for delivery to the residents. The combined capacity of the booster pumps depends on the delivery pressure required, as show in the following table.

Table 2.6 River Pointe Booster Pump Capacity

Booster Pump	Horsepower	Capacity @ 50 psi	Capacity @ 20 psi
R.P. Booster #1	100	1300 gpm	Not rated – exceeds pump curve
R.P. Booster #2	100	1300 gpm	Not rated – exceeds pump curve
R.P. Booster #3	40	650 gpm	Not rated – exceeds pump curve [4]
Total Net Capacity [a]		1,850 gpm	N. A.

a. Generally, booster pump stations are designed assuming that one pump may be out-of-service, so “net” capacity is assumes the largest pump is not available.

[4] River Pointe booster pumps were not designed for pressures as low as 20 psi in the current condition, and operation at these heads may damage pumps. However, consolidation of the River Pointe and Waterford systems will correct this deficiency as 40’ of additional static head will be added to the pump total head requirement.

The net capacity of the booster pumps (assuming largest pump out-of-service) is 1,850 gpm. However, the booster station was constructed with one (1) additional pump chamber that has yet to be equipped. Assuming another 100 h.p. pump/motor were installed, the net capacity of the facility could be increased to approximately 3,000 gpm.

The full potential production of the River Pointe system depends on the conditions assumed. For meeting DDW River Pointe permit requirements, one of the River Pointe wells are removed from service, as is one of the larger booster pumps. Under this scenario, the source capacity is 750 gpm. Using storage, the facility can provide an additional 833 gpm (4-hour peak hour), 1,110 gpm (3-hour fire suppression), or some combination of the two (i.e. 50,000 gallons for peak hour, 150,000 gallons for fire suppression). Storage is dedicated to a particular objective, so the same stored volume cannot be credited to meeting both peak hour and fire suppression demands simultaneously.

The capacity of River Pointe water system can be increased for maximum day and peak hour demands, as shown in Table 2.7. Increased capacity assumes: (1) the system is consolidated with the Waterford service area through construction of a large transmission main, (2) additional wells (or sources) are constructed in the Waterford service area with capacity equal to or greater than the River Pointe wells, and (3) an additional booster pump is added to the River Pointe facility. Since the filter can produce water up to 1,600 gpm, operating both River Pointe wells would allow for full filter production. This in combination with a 4^{th} booster pump, the River Pointe system is capable of producing between 3,000 gpm and 4,000 gpm, depending on system pressures.

Table 2.7 Current and Future River Pointe Capacity

Production Item	Current Capacity (gpm)	Future Capacity (gpm)	Improvement Required
Wells	750 [a]	Up to 1,600 [b]	Consolidation, new well in Waterford service area
Filter	1,600	1,600 [b]	None – as designed
Booster Pumps	1,850 [a]	3,250 [c]	Add 4^{th} booster pump

a. DDW permit requirement: largest producing pump out-of-service
b. Credited toward maximum day demand
c. Credited toward peak hour/fire suppression demands

2.6 CONSOLIDATION OF SERVICE AREAS

Currently, the City operates and maintains three (3) separate service areas; River Pointe, Waterford, and Hickman. Consolidation (physically connecting the systems and operating them as a single system) may be cost effective and advantageous. According to DDW standards, public water systems must provide adequate water for maximum day and peak hour demands, with the largest producing water supply pump out-of-service. The pump could be a booster pump or a well pump. In addition, accepted waterworks standards recommend that water systems have capacity to meet maximum day demands while simultaneously meeting a single high fire suppression demand. The fire suppression capacity is typically from a well (or combination of wells), or storage tank. The combination of these standards requires that each service area have a redundant well or booster pump, and adequate fire suppression capacity. As an example, the River Point system has two (2) wells because one well is needed for redundancy, not to meet demands. Consolidating systems can significantly reduce infrastructure needs.

Consolidation of River Pointe and Waterford Water Systems - With purchase of the Waterford system from Modesto in 2015, the City inherited certain deficiencies in the water system according to DDW, including insufficient source capacity at that time. [5] Specifically, DDW indicated that the Waterford System had a high (Maximum Day) demand of 3,685 gpm. [6] Since the Waterford System has no storage, production is required to meet Peak Hour Demand, calculated as 1.5 x Maximum Day Demand of 5,528 gpm. In addition, Well 244 water quality testing revealed elevated levels of manganese. DDW notified Modesto in 2007 that Well 244 would either need treatment to reduce manganese, or had to be placed in "Stand-By" status. The Waterford system has a net production capacity of 1,660 gpm, assuming the largest producing well and W244 are out-of-service. Hence, an additional 3,870 gpm was needed to meet State Water Code requirements.

Data used to determine the current Maximum Day Demand (MDD), as indicated in the Waterford System permit, was established prior to Waterford's meter installation program. Starting in 2007, Modesto began installing water meters on residential connections, and completed installation of meters on all service connections by 2014. According to well production data, the total system water use began declining after 2007, and continued to decline through 2015.

In February, 2016, the City submitted permit amendment to DDW, asking that the source capacity requirements reflect recent demand reductions due to the meter program. The DDW accepted the new demand values, and adjusted the City's permit reflecting it has sufficient source capacity. The new demands are shown in Table 2.7.

By combining the River Pointe and Waterford water systems, the total effective water production capacity will increase by approximately 1,500 gpm, resulting from additional production of two (2) wells.[7]

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[5] DPH letter dated June 24, 2011, "The City does not have capacity to meet the PPD [Peak Hour Demand] …. The City must … develop a comprehensive plan and time schedule … to improve the water source and/or storage capacity in the Waterford water system".

[6] Based on 10 years of production data, with highest single day occurring in 2007, according to DPH letter of June 24, 2011.

[7] DDW requirements include meeting maximum day demands with the largest producing pump or source out-of-service, while maintaining adequate service pressures (i.e. 40 psi minimum).

Currently, both service areas remove the largest producing well from the effective production value. When the systems are consolidated, one of the two River Pointe wells will become the largest producing well out-of-service. Thus, additional system capacity includes the second River Pointe well and W302 (previously the largest well out-of-service). If W244 remains on standby and is not included in capacity calculations, consolidation of the service areas will result in an effective production capacity of approximately 4,170 gpm.

Two separate system conditions must be evaluated to determine if system water production is adequate. These include *peak hour demands*, a condition that represents the highest 4-hour period of demand from customer use, and *maximum day + fire*, representing high customer water use occurring during a large commercial/industrial fire (3,000 gpm for 3-hours). Peak Hour demand of the proposed consolidated system will include peak hour for both Waterford and River Pointe service areas of 2,565 gpm and 480 gpm respectively, resulting in a total Peak Hour demand of 3,045 gpm. As shown in Table 2.8, the consolidated system has surplus water of 115 gpm after meeting peak hour demands, without using River Pointe storage. Thus, storage can be fully dedicated toward fire suppression.

Table 2.8 Consolidation Demand and Production Values (gpm)

	Current Conditions [a]	With New Demand Values	With Consolidation
Total Well Production	2,875 [b]	2,875	4,425
Effective Well Production	1,660 [c]	1,660	3,160
Maximum Day Demand	3,685 [d]	1,710	2,030
Peak Hour Demand	5,528 [d]	2,565	3,045 [e]
Peak Hour Surplus/Deficit	< 3,870 >	<50>	115
Max Day + Fire	6,185	4,710	5,030
Storage Production (gpm)	0	0	1,110 [f]
Effective Well Production With W244 [g]	2,150	2,150	3,650
Max Day + Fire Surplus/Deficit	< 4,035 >	< 2,560 >	<270>

a. Waterford Service Area only (not including River Pointe).
b. Per efficiency testing conducted by City in fall, 2015.
c. Total production less W302 (largest producer) and W244. Under peak hour, effective well production can include highest producing well, or Total Well Production value.
d. DDW Annual Inspection Memorandum, March 19, 2013.
e. Per DDW current permit requirements (maximum day x 1.5).
f. GPM equivalent of 200,000 g storage for 3 hours.
g. W244 is available during an emergency, per DDW code for standby wells with secondary contaminant violations, and River Pointe wells at 750 each.

The City standards identify 3,000 gpm for maximum fire events. [8] When evaluating a maximum day + fire event, Waterford currently has no storage for fire suppression demands, so water must come solely from well production. Well 244 can be used during an emergency, bringing the total water production for maximum day + fire events to 2,150 gpm. [9] When evaluating the maximum day + fire event, the current Waterford system (without consolidation) the system has a deficiency of 2,560 gpm. Consolidation allows use of the 200,000 gallon storage facility at River Pointe for fire, resulting in a deficiency of 270 gpm. Upon completion of well pump upgrades, it is expected no deficits will remain.

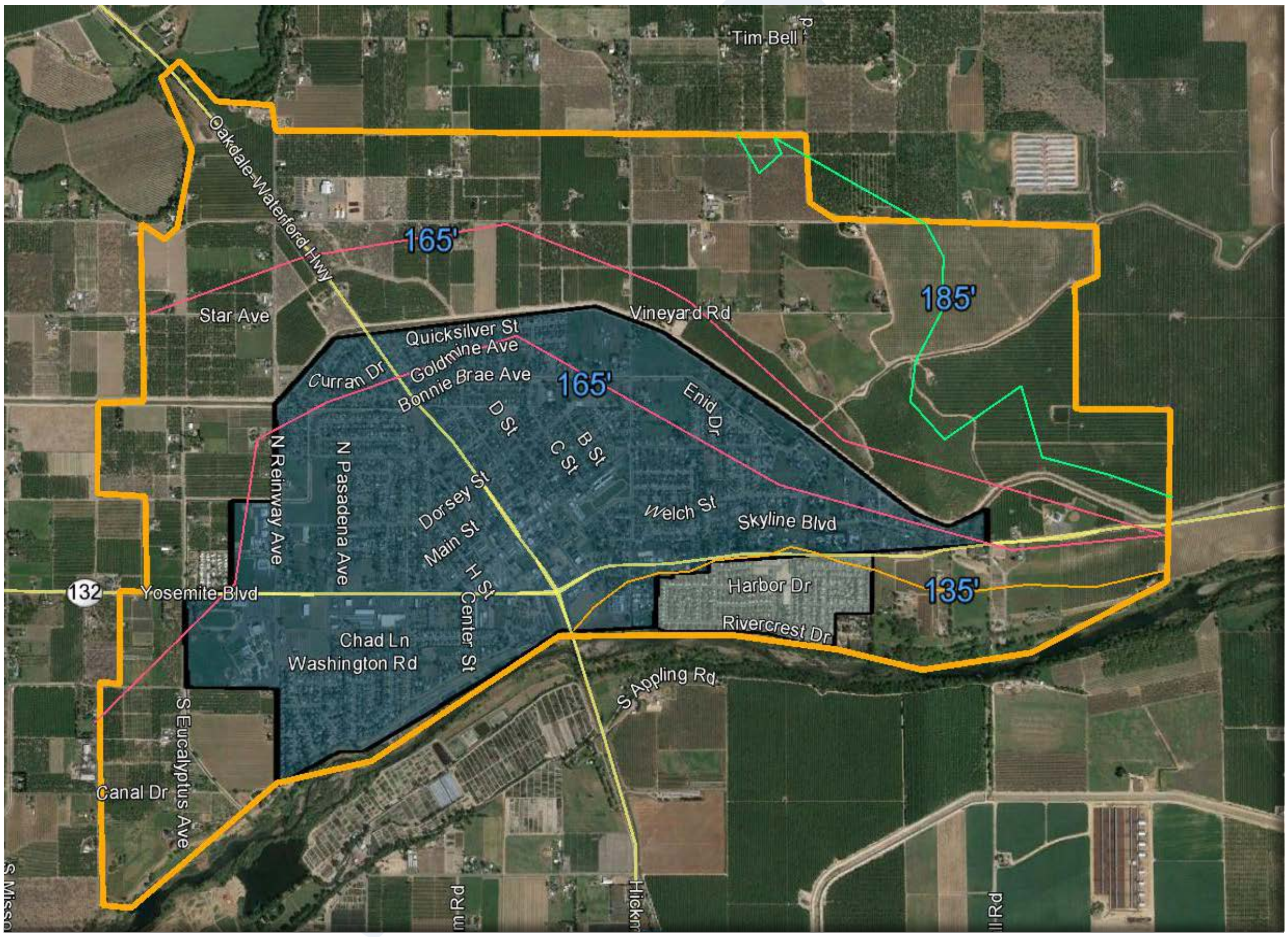

Figure 2.9 - Topographic Ground Elevation Contours

Another issue of concern associated with consolidation of the Waterford and River Pointe water service areas is the ground elevation. River Pointe has topographic elevations as low as 100’, whereas Waterford has elevations as high as 170’. Ultimately with expansion into the City SOI, topographic elevations may be as high as 200’. A difference in elevation from 170’ to 100’ equates to a pressure difference of

[8] Per City and industry standards is to meet maximum day with one (1) major fire suppression demands, while maintaining at least 20 psi system pressure.

[9] For emergency events, W244 can be operated 15 days per year, up to 5 days at a time.

approximately 30 psi. Assuming the highest points in the Waterford system have service pressures of 40 psi (minimum per permit requirements), the lowest areas in River Pointe would exceed 70 psi. Although 70 - 75 psi is an acceptable service pressure, it is recommended that all areas in the City with elevation of approximately 135' be separated with pressure reducing valves to maintain operating pressures between 45 psi and 60 psi. Lowering pressures reduces water use, leakage, strain on pipes, water heaters, etc. The area that falls below 135' elevation is a relatively small area, as shown in Figure 2.3. In the future, when development expands to the east, areas over approximately 185' can be in a third pressure zone, with booster pumps raising pressures from the middle zone into the high zone.

Thus, consolidating River Pointe and Waterford systems addresses all capacity deficiencies. The estimated costs for installing a connecting pipeline between River Pointe and Waterford at F Street and Yosemite Boulevard is $656,000. [10] A smaller project, whereby a pipeline connects at Covey Street and Tim Bell Road has an estimated cost of $405,000. Construction of additional source water to achieve the same source water capacity as the consolidation alternative would be approximately $2.5M, as two (2) new wells would need to be constructed at approximately $1.25M per well.

Consolidation of Waterford and Hickman Systems - Currently, the Hickman system has insufficient source capacity. Hickman has two (2) wells with production capacity of 400 gpm (W309) and 200 gpm (W272). With the largest producing well out-of-service (W309), the total supply is approximately 200 gpm. The maximum day and peak hour demands are estimated at 208 gpm and 313 gpm, neither which can be meet when the largest producing well is off-line. Fire demands for the system equal or exceed 2,500 gpm, thus adequate fire protection is not available at any time.

There are other considerations that factor into the City's decision regarding its long-term plans for the Hickman Water Service Area, as Hickman is not included in the Waterford City limits nor its sphere of influence. Waterford has no annexation plans for Hickman, so consolidation of Hickman and Waterford systems may not be desirable, regardless of the costs. Due to the number of customers in the Hickman system, Waterford residents would likely need to subsidize the cost of water service in Hickman if consolidation were to occur. Unless outside grant funding is provided by the State or other means, system consolidation should not be considered. The cost of a pipeline to join Waterford and Hickman is estimated at approximately $1.6M.

Assuming the system is to remain physically independent, improvements required for the Hickman system to meet State Water Code and industry standards for fire suppression include a storage tank/booster facility. The tank/booster facility must be adequately sized for fire and peak hour demands. Based on a fire suppression demand of 2,500 gpm for 3 hours, plus a peak hour demand for 4 hours, the total storage capacity required in 2016 is approximately 500,000 gallons. Since the smallest well (W272) has production that effectively equals maximum day demands, any addition growth in Hickman will require either (1) increasing the production from existing wells (i.e. increase pumping capacity), or (2) construction of an additional well. Assuming that the tank/booster facility will be sized to accommodate

[10] *Water Consolidation Project at Yosemite and "F" Street*, January 2016, MCR Engineering.

some growth (i.e. additional 25% capacity), the construction cost of the facility is estimated at $2.0M. Cost for adding additional production capacity will range from approximately $200,000 to $700,000.

2.7 SERVICE AREA DESCRIPTION

The topography of Waterford is generally flat, with rolling hills southeast and northwest of the City limits. Historically the City and surrounding area have been used for orchards and other agricultural operations. There are pockets of active agricultural lands within the city limits, with a majority of the lands surrounding Waterford still in agricultural or rural uses. Some lands both within and outside of the City have been designated as Prime Farmland, Farmland of Statewide Importance, and Unique Farmland by the California Department of Conservation Farmland Monitoring and Mapping Program (FMMP). Some of these properties are under Williamson Act contracts (California Land Conservation Act of 1965).

Existing land uses within the City are generally characterized by established and newer suburban style residential neighborhoods, a historic downtown area, commercial corridors, public/semi-public uses, and parkland. Uses surrounding the City, including its future sphere of influence, consist primarily of agriculture with active field crops, orchards, dairy production, pastureland, and/or livestock grazing. Some of these areas also include large lot suburban or rural estate homes. Existing land use and associated acres are shown in Table 2.9.

Table 2.9 Existing Land Use (2015) and Associated Area

EXLU	ACRES
Agricultural	389.18
Commercial	18.33
Commercial Future	20.72
Industrial	12.66
Mobile Home Park	2.72
Multi Family Residential	31.49
Vacant Single Family Residential	85.22
Mixed Use	27.29
Office	1.79
Open Space	19.34
Public/Semi-Public or ROW	260.00
Single Family Residential	447.8
Church	39.46
Schools	51.55
Public Government	41.86
Total Developed Acres in 2015	**1449.41**

The City provides public services within its boundaries, which includes water supply. The water system includes groundwater wells, distribution piping and appurtenance, and booster pumping stations. The water service area has only one pressure zone due to lack of changes in topography. Ground elevations range from approximately 100' (south) to approximately 185' (north east).

2.8 SERVICE AREA CLIMATE

The National Weather Service has maintained a cooperative weather station at Woodward Dam for many years. In January, average temperatures are a maximum of 52.4°F (11.33°C) and a minimum of 35.1°F (1.72°C). In July, average temperatures are a maximum of 102.8°F (39.33°C) and a minimum of 58.4°F (14.67°C). The record high temperature was 114°F (45.56°C) on July 18, 1925. The record low temperature was 12°F (-11.11°C) on December 11, 1932. Annually, there are an average of 84.6 days with highs of 90°F (32°C) or higher and an average of 30.8 days with lows of 32°F (0°C) or lower. Average annual rainfall is 13.33 inches. There are an average of 44 days annually with measurable precipitation. The wettest year was 1958 with 22.15 inches and the driest year was 1947 with 7.99 inches. The most rainfall in one month was 8.63 inches in January, 1911. The most rainfall in 24 hours was 5.72 inches on April 3, 1958. The record snowfall was 1.5 inches in January 1930.Mean monthly rates for evapo-transpiration and precipitation, and mean temperatures are shown in Table 2.9.

Table 2.10 Mean Climate Data for City of Waterford [11]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
ET [12]	1.22	2.04	3.54	4.89	6.85	8.01	8.48	7.50	5.50	3.55	1.77	1.08	**54.43**
Precipitation	2.36	2.06	1.31	1.06	0.68	0.04	0.02	0.01	0.08	0.57	1.01	2.21	**11.42**
Temperature	**46.5**	**51.2**	**56.4**	**60.2**	**68.3**	**74.9**	**79.2**	**77.8**	**73.4**	**64.3**	**54.1**	**47.1**	**62.8**

2.9 SERVICE AREA POPULATION

The 2010 United States Census reported that Waterford had a population of 8,466 (now closer to 8,690). The population density was 7,807.4 people per square mile (3,072.5/km²). The racial makeup of Waterford was 6,003 (70.9%) White, 77 (0.9%) African American, 11 (0.12%) Native American, 129 (1.5%) Asian, 110 (1.3%) American Indian or Alaskan Native, 1,740 (20.6%) from other races, and 386 (4.5%) from two or more races. Hispanic or Latino of any race were 3,579 persons (42.2%).

[11] Precipitation and temperature based on nearest Western Regional Climate Center station in Modesto, CA. Actual precipitation is expected to be slightly greater than that shown.

[12] California Irrigation Management Information System, Department of Water Resources, Station 194 Oakdale, Monthly Average ETo.

There were 2,458 households, out of which 1,314 (53.5%) had children under the age of 18 living in them, 1,499 (61.0%) were opposite-sex married couples living together, 357 (14.5%) had a female householder with no husband present, 191 (7.8%) had a male householder with no wife present. There were 172 (7.0%) unmarried opposite-sex partnerships, and 15 (0.6%) same-sex married couples or partnerships. 305 households (12.4%) were made up of individuals and 106 (4.3%) had someone living alone who was 65 years of age or older. The average household size was 3.43. There were 2,047 families (83.3% of all households); the average family size was 3.71.

There were 2,665 housing units at an average density of 1,125.1 per square mile (434.4/km²), of which 1,627 (66.2%) were owner-occupied, and 831 (33.8%) were occupied by renters. The homeowner vacancy rate was 2.5%; the rental vacancy rate was 7.1%. 5,489 people (64.9% of the population) lived in owner-occupied housing units and 2,944 people (34.8%) lived in rental housing units. The approved City GP land use map is shown in Appendix A.

The City's water service boundaries are congruent with its service area boundaries. The City provides water service to a population of approximately 8,690, through 2,507 metered connections, including 330 in River Pointe, consisting of residential, commercial, and institutional uses. Table 2(D) provides a summary of the City service area populations. Table 2.11 provides a summary of the water service connections by land use type.

Table 2.11 Water Service Connections Including River Pointe, 2015

Land Use/Demand Type	Service Connections
Residential	2,374
Multifamily	49
Commercial	70
Other	14
Total	2,507

2.10 FUTURE PLANNING AND POPULATION PROJECTIONS

In October, 2006, the City approved the 2025 General Plan (GP), which identifies future expansion areas of the City, population estimates, land use designations, public services, etc. According to the GP, build-out of the new General Plan area will take 50+ years, resulting in an estimated population of approximately 28,200 persons, and include 2,329 total acres, including River Pointe, as shown in Table 2.12.

Table 2.12 2025 General Plan Development Holding Capacity, Including River Pointe

Attributes	2015	2035	Build-out
Dwelling Units	1,993	3,699	8,068
Population	8,696	14,600	28,200
Low Income Housing	NA	NA	NA
Total Acres	**694**	**1,210**	**2,329**

The current and 5-year increment projected population estimates for the City are provided in Table 2.13, with associated growth rates for each of the 5-year periods. Population projections are based on the acres of high, low, and medium density residential land, multiplied by an average density 3.2 persons per unit.

Table 2.13 5-Year Population Projections and Growth Rates

	2015	2020	2025	2030	2035	2040	Buildout-2070
Growth Rate	NA	3.98%	2.70%	2.37%	2.12%	1.78%	NA
Population	8690	10,400	11,800	13,200	14,600	15,900	28,200

Section 3 System Demands

3.0 INTRODUCTION

Water use in the state of California varies depending on the location, as expected. Those areas where the climate is warmer and have less rainfall use more water than colder, wetter locations. For example, households in the Bay Area and San Diego use less water than those in Sacramento and Bakersfield. According to DWR, the average water use in the San Joaquin hydrologic region (which includes Stanislaus County) is approximately 248 gallons per person per day (gpcd).[1] In 2005, Waterford had an average use of approximately 225 gpcd. Since 2005, the state has put forward a combination of laws and water codes to reduce average water use in urban settings, with a target of 174 gpcd for the San Joaquin region. (Section 5 provides a comprehensive discussion about conservation laws and codes). It is important that water purveyors account for mandatory conservation requirements in their water programs, otherwise problems may result, including:

- Water rates may not account for fixed operating costs as less water is consumed (sold);
- Infrastructure may be oversized, increasing the cost of construction, replacement, operation, and maintenance;
- Water quality and public health issues, due to stagnant water, formation of disinfection byproducts (carcinogens), etc.

Beginning in 2007, the City of Modesto began installing water meters on all water service connections in Waterford. Upon completion in 2015, water use had declined by approximately 30%, and is expected to remain lower indefinitely since there is a financial incentive for residents to use less water. Additional mandatory water conservation programs are expected to further reduce the water use. In 2015, Waterford use averaged approximately 130 gpcd, likely due to drought restrictions and voluntary conservation efforts by residents.

The City supplies potable groundwater for residential, industrial, and commercial potable use through a combination of groundwater wells, storage tanks, treatment facilities, and network of piping. Each water service is equipped with a water meter for accounting and billing. The City is responsible to operate and maintain the water system up to the water meter. Water meters for residential services range from 5/8” to 1” in diameter. Commercial services are typically 1” or greater, depending on the type of use. The largest connection is 6” in diameter.

The amount of water used by a property owner is a function of several factors. These include the price of water, income, demographics, conservation measures, and climate. Since a large portion of water

[1] “20 x 20 x 20 Water Conservation Plan”, (2020), average water use for region from 1995-2005.

goes to outside use to irrigate landscaping, communities located in warmer areas typically consume more water during the year. Although price is a deterrent, it does not always result in sustained reductions in water use.

There are three main water use values that must be considered when planning and designing water supply programs. These include annual demand, maximum day demand, and peak hour demand, as described below:

- *Annual Demand* – The total amount of water a community uses during the year. This value determines the water needed from source supplies, such as groundwater and/or surface water. Communities must plan to secure long-term water availability based on annual demand projections.
- *Maximum Day Demand* – The highest amount of water used in one 24-hour period. This value determines the capacity of water treatment facilities. Although this condition may only occur a few days each year, communities should plan to size treatment facilities (and storage) to meet maximum day conditions assuming an unscheduled maintenance event removes a portion of the treatment capacity from service.
- *Peak Hour Demand* – The highest amount of water the system will move at any given moment. This value determines the storage and pipe (distribution) capacity of the system. [2] This condition is assumed to last for approximately 4 hours during a maximum day demand.

In the past, public water purveyors would traditionally look to secure additional supplies to meet future demands. However, with the introduction of mandatory water conservation codes and regulations, meeting some or all future demands through demand reduction activities (conservation) is inevitable and often prudent. As such, some water conservation is assumed and incorporated into the City Water Program, and significantly alters future demand projections.

3.1 EXISTING UNIT WATER DEMANDS

As shown in Figure 3.1, the average recorded daily water use per person averaged around 225 gpcd until recent years, prior to installation of water meters. Average water use has declined to as low as 130 gpcd, however the lower water use may not be sustainable. Upon the return to normal hydrologic conditions (i.e. no drought), demands are expected to rise closer to 2010 – 2013 values (150 gpcd). The City is required by law to maintain capacity to provide both maximum day demand and peak hour demand, through a combination of production (wells), and storage. The State of California, Division of Drinking Water (DDW), issues public water system permits to water agencies that include specific operating parameters, including minimum requirements for water quality and water capacity. According to the existing permit, DDW expects Waterford to maintain 3,685 gpm capacity for maximum

[2] Emergency flow conditions (e.g. fire demands) are also taken into account when designing these facilities.

day demands. In early 2016, the City submitted a formal request to DDW to amend its permit by lowering the capacity requirement to reflect the change in use due to installation of water meters. The new capacity requirement is 1,710 gpm, representing a reduction of 54% in required source capacity.

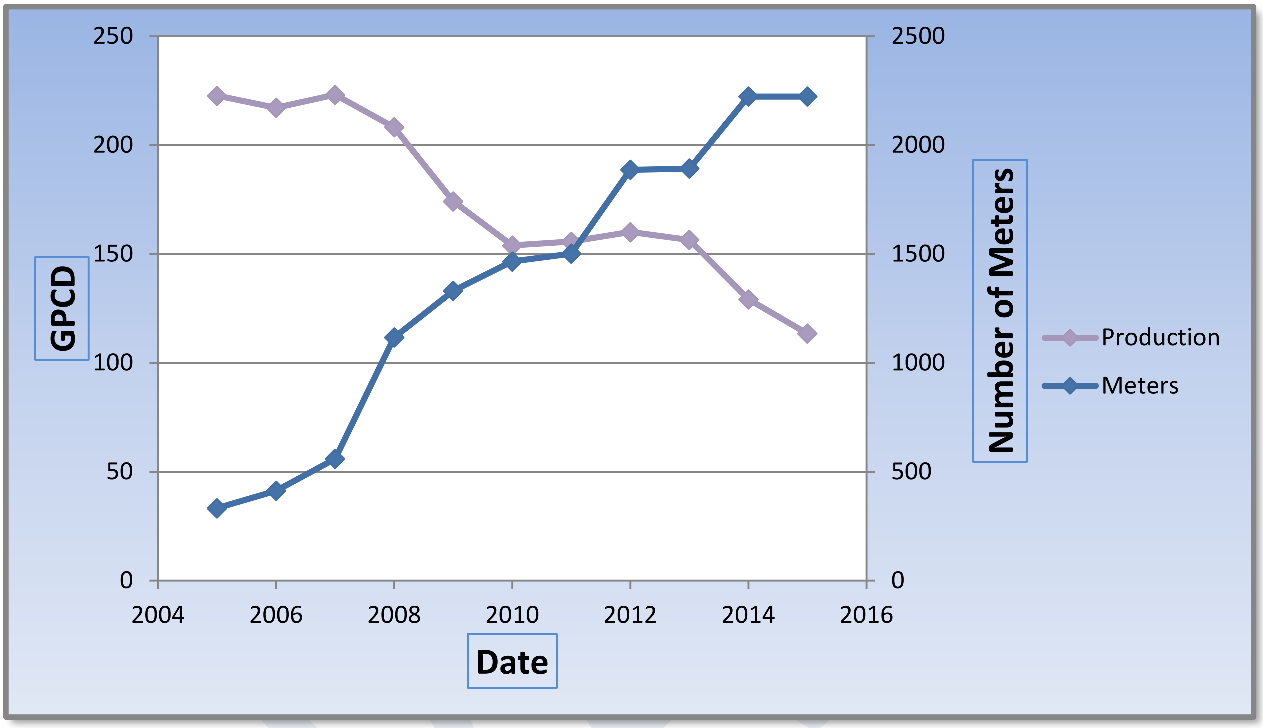

Figure 3.1 Average Annual Water Use vs Meter Installation

3.2 DETERMINING BASE DAILY PER CAPITA WATER USE

Upon reaching 3,000 service connections, the City will be required by state law to reduce its water use based on one of four water use target methods, as specified in the Urban Water Management Planning Act (UWMPA). To measure and monitor this goal, the Water Conservation Bill of 2009 requires each urban retail water supplier to include in its Urban Water Management Plan (UWMP) an estimate of a "base daily per capita water use", or effectively a "historical starting point". Base daily per capita water use is established by reviewing historical data from the previous 10 - 15 years.

3.3 UWMP WATER USE TARGETS

Specific reductions in water use are referred to as "targets", determined by using one of four methods approved by the state, as described in SBx-7x7. Typically use is based on historical "pre-2010" average daily unit demands, 95% of the regional target of 174 gallons gpcd, or other methods as described herein. Upon reaching 3,000 connections, the City will perform the calculations and develop a target in its UWMP.   It was estimated that the City's baseline water use will be approximately 210 gpcd. The acceptable calculation method descriptions used to determine the water use targets and expected targets are defined below:

- **Method 1** :
  - Definition: 80% of the water supplier's baseline per capita water use.
  - Result: 80% of 210 gpcd = 168 gpcd.
- **Method 2**:
  - Definition: Per capita daily water use estimated using the sum of performance standards applied to indoor residential use; landscaped area water use; and CII uses.
  - Result: The data needed to support calculations for a Method 2 calculation may not exist, thus this method may be discarded.
- **Method 3**:
  - Definition: 95% percent of the applicable state hydrologic region target as stated in the State's April 30, 2009, draft 20x2020 Water Conservation Plan.
  - Result: The state target for the Waterford area is 174 gpcd. 95% of 174 = 165 gpcd
- **Method 4**:
  - Definition: For this Target method, savings are assumed between the baseline period and 2020 due to metering of unmetered water connections and achieving water conservation measures in their water use sectors.
  - Result: The City of Waterford has been fully metered since 2014, thus method is not effective.

Table 3.1 Summary Table for Target Demand Methods

Method	Result (GPCD)
Base Historical Daily Water Use	210 [a]
Method 1: 80% of Base	168
Method 2: Performance Standards	NA
Method 3: 95% of Hydrologic Region target (174gpcd)	165
Method 4: Metering	NA

a. Estimated value. Additional analysis will be required when an UWMP is completed.

3.4 WATER USE REDUCTION PLAN

As part of the UWMP, the City must select a target demand method (as described above), and establish a target demand factor for compliance with SBx7. However, due to the significant conservation achieved through installation of water meters, it is evident the City can achieve a lower average water demand than required by law. The benefits of this additional demand reduction are discussed in Section 5. These programs and activities are currently being implemented and are showing to be effective. Mandatory conservation measures (i.e. SBx7-7, SB407, AB 1881, California Green Building Code, and energy conservation programs that impact water use, such as low water use clothes and dishwashing machines) will further increase conservation efforts over time. For example, new development is required by law to use at least 20% less water than existing development. As such, water demand projections were based on reasonable and achievable water demand factors, which result in an average day demand of 145 gpcd. This value represents 6.5% reduction in average water use from 2010-2013 values. Additional reductions in demand may be desired by the City as discussed in Section 5.

3.5 FIRE SUPPRESSION

As part of the WMP, fire suppression demands were evaluated and incorporated into the capacity requirements. The City Construction Standards identify the need for 3,000 gpm capacity available at all times for fire events. Ultimately, the fire marshal determines the fire suppression needs for the community, including what each individual building or general development (i.e. residential) will require for proper fire suppression. Discussions with the Stanislaus Consolidated Fire Protection District (SCFPD) suggest that fire suppression studies of the City have yet to be prepared. According to the SCFPD,

"Without surveying the city, determining the maximum fire suppression water demand in the City of Waterford is difficult. As we examine fire flows for the existing buildings, the fire flows would have been determined through fire codes in effect at the time of construction. To adequately identify the specific demands of the water system based on the target hazards in the community a study would need to be conducted, examining the types of construction, building area and the available fire protection systems. During this study we should also examine the location of the available fire hydrants. This may show limitations of the current system."

Until more information is available from the fire marshal, the exact fire suppression needs of the City are unknown. However, using an industry standard of 3,000 gpm for 3 hours (1,500 gpm for residential), should be adequate for the WMP. Additional efforts to determine maximum fire suppression needs for all structures in the City should be a priority. In the event fire suppression demands exceed 3,000 gpm for 3 hours, the capacity requirements may need to be updated.

3.6 WATER DEMAND FACTORS AND INFRASTRUCTURE REQUIREMENTS

Projections of future water demands were based on land use projections incorporating information from the 2025 GP. The rate of growth and land development were projected through the planning horizon (2070) to determine acres of all land uses (i.e. residential, commercial, industrial, parks, etc.) for a given year. The per acre unit demand estimates were developed from a combination of historical land use and City meter reading data overlapped with county land use information. Future developed acres and populations are based on growth rates as provided in Table 2.6. These values were multiplied by per acre unit demand estimates (ac-ft/acre) to determine total system average water use. Using these land categories, paired with per acre unit demands values, WMP demand projections were calculated. This resulted in an average demand per person (gpcd) of approximately 145 gpcd, representing about 94% of the actual water use from 2010 – 2013. The 145 gpcd value does not include implementation of the conservation scenarios as discussed in Section 5.

Table 3.2 Water Demand Factors and Requirements [3]

	2016	2070
Population	8,690	28,200
Average Annual Demand (Ac-ft/yr)	1,413	4,584
Maximum Day Multiplier [4]	1.9	1.9
Maximum Day Demands (MG)	2.39	7.77
Maximum Day Demands (gpm)	1,662	5,396
Peak Hour Multiplier	3.2	3.2
Peak Hour (gpm)	2,800	9,088
Peak Hour Storage (MG)	0.28	0.89
Fire Suppression Storage (MG) [5]	0.72	0.72
Total Storage Capacity Required (MG) [6]	1.25	1.86

Projected system water demands are illustrated in Figure 3.2. City water production must be designed to meet its maximum day demands, with some redundancy, typically calculating total system production capacity with the flow from the largest producing well or booster pump removed (out-of-service). Based on population projections and proposed conservation goals (see section 5 for details), the City will have a total average day demand of approximately 4.03 MG in 2070. Assuming a multiplier of 1.9 to determine maximum day demands (total water production requirement), the City will need to have a total production capacity of 5,396 gpm without its largest well/booster in service. As shown in the Summary of Well Production (Table 2-1), current well production is not adequate to meet these demands. Based on these numbers, the City will be required to: (1) construct at least three (3) new wells from 2016-2070, (2) proceed with construction of additional storage to account for peak hour and fire suppression demands, and (3) reinforce the source water program with an alternative source (i.e. surface water from Modesto Irrigation District). Additional conservation efforts, if implemented, may change some of the requirements.

[3] These values were used for sizing production, storage, and conveyance facilities. Additional reductions may occur with conservation efforts.

[4] Multiplier based on actual City production data.

[5] Based on 3,000 gpm for 4 hours.

[6] Total storage includes 0.25 MG redundant capacity for emergency conditions and loss of tank service.

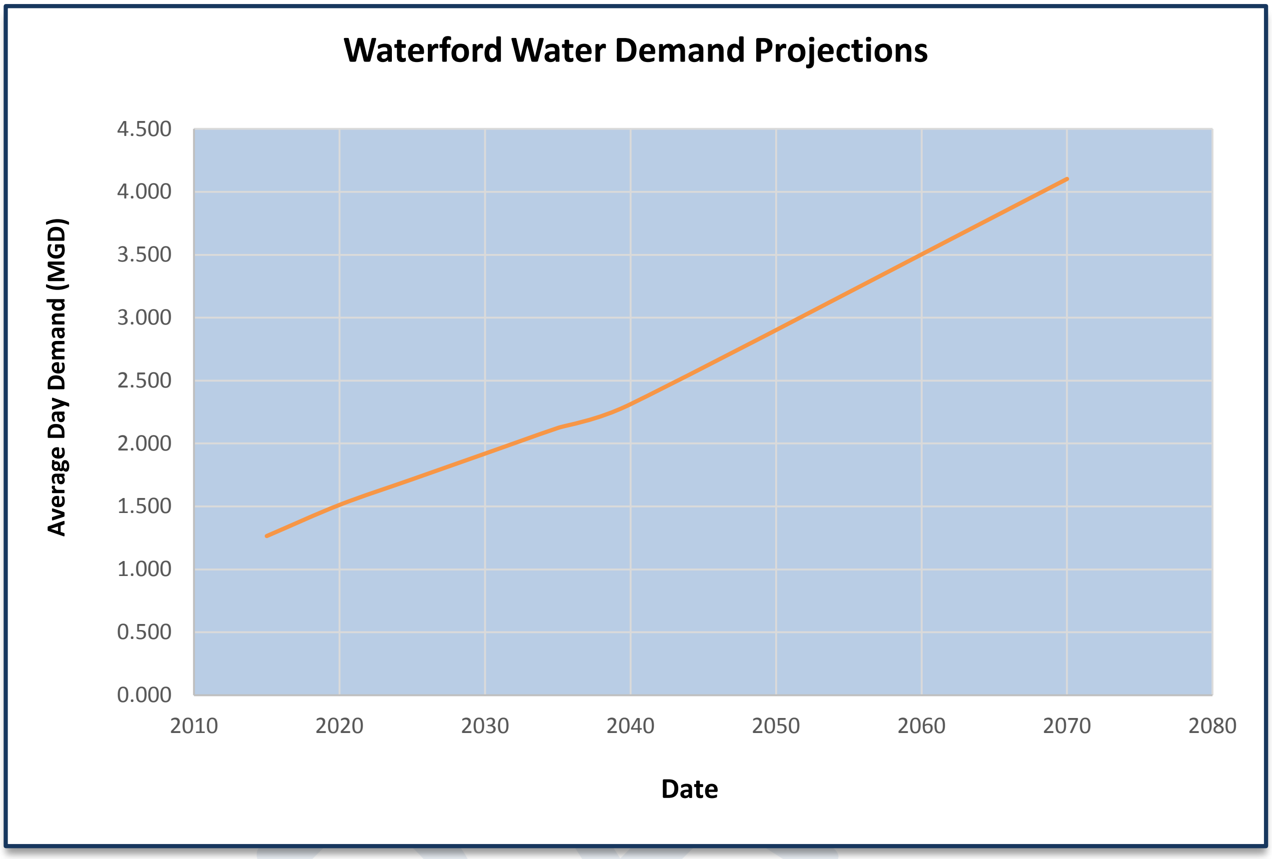

Figure 3.2 City of Waterford Water Demand Projections

Current production capacity will sufficiently meet current demands until additional storage and conservation are implemented. This scenario also assumes that reliable groundwater will continue without interruption indefinitely, which may not be an appropriate assumption, as discussed in detail in Section 4.

3.7 NON POTABLE DEMANDS

An analysis was performed of the potential for non-potable water use, since a portion of the City's water supply is, and will be, used for irrigation of public landscapes, such as parks, schools, cemeteries, landscape corridors, etc. Irrigation of urban and ornamental landscapes can often use a lower quality water supply, assuming it is not exceptionally salty, or the landscape vegetation is not excessively sensitive to salinity. Large parks and landscapes were identified, as shown in Table 3.3. The total current acres of large public landscape is approximately 56.68 acres, with total annual demand (theoretical) of 133.3 ac-ft/yr. The 2025 General Plan requires "*Overall, a minimum of 5 acres of parkland will be provided per 1000 residents in the City, of which 1.75 acres should be in community parks and 1.50 acres should be neighborhood parks.*" The City currently has 58.62 acres of public park space developed or proposed for the near future, which is sufficient for the current population of 8,690. More park space will be required as build out population is approached. The total acre-ft/year required for the public landscape in the build out scenario is 413.85 acre-ft/year. This represents approximately 9% of annual build out demands. Due to the projected non potable demand in combination with the high cost of implementing a recycled water program, it is doubtful treating and distributing recycled water for landscape irrigation is cost effective at this time.

Table 3.3 Current and Proposed Public Landscape Area Water Demand Summary

Irrigated Area Code	Facility Name	Acres	Developed/Proposed (according to City Records)	Theoretical Maximum Water Requirement (Acre-ft/yr)
SB1	Basin Park	1.94	Developed	0.0[7]
P1	Beard Park	11.61	Developed	29.03
P2	Bonnie Brae Strip	0.47	Developed	1.18
P3	Brethren Park	0.58	Developed	1.45
P4	Lambert Parcel	7.51	Proposed	18.78
P5	Lower Reinway Park	10	Proposed	25
P6	Overlook Parcel	1.12	Proposed	2.8
P7	River Park	1.81	Developed	4.53
P8	River Walk Trail	3.36	Developed	0.0
P9	Skyline Park	0.51	Developed	1.28
P10	Upper Reinway Park	19.6	Proposed	49
P11	Welch Strip #1	0.70	Developed	1.75
P12	Welch Strip #2	0.77	Developed	1.93
P13	Welch Strip #3	0.58	Developed	1.45
S1	Waterford Middle School	5.2	Developed	13
S2	Waterford High School	22.7	Developed	56.75
Required Future Parks	NA	82.38[8]	Proposed	205.95
Total		**170.84**		**413.85**

[7] An acre-feet of 0.0 refers to public landscape that does not require irrigation such as storm basins or walkways.

[8] Required additional park acres to meet General Plan requirement at build out.

Section 4 Water Supply Sources

4.0 INTRODUCTION

Of all the possible resources or constraints that can limit a community's ability to expand and thrive, water is often number one. Most problems with urban infrastructure have an engineering solution, assuming sufficient funding is available. A water source cannot be engineered or created. A community either has sufficient water or it does not. Modern agencies in arid climates with visions of long-term expansion and growth develop source water programs that are reliable and robust, capable of carrying them through periods of source water interruption or restriction. Typically this requires that the community develop a diversified water "portfolio", consisting of two or more source waters that are complementary. Multiple water supply sources provide redundancy and can allow the flexibility needed to manage supplies for sustainability. For example, a conjunctive use water program, the gold standard in California, is a water program that consists of both groundwater and surface water sources. During periods of high precipitation, the community leans on its surface water sources (from rivers, streams, etc.), allowing water to accumulate in the ground. During a drought, the community has stored groundwater supplies to draw from. The goals of a conjunctive water program are source water sustainability, self-reliance, and self-management of its resources.

The City of Waterford currently relies solely on groundwater. This water supply strategy has worked fairly well over the last 100 years for many Central Valley communities because it has been able to meet water needs at relatively low capital and operational costs. However, when there are significant increases in groundwater pumping due to growing water demands in the agricultural and urban sectors, and a decrease in groundwater recharge due to drought or other factors, using groundwater as an exclusive water supply source may be a risky decision considering the potential changes in groundwater quantity, quality, reliability, and cost.

Like many areas in California, the City is seeing declines in the local groundwater table. For example, despite a significant decrease in water use over the past two years of nearly 30%, the City has seen an average drop in the groundwater surface elevation of nearly 15 feet. This is likely due to higher reliance on groundwater in areas outside of the City, and is beyond the City's control. Future state groundwater regulations are expected to address this problem eventually, but this could place restrictions on the City's access to local groundwater in the future.

The City currently uses groundwater to provide almost all of its source water. Groundwater is, and is expected to continue to be, a prominent water supply source for the City indefinitely for the following reasons: (1) it is reliable, (2) it is inexpensive relative to other sources, (3) its use and cost are primarily under the control of the City, (4) it is relatively stable during extended periods of drought, (5) the quality is good, and (6) the systems are already in place (no significant additional infrastructure required).

Other sources of water may include surface water, and recycled wastewater from the City's Wastewater Treatment Plant (WWTP). Surface water sources include local rivers, reservoirs, and state/federal water project conveyance systems. In California, all surface water is allocated, hence acquiring surface water entitlements require that the water be obtained from a current holder of the entitlement through purchase, exchange, dedication, etc. Obtaining a surface water supply can be difficult and expensive. Most communities that have access to a surface water supply consider it to be one of their most valuable assets. The City may have a unique opportunity for surface water due to its location near the Modesto Irrigation District's treatment and conveyance facilities.

In addition, conservation and efficient water use will be an important part of managing demands and reducing the amount of source water required. Unit water demand reduction is expected through the planning period. Conservation will be achieved through a combination of mandatory and elected activities, and other water conserving efforts that may be appropriate for the City. Failure to recognize the changing regulatory environment and its impact on future water use can result in oversizing water and wastewater infrastructure, costing the residents of Waterford millions of dollars over the years.

The City should establish a long-term goal to diversify its water supply portfolio (increase the amount of water resources) because of the vulnerabilities associated with relying on one water supply source. The main points of vulnerability for groundwater are reduced quantity (due to drought and increased pumping) and contamination from naturally occurring contaminants and human contributed contaminants. Although surface water is often the most common alternative source to groundwater, the City could also include recycled wastewater, storm water, and conservation in its water portfolio. [1]

Accessing surface water presents several challenges to the City of Waterford including, but not limited to, increased demand and competition for limited supplies exacerbated by:

- Surface water rights constraints
- Reduced availability of surface water due to drought conditions and climate change impacts
- Reduced availability of surface water due to regulatory constraints
- Institutional challenges to the use of surface water by the City.

The following provides a discussion of potential source waters available to the City, the challenges associated with their use and accessibility, and how the sources could be used together for a sustainable water program.

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1. Conservation can be considered a "source" as it is an acceptable and common method used to ensure supplies meet demands. The topic of conservation is discussed in more detail in Section 5.

4.1 WATER SUPPLY CHALLENGES

This section briefly describes the primary water supply challenges that are currently facing the City of Waterford's municipal water system. The water supply challenges considered in this section consist of the following:

A. Reduced groundwater quantity

B. Groundwater quality issues

C. Availability of surface water given drought conditions and water rights, regulatory constraints, and institutional challenges

D. Affordability of surface water.

The following discussion provides a summary of the source water evaluation conducted as part of the WMP. Appendix B provides a complete review of source water options associated with an integrated water management strategy.

A. Reduced Groundwater Availability The City of Waterford overlies the Modesto Groundwater Subbasin and Hickman overlies the Turlock Groundwater Subbasin, with the Tuolumne River marking the boundary between the two subbasins. The current drought conditions and the changes in agricultural land use/irrigation are reducing the quantity of available groundwater to water users across most of Stanislaus County. Reviews of the Department of Water Resources (DWR) groundwater contour maps and groundwater elevations in City of Waterford wells show a steady decline in groundwater elevations (based on mean sea level) over the last 10 to 15 years (see Figure 4.1 and Figure 4.2).

Figure 4.1 and Figure 4.2 are typical of the production well elevation data in the City of Waterford. The decline in elevations indicates that Waterford is experiencing impacts to the quantity of groundwater in its service area. Stanislaus County records show several rural residential wells have "gone dry" in the Waterford area. Similar groundwater elevation declines can be also observed in the Hickman service area (see Figure 4.3).

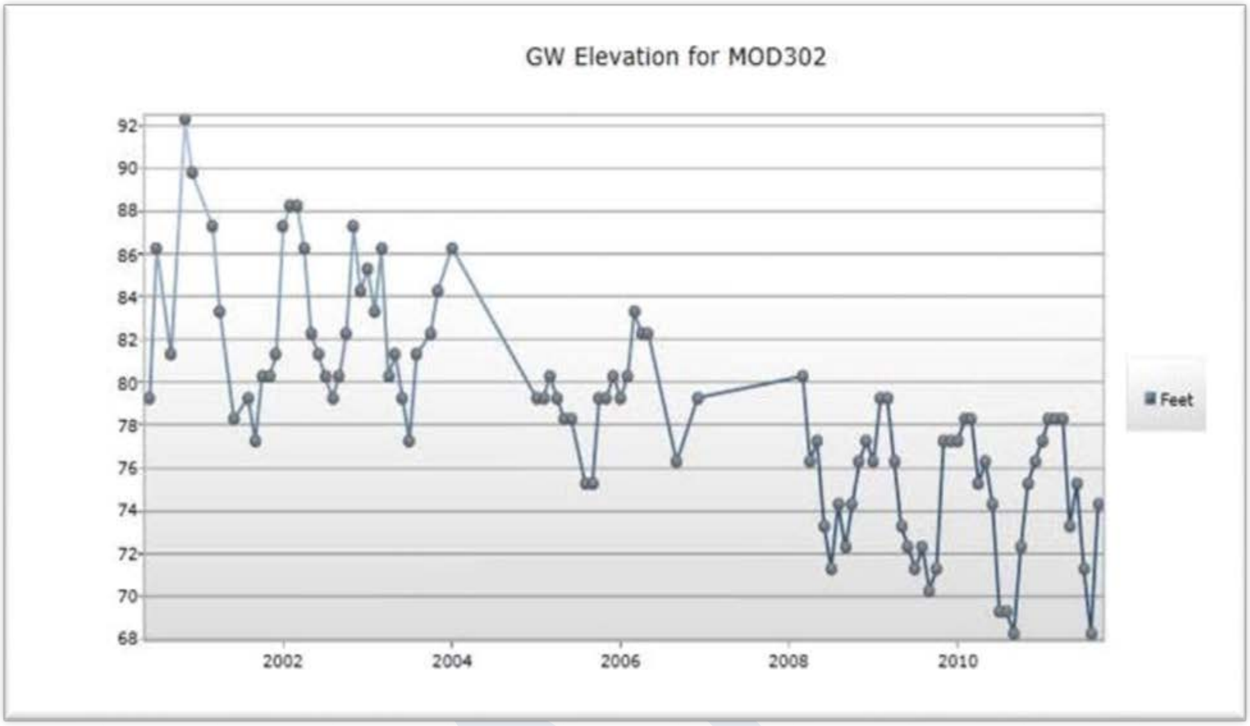

Figure 4.1—Groundwater Elevations in Waterford Service Area – Well 302
Source: Groundwater Resource Information Database 'GRID'

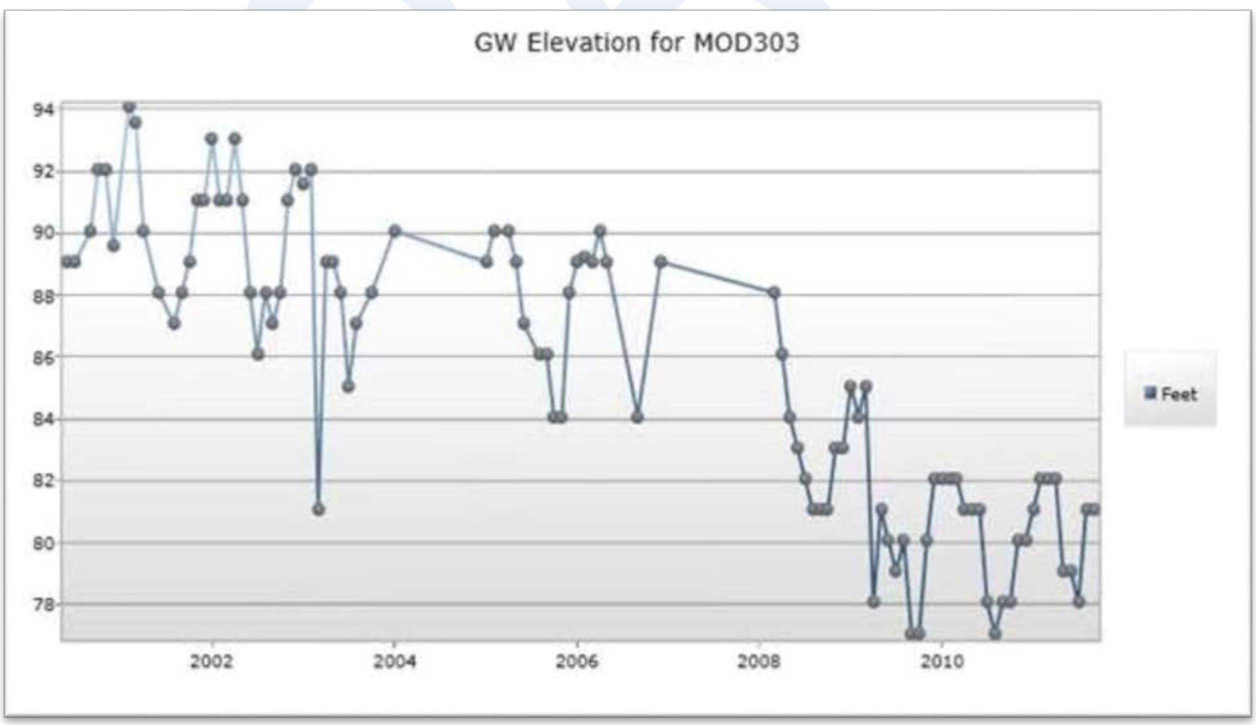

Figure 4.2—Groundwater Elevations in Waterford Service Area – Well 303
Source: Groundwater Resource Information Database 'GRID'

While the groundwater declines in the City of Waterford and Hickman areas are not as severe as in other parts of the San Joaquin Valley, the trend does highlight the vulnerability of groundwater as the sole source of municipal water supply for the City of Waterford and Hickman. The challenge is to stabilize the groundwater levels in Waterford and manage the supply so that it is sustainable. Fortunately, based on the groundwater elevation data, it appears that groundwater elevations rise during periods of recharge and/or reduced pumping. Thus, it appears that groundwater storage in the area can "recover" similar to what is observed within the core of the City of Modesto's contiguous service area where significant recovery was observed after 1995 with the introduction of treated surface water to the City of Modesto water system. This means that conjunctive use of surface water and groundwater by the City of Waterford may help to stabilize groundwater levels in the immediate area.

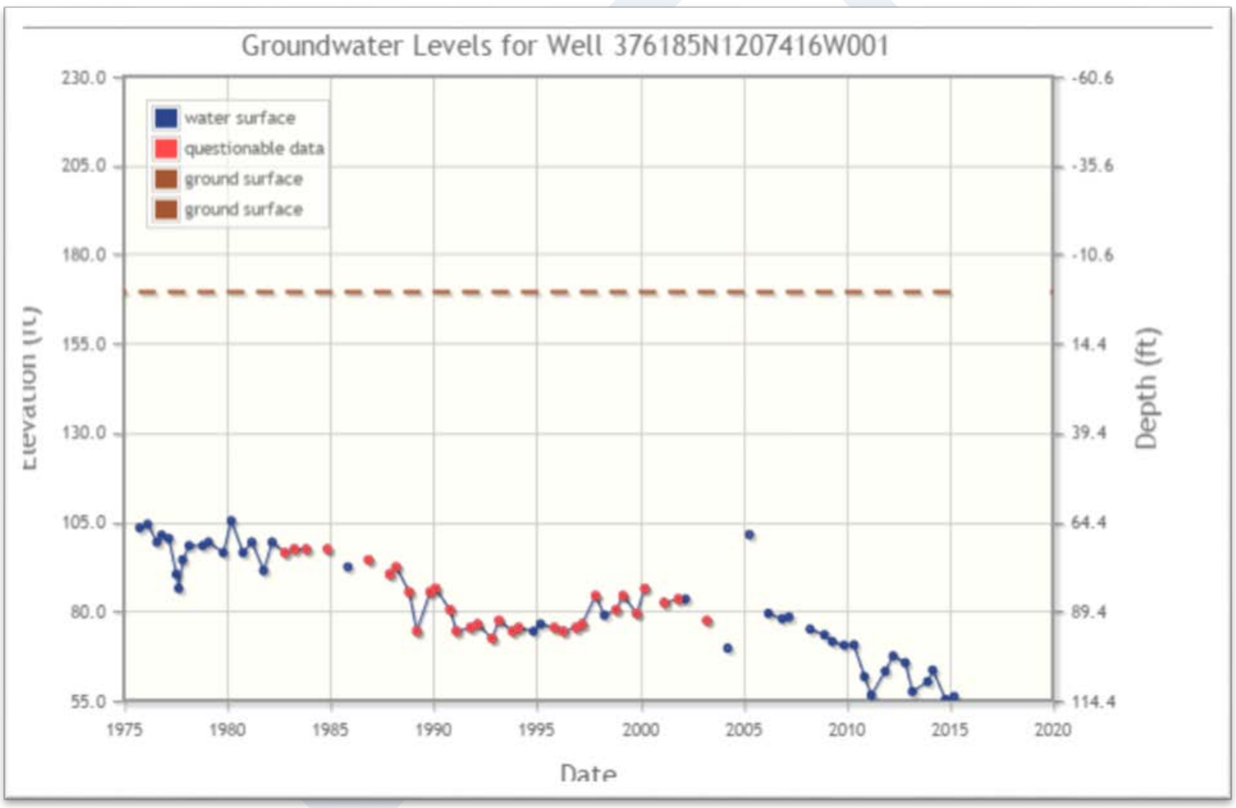

Figure 4.3—Groundwater Levels in the Hickman Area

Source: Department of Water Resources Water Data Library

B. Groundwater Quality Issues U.S. Geological Survey studies of the movement of transport of contaminants in groundwater in the eastern Modesto area show that groundwater pumping for irrigation and drinking-water supplies has increased the rates of downward movement of shallow groundwater into the deeper aquifers.[2] The rate of increased movement from the shallow zones to the deeper zones has most likely accelerated with the increased groundwater pumping due to drought conditions and changes in patterns of agricultural irrigation.

The movement of groundwater from the shallow zones to deeper parts of the aquifer can create problems for public water supply wells by transporting naturally occurring contaminants (such as arsenic and uranium) and man-made contaminants (such as pesticides, herbicides, nitrates, and solvents) into deeper zones typically used for municipal drinking water supplies. Different contaminants can be mobilized in groundwater due to the presence of dissolved oxygen in groundwater, the alkalinity of the groundwater, and the application rates of fertilizers, pesticides, and herbicides to irrigated land.

The way a water well is constructed can also affect the movement of groundwater from the shallow zones to deeper zones. Older open-bottomed well casings that are screened or perforated at several depths may experience "strong vertical hydraulic gradients that cause *shallow* groundwater to migrate from the upper part of the well screen to the near bottom of the well screen and into the *deep* part of the aquifer" when the well is not being operated (static conditions).[3] This can be a very serious problem when chlorinated volatile organic compounds (CVOCs) and dense non-aqueous phase liquids (DNAPLs) are present. DNAPLs are solvents and trichloroethene (TCE) and perchloroethene (PCE) are two carcinogenic solvents that have contaminated numerous wells in California. DNAPLs are heavier than water and will "sink," so wells that connect shallow and deep aquifers can serve as a path to move DNAPLs into the deeper aquifer zones (which are typically used for municipal drinking water supplies).

Removal or remediation of contaminants in groundwater by well-head treatment can be costly, both in terms of capital expense and ongoing operational costs as well as the cost for disposal of contaminants. It is best to prevent or avoid contamination through proper well construction standards, on-going groundwater monitoring via an established monitoring well system, pollution prevention programs, and conjunctive use management of the groundwater basin.

The City of Waterford is fortunate in that its municipal well system has not been significantly impacted by groundwater contamination. However, it should be noted that Well 303 has treatment facilities for dibromochloropropane (DBCP), an agricultural soil fumigant used to control nematodes (worms) in vineyards and orchards. DBCP is a suspected carcinogen that has been detected in many public water supply wells across the San Joaquin Valley. It would not be unlikely to see this contaminant emerge in other shallow wells in the area in time.

2. U.S.G.S. Scientific Investigations Report 2008-5156
3. U.S.G.S. Scientific Investigations Report 2008-5156, pg. 50

Additionally, the City of Waterford's water system is a "dispersed" system with water production coming from wells that are located at different points in the system. These dispersed wells feed a local distribution system of relatively small water mains. If wells have to be taken out of production due to groundwater contamination, it can lead to low water pressures and flows in the system.
The challenge for Waterford is to establish a program to manage groundwater quality in its jurisdiction to prevent contamination and avoid costly groundwater treatment.

C. Availability of Surface Water It goes without saying that there are ongoing multiple competing demands for surface water in California. This competition for surface water supplies is intensified during periods of drought and water scarcity. The challenges to acquiring surface water for the City of Waterford can be summarized as:

1. Surface water rights
2. Regulatory challenges
3. Institutional challenges
4. Drought and climate change
5. Affordability

1. Water Rights Surface water rights in California fall into the categories of riparian rights, pre-1914 appropriative rights, post-1914 appropriative rights, pueblo rights, and prescriptive rights. For the purposes of this Study, only pre-1914 and post-1914 surface water rights will be discussed; the other types do not readily apply to the City of Waterford's situation. A water right gives the holder the right to use surface water for beneficial purposes such as municipal water, agriculture, the environment, and recreation. *Water rights holders do not own the water—the State of California does*.

The City of Waterford holds no right to surface water, other than possibly a riparian right (the right to use water on a parcel that is immediately adjacent to a river or stream) from City-owned land at its wastewater treatment plant (with use limited to the wastewater treatment plant property).

Pre-1914 Appropriative Water Rights

Appropriative water can be defined as water that is diverted for use on non-riparian land (land that is not immediately adjacent to and connected to a river or stream). An appropriative right is the right to divert and use a specific quantity of water for specified purposes in a specific location.[4] Prior to 1914, there was no permit system in California to establish appropriative water rights to surface water and the establishment of such a right required simply posting and recording a notice of intended diversion with a county and the construction and use of actual diversion facilities. The notice had to include the amount

4 California Water II, Littleworth and Garner, Solano Press Books 2007, pg. 48

of water to be diverted, the place of use, and the intended use. California uses the "first in time, first in right" rule, therefore pre-1914 appropriative water rights are considered superior to post-1914 appropriative water rights.

Post-1914 Appropriative Water Rights

In 1914, a comprehensive permit system was established in California under the Water Commission Act of 1913 (State Water Code § 102). All new appropriative uses of water (both for diversion and storage) subsequent to 1913 require application to what is now the State Water Resources Control Board (SWRCB). A "post-1914" appropriative water right "will be granted by the SWRCB only after a public process in which the applicant is required to demonstrate the availability of unappropriated water and the ability to place that water to beneficial use. The SWRCB can verify the issuance and priority of any post-1914 water right." [5] As with pre-1914 appropriative water rights, "the first in time, first in right" rule applies to post-1914 water rights and establishes the priority date or "pecking order" of the right.

Curtailment of Water Diversions and Priority (Cutbacks)

The right to divert surface water in California is based on the type of right and the priority date. In times of drought and limited supply, the most recent water right holder ("junior" right holder) must be the first to discontinue use and will receive a curtailment notice from the SWRCB to stop diverting water. Even more senior water right holders, such as pre-1914 appropriative water right holders, may receive a notice to stop diverting water if their diversions are downstream of reservoirs releasing stored water and there is no natural flow available for the diversion. For example, a curtailment notice was sent to the City of San Francisco on June 26, 2015 for four of the City's appropriative water rights on the Tuolumne River dating back to 1903.

Surface Water Right Holders in the Waterford and Hickman Area

The Modesto Irrigation District (MID) is the agricultural and domestic water supplier for the Waterford area (MID supplies treated surface water to the City of Modesto). Turlock Irrigation District (TID) supplies water for agriculture in the Hickman area. Both MID and TID hold pre-1914 appropriative water rights on the Tuolumne River (under License 11058); however, the majority of the water rights held by both districts are post-1914 appropriative rights. Currently all water received by MID comes from post-1914 appropriative water rights.[6] In 2004, MID petitioned the SWRCB for a license change to allow a long-term transfer agreement with the City of Modesto for up to 67,200 acre-feet per year (AFY) of Tuolumne River water to augment Modesto's municipal supply for its planned needs. In order to access surface water on the Tuolumne River, the City of Waterford should pursue a long-term transfer agreement with MID similar to the City of Modesto's. This makes sense as the City of Waterford is in the

5. A Primer On California Water Rights Prepared by Gary W. Sawyers, Esq.
6. SRWA Water Supply Alternatives Final Report, February 2015, RMC Water & Environment with Carollo, pg. 1-2

MID service area geographically and MID facilities and infrastructure are close to the City of Waterford. A long-term transfer agreement and options are discussed in subsequent sections of this Study.
The challenge for the City of Waterford is to obtain a long-term surface water supply, recognizing that the available supplies may be subject to curtailment in times of drought due to the priority of the available water rights. Thus, it will be important for the City of Waterford to not only pursue a long-term transfer or contract, but to also consider water management strategies that will increase the overall reliability of its water supplies.

2. Regulatory Challenges The most immediate water supply regulatory challenges for the City of Waterford are, for the most part, related to surface water. Two major challenges consist of a proposed SRWCB water quality plan and the Federal Energy Regulatory Commission (FERC) relicensing of the MID/TID hydropower facilities. Both actions may reduce the availability of surface water for new and existing uses (as discussed below). The SWRCB is currently updating the 2006 Water Quality Control Plan (Plan) for the San Francisco Bay / Sacramento-San Joaquin Delta to restore and protect the Delta ecosystem. The Plan amendment being considered would mimic river conditions with unimpaired flow. Unimpaired flow is defined as "the flow that would occur if all runoff from the watershed remained in the river, without storage in reservoirs or diversions, such as irrigation, power generation, or water supply." The SWRCB process is developing flow regimes for tributaries by establishing flow objectives that are a percentage of unimpaired flow to approximate more natural flows for the benefit of salmon and other native species.[7]

The proposed SWRCB Plan amendment would mandate that three rivers—the Merced, Tuolumne, and Stanislaus, each a salmon-bearing tributary of the San Joaquin River—commit 35 percent of unimpaired flow to fish and wildlife into the San Joaquin from February to June each year. If this Plan amendment is adopted by the SRWCB in 2018, both TID and MID would receive significantly less surface water, meaning less water could be available for use the City of Waterford (up to one third of the available MID supply). Additionally, the Don Pedro Dam and Powerhouse (Project) are licensed by FERC. The current FERC license, which is held jointly by MID and TID, expires on April 30, 2016. MID and TID started the relicensing process in 2011 to complete the extensive studies and stakeholder engagement process required for relicensing. The FERC relicensing process takes into account the direct, indirect, and cumulative effects of Project operations and maintenance. Studies of the Project impacts to recreational, water, aquatic, and terrestrial resources are key parts of the process. Relicensing may reduce the amount of available surface water for new uses, depending on the protection, mitigation, and enhancement (PM&E) alternatives that are adopted to address the direct, indirect, and cumulative effects of Project operations and maintenance.

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7. From the Public Draft Substitute Environmental Document in Support of Potential Changes to the Water Quality Control Plan for the San Francisco Bay-Sacramento/San Joaquin Delta Estuary, Executive Summary, 2012

3. Institutional Challenges Institutional challenges consist of potential issues related to the rules, conditions, agreements, and other related mechanisms needed to access and use surface water by the City of Waterford. There are several alternatives identified in this Study and each has a set of institutional requirements. These can be summarized as:

- Establishing collaborative working agreements with potential water suppliers
- Negotiating and securing agreements to use surface water
- Negotiating transfer and/or exchange agreements or contracts
- Complying with State and SWRCB licensing and permitting requirements
- Complying with the California Environmental Quality Act (CEQA)
- Establishing funding for water purchases
- Financing infrastructure for the treatment and delivery of surface water.

There are existing agreements between area agencies that can be used as models to develop agreements for the City of Waterford. The biggest challenge will be to develop collaborative working agreements with potential water suppliers to facilitate surface water supplies for the City and then following through with either exchanges or contracts. There are also existing rules for the use of water within the region that need to be considered when evaluating and pursing water supply alternatives. For example, MID and TID currently have an agreement defining the place of use for their shared rights on the Tuolumne River. Under the terms of the agreement, if the City of Waterford were able to use MID surface water, it could be used to supply Waterford, but not the community of Hickman, because Hickman is in TID's place of use (south of the Tuolumne River). In this case, if the City of Waterford were to intertie its water system with the Hickman water system, an agreement would need to be in place stipulating that the City of Waterford would use groundwater to supply Hickman via the intertie (similar to the arrangement the City of Modesto and MID have regarding supplying water for South Modesto). These institutional challenges are taken into account in the evaluation of water supply alternatives for the City of Waterford.

4. Projected Climate Change Impacts Good water supply planning incorporates projected climate change impacts to help determine the future availability (or scarcity) of water supplies. In 2014, the Bureau of Reclamation released a report on projected climate change impacts to water supplies in the Central Valley entitled "The Sacramento and San Joaquin Basins Climate Impact Assessment." The report assumes that most of the Central Valley may warm by 1°C in the early 21st century with a 2°C increase projected by mid-century. Precipitation patterns indicate that there is a clear north to south decreasing precipitation trend compared to historical trends. The following is the report's summary of the impacts of the projected warming conditions, changes in precipitation, and population growth:

- Due to the warming conditions, storm runoff will increase in winter and decrease in spring as more precipitation falls as rain instead of snow. Reservoirs may fill earlier and excess runoff would have to be released earlier to ensure proper flood protection capacity is maintained. This may lead to reduced water storage in reservoirs when the summer irrigation season begins.
- Water demands are projected to increase. Urban water use is expected to increase due to population increases in the Central Valley while agricultural uses are projected to decrease because of a decline in irrigated acreage and to a lesser extent the effects of increasing carbon dioxide.
- Water quality may decline by the end of the century. Sea levels are predicted to rise up to 1.6 meters in that time frame which will lead to an increase in salinity in the Delta and a decline of habitat for fish and wildlife. River water temperatures may increase because cold water availability from reservoir storage would be reduced.
- The food web in the Bay-Delta is projected to decline. Projected lower flows through the Bay-Delta and reduced cold water due to lower reservoir levels will make less water available for species, including endangered species such as migrating salmon.

The reduction in snowpack due to warming conditions will also negatively impact natural groundwater recharge in the Central Valley. The snowpack in the Sierra Nevada serves as the “headwaters” for the underground recharge that eventually flows to the Central Valley. This underflow is made possible by a healthy snowpack needed to saturate the soil profile. These projected climate change impacts mean that less water will be available for storage, both in reservoirs and underground aquifers, and that irrigation districts and other appropriative surface water rights holders will face more curtailments to water diversions. Water scarcity due to climate change impacts adds additional motivation for the City of Waterford to diversify its water supply through the addition of surface water.

D. Affordability of Surface Water Acquiring surface water is a significant challenge in California. Affording surface water is economically challenging for communities that have not used surface water as a source of drinking water. The cost of using surface water consists of three basic components: the cost of raw or treated water; the cost to finance capital facilities (infrastructure) for the treatment, transmission, and distribution of surface water; and the cost to operate and maintain (O&M) the water infrastructure.

As previously discussed, the City of Waterford uses groundwater as the source of water supply for both Waterford and Hickman. Utilizing groundwater for a municipal water supply is relatively inexpensive when compared to using treated surface water. Typically, the electrical charges and well maintenance are the majority of the costs for pumping groundwater because most groundwater supplies usually require little to no treatment for municipal use. Electrical costs will vary based on the water depth (greater depth requires more electrical energy to lift the water), so declining groundwater levels will increase the cost of pumping groundwater. The average electrical consumption to pump groundwater from a depth of 200 feet is about 292 kilowatt hours per acre-foot of water (kWh/af).[8] Using current MID P-3 electrical rates (not counting fixed charges and tariffs), the cost to pump groundwater should be approximately $35 to $40 per acre-foot. By comparison, the cost of treated surface water for the City of Modesto is approximately $300 to $350 per acre-foot (based on conversations with City of Modesto staff).

In terms of capital facilities, the traditional approach to utilizing treated surface water is to (1) finance and construct water treatment facilities (or an expansion of existing treatment facilities), (2) construct a transmission pipeline from the treatment facilities to the City, and (3) construct a water storage tank with a booster pump station and water distribution infrastructure within the City to integrate the existing groundwater production and distribution with the new surface water supply.

Using the traditional approach and given Waterford's water use, capital costs for treatment facilities, a storage/booster pump station, and pipeline improvements could range from $19 million to $24 million (depending on the type of treatment, plant capacity).[9] Treated water costs, with treatment O&M included, could range from $800,000 per year to $980,000 per year, depending on the amount of water needed.[10] The cost of O&M for the City's water distribution system will also increase as new facilities are added to integrate surface water into the system. Recognizing that these costs will impact the City of Waterford's water rates and connection fees, it is important to consider ways to reduce and control costs to make surface water as affordable as possible for the City of Waterford's water customers. This can be accomplished by considering using the following:

- Phasing of surface water facilities to match demands/needs
- Alternative means for utilizing surface water to reduce capital and operational costs
- Partnerships with other agencies for the joint use of facilities to reduce costs
- Grant funding
- Drinking Water State Revolving Fund (DWSRF) loans
- Public/private partnerships.

4.2 MODESTO IRRIGATION DISTRICT (MID) SURFACE WATER

MID's share of water from Don Pedro Reservoir is 300,000 acre-feet. Approximately 185,000 AFY is distributed to agriculture customers and around 35,000 AFY to the City of Modesto. The remaining water is distributed in operational outflows, utilized for environmental stewardship and groundwater

8. Energy Down the Drain: The Hidden Costs of California's Water Supply, NRDC & Pacific Institute, 2004, pg. 11
9. Rough estimate for purposes of discussion based on the 2012 City of Lodi water treatment plant project
10. Rough estimate for purposes of discussion based on City of Modesto costs for treated surface water

recharge, or kept in storage in Don Pedro. The City of Waterford is within the MID service area, so it would be relatively easy to provide MID surface water to Waterford. MID provides drinking water to the City of Modesto via its surface water treatment plant located at Modesto Reservoir (immediately east of the City of Waterford) and the water transmission pipeline runs along the northern part of the City of Waterford. Additionally, the MID surface water treatment plant was recently expanded to deliver 60 million gallons per day (mgd) of drinking water to the City of Modesto. MID and the City of Modesto have a long-term water sales and delivery agreement to deliver up to 67,200 AFY to the City of Modesto, so MID is well experienced in municipal water treatment and transfers.

MID presents the best opportunity for acquiring surface water for the City of Waterford due to the City's location in the MID service area / place of use, the location of MID's surface water infrastructure, and the likelihood that there are no significant institutional challenges when it comes to considering a long-term water sales and delivery agreement. Using MID surface water also presents some opportunities to keep costs lower than other alternatives due to MID's existing water infrastructure and MID's experience in treating surface water for municipal supplies. A comprehensive review of surface water alternatives is provided in Appendix B.

4.3 GROUNDWATER

A primary source of water used to supply water to the State of California is groundwater, comprising approximately 30% of total agricultural and urban use, and greater amounts are used during periods of drought when surface water is deficient. This has led to declining groundwater tables, some significantly. In some areas, land subsidence is occurring due to excessive groundwater pumping. As a result, active groundwater management and sustainability programs are gaining more support at the State, regional, and local levels.

Unlike most states, California has not generally regulated groundwater, and left management of groundwater to local authorities. The City claims legal access to its groundwater through California groundwater law, which allows an appropriator the right to pump and use the local groundwater for beneficial use. Appropriative rights are second to "overlying" rights of property owners. The amount of groundwater use is generally restricted to the point at which one users actions cause adverse impact to another user. The State has established water quality parameters for groundwater, like standards for potable well construction, and limits on activities that could degrade water, but the amount of groundwater pumped was not specifically addressed.

Successive droughts and overuse have brought attention to past practices. Three groundwater management bills were passed September, 2014, AB 1739, SB 1168, and SB 1319. The general purpose and date of compliance of these bills are:

- Identification of local groundwater management agencies by 2017
- Sustainable plans for overdrafted groundwater basins by 2020

- Sustainable plans for high and medium priority basins by 2022
- Full achievement of Statewide groundwater sustainability by 2040.

Collectively, this package was known as the Sustainable Groundwater Management Act (SGMA). These bills will allow for basin boundary establishment, sub-basin identification, well registration, the management of extraction rates, and other activities to protect and manage the State's groundwater resources. The package also has funding available for efforts made towards sustainable groundwater use and reporting. The intent of the legislation is to allow local and/or regional management of groundwater, but does not exclude State involvement if progress is insufficient. Thus, groundwater in California will go from mostly unregulated and unrestricted, to closely regulated, monitored, and limited. If, for example, a sustainable plan is not developed (by the City of Waterford and other local groundwater stakeholders) and accepted by the State by as early as 2020 (no later than 2022), the State may declare the basin "probationary" and develop a plan for the basin, including but not limited to, restrictions on groundwater use.

Unfortunately, successive droughts have and may continue to complicate the groundwater issue further before the groundwater plans are in place. Declining groundwater conditions could get worse before it gets better, as water purveyors and private land owners rush to drill wells before regulations and production limits are in effect. How this impacts the City of Waterford will partly depend on its own groundwater management and planning, thus moving toward a sustainable groundwater program will be advantageous.

Description of Groundwater Basin - State Groundwater Data The San Joaquin Valley Groundwater Basin comprises the San Joaquin River Hydrologic Region and Tulare Lake Hydrologic Region, as defined by the California Department of Water Resources (DWR). [11] The combination of these two regions is composed of 16 sub-basins, 9 which reside in the San Joaquin River Region and 7 which consist in the Tulare Lake Region. The City of Waterford is located in the Modesto Sub-basin of the San Joaquin River Hydrologic Region, as shown in Figure 4-4.

DWR Bulletin 118 (first released in 1952, and updated 5 times since, last in 2003), contains historical information on groundwater characteristics, well data, relevant permitting and legislation, and concerns regarding the use and management of the State's groundwater. According to DWR, the San Joaquin River Hydrologic Region is heavily groundwater reliant, with groundwater accounting for about 30 percent of the total annual supply used for agricultural and urban purposes. The aquifers are generally quite thick in the San Joaquin valley sub-basins, with groundwater wells commonly extending to depths of 400-800 feet. Aquifers include unconsolidated alluvium and consolidated rocks, with unconfined and confined conditions both found in the region. Typical well yields in the region range from 300 to 2,000 gpm, with potential yields as high as 5,000 gpm.

11 "Groundwater Update-Conjunctive Use." *San Joaquin River Hydrologic Region* (2003): n. page. *Department of Water Resources*. Web.

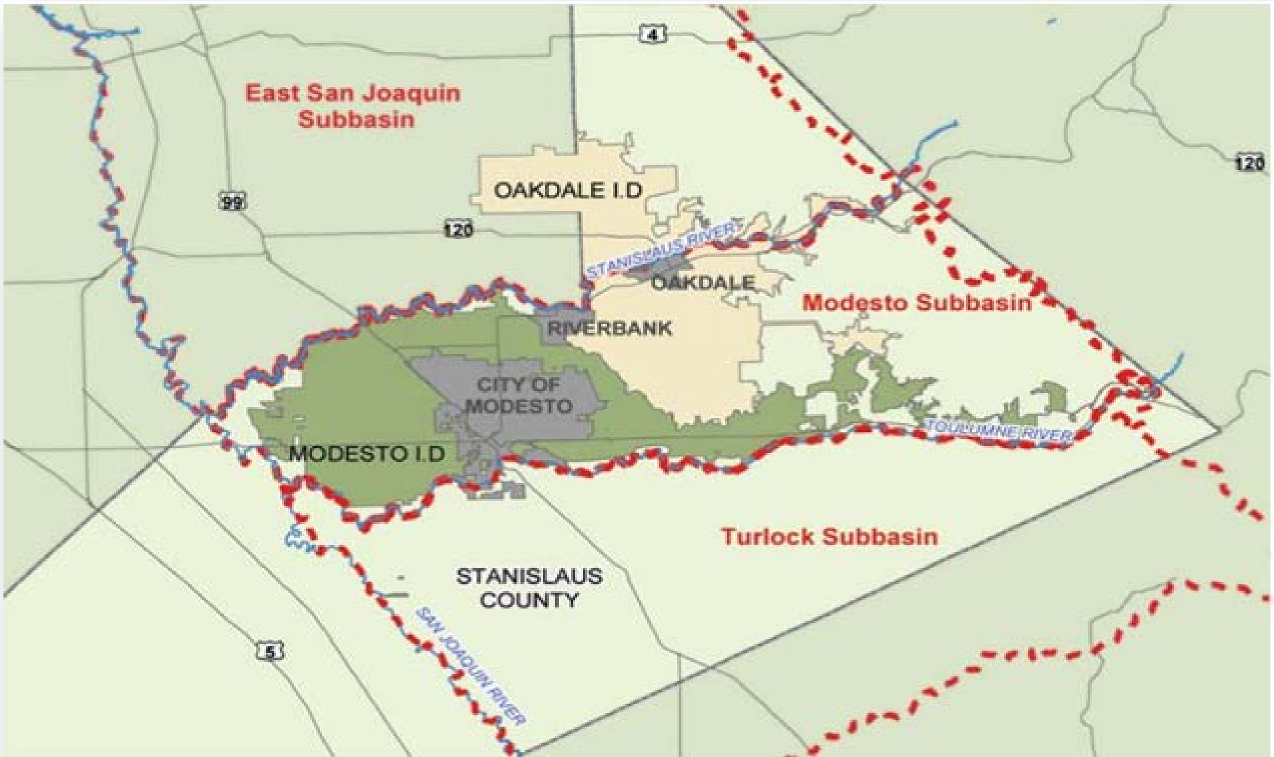


Figure 4.4 Modesto Sub-basin

Depth-to-water measurements collected from a particular well over time can be plotted to create a hydrograph. Hydrographs assist in the presentation and analysis of seasonal and long-term groundwater level variability and trends over time. Because of the highly-variable nature of the aquifer systems within each groundwater basin, and because of the regional differences in annual groundwater extraction, recharge, and surrounding land use practices, the hydrographs selected to depict long-term groundwater level trends for a region (as shown in Figures 4.1, 4.2, and 4.3) do not necessarily capture the local conditions, but rather help "tell a story" of how an aquifer systems responds to fluctuating groundwater extraction and changing resource management practices. According to DWR (Groundwater Update 2013), the San Joaquin River basin is in a condition of *"long-term decline in groundwater levels that have stabilized because of reduced demand, but have not recovered"*.

The Modesto Sub-basin, as defined by DWR Bulletin 118: [12]

- Groundwater Sub-basin Number: 5-22.02
- County: Stanislaus

12 Region, San Joaquin River Hydrologic, and San Joaquin Valley Groundwater Basin. "San Joaquin Valley Groundwater Basin Modesto Subbasin."*California's Groundwater; Bulletin 118* (2004): n. pag. *Department of Water Resources*.

- Surface Area: 247,000 acres (385 square miles)

The hydrogeologic units that comprise the ground water reservoir in the Modesto sub-basin consist of both consolidated and unconsolidated sedimentary deposits. The unconsolidated deposits consist of the Ione Formation of Miocene age, the Valley Springs Formation of Eocene age, and the Mehrten Formation. These deposits are located primarily in the eastern portions of the basin. With the exception of the Mehrten Formation, generally, these deposits yield small amounts of water for wells. Given that the Mehrten Formation yields higher volumes than similarly consolidated deposits, it remains an important aspect of the Modesto sub-basin for those accessing groundwater as a resource. The unconsolidated deposits consist of continental deposits, lacustrine and marsh deposits, older alluvium, younger alluvium, and flood-sub-basin deposits. Of these, the continental and older alluvium deposits are the highest producers in terms of groundwater yields, making them of similar importance to the Mehrten Formation. Younger alluvium deposits can produce moderate yields until reaching maturity.

An excerpt from Bulletin 118 regarding groundwater conditions states:

"Changes in groundwater levels are based on annual water level measurements by DWR and cooperators. Water level changes were evaluated by quarter township and computed through a custom DWR computer program using geostatistics (kriging). On average, the sub-basin water level has declined nearly 15 feet from 1970 through 2000. The period from 1970 through 1978 showed steep declines totaling about 12 feet. The six-year period from 1978 to 1984 saw stabilization and rebound of about 7 feet. 1984 through 1995 again showed steep declines, bottoming out in 1995 at nearly 20 feet below the 1970 level. Water levels then rose about 5 feet from 1996 to 2000. Water level declines have been more severe in the eastern portion of the sub-basin, but have risen faster in the eastern sub-basin between 1996 and 2000 than in any other portion of the subbasin."

There is a direct relationship between groundwater levels in aquifers throughout the Central Valley, including the Modesto Sub-basin, and the use of groundwater for irrigated agricultural acreage. As surface water sources are often utilized during the wet seasons when more precipitation and snow melt is available, aquifers often are recharged during the winter and early spring. However, during the summer, aquifers are depleted due to usage. Approximately 80% of the water used in California is attributed to agricultural practices, explaining the relationship between irrigation uses and aquifer levels. Historically, this relationship has played a vital role in the sustainable use of groundwater resources. During years with sufficient precipitation, recharge volumes have matched or surpassed withdrawal volumes during the summer and fall. However, in years of drought or less than average precipitation, withdrawal volumes have surpassed recharge volumes, leading to an unsustainable use of the aquifer. In an effort to meet all agricultural needs, municipalities have withdrawn volumes necessary, with little regard to a sustainable use of, as well as the lifetime, of the aquifer itself. Years with minimal and less than average precipitation are an inevitable part of future circumstances, presenting a challenge for municipalities in the Central Valley to develop a more sustainable relationship with the local aquifers, both in years with and without sufficient precipitation. Cultivating a culture, legislation, and overall perspective change regarding groundwater usage and sustainability will be a necessary part of Waterford's Water Program. The complete DWR Bulletin 118 description of the Modesto Subbasin can be found on the DWR website.

Figure 4.5 shows the contours regarding groundwater aquifer levels in 1990, showing a cone of depression on the south-western side of Modesto and an aquifer level of around 80 ft under the City of Waterford. Figure 4.6 shows the contours remaining relatively stable around the City of Waterford, hovering between 80 ft and 90 feet with no apparent areas of concern. Figure 4.7 shows the aquifer contours in the year 2010. Though the aquifer level below the City of Waterford remains around 80 ft, levels north of the City have diminished significantly. Cones of depression have shown up throughout the Modesto Sub-basin, two of which are in close proximity to the western and northern sides of Waterford, posing a potential threat in the near future.

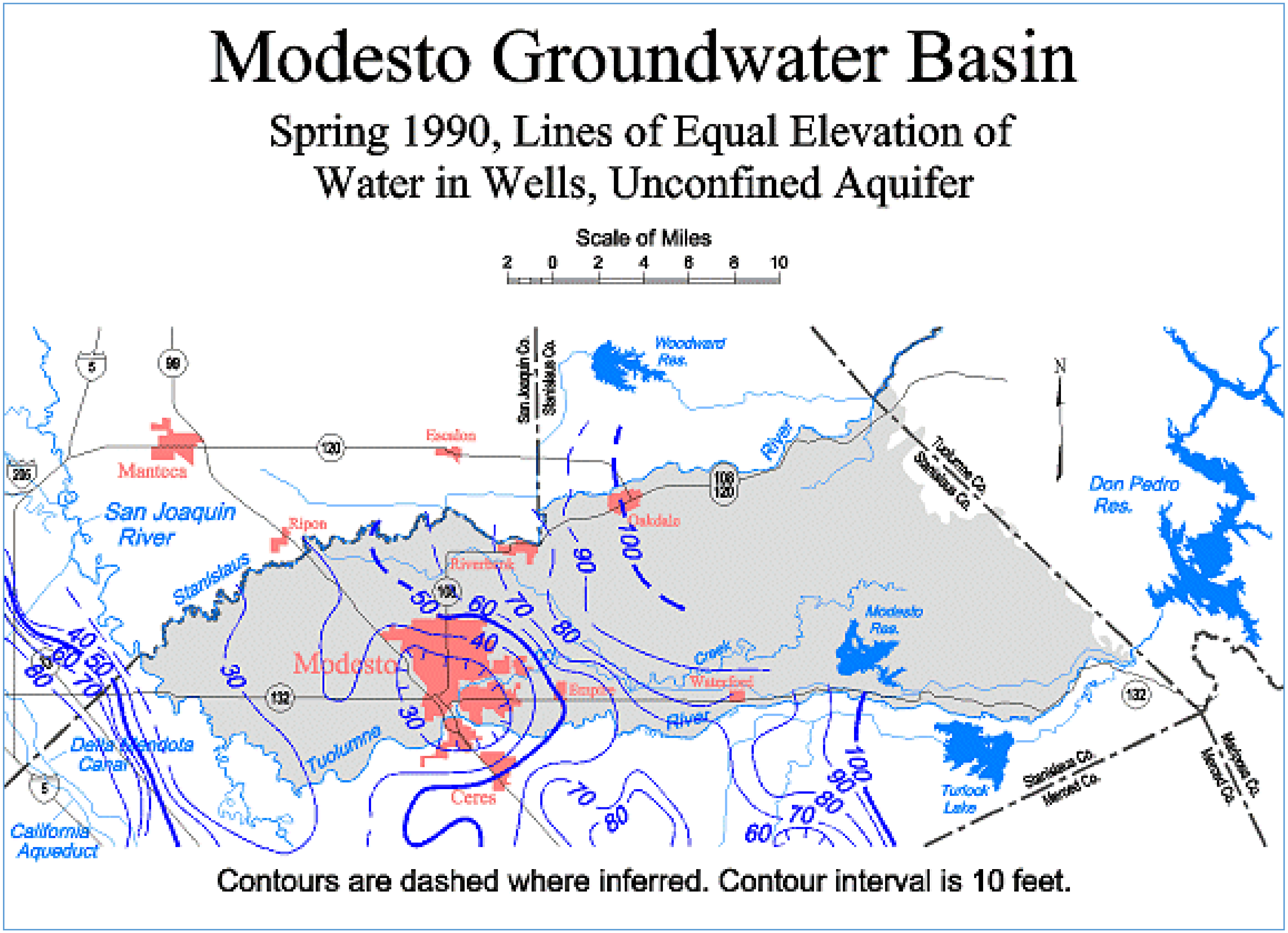


Figure 4.5 Groundwater Contours in the Year 1990

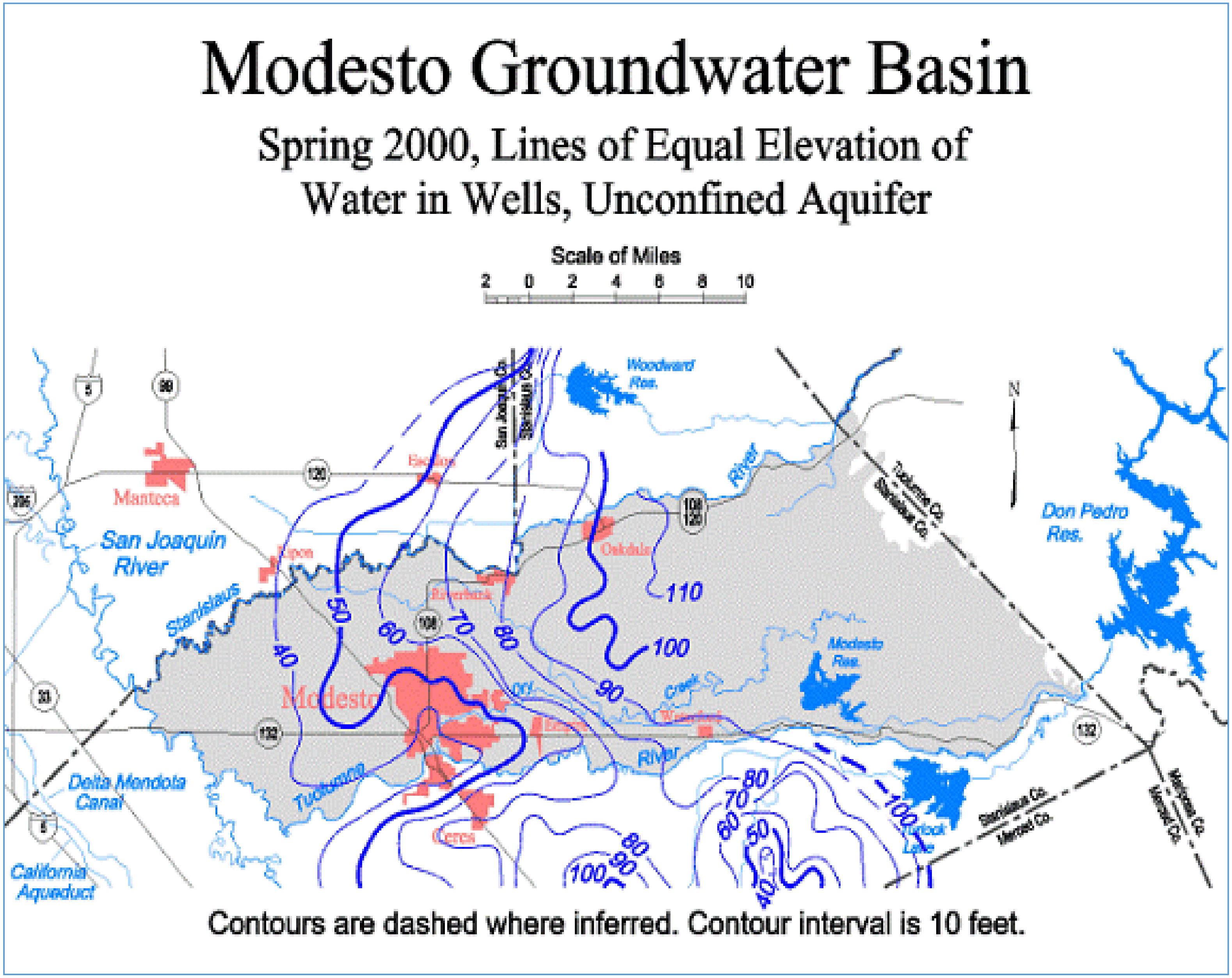


Figure 4.6 Groundwater Contours in the Year 2000

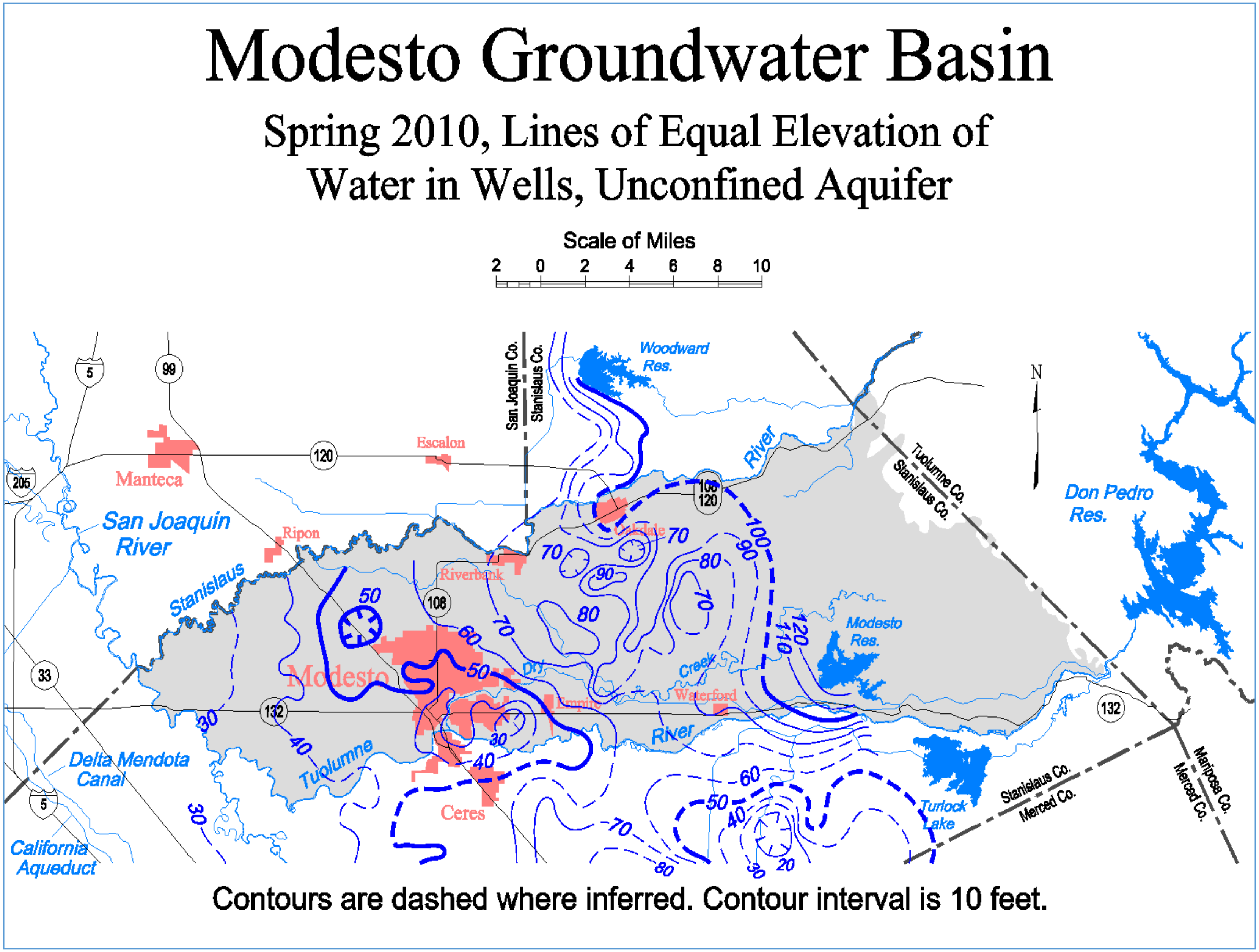


Figure 4.7 Groundwater Contours in the Year 2010

Though the groundwater levels under Waterford show stress on the local water table, cones of depression to the north and northwest of the City may indicate a greater threat. Likely due to agricultural withdrawal, these cones have expanded since 1990 and are pressing closer to Waterford. In 1990, a noticeable cone was not apparent (Figure 4.5), whereas in 2010, two cones are visible within a few miles of the City (Figure 4.7). Should these cones of depression continue to expand, they could pose a threat to City wells in the near future. Consistent monitoring of these cones is prudent, as well as groundwater levels closer to the City itself. Fortunately, the Tuolumne River on the south side of the City serves as a beneficial boundary condition, recharging the aquifer. However, even with local recharge, if cones of depression become too steep or expand in the direction of Waterford, pumping outside the City could impact the City directly.

The latest contour image available from DWR is dated 2010. Recent drought conditions have likely exacerbated the cones of depression and basin-wide decline. Ultimately, all water stakeholders in the Modesto Sub-basin must determine how to conjunctively use both groundwater and surface water in a sustainable manner such that the resources are not exhausted, and threats such as these cones of depression can be mitigated or avoided all together. Sustainable groundwater legislation is accelerating this process, and a plan will need to be developed in the next 4 to 5 years.

Local Groundwater Management and Strategy The analysis of the regional groundwater elevations show that multiple areas in the Modesto Sub-basin are in a state of stress due to over use. In particular, drought years lead to significant reduction of the aquifer sub-basin. Several cones of depression developed in the basin during the period 200-2010, one located north of Waterford. Waterford wells have been impacted, but changes in water table elevations are roughly half that observed in areas 3 to 4 miles north of the City. This is likely due to the proximity of the Tuolumne River which likely creates a boundary condition or “line of recharge” for the local aquifer. The local aquifer may be benefiting from applied surface water for irrigation as well.

The local groundwater change from the year 2005-2015 can be seen in Figure 4.6, illustrating that a decline in the water table elevations was marginal until 2012. During the period of 2010-2015, Waterford reduced its water use by 18%-20% but still witnessed a significant decline in the local groundwater elevations. This would indicate that much of the decline was caused by an increase in pumping by others in the area. The degree of recovery from these declines when drought conditions subside is unknown, as is the impact of sustainable groundwater laws. A declining groundwater table presents several challenges, including addition cost of pumping, replacement of wells and pumping equipment, impacts on water quality, ground subsidence, and in extreme cases, loss of source water. The status of groundwater is expected to remain a priority concern for the City indefinitely, assuming groundwater remains a key source water supply.

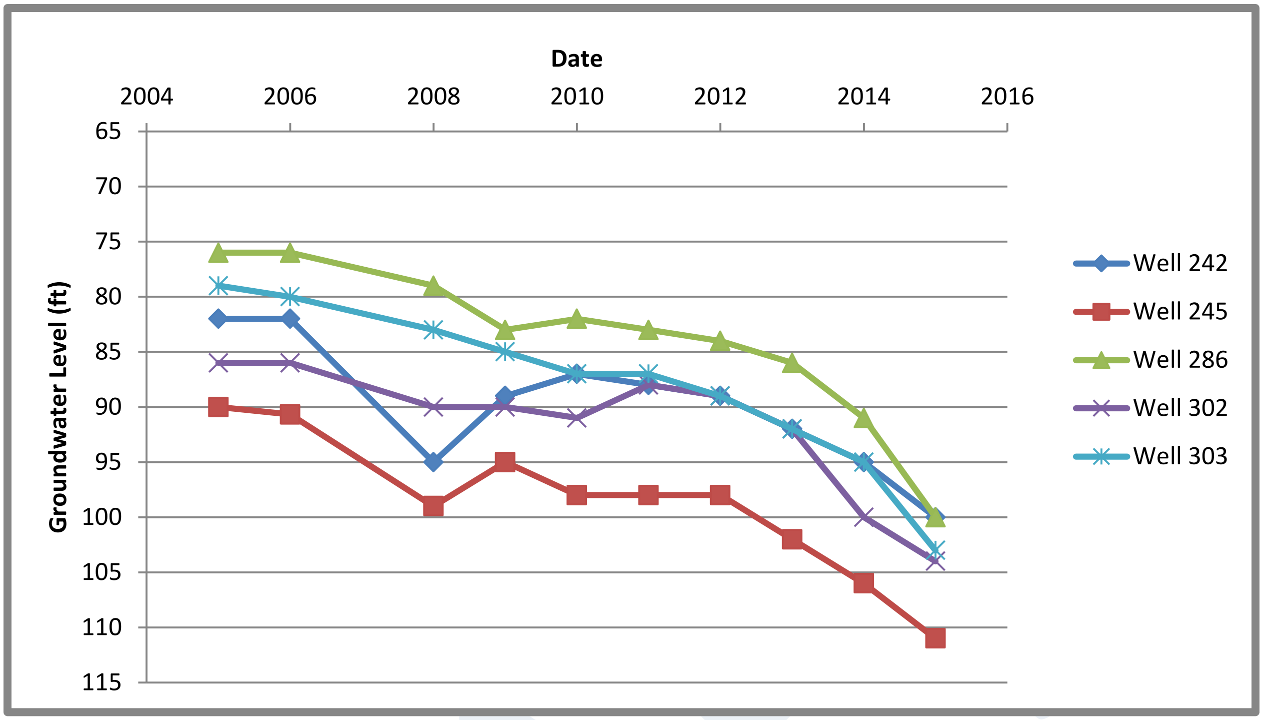


Figure 4.6 Groundwater Level of Waterford Wells (2005-2015)

However, the downward trend in groundwater elevations that has prevailed for many years may be arrested in the near future, since (1) the State of California is taking action to overt unsustainable groundwater pumping, and (2) the County of Stanislaus has acted by limiting the number of new wells being constructed in non-incorporated areas. The full benefits of these programs toward stabilizing falling groundwater tables may take several years to materialize, but stabilization is expected. One possible impact of groundwater sustainability legislation and programs is it may result in pumping limits for groundwater stakeholders, or possibly require existing groundwater users to reduce their current yield. Possible restrictions on future groundwater pumping due to state and/or local statutes should be known in the next 5-10 years.

In the event local groundwater continues to be depleted, the cones of depression expand, or groundwater sustainability programs are ineffective, the City can elect to proactively stabilize local groundwater through the use of surface water (conjunctive use) using direct injection, or surface recharge of treated surface water or recycled wastewater.

Regional Groundwater Management and Strategy The Stanislaus and Tuolumne Rivers Groundwater Basin Association (STRGBA) is the management entity for the Modesto Groundwater Subbasin. STRGBA membership includes MID, OID, and the Cities of Modesto, Riverbank, and Oakdale, and Stanislaus County. STRGBA was formed to carry out the following tasks:

- To determine and evaluate the Modesto Subbasin's groundwater supply.

- To promote coordination of groundwater management planning activities, including the preparation of the groundwater management plan.
- To develop a hydrologic groundwater model of the groundwater basin.
- To determine the Modesto Subbasin's need for additional or improved water extraction, storage, delivery, conservation, and recharge facilities.
- To provide information and guidance for the management, preservation, protection, and enhancement of groundwater quality and quantity in the Modesto Subbasin.

The City of Waterford is now participating in STRGBA. This is important because STRGBA cooperatively develops Local Groundwater Assistance (LGA) Grant applications for the Modesto Groundwater Subbasin. LGA grants provide local public agencies with up to $250,000 to conduct groundwater studies or carry out groundwater monitoring and management activities. The types of projects funded by the grant are groundwater data collection, modeling, monitoring, and management studies; monitoring programs and installation of equipment; basin management; and the development of information systems. It is important for the City of Waterford to continue participating in the STRGBA because LGA grant funding could be applied to the City of Waterford's development of a water level monitoring program and groundwater quality monitoring program. Participation in STRGBA also facilitates the City's ability to be linked into the cooperative sharing of groundwater monitoring data, allowing the City to analyze groundwater trends outside of the City's boundaries that could impact the City's water supply. Finally, participation allows the City of Waterford to be active in groundwater management planning at the regional level.

The City of Waterford is also participating in the Turlock Groundwater Basin Association (TGBA) due to its acquisition of the Hickman water system. This allows the City to "stay in the loop" on groundwater activities in the Turlock Groundwater Subbasin that may impact the Hickman system. In addition to the STRGBA, the City should also continue active participation in the East Stanislaus Regional Water Management Partnership (ESRWMP) as it is the state recognized Regional Water Management Group for the East Stanislaus Integrated Regional Water Management Plan (IRWMP) area. The ESRWMP "opens the door" to state funding for water projects for the region and facilitates regional planning and partnerships. Thus, participation in the ESRWMP represents another opportunity to access funding to implement its water planning needs.

4.4 RECYCLED WASTEWATER

The existing wastewater treatment plant's (WWTP) biological treatment system treats present flows and reduces the strength of the wastewater to meet current permit requirements. However, the WWTP is not rated to accommodate previously projected build-out flows of 3.0 mgd, and cannot produce effluent quality that meets Title 22, California Code of Regulations water recycling criteria. The City of Waterford would need to upgrade its current treatment facilities in order to provide treatment to a level that meets Title 22 guidelines in order to develop a recycled water program. The cost of said upgrades are estimated at $15M to $20M.

The City's (existing) 2006 Wastewater Treatment Plant Master Plan (2006 WWTP MP) evaluated five potential treatment alternatives to accommodate future flows and anticipated water quality requirements. The existing WWTP pond system was not recommended as a feasible alternative because there is not enough space at the existing WWTP for the current treatment process to expand beyond 1.5 mgd. The primary constraint with the other alternatives evaluated was limited available space at the existing WWTP site. Alternative sites were evaluated as part of the 2006 WWTP MP, however, due to the cost of legal fees, environmental studies, land acquisition, and construction of new conveyance facilities, remaining at the existing site outweighed the option of relocating to an alternate site.

Based on RMC's analysis, the recommended alternative included construction of a new membrane bioreactor (MBR) treatment facility at the existing site, at a (present day) cost of approximately $16M. MBR treatment was recommended based on its ability to accommodate buildout flows and produce high quality effluent that will meet anticipated regulatory requirements. Additionally, a MBR system could be implemented without interruption to the existing treatment system during construction.

The 2006 WWTP MP projected that wastewater flows would exceed the existing WWTP capacity by the year 2015. However, slow growth and water conservation efforts have resulted in lower than anticipated flows. The 2015 annual average wastewater flow was approximately 0.51 mgd, which is roughly 61% less than the 1.31 mgd projected in the 2006 WWTP MP for the same year. Additional conservation measures may lead to further reduction in wastewater flows, thereby deferring or avoiding significant capital and operating costs of associated with wastewater treatment and disposal.

Because of this reduction in flows, it is recommended that other treatment alternatives be explored for the near-term planning horizon (within the next 10 years). While the recommendations in the 2006 WWTP MP may have been appropriate for flow projections at that time, it is possible that the City may be able to defer the recommended improvements of a new MBR treatment and associated capital costs beyond the near-term planning horizon. Other alternatives should also be explored based on current flow projections, such as relocating the WWTP to a new location, or the ability to expand the existing treatment process to accommodate flows for the long-term planning horizon (10-30 years). Since it has been 10 years since a WWMP was prepared for the City, it may be appropriate to prepare a current plan in the near future.

Section 5 Conservation

5.0 INTRODUCTION

Water in California is a limited resource. A combination of factors will exacerbate this problem with the passage of time. Population growth, inevitable periods of drought, climate change, and regulatory constraints will all contribute to reductions in water availability for most of California. Market forces of supply and demand will drive the cost of water upwards. These conditions are inexorable, so water purveyors need to prepare accordingly.

The traditional solution in public agency planning, when faced with a resource constraint, is to develop additional supplies. In the water industry, this has often included buying surface water entitlements, constructing or expanding reservoirs, and deepening wells. Of late, alternatives for additional water supplies have included used of recycled wastewater, and desalination of sea water. However, many of these "supply management" alternatives are either not feasible or too costly. Developing additional supplies is often complex, expensive, environmentally adverse, may take years to implement, and must be coordinated at a state or regional level to be successful. Thus, many communities are turning to "demand management" alternatives, also commonly referred to as "conservation."

Water conservation has potential beyond the idea that it is something to be done during a drought, or is environmentally friendly. The average Californian consumes over 200 gallons per day (gpd) between their indoor and outdoor use (EPA, 2006). The City of Waterford is higher than average, at about 220 gpd per person, as of 2005, though a recent meter program has drastically lowered water use to approximately 150 GPCD in 2013. Each of these gallons must be produced, treated, transported, and a portion of it heated, prior to use by homes and businesses. Once used, some of this water becomes waste, where it must be collected, transported, treated, and discharged. All of these actions require the construction of expensive infrastructure, and life-long operation and maintenance. Cost impacts are significant, and summarized herein:

Infrastructure The main cost of water infrastructure associated with meeting demands includes wells and storage tanks. Pipelines represent a major expense, but need to be constructed regardless of the amount of water used, and are typically sized based on fire suppression needs. Based on current use, the proportionate cost of a well and storage for a single family home in Waterford is approximately $4,000. If treatment is required in the future (as a result of declining groundwater tables), this cost could increase to as much as double the above listed cost.

Operation and Maintenance The cost of operating and maintaining a water facility throughout its lifespan is typically estimated to be about half the construction cost. Thus, when budgeting facility costs, an agency can roughly double the figure for a true cost of ownership.

Another important factor when evaluating water infrastructure planning is the impact on electrical systems and availability. As California continues to struggle with its many critical energy supply and infrastructure challenges, the state must identify and address the points of highest stress. At the top of this list is California's water-energy relationship: water-related energy use consumed 19 percent of the state's electricity and 30 percent of its natural gas; and this demand is growing. As water demand grows, so grows energy demand. Since population growth drives demand for both of these resources, water and energy demands are growing at close to the same rate. Water demand and electricity demand are growing rapidly in many of the same parts of the state, stressing already constrained electricity delivery systems. When electric infrastructure fails, water system reliability quickly plummets and threatens the public health and safety. The State Water Plan concludes that the largest single new "supply" available for meeting expected growth in water demand over the next 25 years is water use efficiency, or conservation. The remainder must be provided by the development of new water supplies including water recycling, and desalination of both brackish and sea water. However, these alternatives increase energy demand over current levels (with current technology) and are high in cost. Water conservation results in a corresponding decrease in energy use while simultaneously cutting municipality costs in some situations.

Specifically, the "water-energy" spiral in Waterford is as follows: As water demands increase, more groundwater is pumped. This lowers the local groundwater table, thereby increasing the energy cost to pump the water (from deeper zones). Well pumping equipment must be larger (electric motors) so power supplies must be increased. Often, pumping water from deeper zones increases the salinity and mineral content of the water, resulting in the need for increased treatment. Treatment increases the energy requirement of the water supply.

5.1 WATER CONSERVATION PURPOSE, NEED, AND BENEFIT

Currently, the City has a basic conservation program, consisting primarily of voluntary actions by the water customers. Conservation actions include watering schedules, using shut-off nozzles on hoses, and a call to fix broken sprinkler heads. These conservation actions were commonly included in most city ordinances throughout the Central Valley starting in the 1980s, and have had marginal success. In addition, the City has seen significant water reductions recently due to several years of sustained drought. Whether or not these reductions are sustainable, or will last after the end of the drought, is unknown. Due to this uncertainty, in combination with above given motives for conservation, the City needs to consider more effective conservation strategies. The most effective water conservation programs are those that have changed from a voluntary-base program to a program that is actively implemented and managed by the water purveyor. The "active" conservation programs are often required to achieve the mandatory conservation goals as established by the State of California. Active conservation programs may include residential and commercial water audits, financial incentives to replace old plumbing fixtures or clothes washing machines, tiered billing rates with harsh penalties for overuse, distribution system leak detection, etc.

There are four (4) primary reasons for the City to actively initiate a water conservation program:

A. Many conservation programs are mandatory (per state laws and codes)
B. Offers reductions in capital and operating costs
C. Defer infrastructure construction
D. Consistent with the City's General Plan and policies.

5.2 WATER CONSERVATION CODES AND LAWS

The State of California, Department of Water Resources (DWR) is rapidly moving California's approach to water from one that sought to increase supplies, to one that is based on responsible use of supplies that are currently available. In the 2009 Water Plan, DWR Included three foundational actions one of which is using water more efficiently to gain maximum utility from existing supplies. Translated, this means an aggressive approach to water conservation through a combination of mandatory and incentive-based water laws and programs.

In February of 2008, former Governor Schwarzenegger introduced a seven-part comprehensive plan for improving the Sacramento-San Joaquin Delta. The first element of the Governor's Delta plan is water conservation. In the Governor's words, California must have:

> ***"A plan to achieve a 20 percent reduction in per capita water use statewide by 2020.*** *Conservation is one of the key ways to provide water for Californians and protect and improve the Delta ecosystem. A number of efforts are already underway to expand conservation programs, but I plan to direct state agencies to develop this more aggressive plan and implement it to the extent permitted by current law. I would welcome legislation to incorporate this goal into statute."*

According to the Governor's office, Delta protection and restoration are not the only reasons to increase conservation efforts. Global climate change will affect water management in California, and water conservation will help the state not only mitigate climate change by reducing greenhouse gas emissions and reduce energy use, but also adapt to climate change by reducing water use. Approximately one-fifth of the electricity and one-third of the non-power plant natural gas consumed in the state are associated with water delivery, treatment and use, so efficient use also can reduce water related energy demands and associated greenhouse gas emissions.

Mandatory conservation measures for reducing urban indoor and outdoor water use have been approved by the State legislature, including AB 1881, "Water Efficient Landscape" ordinance, SB 407, "Plumbing Retrofit", and California Green Building Code. Collectively these laws have and will continue to greatly impact the City's future water program and demand projections.

State water conservation measures are imposed through a "carrot and stick" system of making grants and low interest loans available to those communities that implement programs consistent with the state laws, and beginning in 2010, Urban Water Management Plans have not been approved without proper and adequate water conservation measures identified. According to the Urban Water Management Plan Act ("UWMPA") (California Water Code 10610 et seq.), an approved UWMP with appropriate water conservation measures proposed "...is required for an urban water supplier to be eligible for a water management grant or loan administered by DWR, the State Water Resources Control Board (State Water Board), or the Delta Stewardship Council (CWC 10631.1(a)). Changes to California law require that, beginning in 2016, water suppliers comply with water conservation requirements established by the Water Conservation Bill of 2009 in order to be eligible for State water grants or loans.

In July of 2014, the SWRCB adopted unprecedented regulations for water wasting and failure to implement water conservation activities. Resolution 2014-0038 states: "Water conservation is the easiest, most efficient and most effective way to quickly reduce water demand and extend supplies …" The new law declares that water use violations are infractions punishable by fines of up to $500 a day, and tickets could be written by any public employee empowered to enforce said laws. "Water waste" was defined as overwatering of lawns and landscaping that causes runoff onto sidewalks or streets, washing sidewalks, driveways, and other hard surfaces, using a hose to wash a vehicle unless the hose has a shut-off nozzle, and using drinking water in a fountain or decorative water feature unless the water is re-circulated, etc. Under the rules, urban water agencies will have to implement their water-shortage contingency plans to require mandatory restrictions on outdoor water use, if they have not done so already. Urban water agencies not complying with water conservation measures could face fines up to $10,000 each day. Although this action was in response to the 2014 drought, and expired in April of 2015, this plan was continued by Governor Brown's state of emergency declaration in 2015, where all stated regulations were continued and a series of new regulations added.

Water conservation is assumed to become a significant part of the City's water program. Some water conservation efforts are currently mandated, and others will likely follow in time. The City may voluntarily elect to implement certain conservation measures to minimize the cost of supplying water, reduce wastewater production, enhance source water reliability, address environmental concerns, etc. Normally, elected water conservation measures must first prove to be cost effective, prior to implementation. Higher demand reduction may eventually prove to be cost effective or necessary due to reliability/availability issues with source supplies. For the purpose of this study, it is assumed that the City will meet the minimum conservation requirements as identified by the UWMP Act once it reaches 3,000 connections, or sooner, and additional conservation will be realized over time, due to mandatory conservation laws and prudent water system management. As such, conservation becomes a significant source water "supply" in the water program.

Mandatory water conservation programs can be divided into three (3) categories. The first includes conservation programs that are integrated into California law, such as state building and water codes, or included in the City's water or wastewater permits. The second are those required as part of a program whereby the City desires to be a participant, such as state grant or loan programs. The third includes selecting conservation measures from a prescribed list (provided by DWR) to meet an overall conservation goal, and seek exemptions from measures based on a poor cost-benefit evaluation. Obviously, the City could also elect to implement certain water conservation measures or programs in addition to mandatory requirements.

DWR provides "conservation credit" for the use of recycled wastewater. The City does not currently have a non-potable water distribution system or program, and there are no plans to use recycled wastewater for non potable demand (i.e. parks and school landscaping, etc.).

Current Mandatory measures related to water conservation that the City is (or will soon be) required to address are described below:

A. **Water Conservation Act of 2009** (Senate Bill (SB) x7-7): – The overall goal of SBx7-7 is to reduce urban water use statewide by 20% in the next 10 years. This legislation also includes mandatory measures for agricultural conservation. The “mechanism” through which urban water purveyors are to accomplish the provisions of SBx7-7 is in the Urban Water Management Plan (UWMP). [1] In 2010 DWR required urban water purveyors to select one of four methods to determine their “target” water use, or the average amount of water each City resident should use per day after a “20% reduction in per capita use”. Once the target use is determined, the water purveyor must provide a conservation strategy to reduce water use to meet the target, half of the difference by 2015, and the full reduction by 2020. The target and conservation strategies are to be defined and documented in the water purveyor’s 2010 UWMP Update. Conservation measures recommended include the 14 Best Management Practices (BMP’ which are defined by the California Urban Water Conservation Council (CUWCC), or Demand Management Measures (DMM’s) as defined in SBx7-7, and described in more detail below.

In the State’s *20x20x20 Water Conservation Plan* (February 2010), conservation goals for each of the ten (10) hydrologic regions in California. The City lies within the San Joaquin Region, which has a 2015 goal of 211 gpcd, and 2020 goal of 174 gpcd.

B. **Urban Water Management Plan** – All urban water purveyors serving at least 3,000 service connections or delivering more than 3,000 acre-feet of water must prepare, adopt, and submit to DWR, an Urban Water Management Plan in accordance with California Water Code §10610. As part of the 2010 UWMP Update, DWR requires urban water suppliers to report, describe, and evaluate:

- Water deliveries and uses
- Water supply sources
- Efficient water uses
- Demand Mitigation Measures (DMMs), including implementation strategy and schedule.

[1] Although the City is not required to develop an UWMP currently since it has less than 3,000 service connections, it will surpass this threshold long before reaching build-out, and likely in the next 5 – 10 years. Thus, future demands account for mandatory conservation associated with this state code.

DMMs are specific actions a water supplier takes to support its water conservation efforts. Specifically, the UWMP Act identifies 14 DMMs (CWC 10631(f)) that are to be evaluated in each UWMP. The 14 DMMs are:

1. Water survey programs for single-family residential and multifamily residential customers
2. Residential plumbing retrofit
3. System water audits, leak detection, and repair
4. Metering with commodity rates for all new connections and retrofit of existing connections
5. Large landscape conservation programs and incentives
6. High-efficiency washing machine rebate programs
7. Public information programs
8. School education programs
9. Conservation programs for commercial, industrial, and institutional accounts
10. Wholesale agency programs
11. Conservation pricing
12. Water conservation coordinator
13. Water waste prohibition
14. Residential ultra-low-flush toilet replacement programs

These 14 DMM's roughly correspond to the 14 BMP's listed and described in the California Urban Water Conservation Council (CUWCC) Memorandum of Understanding (MOU). Signatory water suppliers to the CUWCC MOU commit to BMPs and implement these measures as part of their urban water conservation programs. An urban water supplier's UWMP is to document its DMM implementation by either:

- Providing the required information for each DMM
- Submitting a copy of its approved CUWCC BMP report, if the supplier is a signatory to the CUWCC MOU

In summary, an urban water purveyor's 2010 UWMP must either show compliance with the DMM's, a schedule of DMM implementation, or a quantitative cost-benefit justification that the DMM/BMP is not cost effective.

C. **The Water Conservation in Landscaping Act - Model Water Efficient Landscape Ordinance** (Assembly Bill (AB) 1881) – The goal of AB 1881 is to establish a method to plan, design, and evaluate water conserving landscapes. Cities and counties in California were provided the option of either creating and adopting their own "*at least as effective*" ordinance, or simply adopting the state model ordinance, *no later than January 1, 2010*. The Model Ordinance (California Code of Regulations Title 23, Waters Division 2, Department of Water Resources Chapter 2.7, Model Water Efficient Landscape Ordinance) is a 33-page document that provides specific direction for agencies to evaluate and approve landscape design and construction.

In summary, the Model Ordinance establishes a water budget for the overall project, based on area and local hydrologic data, by which the landscape design must stay within through selection of low, moderate, and high water use plants and landscaping. Agencies are responsible to review the project landscape, irrigation, and grading designs and certify the installation. Certification of the project installation includes an audit of water use, and verifying the irrigation controller settings, and other miscellaneous items.

DWR made significant changes to the Ordinance in 2015, and are provided herein. Governor Brown's Drought Executive Order of April 1, 2015 (EO B-29-15) directed DWR to update the State's Model Water Efficient Landscape Ordinance (Ordinance) through expedited regulation. The California Water Commission approved the revised Ordinance on July 15, 2015.

The original applicability of the Ordinance was as follow:

(1) new construction and rehabilitated landscapes for public agency projects and private development projects with a landscape area equal to or greater than 2,500 square feet requiring a building or landscape permit, plan check or design review;

(2) new construction and rehabilitated landscapes which are developer-installed in single-family and multi-family projects with a landscape area equal to or greater than 2,500 square feet requiring a building or landscape permit, plan check, or design review;

(3) new construction landscapes which are homeowner-provided and/or homeowner-hired in single family project landscape area equal to or greater than 5,000 square feet requiring a building or landscape permit, plan check or design review;

(4) existing landscapes limited to Sections 493, 493.1 and 493.2; and

(5) cemeteries.

The ordinance does not apply to:

(1) registered local, state or federal historical sites;

(2) ecological restoration projects that do not require a permanent irrigation system;

(3) mined-land reclamation projects that do not require a permanent irrigation system; or

(4) plant collections, as part of botanical gardens and arboretums open to the public.

The following provides specific information regarding changes to the Ordinance, effective December 1, 2015:

- New development projects that include landscape areas of 500 sq. ft. or more are subject to the Ordinance. This applies to residential, commercial, industrial and institutional projects that require a permit, plan check or design review (the previous landscape size threshold for new development projects ranged from 2500 sq. ft. to 5000 sq. ft.). Subdivisions must include all landscaping in the total, not lot-by-lot. The size threshold for existing landscapes that are being rehabilitated has not changed, remaining at 2500 sq. ft. Only rehabilitated landscapes that are associated with a building or landscape permit, plan check, or design review are subject to the Ordinance.

- Local agencies (cities and counties) have until December 1, 2015 to adopt the Ordinance or adopt their own ordinance, which must be at least as effective in conserving water as the

State's Ordinance. If a local agency does not take action on a water efficient landscape ordinance by the specified dates, the State's Ordinance becomes effective by default.

- Dedicated landscape water meters or submeters are required for residential landscapes over 5000 sq. ft. and non-residential landscapes over 1000 sq. ft.

- Irrigation systems are required to have pressure regulators and master shut-off valves.

- All irrigation emission devices must meet the national standard stated in the Ordinance to ensure that only high efficiency sprinklers are installed.

- Flow sensors that detect and report high flow conditions due to broken pipes and/or popped sprinkler heads are required for landscape areas greater than 5000 sq. ft.

- The minimum width of areas that can be overhead irrigated was changed from 8 feet to 10 feet; areas less than 10 feet wide must be irrigated with subsurface drip or other technology that produces no over spray or runoff.

- The maximum amount of water that can be applied to a landscape is reduced from 70% of the reference evapotranspiration (ETo) to 55% for residential landscape projects, and to 45% of ETo for non-residential projects. This water allowance reduces the landscape area that can be planted with high water use plants such as cool season turf. For residential projects, the coverage of high water use plants is reduced from 33% to 25% of the landscaped area. In non-residential landscapes, planting with high water use plants is not feasible. However, unchanged in the Ordinance is the extra water allowance made for non-residential areas when used for specific functional areas, such as recreation and edible gardens. Extra water allowance is also made for landscapes irrigated with recycled water, as was the case in the previous ordinance.

- The irrigation efficiency of devices used to irrigate landscapes is one of the factors that goes into determining the maximum amount of water allowed. Rather than having one default irrigation efficiency for the entire site, the revised Ordinance allows the irrigation efficiency to be entered for each area of the landscape. The site-wide irrigation efficiency of the previous ordinance was 0.71; the revised Ordinance defines the irrigation efficiency of drip as 0.81 and that of overhead spray as 0.75.

- Median strips cannot be landscaped with high water use plants, precluding the use of cool season turf. Also because of the requirement to irrigate areas less than ten feet wide with subsurface irrigation or other means that produces no runoff or overspray, the use of cool season turf in parkways is limited.

- All local agencies will report on the implementation and enforcement of their ordinances to DWR by ***December 31, 2015***. Reporting for all agencies will be due by January 31st of each year thereafter.

D. **2008 California Green Building Standards Code** (California Building Standards Code, Title 24) – New building standards include provisions to reduce the use of water, energy, building materials, as well as reduce waste, pollution, etc. The code includes mandatory and volunteer provisions for residential and commercial building. Mandatory water conservation provisions include the use of water conserving plumbing fixtures, and methods to reduce outdoor water use.

A stated goal of the mandatory water conservation measures is to reduce indoor water use of all new buildings by 20%, as described in Section 4 (Residential) and Section 5 (Non Residential) of the code. Each section is shown below:

4.303.1 *Twenty percent savings. A schedule of plumbing fixtures and fixture fittings that will reduce the overall use of potable water within the building by at least 20 percent shall be provided. The reduction shall be based on the maximum allowable water use per plumbing fixture and fitting as required by the California Building Standards Code. The 20 percent reduction in potable water use shall be demonstrated …*

5.303.2 Twenty percent savings. *A schedule of plumbing fixtures and fixture fittings that will reduce the overall use of potable water within the building by 20 percent shall be provided. The reduction shall be based on the maximum allowable water use per plumbing fixture and fittings as required by the California Building Standards Code. The 20 percent reduction in potable water use shall be demonstrated …*

Outdoor water use is also addressed with installation of "smart" irrigation controllers with rain/moisture sensors, following AB 1881, etc. 2008 Green Building Standards will affect future development by significantly reducing indoor and outdoor water use. Since this law is mandatory, all new developments in the City will be obligated to comply. A 20% reduction in future water use associated with new development was assumed to be part of the City's water supply program and incorporated in to future demand projections.

E. **Property Transfers: Replacement of Plumbing Fixtures** (SB 407) – The goal of SB 407 is to retroactively replace plumbing fixtures in buildings that were built prior to the availability of water efficient models (1994). Specifically, language states:

" *(g)… it is the intent of the Legislature to require that residential and commercial real property built and available for use or occupancy on or before January 1, 1994, be equipped with water-conserving plumbing fixtures, (h) It is further <u>the intent of the Legislature that retail water suppliers are encouraged to provide incentives, financing mechanisms, and funding to assist property owners with these retrofit obligations</u>.*

1101.2. Except as provided in Section 1101.7, this article shall apply to residential and commercial real property built and available for use on or before January 1, 1994.
The schedule for compliance is as follow:

2014: All residential/commercial building alterations or improvements must replace non-compliant fixtures for permit approval;

2017: All noncompliant plumbing fixtures in any single-family residential real property shall be replaced by the property owner with water-conserving plumbing fixtures, and on and after January 1, 2017, a seller or transferor of all residential properties must disclose requirements for replacing fixtures and whether the property is compliant upon sale or transfer;

2019: All multi-family and commercial properties must disclose requirements for replacing fixtures and whether the property is compliant upon sale or transfer, and all fixtures must be replaced by this date.

In effect, the intent of SB 407 is for water purveyors to create programs to ensure that all older buildings (pre-1994) be retrofitted with water conserving plumbing fixtures, regardless of the economic benefits. As such, the City will likely elect to initiate programs to promote and ensure the retrofit of those residential buildings equipped with older fixtures to be in compliance with the code. This is an example of a DMM/BMP that requires a program independent of cost-benefit analysis. The number of homes within the City built prior to 1994 is approximately 2,500 units.

F. **Demand Measurement Implementation** (AB 1420) – This code requires that all water purveyors seeking state grant or loan funding complete an AB 1420 report, which is then submitted to DWR for review and determined by DWR that the water purveyor's DMM/BMP activities are adequate to be eligible to receive funding. AB 1420 allows for proposed and exempted DMM/BMP's. In summary, AB 1420 states that an urban water purveyor has obtained a determination of "compliant" from DWR, it means that the urban water supplier has met one of the following four criteria:

- Has, in the past, implemented all BMPs at a coverage level determined by the CUWCC MOU; or
- Is currently implementing all BMPs at a coverage level determined by the CUWCC MOU; or
- Has submitted a schedule, budget, and finance plan to implement all BMPs at a coverage level determined by CUWCC and commencing within the first year of the agreement for which grant funds are requested; or
- Has demonstrated by providing supporting documentation that certain BMPs are "not locally cost effective."

Table 5.1 Summary of Water Conservation Codes

Code	Description	Applicability
SBx7-7	Reduce urban water use 20% by 2020	Mandatory w/exemptions
UWMP	Address DMM's in 2010 UWMP	Mandatory w/exemptions
AB 1881	Water Conserving Landscape Ordinance	Mandatory
Building Code	Water Conserving Plumbing Fixtures	Mandatory
SB 407	Retrofit Fixtures in Pre-1994 Buildings	Mandatory
AB 1420	Grant Fund Conservation Commitment	Mandatory

5.3 COST BENEFIT ANALYSIS OF WATER CONSERVATION

This section provides a summary of the analysis performed to determine cost savings of conservation activities. All of the conservation activities are among those conservation measures as recommended by the Department of Water Resources (DWR), or as required by the California Water Code. The conservation activities included a total of four (4) independent "scenarios", whereby each was analyzed for cost benefits (i.e. program costs VS energy savings and avoided capital spending for new or replaced water infrastructure).

Four scenarios were selected and analyzed to demonstrate the benefits of reductions in water use, including a "no conservation measures" scenario (for comparison), and three (3) separate conservation scenarios. All conservation scenarios selected are on the DWR list of 14 DMMs, and have "non-behavior dependent" aspects, meaning conservation from these measures does not depend on a voluntary action by the public, but include physical and semi-permanent changes that directly result in reduced water demands (i.e. installing low-flush toilet vs asking the public not to wash their cars). Conservation programs that rely solely on public cooperation are unreliable in the long term and need regular perpetual attention to maintain any effectiveness.

For analysis, it was assumed that SB 407 would be the first conservation activity since it is a mandatory code. Each scenario was added to the subsequent scenarios for a cumulative result in conservation and avoided capital and operating costs. The scenarios were analyzed over a 55-year planning horizon (2015-2070).

The four conservation scenarios analyzed are described in Table 5.2

Table 5.2 Conservation Scenario Descriptions

Scenario	Description
1	No additional conservation measures implemented (Pre 2015 "Business as usual"). Some conservation activities may be needed to maintain near 2010 - 2013 unit demands so water use is not allowed to rebound upon a return to normal hydrology. Activities may include, but are not limited to, public outreach, water-waste fines, education programs, audits, etc.
2	Implementation of SB-407 through replacement of toilets, showerheads, and faucets in all homes constructed prior to 1994 with Green Building Code devices, totaling approximately 1,400 units. Provide rebates or other financial incentives. Assumes conversion of 200 units per year for 5 years under rebate program, then remaining 400 units as they change ownership over following 10 years.
3	Locate and repair water leaks in the distribution system through the use of modern detection equipment and trained personnel. Reduce other unnecessary unaccounted for water by limiting flushing and fire hydrant testing. This scenario complements the reduction in leakage due to replacement of older pipes in the downtown area.
4	Use of high efficiency residential clothes washers. Proposed timing of this measure will result in a "self-implemented" program and require no active participation by the City, as only high efficiency washers will be available in the future.

Water Usage Reduction Calculation Assumptions The analysis assumes that the conservation scenarios are implemented in a linear manner (i.e. Scenario 1 then Scenario 2, etc.). Each additional conservation measure provides further per capita reduction to the total conservation and savings potential. The gallons per capita per day (GPCD) usage for Scenario 1, which was used as a baseline, was estimated at 145 GPCD, an average historic water use for the City in recent years (2010 – 2015). The City had GPCD usage closer to 220 in the past, but following the input of a water meter program, the recorded GPCD fell drastically. The reduction value of each conservation measure was estimated using multiple sources, including an urban water efficiency report by the National Resources Defense Council (NRDC), and the EPA Water Sense program. The reduction in GPCD was then applied to the population of the City. Population projections for current, through build out conditions, were estimated using City Planning Department Data.

Avoided Capital Cost Capital cost savings result from avoided construction of new or replacement infrastructure due to lower demands. With less demand, Waterford would require fewer wells and smaller storage tanks. For this analysis, production wells were assumed to cost $1.5 M to construct and supply 1,000 gpm per unit. These savings were then extrapolated over time to show conservation savings potential growth over the decades. Savings were calculated ranging through build out (2070).

Avoided Energy Costs Energy savings is the cost benefit acquired by using less energy to heat, treat, and transport water from the aquifer to the customer or business. As conservation is implemented, less water has to be distributed and treated, thus lowering energy use and saving energy costs. Energy

savings were calculated by multiplying the number of years from implementation to build out by the annual avoided energy that year associated with the conservation measure (taking into account population and delivery unit growth). The total value of the conservation measures were calculated by subtracting the cost of the program from the capital savings potential.
The following assumptions were used to determine the operating cost savings from avoided water deliveries due to conservation:

- Total Dynamic Head (TDH) is equal to 130' feet pumping water level, plus 60 psi discharge pressure, for a TDH of 268'.
- The cost of power at $0.12 per KwH, the current rate of PG&E power in Waterford.
- The cost of construction for a new well at $1.5 M.
- A new well is required for each average day demand increase of 500 gpm, (assuming new wells will produced 1000 gpm, as needed to provide for maximum day conditions.

Cost savings from water conservation include both operational (energy) and capital costs. Energy savings are realized when less water is pumped from groundwater aquifers to homes and business. The cost of pumping was based on the power required to operate a well pump, as shown in the following equation:

$$\text{Brake Horsepower, BHP} = \frac{TDH * GPM}{3960 * \eta}$$

Where: TDH=Total Dynamic Head (ft)
GPM=Gallons Per Minute
η=Efficiency of Pump of 72% (estimated)

Using the calculated BHP, in combination with an assumed motor efficiency of 95%, and an assumed rate of $0.12/kWh (the current rate of power according to PG&E), the energy cost from reductions in water use were calculated.

Conservation Program Costs Costs for each of the three (3) conservation measures were developed. These costs include implementation (a one-time "start-up" or program development cost), cost to manage the program, and operating costs (i.e. equipment, rebates, contractors, etc.). The annual costs for each scenario are shown in Table 5.4. "Years" indicate the number of annual costs (start up, management, and operation) associated with each conservation measure.

Table 5.3 Conservation Measure Implementation and Operating Cost Estimates

Scenario	Startup	Years	Annual Management	Years	Annual Rebate/Supply	Years	Total Scenario Cost
2	$25,000	1	$40,000	5	$40,000 [a]	5	$425,000
3	$25,000	1	$25,000	3	$35,000	3	$205,000
4	$0	NA	$0	NA	$0	NA	$0 [b]
Total							**$630,000**

a Assumes an average $200 rebate per customer for plumbing fixture replacement.

b. No cost assuming this program is initiated after 2030. Otherwise, a $200,000 rebate program is needed for incentive to replace clothes washers in the near-term.

All of the programs will require a conservation manager or consultant to oversee and administer the programs. Implementing the programs one at a time allows for one person to manage the conservation efforts, and provides the City with the option to use City staff or temporary contracts with private companies for most or all of the work. Start-up costs were assumed to be a onetime cost for developing the program. Management costs, rebate/supply costs, and the number of years required to implement a conservation measure were estimated using existing programs, data from CUWCC, or other means. Scenario 4 was assumed to have no cost and will be self-implementing. Since the average life of a washing machine is 12-15 years, and the market will only provide high efficiency (HE) units per state and federal energy codes in the future. Thus, normal attrition of low efficiency washing machines will be replaced automatically by consumers with higher efficiency versions. It was assumed that by 2040, 90% of the low efficiency clothes washing machines will be high efficiency units. Accelerating the implementation of HE washing machines would require incentives (i.e. rebates), so City costs would be incurred.

Comparison of Avoided Costs and Conservation Program Costs The theoretical capital improvement cost savings (or cost avoidance) potential of conservation programs are shown in Table 5.3. The cost savings assume full implementation of the conservation measures at year 1, with increasing costs avoided over time. Each of the scenarios and their associated savings (capital and operational) are shown for 10, 20, 30, and 55 year projections. Also shown in the table are the program costs and the net value (savings minus conservation program costs,). By implementing all conservation scenarios at year 1, cost savings are not realized until after 2025, even though it would maximize long-term savings.

Table 5.4 Potential Cost Savings from Conservation [a]

Date	2025		2035		2045		2070	
	Capitol [b]	Energy [c]	Capitol [b]	Energy [c]	Capitol [b]	Energy [c]	Capitol [b]	Energy [c]
Scenario 2	$1,415,200	$52,455	$0	$104,910	$206,000	$52,455	$1,500,000	$161,283
Scenario 3	$0	$82,494	$280,350	$82,494	$280,350	$82,494	$1,500,000	$253,644
Scenario 4	$0	$38,282	$280,350	$38,282	$280,350	$38,282	$1,500,000	$117,707
Total Savings	$1,588,431		$786,386		$939,931		$5,032,634	
Total Cost [d]	$830,000		$0		$0		$0	
Total Value [e]	$758,431		$786,386		$939,931		$5,032,634	

a. Assumes all conservation programs are initiated in year 1.
b. Deferred or avoided cost of production facilities (wells).
c. Avoided energy cost due to pumping less water.
d. Cost of all conservation programs, including rebate program for HE washing machines.
e. Total conservation cost less total avoided capital and operational cost.

5.4 PHASING OF PROGRAM MEASURES

To determine the how a conservation program may benefit the City's water program, the cost-effectiveness of the conservation measures were analyzed by comparing conservation program costs to avoided capital and energy costs. The avoided costs are maximized with earlier implementation of all conservation scenarios. However, conservation program phasing is recommended over a period of several years, for the following reasons:

A. Immediate implementation of all programs is not advisable due to finance and management challenges. The cost associated with implementing all programs at once would amount to an estimated $855,000 over approximately five years. This would create financing challenges for the City. Immediate implementation of all conservation programs would result in management challenges, such as hiring multiple staff members, staff managers, work spaces and equipment, etc. Even if the additional staff and resources were available, successful implementation of all programs in the next 3 to 5 years may not be feasible.

B. A key assumption regarding Scenario 2 is that replacement of aging pipes addresses some of the losses, thereby reducing the need to perform line-leakage test on all City water mains.

C. There is no apparent need to implement all conservation scenarios in the next 2 – 5 years, such as severe capacity shortages, water quality issues, etc., other than to maximize energy savings.

The schedule for determining phasing of conservation measures was largely dictated by the need for additional supply. The recommended scenarios and phasing can benefit the City by deferring capital costs of high-dollar infrastructure. For example, without conservation additional source capacity in the form of a well or water storage tank is needed between 2020 and 2025. Implementing conservation as recommended can delay the construction of one or both of these facilities for 5 to 10 years. Since conservation is less expensive than well or tank construction, it is a prudent and reasonable option.

To limit staff requirements and simplify funding issues, a "slow and steady" approach is recommended for conservation program implementation, with full implementation of each conservation measure before proceeding to the next, and all conservation measures completed by 2035. To balance the implementation and management costs, yet maintain most of the cost savings through energy reductions over the longest time period, the implementation schedule and associated costs and savings are shown in Table 5.6, resulting in a total cost savings of $6.5M.

Table 5.5 Cost/Benefit for Proposed Implementation Schedule [a]

Date	2025		2035		2045		2070	
	Capitol	Energy	Capitol	Energy	Capitol	Energy	Capitol	Energy
Scenario 2	$1,415,200	$52,455	$0	$104,910	$206,000	$52,455	$1,500,000	$161,283
Scenario 3	$0	$82,494	$280,350	$82,494	$280,350	$82,494	$1,500,000	$253,643
Scenario 4	$0	$38,282	$280,350	$38,282	$280,350	$38,282	$280,350	$117,706
Total Savings	$1,588,431		$786,386		$939,931		$3,812,984	
Total Cost	$435,000		$205,000		$0		$0	
Total Value [b]	$1,153,431		$581,386		$939,931		$3,812,984	

a. Conservation activity implementation period 2016 through 2030.

b. Value for each period shown. Total value for program is $6.5M.

The impact of the three (3) conservation programs analyzed in the study on system water demands can be seen in Figure 5.1. This chart shows the projected water use for each scenario, approximately when new wells would be required, and the recommended conservation strategy "path", as indicated by triangular symbols. The impact of each scenario is projected, assuming the previous scenario was implemented. Each triangle represents a decision point or date, whereby the City may elect to implement the next conservation measure. Implementing all measures maintains the system water demands below a point that would require a new well (not replacement well), until nearly 2040. Should the City choose not to implement a conservation measure, the chart indicates the approximate date whereby the next well would need to be constructed.

The line on the chart titled "State Mandate" was calculated using DWR mandates in SBx7. Under this code, the municipality has to either reduce its water use by 20% or has to reduce the usage to 95% of the hydrologic region's target (174 gpcd). Both methods result in a DWR maximum water use of approximately 165 gpcd. Well production data from 2010 through 2013 indicate the City's water use was approximately 155 gpcd. Water use dropped to as low as 128 gpcd in 2015, likely due to the public's response to the drought crisis. For planning purposes, it was assumed that the current low use is sustainable in non-drought years, and water use is likely to return to near pre-drought use. For the purpose of the analysis, it was assumed that in the absence of active conservation measures, the water use will return to 145 GPCD or higher. Hence, promoting conservation after the drought through implementation of the recommended scenarios and other conservation efforts are encouraged.

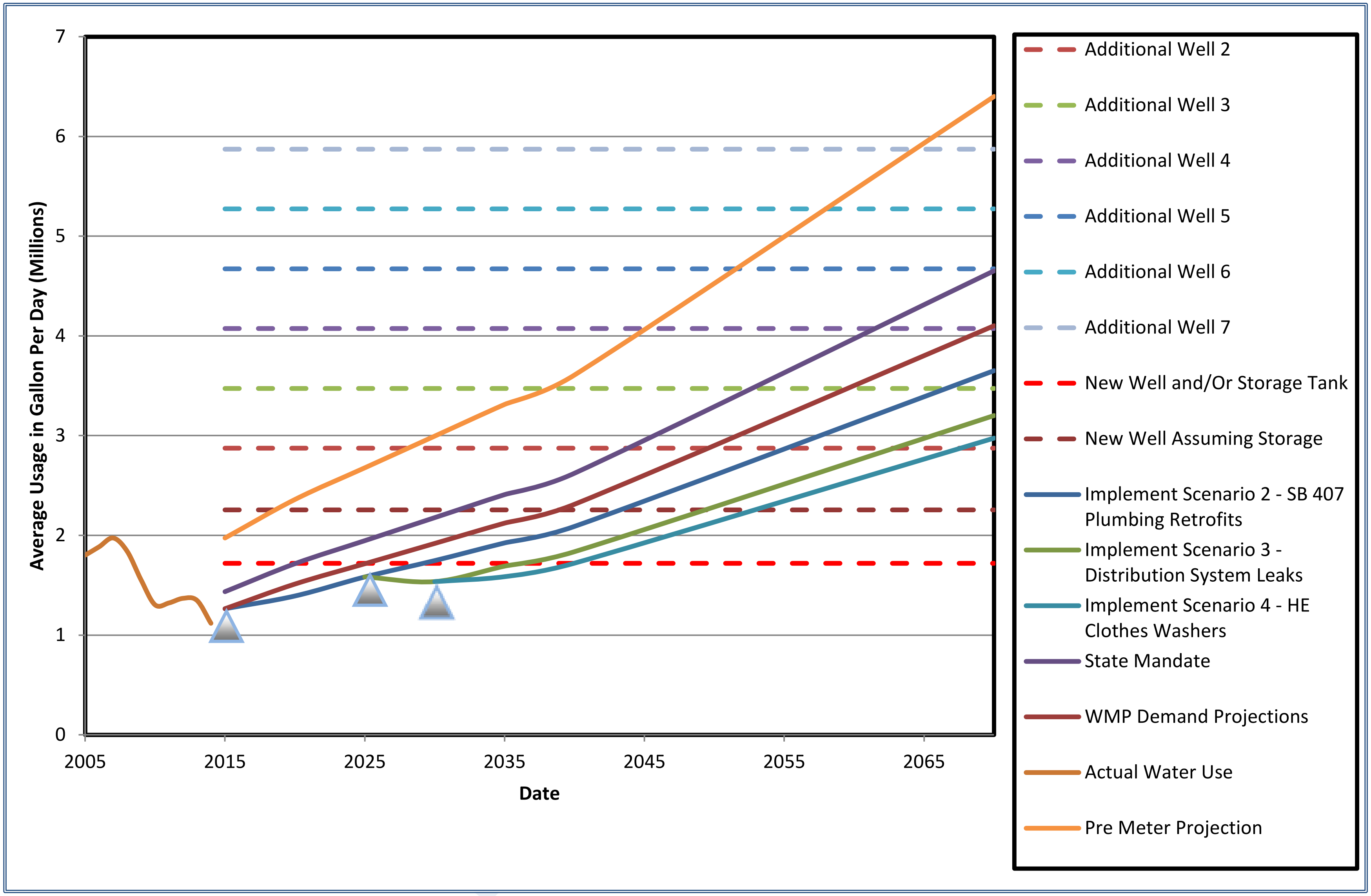


Figure 5.1 - Conservation Strategies and Recommendations

Section 6 HYDRAULIC NETWORK MODLING

6.0 INTRODUCTION

As part of the WMP, a hydraulic network computer model was used to evaluate the water system. The primary purpose of this evaluation was to update the model in order to evaluate the ability of the distribution system to meet current and buildout demands including the existing River Pointe residential development water distribution system and existing facilities which are proposed to be consolidated with the existing City distribution system.

The City's hydraulic network model was developed in 2002, updated in 2006, and evaluated in 2010 as part of the City of Modesto Water System Hydraulic Model Update Project, prior to the system being acquired by the City of Waterford. The 2010 analysis did not include the River Point development, as the system was operating as an independent water system. The existing City water model was used as the base for this analysis. Review of the existing water model included verifying the existing distribution piping layout and pipe sizes with the current City of Modesto Geographic Information System (GIS) data. Current and future buildout water demand projections were determined and provided by Shoreline Engineering and Restoration.

6.1 DESCRIPTION OF SYSTEM

The following provides a general description of the service area, design criteria, assumptions, and analyses methodology. References to figures and graphics can be found in Appendix C.

Service Area The existing City limits totals approximately 1,078 acres, including the River Pointe development. Land uses include low density and multi-family residential, commercial, public/government, and open space/parks. Approximately 10 percent of the service area is undeveloped/vacant land. The Waterford Vision 2025 General Plan Sphere of Influence (SOI) includes approximately 1,638 acres of future buildout of existing agricultural land for primarily residential land use with some commercial and industrial land uses. However, buildout of the SOI is anticipated to occur well after 2025. Figure 1 shows the City limits boundary and future SOI service area boundaries.

Existing Potable Water System The existing City of Waterford water distribution system consists of approximately 130,000 linear feet of 2-inch diameter to 12-inch diameter piping. Newer piping is mostly PVC material and a minimum of 8-inches in diameter. Approximately 46,900 linear feet of the existing distribution system piping is original steel pipe, consisting mostly of 2-inch diameter to 6-inch diameter piping with some 8-inch diameter and 12-inch diameter piping. Six groundwater wells supply the system. Water is chlorinated and pumped directly to the distribution system. All pumps are equipped with variable frequency drives. Pump operations are based on settings meet the system demands while maintaining a system pressure of 55 psi to 60 psi. The total well capacity to meet system demands is approximately 4,020 gpm based previous pump flow testing, with a reliable well capacity of 3,170 gpm (with the largest well out of service). However, current pump flow tests and pump inspections should be completed to determine if well capacities are still feasible based on current mechanical conditions. Per City staff, current operations do not utilize the full capacity of each pump to maintain system pressures. Figure 1 shows an overview of the existing City of Waterford water facilities and distribution system.

River Pointe Potable Water System and Consolidation Infrastructure The City of Waterford proposes to consolidate the City distribution system with the River Pointe water distribution system via connection to the existing 12-inch diameter discharge piping from the River Pointe booster pump station and a proposed 16-inch transmission main in Yosemite Avenue/HWY 132. The 16-inch diameter transmission main will run east on Yosemite Ave./Hwy 132 and connect via a new 12-inch distribution main to the existing 12-inch diameter water main in F Street and existing 8-inch diameter water main in Yosemite Ave./Hwy 132 at F Street . A connection to the existing 4-inch diameter water main at Hickman Road just east of River Pointe is also proposed. The existing River Pointe development consists of 8-inch diameter PVC distribution system piping. The development is supplied by two wells. River Pointe facilities include water treatment filters, two 0.1 million gallon (MG) storage tanks, and a booster pump station equipped with three pumps with a firm capacity of 1,850 gpm (one pump out of service). Figure 2 shows the proposed infrastructure to consolidate the City of Waterford and River Ponte water systems.

Buildout Scenarios This analysis considers four phases of development:

- Existing 2015 – This phase assumes the City of Waterford distribution system and River Pointe development are consolidated. The City of Waterford service area within the City limits is 90% built out. Vacant parcels were identified based on City of Waterford billing data. The River Pointe consolidation infrastructure is existing.

- Existing 2015 (CIP) – This phase assumes the proposed Capital Improvement Projects for the replacement of existing steel pipelines are replaced, and all small diameter pipelines are upsized to 8-inch diameter.

- City Buildout – This phase assumes buildout of the entire City limits service area.

- Future SOI Buildout – This phase assumes buildout of the entire SOI General Plan Boundary.

Estimated Model Water Demands, Design Criteria, and Assumptions Water demands throughout the model are based on land use acreages and water duty factors per acre based on land use (provided by Shoreline Engineering based on current and projected water usage). Water duty factors were provided for existing conditions, City buildout conditions, and SOI buildout conditions. Parcel acreages and land uses were obtained from Stanislaus County GIS data.

The demand scenarios reviewed for this analysis include average day demand, maximum day demand, maximum day demand with fire flow, and peak hour demand conditions. Maximum day demands are estimated to be 190 percent of average day demands, and peak hour demands are estimated to be 320 percent of average day demands. Estimated model water demands are summarized in Table 6.1.

Table 6.1 Estimated Water Demands

Development Phase	Total Water Demand
Existing 2015 and Existing 2015 (CIP)	
Average Day Demand	830 gpm
Maximum Day Demand	1,577 gpm
Peak Hour Demand	2,656 gpm
City Buildout	
Average Day Demand	964 gpm
Maximum Day Demand	1,831 gpm
Peak Hour Demand	2,656 gpm
Future SOI Buildout	
Average Day Demand	2,877 gpm
Maximum Day Demand	5,466 gpm
Peak Hour Demand	9,206 gpm

Water system performance design criteria and assumptions are summarized in Table 6.2.

Table 6.2 Model Design Criteria and Assumptions

Component	Criteria
Fire Flow Requirements:	
Residential Fire Flow	1,500 gpm
Commercial Fire Flow	2,000 gpm
Industrial Fire Flow	2,500 gpm
(Fire flow demand can be met by two adjacent hydrants with a maximum flow per hydrant of 1,500 gpm)	
Water Distribution System (Pipes Less than 18-inches in Diameter):	
Average Day Demand Condition	
Minimum Pressure	40 psi
Maximum Pressure	80 psi
Maximum Headloss	7 ft/kft
Maximum Velocity	6 fps
Maximum Day with Fire Flow Demand Condition	
Minimum Pressure (at fire node)	30 psi (single event)
Maximum Head loss	10 ft/kft
Maximum Velocity	12 fps
Peak Hour Demand Condition	
Minimum Pressure	40 psi
Maximum Head loss	7 ft/kft
Maximum Velocity	8 fps

Pipe roughness coefficients, 'C'-factor are assigned based on the age of pipes and existing material. Ground surface elevations are based on existing aerial maps and range from 125 feet at the southern end of the City limits near the Tuolumne River to 195 feet at the northeastern section of the SOI boundary.

The modeling analysis for all development phases and scenarios assumes that the existing City well source capacity, River Pointe well source, storage, and booster pump station capacity are operational and available to meet system demands.

6.2 MODEL FINDINGS (DEFICIENCIES AND RECOMMENDATIONS)

The following section includes a discussion of system deficiencies and recommended improvements based on the analyses results. The modeling analysis for all development phases and scenarios assumes that the existing City well source capacity, River Pointe well source, storage, and booster pump station capacities are operational and available to meet system demands.

Existing 2015 Water Distribution System Analysis and Recommendations The existing system is sufficient to meet average day demands, maximum day demands, and peak hour demands while maintaining a system pressure of 40 psi throughout the distribution system; however, pressures exceeding 80 psi are located at the River Pointe development. The installation of pressure reducing valves is recommended to mitigate high pressures at the River Pointe development. The existing system cannot maintain a residual pressure of 20 psi and several pipelines exceed the maximum velocity criterion during maximum day with fire flow demand conditions. Fire flow is restricted at identified smaller diameter pipelines resulting in high velocities, high headlosses, and available pressures less than 20 psi at the flowing hydrant. Figure 3 shows the locations of pipelines exceeding 12 ft/s and locations of fire flow nodes where the residual pressure is less than 20 psi. Low residual pressures and high velocities during a fire flow event should be mitigated by replacement of approximately 44,569 linear feet of existing small diameter steel with 8-inch diameter PVC pipe to improve residual pressures and reduce pipeline velocities during maximum day with fire flow demand conditions. Small diameter pipes located within alleys should be replaced in roadways. These improvements are proposed as Capital Improvement Projects and are presented in Figure 4.

Detailed modeling results for each demand scenario are summarized below:

- *Existing 2015 Average Day Demand* - The existing system is sufficient to meet average day demands with pressures ranging from 54 psi to 89.8 psi. Pressures exceeding 60 psi are at locations with lower elevations at the southern end of the system bordering the Tuolumne River or Yosemite Boulevard/Highway 132. Pressures exceeding 80 psi are located at the River Pointe development. The installation of pressure reducing valves is recommended to mitigate high pressures at the River Pointe development. Refer to Figure 5.

- *Existing 2015 Maximum Day Demand* - The existing system is sufficient to meet maximum day demands with pressures ranging from 52.4 psi to 88.6 psi. Pressures exceeding 60 psi are at locations with lower elevations at the southern end of the system bordering the Tuolumne River or Yosemite Boulevard/Highway 132. Pressures exceeding 80 psi are located at the River Pointe development. The installation of pressure reducing valves is recommended to mitigate high pressures at the River Pointe development. Refer to Figure 6.

- *Existing 2015 MDD with Fire Flow* - The existing system cannot maintain a residual pressure of 20 psi and several pipelines exceed the maximum velocity criterion during maximum day with fire flow demand conditions. Fire flow is restricted at identified smaller diameter pipelines resulting in available pressures less than 20 psi at the flowing hydrant and maximum velocity and headloss values exceeding the design criteria, refer to Figure 3. Low residual pressures and high velocities during a fire flow event should be mitigated by replacement of approximately 44,569 linear feet of existing small diameter steel with 8-inch diameter PVC pipe to improve residual pressures and reduce pipeline velocities during maximum day with fire flow demand conditions. Small diameter pipes located within alleys should be replaced in roadways. Figure 4 presents the recommended capital improvement projects to improve system pressures and reduce pipeline velocities during the demand condition.

- *Existing 2015 Peak Hour Demand*: The existing system is sufficient to meet peak hour demands with pressures ranging from 42.5 psi to 72.8 psi. Pressures exceeding 60 psi are at locations with lower elevations at the southern end of the system bordering the Tuolumne River or Yosemite Boulevard/Highway 132. Pressures exceeding 80 psi are located at the River Pointe development. The installation of pressure reducing valves is recommended to mitigate high pressures at the River Pointe development. Refer to Figure 7.

Existing 2015 (CIP) Water Distribution System Analysis and Recommendations The existing system is sufficient to meet average day demands, maximum day demands, and peak hour demands while maintaining a system pressure of 40 psi throughout the distribution system; however, pressures exceeding 80 psi are located at the River Pointe development with the recommended CIP for pipeline replacements completed (refer to Figure 4). The installation of pressure reducing valves is recommended to mitigate high pressures at the River Pointe development. The existing system cannot maintain a residual pressure of 20 psi and the maximum velocity criterion during maximum day with fire flow demand conditions at the commercial zoned area along Yosemite Blvd./Hwy 132. Figure 8 shows the locations of pipelines exceeding 12 ft/s and locations of fire flow nodes where the residual pressure is less than 20 psi. It is recommended that hydrants to provide fire flows to the commercial zoned areas are serviced off the proposed 16-inch diameter and 12-inch diameter consolidation infrastructure in order to maintain sufficient residual pressures and reduce pipeline velocities.

Detailed modeling results for each demand scenario are summarized below:

- *Existing 2015 (CIP) Average Day Demand* - The proposed distribution system is sufficient to meet average day demands with pressures ranging from 55 psi to 90.6 psi. System pressures exceeding 60 psi are at locations with lower elevations at the southern end of the system bordering the Tuolumne River or Highway 132. System pressures exceeding 80 psi are located at the River Pointe development. Installation of pressure reducing valves is recommended to mitigate high pressures at the River Pointe development. Refer to Figure 9.

- *Existing 2015 (CIP) Maximum Day Demand* – The proposed distribution system is sufficient to meet maximum day demands with pressures ranging from 53.4 psi to 89.6 psi. System pressures exceeding 60 psi are at locations with lower elevations at the southern end of the system bordering the Tuolumne River or Highway 132. System pressures exceeding 80 psi are located at the River Pointe development. The installation of pressure reducing valves is recommended to mitigate high pressures at the River Pointe development. Refer to Figure 10.

- *Existing 2015 (CIP) Maximum Day Demand with Fire Flow* - The proposed distribution system cannot maintain a residual pressure of 20 psi and the maximum velocity criterion during maximum day with fire flow demand conditions at the commercial zoned area along Yosemite Blvd./Hwy 132. Figure 8 shows the locations of pipelines exceeding 12 ft/s and locations of fire flow nodes where the residual pressure is less than 20 psi. It is recommended that hydrants providing fire flows to the commercial areas along Yosemite Blvd./Hwy 132 be serviced off the proposed 16-inch diameter and 12-inch diameter River Pointe consolidation infrastructure in order to maintain sufficient residual pressures and reduce pipeline velocities.

- *Existing 2015 (CIP) Peak Hour Demand* - The proposed distribution system is sufficient to meet peak hour demands with pressures ranging from 45.2 psi to 80.5 psi. System pressures exceeding 60 psi are at locations with lower elevations at the southern end of the system bordering the Tuolumne River or Yosemite Boulevard/Highway 132. System pressures exceeding 80 psi are located at the River Pointe development. The installation of pressure reducing valves is recommended to mitigate high pressures at the River Pointe development. Refer to Figure 11.

City Buildout Water Distribution System Analysis and Recommendations The proposed distribution system is sufficient to meet average day demands, maximum day demands, and peak hour demands while maintaining a system pressure of 40 psi throughout the distribution system; however, pressures exceeding 80 psi are located at the River Pointe development. The installation of pressure reducing valves is recommended to mitigate high pressures at the River Pointe development. It is assumed that the recommended CIP system pipeline replacements, including the installation of pressure reducing valves (PRVs) at the River Pointe development, will be completed before City buildout development occurs.

Detailed modeling results for each demand scenario are summarized below:

- *City Buildout Average Day Demand* - The proposed system is sufficient to meet average day demands with pressures ranging from 54.7 psi to 90.3 psi. System pressures exceeding 60 psi are at locations with lower elevations at the southern end of the system bordering the Tuolumne River or Yosemite Boulevard/Highway 132. System pressures exceeding 80 psi are located at the River Pointe development. The installation of pressure reducing valves is recommended to mitigate high pressures at the River Pointe development. Refer to Figure 13.

- *City Buildout Maximum Day Demand* - The proposed system is sufficient to meet maximum day demands with pressures ranging from 54.1 psi to 89.5 psi. Pressures exceeding 60 psi are at locations with lower elevations at the southern end of the system bordering the Tuolumne River or Yosemite Boulevard/Highway 132. System pressures exceeding 80 psi are located at the River Pointe development. The installation of pressure reducing valves is recommended to mitigate high pressures at the River Pointe development. Refer to Figure 14.

- *City Buildout Maximum Day Demand with Fire Flow* - The proposed system cannot maintain a residual pressure of 20 psi and the maximum velocity criterion during maximum day with fire flow demand conditions at the commercial zoned area along Yosemite Blvd./Hwy 132. Figure 12 shows the locations of pipelines exceeding 12 ft/s and locations of fire flow nodes where the residual pressure is less than 20 psi. It is recommended that hydrants providing fire flows to the commercial areas along Yosemite Blvd./Hwy 132 be serviced off the proposed 16-inch diameter and 12-inch diameter consolidation infrastructure in order to maintain sufficient residual pressures and reduce pipeline velocities.

- City Buildout Peak Hour Demand: The proposed system is sufficient to meet peak hour demands with pressures ranging from 45.3 psi to 80.7 psi. System pressures exceeding 60 psi are at locations with lower elevations at the southern end of the system bordering the Tuolumne River or Yosemite Boulevard/Highway 132. Pressures exceeding 80 psi are located at the River Pointe development. The installation of pressure reducing valves is recommended to mitigate high pressures at the River Pointe development. Refer to Figure 15.

Future SOI Buildout Water Distribution System Analysis and Recommendations Based on the modeling analysis of the future SOI buildout distribution system, it is recommended that a new 16-inch transmission main be constructed with a connection to a new water well source, storage tank and booster pump station to provide the additional supply required to meet future maximum day with fire flow and peak hour demands. Distribution system piping to service the Future SOI service area consists of 8-inch diameter and 12-inch diameter piping. Figure 16 presents the proposed buildout infrastructure and facilities. Locations of proposed facilities are for planning purposes only and should be evaluated further preliminary design studies. Sizing of new facilities to meet system demands should be evaluation and determined in future preliminary design studies. Modeling assumptions assumed the proposed facilities are adequately sized to meet system demands. It is assumed that the recommended CIP system pipeline replacements, including the installation of PRVs at the River Pointe development, will be completed before City buildout development occurs.

The proposed buildout infrastructure is sufficient to meet average day demands, maximum day demands, maximum day with fire flow, and peak hour demands while maintaining a system pressure of 40 psi throughout the distribution system, with the exception of development in the northeastern portion of the SOI service area. Development in the northeastern SOI service area with elevations above 185 feet will require an inline booster pump station to serve future development to maintain sufficient pressures above 20 psi during maximum day with fire flow conditions and above 40 psi during peak hour demand conditions. The location of proposed booster pump facilities should be evaluated in future preliminary design studies. Distribution system piping to future commercial and industrial land use service areas should be 12-inches in diameter to maintain system pressures and velocities less than 12 ft/s during fire flow events.

Detailed modeling results for each demand scenario are summarized below:

- *Future SOI Buildout Average Day Demand* - The proposed system is sufficient to meet average day demands while maintaining system pressures above 40 psi. Refer to Figure 17.

- *Future SOI Buildout Maximum Day Demand* - The proposed system is sufficient to meet maximum day demands with system pressures exceeding 40 psi throughout the distribution system. Refer to Figure 18.

- *Future SOI Buildout Maximum Day Demand with Fire Flow* - The proposed system cannot maintain a system pressure of 20 psi and the maximum velocity criterion during maximum day with fire flow demand conditions at the northeastern portion of the SOI service area. Development in the northeastern SOI service area with elevations above 185 feet will require an inline booster pump station to serve future development to maintain sufficient pressures above 20 psi during maximum day with fire flow conditions. The location of proposed booster pump facilities should be evaluated in future preliminary design studies. Distribution system piping to future commercial and industrial land use service areas should be a minimum of 12-inches in diameter to maintain system pressures and velocities less than 12 ft/s to meet commercial and industrial fire flow demands of 2,000 gpm and 2,500 gpm , respectively. Refer to Figure 19 for the required and available fire flow based on the General Plan land use for the future SOI service area.

- *Future SOI Buildout Peak Hour Demand* – The proposed system cannot maintain a system pressure of 40 psi at the northeastern portion of the SOI service area. Development in the northeastern SOI service area with elevations above 185 feet will require an inline booster pump station to serve future development to maintain sufficient pressures above 40 psi during peak hour demand. The location of proposed booster pump facilities should be evaluated in future preliminary design studies. Refer to Figure 20.

Section 7 Findings and Recommendations

7.0 INTRODUCTION

To provide a reliable, cost effective, and high quality water supply for the City, both near and long term, several improvements are recommended. While under Modesto ownership, some infrastructure replacement and improvements were postponed. While consolidation of the River Pointe and Waterford service areas will alleviate many existing deficiencies, improvements are required to replace aging wells and pipelines, and adding additional storage will provide additional capacity and redundancy.

Beginning in 2008, the State of California has continuously added water conservation laws, codes, restrictions, and penalties for urban water suppliers, and this trend is expected to continue indefinitely. The benefit of the State's conservation movement is that the City will have reduced production capacity requirements, and a net cost benefit, as discussed in Section 5. Proactive conservation efforts are shown to be a practical method of reducing both capital and operating costs. Mandatory conservation will automatically reduce demands, but the City may elect to implement additional conservation programs to further reduce water program costs.

A primary objective of the City Water Program includes source water reliability. The projected demands, in combination with sustainable groundwater laws, may not require that the City find alternative sources of water for build-out. However, diversification of water supplies deserves consideration. The City's proximity to the MID system may provide for an affordable secondary water source, to be used to manage local groundwater and reduce risks associated with a mono-source program. Recycled wastewater is also a source water option, but may not be needed for many years.

Capital improvements required for existing and future development include new storage and pipelines, replacement of existing wells and pipelines, and conservation programs. However, the cost of these improvements were significantly reduced through a combination of consolidation of systems, DDW drinking water permit amendments, conservation (demand reduction) activities, re-design of conveyance facilities, evaluation of source supplies, and other strategies. According to prior planning documents, capital improvements for both existing and future growth totaled approximately $65M. [1] The revised capital improvement cost is $17.8M.

7.1 FINDINGS

Key findings and conclusions of the WMP are provided herein. Of most importance, is the topic of source water, or how the City should best secure a reliable supply of water for the long-term. The

[1] City of Waterford Water Master Plan (2006), and Modesto TM engineering report dated March 30, 2010.

solution is a multifaceted approach resulting in a diversified water portfolio, consisting of groundwater, surface water, and conservation.

A. Source Water Options

Three (3) primary source water alternatives were evaluated for the WMP. These included: (1) groundwater, (2) surface water, and (3) recycled wastewater. The following provides a summary discussion regarding the potential use of these sources.

Groundwater One option includes using groundwater as the sole water source, by expanding the groundwater system and replacing aging groundwater production facilities. New wells are expected to be drilled deeper, thereby increasing the production capacity of each well. This option relies on state and regional involvement to develop management strategies that will stabilize declining local groundwater tables, and provide a sustainable solution that is acceptable to the City. This option would provide no proactive groundwater recharge or alternative source to lessen the demands on local groundwater. Depending on the state/regional management solutions, the City may not have water for all development identified in the City's current General Plan.

Historically, local groundwater has been easily accessible, plentiful, and relatively inexpensive. However, to the uncertainties associated with future groundwater use and availability, it is not recommended that the City continue to rely on a groundwater-only program. It may require 10 years or more before the impacts of groundwater sustainability laws are fully realized, and it is doubtful the City will be allowed to pump substantially more groundwater in the future. Thus, pursuit of other water sources should be a primary objective for the City's water program. Waiting to secure these additional sources until they are needed may limit the City's access to new sources or substantially increase their cost.

Even if other sources are implemented (i.e. surface water), the City will need to provide a groundwater system to provide 100% of the City's demands. This will allow the most flexibility for taking surface water, and not be subject to severe water use restrictions due to drought.

Groundwater treatment is not included in the proposed Capital Improvement Program (CIP). Past water planning documents included substantial costs for treatment of DBCP, manganese, and other contaminants. Until groundwater exploration is conducted of deeper aquifers (where future wells will access water), it should not be assumed comprehensive groundwater treatment is needed. If treatment is needed, these costs should be included in the CIP as early as possible. Thus, groundwater exploration should be a high priority in the City water program.

Recycled Wastewater This option consists of using local groundwater as the primary source, and also constructing a non-potable water system for irrigation of landscaping with recycled wastewater. This alternative would take some of the demands from the groundwater system, especially during periods of high demand. Landscape demands would include City parks, cemeteries, schools, commercial landscaping, and possibly new residential landscaping. Disadvantages of this alternative are the cost of constructing tertiary treatment, a new non-potable water distribution system, and storage.

Given the relatively low irrigation demands within the City and the cost to treat and convey non-potable water service to the City, recycled water use within the City will be expensive. A more attractive option for the City may be to sell recycled water at some point in the future. In water short years there are multiple interests downstream that would be willing buyers of City recycled water. The water on the open market in 2015 was sold for approximately $650 per acre foot. The City currently has as much as 1,100 ac-ft available each year, though it may only be able to sell during the irrigation season depending on the buyer. Agreements for water sales can be annual or long-term, and annual sales may not occur in all years. For planning purposes, it could be assumed that the City could sell 600 ac-ft of wastewater at $200 per ac-ft, for average annual sales of $120,000. Given that the cost of tertiary treatment is $15 - $20M, it is not cost effective at this time. However, the City should recognize wastewater effluent as a potential asset, and continue to look for beneficial uses of this resource.

Conjunctive Use/Treated Surface Water This option consists of using both surface water and groundwater for potable and non-potable demands. Access to a treated surface water supply in conjunction with groundwater facilities provides the City with the most flexibility and highest level of defense against drought, climate change, and lowering groundwater tables, etc. Other local Cities that have or are currently developing conjunctive use programs include Modesto, Ceres, Turlock, Manteca, Tracy, Lodi, and Sacramento.

The City's 2006 Water Master Plan identifies the main source supply for growth (outside of the current Waterford service area) as treated surface water from MID:

"Currently, drinking water for the City of Waterford is supplied solely by groundwater wells. As development in the study area takes place, groundwater will continue to be used as a supply, as treated surface water from Modesto Irrigation District (MID) will not become available until 2018. When the Phase III expansion of MID's existing surface water treatment plant (WTP) is completed in 2018, the City will begin purchasing treated surface water to supply a portion of the study area; thus, total groundwater production will decrease, and will thereafter meet only a percentage of study area demands. However, because groundwater will be used to supply the entire study area prior to 2018, the groundwater facilities recommended in this Master Plan have been sized to accommodate the maximum demands expected in 2018. After the transition to surface water, groundwater will be used to meet seasonal demands that exceed the City's entitlement to the WTP's capacity."

Although the inclusion of surface water as a regular source of supply is recommended, replacing groundwater with surface water as the main source of supply may not be prudent at this time. Even with the uncertainties associated with groundwater, it remains as the City's most accessible, reliable, and affordable source supply for the following reasons: (1) groundwater can be locally managed and controlled, (2) the City has established an appropriative right to groundwater through a history of beneficial use, (3) the City is does not need to negotiate with another agency on issues such as cost, time of delivery, service interruptions, etc., (4) the cost of groundwater is typically less than treated surface water, (5) the City has a significant investment in groundwater production facilities, and will likely continue to invest in groundwater facilities in the near term, and (6) the groundwater quality does not have extensive contamination challenges. Declining groundwater elevations is a concern, but state and local agencies are proceeding with programs to arrest over use. The proximity of Waterford to the Tuolumne River will lessen the impact of groundwater decline, and accelerate stabilization and/or recovery.

Further, surface water is subject to significant reductions during extended periods of drought, contamination, or other outages, so the groundwater system should have sufficient capacity to meet all demands, not just a percentage. The 2006 Water Master Plan estimated the cost of improvements to implement surface water deliveries was $13.3M. Today, the same program is likely to exceed $18M. [2]

Yet adding surface water to the City water program is recommended and should be fully explored. Although it is the state's goal that groundwater sustainability laws will eventually stop local groundwater levels from declining, it is not a guarantee, and the levels where stabilization occurs is unknown. Having a second source of water would provide the City with the ability to actively manage its source supplies, and thereby significantly increase reliability. Unlike the 2006 plan, where surface water was to provide a regular and fixed portion of the supply, the City could pursue a long-term conjunctive use program by taking surface water periodically when it is available.[3] In some years, no surface water would be delivered (due to drought or other service issues), with groundwater as the sole source of supply. During periods of surplus, varying amounts of surface water could be delivered depending on MID operations and City demands. If surface water is only delivered during non-summer months, building additional capacity in the MID treatment plant may not be required.

The advantages of the conjunctive use program are: (1) it allows groundwater resource to replenish periodically (during periods of above average rainfall), (2) if water is delivered during non-summer periods, the cost of additional MID water treatment capacity is avoided, and, (3) the City can choose to take water when it is appropriate and affordable. MID surface water could be used directly, or it could be used to recharge the groundwater. The combination of groundwater and surface water will allow the City to proactively manage its water sources, rather than relying on state laws, courts, limiting growth, or other actions if groundwater use becomes restricted.

The most attractive option may be for Waterford to lease capacity in the Modesto Regional WTP for a defined Term. MID and the City of Modesto recently completed a 30 mgd Phase II expansion of the MRWTP. Modesto's build-out is assumed to occur in the 2038-2040 timeframe and the existing City of Modesto water planning documents project that the Phase II expansion will be able to serve Modesto's surface water needs at build-out. Additionally, the current water demands show a reduction in Modesto's water consumption and the new assumption is that growth in water demand will be slower than projected in the City of Modesto's 2010 water planning documents. Thus, there should be water treatment and transmission pipeline available as "interim capacity" that could be "leased" to the City of Waterford for a defined period of time. In comparison to Modesto, the City of Waterford's projected

[2] 2006 WMP Table 5-2 includes 4 MGD treatment and 5 MGD pumping station.

[3] The 2006 WMP recommended that surface water provide 76% of the annual demand, and groundwater provide 24%, every year.

demand for surface water is very small (approximately 3 to 4 mgd for average day demand at build-out). Therefore, developing a defined term for the interim use of treatment capacity could be accomplished with appropriate protections for the City of Modesto's interests and treatment capacity needs while allowing for the City of Waterford's use of the facilities. This alternative offers the following advantages for the City of Waterford:

- It allows the City of Waterford to begin using surface water to augment its drinking water supply quickly, without extensive capital outlay.

- It allows the City of Waterford to defer upfront capital costs of constructing treatment facilities.

- It allows for the phasing of treatment facilities and provides time to plan, fund, and construct these facilities over a defined period, thus allowing for the accumulation of funds and financing to reduce water rate impacts.

- The amount of capacity being used by the City of Waterford can be increased in phases up from 1.5 mgd to 3.0 mgd as needed to meet water demands over time.

- If a Phase III expansion proceeds, this alternative provides a good transition for participating in the project.

The City of Waterford would need a long-term water sales/delivery agreement with MID and an interim capacity "lease" agreement with MID / City of Modesto (for using the MRWTP and water transmission pipeline). The City of Waterford would also need to finance and construct the necessary storage, booster pump station, and distribution system improvements for using surface water. However, this alternative does offer flexibility to phase in some of these improvements due to the ability to slowly ramp-up surface water use.

Implementation of this alternative requires the approval of MID and the City of Modesto per the 2005 "Amended and Restated Treatment and Delivery Agreement" (Agreement) between MID and the City of Modesto. The Agreement stipulates that any lease or sale of water from the MRWTP is subject to offering the water to the City of Modesto first (right of first refusal) and that the cost of the water shall not be less than the full cost of producing the water, including sunk costs, the cost of raw water, operations and maintenance costs, and administrative costs. It further stipulates that the price of furnishing the water shall not be less than what is charged the City of Modesto. Obtaining a water sales and delivery agreement and an agreement to lease capacity represent the more challenging aspects of this alternative. Additionally, recognizing that this is an alternative that uses interim capacity (since that the City Modesto may need the capacity in the future), the City of Waterford would need to plan for the construction of its own water treatment capacity and develop and implement the funding mechanisms for a more permanent solution.

B. Conservation

Due to mandatory conservation codes and the net cost savings from implementing the conservations measures as analyzed, full implementation of the conservation plan is recommended. In addition to meeting several legislative requirements, full implementation will result in the greatest capital and energy cost savings, totaling approximately $6.5 M over the course of the planning horizon. The program should be phased as described herein to allow "pay-as-you-go" financing. It is also recommended that new development participate in the conservation plan funding to assist with retrofitting of existing development plumbing fixtures and system leak detection, as the reduction in water demand reduces infrastructure necessary for the new development.

The City may find that other conservation efforts other than those listed may be appropriate. For example, significant amounts of water can be used for flushing, fire hydrant testing, and construction water. All of these demands add the City's total water use, and must be reported to DWR when determining the City's unit water demand (gpcd). Some of these efforts could be combined, whereby hydrant testing, flushing, and filling water trucks could be done simultaneously, rather than as independent activities. The value and need for fire hydrant testing should also be examined, as data from these tests are becoming obsolete with improved hydraulic modeling and standards for fire hydrants throughout the City.

Finally, the City may elect to implement additional conservation measures or accelerate measures should opportunities present themselves (i.e. state grants for residential water fixture or commercial clothes washer replacement, etc.).

Though the analysis in this report suggest benefits for the City, seeing the efficacy of similar programs elsewhere can solidify confidence in the investment of such programs, and provide "off the shelf" programs that have been successfully implemented. The Central Valley of California has yet to adopt these conservation programs on a large scale, but Southern California has already experimented with several similar programs with positive results. The City should use the experience of existing programs to help implement its water conservation plan.

As an example, the Garden Spot Program, started by the Metropolitan Water District of Southern California (Metropolitan), has employed a series of rebates for water conserving technologies to motivate home owners and commercial/industrial customers to lower their indoor and outdoor water use, including:

- High efficiency toilets, with flush rates of 1.28 gallons/flush. A rebate of $100.00 per toilet is offered.
- High efficiency clothes washers, lowering water use by 55% in comparison to regular clothes washers. A rebate of $85.00 per machine is offered.
- Rotating Sprinkler heads, with an offered rebate of $4.00 per head with a minimum installation of 15 heads.

- Rain catchment barrels for water irrigation repurposing, with an offered rebate of $75.00 per barrel if it is at least 50 gallons in capacity.
- A rebate of $2.00 per square foot of lawn replaced with artificial turf that lowers outdoor water use.
- An $85.00 rebate offered for weather-based irrigation controllers (WBICs) for small properties or a $35.00 rebate per controller offered to properties with greater than one acre of irrigated land.

The program has led to residential and industrial water savings of 2.56 million gallons of water a year, in addition to financial savings for the residential home owners, businesses, and water purveyors. There are numerous existing conservation programs that can be used as templates for developing a successful water conservation program that is best suited for the City.

C. Summary of Key Findings

Several items of interest and concern became apparent during the preparation of the WMP. The following provides a list of key findings that formulated WMP recommendations, as provided later in this Section.

1. **Division of Drinking Water Permit Deficiencies** Prior to purchase of the water system from Modesto, the Waterford Water System was deficient in water production, and Well 244 exceeded the MCL for manganese. These deficiencies were identified in several letters issued by DDW, with a requirement to correct the deficiencies by June, 2015. During preparation of the WMP, the City submitted a proposed permit amendment to DDW, requesting the capacity requirement be lowered due to recent demand reductions from installation of water meters. Said request was accepted, thereby adequately addressing both capacity and water quality issues. Production from Well 244 is no longer needed, thus the well can be placed in "standby" status, and remain available for fire protection or other emergencies. However, virtually no surplus water for new development is available without some system improvements.

2. **Fire Suppression Deficiencies** Deficiencies as identified by DDW address capacity for maximum day and peak hour demands, but do not address fire suppression requirements. Although additional studies need to be conducted by the Stanislaus Consolidated Fire Protection District, it is evident that the City has significant fire suppression deficiencies at this time. Consolidating the Waterford and River Pointe water systems will likely address this deficiency. In addition, fire hydrant location in the Downtown area is lacking. This deficiency will be corrected with replacement of aging pipe, as discussed herein.

3. **Consolidation of Waterford and River Pointe** Consolidation of the two water service areas will be beneficial toward providing additional capacity for Waterford. The elevation difference between the two service areas can be addressed by placing River Pointe and surrounding areas at and below elevation 135' in a separate pressure zone. The booster pumps at the River Pointe WTP will perform better at the higher head (pressure) requirements of the Waterford service area.

4. **Aging Infrastructure** Some of the Waterford Water System infrastructure is very old and past its useful life. This includes pipe and wells. Many older pipes are undersized and do not have the conveyance capacity necessary for modern domestic and fire suppression demands. Old pipes located in alleys should be relocated to streets, due to improper separation between water and sewer mains, safety concerns with working on pipes in the alleys, meter box damage, and potential property damage if pipes leak. As many streets in the Downtown area are in disrepair, pipe replacement should be coordinated to occur in advance of any street work. Replacement of aging pipes will complement the leak detection activities described in the conservation section.

5. **Water Conservation** Water conservation activities are mandatory, required by law, and the City is required to advance mandatory conservation programs using its own resources. Cost/benefit analysis of water conservation indicates that it is in the City's best interest to proactively pursue water conservation programs, as it will avoid or defer high cost water infrastructure and reduce operating costs.

6. **Groundwater Sources** New state laws require local groundwater stakeholders to develop sustainable groundwater programs. The long-term impact of these activities are unknown. However, it is likely local groundwater tables will stabilize over time, but the City's ability to pump additional groundwater may be restricted. As such, seeking and securing other source water options are advisable. New wells constructed to replace older wells should be constructed to take water from deeper aquifers, thereby avoiding problems associated with shallow wells (i.e. going dry, losing production, poor water quality, etc.). Data necessary for design and construction of deeper wells is limited, thus exploratory well drilling is required.

7. **Well Pump Efficiency** All wells (including River Pointe) are not operating optimally. All wells and well pumps are overdue for inspection. As a result, water production has decreased, and the City is paying more to pump water than necessary. Information and data of the Waterford well pumps is unknown (was not available from Modesto), as are the condition of well casings and screens. When pumps are removed for inspection, the wells can be video tapped and inspected at that time.

8. **Recycled Water** The City's Wastewater Treatment Facility (WWTP) does not provide adequate treatment for using the plant effluent as irrigation water, so expensive upgrades would first be needed. In addition, a separate distribution system would need to be installed to convey recycled wastewater to locations where it could be used. Given that public landscaping (parks, schools, etc.) represent less than 9% of the GP buildout demands, a recycled water program is not feasible at this time. However, the City should continue to evaluate the use of recycled water over the next 10 to 20 years, as conditions may change. For example, in the event tertiary treatment is required for discharge of plant effluent, and the City has restricted access to groundwater due to state legislation (i.e. sustainable groundwater laws), use of recycled water may be prudent.

9. **Surface Water** Although there appears to be no immediate need for additional water beyond groundwater, developing a multi-source program is recommended. Treated MID surface water is

the most attractive option, as much of Waterford is in the MID service area, and the conveyance pipeline is located within the City. However, contrary to past water planning documents, the City should pursue an option to receive surface water during “off-peak” periods (i.e. fall, winter, spring) to avoid the need for an MID WTP expansion, and possibly higher costs for acquisition. Treated surface water could be used directly, or also for recharging groundwater in the vicinity of City wells.

7.2 RECOMMENDATIONS

The following recommendations for the City Water Program are based on findings and data as provided in previous sections of the WMP. The goal of the recommendations is to provide the City with a robust, reliable, and affordable water supply that will allow the City to prosper into the indefinite future. It is critical that the City acknowledge the complications facing water programs in California, and that these will become more prevalent in time. As such, managing water programs with a “business as usual" approach will no longer be acceptable, as past practices will not address future challenges. The recommendations provided herein represent a reasonable and proactive approach for developing a viable water program.

A. **Consolidate River Pointe and the Waterford Service Areas** Joining the water service areas will resolve existing permit deficiencies, and provide the City with surplus capacity for growth. The cost of consolidation will be significantly less than constructing new source capacity (i.e. wells) or storage. Although new wells and storage are needed in the near future, consolidation provides the City with an affordable solution that can be implemented immediately.

B. **Implement Water Conservation Activities** Currently, there are several mandatory water conservation laws and codes the City is required to address. These include restrictions on new landscaping, plumbing fixture replacement programs, and others. Once the City has 3,000 water service connections (expected to occur in the next 5 - 10 years), the State of California will require the City to comply with the Urban Water Management Act. Although implementation of water conservation programs is an expense, the benefit for the City is a significant reduction in capital improvements and operating costs over time. Since water conservation is an important part of a source water solution, water conservation programs should be considered a capital improvement program, and funded accordingly.

C. **Perform an Exploratory Drilling Program** Many of Waterford service area wells are past their useful life, and will need to be replaced. Although no addition source capacity is needed in the near term, the City should anticipate some or all of the aging wells will fail. New wells should be drilled into deeper aquifers to avoid impacts from groundwater decline and surface contaminants. However, exploratory drilling in zones below 400’ has not been performed, so the potential for water production and water quality in deeper zones is unknown. The location and depth of the new wells should be identified in advanced, as it requires 18-24 months to complete a well construction project. Knowing the locations and securing the properties for new wells will accelerate completion of a new well. At least two (2) new well sites should be identified. Exploratory drilling will alert the

City to possible treatment requirements on new wells, and incorporation of these costs in its fee program.

D. Pipeline Replacement Program Numerous pipelines in the Waterford service area are aging, past their useful life, in disrepair, or do not meet current standards (i.e. insufficient capacity due to small diameter). Modesto initiated a pipeline replacement program beginning in 1998, resulting in the replacement of 11,650 l.f. of pipe (1998 – 2012). There are 32,000 l.f. of additional aging pipe identified for replacement over the next 10 years. Replacing pipe in advance of catastrophic failure is prudent, since replacing failed pipes in emergency conditions is substantially more costly due to street and property damage, retaining contractors without the benefit of competitive bidding, disruption to customers, etc. Aging pipe replacement complements the water conservation program as old pipes are primary sources of water loss. The water conservation program includes pipe leakage testing, which is substantially reduced if older pipes are replaced in the near-term. Many of the replacement pipes will be of larger diameter, thereby increasing system conveyance capacity. Pipes in alleys (behind residents, primarily in older neighborhoods) should be moved to the street. It is recommended that the City develop an ongoing program to replace a number of pipe segments annually, with the intention of completing all work in 10 years.

E. Evaluation of Existing Pumps/Wells Records available from Modesto were not complete, thus critical data and information regarding the wells and well pumps is unknown. It is standard practice to remove and inspect well pumps every 5 – 10 years, and perform a video of the well at that time. In addition, wells are frequently rehabilitated every 10-15 years, depending on the type and material of well screen, water parameters, and other factors. All wells should have pumps removed (one at a time) to be inspected and rebuilt. Due to declining groundwater elevations, some pumps may need to be replaced so that well production and efficiencies are optimum.

F. Replacement (New) Well Construction Construct new wells to replace aging wells. Wells W242 and W244 are far past their useful life as both were constructed prior to 1950, and require replacement in the near-term. New wells constructed with modern designs and materials are expected to yield more water than old wells, thus one well will provide approximately the same production as W242 and W244 combined. The older wells can be placed on standby until either they fail or additional capacity is provided through storage, additional wells, or surface water. Before the end of the planning period, wells W245 and W286 will need to be replaced with a single, higher producing well.

G. Storage Tank/Booster Pump Station Construct a new storage and booster pump facility to provide peak hour, fire suppression, and emergency flow capacity. Although this project is not expected to occur until addition development occurs (5 – 10 years), acquiring a site for the facility in the near term is recommended. The property should be of sufficient size to locate groundwater treatment in the future, if necessary.

H. **MID Surface Water Contract** It is recommended that negotiations with MID regarding future surface water deliveries to Waterford should begin immediately. The logistics and details of this arrangement (i.e. how much water is available, when could it be delivered and at what quantities, delivery location and facility requirements, cost of delivery, etc.) may take several months or more to confirm. Conditions in the water market suggest that a successful and affordable contract for surface water will become more challenging over time. Although the City does not need surface water at this time, or even in the near term, securing an option for the water in the next 1-3 years is recommended.

Based on the review of surface water opportunities and recognition that the availability of surface water in the area is facing potential reductions due to regulatory challenges and drought and climate change, the following steps to secure surface water are recommended:

- Pursue a Long-Term Water Sales and Delivery Agreement with MID for up to 3,000 AFY – this would require establishing a collaborative agreement between the City of Waterford and MID, and complying with the California Environmental Quality Act (CEQA).
- Monitor the SRWA Regional Surface Water Treatment Project – City staff should monitor the development and progress of the SRWA surface water treatment project to determine if there are any future exchange opportunities.
- Monitor OID – it is advisable to periodically monitor OID's transfers and projects for potential opportunities to acquire surface water.

I. Hickman Water Service Area Alternatives regarding the Hickman water service area include (1) transfer/sale to a third party (i.e. town of Hickman, private water company, etc.), (2) consolidation with the Waterford system, or (3) maintaining the Hickman system as an independent service area and using state funding opportunities for improvements. State grants and/or low-interest loans are possible, and must be fully explored before alternatives can be evaluated, including Hickman's status as a disadvantaged community (DAC). The process of DAC surveys and subsequent discussions with the state could take several months, and likely not less than 1 year. Further, it is not recommended that Waterford water system rates supplement the cost of Hickman operations. The full cost of operating and maintaining the Hickman system has yet to be determined. Thus, it is recommended that once both funding and cost data are available, the alternatives be evaluated. Timely progress toward this end will require regular attention by City staff.

7.3 OTHER RECOMMENDATIONS

Other work incidental to the Water Program include the following:

Fire District Study Coordination with SCFPD is needed to determine fire suppression requirements for existing and future City development. Additional studies are required. Some existing buildings may have higher fire demands than the City can support, or is willing to fund. Assuming the number of these buildings are limited, a plan to address insufficient fire demands should be approached on a case-by-case basis.

Groundwater Management Groundwater monitoring is essential for managing and safeguarding groundwater supplies. For agencies depending exclusively on groundwater, a developed monitoring well network can help define the quantities of groundwater that are available and provide an early warning for quality problems. For conjunctive use agencies, a monitoring network is a tool for managing storage, recharge, and groundwater quality. With these facts in mind, the following is recommended for the City:

- Continue participation in the STRGBA and ESRWMP.
- Continue to monitor groundwater levels using the existing water production wells.
- Continue monitoring groundwater quality using the existing water production wells.
- Fund exploratory groundwater test wells for determining groundwater availability and quality to aid in the construction of a new water production well for the City. Convert test well(s) to dedicated monitor well(s), when possible.
- When planning for the construction of additional new water production wells and water facilities, retain a qualified hydrogeologist to recommend groundwater monitor well siting and design for the establishment of a monitoring network (incorporate groundwater monitoring wells into capital improvement planning).
- Explore the opportunities for grant funding of a monitoring well network through STRGBA, TGBA, and ESRWMP participation.
- Review an expansion of the groundwater monitoring program when surface water becomes available for conjunctive use.

Storm Water Harvesting The concept of collecting and detaining storm water runoff for the purpose of groundwater recharge is discussed in Section 4, and is also a concept promoted in the City General Plan (Policy SD 5.2). It is difficult to quantify the cost-benefit of constructing recharge basins in this WMP, since it will first require soil borings in various parts of the City SOI, and evaluating these results with the City storm water program and infrastructure plans to determine what infrastructure modifications would be required to direct storm water to areas of potential recharge. However, it is recommended that the City require developers to collect soil data, and use these findings when determining locations for storm detention basins.

7.4 WATER PROGRAM COSTS AND IMPLEMENTATION PHASING

The capital improvement program (CIP) provided herein includes a combination of projects that improve service (capacity, quality, reliability), and replace aging infrastructure. Projects can be categorized in terms of priority, or short-term (0 -2 years), mid—term (3 – 10 years), and long-term (11 -20 years). Descriptions and objectives of each is described below:

- ***Short-term (0 – 2 years)*** The goal of the CIP is to implement projects as needed in the short-term that allow the City to address critical issues such as deficiencies, provide water for development, and reliability of the system. The City has no urgent water quality issues, so short-term projects do not include treatment. The short-term projects in the CIP also include planning activities necessary to secure elements of mid-term or long-term projects, such as acquiring properties for future facilities, determining the need for groundwater treatment on future wells, etc.

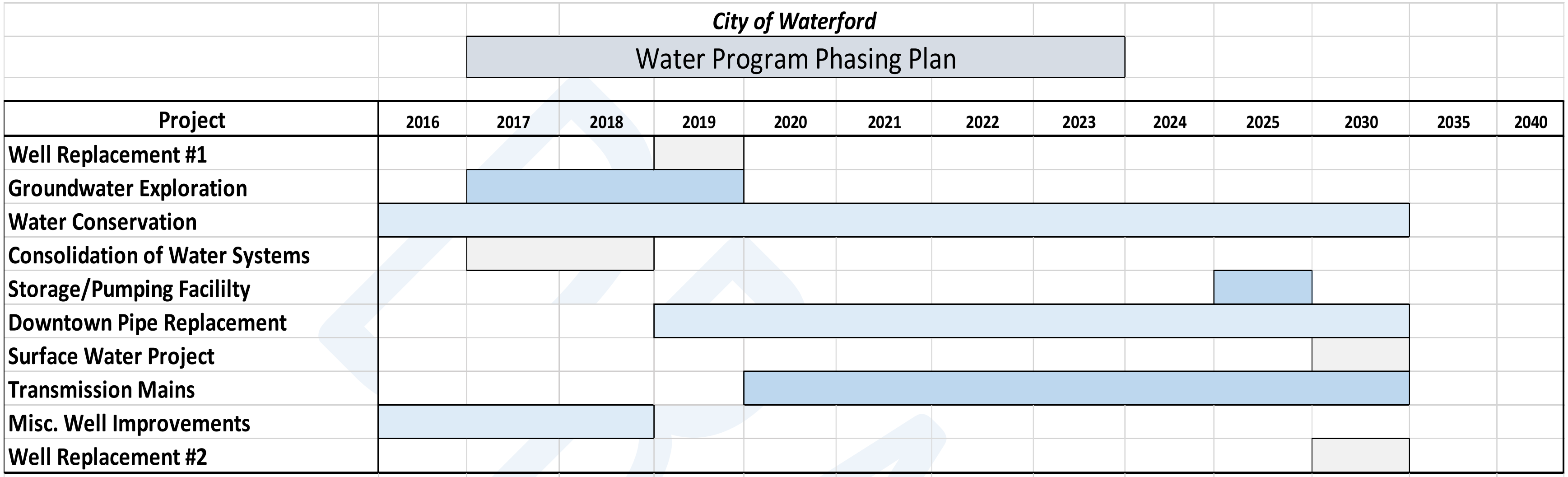
- ***Mid-term (3 – 10 years)*** Mid-term projects that are "on the drawing board", but cannot be implemented in the short-term due to one or numerous constraints. Mid-term projects include projects that will continue to reinforce the water program objectives and are a high priority, but need additional time to plan and secure funding.

- ***Long-term (11 – 20 years)*** Long-term projects are important but not critical. These projects may require years of planning, or substantial growth before they can or should be implemented. Regular preparation or coordination for long-term projects is often required during short-term or mid-term periods.

A summary of proposed Water Program projects, cost, and implementation are provided in Table 7.1, and Figure 7.1.

Table 7.1 Summary of Proposed Projects, Cost Estimates, and Implementation Dates

Project	Description	Year Required	Cost
New (Replacement) Well #1	New well to replace (2) aging production wells with a single well with higher capacity of 1,200 gpm (expected). Includes well, mechanical, civil, and electrical improvements.	2019	$1.25 M
Consolidation of Waterford and River Pointe	16" diameter pipeline from River Pointe WTP to intersection of F Street and Yosemite Boulevard.	2017 - 2018	$650 K
Water Conservation Program	Implement various conservation activities per conservation plan	2016-2030	$630 K
Storage/Pumping Facility	Project includes 2.0 MG storage, booster pump station, site improvements, etc.	2025	$4.7 M
Downtown Area Pipe Replacement	Replace aging steel pipes, valves, and services in older area of the City. Move pipes out of alleys.	2019-2029	$2.4 M
Transmission Mains	Install 12" and 16" transmission pipe loop	2020-2040	$2.7 M
New (Replacement) Well #2	New well to replace (2) aging production wells with a single well with higher capacity of 1,200 gpm (expected). Includes well, mechanical, civil, and electrical improvements.	202	$1.25 M
Surface Water Project	Turn out, meter structure, booster pumps, and other incidental costs to provide MID treated surface water.	2030	$1.2 M
Miscellaneous Well Improvements	Pump upgrades/rebuild, well rehabilitation, etc. as needed to maximize well production and efficiency, SCADA upgrades.	2016 - 2018	$500 K
Groundwater Exploration	Exploratory drilling to find locations of new and replacement wells	2017 -2019	$280 K
	Construction Cost Total		$15.6 M
Other Project Costs (source water studies, environmental, engineering, CM, admin., etc.)			$2.2 M
	Water Program Total Capital Cost		**$17.8 M**



Annual Project Cost Expenditure Estimates

Project	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2035	2040
Well Replacement #1				$1,437,000									
Groundwater Exploration		$100,000	$100,000	$100,000									
Water Conservation	$50,000	$50,000	$50,000	$100,000	$100,000	$100,000	$100,000	$80,000					
Consolidation of Water Systems		$375,000	$375,000										
Storage/Pumping Facililty										$5,400,000			
Downtown Pipe Replacement				$280,000	$280,000	$280,000	$280,000	$280,000	$280,000	$280,000	$800,000		
Surface Water Project											$1,380,000		
Transmission Mains					$310,000	$310,000	$310,000	$310,000	$310,000	$310,000	$1,240,000		
Misc. Well Improvements	$375,000	$100,000	$100,000										
Well Replacement #2											$1,437,000		
Average Annual Cost	**$425,000**	**$625,000**	**$625,000**	**$1,917,000**	**$690,000**	**$690,000**	**$690,000**	**$670,000**	**$590,000**	**$5,990,000**	**$4,857,000**		

Figure 7.1 Water Project Phasing and Annual Expenditures

(Note: All costs shown include full project costs (i.e. engineering, CM, Admin, etc.