SERVING AND ENHANCING OUR COMMUNITY WITH CARE, COMMITMENT AND PRIDE

THE CITY OF BENICIA CALIFORNIA

2015 Urban Water Management Plan

Adopted June 21, 2016

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City of Benicia
2015 Urban Water Management Plan

Final
June 2016

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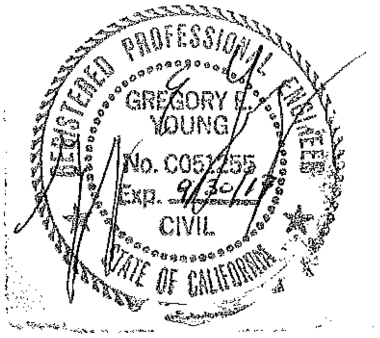
This City of Benicia 2015 Urban Water Management Plan was prepared under the direction of a California licensed civil engineer.



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CHAPTER 1. INTRODUCTION

Located on the northern side of Carquinez Strait, connecting San Pablo Bay with the Sacramento-San Joaquin Bay-Delta Estuary system, the City of Benicia (City) is one of the oldest cities in northern California. Founded in May 1847, the City is a waterfront city containing historic buildings, military establishments, industry, and new residential developments upon a backdrop of rolling hills on the eastern edge of the San Francisco Bay Area region.

Serving a population of nearly 27,000 people, the City has a broad range of water-related responsibilities to serve its citizens, including: controlling surface water assets, treating and distributing potable water, managing wastewater assets, developing new water supplies, and ensuring long-term water supply reliability. All of these duties are conducted in the face of climate change and regulatory uncertainty. The City's water and wastewater services are operated and managed through its Public Works Department.

The first waterworks system for the City, the Benicia Water Company, was built in 1880 by a group of citizens who acquired water rights on Paddy Creek and Sulphur Springs Creek located north of the City. The Benicia Water Company developed storage reservoirs, constructed pipelines into town, and installed some shallow wells to supplement the surface water sources. Sulphur Springs Creek water assets are still used by the City.

Note To DWR

The City of Benicia has written this UWMP primarily as a water resources planning tool and secondarily to satisfy the requirements of the UWMPA.

The body of the document provides narratives and discusses data that DWR requests in its 2015 UWMP Guidebook, including changes to the California Water Code since 2010.

To facilitate review by DWR for compliance with the UWMPA, data from the body of the document has been transferred into DWR Tables consistent with the organization of the tables in Section E of the 2015 UWMP Guidebook Appendices. These tables are in **Appendix A-1**.

Also, this UWMP has been reviewed for adequacy according to the UWMP Checklist as contained in Section F in the 2015 UWMP Guidebook. A completed checklist is included in **Appendix A-2**.

As the City expanded and diversified, so did its water assets. The City currently delivers approximately 10,000 acre-feet per year of treated and raw water supplies, with about 50 percent meeting treated water demands and 50 percent serving the needs of the Valero Benicia Refinery (Valero) – a large, petrochemical industrial facility.

The City has prepared this 2015 Urban Water Management Plan (2015 UWMP) to comply with the Urban Water Management Planning Act (UWMPA) requirements for urban water suppliers. This 2015 UWMP addresses the City's water management

planning efforts to assure adequate water supplies to meet forecast demands over the next 25 years[1]. As required by the UWMPA, the City's 2015 UWMP specifically assesses the availability of its supplies to meet forecast demands during average, single-dry and multiple dry years through 2040. Verification that future demands will not exceed supplies and assuring the availability of supplies in dry-year conditions are critical outcomes of this 2015 UWMP.

The 2015 UWMP is an update to the City's 2010 UWMP and presents new data and analysis as required by the California Department of Water Resources (DWR) and the California Water Code (CWC) since 2010. The 2015 UWMP is also a comprehensive water planning document that describes existing and future supply reliability, forecasts future demands, presents demand management progress, and identifies local and regional cooperative efforts to meet projected water use.

The current four-year drought has emphasized the importance of planning ahead to meet water demands with potentially at-risk water supplies. Such forward planning is an important outcome of the 2015 UWMP, which also addresses the evolving impact of drought and climate change on the City's water supply and operations.

1.1 Urban Water Management Planning Act

The Urban Water Management Planning Act requires every urban water supplier to prepare an urban water management plan pursuant to CWC Section 10610 et seq.[2] Because the City is an urban water supplier that serves over 3,000 customers, it is preparing its 2015 UWMP consistent with the UWMPA. The 2015 UWMP provides a framework for water planning to minimize the negative effects of potential water shortages, and provides useful information to the public about the City and its water management programs.

Specifically, the 2015 UWMP describes and evaluates the reliability of the City's existing and planned water supplies to meet near-term and long-term customer water demands. The plan assesses the availability and sufficiency of surface water and recycled water assets, and the vulnerability of these assets to seasonal, climactic, and regulatory conditions.

The 2015 UWMP also revisits baseline per-capita water use data and target conservation values, first developed and presented in the 2010 UWMP as required by CWC §10608 et seq., and assesses compliance with those targets. Further this UMWP includes narratives

[1] The City uses a 25 year planning horizon rather than the 20 planning horizon prescribed in the Water Code in order to preserve the City's plan throughout the time period leading up to the next UWMP date.
[2] An "urban water supplier" is a supplier, either publicly or privately owned, providing water for municipal purposes either directly or indirectly to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually." CWC § 10617.

describing water demand management measures,[3] the City's long-term plan for efficient water use, and estimated future water savings based on water use projections, where available. Also included are discussions regarding distribution system water loss, information on potential use of recycled water as a water source for the City, and the City's comprehensive water shortage contingency analysis, which details stages of action to be undertaken by the City in response to water supply shortages.[4]

In short, this 2015 UMWP allows the City to assess and plan for short-term and long-term effective management of its water supplies to meet its evolving water demands in the context of climate change and regulatory uncertainty.

1.2 Public Participation and Agency Coordination

The UWMPA requires a water purveyor to coordinate the preparation of its UWMP with other appropriate agencies in and around its service area. This requirement includes coordination with (a) water suppliers that share a common water source, (b) relevant water management agencies that affect the City's water assets, and relevant public agencies that may have land use or other regulatory relationships with the City. The City has prepared this 2015 UWMP in coordination with regional water purveyors and has appropriately notified and coordinated with other appropriate local government agencies as listed in **Table 1-1**. The list of water purveyors notified incorporates entities that share water supplies with the City as well as those that jointly utilize infrastructure and common resources. Copies of correspondence are included in **Appendix B-3**.

1.2.1 Solano County Water Agency

The City participated in the development of Solano County Water Agency's (SCWA's) Integrated Regional Water Management Plan (IRWMP), which is a regional effort to integrate and coordinate water management. The first phase of the IRWMP documented existing SCWA programs and summarized individual member agency water supplies and current demands. The second phase of the regional plan evaluated potential future water management measures and provided guidance on future programs and direction for the SCWA. Numerous water agencies, wastewater, flood protection, and land use agencies, and many nonprofit groups are part of this IRWMP effort. Also incorporated into this effort are water supply reliability analyses that are analyzed in **Chapter 3** of this UWMP.

[3] As detailed in the CWC § 10631 (f)(1) and (2).
[4] A recent amendment to CWC § 10632 includes defining water features that are artificially supplied with water as part of this contingency analysis.

Table 1-1 – Public and Agency Coordination

Coordinating Agencies	Coordinate regarding Demands	Sent Copy of Draft UWMP	Sent 60-Day Notice	Notice of Public Hearing
Cities, Counties, Customers and Interested Parties				
Solano County Water Agency	√	√	√	√
Solano Irrigation District	√	√	√	√
City of Vallejo	√	√	√	√
Valero Benicia Refinery	√	√	√	√
Solano County (Planning Department)			√	√
City of Fairfield			√	√
City of Vacaville			√	√
City of Dixon			√	√
City of Rio Vista			√	√
City of Suisun City			√	√
Reclamation District 2068			√	√
Maine Prairie Water District			√	√
General Public				√

1.2.2 Bay Area Clean Water Agencies

In 2009, as part of the Bay Area IRWMP's Regional Acceptance Process, SCWA indicated that the portion of Solano County that is within the Bay Area IRWMP region (which consists of the majority of the nine county Bay Area) would collaborate with the Bay Area IRWMP in the development and prioritization of water resources management projects. This area of coordination included the City of Benicia. The Bay Area Clean Water Agencies (BACWA) organization is comprised of local governmental agencies that operate publicly owned treatment works (POTWs) which discharge to the waters of San Francisco Bay Estuary. Together, BACWA's members serve more than 7 million people in the nine-county Bay Area, treating all domestic and commercial wastewater and a significant amount of industrial wastewater.

1.2.3 Bay Area Water Forum

The Bay Area Water Forum (Forum) is a regional group of water agencies and stakeholders that focuses, in particular, on water issues affecting the Bay Area and the Sacramento-San Joaquin Delta. The Forum also functions as the public outreach mechanism for the Bay Area IRWMP. It may be part of the future governance organization that DWR continues to seek to have better definition from the Bay Area. The Forum has encouraged all Bay Area jurisdictions to consider a set of water and land use principles as part of land use and water resource planning.

1.2.4 City of Benicia General Plan

This 2015 UWMP is based on the City's adopted General Plan land uses and policies, and focuses on water demand and supply. Many of the Ahwanhee Principles[5] are addressed by the City's General Plan, which encompasses all aspects of community planning. The City's General Plan guides land use and development policies. The Ahwanhee Principles incorporated into its General Plan and/or land use planning efforts, with guidance from the Planning Division, aim to encourage more efficient use of water resources. These principles include: designing all aspects of landscaping to reduce water demand and retain runoff; minimizing impervious surfaces so land is available to absorb storm water; and incorporating water holding areas such as creeks and ponds into the urban landscape. The Ahwanhee Principles specifically discussed in this 2015 UWMP include: recycled water, implementing urban water conservation technologies, and exploring locally available drought-proof water supplies, such as desalination of non-potable water.

1.2.5 Additional Entities

The City has shared water interests with several other entities due to their shared water use and participation in the SCWA. These neighboring entities include Dixon, Fairfield, Rio Vista, Suisun City, Vacaville, and Vallejo; the Solano Irrigation and Maine Prairie Water Districts; and Reclamation District 2068. All parties, including the general public and adjacent water suppliers, were sent 60 day notices and encouraged to attend the public hearing prior to the adoption of the 2015 UWMP. A copy of the letter is provided in **Appendix B-3**.

1.3 Plan Adoption

City held a public hearing regarding its 2015 UWMP on June 7, 2016.[6] Before the hearing, the City made a draft of the 2015 UWMP available for public inspection at the City's Public Works Department, City's website, as well as conducting social media outreach. Pursuant to CWC Section 10642, general notice of the public hearing was provided through publication of the hearing date and time,[7] and posting of the hearing at the City's office.

As part of its public hearing, the City received community input regarding its implementation plan for complying with the water conservation requirements contained

[5] Local Government Commission (LGC - www.lgc.org) developed the Ahwahnee Principles of Resource-Efficient Communities (1991), Ahwahnee Principles for Economic Development (1997), Ahwahnee Water Principles (2005), Ahwahnee Principles for Climate Change (2008), as comprehensive blueprints to help city and county planners adopt resource-efficient land use and community development principles.
[6] The hearing was held on June 7, 2016 and continued to June 21, 2016.
[7] See **Appendix B-2** for copies of the published notices.

in CWC § 10608.20 et seq., including the implementation plan's economic impacts.[8] Also, at the public hearing, the City presented the method for determining its urban water use target pursuant to CWC § 10608.20(b).

The City adopted this 2015 UWMP on June 21, 2016.[9] A copy of the adopted 2015 UWMP will be provided to the County and the California State Library, and posted onto the City's website.

1.3.1 Additional Compliance

The City plans to submit all required documentation related to the UWMPA soon after adoption. These include the required DWR UWMP Tables as **Appendix A-1**, the DWR Checklist as **Appendix A-2**, the SB 7-7X compliance forms as **Appendix A-3**, and the AWWA Water Audit worksheet as **Appendix A-4**.

1.4 Previous Reports

The 2015 UWMP has been prepared using a number of related planning documents and previous reports, including, but not limited to:

- City of Benicia's 2010 Urban Water Management Plan;
- 2013 Solano County Water Agency Integrated Regional Water Management Plan;
- City of Benicia 2012 Water System Master Plan;
- City of Benicia 1999 General Plan

1.5 Plan Organization

This UWMP is organized as follows:

- Chapter 2 provides a description of the City's (a) service area, including climate; demographic and population characteristics; and current and projected land-use changes integral to the demand forecasts, and (b) water system, including the potable and non-potable delivery systems.
- Chapter 3 describes the City's current and future water supplies and the reliability of the supplies.
- Chapter 4 details the demands on the City's system, including the past and future estimated demands.

[8] CWC § 10608.26
[9] The resolution adopting the 2015 UWMP is in **Appendix B-1**.

- Chapter 5 provides information regarding the City's demand management measures.
- Chapter 6 discusses the City's water shortage contingency plan.
- Chapter 7 compares the City's supplies and demands in normal and dry years.

- The appendices include background information, details, and necessary supporting documents.

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CHAPTER 2. WATER SYSTEM INFORMATION

2.1 City of Benicia Service Area General Description

The City is a public water agency that provides potable and non-potable water directly to retail customers throughout the roughly 16 square miles of the City boundary (see **Figure 2-1**). The City's service area exists within Solano County.

The City and surrounding area gently slope to Suisun Bay and the Carquinez Strait. **Figure 2-2** shows the major drainage watersheds, as identified in the City's General Plan, that drain surface runoff to creeks and water bodies in and adjacent to the City. Sulphur Springs Creek and its main tributary, Paddy Creek, form the largest watershed that drains the central part of the General Plan area, and includes Lake Herman. The Sulphur Springs Creek watershed is approximately 18 square miles, with the upper six square miles located outside the City's planning area within the City of Vallejo's sphere of influence. The Paddy Creek tributary drains a three square mile area at the lower reach of Sulphur Springs Creek just below the Lake Herman outlet. Lake Herman serves as part of the City's water supply and infrastructure system.

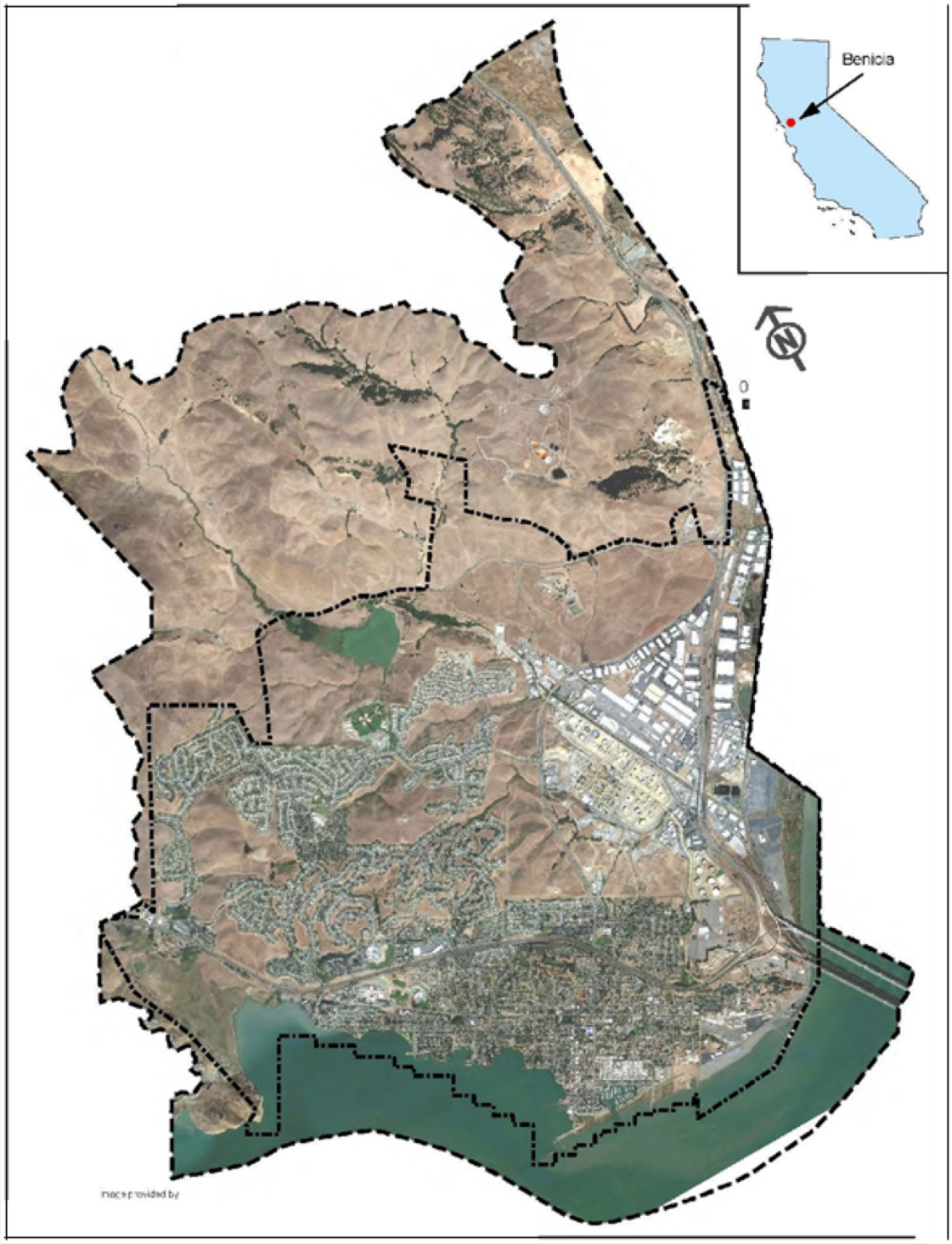
As represented by the General Plan, the City is almost entirely built out. Beyond anticipated in-fill projects, only a few areas remain where new development may occur. The City's build-out condition is further discussed later in this chapter.

2.1.1 Climate

The City of Benicia has coastal Mediterranean climate with frequent sea breezes from the west and periods of fog. The waterfront proximity keeps the climate temperate with warm, dry summers and moderate to cool winters. Climate data for the City of Benicia was obtained from local reporting stations with the same microclimate characteristics as the City's service area.

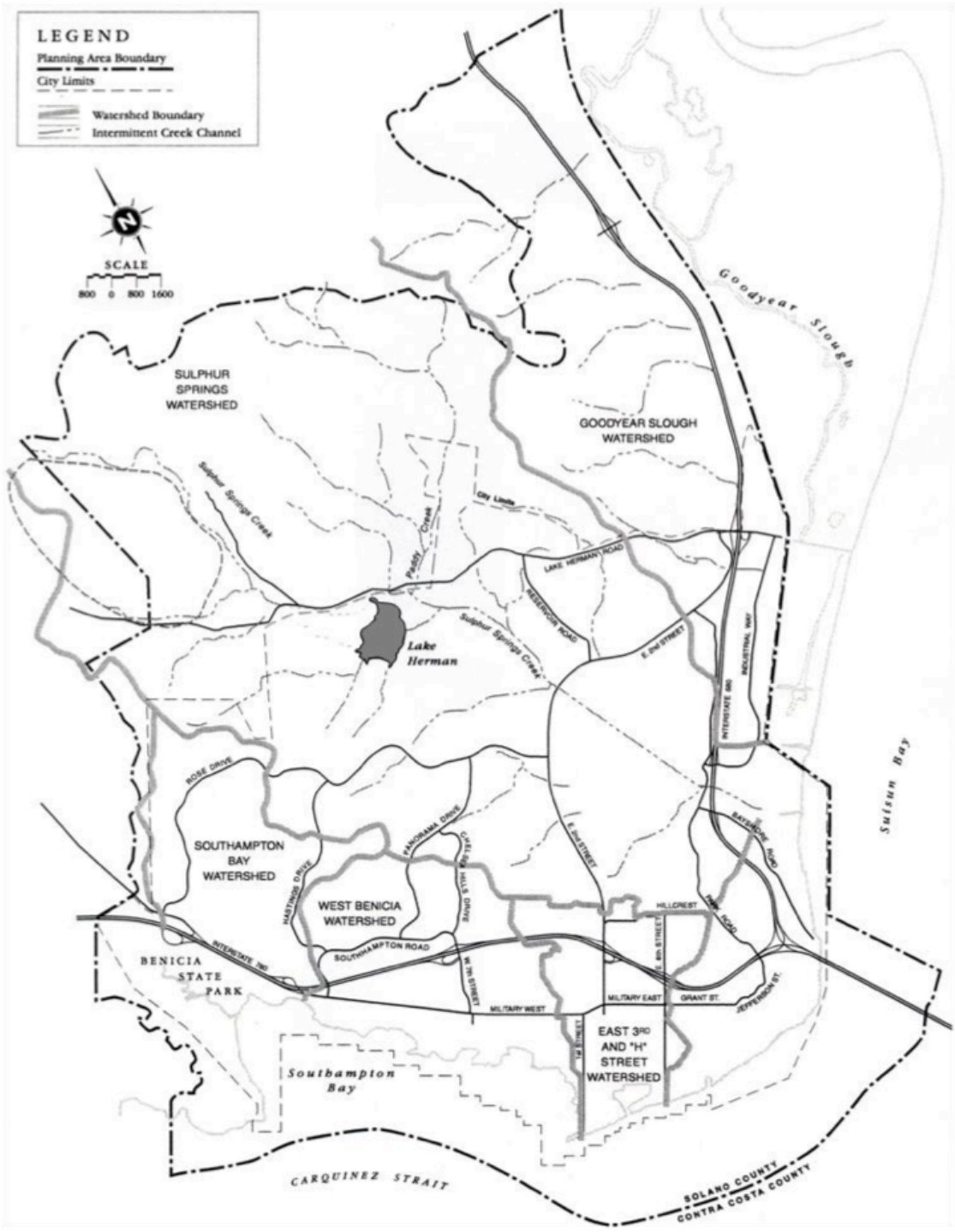
Standard monthly average evapotranspiration (ETo), precipitation and temperature data were obtained from the California Irrigation Management Information System's (CIMIS) Station #170, located about 5 miles southeast of the City in Concord, California. ETo at this location is likely higher than the City's as it provides a conservative baseline from which to assess climate. Evapotranspiration varies seasonally, and during a drought the significance of evapotranspiration is magnified because it continues to deplete surface and soil water supplies, which are not being replenished by sufficient precipitation. Average annual ETo for the period 2002-2015 is 50 inches. Average precipitation for the period 2002-2015 was 13.67 inches, notably lower than the 19.58 inches reported in the 2010 UWMP. The wettest months are December, January and February, and the driest months are normally July and August.

Figure 2-1 – City of Benicia Service Area[10]



[10] From 2010 UWMP

Figure 2-2 – Map of Surrounding Watersheds[11]



[11] From 2010 UWMP

For the same time period, average daily maximum and minimum temperature was recorded by month. Typically, July and August are the hottest months of the year with an average daily temperature of about 69 degrees Fahrenheit, though daytime high temperatures average close to 85 degrees. December and January are generally the coolest months of the year, with an average annual temperature of about 46 degrees, with the average minimum dipping down to 37 degrees.

All evapotranspiration (ETo), rainfall, and temperature data is provided in **Table 2-1**.

Table 2-1 – City of Benicia Climate Information[12]

Month	Standard Monthly Average ETo (inches)	Average Precipitation (inches)	Average Temperature (Fahrenheit)	Average Maximum Temperature (Fahrenheit)	Average Minimum Temperature (Fahrenheit)
January	1.31	1.74	46.5	57.5	37.0
February	1.88	2.45	50.7	62.4	39.9
March	3.42	1.80	54.0	66.6	42.2
April	4.67	1.28	56.7	69.0	44.9
May	6.25	0.63	61.5	74.5	49.6
June	7.13	0.22	66.6	80.8	54.6
July	7.49	0.05	69.0	84.7	57.1
August	6.67	0.01	68.4	84.2	56.8
September	5.07	0.04	67.1	83.1	54.5
October	3.32	0.77	61.0	75.8	48.1
November	1.78	1.20	52.2	64.9	40.9
December	1.10	3.48	46.0	56.6	36.7
Annual	50.08	13.67	58.3	71.7	46.9

2.1.2 Demographics and Population Characteristics

The City of Benicia had a period of rapid growth starting in the 1970s but has slowed significantly in recent years and is now very close to build-out. The City has even designated an Urban Growth Boundary[13] (UGB) in which no urban development beyond the UGB shall be served by City water and/or sewer. This designation furthers with the City's goal to focus growth and prevent urban sprawl due to its limited ability to extend services and desire to protect sensitive lands.[14]

The City experienced a ten percent increase in population from 1990-2000, but from 2000-2010 growth slowed to just under one half of a percent, and is expected to maintain

[12]DWR CIMIS Data, Concord Station 170, 2002-2015. The data presented in this table will require future revisions in the context of MAWA calculations under MWELO.
[13]Policy 2.1.5 City of Benicia General Plan, Updated April 2016
[14] Section A – Land Use and Growth Management, City of Benicia General Plan

limited growth and reach build-out by 2035. In 2010 the City was estimated to have 11,306 housing units, growing to an estimated 11,329 units by 2015.[15] This number is not expected to grow significantly and build-out will occur largely from infill and redevelopment.

As determined by the 2010 Census, the average single-family household size was 2.61 people. The historical population estimates for the City were calculated from Department of Finance (DOF) and Census data.[16] Population estimates for the period 2000-2010, a key timeframe for determining baseline per-capita water use values discussed further in Chapter 4, are adjusted from estimates presented in the 2010 UWMP due to the availability of 2010 census data in 2012.[17] The City's population estimates as developed using the DWR tool are presented in **Table 2-2,** accompanied by the 2010 UWMP projections for comparison. The future populations were obtained from an analysis undertaken by the Solano County Water Agency on behalf of its members.[18] That analysis also utilized the DWR tool. The population reflects an approximate one-percent annual growth rate to 2040.

The City does not have significant seasonal population swings based on vacation, agricultural, or institutional economies, which would factor into population projections and water demand planning.

2.1.3 Current and Projected Land use

Figure 2-3 presents the City's current land use diagram. Although it appears a few of the areas designated as "single family residential" are yet to be developed, the reality is that they have already been built. As indicated previously, the City has almost reached build-out. Growth is expected as either infill projects or as part of potential growth near the northeastern Urban Growth boundary. Infill is assumed to simply add one residential housing unit and one commercial unit annually.

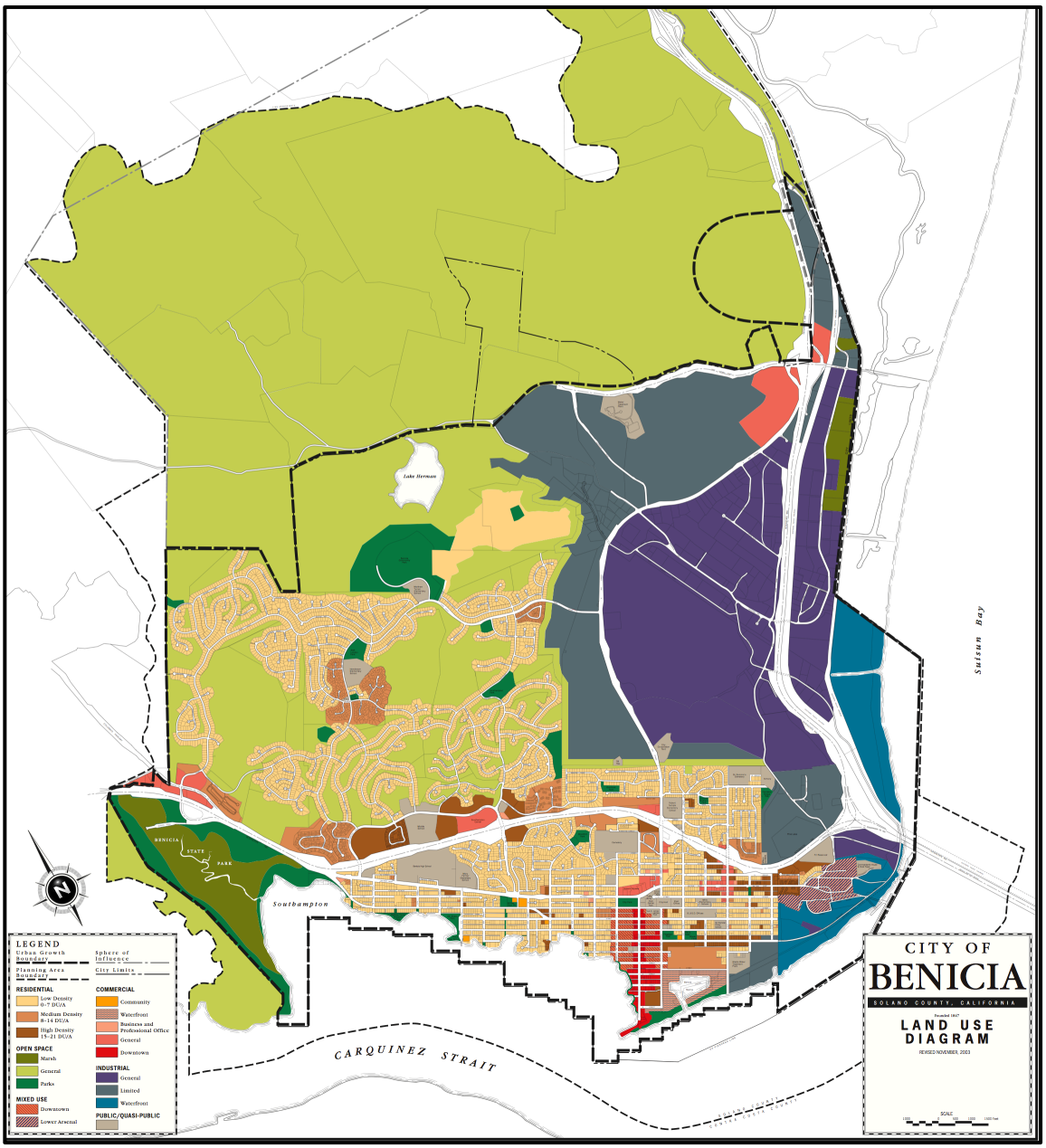
[15] U.S. Census, Department of Finance E-5 Report, U.S. Census 2010

[16] According to the DWR's Methodologies for Calculating Baseline and Compliance Urban Per Capita Water Use document the City of Benicia falls in Category 1: Water suppliers whose actual distribution area overlaps substantially (≥95%) with city boundaries (may be a single city or a group of cities) during baseline and compliance years.

[17] The 2010 UWMP's population estimates were based on extensions of the 2000 Census data as the 2010 data was not yet available.

[18] Memorandum: *SCWA – Partner Agency 2020-2040 Population Projections*, provided to Thomas Pate, Solano County Water Agency, from Kennedy/Jenks Consultants, April 20, 2016.

Figure 2-3 – City of Benicia General Land Use Map[19]



[19] Taken from City of Benicia General Plan, Land Use Diagram

Table 2-2 – Historic and Projected Population

Year	Population From 2010 UWMP	Revised Population For 2015 UWMP
2000	26,865	26,865
2001	27,155	26,878
2002	27,188	26,891
2003	27,123	26,905
2004	27,005	26,918
2005	27,163	26,931
2006	27,159	26,944
2007	27,768	26,958
2008	27,830	26,971
2009	27,912	26,984
2010	28,086	26,719
2015	28,504	27,689
2020	28,929	27,908
2025	29,360	29,246
2030	29,800	30,650
2035	30,100	32,120
2040	-	33,661

In early 2016 the City's Planning Commission received information and listened to a staff presentation regarding a proposed new mixed-use development, referred to as the Northern Gateway project that would develop this northeastern area.[20] The project proposes just over 600 residential units and 170 acres of industrial and commercial use (see **Figure 2-4**). While the project's preliminary scope was not approved, for purposes of forecasting water demands in **Chapter 4**, this project is included as a future demand, but is not anticipated to begin development until 2030.

[20] Special Meeting Planning Commission, January 26, 2016 Workshop Item.

Figure 2-4 – Northern Gateway Project Location

2.2 Potable Water Delivery System

The existing City water treatment plant was constructed in 1971. The plant was originally designed for a capacity of 6 million gallons per day (mgd). In 1989, the plant was expanded to 12 mgd, with additional reliability and redundancy improvements in 2006. There are 6 reservoirs throughout the City to provide potable water storage during peak demands periods that are capable of storing up to 12.8 million gallons. Each reservoir has the capacity to store from 1 to 3 million gallons.

Raw water is delivered to the City via the raw water transmission system, which is comprised of two pump stations and approximately 75,000 feet of pipe. The primary raw water source for the City is the State Water Project (SWP). This water is delivered from Barker Slough on the Sacramento-San Joaquin River Delta via the North Bay Aqueduct (NBA). Additional water comes through the Solano Project via the Putah South Canal (PSC) to the Terminal Reservoir. Water is then conveyed from either the NBA Cordelia Pumping Plant or the PSC Cordelia Pump Station to a diversion structure located at the City's water treatment plant. The flows in excess of daily demand are diverted to Lake Herman by gravity through a pipeline. The City also delivers raw water to the Valero

refinery. The City can also convey raw water to Lake Herman for emergency supply as well as utilize the lake as a storage reservoir for up to 1,400AF.[21] **Figure 2-5** illustrates the layout of the raw water conveyance system that serves the City. **Figure 2-7** represents a diagram of the City's potable and raw water infrastructure.

From 2002 to 2015 the annual production of the water treatment plant ranged from 1,783.5 to 2,175.8 million gallons per year (MG/year), corresponding to annual average day demands of 4.89 million gallons per day (mgd) and 5.96 mgd, respectively. The water system distribution has pipelines ranging from 4-inch pipes to 30-inch pipes. The majority of the larger pipes are ductile iron with most 12-inch pipelines constructed with asbestos cement or ductile iron.[22] **Figure 2-6** presents a map of the City's potable water distribution system.

2.2.1 Non-Potable and Recycled Water Systems

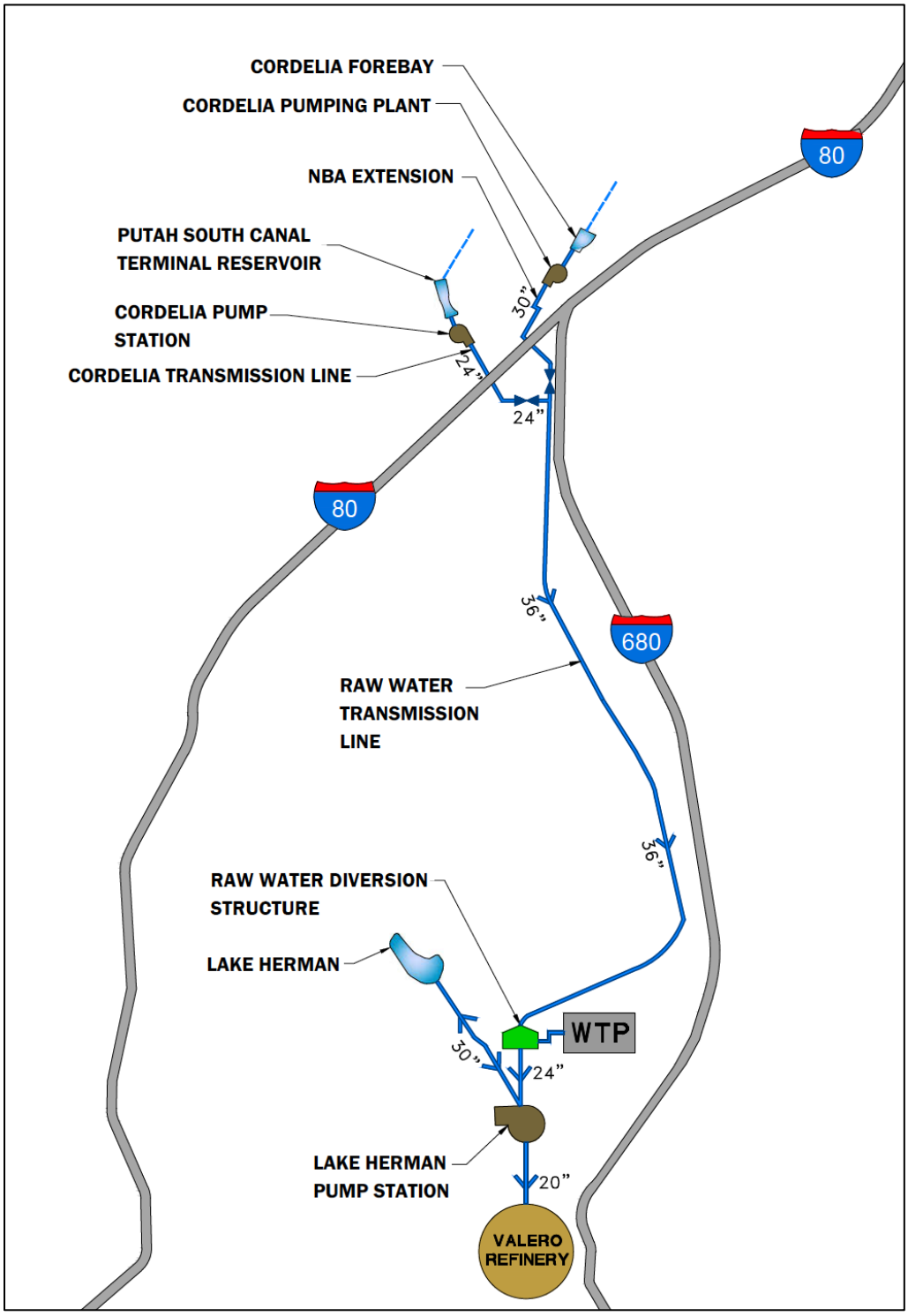
The City's primary non-potable system consists of simple delivery infrastructure to serve raw water supplies to Valero. Raw water is treated by Valero at its own facilities with its own treatment technologies.

The City also provides wastewater collection, treatment, and disposal services to customers within its service area. The City's wastewater collection system consists of approximately 150 miles of pipelines and 24 lift stations. The majority of the collection system relies on gravity flow through the pipelines. Due to terrain restrictions, it also relies on 24 pump stations to transport the collected wastewater from low points to suitable locations for continued transmission by gravity. The City operates and maintains a 4.5-mgd wastewater treatment plant (WWTP) facility.

Though the WWTP provides secondary treatment, the City and Valero completed a preliminary design report in 2008 to upgrade the WWTP to tertiary treatment allowing for non-restricted recycled water reuse.[23] The refinery has consumed an average of 4.4 mgd of raw water over the past 10 years; therefore, any use of recycled water by the refinery would free-up raw water for use by the City. The project is currently undergoing CEQA review and a Feasibility Study Final Report is on schedule to be completed in June of 2016. Construction of the project is anticipated to begin in 2018.[24]

[21] 2012 Water System Master Plan
[22] 2012 Water System Master Plan
[23] City of Benicia Water Reuse Feasibility Study.
[24] The Feasibility Study Final Report can be found at http://www.ci.benicia.ca.us/index.asp?SEC=C3FFA6AD-0946-43A8-981A-ED1DC0107806&DE=00FB6F6B-AE14-40A7-A2F2-0AA893F87BBC&Type=B_BASIC.

Figure 2-5 – Map of Benicia's Raw Water System[25]

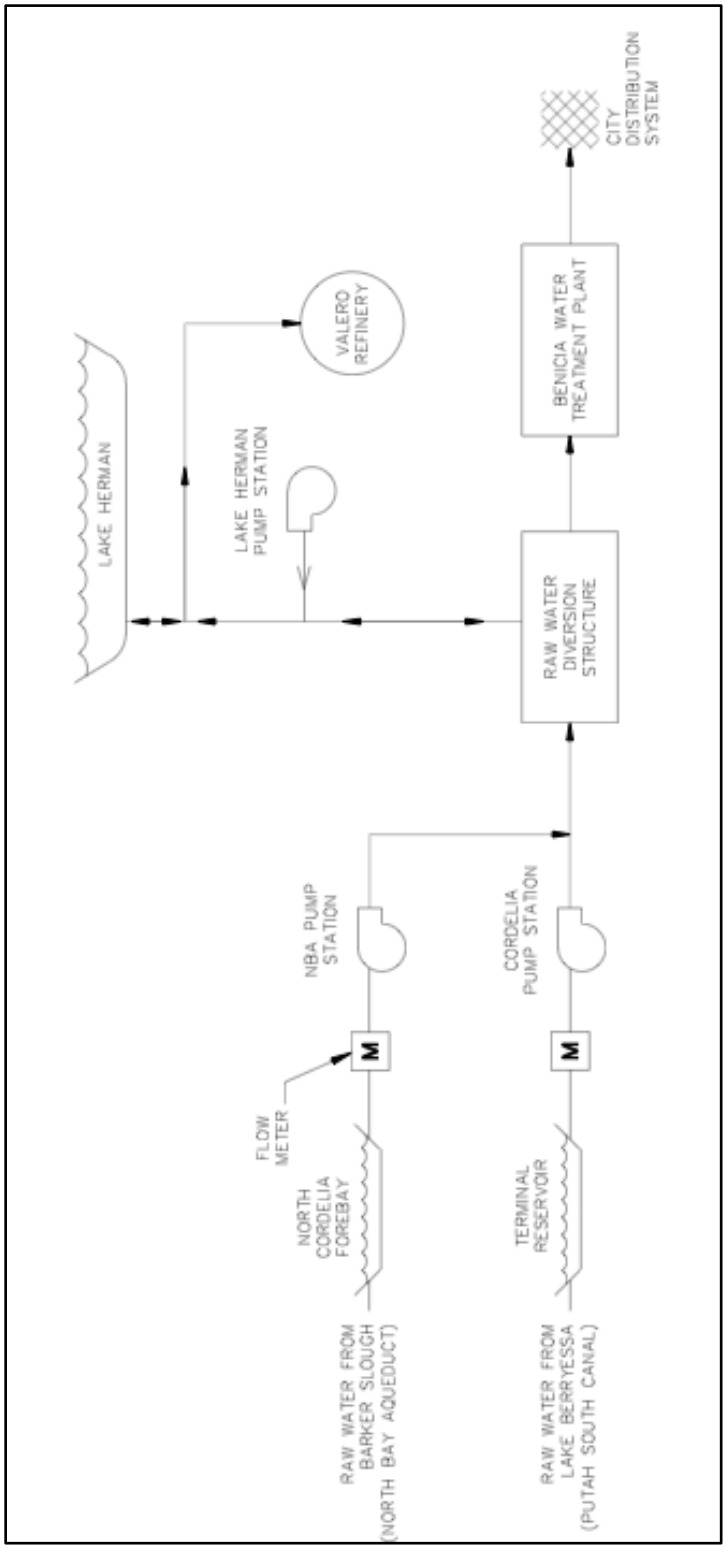


[25] 2012 Water System Master Plan, Figure 4-3 (revised).

Figure 2-6 – Potable Water Service Map[26]

[26] 2013 Potable Water System Map, City of Benicia

Figure 2-7 – Raw Water System Diagram[27]



[27] Taken from 2012 Master Water Supply Plan, Figure 3-2

CHAPTER 3. WATER SUPPLY CHARACTERISTICS

3.1 Water Supply Sources

Chapter 3 describes the City of Benicia's existing and planned water supplies. The City's water supplies are derived from three surface water sources: the Sacramento River watershed, the Solano Project, and the Lake Herman watershed. All water supplies derived from these sources are collectively managed in order to best meet the City's demands in different year types, reduce delivery costs, manage water quality issues, and handle emergency situations. As such, water deliveries from each identified water source may fluctuate in any given year.

The City's Sacramento River watershed water supplies are derived from a variety of water rights and contracts. The water supplies are diverted from the Sacramento River watershed at the North Bay Aqueduct – a State Water Project (SWP) facility located in Barker Slough. The water supplies from the Sacramento River watershed that are conveyed through the North Bay Aqueduct (NBA) serves the majority of the City's needs in normal years.

The primary supply source for the Solano Project is Lake Berryessa. Lake Berryessa is located in the Vaca Mountains in Napa County and formed by Monticello Dam. Lake Berryessa is a multi-purpose lake that, combined with the Putah Diversion Dam and other associated infrastructure, makes up the Solano Project – a federal water project operated by the United States Bureau of Reclamation. Solano Project water is transported to Benicia through the Putah South Canal and provides approximately 20 percent of the City's total consumption in normal years.

Lake Herman – an artificial reservoir originally built at the time of the City's foundation – diverts water to storage from the Sulphur Springs Valley Creek watershed and stores additional water delivered through the Solano Project and North Bay Aqueduct as needed. Lake Herman is primarily used as a backup or peaking supply for Valero, an emergency water supply source, and as a means to regulate raw water supplies coming into the City's system from alternative sources.

A Note on Units of Measurement

This 2015 UWMP uses acre-feet per year as the standard unit of measurement. This unit of measure is commonly used when analyzing water supply and demand on an annual basis. An acre-foot of water is approximately equal to one foot of water covering an entire football field. The formula for conversion is:

Acre-Feet to Gallons: Acre-feet x 325,851= Gallons

All three of these water supply sources are described in much more detail in the sections below. Copies of all the water supply documents discussed below can be found in **Appendix C-1** for further reference. And each asset is assessed for normal, single dry year, and multiple dry years reliability in **Chapter 7** of this Urban Water Management Plan.

3.2 Sacramento River Watershed Water Supplies

The City has two sources of contractual water assets derived from the Sacramento River Watershed: (1) Participating Agency Contract with Solano County Water Agency for State Water Project water; and (2) Settlement Agreement with the California Department of Water Resources. The details underlying both of these water supply sources as well as their conveyance and delivery components affect their short-term and long-term reliability.

3.2.1 Participating Agency Contract with Solano County Water Agency

The California State Water Project (SWP) was created in 1957 following the devastating floods that inundated great portions of the Sacramento Valley. In 1960, under the Burns-Porter Act (also known as the California Water Resources Development Bond Act), the SWP was funded for construction. Today, the SWP diverts, stores, and distributes water to 29 agricultural and urban suppliers throughout Northern, Central and Southern California. Approximately 70 percent of the SWP supply is contracted for urban uses and 30 percent is contracted for agriculture. The diversion rights are based upon State Water Resources Control Board issued appropriative water rights with 1927 priority dates.

The Solano County Water Agency (SCWA) is one of the 29 water suppliers that executed a State Water Project Contract with the California Department of Water Resources. The original contract was signed in 1963 and includes 20 amendments. In 2003, DWR and SCWA signed another agreement that attempted to amalgamate all of the amendments that were added to the 1963 contract. However, DWR disclaims legal validity of the consolidated document by stating that:

[the 2003 document] is intended only to provide a convenient reference source, and the Department of Water Resources is unable to provide assurances that this integrated version accurately represents the original documents. For legal purposes, or when precise accuracy is required, users should direct their attention to the original source documents rather than this integrated version.

As such, the 1963 Contract and its 20 amendments should be consulted when assessing SCWA's SWP water assets.

The City derives a portion of its water supplies from the SWP contract between SCWA and DWR. Importantly, entire portions of SCWA's SWP contract are fully incorporated into the City's Participating Agency contract. As such, the City is bound by the qualifying language contained in SCWA's SWP contract that affects supply allocations in the City's Participating Agency Contract.

The City originally entered into a "Member Unit Contract" with SCWA in 1977 in order to receive water derived from SCWA's SWP contract. The City and SCWA entered a second contract in 1985 superseding the 1977 contract. In 2013, the City and SCWA entered the "Participating Agency Contract" superseding the 1985 contract and its amendments. Accordingly, the City's current SWP-based water supplies are derived from its 2013 Participating Agency Contract (2013 PAC) with SCWA.

The 2013 PAC grants the City a Table A allocation of 17,200 acre-feet annually. This allocation represents the maximum amount of water that is available to the City through this water agreement. The 2013 PAC; however, recognizes that SCWA's SWP contract may be subject to shortages that require all participating agencies to reduce water supply deliveries that that are derived from SCWA's SWP contract and its 20 amendments. As such, the 2013 PAC allocates proportionate water supply shares in times of shortage. The City's share is 41 percent of the total SWP allocation to SCWA.[28]

The primary source of the SWP water for the City's allocation is Lake Oroville. However, additional SWP facilities – including San Luis Reservoir, located south of the Sacramento-San Joaquin Reservoir – also contribute to the City's ability to utilize SWP water assets. Since 2010, the City has received the following allotments listed in **Table 3-1** under the 1985 Member Unit Contract and the 2013 PAC.

Table 3-1 – 2013 PAC Allotment

Year	Allotment	Percentage
2010	8,600	50%
2011	13,760	80%
2012	11,180	65%
2013	6,020	35%
2014	860	5%
2015	4,300	25%

The City's 2013 PAC, in concert with SCWA's SWP contract, allow the City to manage water assets derived from SWP sources through management of "Carryover Water" (water carried over from year to year in the SWP facilities), acquisition of water under Article 21 of SCWA's SWP contract, and water banked with Mojave Water Agency.

[28]Participating Agency Contract Between Solano County Water Agency and the City of Benicia, dated October 30, 2013 at Table C.

"Carryover Water" can readily be lost; however, as it is the first to spill when reservoirs refill during normal and wet years.

The following table represents the City's management of its SWP-based water assets derived from these three additional variables. **Table 3-2** below lists the water assets derived from these additional SWP related sources.

Table 3-2 – Additional SWP Water Assets

Year	Carryover	Mojave	Article 21
2010	1,689	3,000	0
2011	0	0	4,278
2012	7,014	0	384
2013	8,030	8,030	193
2014	3,351	1,000	0
2015	4,247	1,000	0

In 1985, the cities of Benicia, Fairfield, and Vacaville agreed to reduce their annual allotment under their Member Unit Contracts in order to provide SWP water to the cities of Rio Vista and Dixon. Under the agreement, Rio Vista and Dixon must develop facilities to use the SWP water by 2016 in order to take advantage of this offering. At the time of writing this Urban Water Management Plan, Rio Vista and Dixon had not completed the infrastructure necessary to deliver SWP water supplies. Nevertheless, under this agreement, the City's contract may diminish by as much as 1,125 acre-feet with the initial reduction at 225 acre-feet per year. For purposes of this analysis, we assume that the City's annual 2013 PAC allotment will imminently be reduced by 225 acre-feet and be further reduced by an additional 900 acre-feet by 2025.

In 2010, 2014 and 2015, the City used water pursuant to the terms of a water banking agreement it had with Mojave Water Agency. This agreement has expired and not been renewed. As such, the City has no current plans to derive any future SWP-based water asset from this groundwater banking activity but may develop similar activities with other agencies in the future.

Article 21 water is that water that is surplus to the Department of Water Resources SWP contract delivery obligations. When available, this water can be made available to the SWP contractors.

SWP-derived water assets are conveyed through the North Bay Aqueduct (NBA) – a State Water Project facility. All conveyance of water assets through the NBA are generally controlled by DWR and Solano County Water Agency since SCWA is the regional wholesale contracting agent with DWR. SCWA's distribution of water is subject to a series of conveyance agreements. All of these conveyance arrangements are described in **Section 3.2.3** below.

3.2.2 Settlement Agreement with Department of Water Resources

In 1998, the City of Benicia, along with the cities of Fairfield and Vacaville, asserted a priority right with the State of California for water from the Sacramento-San Joaquin Delta pursuant to the Watershed-of-Origin statutes. The Watershed-of-Origin statutes along with similarly related statutes – collectively known as Area of Origin law – were created in order to preserve the water supplies of local areas as against the long-term potential export of water supplies to distant places far from their originating sources. In short, these laws were designed to protect local water users from the federal Central Valley Project and State Water Project exporters.

DWR protested the cities' applications in a matter held before the State Water Resources Control Board (SWRCB). DWR and the cities negotiated a comprehensive settlement to resolve the dispute before the area of origin legalities were debated in a hearing before the SWRCB. The final negotiated agreement is titled: "Settlement Agreement Among the Department of Water Resources of the State of California, Solano County Water Agency, and Cities of Fairfield, Vacaville, and Benicia for Purposes of Water Supply" (hereafter Settlement Agreement) and is dated May 19, 2003. The subsequent settlement and conveyance agreements define the basis to make water available for use in the cities' service areas and how the existing DWR facilities would be used to convey the water to the participating cities. SCWA was a necessary party in interest to the Settlement Agreement because of its relationship to the SWP facilities needed to deliver the settlement water assets.

DWR diverts water to meet its obligations under various appropriative water rights with priority dates of approximately 1927. These water rights are used to fulfill contractual obligations related to its 29 State Water Project contracts as well as meet other water delivery obligations in settlement negotiations throughout the state. In this instance, DWR is utilizing water it would otherwise divert to meet SWP contract obligations in order to satisfy the requirements of the Settlement Agreement.

The Settlement Agreement provides all three cities a total of 31,620 acre-feet of water. The City of Benicia was awarded 10,500 acre-feet per year of this total in order to meet the City's projected General Plan build-out demands. The supplies are derived from the Department of Water Resources Sacramento River watershed water rights diversions – they are not derived from water diversions made to storage at Oroville or other project facilities. The distinction is important because when water supplies are unavailable under the direct diversion provisions under DWR's appropriative water rights – as happened in 2014 and 2015 – or when "Term 91" is declared, then water under this Settlement Agreement may not be diverted for use in the City of Benicia. Although DWR's water rights are not subject to Term 91, the Settlement Agreement invokes SWRCB action in declaring Term 91 "in effect" in order to curtail water usage in the Settlement Agreement. Term 91 is declared by the SWRCB when it is determined that the SWP and

U.S. Bureau of Reclamation's Central Valley Project (CVP) are required to release stored water in excess of low natural flow to meet Sacramento Valley in-basin uses plus export demands. Natural flow is the flow that would have been in existence if the dams had not been built. In short, when direct diversions are not allowed, the City of Benicia is denied water under this Settlement Agreement and no water stored in DWR's SWP facilities may be used to meet the City's needs.

The Settlement Agreement allows the City, in the future, to apply to the SWRCB for a Watershed of Origin appropriation higher than the Settlement Agreement amount if demands exceed those upon which the Settlement Agreement was based. The Settlement Agreement automatically expires in 2035 unless it is renewed subject to specific terms identified in Article 9.

Settlement Agreement water is conveyed through the North Bay Aqueduct under the provisions of additional conveyance agreements between the Participating Agencies and SCWA described in **Section 3.2.3** below. Once conveyance volumes are determined, the water is delivered to the City in the same manner as 2013 PAC water. The City can preferentially use Settlement Agreement water during the periods when it is available and capacity is available. The City typically uses its Settlement Agreement water in the spring and fall when it is most often available.

Table 3-3 below shows the total Settlement Agreement water used by the City of Benicia since 2010. This water supply is not available for banking or carryover as are the City's other SWP-derived water assets.

Table 3-3 – Settlement Agreement Water Use

Year	Settlement
2010	158
2011	900
2012	900
2013	135
2014	1,580
2015	504

Importantly, Settlement Agreement water is characterized in the Settlement Agreement and the accompanying conveyance agreements as "non-project water." Besides the issues related to diversion of this water (because it is not stored water), there are additional issues associated with this water's conveyance. In short, and described more fully below, "non-project water" is relegated to a junior position in water asset deliveries utilizing the North Bay Aqueduct which may render the supply vulnerable under certain hydrologic or regulatory conditions.

3.2.3 North Bay Aqueduct Conveyance

The North Bay Aqueduct (NBA) is an infrastructure component of the State Water Project. The NBA extends for 27.6 miles from Barker Slough in the Delta to the end of the Napa Pipeline, providing water supplies to Napa and Solano Counties. The NBA was designed to deliver 175 cubic feet per second (cfs) of water, but construction constraints limited the delivery to 142 cfs. The Barker Slough Pump Station in the Delta was designed to deliver a total of 113 million gallons per day (mgd), but pump tests have shown it can only deliver about 92 mgd due to biofilm growth. Moreover, Longfin Smelt issues – a federally listed endangered species under the federal Endangered Species Act – further limit flows from 130 cfs to 50 cfs under certain conditions. DWR delivers Sacramento River watershed water derived from SWP facilities and water rights to SCWA per SCWA's SWP contract. SCWA then delivers water received through the NBA to SCWA's Participating Agencies.

The City of Benicia's turnout on the NBA is at the Cordelia Forebay and Pumping Plant, about 21.3 miles from Barker Slough. Benicia's contracted allotment is 24.7 mgd, but currently it can only receive about 22.5 mgd due to biofilm growth in Barker Slough. The NBA's pipe diameter ranges from 72 inches at Barker Slough to 36 inches at Cordelia Forebay.

From the Cordelia Forebay, raw water is transmitted to the City's water treatment plant through a 30-inch and then a 36-inch raw water transmission line. The NBA Cordelia Pumping Plant, which is operated by the Department of Water Resources, has a rated capacity of 20.7 mgd for the three Benicia pumps.

The City's 2013 PAC water supply and Settlement Agreement water supply come through the NBA. As described above, NBA diversions have both regulatory and technical limitations. Article 12(f) of SCWA's State Water Project Contract – which is incorporated by reference into both the 2013 PAC and Settlement Agreement – established the priorities to utilize available capacity in the NBA. The designated water delivery priorities are as follows:

1. Project water
2. Interruptible water under Article 1(jj)
3. Project water "not delivered"[29]

[29] Project water "not delivered" is defined as: "In the event of any discontinuance or reduction of delivery of project water… the Agency may elect to receive the amount of annual entitlement which otherwise would have been delivered to it during such period under the water delivery schedule for that year at other times during the year or the succeeding year…." At Article 14(b) DWR and SCWA Agreement (2003)

4. Carryover water

5. Non-project water to meet annual entitlements

6. Additional interruptible water in excess of annual entitlements for that year

7. Additional non-project water in excess of annual entitlements for that year

These priorities are important to consider in light of the shared use of the NBA among water purveyors in both Napa and Sonoma counties.[30] Specifically, if purveyors that utilize the NBA seek to deliver significant volumes of Project Water – whether it is an annual allocation or Carryover supplies – other sources may be unable to deliver sources normally used to meet annual demands. The City's junior priority designation of its Settlement water as "non-project water" may render that water less reliable for diversion in the NBA under certain yet-to-be-defined conditions.

3.3 Solano Project Water Assets

The Solano Project is a federal project operated by the United States Bureau of Reclamation Project. The Solano Project stores water in Lake Berryessa behind Monticello dam for delivery to end users throughout Solano County. Lake Berryessa has a capacity of 1.6 million acre-feet. Congress authorized the project in 1959 to meet agricultural and urban demands and final construction on the major infrastructure portions was completed in 1957. All water deliveries to Solano County Water Agency that are derived from this project are governed by federal law and a Water Service Contract between the United States and Solano County Water Agency – Contract No. 14-06-200-4090R (hereafter "Water Service Contract"). The Water Service Contract determines all aspects of obligations for receiving water supplies from the Solano Project and is incorporated into the Participating Agency contracts of water purveyors linked to the Solano Project through association with SCWA. At one time, the City of Benicia was a participating agency in the Solano Project. The City, now, however, derives its water supplies through sub-contracts with other agencies that are more actively linked to the Solano Project operations.

The City has two sources of water assets that originate from the Solano Project: (1) Agreement for Water Service with the City of Vallejo; and (2) the Solano Irrigation District / City of Benicia Solano Project Water Allotment Transfer Agreement. The details underlying both of these water supply sources as well as their conveyance and delivery components affect their short-term and long-term reliability. In general, it is easier and less expensive to treat Solano Project water than SWP water, especially in winter, where the SWP water has a high total organic carbon content (TOC). Treating

[30] The priority for Vallejo Water Right Permit Water is unclear and undergoing further investigation.

water with high TOC increases the amount of disinfected byproducts, which must be kept under the limit in the drinking water permit.

3.3.1 Agreement for Water Service with the City of Vallejo

The Agreement for Water Service with the City of Vallejo (Vallejo Agreement) was originally executed in February of 1962 and has been amended twice – once in April of 1962 and again in April of 1989. The second amendment extended the expiration date of the Vallejo Agreement to February 28, 2025. For purposes of this UWMP, we assume that the Vallejo Agreement will be renewed through 2040 under similar terms upon its expiration.

The City of Vallejo is the holder of a contractual right to receive allotments from the Solano Project as a Participating Agency of the SCWA. Vallejo's Participating Agency Contract provides for the delivery of 14,600 acre-feet of water under the standard terms contained in a Participating Agency Contract.[31] Although the Vallejo Agreement does not specifically reference Vallejo's Participating Agency Contract (other than the Cost of Water in Paragraph 16), the reliability assessment may be tied to the reliability conditions in the Vallejo Participating Agency Contract and should be considered in future analyses. We also assume for purposes of this UWMP that the City of Vallejo has received all necessary permissions from SCWA to deliver Solano Project water to the City of Benicia under its Participating Agency Contract.

The Second Amendment to the Vallejo Agreement, however, allows the City to purchase up to 1,100 acre-feet per year of Vallejo's Solano Project water. The Vallejo Agreement also provides that the City may receive up to 3 million gallons a day of the water as treated water, in lieu of raw water, by means of an inter-connection between the Benicia and Vallejo treated water systems. In order for the City to receive treated water, a new interconnection would need to be constructed. Currently, the City can only receive raw water from Vallejo by means of the Cordelia Pump Station and Cordelia Pipeline.

The Vallejo Agreement provides that shortages (reductions) in the Solano Project supply may be passed on to Benicia. Specifically, the pertinent portions of Article 4 of the Vallejo Agreement states:

Vallejo agrees to exercise reasonable diligence and care to effect the delivery of such quantities of water requested by Benicia…out of any water surplus to Vallejo's requirements, but Vallejo shall not be liable for interruption or shortages caused by insufficiency of supply, rights of other users, or for any loss or damage occasioned thereby….

[31] City of Vallejo 2010 UWMP at page 4-4.

This provision indicates that the water supplies under the Agreement made available by Vallejo to Benicia are only "surplus" water beyond Vallejo's needs. As such, Benicia's long-term reliability estimations based on this contract may be tied to Vallejo's long-term growth projections as well as Vallejo's water supply need under variable hydrologic and regulatory conditions. Moreover, this provision is unclear on how water will be allocated in case there is a "shortage caused by insufficiency of supply." For purposes of this UWMP, we have assumed that the full contract allocation of 1,100 acre-feet is available in all year types because the full contract allocation was delivered in both 2014 and 2015 – the driest years in California's history.

Table 3-4 below shows the water deliveries under the Vallejo Agreement. Those deliveries have fluctuated based upon water supplies available to the City in each year.

Table 3-4 – Vallejo Agreement Deliveries from Solano Project

Year	Delivery
2010	841
2011	729
2012	2,200
2013	1,100
2014	1,100
2015	1,100

Interestingly, in 2012, the City received 2,200 acre-feet of Solano Project water through the Vallejo Agreement – double the available allocation. This excess delivery beyond the contract allocation occurred when accounting switched from a Water Year (March 1 to February 28) to a Calendar Year (January 1 to December 31). Thus, 2012 showed delivery for both a Water Year and a Calendar Year. It is important to note that the Vallejo Agreement water that is not used cannot be banked or carried-over to future years.

3.3.2 Solano Irrigation District Agreement

The Solano Irrigation District / City of Benicia Solano Project Water Allotment Transfer Agreement (SID Agreement) was executed on March 3, 2009. The SID Agreement has no automatic expiration date, but is subject to a number of conditions for its continuance that are outlined in Article 3. For purposes of this UWMP, we assume that all of the conditions will continue to be met so that the SID Agreement does not terminate before 2040.

Solano Irrigation District (SID) is the holder of a contractual right to receive allotments from the Solano Project as a Participating Agency of the SCWA under the terms of a Participating Agency Contract. SID's Participating Agency Contract provides for an allotment of 141,000 acre-feet per year from the Solano Project to SID. Article 1 of the SID Agreement indicates that SID has an additional 10,000 acre-feet per year of Solano

Project Water resulting from an assignment from Maine Prairie Water District. This additional 10,000 acre-feet per year is not available to meet the delivery obligations under the SID Agreement as noted in Article 3.1. Nevertheless, SID's Participating Agency Contract was signed in 1999 and has a term of 25 years with a right of renewal. Thus, SID's contract expires in 2024. For purposes of this UWMP, we assume that the contract is renewed under similar terms and conditions through 2040 and does not reduce SID's water supply commitments to the City of Benicia.

SID's allotment is subject to the standard Participating Agency terms and reduction provisions in the Participating Agency Contract. These conditions include water supply allocations made by Solano County Water Agency based on formulaic calculations of inflow and stored water in Lake Berryessa. The SID Agreement has incorporated the reduction provisions from the SID Solano Project Participating Agency Contract into the City of Benicia's SID Agreement through Article 3.1 (discussed in more detail below).

The SID Agreement provides the City a maximum of 2,000 acre-feet of water per year. The 2,000 acre-foot allocation is derived only from SID's 141,000 acre-foot Solano Project allotment. SID has additional Solano Project water assets that are not considered as part of the SID Agreement. SID provides water to the City from Lake Berryessa and the Putah South Canal.

The SID Agreement specifies that the water supplied under the SID Agreement may be reduced "in the same Proportion as the reduction in acre feet to be delivered to District bears to its 141,000 acre-feet Annual Allotment…." In other words, if SID's annual allotment is reduced by 10 percent, then the City of Benicia's 2,000 acre-foot allocation would also be reduced by 10 percent or 200 acre-feet in a single year. The shortage provision, however, is subject to an unusual caveat in that the reduction or suspension in delivery must be due to "Force Majeure Conditions." In this instance, Force Majeure Conditions can result from "nature" – an ambiguous term – as well as a "governmental order." Although Force Majeure Conditions normally only include unforeseeable and catastrophic events, the inclusion of "nature" and "governmental order" seems to expand the definition to a much broader set of conditions that are quite normal – like drought or regulatory actions and orders. Nevertheless, for purposes of this UWMP we assume that the City of Benicia is subject to proportional reductions in its water supply based upon SCWA Solano Project delivery actions.

The City is also subject to the Solano Project member's "Drought Measures Agreement" as noted in Article 4. The Drought Measures Agreement places restrictions on the City's annual allotment and the ability to carryover a portion of that allotment for use in future years.

Importantly, the SID is limited in its utility. The SID Agreement water was purchased to improve drinking water quality when the water drawn from the Sacramento River

watershed that is delivered through the North Bay Aqueduct is high in total organic carbon. More specifically, in the City Council Minutes accepting the SID Agreement in 2009, Mayor Patterson stated that the City should not "use the SID 2,000 AF as additive to the City's water supply." Thus, although this water source can be counted toward the total water supply available to the City, it was not intended to increase availability for future growth. Any new water use of SID Agreement water that is not supporting drought mitigation or water quality conditions should be analyzed in this context.

Table 3-5 below shows the water deliveries under the SID Agreement. Those deliveries have fluctuated based upon water supplies available to SID in each year since the SID Agreements execution in 2009.

Table 3-5 – SID Agreement Deliveries from Solano Project

Year	Delivery	Carryover	Balance
2010	1,177	823	823
2011	1,868	132	955
2012	2,088	-88	867
2013	296	1,704	2,571
2014	809	1,191	3,762
2015	0	2,000	5,762

In 2012, the City's water supply under the SID Agreement exceeded the contract maximum by 88 acre-feet, demonstrating that the full 2,000 AF for that year was used, plus 88 AF from carry-over. For purposes of this UWMP, we assume that the maximum available contract amount of 2,000 acre-feet will not be exceeded and that water supply reliability provisions recently prepared by SCWA are used to allocate the supply in different year types. In addition, if Lake Berryessa fills and water spills over the "glory hole," then the carryover water of each agency is reduced by a percentage amount related to the amount of total spill.

3.3.3 Solano Project Water Deliveries

The City has the ability to obtain Lake Berryessa water from the Putah South Canal Terminal Reservoir through its agreements with the City of Vallejo and Solano Irrigation District (SID). During these deliveries, the City manually operates the Cordelia Pump Station to take water from the Reservoir and deliver it to the City's treatment facility through a 24-inch diameter pipeline that connects to the City's 36-inch Raw Water Transmission Line. In March 2016, Stantec Consulting Service, Inc. (Stantec) published a hydraulic analysis report for both the pump station and the transmission line. As a result of Stantec's field-testing, it was determined that the maximum current pumping capacity of the Cordelia Pump Station is 10.5 mgd. Recommendations in the Stantec report to increase the pump station capacity included installation of new pumps. After modifications to the pump station, the maximum capacity of the Cordelia Pump Station

will be 14 mgd, due to the maximum Total Dynamic Head calculated for the 24" Cordelia Pipeline.

3.4 Water Right License 4900 (Lake Herman Reservoir)

The first Lake Herman dam may have been built as early as 1880. The dam was built higher in 1905 and then again in 1947. These historical items are relevant to the existence of the City's water right. Water Right License 4900 was assigned to the City of Benicia from California Pacific Utilities Company (Company) in 1962. Company applied for the water right on January 28, 1943 and the License maintains this priority date. License 4900 allows the City to divert 1.4 cfs from January 1 to December 31 each year by direct diversion from Sulphur Springs Valley Creek for beneficial uses and to collect 1,200 acre-feet per year in storage from December 1 to May 1 each year. Thus, the total face value of the water right is 2,213.6 acre-feet per year.[32] The maximum withdrawal from storage under the License is 800 acre-feet per year.

The average yield of the Sulphur Springs Valley Creek watershed varies between 500 acre-feet per year to 1,000 acre-feet per year, with almost no yield in dry years.[33] Thus, total diversions exceeding 1,000 acre-feet are likely very rare. Lake Herman serves as the storage reservoir for water derived from this entire watershed and diverted under License 4900. Lake Herman has a total storage capacity of 1,400 acre-feet. A reservoir at the same location as the current Lake Herman Reservoir was constructed in 1905 and water was diverted into this reservoir at that time. Although this indicates a potential claim of a pre-1914 appropriative water right, further research would need to be conducted in order to prove that claim.

According to the City's Statements of Diversion and Use filed for the period of 2009 through 2014, the City has diverted and used water derived from License 4900 and stored a portion of that water in Lake Herman. **Table 3-6** below shows the water directly diverted or collected to storage as well as the amount of water used by the City from 2009 to 2015.[34] When the difference is positive, then more State Water Project water and Solano Project water was put into the lake than was used. When the difference is negative then rainfall runoff from the watershed was used as a water supply.

[32]License 4900 and 2014 Report of Licensee
[33] City of Benicia 2012 Water Master Plan
[34]2015 diversion numbers approximated based upon most recent data.

Table 3-6 – License 4900 Statistics (AF)

Year	Diversion and Storage	Amount Used	Difference
2010	619.9	178.6	441.3
2011	843	526.7	316.3
2012	949.9	216.6	733.3
2013	1039.1	370.5	668.6
2014	1047.8	1883.7	-835.9
2015	750	750	0

The 2014 amount used exceeds the maximum allowed storage use of 800 acre-feet per year by 1,003 acre-feet per year. As such, the additional water use is attributable to direct diversions from Sulphur Springs Valley Creek for use in the City's service area.

The City also utilizes Lake Herman as a raw water reservoir for water supplies derived from the Sacramento River watershed and Solano Project.[35] Surplus flows from these water sources are diverted by gravity to Lake Herman through a 24-inch diameter pipeline. As a source of emergency storage, the City has the ability to pump water from Lake Herman back to the treatment facility through the Lake Herman Pump Station. Diversions through the Lake Herman Pump Station are typically conducted during emergencies when adequate supplies from the Sacramento Watershed or Solano Project are not available. The pump station has a total pumping capacity of 9.6 million gallons per day. Raw water may also be diverted from Lake Herman to Valero.

On February 1, 2009, the City of Benicia and Valero executed an agreement titled "Agreement Between the City of Benicia and Valero Refining Company-California for the Supply of Untreated Water" (Valero Agreement). The Valero Agreement requires the City to deliver a minimum of 3,600 acre-feet of water per year and a maximum of 5,800 acre-feet of water per year to Valero's refinery. This demand is further discussed in **Section 4** of this UWMP.

Importantly, however, under Article 13 of the Valero Agreement, "The City agrees to operate Lake Herman and to reserve in Lake Herman a minimum pool of 230 acre feet of water for use by the Refinery as a water supply for emergency needs." As noted above, the Sulphur Springs Valley Creek watershed may produce less than that volume of water in some years requiring the City to maintain this minimum pool solely for Valero from its Sacramento Watershed and Solano Project water sources. Accordingly, the 230 acre-foot minimum pool must also be considered in assessing demands on the City's water system.

During the 2014 and 2015 drought years, City staff used water stored in Lake Herman during the winter and filled the lake during the spring, keeping the lake full during the

[35] The legalities of diverting these foreign sources of water into Lake Herman are not discussed in this UWMP but should be addressed.

summer and fall. Because of algae growth during the summer, it would be difficult to treat the water and stay in compliance with the City's drinking water permit.

3.5 Water Treatment Plant [36]

The City's WTP was constructed in 1971 and was originally designed for a capacity of 6.0 mgd. In 1989, the plant was expanded and now has a design capacity of 12 mgd.

The water treatment process involves a series of steps to remove suspended sediment and dissolved organic matter, then filter and disinfect the water prior to distribution to customers. As a first step, incoming raw water is treated with coagulating chemicals and then passed through flocculation/sedimentation basins where a majority of the sediments settle out. The next treatment step involves filtration of the water using dual media filters equipped with granulated activated carbon and sand media. After filtration, the water is disinfected using chlorine, followed by pH adjustment for corrosion control, and fluoridation. To achieve full disinfection, the treated water is circulated through a 1-MG chlorine contact tank and flows into the clearwell. At the WTP, the clearwell has a capacity of 3 million gallons (MG). The City has four (4) additional storage tanks in the distribution system with a combined capacity of 8.8 MG. Therefore, the City has a total storage capacity of 12.8 MG.

Raw water quality varies throughout the year, which presents challenges at the treatment plant. During the winter months, especially after heavy rain, raw water from the Sacramento River is very turbid with high total organic compound concentrations and low alkalinity. The WTP is challenged to treat this water effectively and at times blending with Lake Berryessa water is required.

The plant was modified in 2006 to increase its reliability, flexibility, and redundancy so that it can effectively treat 12 mgd throughout the year. The modifications enable the plant to effectively treat water all year, and to stay in compliance with current and anticipated water quality regulations. The modifications provided additional sedimentation facilities, additional filters, a second backwash tank, a new washwater recovery basin, and a 1-MG chlorine contact tank to more easily meet disinfection requirements.

3.6 Other Water Sources

The City of Benicia has considered acquiring water assets from other water sources to meet reliability needs. In 2014, the City acquired water from the City of Vacaville through a water transfer agreement and the City continues to explore other transfer opportunities within its service area. The SCWA Integrated Regional Water

[36] City of Benicia 2010 UWMP.

Management Plan (IRWMP) also assesses water transfer opportunities that are generally described in portions of the text below.

3.6.1 Vacaville Water Transfer Agreement

On July 25, 2014, the City of Benicia and the City of Vacaville executed a water transfer agreement titled "Agreement Between the City of Vacaville and the City of Benicia Relating to the Purchase of Solano Project Carryover Water" (Vacaville Agreement). The Vacaville Agreement was executed because the City of Benicia was facing a critical water supply shortage because of the severe 2014 drought. The Agreement was subsequently continued into 2015 so that Benicia could provide adequate water to meet its demands.

The Vacaville Agreement enabled Benicia to purchase up to 4,000 acre-feet from the City of Vacaville's Solano Project Carryover Water stored in Lake Berryessa. The water could be sold in "blocks of 1,000 acre-feet." The City purchased 2,000 AF of water under the Vacaville Agreement in July 2014 and another 2000 AF in December 2014. Under Article C, Paragraph 1, the City of Benicia retains the right to "banking any unused supply that remains in Vacaville's Solano Project Carryover Water account in Lake Berryessa.

3.6.2 Transfer or Exchange Opportunities

The availability of conveyance facilities from the Sacramento Watershed via the North Bay Aqueduct and from the Solano Project through Lake Berryessa and the Putah South Canal allow for a variety of short-term or long-term water transfer or exchange opportunities. Such transfers or exchanges might occur with other SCWA members, other NBA users like Napa County, other SWP contractors in California, water right holders in the Sacramento River watershed, or Solano Project members. These shared opportunities highlight the value of statewide and regional water management planning efforts. Several specific options are available to the City:

Storage Agreement for Solano Project Water – The City has a storage agreement with SCWA that provides an option to store up to 9,000 AF in Lake Berryessa for use as emergency supply. To exercise this agreement, Benicia must exchange a portion of its SWP water (Table A water) water for Solano Project water or purchase it from other members that have the capability to use either source. The other entity uses the NBA water and foregoes the use of the Solano Project water. The City has not exercised this agreement to date since it specifies that the first Project water spilled (released over the dam), if the lake is full, is Benicia's water whether the City needs it at the time or not. The City would only consider exercising this agreement if lake levels were low enough that it was not likely that the lake would spill.

Solano Project Drought Measures Agreement – The Solano Project contracting cities (Fairfield, Vacaville, Vallejo, and Suisun City) have an agreement with the two agricultural Solano Project contracting districts (SID and Maine Prairie Water District) to share water supplies during drought periods. Benicia is not a member of the Project, since the City relinquished its contractual rights to Solano Project water when SWP water was made available. However, Project members may transfer water from the Solano Project to the City. The region has historically cooperated in this regard to collectively maintain the interdependent urban and agricultural economies of the region.

Conjunctive Use Management Actions – Several of the SCWA's Solano Project and North Bay Aqueduct members have access to groundwater resources in Solano and Napa counties. The City of Benicia could pay these users to access their groundwater resources in times of water shortage in exchange for delivery of allocated surface water assets coming through the North Bay Aqueduct or Solano Project. In return, the City of Benicia could offset groundwater uses in times when it has surplus water deliveries from the Sacramento River watershed or Solano Project by delivering those surplus supplies to areas that would normally access groundwater. In short, the net water withdrawals from the groundwater basin would be equalized through the sharing of both types of water assets in times of shortage and surplus.

The general types of transfers or exchanges that the City can continue to use, if needed, are summarized below:

- Long-term transfers make water available through multi-year contracts that convey a specific amount of water to the purchaser each year. The specific conditions depend on the agencies involved and contract terms. Examples include the City's 2009 SID Agreement and its 1962/1989 Vallejo Agreement.

- Spot Transfers make water available for a limited duration (typically one-year or less) through a contract executed during the year of delivery. Some examples of spot transfers are the City's 2014 Vacaville Agreement, the State Drought Water Bank in the critically dry year of 1991, the State's voluntary water purchase program in 2001, and Benicia's previous short-term agreements with SID.

- Option Transfers are multi-year contracts that allow the purchaser to obtain a specified quantity of water at some future date at its option. They usually require a minimum payment for water even if the water is not needed in a given year in order to cover the value of the option. An option or "take" price is established in years water is drawn.

- Storage Agreements allow one entity to lease or purchase storage in another entity's surface or groundwater storage facility. An example is Benicia's storage agreement for Solano Project water.

- Water Exchanges are agreements that allow two agencies to exchange water from one source for water from another source, typically during the same year. Exchanges can also occur with the same source where one agency exchanges its right to take water at a given time from the source with another agency, and then can take the water from the source at another time. Exchanges can also involve storage agreements. Two examples are Benicia's agreement with Mojave Water Agency for the Mojave Banking and Water Exchange related to SWP supplies; and the ability to capture and utilize water under the Yuba Accord through Yuba County Water Agencies' commitment to SWP contractors.

3.6.3 Groundwater

The City currently does not use groundwater as a potable water source and has no plans to use groundwater in the future. However, the City may establish conjunctive use activities with neighboring water purveyors or water purveyors in distant places that have access to groundwater resources.

3.6.4 Indirect Potable Water Reuse

The City currently does not have any plans for implementing indirect potable water reuse.

3.6.5 Desalinated Water

Desalination involves removing salts and impurities from seawater or non-potable surface water or groundwater using treatment technologies such as reverse osmosis membranes or distillation methods. Desalination facilities are costly to construct and operate relative to the City's current supply sources. There are also significant environmental and permitting issues associated with the water intake and with disposal of brine from the treatment process. The City currently does not have any plans for implementing desalinated water. However, the City's proximity to brackish and salt water sources could make desalination a viable water option in the future if costs can be controlled.

3.6.6 Recycled Water

The City provides wastewater collection, treatment, and disposal services to customers within its service area. The City's wastewater collection system consists of approximately 150 miles of pipelines and 24 lift stations. The majority of the collection system relies on gravity flow through the pipelines. Due to terrain restrictions, the City also relies on 24 pump stations to transport the collected wastewater from low points to suitable locations for continued transmission by gravity.

The City operates and maintains a 4.5-mgd wastewater treatment plant (WWTP) facility located on seven acres of land at the south end of East 5th Street. The WWTP provides secondary treatment to domestic, commercial, and industrial wastewater. The facility

receives flows from two main service areas: the predominantly residential area located west of the plant and the predominantly industrial area located east of the plant. Average dry weather effluent flow from the WWTP in 2010 was 2.1 mgd and is projected to increase to 2.7 mgd at build-out. Treated wastewater or effluent is discharged into the Carquinez Strait of the San Francisco Bay via a deep water outfall.

In 2009, the City and Valero completed a preliminary design report to upgrade the WWTP to tertiary treatment allowing for tertiary treated unrestricted recycled water reuse of effluent. A copy of this report can be found in **Appendix D-3**. The project would involve expansion of the wastewater treatment facility to include microfiltration/reverse osmosis and nitrifying trickling filters. The initial concept is to provide up to 2 mgd of recycled water for use by the refinery as cooling tower make-up water. In 2015, the City and Valero began preparing a new feasibility study for a less expensive treatment process and pipeline alignment. The feasibility study is scheduled to be completed in June 2016.

3.6.7 Potential Future Water Supply and Storage Opportunities

The following projects are being developed through the Solano Water Authority (SWA). The SWA is a joint powers authority made up of 11 Solano County agencies, including the seven cities, three agricultural districts, and the County. The SWA, through the Joint Exercise of Powers Agreement, provides a mechanism whereby the agencies may participate in jointly funded water projects for their mutual benefit.

Noonan Reservoir. This proposed project would construct a joint use water storage reservoir benefitting municipal interests in Solano County and SID. The reservoir would be located on the southerly side of the Putah South Canal between Fairfield and Vacaville. The reservoir would provide the capability of commingling and storing both NBA and Solano Project water supplies. The project would provide the flexibility for public agencies within Solano County (Benicia is a participant) to enter into water exchange agreements or wheeling agreements for NBA and Solano Project water.

Highline Canal. Considered an initial stage of the Noonan Reservoir project, although also a standalone project, the Highline Canal project would allow project participants to exchange NBA water for Solano Project (Lake Berryessa) water, presently used in SID's Dally service area (west of Travis Air Force Base). The proposed project includes a pump station on the NBA and a pipeline from the pump station to the head of SID's Dally Highline Canal. The benefits of the project for the City are related to both water quality improvement and water supply. With the project, the City will be able to deliver NBA water to SID at times during SID's irrigation season. In exchange, SID would provide the City with Solano Project water that would be used at other times of the year when either the NBA is shut down due to maintenance or because of environmental constraints. SCWA's IRWMP, with the City as a participant, includes a high priority action to work with DWR and other agencies to explore water supply and storage opportunities that

could increase the reliability of Solano County's water supplies. Storing water in wet years for later use in drier years would help Solano water agencies maintain reliable water supplies. Storage could be in the form of groundwater banking (groundwater storage) or surface water storage. The City participates in these regional planning efforts through the SCWA.

The SCWA IRWMP includes a high priority item to identify opportunities for conjunctive groundwater use as a means of increasing water supply and reliability. Conjunctive use projects integrate the use of groundwater and surface water. The surface water provides supplies to local users and recharges the groundwater basin in normal or wet years. Groundwater in storage then provides supply during drier years when surface supplies are reduced. Agencies within the County with good groundwater resources would use groundwater during dry years, which would free up more surface water for those agencies that have poor quality groundwater, such as the City of Benicia.

3.7 Water Supply Reliability Assessment

The purposes of this section are to present the current and projected water supplies for the City of Benicia and assess those supplies reliability under certain hydrological and regulatory conditions. **Table 3-7, Table 3-8,** and **Table 3-9** illustrate the City's water supplies under normal, single dry, and multiple dry years.

3.7.1 Normal Year Water Supplies

In normal years, the City anticipates that it will have ample water supplies derived from its Sacramento River Watershed water assets. Specifically, the City through its 2013 Participating Agency Contract with Solano County Water Agency will meet the State Water Project normal year allocation projections, which is 73 percent of full contract allocation. For Benicia, this number equates to 12,556 of its 17,200 acre-foot Table A allotment.[37] In normal years, the City will forgo utilizing any Table A allotment and will utilize its carryover water from previous years. Unused Table A allotment will be carried over into next year's "carry-over account." Further, the City has access to 10,500 acre-feet of Settlement Agreement water through its contract with DWR. In normal years, this water supply would not be subject to Term 91.

The City also anticipates contractual water assets would be available in normal years from its Solano Project water assets. The City anticipates 1,100 acre-feet of water available under the Vallejo Agreement as well as an additional 2,000 acre-feet available under the City's agreement with Solano Irrigation District.

[37] This information is derived from the SCWA Water Reliability report dated April 14, 2016.

Last, the City anticipates access to 750 acre-feet of its License 4900 water asset as well as an additional 2,000 acre-feet of its recycled water. These two assets are reliable in normal years.

The City's normal year water supply totals 32,906 acre-feet through 2040. **Table 3-7** below summarizes the normal year reliability of the City's Sacramento River Watershed water assets, the Solano Project water assets, and its local water assets.

Table 3-7 – City of Benicia Normal Year Water Supplies[38]

Supply Source (values in acre-feet/yr)	2020	2025	2030	2035	2040
2013 PAC	12,556	12,556	12,556	12,556	12,556
PAC Carryover	4,000	4,000	4,000	4,000	4,000
Settlement Agreement	10,500	10,500	10,500	10,500	10,500
Vallejo Agreement	1,100	1,100	1,100	1,100	1,100
SID Agreement	2,000	2,000	2,000	2,000	2,000
SID Carryover	0	0	0	0	0
Licence 4900	750	750	750	750	750
Recycled	2,000	2,000	2,000	2,000	2,000
Other (Transfers)	0	0	0	0	0
Total Supply	**32,906**	**32,906**	**32,906**	**32,906**	**32,906**

3.7.2 Single Dry Year Water Supplies

In a single dry year, the City anticipates that it will access supplies derived from its Sacramento River Watershed water assets. Specifically, the City through its 2013 Participating Agency Contract with Solano County Water Agency will meet the State Water Project dry year allocation projections which is 22 percent of full contract allocation. For Benicia, this number equates to 3,784 acre-feet of its 17,200 acre-foot Table A allotment.[39] In a dry year, the City will also utilize its Table A carryover water that is derived from its SWP related resources. Thus, in a dry year, the City would use 1,500 acre-feet of SWP 2013 PAC carryover water. Further, the City has access to water supplies under its Settlement Agreement with DWR. In a dry year, this water supply is subject to Term 91 and is accordingly only available for diversion in "non-Term 91" months. As such, the City could access approximately 3,000 acre-feet of water per year under this water asset.

[38] The PAC Carryover supply and SID Carryover supplies are conservatively estimated in this table. The purpose for that conservative estimation is to demonstrate the availability of contract supplies. But it may be possible that the PAC and SID Carryover supply numbers are much greater in any given year.
[39] This information is derived from the SCWA Water Reliability report dated April 14, 2016.

The City also anticipates additional water supplies would be available in a dry year from its Solano Project water assets. The City anticipates 1,100 acre-feet of water available under the Vallejo Agreement as well as an additional 1,960 acre-feet available under the City's agreement with Solano Irrigation District. The Solano Irrigation District water is pegged directly to the supply availability curves prepared by SCWA. As such, the water supply is 98 percent reliable in a single dry year. Moreover, in a single dry year, the City would call upon, as needed, any Solano Project carryover water that it may have access to through its agreements with Vallejo and Solano Irrigation District. As such, this supply is quantified as 1,000 acre-feet in single dry years.

Last, the City anticipates access to 250 acre-feet of its License 4900 water asset as well as an additional 2,000 acre-feet of its recycled water in a single dry year. The licensed supply is quite variable based upon the nature and duration of storm events in the eastern Bay Area. Out of an abundance of caution, we have reduced the total volume available under this supply by 67 percent.

The City's single dry year water supply total is 14,594 acre-feet through 2040. **Table 3-8** below summarizes the single dry year reliability of the City's Sacramento River Watershed water assets, the Solano Project water assets, and its local water assets.

Table 3-8 – City of Benicia Single Dry Year Water Supplies[40]

Supply Source (values in acre-feet/yr)	2020	2025	2030	2035	2040
2013 PAC	3,784	3,784	3,784	3,784	3,784
PAC Carryover	1,500	1,500	1,500	1,500	1,500
Settlement Agreement	3,000	3,000	3,000	3,000	3,000
Vallejo Agreement	1,100	1,100	1,100	1,100	1,100
SID Agreement	1,960	1,960	1,960	1,960	1,960
SID Carryover	1,000	1,000	1,000	1,000	1,000
Licence 4900	250	250	250	250	250
Recycled	2,000	2,000	2,000	2,000	2,000
Other (Transfers)	0	0	0	0	0
Total Supply	14,594	14,594	14,594	14,594	14,594

3.7.3 Multiple Dry Year Water Supplies

In multiple dry years, the City anticipates that it will access supplies derived from its Sacramento River Watershed water assets. Specifically, the City through its 2013 Participating Agency Contract with Solano County Water Agency will meet the State Water Project multiple dry year allocation projections, which is 24 percent of full contract allocation. For Benicia, this number equates to 4,128 acre-feet of its 17,200 acre-foot Table A allotment.[41] In multiple dry years, the City will also utilize its Table A carryover water that is derived from its SWP related resources. Thus, in multiple dry years, the City would use 1,500 acre-feet of SWP 2013 PAC carryover water in years one and two. Because of the drought, we would anticipate that the City's SWP 2013 PAC carryover supplies would further diminish in the final year of a drought. As such, this supply is reduced to 1,000 in year three.

The City also has access to water supplies under its Settlement Agreement with DWR. In multiple dry years, this water supply is subject to Term 91 and is accordingly only available for diversion in "non-Term 91" months. As such, the City could access approximately 3,000 acre-feet of water per year under this water asset in the first year of a multiple year drought. But, as recorded in previous droughts, Term 91 is often declared earlier in the year in order to protect resources for needed Delta outflows. Out of an abundance of caution, we have reduced the available supplies under the Settlement Agreement to 2,000 acre-feet in the second and third year of a multiple dry year scenario.

[40] The PAC Carryover supply and SID Carryover supplies are conservatively estimated in Tables 3-8 and 3-9. It may be possible that the PAC and SID Carryover supply numbers are much greater in any given year.
[41] This information is derived from the SCWA Water Reliability report dated April 14, 2016.

The City also anticipates additional water supplies would be available in multiple dry years from its Solano Project water assets. The City anticipates that in the first year of a multiple year drought 1,100 acre-feet of water available under the Vallejo Agreement as well as an additional 1,960 acre-feet would be available under the City's agreement with Solano Irrigation District. The Solano Irrigation District water is pegged directly to the supply availability curves prepared by SCWA. As such, the water supply is 98 percent reliable in a single dry year. In the second and third dry year, however, the Solano Irrigation District water would be reduced to 89 percent of normal to 1,780 acre-feet. Moreover, in multiple dry years, the City would call upon, as needed, any Solano Project carryover water that it may have access to through its agreements with Vallejo and Solano Irrigation District. As such, this supply is quantified as 1,000 acre-feet in the first two years of a multi-year drought and 500 acre-feet in the last year of a multi-year drought.

Last, the City anticipates access to 250 acre-feet of its License 4900 water asset as well as an additional 2,000 acre-feet of its recycled water in the first year of a multi-year drought. In the second and third years, License 4900 would be reduced to a total of 100 acre-feet. Recycled water, however, is not subject to reductions since it is the byproduct of indoor deliveries derived from human consumption. Thus, it remains static in all dry years.

The City's multiple year water supply totals are 14,938 acre-feet in year one through 2040.[42] In the second year of a multiple year drought, the City supply would total 13,608 acre-feet. And in the third year of a multi-year drought the annual supplies would total 13,264 acre-feet. **Table 3-9** on the following page summarizes the multiple dry years reliability of the City's Sacramento River Watershed water assets, the Solano Project water assets, and its local water assets.

The State of California's water supply conditions may be drastically altered in the context of climate change. The City has undertaken a rigorous assessment of its climate change vulnerability. The City's full report can be found at **Appendix D-4**. Importantly, the climate-induced conversion of snow to rain, the timing of runoff in the Sacramento River watershed, or a decrease in overall precipitation could greatly impact the City's water supplies. Specifically, climate change could alter the statistical probability of a particular type of year – normal or dry – in happening. In a worst-case scenario, what this UWMP characterizes as a dry year becomes for future purposes a normal year for the City's water assets. This analysis must be addressed as the City progresses in its future water supply planning by gathering and assessing new data in cooperation with the California Department of Water Resources.

[42] The availability of supply exceeds the single dry year supply number by 344 acre-feet because the modeling calculations for SWP water in multiple year droughts indicates that additional supplies would be available.

Table 3-9 – City of Benicia Multiple Dry Year Water Supplies

Supply Source (values in acre-feet/yr)	2020	2025	2030	2035	2040
Multi-dry Year 1 (same as "Single-dry")					
2013 PAC	4,128	4,128	4,128	4,128	4,128
PAC Carryover	1,500	1,500	1,500	1,500	1,500
Settlement Agreement	3,000	3,000	3,000	3,000	3,000
Vallejo Agreement	1,100	1,100	1,100	1,100	1,100
SID Agreement	1,960	1,960	1,960	1,960	1,960
SID Carryover	1,000	1,000	1,000	1,000	1,000
Licence 4900	250	250	250	250	250
Recycled	2,000	2,000	2,000	2,000	2,000
Other (Transfers)	0	0	0	0	0
Total Supply	14,938	14,938	14,938	14,938	14,938
Multi-dry Year 2					
2013 PAC	4,128	4,128	4,128	4,128	4,128
PAC Carryover	1,500	1,500	1,500	1,500	1,500
Settlement Agreement	2,000	2,000	2,000	2,000	2,000
Vallejo Agreement	1,100	1,100	1,100	1,100	1,100
SID Agreement	1,780	1,780	1,780	1,780	1,780
SID Carryover	1,000	1,000	1,000	1,000	1,000
Licence 4900	100	100	100	100	100
Recycled	2,000	2,000	2,000	2,000	2,000
Other (Transfers)	0	0	0	0	0
Total Supply	13,608	13,608	13,608	13,608	13,608
Multi-dry Year 3					
2013 PAC	3,784	3,784	3,784	3,784	3,784
PAC Carryover	1,000	1,000	1,000	1,000	1,000
Settlement Agreement	2,000	2,000	2,000	2,000	2,000
Vallejo Agreement	1,100	1,100	1,100	1,100	1,100
SID Agreement	1,780	1,780	1,780	1,780	1,780
SID Carryover	500	500	500	500	500
Licence 4900	100	100	100	100	100
Recycled	2,000	2,000	2,000	2,000	2,000
Other (Transfers)	1,000	1,000	1,000	1,000	1,000
Total Supply	13,264	13,264	13,264	13,264	13,264

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CHAPTER 4. WATER DEMAND CONDITIONS

Understanding water demand characteristics enables the City of Benicia to reliably and cost-effectively manage its water supplies to meet customer needs. This section characterizes the City's retail customer demands over the next few decades. Specific water demand characteristics such as how demands vary among different land use classifications and under differing hydrologic conditions, all help illustrate customer needs under variable conditions. As such, this section is organized as follows:

- Review and refinement of the *2020 Urban Water Use Target*– This subsection presents the review and refinement of 2015 and 2020 water use targets as allowed under CWC Section 10608.20(g).[43]
- Compliance with *Interim 2015 Urban Water Use Target* – This subsection documents the derivation of the 2015 GPCD value and comparison to the 2015 interim target.
- Historic and Current Water Demands – This subsection presents data reflecting the historic and current water demand conditions for residential and non-residential customers in the City.
- Future Water Demands – This subsection presents the derivation of future demands for potable and non-potable water within the City's service area, including land-use classifications, unit demand factors, and estimation of non-revenue water.
- Summary of Water Demands – This subsection presents a summary of the projected current and future water demands in five-year increments.

4.1 Review and Refinement of GPCD Targets

As detailed in the City's 2010 UWMP, population, residential connections, and water production data were used to generate a gallon per capita day (GPCD) baseline. From this GPCD baseline, the City assessed and determined a *2020 Urban Water Use Target* and an *Interim 2015 Urban Water Use Target*. These values were determined to be 180 and 188, respectively, as presented in the 2010 UWMP.[44]

[43] 10608.20(g): *An urban retail water supplier may update its 2020 urban water use target in its 2015 urban water management plan required pursuant to Part 2.6 (commencing with Section 10610).*
[44] City of Benicia 2010 UWMP, p. 3-9 (available at: http://www.water.ca.gov/urbanwatermanagement/2010uwmps/Benecia,%20City%20of/City%20of%20Bencia_UWMP_Final%20Report_June%202011.pdf)

According to the DWR Guidebook, a retail water purveyor who did not use actual 2010 Census data must re-calculate its baseline using the available 2010 Census data.[45] For the City's 2010 UWMP, the 2010 Census data was not fully available, causing the City to use other methods to estimate 2010 population.[46] Thus, the City must recalculate its baseline GPCD and re-establish its target and interim-target values with the available 2010 Census data.[47] Additionally, the UWMP Guidebook added detail to the population analysis procedures.

To recalculate the annual GPCD values using the 2010 Census data, the City utilized the available population information from the California Department of Finance (DOF) as presented in the UWMP Guidebook. Use of this published analysis requires that a water service area boundary substantially coincide with a City boundary. In the case of the City, the DOF population is the clear choice because the City boundary coincides with the water service area. The result of the analysis provided new population values for 1995 through 2015.[48] New population values divided into the previously determined gross water values (as documented in the 2010 UWMP) provided revised GPCD values for this period. **Table 4-1** provides a comparison of the yearly population and GPCD estimates from the 2010 UWMP and as revised using 2010 Census data.

With revised GPCD values, the City reassessed the 2020 GPCD Target established in the 2010 UWMP. At that time, the City did an analysis using Method 2. But, upon comparing the resulting Method 2 reduction with the alternative minimum reduction requirement, the City was required to adopt the minimum and not use Method 2.[49] The resulting 2020 GPCD Target value was therefore set at 180 gpcd.

To reassess whether the minimum still was applicable given the revised population data, the 5-year average for the 2003 through 2010 period was recalculated. The result increased the minimum reduction target to 183 gpcd (see **Table 4-2**).

The second step in the reassessment was to evaluate the previous Method 2 calculation and determine if the resulting target value was still greater than 183 gpcd. The City's 2010 UWMP calculated the Method 2 target as 195 gpcd (see **Table 4-3**).

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[45] "If an agency did not use 2010 U.S. Census data for its baseline population calculations in the 2010 UWMP (the full census data set was not available until 2012) the agency must re-calculate its baseline population for the 2015 UWMPs using 2000 and 2010 Census data. This may affect the baseline and target GPCD values calculated in the 2010 UWMP, which must be modified accordingly in the *2015 UWMP*." (2015 Urban Water Management Plans: Guidebook for Urban Suppliers, DWR, January 2016, p. 5-8)

[46] The City's 2010 UWMP used Data provided by City's Planning Department. Source: Association of Bay Area Governments, Projections and Priorities 2009.

[47] According to CWC Section 10608.20(g), the City may also re-assess the methodology chosen to determine its 2015 and 2020 GPCD targets and update these targets, even if the 2010 population data was appropriate.

[48] The population for 2000 is the same in both the 2010 UWMP and this 2015 UWMP since it is the Census data for that year. Because actual 2010 Census data was different than calculated for the 2010 UWMP, the years between 2000 and 2010 were reassessed by DOF with new populations generated.

[49] CWC 10608.22 requires the target to at least be no less than 5 percent of base daily per-capita use for the most recent 5-year period ending no later than December 31, 2010.

Table 4-1 – Revised Annual GPCD using 2010 Census Data

	From 2010 UWMP			For 2015 UWMP	
Year	Gross Water Use	Population	GPCD	Revised Population	Revised GPCD
1995	5,665	25,651	197	26,298	192
1996	5,994	25,894	207	25,868	207
1997	6,518	26,137	223	25,905	225
1998	4,916	26,379	166	26,040	169
1999	5,610	26,622	188	26,753	187
2000	5,703	26,865	190	26,865	190
2001	5,848	27,155	192	27,032	193
2002	5,645	27,188	185	26,962	187
2003	5,889	27,123	194	26,811	196
2004	6,271	27,005	207	26,624	210
2005	5,883	27,163	193	26,674	197
2006	5,372	27,159	177	26,565	181
2007	5,496	27,768	177	27,119	181
2008	5,233	27,830	168	27,122	172
2009	5,777	27,912	185	27,130	190
2010	5,500	28,086	175	26,719	184

Table 4-2 – Revised Minimum Water Use Reduction

	From 2010 UWMP				For 2015 UWMP		
Year	Gross Water Use	Population	GPCD	5-Year Ave GPCD	Revised Population	Revised GPCD	5-Year Ave GPCD
2003	5,889	27,123	194	--	26,811	196	--
2004	6,271	27,005	207	--	26,624	210	--
2005	5,883	27,163	193	--	26,674	197	--
2006	5,372	27,159	177	--	26,565	181	--
2007	5,496	27,768	177	190	27,119	181	193
2008	5,233	27,830	168	184	27,122	172	188
2009	5,777	27,912	185	180	27,130	190	184
2010	5,500	28,086	175	176	26,719	184	182
Minimum Water Use Reduction (0.95 * max 5 year average)				**180**			**183**

However, upon inspection of the underlying data, the value determined for the CII water use was overstated as a result of a data recording change in the City's water use records. In 1999, the City apparently switched the category for logging some of the landscape water demands, placing the demand instead in the "commercial/institutional" category in its tracking system. This continued until 2007, when landscape irrigation use was again recorded under a "landscape irrigation" category. The impact was that for the period 1999 through 2006, landscape water use was counted both in the CII baseline and separately as part of the "landscape area water use" calculation completed for Method 2. The resulting CII baseline value was determined to be 37 gpcd. Ninety percent of this value resulted in the 33 gpcd shown as the original CII target value in **Table 4-3**.

Correcting for this recording change, the CII baseline value for 1997-2006 was determined to instead be 19 gpcd, with 90 percent equal to 17 gpcd. This revised CII target was used in the Method 2 calculation, with the new Method 2 target determined to be 179 gpcd.

Table 4-3 – Comparison of 2010 and 2015 UWMP target values

Demand Category	GPCD	
	Original	Revised
Indoor Residential Water Use	55	55
Landscape Area Water Use	107	107
CII Baseline Water Use	33	**17**
Total Estimated Method 2 Target	195	179
Minimum Water Use Reduction Target (Table 4-2)	180	183
Resulting 2020 Target	**180**	**179**
Percent Reduction	**7.7%**	**7.3%**
Base Daily Per Capita Water Use (Table 4-1)	195	193
Interm 2015 Target	188	186

Comparing the revised Method 2 target of 179 to the revised minimum reduction target of 183 gpcd results in Method 2 now being the lower value, and thus is chosen as the new 2020 GPCD Target. Though this change from the 2010 UWMP's target is indiscernible, the revised calculation results in the use of Method 2 by the City to set its 2020 GPCD Target, rather than using the minimum reduction method outlined by CWC Section 10608.22.

The comparative results are shown in **Table 4-3**.

Pursuant to CWC 10608.20(g) the City may choose to select a different method for calculating its 2020 GPCD target. Upon review of the analysis in the 2010 UMWP that resulted in the choice of Method 2, the City finds no reason to vary from the prior method choice. Thus, the City is officially using Method 2 to establish its 2020 GPCD target. However, to accurately reflect the use of the 2010 Census data, and the revised Method 2 calculation, the City will modify its 2020 GPCD Target to be 179 gpcd.

4.2 Compliance with 2015 Interim Target

Pursuant to CWC Section 10608.40, the City is to report to DWR on its progress in meeting its urban water use targets as part of its 2015 UWMP. As part of the progress reports, the City should include its "compliance daily per capita water use" (Compliance Value), which is the gross water use during the final year of the reporting period, reported

in gallons per capita per day.[50] Documentation of the Compliance Value must include the basis for determining the estimates, including references to supporting data. Furthermore, pursuant to CWC Section 10608.24(a), the City must demonstrate that it has met its 2015 Interim GPCD Target as of December 31, 2015 through its calculation of its 2015 Compliance Value.

Extending the population analysis that was revised during the reassessment of the baseline GPCD, the City is able to calculate its 2015 Compliance Value. **Table 4-4** presents the extended population calculation for 2011 through 2015, the associated gross water use in each year, and the resulting annual GPCD. As demonstrated, the City's 2015 Compliance Value is 135 gallons per capita per day, which is significantly below the 2015 Interim GPCD value of 186.

Table 4-4 – Annual GPCD for 2010 through 2015

Year	Population	Gross Water Use (af/yr)	GPCD
2010	26,719	5,500	184
2011	26,904	5,608	186
2012	27,165	5,822	191
2013	27,325	6,479	212
2014	27,495	5,169	168
2015	27,689	4,189	135

Though the 2015 Compliance Value seems impressive, the City does not believe it represents the actual progress toward its 2020 GPCD Target conditions due to two factors: (1) weather conditions in 2015, and (2) mandatory conservation requirements imposed by the State Water Resources Control Board. While normalizing for weather is recognized and suggested in statute[51], with a tool available from DWR to perform the calculation, the State mandated conservation likely had a greater downward effect on the 2015 Compliance Value.

Although adjustments for weather are allowed, they are not required.[52] Because the City's 2015 Compliance Value demonstrates that the City is in compliance with the statutes, it has elected to not adjust the 2015 Compliance Value for weather. However, it has chosen to adjust the value to understand what 2015 GPCD conditions may have been absent the State conservation mandate, so that it can appropriately assess progress toward its 2020 Target GPCD.

[50] CWC § 10608.12(e).
[51] CWC Section 10608.24(d)(1)(A).
[52] CWC Section 10608.24(d)(2).

One option for the City to understand its progress toward the 2020 Target GPCD is to look at the most recent "average" year, which would be 2013. In 2013 there were no mandatory conservation measures, weather was not significantly different than average conditions (though it was the beginning of the current drought cycled), and the high apparent losses were just being identified. The GPCD in 2013 was 212 gpcd, well above the baseline and the revised 2020 Target GPCD value of 179 as well as the 2015 Interim GPCD Target of 187 (see **Table 4-3**).

The City is in a unique situation where end users are consuming more water than they are being billed for at homes and offices. This "overuse" is artificially inflating the GPCD over time. The cause of this expanded yet unbilled consumption is caused by meter inaccuracies. If all of this unbilled consumption were eliminated, then the 2013 GPCD would have been 179 GPCD. This normalized value is below the 2015 Interim GPCD Target and matches the 2020 GPCD Target. Though customers are not likely to reduce consumption completely after meter inaccuracies are addressed, real and significant savings will be realized. From this information, the City concludes that it is on track to achieve its 2020 GPCD Target when it reports the 2020 Compliance Value in its next UWMP update. The City recognizes that a primary factor in the success of this target is the completion of its customer meter retrofit program, which will allow customers an opportunity to accurately understand their individual water use behaviors and take appropriate actions to reduce demand.

4.3 Current and Forecast Water Demands

Based on available records for water production, water sales and deliveries, the City's water demands for the past five years were previously presented in **Table 4-4**. As demonstrated by the gross water use values presented in the table, the City has not experienced much growth since the 2010 UWMP. And, as described in Chapter 2, the City only anticipates limited growth into the future.

Forecasting future demand requires assessing several factors: the future water use habits of existing customers that will lower their existing use, the land use plans demonstrating types of anticipated growth, and the various laws and regulations that govern future water use demand factors such as water-efficient fixtures, appliances, and landscaping.

4.3.1 Existing Customers

As described in Chapter 2, the City serves a mostly built-out area of Solano County with a variety of residential and non-residential customers with varying uses. Existing potable water customers are generally categorized in fairly broad land-use classifications: single family residential, multi-family residential, commercial/institutional, and landscape irrigation.

With account numbers and meter data, the existing unit demand factors for each potable water classification can be determined. This information provides a baseline for estimating the future demands of existing customers. **Table 4-5** provides the baseline demand factors for each land use category using 2013 account and meter data. The City believes 2013 was more representative of average conditions, and understood that the data would be skewed if 2014 or 2015 customer use data were used for baseline conditions. This is confirmed further when reviewing the GPCD values in **Table 4-4**.

Because a vast majority of the existing customers reside in homes built before the last decade, existing customers' future unit demand factors are assumed to change mostly from drivers such as the implementation of volumetric billing, Cal Green Code, and MWELO (all discussed later in this section). A reflection of the impact of these drivers is presented as the unit demand factors for new residences, also provided in **Table 4-5**. The future demand factors for existing single family customers reflect a jump in consumption to account for increased billing following the City's current meter retrofit program and a small reduction from the current value in all other demands categories. This reduction is reasonable as it reflects expected benefits of on-going customer conservation efforts, coupled with the use of 2013 for baseline conditions.

Table 4-5 – Existing Treated Water Customer Characteristics

Existing Treated Water Customers				
Land-class	**Current Accounts**	**Current Demand Factors**	**Future Demand Factors**	**Notes**
Single Family	8,544	0.35 (AF/year) 312 (gal/day)	0.37 (AF/year) 330 (gal/day)	"Current" demand factor is artificial low due to meter inaccuracies
Mobile Home	13	3.3 (AF/year) 2,946 (gal/day)	3 (AF/year) 2,678 (gal/day)	Demand factors represent accounts that may have multiple units
Multi Family	305	1.65 (AF/year) 1,473 (gal/day)	1.5 (AF/year) 1,339 (gal/day)	Demand factors represent accounts that may have multiple MF units
Commercial	494	0.87 (AF/year) 777 (gal/day)	0.83 (AF/year) 741 (gal/day)	
City Buildings	31	0.97 (Af/year) 866 (gal/day)	0.9 (AF/year) 803 (gal/day)	
Industrial	75	1.17 (AF/year) 1,045 (gal/day)	1.17 (AF/year) 1,045 (gal/day)	
Landscape 1	80	3.5 (AF/year) 3,125 (gal/day)	3.25 (AF/year) 2,901 (gal/day)	
Landscape 2	208	2.05 (Af/year) 1,803 (gal/day)	2 (AF/year) 1,785 (gal/day)	
Other	6	1.57 (AF/year) 1,402 (gal/day)	1.5 (AF/year) 1,339 (gal/day)	

In addition to the City's potable water customers, the City also provides non-potable water service to the Valero. This demand is governed by a February 2009 agreement between the City and Valero that defines minimum and maximum annual quantities (see **Appendix C-2**). The agreement specifies deliveries between 1,160 million gallons (~3,560 acre-feet) and 1,890.8 million gallons (5,800 acre-feet) annually. The actual use each year is driven by the market forces that dictate petroleum refinery operations, but demand has recently averaged around 4,900 acre-feet.

4.3.2 Future Customers

There are several factors that affect the development of future unit water demand, which in turn affect the forecasted water demand for future customers. These factors range from state mandates to changes in the types of housing products being offered. These are incorporated into the determination of future unit water demand factors, discussed later in this chapter. Characteristics of the most important factors are described below

4.3.2.1 Factors Affecting Future Water Demands

These following factors are generally recognized to result in lower per unit demand factors for future residential and non-residential customers. A brief discussion of each follows:

Water Conservation Objectives

On November 10, 2009, Governor Arnold Schwarzenegger signed SBX7 7, which required each urban water supplier to reduce their per-capita water use by 2020, with a statewide goal of achieving a 20-percent reduction by 2020.[53] As discussed previously, the City has established a 2020 Target GPCD in response to this requirement.

Achieving the City's 2020 conservation target will require the City to continue its on-going conservation efforts. As illustrated by the compliance analysis previously discussed, the City has already achieved its goal – even when normalizing the data for the last normal water year (2013). New customers will likely further reduce the City's annual GPCD since the factors described below are designed to further reduce per capita water use.

Indoor Infrastructure Requirements

In January 2010, the California Building Standards Commission adopted the statewide mandatory Green Building Standards Code (hereafter the "CAL Green Code") that requires the installation of water-efficient indoor infrastructure for all new projects beginning after January 1, 2011. The Cal Green Code was revised in 2013 with the revisions taking effect on January 1, 2014. However these revisions do not have substantial implications to the water use already contemplated by the 2010 Cal Green Code.[54] The CAL Green Code applies to the planning, design, operation, construction, use and occupancy of every newly constructed building or structure.

All new developments must satisfy the indoor water use standards directed by the CAL Green Code, which essentially require new buildings and structures reduce overall potable water use by 20 percent. Expected future customers will satisfy the standards through the use of appliances and fixtures such as high-efficiency toilets, faucet aerators, on-demand water heaters, or other fixtures as well as Energy Star and California Energy Commission-approved appliances.

[53] California Water Code § 10608.20

[54] "The 2010 CALGreen Code was evaluated for updates during the 2012 Triennial Code Adoption Cycle. HCD evaluated stakeholder input, changes in technology, implementation of sustainable building goals in California, and changes in statutory requirements. As such, the scope of the CALGreen Code was increased to include both low-rise and high-residential structures, additions and alterations." *Guide to the 2013 California Green Building Standards Code (Residential)*, California Department of Housing and Community Development, 2013.

California Model Water Efficient Landscape Ordinance

The Water Conservation in Landscaping Act was enacted in 2006, requiring the California Department of Water Resources (DWR) to update the Model Water Efficient Landscape Ordinance (MWELO).[55] In 2009, the Office of Administrative Law (OAL) approved the updated MWELO, which required a retail water supplier or a county to adopt the provisions of the MWELO by January 1, 2010, or enact its own provisions equal to or more restrictive than the MWELO provisions.[56]

In response to the Governor's executive order dated April 1, 2015, (EO B-29-15), DWR updated the MWELO and the California Water Commission approved the revised MWELO on July 15, 2015. The changes include a reduction to 55 percent for the maximum amount of water that may be applied to a landscape for residential projects, which reduces the landscape area that can be planted with high water use plants, such a turf. The MWELO applies to new construction with a landscape area greater than 500 square feet (the prior MWELO applied to landscapes greater than 2,500 sf).[57] For residential projects, the coverage of high water use plants is reduced to 25 percent of the landscaped area (down from 33 percent in the 2010 MWELO).

It is difficult to predict the ultimate impact of the MWELO requirements on future water demand. While the requirement is for development of a landscape design plan that uses plants and features that are estimated to use no more than 55 percent of ETo, some provision must be made for the inherent tendency to over-water even with irrigation controllers installed, piecemeal changes in landscape design, reductions in irrigation efficiency through product use, and limited resources for enforcement in the absence of dedicated irrigation meters.

California Urban Water Conservation Council BMPs

The City is a signatory to the California Urban Water Conservation Council (CUWCC) Best Management Practices (BMP) Memorandum of Understanding (MOU). Due to this affiliation, the City has modified existing BMPs and implemented others to follow that of the CUWCC. These practices further reduce the City's demands. Further details on the City's conservation efforts can be found in **Chapter 5**.

[55] Gov. Code §§ 65591-65599

[56] California Code of Regulations (CCR), Tit. 23, Div. 2, Ch. 27, Sec. 492.4. The MWELO provides the local agency discretion to calculate the landscape water budget assuming a portion of landscape demand is met by precipitation, which would further reduce the outdoor water budget. For purposes of this UWMP, precipitation is not assumed to satisfy a portion of the outdoor landscape requirement because the determination of an appropriate effective precipitation factor is highly uncertain given the various landscape slopes, terrain composition, concurrent watering schedules, etc.

[57] CCR Tit. 23, Div. 2, Ch. 27, Sec. 490.1.

4.3.2.2 Future Unit Demand Factors

When considering the various factors discussed above, coupled with a review of current customer use characteristics, the City has established the demand factors presented in **Table 4-6** for estimating future customer demand. The majority of the representative growth occurs is projected to result from a potential Northern Gateway development project.[58] The expected residential and non-residential connections from this project are also provided in **Table 4-6**, along with minor anticipated in-fill within the current City. While highly conjectural at this time, the City is using these estimates as the best available data purely for purposes of forecasting future demands.

Table 4-6 – Future Customer Accounts and Demand Factors

Land-class	New Connections (cumulative)					Future Demand Factors
	2020	2025	2030	2035	2040	
Single Family	0	0	50	300	602	0.32 (AF/year) 286 (gal/day)
Multi-Family	5	10	15	20	25	0.19 (AF/year) 170 (gal/day)
Commercial/Institutional	--	--	21	21	21	0.9 (AF/year) 803 (gal/day)
Industrial	--	--	50	100	136	1.1 (AF/year) 982 (gal/day)

4.3.3 Demand Forecast Summary

Water demand projections within the City's service area reflect the combination of continued conservation by existing customers and the addition of new customers over the planning horizon. Additionally, the demand forecast recognizes Valero's continued demand per the agreement between Valero and the City, with that demand represented as the maximum allowed (see **Appendix C-2**). The recent and forecast Valero demand is included in **Table 4-7**.

Table 4-8 provides the summation of this forecast analysis and the resulting expected demands for each 5-year planning horizon.

[58] The Northern Gateway project has been brought before the City's Planning Commission and is documented in a City-staff produced report dated January 26, 2016.

Table 4-7 – Valero Water Demands

Year	Water Use (AFY)
2010	4,792
2011	4,541
2012	4,942
2013	4,716
2014	4,792
2015	5,011
2020	5,800
2025	5,800
2030	5,800
2035	5,800
2040	5,800

Table 4-8 – Projected Water Demands

Land-class		Forecast Demand (af/yr)				
		2020	2025	2030	2035	2040
Single Family	Existing	3,886	3,458	3,200	3,200	3,200
	Future	0	0	16	96	193
	Subtotal	3,886	3,458	3,216	3,296	3,393
Multi-Family	Existing	488	473	458	458	458
	Future	1	2	3	4	5
	Subtotal	489	475	460	461	462
Commercial/ Institutional	Existing	546	546	535	557	557
	Future	0	0	74	129	169
	Subtotal	546	546	609	686	726
Landscape Irrigation	Existing	684	684	676	706	706
	Future	0	0	0	0	0
	Subtotal	684	684	676	706	706
Potable		5,605	5,163	4,961	5,150	5,287
Estimated System Losses		835	573	551	572	587
Valero Raw		5,800	5,800	5,800	5,800	5,800
Total Demand		12,240	11,540	11,310	11,520	11,670
Total Demand (Million Gallons/Day)		10.9	10.3	10.1	10.3	10.4

4.3.4 Distribution System Water Losses

The demand factors presented earlier in this chapter represent the demand for water at each customer location. To fully represent the demand, distribution system losses must also be included. Often, distribution system losses represent water that is lost due to system leaks, fire protection, construction water, unauthorized connections, and inaccurate meters. Essentially, this is the water that is produced at the City's treatment plant that does not make it to the customer – either as a real loss or an apparent loss (e.g. such as may result when a customer meter underreports actual use).

In most instances, the predominant source of distribution system losses is from leaks that inevitably exist throughout the many miles of pipes and fitting that bring water to the

City's customers. However, for the City, the primary source of loss stems from customer meter inaccuracies. As evidenced by the population numbers from **Tables 4-1** and **4-5**, the City had the majority of its housing stock existing by 1995. This detail has two major impacts on water usage. First, most of the water meters are over 20 years old. And second, most of the housing pre-dates the modern plumbing codes. Both of these factors contribute to an artificially high per capita water use figure because the meters are inaccurate and the plumbing systems are less efficient than those established after the plumbing codes implementation, which are amplified by the meter inaccuracies.

Pursuant to CWC 10631(e)(3)(B), the City must quantify and report the distribution system loss for 2015 using methodology developed by the American Water Works Association (AWWA) and provided as a worksheet through DWR. The AWWA spreadsheets are included as **Appendix A-4**. The results of this AWWA analysis show that of the 27 percent, only 11 percent are Real Water Losses (e.g. caused by actual background, reported or unreported leaks). The remaining 16 percent of quantified losses are Apparent Water Losses attributed to the inaccuracies and underreporting of customer meters.

For purposes of estimating future demand from new connections, the distribution system loss is assumed to be reduced by 2020, with continued improvements in the distant future. Because the City has recognized that meter inaccuracies are a large cause of its reported losses, it is anticipated that it will undertake an extensive meter replacement program starting in the latter part of 2016.

Currently, the City is working with a consultant to complete an *Investment Grade Audit and Financing Model* that will further define the meter replacement program. Should the meter replacement project receive approval by City Council, the City anticipates it would be completed in 2017, with a resulting change in the representation of system losses compared to customer demand factors – especially single family residential use factors. As previously detailed in **Table 4-5**, the City anticipates an initial increase in residential unit demand factors as customers receive improved meters. This sudden change to a customer's water use will then result in further conservation measures and a subsequent lowering of demand factors.[59]

The City will also continue to find and fix reported and unreported real water losses, which will further lower the calculated distribution system loss. Collectively, these actions are reflected in **Table 4-8**'s system loss values as 13 percent for 2020 and 10 percent for 2025 and beyond.

[59] Because of meter inaccuracies existing customers are currently seeing artificially low monthly water use quantities on their water bills. The same customer behavior, with a new meter, will result in higher (and more accurate) monthly water use. Customers are expected to respond through actions to lower their use.

4.3.5 Low Income Water Demands

Low income households are classified as households that have an annual income below 80 percent of the area median household income adjusted by the number of persons in the household (California Health and Safety Code Section 50079.5).

The City has provided affordable housing units (AHUs) for low income residents. The water use for the 139 single-family AHUs and the 261 multi-family AHUs are included in the demand forecast presented in **Table 4-8**.[60] There are currently no new AHU development projects planned in the City, and no additional units have been assigned to the City by the regional housing authority.

Aside from these AHUs, there are 372 "low income" rental units through the Housing Choice Voucher Program (HCV), formally known as the Section 8 Voucher program. Per the Benicia Housing Authority, HCV housing is not designated as "affordable"; however, the families that live in those units are "low income." HCV vouchers are for rental properties at market rate rent. The City's Housing Authority has 372 vouchers available, but not enough units to accommodate all voucher holders. About 350 vouchers are currently in use. Low income families receive vouchers to help with the rental and utility payments.

[60] All of these units qualify as AHUs. However, at any given time, some units may be rented by those that do not quality as low-income. Currently, approximately 27 are rented by moderate or above moderate income families.

CHAPTER 5. WATER DEMAND MANAGEMENT MEASURES

5.1 City Participation

CWC § 10631 requires that an UWMP include a description of the urban water supplier's water demand management measures. CWC § 10631 also provides that members of the California Urban Water Conservation Council shall be deemed in compliance with the UWMPA demand management measure requirements by complying with all the provisions of the CUWCC MOU and by submitting the annual reports.[61]

The CUWCC MOU for Best Management Practices (BMP) is organized into five categories. Two categories, utility operations and education, are "Foundational BMPs" because they are considered to be essential water conservation activities by any utility and are adopted for implementation by all signatories to the MOU as ongoing practices with no time limits. The remaining BMPs are "Programmatic BMPs" and are organized into residential indoor and landscape, commercial/industrial/institutional (CII) indoor and landscape, and CII dedicated large landscape categories.[62] All the categories are outlined in **Table 5-1**.

The City is a current member of CUWCC and has submitted annual reports to the Council, complying with CWC § 10631. A copy of the most recent report from 2013-2014 is available in **Appendix D-1**. As a signatory to the CUWCC MOU, the City is committed to implementing best management practices (BMP) designed to achieve water conservation across existing and future demand sectors. The CUWCC MOU requires that a water utility implement only the BMPs that are economically feasible. The City's continued implementation of the CUWCC BMPs should reduce some of the unit demand factors for its existing connections and help maintain the unit demand factors for future connections.

[61] CWC § 10631(j)
[62] https://www.cuwcc.org/Resources/BMP-Resources.

Table 5-1 – CUWCC BMP Requirements[63]

FOUNDATIONAL BMPS
1. Utility Operations Programs
1.1 Operations Practices
Staff and maintain the position of a trained conservation coordinator
Enact and enforce an ordinance designed to prevent water waste
Enact and enforce an ordinance designed to promote water efficient design in new development
Enact and enforce an ordinance designed to facilitate water shortage response measures
1.2 Water Loss Control
Compile a standard water audit and balance annually
Improve data accuracy and completeness of water audit during first four years
During 5th through 10th year, demonstrate progress in water loss control
1.3 Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections
Initiate volumetric billing for all metered customers within one year after signing MOU
Complete meter installations for all connections no later than July 1, 2012
Assess feasibility of moving mixed-use metered landscape uses to dedicated landscape meters
Develop a written plan, policy or program to test, repair or replace meters
1.4 Retail Conservation Pricing
Develop water rates such that 70% of revenue is generated from volumetric billing
Develop conservation pricing for retail sewer service
2. Education Programs
2.1 Public Information Programs
Implement public information programs to promote water conservation and water-conservation benefits
2.2 School Education Programs
Educate students about water conservation and efficient water use
PROGRAMMATIC BMPS
3. Residential
Develop a Residential Assistance Program - including leak detection assistance, conservation surveys, and efficiency suggestions, as well as provision of high-efficiency appliances
Perform site-specific landscape water surveys
Provide financial incentives for, or institute ordinances requiring, purchase of efficient clothes washers
Provide incentives or ordinances for replacement of toilets using 3.5 or more gallons per flush
4. Commercial, Industrial and Institutional
Implement measures to achieve water savings for Commercial, Industrial and Institutional (CII) accounts of 10% compared to baseline water use (i.e., 2008 water use by CII accounts)
5. Landscape
Identify accounts with at least one dedicated irrigation meter and assign an ETo based budget of no more than an average of 70% of ETo for metered irrigation uses; "Recreational" areas may be so designated and may use up to 100% of ETo
Provide notices to irrigation meter customers comparing actual use to the water budget
Offer site-specific technical assistance to those accounts at least 20% over budget
Target and market landscape surveys to CII accounts with mixed-use meters, and those CII accounts with large landscapes and offer financial incentives to both

Since filing its 2013-2014 CUWCC report, the City has continued to aggressively promote and implement water conservation actions to address the challenges of the on-going drought. During 2015, the City reached remarkable conservation levels through the attentive actions of its citizens. Highlights of the City's actions and conservation measures include:

- Operating a booth at the weekly farmer's market providing giveaways and promoting water conservation

[63]Taken from the CUWCC site at https://www.cuwcc.org/Resources/BMP-Resources.

- Providing flyers and brochures, updated throughout the year
- Hosting a conservation-focused website: BeniciaSavesWater.org
- Conducting nearly 50 residential survey programs
- Fixing 188 system leaks saving more than 3 million gallons
- Offering rebate programs for turf and appliances, which in 2015 resulted in:
    - 109 High efficiency washer rebates
    - 14 High efficiency toilet rebates (following over 300 the prior two years)
    - 158 turf replacement rebates

The City's overall water management efforts have resulted in significant and long-term water conservation savings. Even though the City's residents showed tremendous ability to temporarily reduce water usage as part of the 2013-2015 drought, the City anticipates that many of the efforts will have long-term viability, providing on-going savings well into the future.

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CHAPTER 6. WATER SHORTAGE CONTINGENCY PLAN

As an urban water purveyor, the City of Benicia must meet the minimum health and safety requirements of a drinking water purveyor at all times. The City has created a water shortage contingency plan to help meet this goal during water shortages. The full version of this plan can be found in **Appendix D-2**.

The strategy for allocating water during shortages for the City is complex. Detailed discussion of water supply, water shortage actions, catastrophic failure, financial impacts, and prohibitions during shortages is also provided in the City's Emergency Water Conservation Plan. The City adopted its current Emergency Water Conservation Plan in 1990 through an ordinance adding to the City Code, Title 13, Chapter 13.35 (included in **Appendix D-2**). The ordinance provides for emergency water supply management related to general supply shortages due to severe droughts, infrastructure failure, or any other cause. While the current ordinance provides an adequate framework for managing supply shortages, it should be updated to reflect current conditions including the current drought and 20x20 legislation. The City also coordinates regionally through the SCWA with respect to emergency water shortage planning and response.

6.1 Water Shortage Contingency Resolution

The City's current ordinance allows for declaration of water shortages by the City Manager upon recommendation of the Director of Public Works. When a shortage occurs, the City Council assesses if the stages of action discussed in **Section 6.2** should be implemented.

6.2 Stages of Action and Reduction Goals

The City has developed a five-stage shortage contingency plan as shown in **Table 6-1**. Each stage corresponds to an increased demand reduction target to align with anticipated supply availability. The shortage contingency plan includes voluntary and mandatory actions that expand under each stage, depending on the cause, severity, and anticipated duration of the water supply shortage. The Plan also prioritizes essential health and safety water uses over economic and discretionary uses. The details of these stages are provided in the Emergency Water Conservation Plan and City ordinances.[64]

[64] See Appendix D-2

Table 6-1 – Drought Stages Contingency Plan

Stage	Water Supply Conditions	Response Actions
1 – Voluntary	Normal Supply Conditions	Voluntary Conservation
2 – Water Alert	Slightly restricted water supplies	Voluntary conservation and up to a 10% water use reduction
3 – Water Warning	Moderately Restricted Water Supplies	Moderate conservation with some mandatory conservation for up to 25% water use reduction
4 – Water Emergency	Severly Restricted Water Suuplies	Mandatory water conservation and some use prohibition with up to 35% water use reduction
5 – Water Crisis	Extremely restricted water supplies	Mandatory prohbitions and conservation for up to 50% water use reduction

6.3 Mandatory Prohibitions on Water Waste

The City instituted a city emergency water conservation plan under Ordinance 12-02 § 1, 2012, which was an update to the original ordinance established an emergency water conservation plan. The ordinance prohibits intentional or unintentional water waste and encourages beneficial water use.[65] Allowing cooling fixtures to leak, maintaining waterways without recirculation devices and irrigation of landscaping during rainfall are a few examples of actions that would qualify as water waste under the regulation. Details on the prohibited types of use for each stage of action are also outlined below in **Section 6.5**.

6.4 Penalties

The City of Benicia Municipal Code section 13.35.090 provides the stages of penalties for violators of the water waste regulation. For the first violation, the City shall issue a written notice of the fact of such violation. For the subsequent violations within the preceding 12 calendar months, the City shall impose a surcharge of $50.00 for the second violation, $100.00 for the third violation and $250.00 for the fourth and any other subsequent violations. The City may also install a flow restrictor on the property or disconnect service at its discretion after a fourth violation. In addition to these penalties, water users will also be charge excessive water use penalties during a drought as outlined in **Table 6-2**.

[65] City of Benicia, Municipal Code 13.35.020

Table 6-2 – Excessive Water Use Penalties

Amount of Excess Water Use	Increased Rate for Use in Excess
<=10% higher than baseline for conservation stage	2 times the regular rate
10.01% to 20% higher than baseline for conservation stage	3 times the regular rate
>20% higher than the baseline for conservation stage	4 times the regular rate

6.5 Consumption Reduction Methods

CWC 10632 (a)(1) requires that all water purveyors establish stages of action to be undertaken in the event of a water shortage. The code section also specifies that a 50 percent reduction in supply must be considered and addressed. This specific supply reduction is addressed at Stage Five in **Section 6.5.5**. It should be noted that the following sections on each stage of action are a summary of the key points established by the City in its Emergency Water Conservation Plan. The City provides water users notice about water restrictions through direct mail, newspaper advertising and information posted on their website BeniciaSaverWater.org.[66] For the full body of text and all the details of each stage please refer to these documents in **Appendix D-2**.

6.5.1 Stage One – Voluntary Conservation

Stage One involves the City's request that customers voluntarily limit their water use and attempt to conserve water that is only necessary for health, business and irrigation. It also outlines that the general waste of water is prohibited. The words "general waste" include allowing water to run off into an unused ditch, failing to repair a leak, irrigating during rain events, and other negligent uses of water under certain conditions.

6.5.2 Stage Two– Water Alert

If water supplies become slightly restricted, the Plan calls for Stage 2 drought response, during which customers are informed of possible shortages and asked to voluntarily conserve 10 percent. Additionally some mandatory restrictions including limiting the use of fire hydrant water, the service of restaurant water only upon request and the use of non-potable water for construction will be implemented.

6.5.3 Stage Three – Water Warning

In the event Stage Three is implemented under normal circumstances, the City will continue to encourage community-oriented voluntary conservation measures, enforce

[66] City of Benicia Press Release, 7/2/2014

some conservation measures and implement mandatory water use reduction measures to decrease "normal" demand by up to 25 percent. Stage Three activities include a continuation of activities described under Stages 1 and 2, as well as greater conservation and water use restrictions. Stage 3 also restricts landscape watering to Mondays, Wednesdays and Fridays for odd numbered addresses; and Tuesdays, Thursdays and Saturdays for even numbered addresses; with no watering on Sundays.

6.5.4 Stage Four – Water Emergency

Stage Four's primary purpose is to reduce water use by 35 percent. In addition to all the voluntary and mandatory restrictions previously implemented under the earlier stages, water users are also required to disable automatic timers for sprinklers unless they are for public spaces such as parks or school grounds.

6.5.5 Stage Five – Water Crisis

Stage Five's purpose is to ensure the protection of the water supply for all public health and safety purposes. This Stage will require reductions in water demand by up to 50 percent. Under this stage all previous conservation restriction will apply, except for medical requirements, severe economic hardship and protecting mature community trees are no longer excluded from the previous water restrictions.

6.6 Revenue and Expenditure Impacts

When a drought or water shortage occurs, the City's costs will increase due to the additional activities and duties of instituting a stage of action. Not only will there be costs for materials, and time from permanent staff, but additional staff may need to be hired to assist in implementing the Emergency Water Conservation Plan. As conservation measures and requirements increase and the water supply decreases, the City could potentially realize a fall in revenue. To combat this and help pay for the expenses discussed above, a drought surcharge may be implemented by the City. This will help compensate for the loss of water revenue and pay for drought related costs.[67] Additional revenue will further be provided by the penalties incurred by excessive water users as discussed in **Section 6.4**.

6.7 Conservation Rate Structures

As discussed above in **Section 6.6**, a drought surcharge may be added to rates in the event of water shortage and increased progressively through each stage of action.

[67] CBM 13.35.100

6.8 Reduction Measuring Mechanism

In order to determine the City's success in achieving its conservation goals, the actual water savings will be determined by quantifying the water treatment plants output. The City will continue to utilize the WaterSmart program it began using in 2015 to monitor customer water use and provide tools to customers for understanding their water use.[68]

6.9 Catastrophic Supply Interruption

In addition to climate, other factors that can cause water supply shortages are earthquakes, chemical spills, dam failures, canal breaks, waterline ruptures, and energy outages at treatment and pumping facilities. The City has an emergency operation plan.[69] This plan provides procedures and guidance to the City personnel in responding to emergency situations including catastrophic events, both natural and manmade.[70] The plan provides procedures for preparing, mobilizing and employing city resources and coordinating outside resources during an emergency.

6.10 Minimum Supply Next Three Years

Pursuant to CWC Section 10632(a)(2), the City is required to estimate the water supplies available for the next three years, specifically 2016, 2017 and 2018. Because of diligent planning efforts, the City believes it has ample water supplies available to meet its demand during this time frame as detailed in **Chapter 3**. Any potential shortfall in supply that may occur will be addressed through combinations of demand reductions as detailed in the Emergency Water Conservation Plan and the use of interties with neighboring purveyors (once constructed), and supplemental sources (including the potential for spot market water transfers).

However, to specifically address the statutory language, which requires water purveyors to assume a period of three dry years, the City has prepared **Table 6-3**. The values in this table represent the supply reliability for multiple dry years as detailed in **Table 3-9**, with the exception of recycled water. The City anticipates recycled water supplies available by 2020, but not in the next three years.

Table 6-3 – Minimum Water Supply Available

(acre-feet/yr)	2016	2017	2018
Available Supply	12,938	11,608	11,264

[68] Benicia City Council Meeting Minutes, 2/2/2016.
[69] City of Benicia Emergency Operations Plan, 2007, accessible at http://www.ci.benicia.ca.us/vertical/sites/%7BF991A639-AAED-4E1A-9735-86EA195E2C8D%7D/uploads/EOP.pdf.
[70] NBA and Solano project plans.

6.11 Current Drought

The current drought has impacted the City's drought and water shortage plans through Executive Orders and new statewide conservation goals. Executive Order B-29-15 required the City to achieve 25 percent water use reduction by June 2015. Similarly, the 2020 goal for a 20 percent reduction in water use encourages irrigation districts and end users to conserve more water. To comply with these conservation goals, the City has continued to promote conservation with all water users. The City also adopted an Emergency Ordinance in July 2014 limiting landscape watering. Some of these restrictions include: restricting outdoor landscape watering to once a week during the winter months, requiring all fountains to circulate water, and requiring no visible runoff. This ordinance was issued in response to the SWRCB's restrictions.[71]

[71] City of Benicia Press Release, 7/2/2014.

CHAPTER 7. SUPPLY & DEMAND INTEGRATION

The purpose of this chapter is to compare the total water supply sources available to the City with the total projected water use over the next 25 years, in five-year increments, for a normal water year, a single-dry water year, and multiple dry water years.[72] Water supply and demand data presented in this section is presented in prior sections of this UWMP.

7.1 Normal Water Year Conditions

Under this water supply scenario, the City would anticipate full availability of its surface supplies under the statistical delivery calculations associated with its SWP PAC supply as well as full delivery of its other sources, including Settlement Water with no Term 91 activation as well as recycled water supplies. The resulting total supplies from **Table 3-7** and the forecasted demands from **Table 4-8** are shown in **Table 7-1**. As demonstrated, the City projects adequate water supplies through 2040.

Table 7-1 – Supply and Demand Comparison (Normal Year)

(acre-feet/yr)	2020	2025	2030	2035	2040
Supplies	32,906	32,906	32,906	32,906	32,906
Demands (potable)	6,441	5,736	5,512	5,722	5,874
Demands (Valero)	5,800	5,800	5,800	5,800	5,800
Difference	20,665	21,370	21,594	21,384	21,232
Difference (Million Gallons/Day)	18.5	19.1	19.3	19.1	19.0

Note: This table does not reflect the operational and water asset restrictions that can affect availability on a daily and month-by-month basis. The comparison of annually available supplies and annual demand therefore should not be considered representative of availability in a particular month. These characteristics are detailed in Section 3.

[72]This is consistent with CWC Section 10635, but extends the period an additional five years to provide "20 year" analysis coverage for the intervening years between UWMP updates.

7.2 Single Dry Year Conditions

In a single dry year condition, the City anticipates reductions to its surface water supplies consistent with the projection in **Table 3-8**.

For purposes of this UWMP, the City's forecast water demands are expected to increase in a single dry year. This increase represents the generalized expansion of the landscape irrigation season due to limited rainfall – meaning customers begin demanding supplies from the City earlier in the spring than during a normal year when rainfall would otherwise satisfy landscape water needs. Though the increase is dependent on actual conditions, it is represented by adjusting the normal year annual forecast demand value upward by five percent for each five-year increment to 2040. This adjustment reflects rudimentary relationships between, historic use variances and other conditions and is meant only to highlight the anticipated increase in demands for purposes of City planning.

As shown in **Table 7-2**, the City anticipates adequate water supplies through 2040. It is important to note, however, that the demand associated with the Valero refinery remains constant through the dry year conditions. This elevated demand – equivalent to the normal year Valero demand – is used out of an abundance of caution in order to provide a conservative estimate of the impacts of demands on the City's water supply system.

Table 7-2 – Supply and Demand Comparison (Single Driest-Year)

(acre-feet/yr)	2020	2025	2030	2035	2040
Supplies	14,594	14,594	14,594	14,594	14,594
Demands (potable)	6,763	6,022	5,732	5,950	6,109
Demands (Valero)	5,800	5,800	5,800	5,800	5,800
Difference	2,031	2,772	3,062	2,844	2,685
Difference (Million Gallons/Day)	1.8	2.5	2.7	2.5	2.4

Note: This table does not reflect the operational and water asset restrictions that can affect availability on a daily and month-by-month basis. The comparison of annually available supplies and annual demand therefore should not be considered representative of availability in a particular month. These characteristics are detailed in Section 3.

7.3 Multiple Dry Year Conditions

For purposes of this UMWP, the City has assessed a three-year series of dry conditions. As detailed in Section 3, the City again anticipates reductions in available water supplies during these multiple dry years. The total supply available will vary across each of the three years.[73] Table 3-9 details the multiple dry year conditions.

Demand, will also vary across this planning scenario. This variance is represented by setting the forecast demands for the first of three years equal to the demand used in the single dry year scenario. In the second year, the City would anticipate that its water shortage contingency plan would be triggered, resulting in a demand reduction for that year. The City's WSCP Stage 2 reduction target is assumed (see **Chapter 6**). Similarly, in the third year, the City would expect further reductions resulting from implementing further WSCP actions. For this third year, the City's Stage 4 reduction target is assumed. However, as described in **Section 7.2**, the City has assumed full deliveries to the Valero refinery – even though the City has no obligation to deliver any amount above a minimum volume.

This resulting analysis has been represented in **Table 7-3**. During each multiple dry year period projected in **Table 7-3**, the City anticipates adequate water supplies being available.

[73] As described in Section 3, supplies may become more constrained during a prolonged drought, such as the drought that began in 2013. But, as noted in that section, the City has secured redundant supplies that would be available when certain other supplies are constrained (e.g. if the SWRCB issues Term 91 early in the season, the City will rely on other carryover supplies to meet certain conditions). In extreme conditions, as occurred in 2015, the City not only will implement mandatory conservation actions, but will also work with its neighboring agencies to secure transfer water to meet any deficits.

Table 7-3 – Supply and Demand Comparison over Multiple Dry Years

	(acre-feet/yr)	2020	2025	2030	2035	2040
Year 1	Supplies	14,938	14,938	14,938	14,938	14,938
	Demands (potable)	6,763	6,022	5,732	5,950	6,109
	Demands (Valero)	5,800	5,800	5,800	5,800	5,800
	Difference	2,375	3,116	3,406	3,188	3,029
	Difference (Million Gallons/Day)	2.1	2.8	3.0	2.9	2.7
Year 2		2020	2025	2030	2035	2040
	Supplies	13,608	13,608	13,608	13,608	13,608
	Demands (potable)	6,086	5,420	5,159	5,355	5,498
	Demands (Valero)	5,800	5,800	5,800	5,800	5,800
	Difference	1,722	2,388	2,649	2,453	2,310
	Difference (Million Gallons/Day)	1.5	2.1	2.4	2.2	2.1
Year 3		2020	2025	2030	2035	2040
	Supplies	13,264	13,264	13,264	13,264	13,264
	Demands (potable)	5,410	4,818	4,586	4,760	4,887
	Demands (Valero)	5,800	5,800	5,800	5,800	5,800
	Difference	2,054	2,646	2,878	2,704	2,577
	Difference (Million Gallons/Day)	1.8	2.4	2.6	2.4	2.3

Note: This table does not reflect the operational and water asset restrictions that can affect availability on a daily and month-by-month basis. The comparison of annually available supplies and annual demand, therefore, should not be considered representative of availability in a particular month. These characteristics are detailed in Section 3.

7.4 Climate Change and Supply Reliability

The City of Benicia has undertaken a rigorous assessment of its vulnerability to climate change. The full document can be found in **Appendix D-4**. The City's water supply reliability could be victimized by climate change if the dire predictions about precipitation actually manifest. In some instances, like the Solano Project, a similar amount of precipitation at a higher temperature may have little if any impact on overall storage and supplies. But in the Sacramento River watershed, the predicted change in precipitation type (from snow to rain), the earlier snowmelt, and the lack of surface storage could create supply reliability problems to the City's main water sources. An ongoing assessment of relevant and developing data is the critical component of assessing the true implications of climate change on the City's water assets. With these analyses, sound solutions may be developed.

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