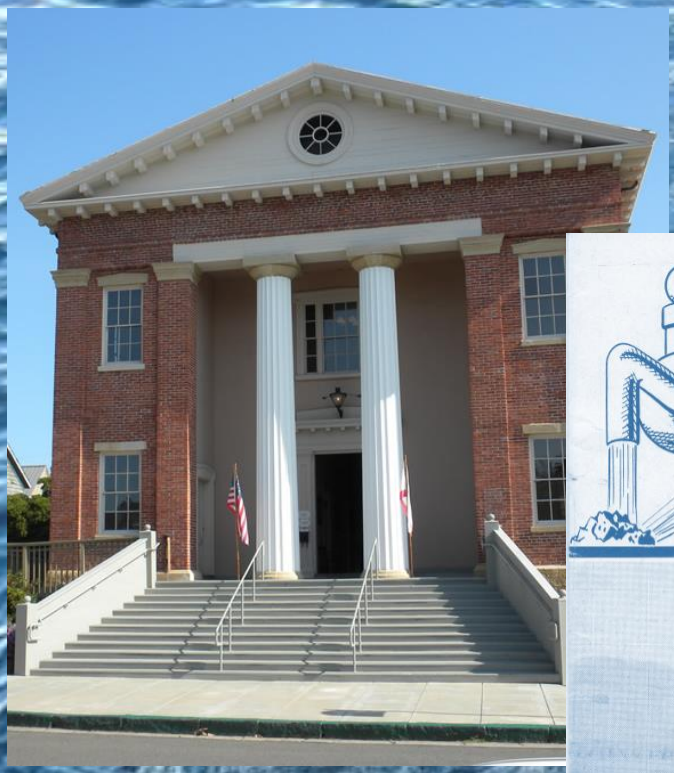

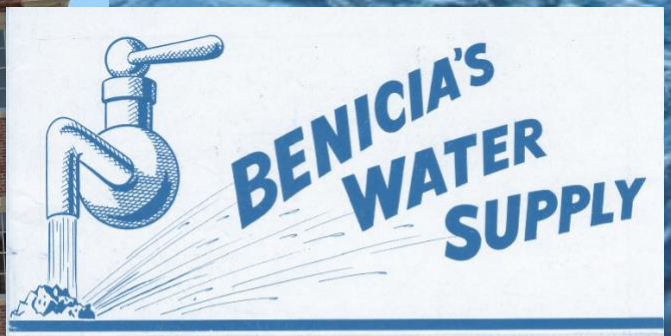

2020 Urban Water Management Plan

THE CITY OF BENICIA CALIFORNIA

Prepared by

Tully & Young
Comprehensive Water Planning

Final: Adopted May 18, 2021

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2020 Urban Water Management Plan

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2020 UWMP

Executive Summary
Layperson's Description

After the devastating drought in the late 1970s, the California Legislature declared California's water supplies a limited resource, subject to ever-increasing demands and that the long-term, reliable supply of water is essential to protect California's businesses, communities, agricultural production, and environmental interests. The Legislature also recognized a need to strengthen local and regional drought planning and increase statewide resilience to drought and climate change. Thus, in 1983, the California Legislature created the Urban Water Management Planning Act (UWMPA).[1] The UWMPA requires urban water suppliers serving over 3,000 customers or supplying at least 3,000 acre-feet of water annually to prepare and adopt an urban water management plan every five years,[2] and demonstrate water supply reliability in a normal year, single dry year, and droughts lasting at least five years over a twenty-year planning horizon.[3] The UWMPA also requires each urban water supplier to prepare a drought risk assessment and water shortage contingency plan.[4] And last, beginning in July 2022, each urban water supplier must prepare an annual water supply and demand assessment.[5] The California Legislature asserts that aggregating all of these legal requirements at the urban water supplier level will improve local, regional, and statewide water planning and water resilience.

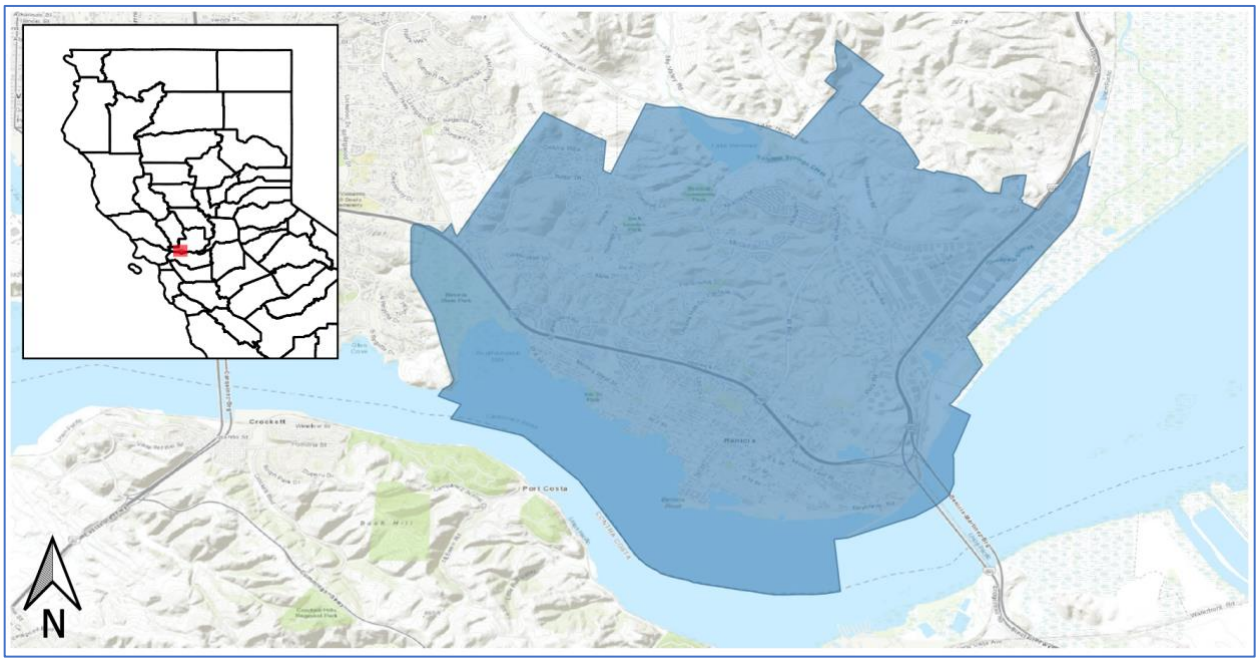
At a practical level, the Urban Water Management Plan (UWMP) is the legal and technical water management foundation for urban water suppliers throughout California. A well-constructed UWMP will provide the supplier's elected officials, management, staff, and customers with an understanding of past, current, and future water conditions and management. The UWMP integrates local and regional land use planning, regional water supply, infrastructure, and demand management projects as well as providing for statewide challenges that may manifest through climate change and evolving regulations. Thoughtful urban water management planning provides an opportunity for the supplier to integrate supplies and demands in a balanced and methodical planning platform that addresses short-term and long-term planning conditions. In brief, the UWMP gathers, characterizes, and synthesizes water-related information from numerous sources into a plan with local, regional, and statewide practical utility.

[1] California Water Code Section 10610 *et seq*. (Chapter 1 added by Stats. 1983, Ch. 1009, Sec. 1).
[2] California Water Code Section 10610 *et seq*.
[3] California Water Code Sections 10631-10635
[4] California Water Code Sections 10632
[5] California Water Code Sections 10632.1

ES-1 The City of Benicia

The City of Benicia covers approximately 15 square miles on the northern shore of the Carquinez Straight in Solano County. Benicia was founded in 1847, incorporated in 1851, and served as California's capitol from 1853 through 1854. The City has repeatedly adapted to changed political and economic opportunities as a threshold location for the gold rush, a shipbuilding center through World War I, and a modern urban and industrial city in the 21st Century. The City's water supplies have expanded and transformed to adjust to the City's changing conditions. The City's water service area is shown in Figure ES-1.

Figure ES-1: City of Benicia Water Service Area



The City's water supply was historically derived from Sulphur Springs Creek watershed (both surface water and groundwater) but expanded to include various supplies from both the Putah Creek drainage and Sacramento River watershed. Although the City still uses supplies from Sulphur Springs Creek watershed to serve its urban and industrial demands, it currently relies on supplies derived from the State Water Project and Solano Project to meet its needs. Specifically, the City's water supply portfolio contains the following rights and contracts:

- Participating Agency Contract with Solano County Water Agency for State Water Project supplies
- Settlement Contract with the State of California for Sacramento River watershed water supplies
- Water Supply Agreement with Solano Irrigation District
- Appropriative Water Rights to Sulphur Springs Creek watershed supplies
- Water Supply Agreement with City of Vallejo

Each of the City's water supplies have unique provisions that impact their utility under varying regulatory and hydrological conditions. For example, all of the City's water supplies may be reduced in dry conditions, but some of the water supplies allow for water storage in wetter conditions for the City's use in dry conditions. These sorts of management provisions imbedded in each of the City's water supplies must be carefully considered so as to improve the collective utility of all of the City's water supplies.

The City coordinates its water supply management with Solano County Water Agency (SCWA). SCWA is a regional wholesale water agency that helps manage water supply deliveries to the City and other public agencies within Solano County. The City collaborates with SCWA to determine which sources of its water supply portfolio should be delivered at different times of the year based upon the regional and statewide hydrology and regulatory conditions. This management collaboration requires accurately assessing available information and appropriately planning for potential future water supply conditions.

The City's population has remained relatively stable over the last twenty years hovering near 27,000 residents. This urban population coupled with the Valero Refining Company and other commercial and industrial users constitute the total water demand in the City. This total demand is just under 10,000 acre-feet of water per year (where one acre-foot of water is about the size of one football field covered in one foot of water). The City is analyzing its water supplies in the context of potential future growth that would increase future water demands by approximately 1,000 acre-feet per year. In this way, the City analyzes its current water demands and potential future water demands in order to assess how it must manage its water supplies to meet those demands. Comparing current and future demands with the City's water supply portfolio illustrates the City's current and future water service reliability.

ES-2 Benicia's Water Service Reliability

The City of Benicia's water service reliability hinges on the active management of the City's water supply portfolio to meet its demands. More succinctly, even though the City's total annual water supplies are more than enough to meet the City's annual water demands, the monthly availability of each supply must be actively managed to meet the City's monthly water demands of the course of any given year. In addition, the supplies must be even more astutely managed in order to provide sufficient water supplies to meet the monthly demands during extended dry conditions.

The fundamental management tenet for the City of Benicia's water service reliability in dry periods is to preserve as much water supply during normal and wet conditions in order to make those water supplies available during dry conditions. The City's water supply contracts with SCWA, the City of Vallejo, and Solano Irrigation District provide opportunities to forego a portion of a normal or wet year water supply so that this water supply can be accessed for use in dry conditions. These "carryover" provisions allow water to be stored in the Solano Project and State Water Project systems for use in a subsequent year. Each year, the City looks to maximize its carryover water supplies in order to recapture those supplies during dry conditions.

A second management principle for the City is to use supplies that would otherwise be lost if they are not used when those supplies are available. For example, in normal and dry year conditions, the City's

Settlement Contract water supply is generally available between 6 and 8 months of the year. During the months when this supply is available, the City should use this water because if the water supply is not used, it cannot be stored or otherwise preserved for other future uses.

Last, the City should preserve other water supplies in its portfolio that have additional flexibility related to their potential delivery. For instance, in a normal or dry year, the City has access to its Solano Project and State Water Project water supplies in all months of the year, but it should plan to take these water supplies only when other water supplies become unavailable (like the Settlement Contract water noted above). Managing the City's water supply portfolio with these three management principles in mind, creates the water service reliability for the City to weather a drought lasting five consecutive years.

Over the long term, the City's water supply portfolio should be adequate to meet its potential long-term growth objectives. The City's long-term water service reliability considerations have three important components: (1) an increase in the annual total demand that the City's water supplies will need to satisfy; (2) an increase in the monthly demands that will impact the City's active annual water management; and (3) no increase in the City's total water supply available in its water supply portfolio. All of these items are considered in the City's water service reliability projections. The analysis in this 2020 UWMP contemplates all of these components in showing the City's water service reliability through 2045.

In addition to these water service reliability considerations, the City also has updated its Water Shortage Contingency Plan (WSCP) under Chapter 13.035 of the Municipal Code to address any potential water shortage conditions. This updated WSCP allows the City to reduce the water demands on its water system in shortage or catastrophic outage conditions. The measures contemplated in the updated WSCP include typical dry condition water management actions – like mandatory outdoor irrigation during evening, nights, and early mornings – imbedded into six water shortage categories (up to 10%, 11-20%, 21-30%, 30-40%, 40-50% and over 50%). Importantly, in the event there were to be a catastrophic water outage in the City, water demands will be limited to use for health and safety purposes only. Combining the updated WSCP with the City's active water management of its supply portfolio provides additional buffer against unpredictable water conditions.

In summary, the City of Benicia's diverse surface water supply portfolio, its active management of its water supply portfolio, and its WSCP provide the City with stable and reliable water service to meet the City's current and 2045 projected water demands. This supply reliability encompasses normal, single dry, and five consecutive dry year scenarios.

Chapter 1
Introduction

The City of Benicia (City or Benicia) is located on the northern shore of the Carquinez Straight in Solano County (County), connecting San Pablo Bay with the Sacramento-San Joaquin Bay-Delta Estuary system. Benicia is one of the oldest cities in the San Francisco Bay Area, and indeed, in all of California. The City was incorporated in 1851 and its waterworks go back to at least 1880 when citizens acquired water rights to Paddy Creek and Sulphur Springs Creek flows which lie to the north of the City. Sulphur Springs Creek water assets are still used by the City today. The Benicia Water Company, the City's predecessor water management entity, established the original reservoirs, pipelines and wells to supplement surface water supplies. Now City's water treatment plant, conveyance, and wastewater treatment plant are managed by the City's Public Works Department.

Benicia was a shipbuilding center through World War I, and also supported other waterfront industries such as canning and tanneries. It also housed a former U.S. Army Armory and currently supports an industrial park in the northeast part of the City which includes the Valero oil refinery. The City still retains a small-town charm with a downtown retail district, several residential neighborhoods and its own school district. Land Use in Benicia is guided by the concept of sustainable development, in that, "land be used efficiently to reduce traffic, preserve land at urban fringes, reduce infrastructure costs, and minimize the loss of farmland, wetlands, and open space. By doing these things, it is hoped that Benicia can avoid the costs of sprawl and erosion of the quality of life."[6]

Ensuring an adequate supply of water is available to serve the existing and future needs for the City's residents and Commercial, Institutional and Industrial (CII) customers is a critical component of successful city planning. This Urban Water Management Plan (UWMP) draws on local, regional and statewide inputs to synthesize information from numerous sources into a reliable water management action plan designed to be referred to as management decisions arise and conditions change.

1.1 Background and Purpose

The City has prepared this 2020 UWMP to comply with the Urban Water Management Planning Act (UWMPA) requirements for urban water suppliers.[7] This 2020 UWMP addresses the City's water management planning efforts to assure adequate water supplies to meet forecast demands over the next 25 years. As required by the UWMPA, the City's 2020 UWMP specifically assesses the availability of its supplies to meet forecast water uses during average, single-dry and five consecutive drought years

[6] City of Benicia General Plan, 2016 Update
[7] California Water Code sections 10610 through 10657.

through 2045. Verification that future demands will not exceed supplies and assuring the availability of supplies in dry-year conditions are critical outcomes of this 2020 UWMP.

The 2020 UWMP is an update to the City's 2015 UWMP and presents new data and analysis as required by the California Department of Water Resources (DWR) and the California Water Code (CWC) since 2015. The 2020 UWMP is also a comprehensive water planning document that describes existing and future supply reliability, forecasts future water uses, presents demand management progress, and identifies local and regional cooperative efforts to meet projected water use.

The UWMP is designed to be a valuable water management and planning tool to guide and inform the City's managers, customers and the State of California about its water management practices. It reflects the City's planning assumptions and goals and should be used in combination with other planning resources and documents over the UWMP planning horizon.

The State of California's drought vulnerability and the additional pressures of climate change and population growth have 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 2020 UWMP.

1.2 Basis for Plan Preparation

The City operates a Public Water System as described in California Health and Safety Code 116275. The Agency qualifies as a Retail Urban Water Supplier as described in Water Code Section 10617, providing water for municipal purposes to more than 3,000 customers or 3,000 acre/feet of water per year. This qualification require the preparation of an Urban Water Management plan every five years. The Agency's Public Water System detail is listed in Table 1-1.

Table 1-1: Public Water System Information

Public Water System Number	Public Water System Name	Number of Municipal Connections 2020
CA4810001	City of Benicia	~ 9,700

The State Legislature passed numerous new requirements since the 2015 UMWP which are detailed throughout this 2020 UWMP.[8] Major updates to the requirements are listed below along with a reference to the corresponding section in which they are addressed in this document.

- **Five Consecutive Dry-Year Water Reliability Assessment:** The Legislature modified the dry-year water reliability planning from a "multiyear" time period to a "drought lasting five consecutive water years" designation. This statutory change requires a Supplier to analyze the reliability of its water supplies to meet its water use over an extended drought period. This new requirement is addressed in Chapter 3—Water Supply Characterization, Chapter 4–Water Use, and Chapter 5— Water Service Reliability Assessment.

[8] California Water Code Section 10608 to 10608.44; Section 10609 to 10609.38; Section 10610 to 10657

- **Drought Risk Assessment (DRA):** Due to the extensiveness of recent California droughts and the variability associated with climate change predictions, the California Legislature created a DRA requirement for UWMPs. The DRA requires assessment over a five-year period from 2021 to 2025 that examines water supplies, water uses, and the resulting water supply reliability for five consecutive dry years. The DRA is addressed in Chapter 5— Water Service Reliability Assessment and Chapter 6—Water Shortage Contingency Plans.
- **Seismic Risk:** Evaluating seismic risk to water system infrastructure and facilities and having a mitigation plan is now required by the Water Code. Incorporating the water system into regional or county hazard mitigation planning is an important aspect of this new statue. Seismic risk is addressed in Chapter 6.
- **Water Shortage Contingency Plan:** In 2018, the Legislature modified the UWMPA to require a Water Shortage Contingency Plan (WSCP) with specific elements. The WSCP is a document that provides a Supplier with an action plan for a drought or catastrophic water supply shortage. The WSCP is in Chapter 6 of this UWMP.
- **Groundwater Supplies Coordination:** 2020 UWMPs are required to be consistent with Groundwater Sustainability Plans following the 2014 Legislature enactment of the 2014 Sustainable Groundwater Management Act (SGMA). The City's Groundwater Supplies are described in Chapter 3—Water Supply Characterization.
- **Lay Description:** A synopsis of the fundamental determinations of the UWMP is a new statutory requirement in 2020. This section of the is intended for new staff, new governing members, customers, and the media, and it can ensure a consistent representation of the Supplier's detailed analysis.

1.3 Coordination and Outreach

As required by the Urban Water Management Planning Act (UWMPA) the City has coordinated with nearby agencies while developing this UWMP in order to ensure consistency with other related City planning efforts such as the City's General Plan, Water Master Plan (WMP) and Groundwater Sustainability Plan (GSP). 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 2020 UWMP in coordination with regional water purveyors and has appropriately notified and coordinated with other appropriate local government agencies as listed in Table 1-2.

The City participates in region-wide planning efforts as a part of the Solano County Water Agency (SCWA). SCWA members include the Cities of Benicia, Dixon, Fairfield, Rio Vista, Suisun City, and Vacaville; the Solano Irrigation and Maine Prairie Water Districts; and Reclamation District 208. Benicia also coordinates with Travis Air Force Base, Vallejo Flood and Wastewater District, and the City of American Canyon. The SCWA completed an initial Integrated Regional Water Management Plan (IRWMP) and Strategic Plan and includes the City of Benicia as a part of its ongoing planning framework.

Benicia is also an affiliate member of the Bay Area Clean Water Agencies (BACWA). This 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.

As stipulated in Water Code Section 10621(b), every urban water supplier shall conduct a public hearing in order to encourage active involvement from diverse elements of the community. The City sought public participation with a public hearing and appropriate notices as required by law. These coordination efforts and Statutory Requirements for Notice are also included in Table 1-2.

Table 1-2: 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	X	X	X	X
Solano Irrigation District	X	X	X	X
City of Vallejo	X	X	X	X
Valero Benicia Refinery	X	X	X	X
Solano County (Planning Department)	X	X	X	X
City of Fairfield	X	X	X	X
City of Vacaville	X	X	X	X
City of Dixon	X	X	X	X
City of Rio Vista	X	X	X	X
City of Suisun City	X	X	X	X
Reclamation District 2068	X	X	X	X
Maine Prairie Water District	X	X	X	X
State Water Resources Control Board	X	X	X	X
Department of Water Resources	X	X	X	X
General Public	X	X	X	X

1.3.1 Water Supplier Information Exchange

Water Code Section 10631 requires wholesale and retail water agencies to provide each other with information regarding water supply and demand. Since the City receives water from a wholesaler it coordinates regarding supply and demand information.

1.3.2 Statutory Requirements for Notice

The City provided formal written notification to Solano County that the City's UWMP was being updated. In accordance with the UWMPA, this notification was provided at least 60 days prior to the public hearing of the plan as required by Section 10642 of the Water Code. Electronic copies of the final UWMP will be provided to the County no later than 30 days after its submission to DWR.

1.4 UWMP Adoption

The City held a public hearing regarding its 2020 UWMP on May 18, 2021. Before the hearing, a draft was made available for public inspection at Benicia City Hall, 250 East L Street Benicia, CA 94510, and on the City's website. Pursuant to CWC Section 10642, general notice of the public hearing was provided through publication of the hearing date and time in the local press as required under the UWMPA, and posting of the hearing at the City's office.

The City adopted this 2020 UWMP on May 18,2021. A copy of the adopted 2020 UWMP will be submitted to DWR, provided to the County and the California State Library, and posted onto the City's website.

The City plans to submit all required documentation related to the UWMPA through the DWR submittal website soon after adoption. These include the following required DWR Excel workbooks:

- "FINAL Submittal 2020 UWMP Tables 05.10.2021.xls"
- "FINAL SBX7-7 Compliance Form 04.02.2021.xls"
- "FINAL Energy Use Tables 04.01.21.xls"

1.5 Document Organization

This UWMP is organized as follows:

- Chapter 2 provides a description of the City's service area, demographic characteristics and climate, and describes the future population the City anticipates needing to serve.
- Chapter 3 describes the City's current and future water supplies and the reliability of the availability of supplies through 2045.
- Chapter 4 details the customer uses, including the past and future estimated uses, and describes the City's past and on-going demand management measures.
- Chapter 5 presents the City's water system service reliability into the future, including an assessment of reliability if a drought occurred over the next five consecutive years.
- Chapter 6 is the City's stand-alone water shortage contingency plan, incorporated as a chapter in this UWMP, but also available to be shared and utilized separate from the UWMP.

NOTE TO DWR:

The City of Benicia has written this Urban Water Management Plan (UWMP) primarily as a water resources planning tool to effectively manage water supply, reliability and demand. This UWMP also satisfies all the requirements of the Urban Water Management Planning Act (UWMPA).

The body of the document provides narratives, analysis and data that DWR requests in its 2020 UWMP Guidebook, including changes to the California Water Code since 2015. Efforts have also been made to include enhancements to this document wherever possible as recommended in the 2020 UWMP Guidebook.

To facilitate review by DWR for compliance with the UWMPA, data from the body of the document has been transferred into required DWR submittal tables consistent with the organization of the tables in Appendix E of the 2020 UWMP Guidebook. These tables are separately uploaded to DWR's web portal. This UWMP has been reviewed for adequacy according to the UWMP Checklist as contained in Appendix F in the 2020 UWMP Guidebook.

Chapter 2
Water Service and System Description

The City of Benicia is located in the northeastern San Francisco Bay Area along the Carquinez Strait (Strait) which is the termination of the Sacramento and San Joaquin River Delta. The City is located in Solano County and sits on a gentle slope leading down to the water. The City's water service area contains its own surface drainage watersheds which drain runoff to creeks and water bodies in, and adjacent to, the City. The largest watershed is located in the central part of the area and includes Sulphur Springs Creek and its main tributary, Paddy Creek. This watershed also includes Lake Herman, a key elements of the City's water delivery and management system. The Sulphur Springs watershed is approximately 18 square miles with six square miles in the higher elevation and northern part of the area outside the City's planning area and within the neighboring City of Vallejo's sphere of influence. Paddy Creek drains a 3 square mile are at the lower reach of Sulphur Springs Creek just below the Lake Herman outlet. Although part of Solano County, Benicia is closely linked to Contra Costa County across the Strait. Views from Benicia encompass the Strait, the foothills of northern Contra Costa County, and Mt. Diablo in the distance.

Benicia's water related responsibilities include a large residential population, commercial and retail connections and significant industrial and manufacturing customers, including the Benicia Valero Oil Refinery, a large petrochemical industrial facility. Benicia provides both water and wastewater services to its community. The water service area is about 14.15 square miles and is contiguous with City boundaries (see Figure 2-1). The City provides water service to approximately 9,800 residential, commercial, irrigation, industrial and institutional/governmental service connections. Much of the development is low-density, single-family housing and retail related commercial use. Table 2-1 shows the historical and current service connections by customer class.

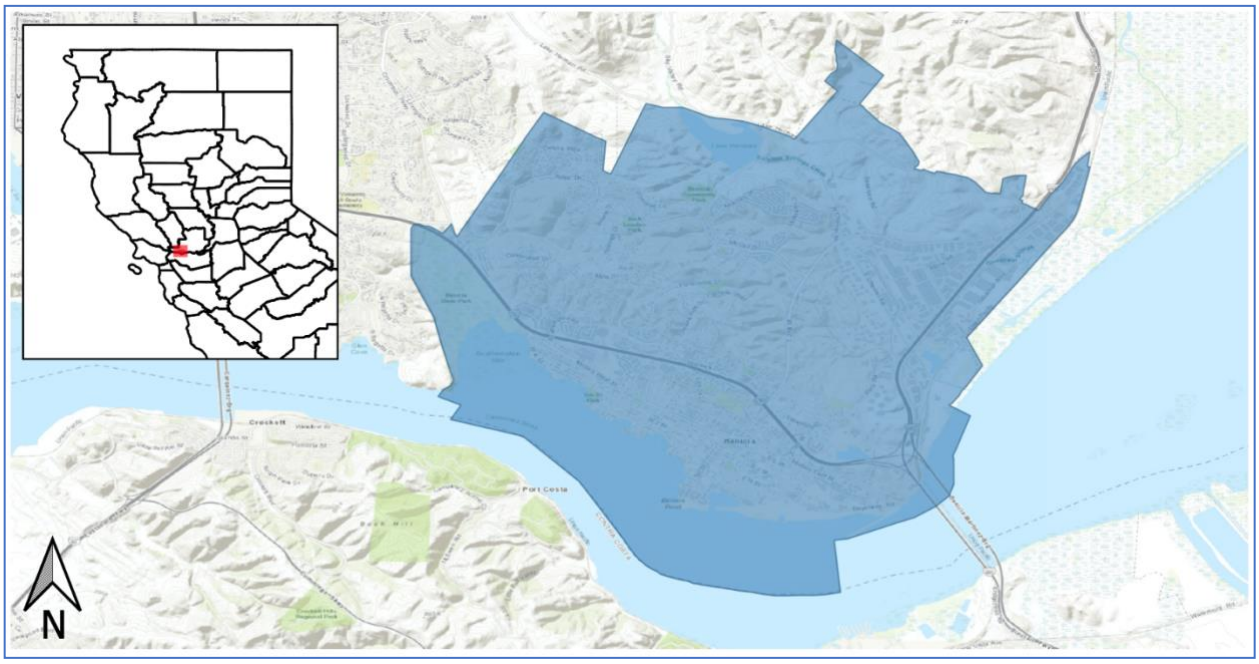
Table 2-1: Customer Water Service Connections

Customer Class	2015	2016	2017	2018	2019	2020
Single Family Residential	8,584	8,603	8,603	8,577	8,574	8,557
Multi-Family Residential	308	311	311	312	312	313
Commercial/Institutional	543	530	530	541	540	531
Industrial	87	77	77	74	77	82
Landscape Irrigation	304	293	293	314	320	315
Other	12	16	21	22	21	16
Total	9,840	9,830	9,835	9,840	9,828	9,814

Benicia's water supply and wastewater services are managed within the City's Public Works Department, which operates the Water Treatment Plant (WTP), transmission, distribution, and storage systems. The Wastewater Operations Division operates and provides maintenance, repair, and capital improvements of the Wastewater Treatment Plant (WWTP) and collection and discharge systems. The WTP, located on Lake Herman Road, was last expanded in 1989.

Though the City has local freshwater supplies from the Sulphur Springs Watershed, potable water is principally imported from other watersheds that bring water into the City (see Chapter 3).

Figure 2-1: Water Service Area

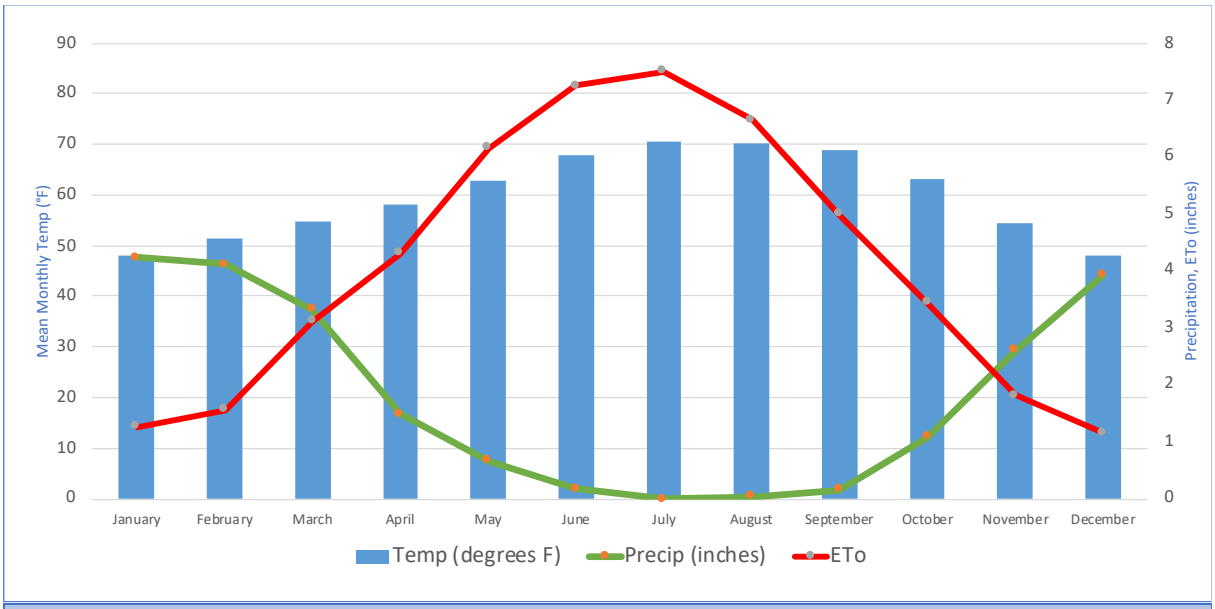


2.1 Service Area Climate

With its location near sea level and within the San Francisco Bay Area region, it has a mild coastal Mediterranean climate with a wet winter and a dry summer. Due to its location near the San Pablo Bay, the weather is usually cooler than neighboring areas further inland, but warmer than those closer to the Pacific coast. Despite its semi-marine environment, there is a long summer period with highest average temperatures occurring from July to September. This seasonal lag means October temperatures are usually warmer than May's. December through early February is the coldest period. The rainy season ranges from November to March with average rainfall of nearly 22 inches. The annual mean temperature is 59.3 degrees Fahrenheit, but the summer months can regularly see average highs in the low 80s, and average winter lows can drop down to the upper 30s. Autumns remain comparatively warm, cooling dramatically by late November, when the rainy season usually starts. Spring brings gradual warming by late March with most winter rain ending by late April.

Figure 2-2 shows the average monthly temperature, rainfall, and evapotranspiration (ETo) for the service area. Actual annual rainfall totals deviate quite significantly from the 30-year average as illustrated in Figure 2-3; in most years, precipitation totals fall below the mean.

Figure 2-2: Average Climate Conditions[9]



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp	48.0	51.4	54.6	58.3	62.9	67.9	70.5	70.3	68.7	63.3	54.5	48.0
Precip	4.24	4.11	3.32	1.49	0.66	0.18	0.00	0.03	0.16	1.08	2.61	3.92
ETo	1.26	1.56	3.11	4.30	6.16	7.25	7.51	6.65	4.99	3.45	1.81	1.16

2.1.1 Climate Change

While the California Water Code does not prescribe specific climate change planning and management measures for water suppliers, it does emphasize that climate change is appropriate to consider when assessing drought risk assessment, water conservation and use efficiency, and demand management and supply—both in a historical and projected context. Given its reliance on imported water from other watersheds, including from the Sacramento Valley, any effect from climate change on Sierra Nevada snowpack and flows into Northern California reservoirs and the Delta region will have a serious impact on water availability. Risks to the City's specific water supplies are further discussed in Chapter 3.

As shown by the trendlines in Figure 2-4, there has been a gradual warming in average temperatures over the past 100 years. Increasing temperatures regionally can result in increased demands, especially from outdoor water uses, and place further stress on supply reliability if current surface water sources are not sufficient to meet increasing need. The City has experienced a general warming trend over the

[9] Temperature and rainfall data represents annual averages from 1981-2019 from the PRISM Climate Group https://prism.oregonstate.edu/ Location: Lat: 38.0650 Lon: -122.1512 Elev: 295ft; ETo data is from CIMIS Concord - San Francisco Bay - Station 170, Jan 2010-Nov 2020.

last 100 years, as shown by the trendlines in Figure 2-4. Additional discussion regarding the potential effects of climate change are included in Chapter 3, Chapter 4, and Chapter 5.

Figure 2-3: Annual Precipitation Variability (1981-2019)

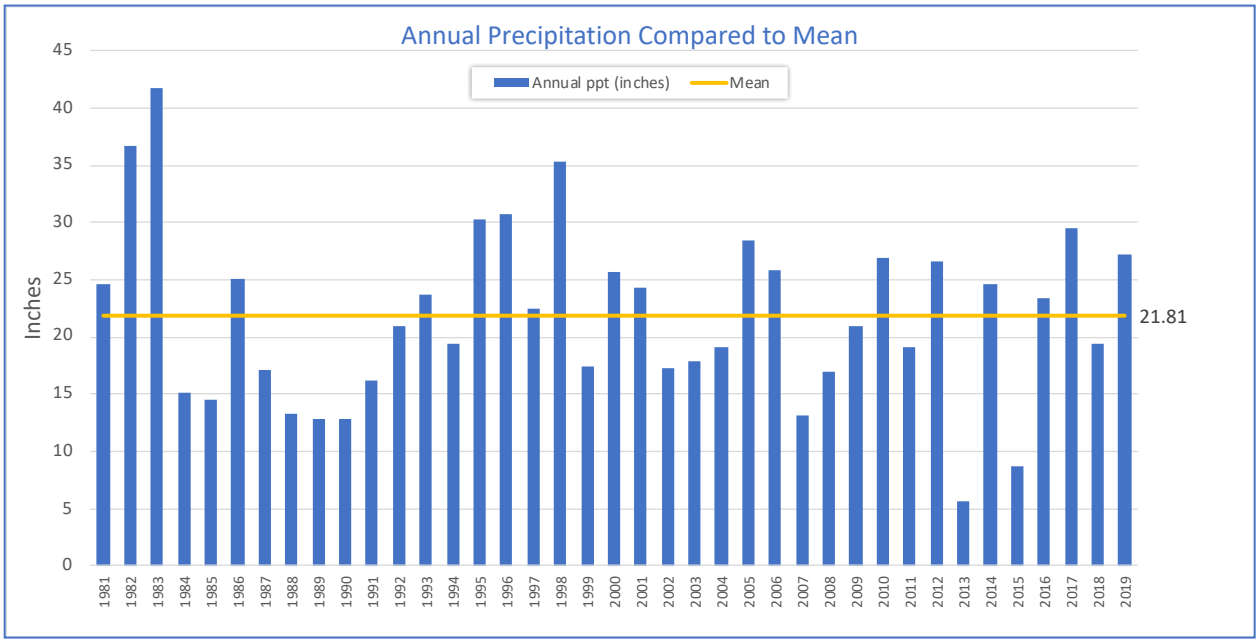
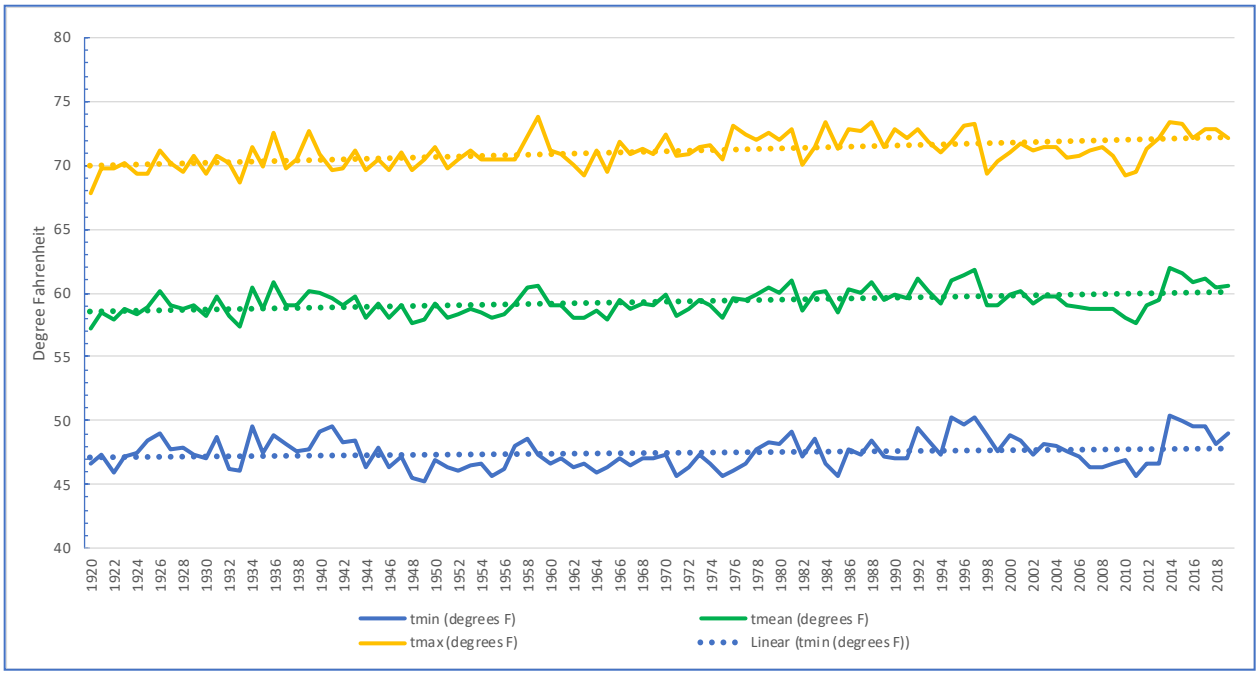


Figure 2-4: Historical Annual Temperature (1920-2019)[10]



[10] Temperature data is from the PRISM Climate Group https://prism.oregonstate.edu/ Location: Lat: 39.1239 Lon: -121.6174 Elev: 56ft

2.2 Current and Projected Population, Land Use, Economy, and Demographics

Service area population and land use projections are critical to developing a useful planning framework as population dynamics and growth are a primary influence on water use. These projections directly influence planning measures for system supply, delivery, infrastructure, and demand management. Similarly, understanding the City's economic, social, and demographic trends give valuable insight to water management and planning. This section of the UWMP addresses these factors to provide a supportable basis for forecasting future water use.

2.2.1 Current Population and Historic Trends

After being one of the first cities founded in California, Benicia had a history as a waystation for travelers to and from the Sacramento Valley and the Gold Country from San Francisco and Oakland. The economic boom after World War II doubled the population to 7,000 residents, but the real growth in the City began in the 1960s after the Benicia-Martinez bridge was completed and made it possible for Benicia to become a suburb of Oakland and San Francisco. Between 1970 and 1995 the population steadily grew by approximately 1,000 per year, fueled much in part by the Valero refinery (formerly Exxon) which was completed in 1969 and still serves as a major employer and economic driver today. Population growth has slowed significantly in recent years and the City is very close to build-out capacity. The City designated an Urban Growth Boundary (UGB) in which no urban development beyond the UGB shall be served by City water and/or sewer.[11] This policy adheres to the City's stated goal of focusing growth and preventing urban sprawl while promoting the City's goal of creating a sustainable community.[12]

The City experienced a ten percent increase in population from 1990-2000, and from 2000-2010 growth slowed to just under one half of a percent. From 2010-2019 this trend continued with population increasing just 0.45% with an annual rate of change of just 0.11%. Data gathered during a recent development impact fee study commissioned (the EPS Study) by the City determined the City to have 10,515 residential units in 2020.[13,14]

The EPS Study also estimated the average single family household size in 2020 as 2.68 people with 2.08 people average in multi-family households, and 1.5 people estimated in Accessory Dwelling Units. The California Department of Finance recognizes an average occupancy in the City of about 2.5, consistent with the City's independent finding.[15] Notably, the City's population decreased in both 2018 and 2019.

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[11] Policy 2.1.5 City of Benicia General Plan, Updated April 2016

[12] City of Benicia General Plan, Updated April 2016

[13] *Nexus Study for Update of Development Impact Fees*, Economic & Planning Systems, Inc. (EPS), November 9, 2020. Sources: Average household size per occupied housing unit in Benicia based on data from the 2018 American Community Survey (5-year estimates) conducted by the U.S. Census Bureau

[14] This number reflects both single-family door fronts, as shown in Table 2-1, and an estimate of the door fronts associated with the multi-family connections, where often multiple units are served by a single connection.

[15] California Department of Finance, E-5 City/County Population and Housing Estimates

Historical population dating back to 1990 is shown in Table 2-2, and population and growth rate over the last decade is provided in Table 2-3.

Table 2-2: Population - Historical[16]

1990	1995	2000	2005	2010	2015	2020
24,437	26,298	26,865	26,931	26,971	27,369	27,570

Table 2-3: Population Growth Rate – 2010-2019 [17]

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
26,971	26,888	27,025	27,110	27,235	27,369	27,383	27,463	27,376	27,237
	-0.31%	0.51%	0.31%	0.46%	0.49%	0.05%	0.29%	-0.32%	-0.51%
Net Growth 2010-2019: 0.45% Average Annual Growth: 0.11%									

2.2.2 Projected Population

To forecast projected service area population as accurately as possible requires consideration of the past growth rate, local economic predictions, and current and projected land uses. Importantly, one of the recent statutory updates to the UWMP Act states urban water suppliers "shall coordinate with local or regional land use authorities"[18] regarding land uses that may affect water management planning.

The City's projected population growth is based on a combined methodology. The first uses growth projections through 2040 based on the aforementioned EPS Study,[19] and the second ties projections to the Solano County growth rate through 2060.[20] The 2015 UWMP used an analysis by the Solano County Water Agency[21] which utilized the DWR population tool and reflects an approximate one-percent annual growth rate. The EPS Study and Solano County projections factor in slower growth further into the planning horizon which are more realistic for the City considering how close it is to build-out. The EPS projections use a 0.4% to 0.6% growth rate through 2040. The Solano County annual growth rate from 2040-2060 hovers around 0.25% on average. The resulting population and associated growth rate are presented in Table 2-4.

[16] U.S. Census 2010-2019 Annual Estimates Resident Population for Incorporated Places; California Department of Finance, E4 Historical City, County, State Population Estimates

[17] California Department of Finance, E-5 City/County Population and Housing Estimates

[18] CA Water Code Section 10631(a).

[19] EPS Nexus Sources: ABAG/MTC Plan Bay Area 2040 Projections; City of Benicia Planning Department; Benicia Business Park 2007 EIR; Economic & Planning Systems, Inc.

[20] California Department of Finance Report P-2A 2010-2060

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

Table 2-4: Population Forecast and Growth Rate[22]

2020	2025	2030	2035	2040	2045
27,570	28,259	28,966	29,722	30,735	33,177
	0.6%	0.6%	0.5%	0.4%	0.25%

2.2.3 Current and Projected Land Use

As discussed previously, the City is mostly build-out. Development is largely expected to be limited to infill projects or as part of potential growth near the northeastern Urban Growth Boundary.

The recent EPS Study estimated 830 dwelling units would be necessary to reach its 2040 projected population, subdivided as 90 single-family and 740 multi-family units.[23] To reach the 2045 projected population would require an additional 600 dwelling units.

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 in the northeastern area.[24] While the project discussed in 2016 is no longer current, the City presumes a representative growth may still occur in this undeveloped area in order to conservatively plan for the potential water need. In 2016, the project proposed about 600 residential units and 150 acres of industrial and commercial use. While the project's preliminary scope was not approved, for purposes of forecasting water demands in Chapter 4, this project's land use mix is included as a future demand, though anticipated to begin development after 2030.

Table 2-5 represents the planned mix if new residential and non-residential connections expected by the City between now and 2045. This information is used in Chapter 4 to forecast future water use needs.

Figure 2-5 presents the City's current land use map.

Table 2-5: Summary of Land Use Plans in Benicia with Anticipated Future Residential Units

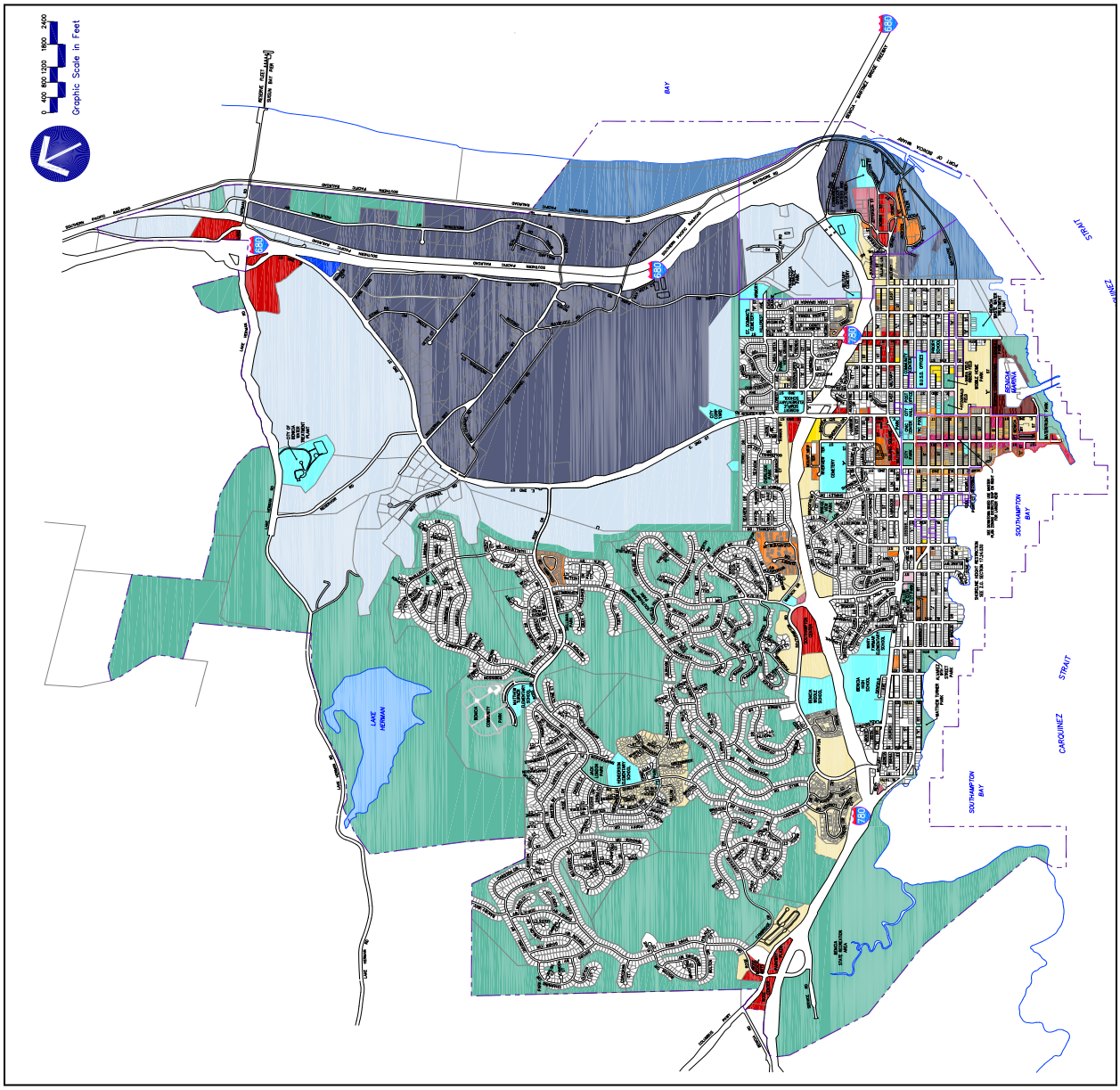
	Residential Units		Non-Residential
	Single-family	Multi-family	
Northern development area	525	75	150 acres
City infill and vacant lands in City Limits	90	740	20 connections

[22] Forecast for 2025 through 2040 are from the EPS Study. Forecast for 2045 is based upon California Department of Finance projections.

[23] *Nexus Study for Update of Development Impact Fees*, Economic & Planning Systems, Inc. (EPS), November 9, 2020, Table 2.

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

Figure 2-5: City of Benicia General Land Use Map[25]



2.2.4 Economic Trends & Other Social and Demographic Factors

Benicia's local economy is centered around its established industrial and manufacturing sectors. It has a significant concentration of economic activity in the Port and Benicia Industrial Park, which includes the Valero Refinery. These "heavy industries" provide a strong economic base for the City. Business that support the refinery, port, and manufacturing industries are also prevalent in the City. Benicia is in a

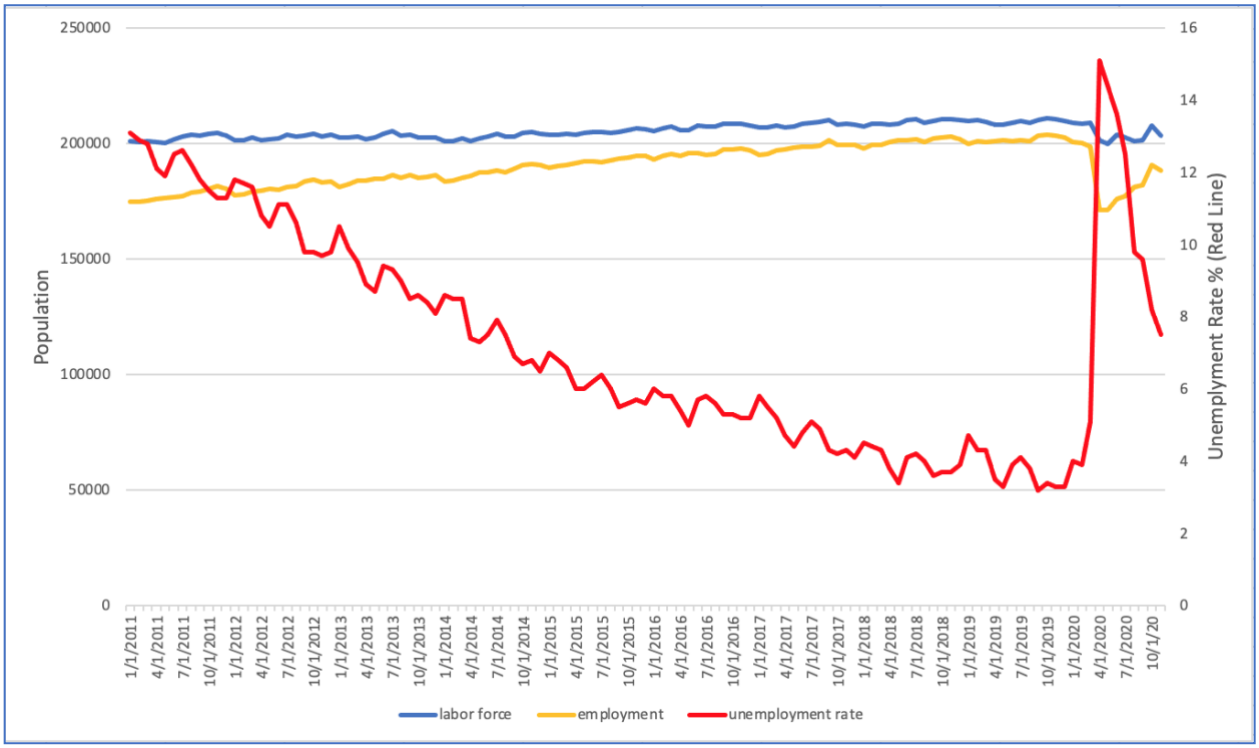
[25] April 2012 City Zone Map available on the City's website.

central location between the major economic centers of the San Francisco Bay Area and Sacramento, and is an important transportation hub with freeway accessibility and its port location.

Since 2010 Benicia has seen impressive growth adding jobs and decreasing the unemployment rate from as high as 13% in 2011 to just over 3% as recently as September 2019. However, the coronavirus pandemic has crippled the national (and global) economy in 2020 and Benicia is no exception. In the Vallejo-Fairfield metropolitan area, of which Benicia is a major component, unemployment rate spiked to 15% in April 2020; for the City of Benicia, unemployment spiked at 12.2% in May 2020. Since then, the area has regained some of the jobs, but the labor force has dropped ~4% year over year and there remains a high level of uncertainty with the pace of economic recovery due to the pandemic. These data are shown in Figure 2-6.[26]

According to the 2010 US Census, the ethnic makeup of Benicia is 72.5% White, 12% Hispanic/Latino, 11% Asian, 5.6% Black or African American, 10% other races or mixed race, 0.5% Native American, 0.4% Pacific Islander. California Department of Finance estimates occupancy in Benicia to be 2.51 persons per household.[27]

Figure 2-6: Benicia Area Employment Data



[26] U.S. Bureau of Labor Statistics: Vallejo-Fairfield, CA Metropolitan Statistical Area

[27] California Department of Finance, E-5 City/County Population and Housing Estimates, 1/1/2020

2.3 Delivery System Details

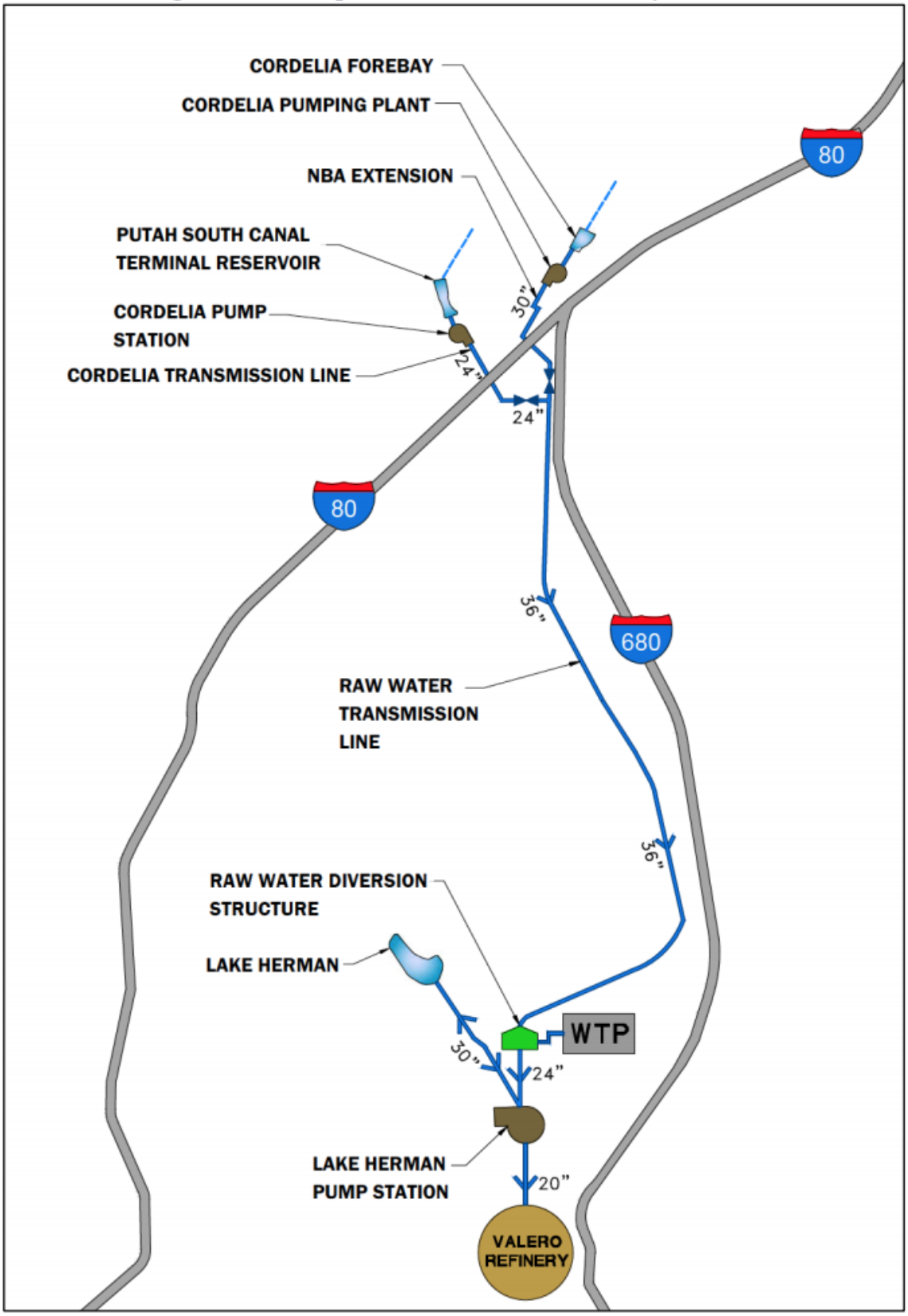
This subsection focuses specifically on Benicia's potable and raw water delivery systems. The water supplies are described in Chapter 3, with water uses described in Chapter 4.

2.3.1 Potable Water System

The City operates a potable water system to provide water service to its customers. Figure 2-7 represents the major features of the raw water conveyance system, while Figure 2-8 represents the major features of the 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. The distribution system consists of 3 pump stations, 8 pressure-reducing stations, and approximately 150 miles of pipelines. The storage system consists of 5 treated water reservoirs and Lake Herman with a capacity of 1,800 acre-feet of untreated water. Raw water is delivered to the City via the raw water transmission system, which consists of two pump stations and approximately 18 miles of pipeline.

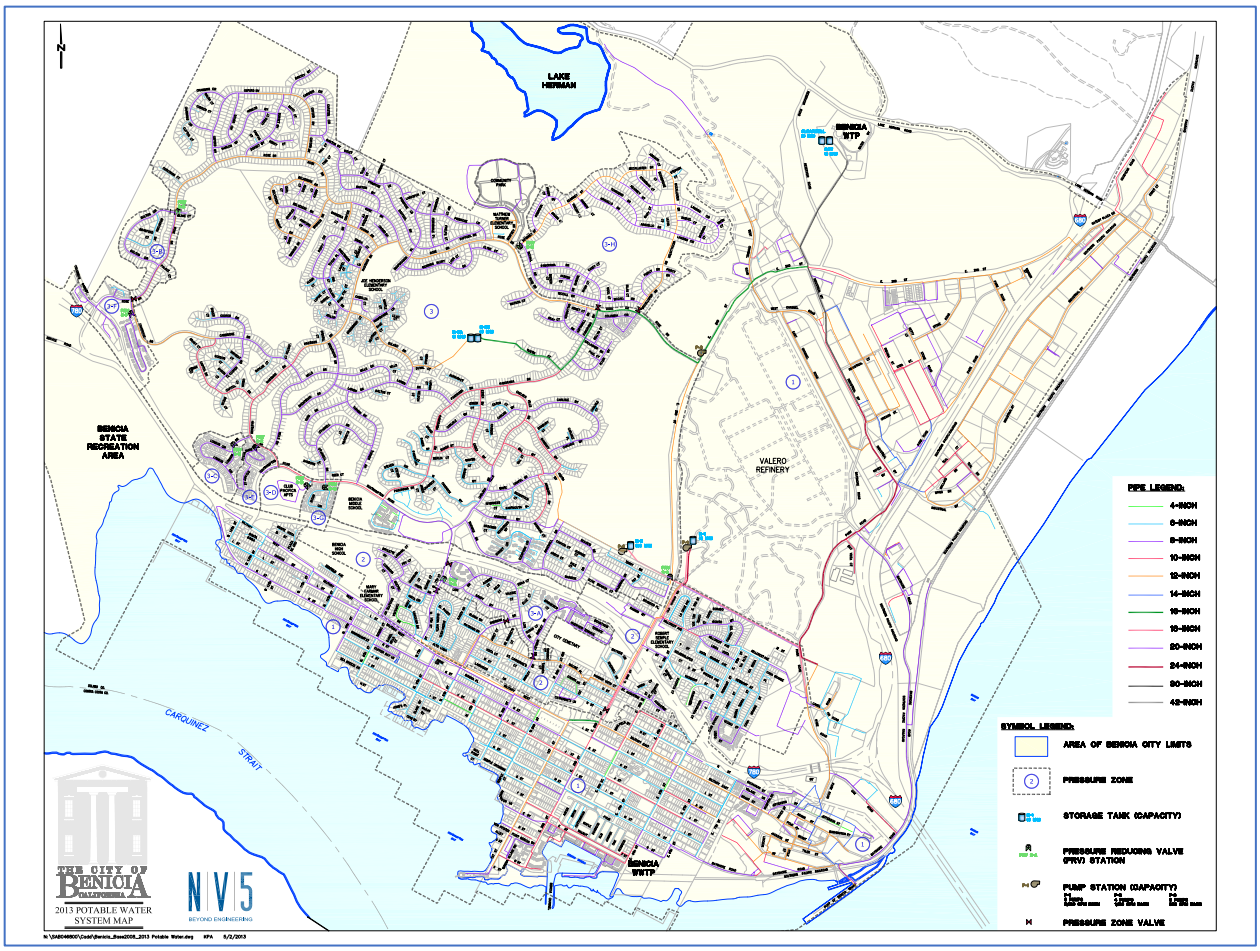
The primary raw water source for the City is the State Water Project (SWP). This water is delivered from Barker Slough on the Sacramento-San Joaquin River Delta via the North Bay Aqueduct (NBA). Additional water comes through the Solano Project (SP) via the Putah South Canal (PSC) to the Terminal Reservoir. 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 as an operational buffer and use the lake as a storage reservoir for up to 1,800 acre-feet.

Figure 2-7: Raw Water System



The potable water distribution system consists of three main pressure (or service) zones: Zone I (primarily serves CII connections along the eastern sector of the City); Zone II (primarily serves the western residential area; Zone III (primarily serves residential area north of I-780 and west of East 2nd Street). Zone III includes several intermediate pressure zones which rely on pressure-reducing valve stations. Storage reservoirs are located in each of the main pressure zones to provide water during peak demand periods and to provide fire and emergency storage capacity. There are currently six water storage tanks (located at three reservoir sites and the WTP) in the distribution system, with a total capacity of 12.8 million gallons. The reservoirs range in size from 1.0 to 3.0 million gallons. Three of the reservoirs are prestressed concrete tanks and the other three reservoirs are welded steel tanks. Water is delivered to Pressure Zones II and III by three pump stations. The P-1 Pump Station delivers water to Zone II from Zone I. The P-2 Pump Station conveys water from Zone II to Zone III. The P-3 Pump Station delivers water directly from Zone I to Zone III. The P-1 Pump Station has a stationary emergency generator, manual transfer switch, and load bank[28]. Pipelines for the water distribution system range in diameter from 4-inch pipes to 30-inch pipes. Most pipelines 12-inch in diameter or less are constructed of ductile iron pipe, while most of the larger pipelines are steel.

Figure 2-8: Potable Water System



[28] The City of Benicia 2012 Water System Master Plan

The City installed Advanced Metering Infrastructure (AMI) to replace all older commercial and residential water meters, which account for approximately 85% of all system meters in 2017. Individual connection Meter Transmission Units (MTUs), which collect hourly water data, were installed along with 26 Data Collector Units (DCUs) to transmit the data to a cloud-based computer system. Benefits include eliminating the need for manually reading meters, an enhanced customer web portal to track and monitor water use, and real-time leak monitoring and water loss notification.

The City does not have an economically viable groundwater supply. The Public Safety Background Report lists a number of confirmed and potential groundwater contamination sites throughout the City. However, Benicia's reliance on imported SWP water for its municipal water supply means that the groundwater quality problem sites have little significant impact on drinking water quality. Instead, they have the potential to affect water quality in local creeks and the receiving waters in the Carquinez Strait and Suisun Bay, since groundwater eventually flows to surface locations. Groundwater contamination upstream from Lake Herman could reach the City's water supply. Two upstream contamination sites have been identified at Syar Quarry and the Hastings Mercury Mine. While these sites appear to be of relatively lower concern than downstream sites, the City should continue to monitor these sites.

2.3.2 Non-Potable Water System

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.

2.4 Energy Intensity

Among the statutory changes enacted with new requirements for 2020 UMWPs, an urban supplier shall include information it can readily obtain related to the energy use to produce, treat and deliver water:[29]

Referred to as "Energy Intensity Reporting" for urban water suppliers. Energy Intensity is defined as: total amount of energy expended in kilowatt-hours (kWh) by the urban water supplier on a per acre-foot basis to take water from the location where the urban water supplier acquires the water to its point of delivery.

Due to the way that water is supplied in the various City service areas, it is not currently possible to separate out extraction, treatment, storage, and distribution energy uses. This is due to delivery and

[29] California Water Code Section 10631.2(a).

treatment facilities on single power meters, the use of some gravity-fed storage tanks, and the use of solar at some of the facilities. Given this, the City uses the Total Utility Approach. This method sums the annual net energy consumed for all water management processes, divided by total volume of water in acre feet.[30] These processes include diversion, conveyance, placement into storage, treatment, and distribution. The total energy intensity is reported in Table 2-6.

Table 2-6: Energy Intensity – Total Utility Approach[31]

Sum of All Water Management Processes	
Volume of Water Entering Process (acre-feet)	9,483
Energy Consumed (kWh)	1,111,828
Energy Intensity (kWh/acre-foot)	117

[30] Net energy is used due to solar production not being tracked separate from consumption.

[31] Energy consumption numbers cover July 2019 to June 2020, total water production including Valero has been used for the same period.

Chapter 3
Water Supply

The City of Benicia has numerous water supply sources that serve its customers. The City's diverse surface water supplies – derived from water rights and contracts – provide significant annual volumes of water that can be used to meet end user demands. However, the details imbedded in each water right and contract impact the monthly availability of each supply source. This limited availability requires the City to carefully manage its water supply portfolio in order to have sufficient water supply available in extended drought periods. Furthermore, as noted below, the City's water supply portfolio has additional administrative matters that require resolution in order to support the long-term reliability projections. This section details the City's water supply portfolio and identifies the key components within each water asset that impact the City's long-term water supply reliability.

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 general surface water sources: the Sacramento River watershed, Putah Creek and the Solano Project, and Sulphur Springs Creek watershed through Lake Herman. 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. Solano County Water Agency has historically managed the Sacramento River and Solano Project supplies on behalf of the City.

A fundamental conclusion from the City's water supply analysis in this 2020 UWMP is that the City and SCWA will need to closely coordinate future water management efforts in order to prevent water supply deficits in extended dry conditions. With these management challenges in mind, the water deliveries from each identified water source will likely change in any given year in order to best preserve water assets for unknown, yet predictable, future dry conditions. Specifically, the City and SCWA management efforts should focus on preserving as much of the City's water as possible in carryover and/or storage in order to preserve those water supplies for future uses.

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.[32] Solano Project water is transported to Benicia through the Putah South Canal and provides a varying percentage of the City's total consumption depending on the hydrological and regulatory conditions.

Sulphur Springs Creek Watershed and Lake Herman water assets deliver supplies derived from the watershed into an artificial reservoir originally built at the time of the City's founding. The City diverts water to storage from the Sulphur Springs Creek Watershed and stores additional water in Lake Herman 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. All three of the City's water supply sources are described in much more detail in the sections below.

3.2 Sacramento River Watershed Water Supplies

The City has two primary 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 City occasionally receives water from the City of Vallejo through its Sacramento River watershed water rights, but the City does not rely on those rights to meet its annual needs. The details underlying the City's Sacramento River watershed 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 and most facilities were completed by 1973. The State Water Project (SWP) is the largest state-built, multi-purpose water project in the country. Today, the SWP includes 28 dams and reservoirs, 26 pumping and generating plants, and approximately 660 miles of aqueducts.

The primary water source for the SWP is the Feather River, a tributary of the Sacramento River. The water flowing in the Feather River is captured by the SWP in Oroville dam and reservoir. Storage released from Oroville Dam flows down the Feather River and then the Sacramento River until it reaches the Sacramento-San Joaquin River Delta (Delta). 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.

[32] https://www.usbr.gov/projects/index.php?id=421

The diversion rights are based upon State Water Resources Control Board issued appropriative water rights with 1927 priority dates.

The total planned annual delivery capability of the SWP and the sum of all contractors' maximum Table A was originally 4.23 million acre-feet. The initial SWP storage and conveyance facilities were designed to meet contractors' water demands with the construction of additional storage facilities planned as demands increased. However, few additional SWP storage facilities have been constructed since the early 1970s and a portion of the original conveyance design was never completed. SWP conveyance facilities were generally designed and have been constructed to deliver Table A to all contractors. The maximum Table A of all SWP contractors now totals about 4.133 million AF.[33]

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.

City of Benicia Table A Allocation

The 2013 PAC grants the City a Table A Amount 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

[33] The Final State Water Project Delivery Capability Report, DWR, August 2020 at 30.

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 annual allocation to SCWA.[34]

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: City of Benicia Table A PAC Allotments 2010-2020

Year	Table A Allocation (acre-feet)	% Allocation
2010	8,600	50%
2011	13,760	80%
2012	11,180	65%
2013	6,020	35%
2014	860	5%
2015	4,323	25%
2016	12,900	75%
2017	17,200	100%
2018	6,600	38%
2019	14,620	85%
2020	5,160	30%

Future SWP Allocations and Long-Term Reliability

DWR has intimated that it is less likely that 100% allocation years will occur on a regular basis in the future. In August 2020, DWR finalized the "2019 SWP Delivery Capability Report" (DCR) that outlined the probable future water supply allocations for the SWP system. The DCR showed variations in future Table A deliveries based upon hydrological and regulatory conditions. These conditions are summarized in Table 3-2 below.

Table 3-2: SWP Estimated Table A Deliveries from DCR (acre-feet per year)[35]

Year	Long Term Average		Single Dry Year (1977)		Dry Periods							
					2 Year Drought (1976-1977)		4-Year Drought (1931-1934)		6-Year Drought (1987-1992)		6 Year Drought (1929-1934)	
2017 Report	2,571	62%	336	8%	1,206	29%	1,397	34%	1,203	29%	1,408	34%
2019 Report	2,414	58%	288	7%	1,311	32%	1,228	30%	1,058	26%	1,158	28%

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

[35] The Final State Water Project Delivery Capability Report, DWR, August 2020 at 30 with values in TAF/Yr.

As shown in Table 3-2, DWR's long-term average reliability shows a downward trend from 62% in the 2017 SWP DCR to 58% in the 2019 DCR. However, as a result of the North of Delta Settlement (December 31, 2013), the North of Delta (NOD) allocation should be larger than the identified reliability described in the 2019 DCR. Specifically, the NOD allocation should increase the future annual Table A allocation by approximately 10%. Accordingly, the City will incorporate the NOD allocation bump in considering its long-term water supply availability of 68%. Table 3-3 depicts the Future Table A Projected Normal Year Water Year Deliveries.

Table 3-3: SWP Future Table A Projected Normal Water Year Deliveries (acre-feet per year)

Year Type	Table A Allocation	% Allocation
Normal Year	11,696	68%

The 2017 and 2019 DCR depict the single driest year as 1977 with an 8% allocation estimate in 2017 and a 7% allocation estimate in 2019. The single lowest historical SWP allocation occurred in 2014 at 5% as shown in Table 3-1. Although the City anticipates the NOD allocation applying in critically dry years, out of an abundance of caution and in accordance with the 2021 SWP allocation, the City will assess a critically dry year at 5% allocation. In less dry years, however, the City will increase this baseline number by 10%.

The DCR also identifies various drought periods for purposes of characterizing SWP allocation percentages that would accompany those drought periods. The averaging of the allocations over the course of the drought period is not representative of the City's drought planning purposes. The City will use the following drought characterization for its short-term and long-term planning, incorporating both the 2021 critical year allocation and the NOD Allocation adjustment: year 1 at 45%; year 2 at 30%; year 3 at 5%; year 4 at 15%; and year 5 at 30%. This characterization adequately represents a drought over a five consecutive year period. Table 3-4 shows the Table A allocation over five consecutive dry years from 2021-2025. It is important to note that the Table A allocation available may not be used in the identified dry year as it could be carried over for future year uses.

Table 3-4: SWP Allocation for Five Consecutive Dry Years from 2021-2025 (acre-feet per year)

Year	Amount	Managed Amount
Normal	11,696	2,339
Single Dry	860	430
Dry Year 1	7,740	3,870
Dry Year 2	5,160	2,580
Dry Year 3	860	430
Dry Year 4	2,580	1,290
Dry Year 5	5,160	2,580

Table A supply reliability has also been examined over the broader planning horizon considered in this 2020 UWMP. Table 3-5 shows the normal year, single dry year, and five consecutive dry years planned SWP Table A Allocation for the City of Benicia through 2045.

Table 3-5: Future SWP Allocations by Year Type Through 2045 (acre-feet per year)

Table A Allocation	Year Type	2025	2030	2035	2040	2045
Normal		11,696	11,696	11,696	11,696	11,696
Single Dry Year		860	860	860	860	860
Five Consecutive Drought Years	Year 1	7,740	7,740	7,740	7,740	7,740
	Year 2	5,160	5,160	5,160	5,160	5,160
	Year 3	860	860	860	860	860
	Year 4	2,580	2,580	2,580	2,580	2,580
	Year 5	5,160	5,160	5,160	5,160	5,160

The characterizations of the City's SWP Table A Allocation long-term reliability reflect numerous hydrological and regulatory issues that inform the DCR modeling, are reasonable assessments related to SWP system management, and reflect the City's local conditions. Long-term hydrological and regulatory issues that affect the water management include the Bay-Delta Water Quality Control Plan, the Coordinated Operations Agreement, the Delta Biological Opinion, modifications to San Luis Reservoir, SWP Seismic considerations, DWR's Emergency Planning, and assessments related to the City's local conditions and climate. These issues are all considered in the City's planning incorporated into it supply characterizations in this 2020 UWMP.

Table A Carryover Supply

The City's PAC Contract allows it to forego use of its allocated SWP Table A supply and retain a portion of that allocated supply in storage for future use. This retained supply is termed "Carryover" and is governed under Article 56 of SCWA's SWP contract. Carryover water is water that is released from Oroville dam and reservoir, re-diverted at the Delta, and then stored in San Luis Reservoir – an offstream reservoir located just outside the City of Santa Nella at the junction of Interstate 5 and California State Highway 152. San Luis Reservoir is jointly owned and operated by the state and federal governments and all SWP contractors may use the storage facility to manage Carryover water supplies. In short, the San Luis Reservoir receives, regulates, and stores exported water derived from the State Water Project and Federal Central Valley Project.

The amount of water that the City may carryover in any given year is subject to a set of rules that implicate all SWP contractors throughout California. In brief, the City delivers its Table A supplies to Carryover in San Luis Reservoir with an expectation that it will be able to divert all or a portion of these supplies in a subsequent year. In the event that water supplies are abundant, San Luis Reservoir may "spill." When San Luis Reservoir reaches a "spill" stage, DWR releases the City's Carryover in accordance with the aforementioned rules as they apply in the context of all entities with stored water in San Luis Reservoir. Nevertheless, the City generally retains a portion of its Table A Allocation as Carryover in any

given year and continues to maintain a Carryover balance. Table 3-6 shows the City's Carryover balance from 2010 through 2020.

Table 3-6: City of Benicia Historic SWP Carryover (acre-feet per year)

Year	Carryover
2010	8,656
2011	11,177
2012	8,776
2013	13,018
2014	9,346
2015	6,525
2016	6,601
2017	13,541
2018	8,600
2019	7,870
2020	8,522

The City will have access to its Table A Carryover supplies in future years based upon the hydrological and regulatory conditions. The Table A Carryover supplies result from a number of variables that are both tied to the SWP Table A annual percent allocation, operations in San Luis Reservoir, and water supply management by the City and SCWA. The City conservatively estimates that its future Carryover supplies will equate to approximately one-half of its Table A Allocation. Thus, in a normal year, the City expects the carryover supply to be approximately 5,848 acre-feet. In a single dry year, the Carryover supply is expected to remain at 5,848 as a remnant of a previous dry year storage action. However, Carryover supply decreases over time as it relates to the previous year's Table A Allocation. Thus, for five consecutive dry years, the pattern for Carryover would be 50% of the previous year's Table A Allocation. Importantly, however, the City will manage these supplies over the five-year drought planning horizon to satisfy the City's demands in light of other constraints on other water resources.[36] This analysis is more fully vetted in Chapter 5. Table 3-7 shows the representative Table A Carryover supplies in normal, single dry, and five consecutive dry years from 2021 through 2025. Table 3-8 shows the representative Table A Carryover supplies from 2025 through 2045.

[36] Carryover supplies in the State Water Project system are managed to address water supply shortages when direct diversion rights are insufficient to satisfy demands. Moreover, the Carryover supplies may have applicability over the course of many years after they are designated for carryover.

Table 3-7: Future Available Table A Carryover Supplies from 2021 through 2025 (acre-feet per year)

Year	Amount
Normal	5,848
Single Dry	5,848
Dry Year 1	5,848
Dry Year 2	3,870
Dry Year 3	2,580
Dry Year 4	430
Dry Year 5	1,290

Table 3-8: Available Table A Carryover Supplies from 2025 through 2045 (acre-feet per year)

Year Type		2025	2030	2035	2040	2045
Normal		5,848	5,848	5,848	5,848	5,848
Single Dry Year		5,848	5,848	5,848	5,848	5,848
Multi-Year Drought	Year 1	5,848	5,848	5,848	5,848	5,848
	Year 2	3,870	3,870	3,870	3,870	3,870
	Year 3	2,580	2,580	2,580	2,580	2,580
	Year 4	430	430	430	430	430
	Year 5	1,290	1,290	1,290	1,290	1,290

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 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. In short, when Term 91 is activated, 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.

Table 3-9 below shows the total Settlement Agreement water used by the City of Benicia since 2010.

Table 3-9: City of Benicia Settlement Water 2010-2020 (acre-feet per year)

Year	Settlement	Used
2010	10,500	158
2011	10,500	900
2012	10,500	1,360
2013	10,500	900
2014	10,500	1,580
2015	10,500	504
2016	10,500	574
2017	10,500	3,072
2018	10,500	1,163
2019	10,500	1,753
2020	10,500	1,028

The Settlement Agreement allows the City, in the future, to apply to the SWRCB for a Watershed of Origin appropriation for an amount that exceeds 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. For purposes of this UWMP, we assume that the Settlement Agreement will be renewed. Table 3-10 shows the projected Settlement Agreement water available in normal, single dry, and five consecutive dry years from 2021 through 2025. Table 3-11 shows the availability of Settlement Water from 2025 through 2045.

Table 3-10: City of Benicia Settlement Water Availability from 2021 through 2025 (acre-feet per year)

Year Type		Amount
Normal		10,500
Single Dry Year		10,500
Multi-Year Drought	2021	10,500
	2022	10,500
	2023	10,500
	2024	10,500
	2025	10,500

Table 3-11: City of Benicia Settlement Water from 2025 through 2045 (acre-feet per year)

Year Type		2025	2030	2035	2040	2045
Normal		10,500	10,500	10,500	10,500	10,500
Single Dry Year		10,500	10,500	10,500	10,500	10,500
Multi-Year Drought	Year 1	10,500	10,500	10,500	10,500	10,500
	Year 2	10,500	10,500	10,500	10,500	10,500
	Year 3	10,500	10,500	10,500	10,500	10,500
	Year 4	10,500	10,500	10,500	10,500	10,500
	Year 5	10,500	10,500	10,500	10,500	10,500

Importantly, although the total volumes of Settlement Agreement water seem substantial, the availability of these supplies on a monthly basis are much more limited. In other words, the monthly availability of these supplies essentially mislead the reliability of the annual supply volume. In addition, Settlement Agreement water is characterized 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. Although these conditions have not manifested since the Settlement Agreement was executed, it is noted here for to comprehensively address the City's long-term water management planning.

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 3.2.4 below. Once conveyance volumes are determined, the water is delivered to the City in the same manner as 2013 PAC water. The City generally seeks to use Settlement Agreement water when it is available and NBA capacity is available.

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. In addition, the City's Settlement Agreement water is also diverted at the NBA.

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.

Both 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"[37]
4. Carryover water
5. Non-project water to meet annual entitlements
6. Additional interruptible water in excess of annual entitlements for that year

[37] 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)

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.[38] 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. As noted previously, these hierarchical diversion limitations have not impacted the City's access to its water supply portfolio.

3.3 Solano Project Water Assets

The Solano Project is a federal project operated by the United States Bureau of Reclamation. 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 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 2045 under similar terms upon its expiration.

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

The City of Vallejo holds 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. 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….

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 3-13 below shows the water deliveries under the Vallejo Agreement since 2010. Those deliveries have fluctuated based upon water supplies available to the City in each year.

Interestingly, in a few years, the City received more supply from Solano Project water than was normally available under the Vallejo Agreement. This excess delivery is not expected in the future. Table 3-14 and Table 3-15 show projected Vallejo Agreement water availability in the future in normal, single dry, and five consecutive dry year conditions through 2045. Although this supply has been available in the driest years, out of an abundance of caution we are assuming 50% reliability in all dry years through 2045.

Table 3-13: Vallejo Agreement Water Use 2010-2020 (acre-feet per year)[39]

Year	Vallejo Contract	Used
2010	1,100	373
2011	1,100	1,100
2012	1,100	1,100
2013	1,100	1,100
2014	1,100	1,100
2015	1,100	2,611
2016	1,100	3,089
2017	1,100	455
2018	1,100	711
2019	1,100	289
2020	1,100	0

Table 3-14: Vallejo Agreement Water Available from 2021 through 2025 (acre-feet per year)

Year	Amount
Normal	1,100
Single Dry	550
Dry Year 1	550
Dry Year 2	550
Dry Year 3	550
Dry Year 4	550
Dry Year 5	550

Table 3-15: Vallejo Agreement Water Available from 2025 through 2045 (acre-feet per year)

Year Type		2025	2030	2035	2040	2045
Normal		1,100	1,100	1,100	1,100	1,100
Single Dry Year		550	550	550	550	550
Multi-Year Drought	Year 1	550	550	550	550	550
	Year 2	550	550	550	550	550
	Year 3	550	550	550	550	550
	Year 4	550	550	550	550	550
	Year 5	550	550	550	550	550

The potential to carryover Vallejo Agreement water is the subject of ongoing discussion between the cities and SCWA. Although the City of Benicia has not historically relied upon carryover water from Vallejo, the terms of the contract indicate that water storage is a possibility and that the Benicia may be able to use carryover supplies in dry conditions. As such, Benicia has incorporated Vallejo Agreement carryover water supplies into its future water supply planning. For purposes of this assessment, the City

[39] Reported use for various water supply sources has been updated since the City's 2015 UWMP. Updated data from SCWA Solano Project annual reports.

considers only 50% of the water to be available for carryover after a normal water year. Table 3-16 and Table 3-17 show potential Vallejo Agreement carryover water supplies from 2021 through 2025 and from 2025 through 2045, respectively.

Table 3-16: Vallejo Agreement Carryover Water Available from 2021 through 2025 (acre-feet per year)

Year	Amount
Normal	1,100
Single Dry	550
Dry Year 1	550
Dry Year 2	0
Dry Year 3	0
Dry Year 4	0
Dry Year 5	0

Table 3-17: Vallejo Agreement Carryover Water Available from 2025 through 2045 (acre-feet per year)

Year Type		2025	2030	2035	2040	2045
Normal		1,100	1,100	1,100	1,100	1,100
Single Dry Year		550	550	550	550	550
Multi-Year Drought	Year 1	550	550	550	550	550
	Year 2	0	0	0	0	0
	Year 3	0	0	0	0	0
	Year 4	0	0	0	0	0
	Year 5	0	0	0	0	0

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 automatically terminate before 2045.

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, the City and SID contract expires in 2024. For purposes of this UWMP, we assume that the contract is renewed under similar terms and conditions through 2045 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 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 Agreement 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 3-18 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 3-18: SID Agreement Water Use 2010-2020 (acre-feet per year)[40]

Year	SID	Used
2010	2,000	554
2011	2,000	70
2012	2,000	0
2013	2,000	983
2014	2,000	442
2015	2,000	0
2016	2,000	0
2017	2,000	1,064
2018	2,000	1,236
2019	2,000	1,732
2020	2,000	476

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. Table 3-19 and Table 3-20 show the availability of SID Agreement Water in normal, single dry, and five consecutive dry years from 2021 through 2025 as well as from 2025 through 2045.

Table 3-19: SID Agreement Water Available from 2021 through 2025 (acre-feet per year)

Year	Amount
Normal	2,000
Single Dry	1,000
Dry Year 1	1,000
Dry Year 2	1,000
Dry Year 3	1,000
Dry Year 4	1,000
Dry Year 5	1,000

[40] Reported use for various water supply sources has been updated since the City's 2015 UWMP. Updated data from SCWA Solano Project annual reports.

Table 3-20: SID Agreement Water Available from 2025 through 2045 (acre-feet per year)

Year Type		2025	2030	2035	2040	2045
Normal		2,000	2,000	2,000	2,000	2,000
Single Dry Year		1,000	1,000	1,000	1,000	1,000
Multi-Year Drought	Year 1	1,000	1,000	1,000	1,000	1,000
	Year 2	1,000	1,000	1,000	1,000	1,000
	Year 3	1,000	1,000	1,000	1,000	1,000
	Year 4	1,000	1,000	1,000	1,000	1,000
	Year 5	1,000	1,000	1,000	1,000	1,000

The SID Agreement water may be carried over in years where the allocation goes unused. Although the City has not historically relied upon carryover water from SID, the terms of the contract indicate that the City may be able to use carryover supplies in dry conditions. As such, the City has incorporated SID Agreement carryover water supplies into its future water supply planning. Table 3-21 and Table 3-22 show potential SID Agreement carryover from 2021 through 2025 and from 2025 through 2045.

Table 3-21: SID Agreement Carryover Water Available from 2021 through 2025 (acre-feet per year)

Year	Amount
Normal	1,000
Single Dry	1,000
Dry Year 1	1,000
Dry Year 2	0
Dry Year 3	0
Dry Year 4	0
Dry Year 5	0

Table 3-22: SID Agreement Carryover Water Available from 2025 through 2045 (acre-feet per year)

Year Type		2025	2030	2035	2040	2045
Normal		1,000	1,000	1,000	1,000	1,000
Single Dry Year		1,000	1,000	1,000	1,000	1,000
Multi-Year Drought	Year 1	1,000	1,000	1,000	1,000	1,000
	Year 2	0	0	0	0	0
	Year 3	0	0	0	0	0
	Year 4	0	0	0	0	0
	Year 5	0	0	0	0	0

The 2020 SID Agreement carryover and use is shown in Table 3-23.

Table 3-23: SID Agreement Carryover (acre-feet per year)

Year	SID Carryover	Used
2020	509	509

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. The maximum current pumping capacity of the Cordelia Pump Station is 10.5 mgd. After modifications to the pump station, the maximum capacity of the Cordelia Pump Station could be 14 mgd, due to the maximum Total Dynamic Head calculated for the 24" Cordelia Pipeline.

3.4 Sulphur Springs Creek Watershed

The City of Benicia has long relied on the water supplies derived from Sulphur Springs Creek Watershed. As early as 1880, the City had constructed diversion and storage facilities to preserve the water supplies in the watershed for the City's uses that it had been diverting for many years. And although the City outgrew the water supply in the watershed, it continually captured and used these supplies since the City's inception. As such, the City holds two water rights from Sulphur Springs Creek Watershed – a pre-1914 appropriative water right and License 4900.

3.4.1 Pre-1914 Appropriative Water Right (S028393)

The first diversions from Sulphur Springs Creek Watershed were likely diversions for irrigated pasture or other agricultural activities in the City of Benicia area, in 1849, long before the City was founded. In 1879, the City's residents initiated the first formal work on diverting and managing the water assets from Sulphur Springs Creek watershed and by 1884, the first dam was constructed in the watershed.[41] The water supply has been continually used by the City and its residents since 1879 and the City recently protected its water supply through filing a Statement of Diversion and Use with the State Water Resources Control Board. The City has a maximum of 1,500 acre-feet of water supply derived from its pre-1914 appropriative water right. The pre-1914 appropriative water right will be considered in conjunction with the City's water right license 4900 described in the following section.

3.4.2 Water Right License 4900

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.[42] The maximum withdrawal from storage under the License is 800 acre-feet per year. Lake Herman serves as the storage reservoir for water derived from this entire

[41] Historical Analysis from JRP Historical Consulting dated September 20, 2019.
[42] License 4900 and 2014 Report of Licensee

watershed and diverted under the City's pre-1914 appropriative water right and License 4900. Lake Herman has a total storage capacity of approximately 1,800 acre-feet. According to the City's Reports of Licensee filed for the period of 2010 through 2020, the City has diverted and used water derived from License 4900 and stored a portion of that water in Lake Herman. Table 3-24 below shows the water directly diverted or collected to storage as well as the amount of water used by the City from 2010 to 2020 under both its pre-14 appropriative water right and License 4900.[43]

Table 3-24: S028393 and License 4900 Water Use 2010-2020 (acre-feet per year)

Year	Lake Herman Diverted	Used
2010	620	179
2011	843	527
2012	950	217
2013	1,039	371
2014	1,048	1,884
2015	324	1,152
2016	458	918
2017	933	1,670
2018	1,743	1,670
2019	452	1,026
2020	1,235	562

The City also utilizes Lake Herman as a raw water reservoir for water supplies derived from the Sacramento River watershed and Solano Project.[44] Surplus flows from these water sources are diverted by gravity to Lake Herman through a 24-inch diameter pipeline. As a source of 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 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

[43] Diversion numbers approximated based upon most recent data.
[44] The legalities of diverting these foreign sources of water into Lake Herman are not discussed in this UWMP but should be addressed.

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. Table 3-25 and Table 3-26 show the availability of the Sulphur Springs Creek water supplies in normal, single dry, and five consecutive dry years from 2021 through 2025 and from 2025 through 2045.

Table 3-25: S028393 and License 4900 Water Available from 2021 through 2025 (acre-feet per year)

Year	Amount
Normal	1,800
Single Dry	900
Dry Year 1	900
Dry Year 2	450
Dry Year 3	300
Dry Year 4	150
Dry Year 5	150

Table 3-26: S028393 and License 4900 Water Available from 2025 through 2045 (acre-feet per year)

Year Type		2025	2030	2035	2040	2045
Normal		1,800	1,800	1,800	1,800	1,800
Single Dry Year		900	900	900	900	900
Multi-Year Drought	Year 1	900	900	900	900	900
	Year 2	450	450	450	450	450
	Year 3	300	300	300	300	300
	Year 4	150	150	150	150	150
	Year 5	150	150	150	150	150

3.5 Water Treatment Plant [45]

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

[45] City of Benicia 2015 UWMP.

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. Appendix 1 has specific water quality parameters for the City.

Raw water quality varies throughout the year, which presents challenges at the WTP. 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 WTP 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 and filters, a second backwash tank, a new wastewater recovery basin, and a 1-MG chlorine contact tank.

3.6 Other Water Sources

The City of Benicia has considered acquiring water assets from other water sources to meet reliability needs. The City continues to explore other transfer opportunities within its service area and has worked with neighboring agencies to identify and potentially use additional water supplies that meet the regional water management objectives.

3.6.1 City of Vallejo License 7848

The City has used the City of Vallejo's licensed appropriative water right number 7848 on occasion to supplement its water supply reliability objectives. License 7848 allows the City of Vallejo to divert up to 31.52 cubic feet per second from January 1 through December 31 each year. License 7848 has a priority date of February 2, 1948. The City of Benicia is within the authorized place of use of Vallejo's water right license and has received water supplies under this license in the past. Table 3-11 shows the City of Benicia's use of the City of Vallejo's water right from 2010 through 2020.

The City does not anticipate relying upon the City of Vallejo supply to meet its long-term water supply reliability objectives. Although the City may occasionally use this water supply, it does not have a contract with the City of Vallejo that would facilitate long-term planning related to this water resource. Accordingly, the City does not include the Vallejo License 7848 supply in its water asset portfolio.

Table 3-27: Vallejo License 7848 use 2010-2020 (acre-feet per year)[46]

Year	Vallejo Permit	Used
2010	0	0
2011	0	0
2012	0	0
2013	0	0
2014	0	688
2015	0	787
2016	0	0
2017	0	0
2018	0	0
2019	0	0
2020	0	0

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 will be addressing opportunities under this agreement in the upcoming years.

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

[46] Reported use for various water supply sources has been updated since the City's 2015 UWMP. Updated data from SCWA Solano Project annual reports.

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.

3.6.3 Groundwater

The City currently does not use groundwater as a potable water source and has only conceptual plans to conjunctively use groundwater in the future in coordination with neighboring agencies. 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 Water Reuse and 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.

Recently, the City has considered additional potential uses of its treated effluent. The City has identified that the wastewater could be treated and potentially blended with its raw water sources in Lake Herman. The combined actions of treating the wastewater to a higher standard and then blending the supply would expand the utility of the Lake Herman raw water system. This investigation is in its early developmental stages but could provide a long-term additional reliable water supply.

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.

3.7 Water Supply Portfolio 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. The City is in the unique position of having significant water assets that can be made available on an annual basis but constraints on those water assets that make them less reliable on a monthly basis, especially in drought conditions. The following tables represent the overall water supply availability of the City of Benicia in light of monthly demands. In other words, the supply picture identified in the tables below represent a realistic water demand pattern and a management structure for all water assets to satisfy the monthly demand. Long-term future demand assessments are characterized elsewhere in this chapter.

Table 3-28: SWP Table A Monthly Supply Availability With Management Constraints (acre-feet)

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Normal Year		487	487	487	487	487	487	487	487	487	487	487	487	5,848
Single Dry Year		0	0	0	0	143	143	143	143	143	143	0	0	860
Multi-Year Drought	2021	0	0	0	0	413	518	844	907	766	423	0	0	3,870
	2022	0	0	0	310	350	550	725	215	215	215	0	0	2,580
	2023	0	0	0	0	72	72	72	72	72	72	0	0	430
	2024	0	0	0	215	215	215	215	215	108	108	0	0	1,290
	2025	0	0	0	0	530	430	445	530	430	215	0	0	2,580

Table 3-29: SWP Table A Carryover from Previous Year (acre-feet)

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Normal Year		487	487	487	487	487	487	487	487	487	487	487	487	5,848
Single Dry Year		25	263	487	487	487	599	799	799	637	587	487	188	5,848
Multi-Year Drought	2021	0	0	0	0	0	10	0	0	0	0	0	0	10
	2022	0	0	0	266	192	192	263	802	648	531	0	0	2,894
	2023	0	0	0	601	496	719	950	947	836	675	0	0	5,224
	2024	0	0	0	410	377	577	802	802	756	639	0	0	4,363
	2025	0	0	0	0	90	289	215	169	315	401	0	0	1,479

Table 3-30: DWR Settlement Contract Water Management Summary (acre-feet)

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Normal Year		1,313	1,313	1,313	1,313	1,313	0	0	0	0	1,313	1,313	1,313	10,500
Single Dry Year		1,750	1,750	1,750	1,750	0	0	0	0	0	0	1,750	1,750	10,500
Multi-Year Drought	2021	1,750	1,750	1,750	1,750	0	0	0	0	0	0	1,750	1,750	10,500
	2022	2,100	2,100	2,100	0	0	0	0	0	0	0	2,100	2,100	10,500
	2023	2,100	2,100	2,100	0	0	0	0	0	0	0	2,100	2,100	10,500
	2024	2,100	2,100	2,100	0	0	0	0	0	0	0	2,100	2,100	10,500
	2025	1,750	1,750	1,750	1,750	0	0	0	0	0	0	1,750	1,750	10,500

Table 3-31: City of Vallejo Agreement Water Management Summary (acre-feet)

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Normal Year		92	92	92	92	92	92	92	92	92	92	92	92	1,100
Single Dry Year		46	46	46	46	46	46	46	46	46	46	46	46	550
Multi-Year Drought	2021	0	0	0	0	92	72	0	72	92	223	0	0	550
	2022	0	0	0	92	92	72	0	72	46	177	0	0	550
	2023	0	0	0	92	92	72	0	72	46	177	0	0	550
	2024	0	0	0	92	92	72	0	72	46	177	0	0	550
	2025	0	0	0	0	92	72	0	72	92	223	0	0	550

Table 3-32: City of Vallejo Agreement Carryover Management Summary (acre-feet)

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Normal Year		46	46	46	46	46	46	46	46	46	46	46	46	550
Single Dry Year		46	46	46	46	46	46	46	46	46	46	46	46	550
Multi-Year Drought	2021	0	0	0	0	46	46	46	46	46	46	0	0	275
	2022	0	0	0	0	0	0	0	0	0	0	0	0	0
	2023	0	0	0	0	0	0	0	0	0	0	0	0	0
	2024	0	0	0	0	0	0	0	0	0	0	0	0	0
	2025	0	0	0	0	0	0	112	92	72	0	0	0	276

Table 3-33: SID Contract Supply Management Summary (acre-feet)

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Normal Year		167	167	167	167	167	167	167	167	167	167	167	167	2,000
Single Dry Year		83	83	83	83	83	83	83	83	83	83	83	83	1,000
Multi-Year Drought	2021	0	0	0	0	250	260	166	83	83	157	0	0	1,000
	2022	0	0	0	83	167	167	167	167	167	83	0	0	1,000
	2023	0	0	0	83	167	167	167	167	167	83	0	0	1,000
	2024	0	0	0	83	167	167	167	167	167	83	0	0	1,000
	2025	0	0	0	0	167	167	167	167	167	167	0	0	1,000

Table 3-34: SID Contract Carryover Water Management Summary (acre-feet)

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Normal Year		83	83	83	83	83	83	83	83	83	83	83	83	1,000
Single Dry Year		83	83	83	83	83	83	83	83	83	83	83	83	1,000
Multi-Year Drought	2021	0	0	0	0	83	83	83	83	83	83	0	0	500
	2022	0	0	0	0	0	0	30	0	0	0	0	0	30
	2023	0	0	0	0	0	0	0	0	0	0	0	0	0
	2024	0	0	0	0	0	0	0	0	0	0	0	0	0
	2025	0	0	0	0	0	73	260	137	0	0	0	0	470

Table 3-35: Lake Herman Water Management Summary (acre-feet)

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Normal Year		150	150	150	150	150	150	150	150	150	150	150	150	1,800
Single Dry Year		75	75	75	75	75	75	75	75	75	75	75	75	900
Multi-Year Drought	2021	75	75	75	75	75	75	75	75	75	75	75	75	900
	2022	75	75	75	75	75	75	0	0	0	0	0	0	450
	2023	50	50	50	50	50	50	0	0	0	0	0	0	300
	2024	25	25	25	25	25	25	0	0	0	0	0	0	150
	2025	0	0	0	0	25	25	0	100	0	0	0	0	150

Table 3-36: Total City of Benicia Supply Summary (acre-feet)

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Normal Year		2,825	2,825	2,825	2,825	2,825	1,512	1,512	1,512	1,512	2,825	2,825	2,825	28,645
Single Dry Year		2,109	2,347	2,571	2,571	964	1,076	1,276	1,276	1,114	1,064	2,571	2,271	21,208
Multi-Year Drought	2021	1,825	1,825	1,825	1,825	958	1,063	1,214	1,266	1,145	1,008	1,825	1,825	17,605
	2022	2,175	2,175	2,175	825	875	1,055	1,185	1,255	1,075	1,007	2,100	2,100	18,003
	2023	2,150	2,150	2,150	826	876	1,079	1,188	1,257	1,120	1,007	2,100	2,100	18,004
	2024	2,125	2,125	2,125	825	875	1,055	1,184	1,255	1,076	1,007	2,100	2,100	17,853
	2025	1,750	1,750	1,750	1,750	903	1,055	1,199	1,266	1,076	1,006	1,750	1,750	17,006

Chapter 4
Water Use

Understanding water use characteristics is essential to enable the City to reliably and cost-effectively manage its water supplies to continue to meet customer needs. This chapter characterizes the City's retail customer water needs – current and forecast over the next few decades. Characteristics such as how water uses vary among different land use classifications, throughout the year, and under differing hydrologic conditions, all help with that understanding.

A thorough characterization and analysis provides a realistic prediction of future water use based upon the City's past and current water use, in addition to considerations of anticipated growth, new regulations, changing climate conditions and trends in customer water use behaviors. A thorough analysis examines each water use sector for a variety of factors, then aggregates the information into a comprehensive projection of customer water use that becomes the foundation for integration with the City's water supplies (see Chapter 3) to assess long-term water system reliability (see Chapter 5).

Several legislative changes were enacted since the City completed its 2015 UWMP. The new requirements must be addressed in the City's 2020 UWMP in addition to completing requirements from the prior statutory language. While there have been many changes, the critically important items the City must address are highlighted below:

- Provide quantified distribution system losses for each of the 5 preceding years. [CWC 10631(d)(3)(A) and (C)]
- Include a drought risk assessment (DRA) for a drought period that lasts five consecutive water years, starting from the year following the assessment, which would be 2021 for this round of UWMPs. The DRA requires a comparison of water supplies with total projected water use. Therefore, the City must produce a projected water use for the years 2021 through 2025 as part of the water use projections up to 2045. [CWC 10635(b)]
- Conduct an annual water supply and demand assessment on or before July 1 of each year (following adoption of its 2020 UWMP) where the annual assessment includes current year unconstrained demand. The City will consider "unconstrained demand" as the expected water use in the upcoming year, based on recent water use, before any projected response actions it may trigger under its Water Shortage Contingency Plan (see Chapter 6). [CWC 10632.1]

This section is organized as follows:

- Current Customer Water Use – This subsection presents data reflecting the City's residential and non-residential customers for 2016 through 2019 as well as the actual 2020 water use and presents the City's distribution system losses for this same period.

- Compliance with 2020 Urban Water Use Target – This subsection documents the derivation of the 2020 GPCD value and comparison to the 2020 GPCD target.
- Demand Management Measures – This subsection provides a narrative description of each water demand management measure implemented by the City over the past five years, and describes the City's planned measures for the foreseeable future.
- Forecasting Customer Use – This subsection presents the derivation and results of future water use forecasts for potable and non-potable water within the City's service area, including land-use classifications, unit demand factors, and estimation of distribution system losses. This subsection also estimates the variations in customer water use the City should expect during years with low rainfall as well as discusses longer-term climate change considerations.
- Forecasting Water Use for DRA and Annual Assessment – This subsection focuses on the subset of the customer water use forecast that is necessary for completing the 5-year Drought Risk Assessment (DRA) and defining the "unconstrained demand" for purposes of the City's annual water supply and demand assessment.
- Projecting Disadvantaged Community Water Use – This subsection presents the estimated water use necessary to meet lower income households, pursuant to California Water Code 10631.1.

4.1 Current Customer Water Use

As described in Chapter 2, the City has been serving potable water to about 9,800 customer connections for the past several years. Under normal operations, all of the water supplied to its customers is drawn from the City's multiple sources (see Chapter 3), treated at the City's water treatment plant, and delivered through an array of pipelines and turnouts (see Figure 2-8). The current customers, their recent and expected water use trends, and the City's on-going demand management efforts targeting these customers provide a foundational basis for this UWMP's water use forecast to 2045.

Furthermore, the actual water use in 2020 is the basis for determining the City's compliance with its 2020 gallons per capita per day (GPCD) target established in its 2015 UWMP. This subsection presents this relevant information.

4.1.1 Customer Water Use: 2016 to 2019

Recent customer water use can help the City understand water use trends, effects of temporary use restrictions imposed during the most recent prolonged drought and recovery from such temporary restrictions, effects of long-term demand management measures, and other pertinent water use factors relevant to its forecast of future water use. Water Code Section 10631(d)(1) also requires the City to quantify past customer water use.

Table 4-1 presents the City's past customer potable water use by customer classification for 2016 through 2019. The City records potable water use within five primary categories:

- Single-family residential
- Multi-family residential
- Commercial and Institutional

- Industrial
- Landscape Irrigation

The City also records a small quantity of water under "other" which captures a range of small, non-standard uses such as hydrant flushing and street sweeping. Additionally, the City supplies non-potable supplies to the Valero refinery, where the refinery provides its own necessary treatment for industrial purposes. Table 4-2 provides the historic monthly deliveries of non-potable water.

Table 4-1: Potable Customer Use: 2016 to 2019 (values in acre-feet)

	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Single-Family Residential	2016	112	103	94	111	129	187	206	203	213	219	146	113	1,836
	2017	114	105	101	108	118	198	238	248	247	266	184	148	2,078
	2018	128	126	119	123	124	179	225	259	238	233	189	173	2,114
	2019	121	107	101	94	139	191	181	257	261	199	194	174	2,018
Multi-Family Residential	2016	47	12	37	12	56	13	62	12	64	13	44	11	383
	2017	42	12	41	12	41	12	63	13	74	16	63	14	401
	2018	59	14	56	12	49	12	67	14	69	14	61	13	440
	2019	47	12	44	11	54	13	60	14	73	12	67	73	479
Commercial Institutional	2016	22	20	21	37	26	35	35	30	35	34	25	19	337
	2017	21	21	22	29	22	24	33	31	29	36	28	31	327
	2018	24	31	24	26	22	27	30	37	30	34	27	32	345
	2019	23	24	22	23	25	27	27	39	32	38	29	32	340
Industrial	2016	0	16	0	16	0	16	0	15	0	18	0	14	95
	2017	0	13	0	14	0	17	0	15	0	19	0	14	93
	2018	0	14	0	16	0	16	0	20	0	19	0	18	104
	2019	0	14	0	13	0	17	0	17	0	16	0	0	78
Landscape Irrigation	2016	3	5	2	7	15	51	44	81	54	81	23	16	383
	2017	2	9	5	7	9	56	57	109	66	112	41	39	513
	2018	6	11	7	12	12	52	55	120	63	98	39	48	523
	2019	7	6	2	5	18	62	44	115	62	95	44	62	524
Other	2016	0	0	0	1	0	1	0	2	1	2	0	2	8
	2017	0	2	0	1	0	1	0	2	0	2	0	2	10
	2018	1	2	0	2	0	4	1	6	2	2	3	2	24
	2019	0	5	3	2	0	4	0	2	0	4	0	0	20
Total Metered Deliveries	2016	184	156	155	184	226	303	347	342	367	367	237	173	3,041
	2017	180	162	169	171	190	309	391	418	417	451	315	249	3,422
	2018	218	197	206	192	208	289	377	456	401	401	319	286	3,551
	2019	199	168	173	147	236	314	312	444	427	364	335	340	3,460

These historic data also provide insight into the relative ratio of differing customer classifications to each other as well as seasonal variations. For instance, commercial demands remain fairly constant month to month and generally year to year. In contrast, landscape irrigation is significantly higher in the summer months compared to the winter, when generally rainfall is sufficient to meet the water needs of large landscapes (e.g., parks and play fields). The monthly variance seen in the multi-family class results from bi-monthly meter readings.

Table 4-2: Valero Non-Potable Use: 2016 to 2020 (values in acre-feet)[47]

	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Valero Raw-Water Use	2016	396	317	367	459	453	431	455	436	452	436	405	402	5,010
	2017	316	78	374	380	401	442	454	476	474	493	442	443	4,774
	2018	419	393	446	428	461	410	514	459	448	461	419	426	5,284
	2019	433	361	449	210	423	478	502	512	501	487	429	427	5,211
	2020	424	369	386	372	396	439	460	485	472	510	442	446	5,203

The single-family residential classification illustrates two important characteristics of the City's water service: (1) it represents about 60% of the City's annual potable water demand, and (2) it has summer demands that are two times the monthly volume needed in winter months. Combined with the multi-family residential use, overall residential use represents over 70% of the City's potable water service.

However, when viewed in relation to the non-potable deliveries to Valero, the entire potable customer use represents less than 50% of the annual demand upon the City's water supplies. And during winter months, the non-potable water need is twice the potable need, while during summer the needs are nearly equivalent.

The potable use seasonal variations along with the non-potable dominance as the highest water using classification provide the City with additional insight necessary for assessing the seasonal reliability of its water supplies and developing and quantifying successful water management approaches and water shortage contingency response actions.

4.1.2 Customer Use in 2020

Customers served by the City are metered at their connection to the City's potable water distribution system. These metered values are collected periodically for each customer account and summarized into the City's annual reporting to the SWRCB Division of Drinking Water and to DWR.[48] The 2020 actual customer use presented in Table 4-3 represents the summarized delivery to all the City's potable customers. It does not, however, include the distribution system losses inherent in a pressurized water

[47] Valero monthly delivery data was provided through 2020 in this table. Potable use in 2020 is presented in a separate table as it is used to determine compliance with the City's 2020 GPCD target.

[48] The annual SWRCB report is referred to as the 'electronic Annual Report' or eAR, and the annual DWR report is known as the Public Water System Statistics report.

delivery system that occur during the City's efforts to treat, store and route the water throughout the extensive distribution system to each customer's connection.

Further, comparing to the total values in Table 4-1, the 2020 annual customer use is about 10% higher than the 2017 through 2019 average use, which was fairly consistent. Comparing the specific customer classifications, the 2020 data displays two unique circumstances: (1) other than the commercial category, nearly all other categories saw an increase of about 10% from recent conditions, and (2) single-family use in April and May was about 30% higher than during prior years.

The higher-than-average use is likely due to the pandemic that dominated 2020 and the multiple advisories and even government-imposed restrictions that resulted in many people working from, learning from, or simply staying at home.

Table 4-3: Potable Customer Water Use: 2020 Actual Use (values in acre-feet)

Use Category	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Single-family Residential	141	117	127	140	168	227	240	282	245	236	205	175	2,302
Multi-family Residential	55	13	48	14	61	14	73	15	78	14	70	14	468
Commercial/Institutional	27	27	25	27	18	30	25	39	26	35	30	36	345
Industrial	0	16	0	16	0	16	0	19	0	19	0	17	102
Landscape Irrigation	13	7	15	38	17	74	49	113	59	91	42	48	565
Other	0	5	3	2	0	2	0	3	0	1	0	1	18
Total	236	186	218	235	264	362	388	471	407	396	347	290	3,800

4.1.3 Existing Distribution System Losses

Distribution system water losses (also known as "real losses") are the physical water losses from the City's water distribution system up to the point of delivery to the customer's system (e.g., up to the residential water meter).

Since 2016, the City has been required to quantify its distribution system losses using the American Water Works Association Method (Title 23 California Code of Regulations Section 638.1 et seq.). An electronic copy of the audit in Excel format is to be submitted to the DWR by October 1 of each year for the prior year's estimated system losses, using DWR's online submittal tool pursuant to Code of Regulations Section 638.5. The City's submittals for the last 5 years are shown in Table 4-4. The 2020 estimate has not been officially submitted to DWR as of the drafting of this UWMP but is estimated to be approximately 380 acre-feet over the year, or about 9.1% of the water entering the City's distribution system. The City addressed a metering discrepancy such that the 2019 submitted value and the 2020 to-be-submitted value are presumed more representative of actual distributions system losses.

Table 4-4: Distribution System Loss: 2016 through 2020

2016	2017	2018	2019	2020
17.4%	26.1%	3.7%	10.6%	9.1%
			Average 2019/2020 =	9.8%

As can be anticipated given the dynamic functions of a pressurized potable water distribution system, the estimated annual distribution system loss as a percentage of water entering the system will vary year-to-year and month to month. On average, however, the City's distribution system loss represents about 10% of the water entering the City's distribution system. This average is used for purposes of forecasting water use to 2045.

4.2 Compliance with 2020 Urban Water Use Target

Pursuant to California Water Code Section 10608.24(b),[49] the City must demonstrate its 2020 water use met the GPCD target adopted in its 2015 UWMP. As set forth in the 2015 UWMP, the City's 2020 GPCD target was established as 180 GPCD, derived as the "gross water use" divided by the population during a defined baseline period, and reduced pursuant to one of four methods defined under California Water Code Section 10608.20(b). The City's 2020 actual GPCD must use the same methodology to derive "gross water use" for 2020, then divide by the estimated 2020 population presented in Chapter 2.

As presented in the City's 2015 UWMP, gross water was determined to be the total water leaving the City's water treatment plant. This value corresponds to the total "Potable Water" for 2020 as recorded by the City on it 2020 Water Systems Statistics Report, which was 1,362.008 million gallons – or 4,180 acre-feet. This value represents both the customer deliveries shown in Table 4-2 and the distribution system losses recorded in Table 4-4. As shown in Table 2-4, the City's population in 2020 was estimated to be 27,570. This results in a calculated 2020 compliance value of 135 GPCD, which is less than the City's established target. Thus, the City is in compliance with CWC Section 10608.24(b). The important compliance calculation parameters are summarized in Table 4-5.

Table 4-5: Demonstration of Compliance with 2020 GPCD Target

2020 Volume into Distribution System =	4,180	acre-feet
Allowable Adjustments	0	acre-feet
2020 Gross Water Use =	4,180	acre-feet
2020 Population =	27,570	people
2020 Actual GPCD =	135	
2020 Target GPCD =	180	
Compliance Achieved?	Yes	

4.3 Demand Management Measures

Pursuant to California Water Code Section 10631(e), the City needs to provide a narrative discussion of the water demand management measures it has implemented, is currently implementing, and plans to implement. The historic and on-going measures can help the City understand the effectiveness on

[49] 10608.24. (b) Each urban retail water supplier shall meet its urban water use target by December 31, 2020.

managing existing customer uses so as to help guide refinements, emphasis or augmentation that will help position the City to best meet its undefined, to-be-established water use objective.[50]

To date, the City's overall water management efforts have resulted in significant and long-term water conservation savings. During the 2013 to 2015 drought, the City's residents showed tremendous ability to temporarily reduce water usage and many of the efforts have had long-term viability, providing on-going savings well into the future. The City is also a member of the California Urban Water Conservation Council (CUWCC) successor organization, California Water Efficiency Partnership (CalWEP).

The City's demand management measures are highlighted in this subsection.

4.3.1 Foundational Demand Management Measures

This subsection describes the foundational demand management measures (DMMs) that underpin the City's operations and customer deliveries. These particular DMMs represent adopted ordinances, policies, and long-standing budgeted conservation programs.

Water Waste Prevention Ordinances

Wasteful water is prohibited in the City's service area as recognized in Chapter 13.35 of its municipal code. These fundamental prohibitions align with state-mandated requirements.

Metering

All water service connections in the City's service area are metered. The City implemented a smart meter program to replace existing meters, including new ultrasonic water meters to provide customers with immediate access to real time water usage, including leak alerts.[51]

Conservation Pricing

The City's water rate structure is set to generate the necessary funds to efficiently operate the City's water system and maintain reliable water supplies. The City uses a single-tier pricing structure for monthly volumes, in addition to a fixed-fee portion. The fee structure, coupled with the new smart meter program will continue to help customers manage their water use in an efficient manner. Under normal water supply conditions, this rate structure has effectively reduced customer water use.

Public Education and Outreach

The City regularly engages its customer base with a number of conservation and demand management outreach programs. Promoting water-wise activities, watering schedules, and educational programs are part of the City's regular outreach efforts, which include a conservation web page providing resources to

[50] Beginning in 2023, all urban water suppliers will be required to begin reporting their use compared to a "Water Use Objective" that is being established pursuant to the recently enacted California Water Code Section 10609.20.
[51] For instance, this web page provides an example of each customer's unique information available through the WaterInsight program: http://beniciasaveswater.org/

the community for conserving water. The City is also an active participant with Solano County Water Agency to offer residential and commercial rebate programs, such as for turf replacement.[52]

Programs to Assess and Manage Distribution System Real Loss

The City's water loss assessment and management program includes annual water audits and an ongoing leak detection and repair. This includes an ongoing meter calibration and replacement program for all production and distribution meters. The City's activities include:

- Annual water audit and water balance
- Proactive leak identification and repair in the City's distribution system
- Customer leak identification and repair assistance: A consulting water auditor assists customers in locating leaks both inside and outside the home or business.

Water Conservation Program Coordination and Staffing Support

The City funds one full time equivalent (FTE) staff to run the City's water conservation programs with an annual budget of $80,000. The conservation budget is used to fund various rebate and conservation and education programs. The City works with customers, neighboring water suppliers and Solano County Water Agency to promote conservation through public education, water audits, landscape studies to affect water conservation, and monitoring conservation efforts.

4.3.2 Recent DMM Activities

The City has continued to aggressively promote and implement water conservation actions with great success. Since prior to the 2013 to 2016 drought, the City reached remarkable on-going conservation levels through the attentive actions of its citizens. Highlights of the City's recent actions and conservation measures include:

- Operating a booth at the weekly farmer's market providing giveaways and promoting water conservation
- Providing flyers and brochures, updated throughout the year
- Respond to over 5,000 service calls per year and fixing over 100 leaks in the distribution system saving more than 3 million gallons
- Offering rebate programs for turf and appliances, which in 2020 resulted in:
  - 17 high-efficiency washer rebates
  - 25 CII high-efficiency toilet rebates (residential program discontinued in 2016)
  - 9 water efficient landscape rebates

4.3.3 Planned DMM Activities

In addition to ongoing water conservation commitments, the City will continue to evaluate the need for additional programs and actions necessary to achieve water use objectives in compliance with California

[52] https://www.scwa2.com/water-efficiency/rebates-programs/

Water Code Section 10609.20. Resources will be dedicated in the City's budget for demand management activities which will help comply with these future water use objectives. Special consideration will be taken regarding changing urban water use patterns in the service area as well as the configuration of anticipated new residential customers to assure use remains efficient.

4.4 Forecasting Customer Use

Forecasting future water demands begins with an understanding existing customer demands and trends, recognizing the additional customers expected through growth, and considering the factors that will influence the water use of both existing and new customer well into the future – especially factors that directly affect the efficiency of water use.

Pursuant to California Water Code 10610.4(c), an urban water supplier "*shall be required to develop water management plans to actively pursue the efficient use of available supplies*." One challenge from this directive is reflecting how the pursuit of efficient use is best represented in the forecast water uses that are the cornerstone of good planning. As required by the Act, the future water uses of both existing customers and those added over the 25-year planning horizon should reflect the "efficient use" of water.

4.4.1 Representing Current Customer Water Use

Table 4-1, Table 4-2, and Table 4-3 provided the actual monthly customer water use for 2016 through 2020 for both potable and non-potable customers. From this information, an estimate of the representative "current" water use by existing customers has been developed. Knowing that actual use by existing customers varies slightly year-to-year based on a variety of factors (e.g., total rainfall and the timing of spring rain events impacting when landscape irrigation may begin), the recent data provides a basis for estimating current water use. The City also has a desire to conservatively assure long-term water system reliability (see Chapter 5), thus the actual higher demand from 2020 is also a useful proxy.

For this UWMP, an approximation of the City's actual 2020 potable water use was used to represent current conditions, while the non-potable use was set to match the maximum contract demand of 5,800 acre-feet – using an average monthly delivery pattern from the past 5 years. The result is a proxy for "current" water use for each customer classification, which allows a baseline from which to estimate the future use of these existing customers.

This target total 'current water demand' was then estimated using customer-type demand factors and 2020 connection by classification (see Table 2-1) to generate a comparable estimate. This representative water use for current conditions provides the foundation for estimating the future needs of these existing customers. Table 4-6 provides the representative monthly and annual current water use, including distribution system losses.

Table 4-6: Representative Current Water Use (acre-feet)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Potable Use	243	212	219	216	268	378	443	516	501	492	375	326	4,187
Non-Potable Use	452	346	460	421	486	501	543	539	534	543	487	488	5,800

4.4.2 Factors Affecting Future Customer Use

There are several factors that affect the forecast of future customer use, ranging from State and local landscape regulations, building code requirements, and other water-use mandates, to changes in the types of housing products being offered. These factors are incorporated into determining appropriate per-dwelling unit or per customer connection water demand values for use in forecasting future water needs. Relevant characteristics of the factors are described here.

Water Conservation Objectives

In 2009, Governor Arnold Schwarzenegger signed Senate Bill No. 7 (SBX7-7), which established a statewide goal of achieving a 20 percent reduction in urban per capita water use by 2020 for urban retail water suppliers.[53] As presented previously, the City met this mandated target.

Furthermore, the efforts undertaken by the City and its customers to meet these targets, as well as efforts throughout the State by other urban retail suppliers, have changed the availability and use of appliances, fixtures, landscapes and other water using features, through changes or additions to ordinances and/or through a continuing "conservation ethic."

In response to the recent multi-year drought conditions, Governor Brown issued Executive Order B-37-16 in May 2016 entitled "*Making Water Conservation a California Way of Life*." In May 2018, Governor Brown signed into law SB 606 and AB 1668, which imposed additional statutory requirements above and beyond the 20 percent by 2020 target reflected in the 2009 legislation. This is expected to result in continued efforts to increase water use efficiency and ultimately to reduce water demands of existing water users and continue to influence the expected demands of future water users.

Requirements in California Building Code

Beginning in January 2010, the California Building Standards Commission adopted the statewide mandatory Green Building Standards Code (hereafter the "CAL Green Code") requiring the installation of water-efficient indoor and outdoor infrastructure for all new projects after January 1, 2011. The CAL Green Code was incorporated as Part 11 into Title 24 of the California Code of Regulations, and was revised in 2013 and in 2016 to address changes to the State's Model Water Efficient Landscape

[53] California Water Code § 10608.20.

Ordinance ("MWELO") adopted during the drought.[54] Revisions to the CAL Green Code in 2019 modified sections to direct users to MWELO regulations contained in other regulatory sections.[55]

The CAL Green Code applies to the planning, design, operation, construction, use and occupancy of every newly constructed or remodeled building or structure. All new residential and non-residential customers must meet the water use requirements of the CAL Green Code as well as the outdoor requirements described by MWELO. The CAL Green Code's requirements generally manifest through: (1) installation of plumbing fixtures and fittings that meet the 20 percent reduced flow rate specified in the CAL Green Code, or (2) by demonstrating a 20 percent reduction in water use from the building "water use baseline."[56] Future customers are expected to satisfy one of these two requirements 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.

California Model Water Efficient Landscape Ordinance and County Ordinance

The Water Conservation in Landscaping Act was enacted in 2006, and has since been revised and expanded multiple times by DWR resulting in today's MWELO.[57] In response to Governor Brown's executive order dated April 1, 2015, (EO B-29-15), DWR updated the MWELO and the California Water Commission approved the adoption and incorporation of the updated State standards for MWELO on July 15, 2015. MWELO requires a retail water supplier or a county to adopt the provisions of the MWELO or to enact its own provisions equal to or more restrictive than the MWELO provisions.[58]

The changes included a reduction to 55 percent of reference evapotranspiration rates for the maximum amount of water that may be applied to residential landscapes, and non-residential projects to 45 percent, which effectively reduces the landscape area that can be planted with high water use plants, such a turf. For residential projects, the allowable maximum coverage of high-water use plants is reduced to 25% of the landscaped area (down from 33%). The newly updated MWELO also now applies to new construction with a landscape area greater than 500 square feet (the prior MWELO only applied

[54] The 2016 Triennial Code Adoption Cycle consisted primarily of the MWELO updates adopted in response to the drought. Indoor infrastructure changes were limited to some minor non-residential fixture changes and changes to the voluntary Tier 1 and Tier 2 requirements. Additionally, the Code was updated to match the new Title 20 Appliance Efficiency Regulations.

[55] The 2019 updated sections to direct CAL Green code users to Title 23 of the California Code of Regulations to allow Title 23 to be the sole location of MWELO requirements.

[56] See CAL Green Code. For Residential construction, Section 4.303.1 provides the residential water conservation standard and Table 4.303.2 identifies the infrastructure requirements to meet this standard. Table 4.303.1 and Worksheets WS-1 and WS-2 are to be used in calculating the baseline and the reduced water use if Option 2 is selected. For non-residential construction, Section 5.303.2.3 provides the water conservation standard as well as the baseline and reduced flow rate infrastructure standards. Note that Worksheets WS-1 and WS-2 incorporate both residential and non-residential fixtures, yet the water use is still to be analyzed by "building or structure" as specified in Chapter 1, Section 101.3.

[57] Gov. Code §§ 65591-65599

[58] The City has incorporated the State's MWELO requirements and includes a Water Efficiency Application Form that must be submitted with any new project brought before the City's Planning Department.

to landscapes greater than 2,500 square feet).[59] The City reviews all new development for conformance with these standards.

Metering, Volumetric Pricing, and Water Budgets

California Water Code section 525 requires water purveyors to install meters on all new service connections after January 1, 1992. California Water Code Section 527 requires water purveyors to charge for water based upon the actual volume of water delivered if a meter has been installed. This action alone is not expected to substantially reduce water use. However, it is anticipated that the retail billing system will encourage and help maintain reasonable use (e.g., through implementation of a tiered rate structure and/or water budgets), so that individual customer water demands are reasonably not expected to increase over time.

4.4.3 Customer Water Use Forecast

The following subsections detail the assumptions used to forecast customer water use and gross water needs for the City's water service area, separated into the needs of (a) existing potable water use customers, (b) new potable water use customers, and (c) non-potable uses for Valero.

Existing Customer Future Use - Potable

To be conservative and assure the analysis of water system reliability is adequate (see Chapter 5), the City is maintaining the annual "current" customer demand as shown in Table 4-6, a total annual customer demand of about 3,800 acre-feet, with a production need of just under 4,200 acre-feet when considering system losses.

While these existing customers may undertake a variety of conservation measures – actively through decisions to modify a behavior or a water use, or passively through the purchase of appliances and fixtures that simply use less water – they may also maintain their use as-is. Holding the current use as a constant for all existing customers into the future will provide a conservative number that can be re-evaluated prior to the 2025 UWMP and the compliance with forthcoming water use objectives.[60]

New Customer Future Use - Potable

As detailed in Chapter 2, the City anticipates continued growth with an associated increased demand placed upon the City's water supplies. Forecasting the needs of these future customers is dependent upon the type and number of customers and the unit water demand factors associated with each customer type.

For this UWMP, two distinct customer classifications are anticipated: (1) residential, and (2) non-residential. Residential customers will include both single-family dwelling units built under a variety of

[59] CCR Title 23, Div. 2, Ch. 27, Sec. 490.1.

[60] Per California Water Code Section 10609.20, urban water suppliers shall calculate a water use objective composed of, among other factors, aggregated efficient indoor water use based upon standards of no more than 55 gpcd.

densities and multi-family residential dwelling units. Non-residential uses are expected to include a blend of commercial, institutional, industrial and active landscapes, such as parks, in ratios similar to the City's current residential-to-non-residential customers.

Values developed for each distinct land use are based on several sources of information, details of which are provided in the following subsections.

New Residential Customer Water Use

Table 2-7 summarized the City's anticipated new residential growth over the UWMP planning horizon. This growth provides the basis for the estimated future customer water needs, as the non-residential customers will be a ratio of the new residential customers. Table 4-7 presents the relevant residential growth information from Table 2-5.

Table 4-7: Anticipated New Residential Units (from Table 2-5)

	Residential Units	
	Single-family	Multi-family
Northern development area	525	75
City infill and vacant lands in City Limits	90	740

The City anticipates these new residential elements will be built in accordance with all applicable building codes including the Cal Green Code discussed previously, and relevant City ordinances.

Distinct demand factors are provided for the following residential uses:

- Indoor Residential Use – this category identifies the generally anticipated water use for single-family and multi-family dwelling units.
- Outdoor Residential Use – this category addresses the landscape water demands commonly anticipated for the two primary dwelling unit types.

For purposes of this UWMP, residential unit water demand factors are described as "the acre-feet of water use annually per dwelling unit" – or acre-feet/dwelling unit ("af/du").

Residential indoor water demands are estimated using an assumed value of 50 gallons-per person per day, multiplied by the assumed occupancy rates for anticipated residential densities for single-family or multi-family classifications in the City. The assumed per-person rate of 50 gallons per day is derived from California Water Code Section 10609.4(a)(3), which states a value of 55 gallons per capita (i.e., per person) per day ("gpcd") be used for estimating indoor residential use targets, though the value is stated to drop to 50 gpcd by 2030.[61]

[61] Water Code Section 10609.4(a) also establishes the indoor residential water use 'standard' to be 52.5 gpcd beginning in 2025 and as low as 50 gpcd by 2030, though the Water Code also provides provisions for the water use target to revert above 50 gpcd. For purposes of this UWMP, the higher value of 55 gpcd is assumed.

Based on this per-capita assumption, the following indoor per-dwelling unit value is assumed for each new residential unit:

- Single-family residential indoor use: 0.15 acre-feet per year based upon an assumed occupancy of 2.68 people per unit (see Chapter 2.2.1).
- Multi-family residential indoor use: 0.12 acre-feet per year based upon an assumed occupancy of 2.08 people per unit (see Chapter 2.2.1)

Outdoor residential water use is primarily a factor of lot size and the type and extent of landscaped area and is governed by MWELO. The City's anticipated growth will likely include a range of residential densities (e.g., houses per acre) that will mimic the range of existing housing densities.

As described in Chapter 2, the climate that affects landscape use is unique in Benicia. Limited reference evapotranspiration data is available to use within the MWELO calculation, therefore, the estimated outdoor demand factor for existing single-family residential customers is used as a planning proxy for the new planned single-family units. Based upon analysis of the monthly data presented in Table 4-1 for single-family customers, an indoor demand factor of 0.10 acre-feet per unit per year was estimated.[62]

Multi-family units were assumed at 50% of the single-family outdoor rate – or 0.05 acre-feet per unit.

The resulting forecast water use for existing and new residential customers is provided in Table 4-8.

New Non-Residential Customer Water Use

Also as described in Chapter 2, the City anticipates several acres of non-residential uses to be developed in the future. Non-residential per-connection demand factors were also estimated for purposes of forecasting the water needs of these anticipated commercial, institutional, industrial and irrigated landscape customers.

For purposes of this 2020 UWMP, demand factors were developed for two categories of non-residential use: Commercial, institutional, and industrial (CII), and Irrigated Landscape.

- CII Connections – this customer classification includes a wide array of different uses from neighborhood retail centers, to large retail centers, to office and government buildings, to light and even heavy industrial uses. To reflect this variety, each acre of new CII use is assumed to use of 1 acre-foot per gross acre is assumed. The City's current CII customers have average annual use per connection by classification of Commercial, City, and Industrial ranging from 0.5 acre-feet to 1.25 acre-feet.[63]

[62] By evaluating winter-time use, which is a reasonably proxy of indoor demand per month, and removing 12-months of that use from the total provides a reasonably estimate of the average outdoor demand factor.
[63] The analysis of connections, as shown in Chapter 2, and existing use, as shown in Table 4-1, provides this range of use by connection. The size associated with each connection is unknown. Generally, commercial facilities occupy less than an acre, so several connections may be present on a single acre, while industrial uses may occupy several acres.

- Irrigated Landscape – this classification includes passive and active parks, streetscapes, and other dedicated landscape areas. Each landscape connection is assumed to have an average annual water need of 1.83 acre-feet per acre. This is based upon the City's existing use for landscape connections.

The resulting forecast future use of existing and new non-residential customers is provided in Table 4-8.

Future Non-Potable Use

As detailed in Chapter 3, the City has a contract to serve raw water to Valero. As shown in Table 4-2, recent Valero water use has averaged around 5,200 acre-feet annually. However, since the contract allows for a maximum quantity of 5,800 acre-feet, the City is presuming the full quantity as part of future demands upon its water resources. This helps evaluate potential reliability circumstances the City may realize, as detailed in Chapter 5.

4.4.4 Summary of Forecast Water Use

Based upon the estimated water use of the existing and new customers, the City anticipates a minor increase in potable water use over the planning horizon while also reflecting the full contract quantity for non-potable uses. Table 4-8 presents the resulting customer water use forecast. Although the forecast is presented on an annual basis in 5-year increments through 2045, the monthly pattern is expected to mimic the current monthly pattern detailed in prior tables. This characterization is important when evaluating the City's water service reliability as detailed in Chapter 5.

Table 4-8: Forecast Future Water Use (values in acre-feet per year)

Classification		2025	2030	2035	2040	2045
Existing	Single-family Residential	2,296	2,296	2,293	2,293	2,293
	Multi-family Residential	470	470	470	470	470
	Commercial	346	346	346	346	346
	Industrial	102	102	102	102	102
	Landscape and Other	594	594	594	594	594
New	Single-family Residential	5	9	40	71	154
	Multi-family Residential	0	31	64	98	136
	CII	0	10	50	81	172
	Landscape	0	0	3	6	14
Potable Customer Water Use Subtotal		3,812	3,857	3,962	4,059	4,281
Distribution System Water Loss		423	428	440	451	475
Total Potable Water Use		4,235	4,285	4,402	4,510	4,756
Non-Potable (Valero)		5,800	5,800	5,800	5,800	5,800
Total Production		10,035	10,085	10,202	10,310	10,556

4.4.5 Adjusting Water Use Forecasts for Single-Dry and Multiple Dry Conditions

The demand forecasts presented in the prior subsection represent expected water needs under normal hydrologic conditions. To credibly forecast potential maximum future water use, the forecasted normal-year water uses must be modified to reflect anticipated increases in demand during drier conditions.

Conservative modifications to the forecasted normal year water use to more likely reflect use conditions during drier and dry years are warranted to help adequately address water service reliability in Chapter 5. For purposes of this UWMP, the following adjustment is made:

- Single dry year: Landscape irrigation needs would increase to reflect the generalized earlier start of the landscape irrigation season due to limited rainfall in the single driest year. Since this increase only applies to the outdoor portion of a customer's forecast use, an adjustment factor of 5% is applied to the total normal-year forecasts to conservatively reflect the expected increase in demand for water for landscaping.
- Multiple dry years: During multiple dry years, demands are also expected to increase similar to the single dry year. For multiple dry year conditions, the single dry year increase of 5% is held in each of the subsequent years. This is representative of an "unconstrained demand" as should be represented when evaluating whether Water Shortage Contingency Plan actions may be warranted.[64]

These values are reflected in tables provided for the Drought Risk Assessment and Annual Reliability Assessment presented in later subsections.

4.4.6 Climate Change Considerations

Including climate change analysis into a water use analysis will assist the City in understanding the potential effects on long-term reliability, which in turn, allows the City to proactively begin planning appropriate responses. For example, hotter and drier weather may lead to an increased demand in landscape irrigation, especially during spring and fall months, increasing the pressure on water supplies that may have availability restrictions during these periods.

This potential is reflected in the consideration of the single dry year increase of 5% that is used for the water service reliability analysis, as discussed previously. Whether the elevated single dry year water forecast becomes more akin to the "normal" demand will become more apparent as the City continues to assess monthly water use trends throughout its service area.[65]

[64] California Water Code Section 10632(a)(2) states water suppliers should use "unconstrained demand" when performing their annual water supply and demand assessment.

[65] A closer assessment of the correlation of monthly water use by customer type to rainfall and temperature will help the City improve water use forecasts to assure the effects of climate change are adequately being reflected in water service reliability analyses.

4.5 Forecasting Water Use for the DRA and Annual Assessment

The California Legislature created two new UWMP requirements to help suppliers assess and prepare for drought conditions: The Drought Risk Assessment,[66] and the Annual Water Supply and Demand Assessment.[67] These new planning requirements were established in part because of the significant duration of recent California droughts and the predictions about hydrological variability attributable to climate change.

The Drought Risk Assessment (DRA) requires assessing water supply reliability over a five-year period from 2021 to 2025 that examines water supplies, water uses, and the resulting water supply reliability under a reasonable prediction for five consecutive dry years.

As a slight variant, the Annual Water Supply and Demand Assessment (Annual Assessment) undertakes a similar analytical exercise as the DRA but is to focus on actual, and not hypothetical, conditions anticipated for the upcoming water year. The previously presented water use forecasts facilitate both of these planning exercises as described in the following subsections.

4.5.1 Projecting Water Use for 5-year Drought Risk Assessment

A critical component of new statutory language for the 2020 UWMP cycle is the requirement to prepare a five-year DRA using a supplier-defined hypothetical drought conditions expected to occur from 2021 through 2025. This drought condition is meant to allow suppliers to test the resiliency of their water supply portfolio and their Water Shortage Contingency Plan actions to meet severe conditions.

DWR recommends that suppliers first estimate expected water use for the next five years without drought conditions (also known as unconstrained demand). In other words, unconstrained demand is water demand absent any water supply restrictions and prior to implementing any short-term WSCP demand reduction actions. If normal water use includes water conservation programs, either currently implemented or planned for implementation, estimated water use values would incorporate the effect of those conservation programs when reporting projected water use during this period.

Total water use for 2021, for example, is developed by modifying the water use representation for "current" conditions (see Table 4-6) taking into consideration the anticipated factors affecting water use, with each subsequent year further adjusted, as appropriate. Adjustments year-to-year reflect several factors the City anticipates may occur, including increases from growth. To make these adjustments, the difference in annual water use between the "current" condition and the forecast potable use in 2025 is prorated equally across each of the years 2021 through 2025, so that the same 2025 forecast water use is matched.

With an initial annual estimate, each year is further adjusted to reflect anticipated increases in the "unconstrained demand" during a single dry year. As noted previously, this is reflected by applying a 5% increase to the total potable water use forecast. To this adjusted value, the monthly non-potable Valero

[66] California Water Code Section 10635(b)
[67] California Water Code Section 10632.1

water use is also added (see Table 4-6). The resulting unconstrained demand during a dry year for 2021 through 2025 are shown in Table 4-9.

Table 4-9: Forecast DRA Water Use for 2021 through 2025 (acre-feet per year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2021	725	561	713	693	791	920	992	1,084	1,006	1,001	888	824	10,199
2022	726	562	714	694	792	921	993	1,086	1,007	1,003	889	825	10,211
2023	727	562	715	695	793	922	994	1,087	1,008	1,004	890	825	10,223
2024	727	563	715	696	794	924	996	1,089	1,010	1,005	891	826	10,235
2025	728	564	716	696	795	925	997	1,090	1,011	1,006	892	827	10,247

4.5.2 Projecting Water Use for Annual Assessments

The City will need to perform an Annual Assessment and submit the findings to DWR beginning in 2022. To evaluate the plausible water service reliability conditions for 2021 or 2022, described in Chapter 5, requires two separate representative "current" water use conditions to be developed. The first condition uses the "current" water use characterization included in Table 4-6. These demands represent the water use under a normal condition. Alternatively, a "single-dry year current" forecast is also calculated to provide the District with representative current unconstrained demands. This second characterization of current water use applies the same single-dry year adjustment described previously, represented by a 5% increase in the current water use values. Table 4-10 provides the Normal Year and Single Dry Year current water use for the City's water service area. These are used in Chapter 5.

Table 4-10: Normal and Single Dry Year "Current" Water Use (acre-feet)

Year Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Normal	695	558	679	637	753	878	986	1,055	1,035	1,035	861	814	9,987
Single Dry	730	586	713	669	791	922	1,036	1,108	1,087	1,087	904	855	10,487

4.6 Projecting Disadvantaged Community Water Use

Pursuant to CWC Section 10631.1, retail suppliers are required to include the projected water use for lower income households in 2020 UWMPs. Per California Health and Safety Code Section 50079.5, a lower income household has an income below 80 percent of area median income, adjusted for family size. For purposes of this UWMP, annual median income was derived from 2019 U.S. Census Bureau and determined to be about $103,000 for the City.[68] Therefore, 80% of this is estimated to be about $83,000 per year. According to the detailed data, approximately 40% of the households earn at or below this 80-percentile income.

[68] This data is from the Household Income in the Past 12 Months (In 2019 Inflation-adjusted Dollars) American Community Survey 1-year estimates. https://censusreporter.org/profiles/16000US0605290-benicia-ca/

For purposes of estimating the future water needs, 40% of the total single-family and multi-family connections are presumed to represent disadvantaged households. Applying this condition to the forecast water use for the entire City results in the estimate provided in Table 4-11.

Table 4-11: Estimated Low-Income Water Use Forecast (acre-feet)

	2025	2030	2035	2040	2045
Total Potable Use	4,235	4,285	4,402	4,510	4,756
Low Income Use	1,106	1,106	1,105	1,105	1,105
% of Total Potable	26%	26%	25%	25%	23%

Chapter 5
Water System Reliability

This chapter provides the City of Benicia's (Benicia) water system reliability findings as required under Water Code Section 10635 and provides reliability information that Benicia may use in completing an annual supply and demand assessment pursuant to Water Code Section 10632.1.

Assessing water service reliability is the fundamental purpose for Benicia in preparing its 2020 UWMP. Water service reliability reflects Benicia's ability to meet the water needs of its customers, including end-use customers and retail urban suppliers, with water supplies under varying conditions. Benicia's UWMP considers the reliability of meeting customer water use by analyzing plausible hydrological variability, regulatory variability, climate conditions, and other factors that impact Benicia's water supply and its customers' water uses. The reliability assessment looks beyond Benicia's past experience and considers what could be reasonably foreseen in the future. Moreover, the analysis posits that active supply management will be integral to Benicia's long-term water reliability. This chapter synthesizes the details imbedded in the Chapters 3 and 4 and provides a rational basis for future decision-making related to supply management, demand management, and project development. This chapter presents three system reliability findings:

- Five Year Drought Risk Assessment: The 2021 through 2025 Drought Risk Assessment (DRA) for all of Benicia's service areas.
- Long-Term Service Reliability: The reliability findings for a Normal Year, Single Dry Year, and Five Consecutive Drought Years in five-year increments through 2045.
- Annual Reliability Assessment: The reliability findings for an existing condition for both a Normal Year and Single Dry Year that can inform an annual supply and demand assessment for 2021 or 2022.

In short, through active management, Benicia has reliable water supplies available for its service area through 2045.

5.1 Five Year Drought Risk Assessment

The Drought Risk Assessment is a new requirement for the 2020 UWMP cycle. The DRA requires a methodical assessment of water supplies and water uses under an assumed drought period that lasts five consecutive years. Benicia has prepared an independent monthly assessment of the water supplies and demands for its system because of the monthly variability associated with the surface water supplies that are used to serve that system. Moreover, Benicia has incorporated other constraints in its

system, like infrastructure constraints at its pumping and treatment facilities, which may also influence the near-term management of Benicia's water asset portfolio.

Benicia has a unique water supply portfolio and system operations. Benicia currently has access to six sources of supply and each source has unique attributes that affect reliability under various hydrological and regulatory conditions. These supply sources are further complicated by the carryover and storage provisions available to some of the water assets. This diverse water supply portfolio creates a water management structure that requires careful consideration of hydrological, regulatory, and institutional variability. Specifically, some water assets are particularly susceptible to drought while other water assets have varying degrees of reliability based upon regulatory constraints and historical water use. Nevertheless, Benicia has organized and coordinated its water portfolio management to ensure water supply reliability in the event of a severe drought. The Benicia DRA represents a consolidation of its surface water supplies into an organized monthly management structure.

Table 5-1 below shows Benicia's DRA that integrates all of its supplies for 2021 through 2025 as described in Chapter 3 and reflects the dry year unconstrained water uses described in Chapter 4. As the table shows, Benicia has surplus water assets available in all months under its prescribed water management protocol although some months have limited surplus supplies.

Table 5-1: Five Year Drought Risk Assessment (acre-feet)

Five Year Drought		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2021	Supply	1,825	1,825	1,825	1,825	958	1,063	1,214	1,266	1,145	1,008	1,825	1,825	17,605
	Demand	725	561	713	693	791	920	992	1,084	1,006	1,001	888	824	10,199
	Difference	1,100	1,264	1,112	1,132	167	143	222	182	139	6	937	1,001	7,405
2022	Supply	2,175	2,175	2,175	825	875	1,055	1,185	1,255	1,075	1,007	2,100	2,100	18,003
	Demand	726	562	714	694	792	921	993	1,086	1,007	1,003	889	825	10,211
	Difference	1,449	1,613	1,461	131	83	134	191	170	68	4	1,211	1,275	7,792
2023	Supply	2,150	2,150	2,150	826	876	1,079	1,188	1,257	1,120	1,007	2,100	2,100	18,004
	Demand	727	562	715	695	793	922	994	1,087	1,008	1,004	890	825	10,223
	Difference	1,423	1,588	1,435	131	83	157	194	170	112	4	1,210	1,275	7,781
2024	Supply	2,125	2,125	2,125	825	875	1,055	1,184	1,255	1,076	1,007	2,100	2,100	17,853
	Demand	727	563	715	696	794	924	996	1,089	1,010	1,005	891	826	10,235
	Difference	1,398	1,562	1,410	130	82	132	188	167	66	2	1,209	1,274	7,618
2025	Supply	1,750	1,750	1,750	1,750	903	1,055	1,199	1,266	1,076	1,006	1,750	1,750	17,006
	Demand	728	564	716	696	795	925	997	1,090	1,011	1,006	892	827	10,247
	Difference	1,022	1,186	1,034	1,054	109	131	202	176	65	0	858	923	6,759

5.2 Long Term Service Reliability

The Urban Water Management Planning Act directs urban water purveyors to analyze water supply reliability in a normal, single dry, and five consecutive dry years over a 20-year planning horizon. The 2020 UWMP Guidebook recommends extending that period to twenty-five (25) years to provide a guiding document for future land use and water supply planning through the next UWMP cycle. The following subsections describe the long-term water service reliability for Benicia through a 25 year planning horizon.

5.2.1 Benicia Long Term Service Reliability

Benicia's long term service reliability reflects the recommended 25-year planning horizon anticipating a normal, single dry, and five consecutive dry years from 2020 through 2045.

Normal and Single Dry Conditions 2025-2045

Benicia's future water supplies in normal and single dry conditions reflect the same hydrological, regulatory, and institutional criteria described in previous sections. In normal years, supplies are generally constrained only by their express limiting features. In dry years, additional hydrological, regulatory, and institutional issues will constrain the availability of water. However, future water supplies remain relatively constant as average demands grow over time. All of this information is described in detail in Chapters 3 and 4 and is reflected in the tables below.

Benicia's future water demands in normal and single dry conditions through 2045 reflect the same considerations described in previous sections of this chapter. In normal conditions, demands tend to reflect anticipated uses based upon normal hydrological conditions. But in dry conditions, demands increase to reflect dry conditions and additional application of water for outdoor irrigation. Future water demands are generally predicted to increase as land uses and populations within Benicia's boundaries grow. All of this information is detailed in Chapter 4 and reflected in the numbers shown in the tables below.

Table 5-2 shows the normal year supplies and demands on an annual timestep from 2025 through 2045.

Table 5-2: Normal and Single Dry Year Water Supply and Demand through 2045 (acre-feet per year)

Normal Year	2025	2030	2035	2040	2045
Supply	28,646	28,646	28,646	28,646	28,646
Demand	10,035	10,085	10,202	10,310	10,556
Difference	18,611	18,561	18,444	18,336	18,090

Single Dry Year	2025	2030	2035	2040	2045
Supply	21,208	21,208	21,208	21,208	21,208
Demand	10,247	10,301	10,424	10,538	10,798
Difference	10,961	10,907	10,784	10,669	10,410

Benicia Five Consecutive Dry Years 2025 – 2045

Benicia defines drought condition lasting five consecutive years as one that constrains Benicia from obtaining some of its water supplies in its water supply portfolio due to hydrological, regulatory, and institutional constraints. These conditions include more restrictive regulatory constraints on its water rights and constrained conditions for its water supply contracts. The restrictive conditions manifest in changes to the availability of Benicia's water assets during different periods in a given year but keep the annual volumes above the annual need. Moreover, these restrictive conditions may also impact the increased uses of available supplies in the future that are associated with land use and population growth. These conditions are described in significant detail in Chapter 3 and reflected in the tables below.

Five consecutive dry year demands include the anticipated demands based upon historical trends in water usage in drought conditions by Benicia's customers. Demands in extended dry conditions may increase as hydrological conditions generate additional customer uses for outdoor irrigation. As droughts persist, however, demands may decline as the realistic constraints on supply availability are realized at the customer level. Out of an abundance of caution to ensure supplies are available to meet projected demands, the fluctuating demand pattern is not reflected in this future reliability assessment. The gradual increase in demands also account for reasonable water conservation measures derived from improved efficiencies in indoor fixtures, improved management of outdoor landscape irrigation, and a general awareness of the value of long-term water conservation at the consumer level. In addition, the future dry conditions reflect increased land use and populations that would rely upon available supplies. These variable conditions are described in significant detail in Chapter 4 and reflected in the tables below. Table 5-3 below shows the annual water supply and demand conditions for Benicia's service area in five consecutive dry years from 2025 through 2045.

Table 5-3: Five Consecutive Dry Years Water Supply and Demand through 2045 (acre-feet per year)

Five Year Drought		2025	2030	2035	2040	2045
Year 1	Supply	28,088	28,088	28,088	28,088	28,088
	Demand	10,247	10,301	10,424	10,538	10,798
	Difference	17,841	17,787	17,664	17,549	17,290
Year 2	Supply	21,530	21,530	21,530	21,530	21,530
	Demand	10,247	10,301	10,424	10,538	10,798
	Difference	11,283	11,229	11,106	10,992	10,732
Year 3	Supply	15,790	15,790	15,790	15,790	15,790
	Demand	10,247	10,301	10,424	10,538	10,798
	Difference	5,543	5,489	5,366	5,252	4,992
Year 4	Supply	15,210	15,210	15,210	15,210	15,210
	Demand	10,247	10,301	10,424	10,538	10,798
	Difference	4,963	4,909	4,786	4,672	4,412
Year 5	Supply	18,650	18,650	18,650	18,650	18,650
	Demand	10,247	10,301	10,424	10,538	10,798
	Difference	8,403	8,349	8,226	8,112	7,852

5.3 Annual Reliability Assessment

Benicia may consider current supply and demand conditions and perform an annual water supply and demand assessment (Annual Assessment) pursuant to Water Code Section 10632.1 to evaluate real-time or near-term circumstances that are different than the DRA scenario. This assessment would evaluate actual current water supply and use conditions. For purposes of this UWMP, the "current" water use conditions as described in Chapter 4 are compared to the availability of Benicia's existing water supplies as described in Chapter 3. Two scenarios are illustrated for Benicia's service area:

- Normal Year condition: reflecting the availability of supplies under normal conditions and the "current" water uses
- Single-Dry Year condition: reflecting the availability of supplies under a severe, single-dry year and elevated "current" water uses reflecting increased demands expected in a single dry year.

5.3.1 Benicia Normal Year Supply and Current Water Use

Benicia defines a normal year condition as one that allows the agency to obtain water supplies from all sources under its Benicia water supply portfolio under normalized conditions. These conditions include normally anticipated regulatory constraints on its water rights and limited constrained conditions for its water supply contracts. These conditions are described in significant detail in Chapter 3 and reflected in the monthly supply determinations shown below.

Normal year demands include the anticipated demands based upon historical trends in water usage in non-drought conditions by Benicia's customers. Demands in normal conditions generally are lower in the wetter months and higher in the drier months. These demands may fluctuate over time as land uses and populations change within Benicia's service area. The monthly demands also account for reasonable water conservation measures derived from improved efficiencies in indoor fixtures, improved management of outdoor landscape irrigation, and a general awareness of the value of long-term water conservation at the consumer level. These demand conditions are described in significant detail in Chapter 4 and reflected in the monthly demand assessments shown below.

Table 5-4 below shows the normal year water supply and demand conditions for Benicia's service area on a monthly timestep.

Table 5-4: Normal Year Water Supply and Demand in Benicia (acre-feet)

Normal Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Supply	2,825	2,825	2,825	2,825	2,825	1,512	1,512	1,512	1,512	2,825	2,825	2,825	28,645
Demand	711	550	701	680	776	899	969	1,057	982	978	868	807	9,979
Difference	2,113	2,274	2,124	2,145	2,049	613	543	455	530	1,846	1,957	2,018	18,666

5.3.2 Benicia Single Dry Year Supply and Dry-Year Current Demand

Benicia defines a single dry year condition as one that constrains Benicia from obtaining some of its water supplies in its water supply portfolio due to hydrological, regulatory, and institutional constraints. These conditions include more restrictive regulatory constraints on its water rights and significantly constrained conditions for its numerous water supply contracts. The restrictive conditions manifest in changed availability of some Benicia water assets in various months depicted in the tables below. These changed monthly water supply conditions are described in significant detail in Chapter 3.

Single dry year demands include the anticipated demands based upon historical trends in water usage in drought conditions by Benicia's customers. Demands in dry conditions may increase in the normally wetter months as denuded hydrological conditions generate additional customer uses for outdoor irrigation. These conditions are described in significant detail in Chapter 4 and reflected in the monthly demand tables below. The analysis uses the "current" water use, adjusted as described in Chapter 4.

Table 5-5 below shows the single dry year water supply and demand conditions for Benicia's service area.

Table 5-5: Single Dry Year Water Supply and Demand in Benicia (acre-feet)

Single Dry Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Supply	2,109	2,347	2,571	2,571	964	1,076	1,276	1,276	1,114	1,064	2,571	2,271	21,208
Demand	724	561	713	693	790	919	991	1,083	1,005	1,000	887	823	10,188
Difference	1,384	1,786	1,858	1,878	174	157	285	193	109	64	1,684	1,449	11,020

5.4 Water Supply Reliability Summary

The City of Benicia has a diverse and robust water supply portfolio capable of meeting the water demands in its service area in normal, single dry, and five consecutive dry years from 2020 through 2045 so long as active management of its supply portfolio occurs. Benicia's diverse water supply portfolio requires coordinated water management between the City and Solano County Water Agency in order to render the supply reliable in all year types through 2045.

Chapter 6
Water Shortage Contingency Plan

This Water Shortage Contingency Plan (WSCP) addresses the requirements in Water Code Section 10632 of the Urban Water Management Planning Act (The Act). The WSCP is incorporated into the 2020 Urban Water Management Plan (UWMP) and is used by the City of Benicia (City or Benicia) to respond to water shortage contingencies as they may arise. The WSCP addresses possible conditions in which the water supply available to customers of the City is insufficient to meet the normally expected customer water use at a given point in time due to drought, regulatory action constraints, and natural and man-made disasters. This WSCP describes the City's strategy for allocating water during such water supply shortages, while assuring customers that at all times it will meet the minimum health and safety requirements of a drinking water purveyor.

This WSCP consists of the following required elements:

1. An analysis of water supply reliability.
2. Procedures for conducting an annual water supply and demand assessment.
3. Six standard water shortage levels corresponding to progressive ranges of up to 10, 20, 30, 40, and 50 percent shortages and greater than 50 percent shortage.
4. Shortage response actions that align with the defined shortage levels.
5. Communication protocols and procedures.
6. Customer compliance, enforcement, appeal, and exemption procedures.
7. A description of legal authorities.
8. A description of financial consequences.
9. Monitoring and reporting requirements.
10. Reevaluation and improvement procedures.
11. Special Water Feature Distinction.
12. Plan Adoption, Submittal, and Availability.

The Act contains specific requirements for each of these elements.[69] As required by Water Code Section 10632 this WSCP is incorporated into the UWMP, yet it is also a stand-alone plan that is adopted independently from the UWMP and may be amended or refined and readopted over coming months and years as needed (see subsection 6.12 Plan Adoption, Submittal, and Availability, below).

The City has enacted Chapter 13.35 of the Benicia Municipal Code to address water shortages.[70] These local rules were developed to help manage water shortage conditions in the event of drought, catastrophic outage, or regulatory mandate requiring statewide reduction in water use. This WSCP is fully integrated with the City's most recent Municipal Code Chapter 13.35 update.

6.1 Water Supply Reliability Analysis

The City of Benicia was incorporated in 1851 and shortly thereafter acquired water assets in Sulphur Springs Creek watershed. As the City grew, additional water supplies were acquired to serve Benicia's growing needs. The City's water supply is surface water derived from the Sacramento River watershed, the Solano Project, and Sulphur Springs Creek Watershed. These sources feed the City's potable water treatment plant and a raw water storage facility in Lake Herman. The City's water supply sources may be impacted by climate factors, catastrophic events, and regulatory measures – all of which are considered in the reliability assessment in Chapter 5. The City regularly evaluates its overall water supply reliability through its Urban Water Management Plan and through regional planning efforts in coordination with Solano County Water Agency and other neighboring water purveyors.

Benicia delivers quality, reliable water to approximately 10,000 active service connection within its service area boundary (See Chapter 2). As described in Chapter 5 of this UWMP, the City has a reliable water supply in normal, single dry and five consecutive dry years through 2045. Although Benicia has a secure water supply, this WSCP serves as a roadmap to help the City meet the challenges that may arise from future droughts, regulatory actions, and unforeseen man-made and natural disasters.

6.2 Annual Water Supply and Demand Assessment Procedures

The WSCP describes the City's procedural methodology for managing shortages and conducting its required Annual Water Supply and Demand Assessment (Annual Assessment). The Annual Assessment is to be submitted to California Department of Water Resources (DWR) by July 1 each year with the first Annual Assessment due July 1, 2022. The Annual Assessment examines Benicia's anticipated water reliability for the current year and one additional dry year. The Annual Assessment will be prepared at the beginning of each calendar year to evaluate near-term water supply reliability and determine what, if any, water shortages stages may be triggered during the required period. The Annual Assessment will be used by Benicia decision-makers to prepare for and initiate implementation of any needed response

[69] California Water Code Section 10632, available at: (https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=WAT&sectionNum=10632)
[70] Benicia Municipal Code Chapter 13.35 Emergency Water Conservation Plan.

actions, as well as to inform customers, the general public, interested parties, and local, regional, and state governmental entities to prepare for such required actions.

6.2.1 Analytical and Decision-making Processes

Benicia plans to conduct its Annual Assessment according to the following timeline and process:

By February 1	Initial data collection and analysis
By March 1	Preliminary Draft Annual Assessment internal review and revisions
By April 1	Draft Annual Assessment and results briefing for Benicia decision-makers
By May 1	Public Notification and Release of Draft Annual Assessment
By June 1	Approval of Annual Assessment by Benicia Decision-makers
By June 15	Submit Annual Assessment to DWR in advance of July 1 deadline

The City will prepare its Annual Assessment using the following key data and analytical procedures (which may be modified as needed):

- Prepare supply estimates for each water source on a monthly basis for the analysis period.
- Update unconstrained customer demand and estimate anticipated actual water use on a monthly basis for the analysis period.
- Update infrastructure assessment, including estimated water supply production capability on a monthly basis for the analysis period.
- Identify and quantify any locally applicable factors that may influence or disrupt supplies during the analysis period.
- Refine the definition of “dry year” as relevant to dry conditions like water year 2015 and 2021.
- Identify any shortfall between projected supply and anticipated demand.
- Identify and incorporate any applicable constraints (infrastructure, regulatory, etc.).
- Develop, analyze, and propose water resource management strategies to address any shortfall between projected supply and anticipated demand with reference to the water shortage stages identified in this WSCP.
- Present the Annual Assessment (and resulting water shortage stage declaration, if applicable) to the City decision-makers.

If the results of the Annual Assessment indicate the need for any alternative water shortage response actions which may be addition to those specified in Section 6.4, below, the alternative response actions will be described and submitted in the Annual Assessment, as specified in CWC 10632.2.

6.2.2 Submittal Procedure

The City will submit its Annual Assessment to the DWR via email by June 15 each year, but in no case later than July 1 each year. At the time of DWR submittal, Benicia will also notify Solano County Water

Agency, Solano County, the public, and other stakeholders concerning the results of the Annual Assessment and where it is available for review.

6.3 Six Standard Water Shortage Stages and Triggers

New state requirements for the WSCP require water suppliers to adopt six water shortage stages, which correspond to progressively severe water shortage conditions (up to 10%, 20%, 30%, 40%, 50%, and greater than 50% percent shortage), as compared to the normal service reliability condition. The City has adopted the six standard water shortage stages as shown in Table 6-1 that are included in section 13.35.060 of the Municipal Code. Each stage corresponds to a range of reduction in anticipated water supply availability and is aligned with shortage response actions which can reduce water demand as needed to address the water shortage. Reduction of available water supply by the indicated percentages will trigger an appropriate water shortage stage and the City will implement the response actions identified in Table 6-1.

6.4 Shortage Response Actions

The WSCP is required to identify locally appropriate shortage response actions that align with the defined shortage stages and include demand reduction actions, supply augmentation actions, system operational changes, and mandatory prohibitions against specific water use practices that are in addition to state-mandated prohibitions and appropriate to the local conditions. For each response action the WSCP is to provide an estimate of the extent to which the gap between supplies and demand will be reduced by implementation of the action.

6.4.1 Stages of Shortage Response Actions

The City has identified shortage response actions to be implemented during each of the six sequential stages and corresponding water shortage conditions. These actions are based on specific hydrological and regulatory conditions and the fundamental need to meet water service requirements within the City's service area. Moreover, the shortage response actions provide the City with some flexibility to address water dynamic water shortage conditions while protecting the City against extreme conditions where supplies are drastically reduced beyond 50%. The following is an overview of the staged response actions the City could follow during a given water shortage condition based on shortage severity, relative supply conditions for each stage, and percent shortage reduction levels. A water shortage declaration would be made by resolution of the Benicia City Council, with administrative discretion delegated to the City Manager.

The shortage response actions derived from Municipal Code Chapter 13.35 that may be implemented in each stage include, but are not limited to, the following:

Stage 1 (up to 10 percent shortage) "Water Alert" – If water supplies are threatened with constraint, the Plan calls for an introductory Stage 1 drought response, during which customers are informed of possible shortages and asked to voluntarily conserve 10 percent. In addition, customers are prohibited

from wasting water or unreasonably using water for beneficial purposes. For example, prohibited water uses under this stage include: allowing water to run off unused into a gutter, ditch, or drain; failing to repair a controllable leak; washing sidewalks, driveways, parking areas, tennis courts, patios, or other paved or areas; utilizing a hand-held hose without an automatic shut-off nozzle; and irrigating during a precipitation event. Additional prohibitions will apply to new developments prohibiting single pass-through cooling water systems, commercial car washes and laundries without recirculating water systems, and decorative fountains without recirculating water systems.

This stage includes performing public outreach and education about the shortage and methods individuals can implement to reduce their water use. The City will inform the public and neighboring governmental bodies of the potential shortage condition and will coordinate with customers to implement the actions consistent with this Stage.

Stage 2 (11 - 20 percent shortage) "Water Warning" – In the event Stage 2 is implemented the City will continue to encourage community-oriented voluntary conservation measures, enforce conservation measures, and implement mandatory water use reduction measures to decrease demand by up to 20 percent. Stage 2 activities include a continuation of activities described under Stage 1, as well as greater conservation and water use restrictions. These additional restrictions include beyond those identified in Stage 1, limiting outdoor irrigation only between the hours of 6:00 PM and 9:00 AM and vehicle washing must be done using a bucket or hand-held hose with an automatic shut-off nozzle, or take place at a commercial car wash. Customer baseline water use will be monitored and addressed with excess use above the shortage percentage subject to financial penalties under Ordinance 13.35.090.

The City will also continue to engage in public outreach and education as it applies to the water shortage conditions and the actions necessary to achieve up to 20% reduction in use.

Stage 3 (21 - 30 percent shortage) "Severe Shortage" – Stage 3 includes all response actions taken in Stages 1 and 2 and is focused on continuing to encourage customers to voluntarily reduce water use regarding turf watering, fillings pools, etc., mandatory-watering restrictions will be implemented following additional shortage actions described in Stage 2. Increased monitoring related to prescribed water conservation actions will occur under this stage. Customer baseline water use will be monitored and addressed with excess use above the shortage percentage subject to financial penalties under Ordinance 13.35.090.

The City will also continue to engage in public outreach and education as it applies to the water shortage conditions and the actions necessary to achieve up to 30% reduction in use.

Stage 4 (31 - 40 percent shortage) "Critical Shortage" – Stage 4 includes all response actions taken in prior stages regarding mandatory conservation and intensifies their implementation and enforcement. Stage 4 restrictions will be implemented if the Stage 3 demand reduction and other response actions are deemed insufficient to achieve reductions due to water supply shortages. All Stage 3 response actions will be intensified, and water production will be monitored daily by Benicia for compliance with necessary reductions. Customer baseline water use will be monitored and addressed with excess use above the shortage percentage subject to financial penalties under Ordinance 13.35.090.

The City will also continue to engage in public outreach and education as it applies to the water shortage conditions and the actions necessary to achieve up to 40% reduction in use.

Stage 5 (41 - 50 percent shortage) "Water Crisis" – Stage 5 includes all response actions taken in prior stages regarding mandatory conservation. The primary focus of Stage 5 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 and will follow all voluntary and mandatory actions described in Stages 1-4. Customer baseline water use will be monitored and addressed with excess use above the shortage percentage subject to financial penalties under Ordinance 13.35.090.

The City will also continue to engage in public outreach and education as it applies to the water shortage conditions and the actions necessary to achieve up to 50% reduction in use.

Stage 6 (greater than 50 percent shortage) "Water Emergency" – Stage 6 includes all response actions taken in prior stages focused on reducing water demands by more than a fifty percent in response to greater than 50 percent water shortages. This stage requires only use of water for human health and safety purposes. No additional water uses are permitted, including any outdoor irrigation for anything other than maintenance of legacy vegetation. Customer baseline water use will be monitored and addressed with excess use above the shortage percentage subject to financial penalties under Ordinance 13.35.090.

The City will also continue to engage in public outreach and education as it applies to the water shortage conditions and the actions necessary to achieve greater than 50% reduction in use.

Tables 6-1 through 6-6 show a summary of the staged response actions.

Table 6-1: WSCP Actions to Reduce Customer Use - Stage 1

Water Alert: Savings up to 10%
1. Waste and Unreasonable Use of Water Prohibited and Voluntary conservation encouraged (up to 10%) 2. Situation and possible subsequent water shortage stages explained to the public and governmental bodies (up to 10%) 3. Focus on customers with high per capita water usage to achieve proportionally greater reduction than those with low use 4. Actions include, but not limited to: • Public information campaign consisting of distribution of literature, speaking engagements, website updates, bill inserts, and conversation messages printed in local newspapers • Educational programs in area schools • Conservation Hotline • Discussion of equitable water waste response policy. (combined up to 10%) 5. Consumption Reduction Methods, including: • Demand reduction program • Plumbing and irrigation fixture replacement • Water conservation kits • Education programs • Voluntary rationing (combined up to 10%)

Table 6-2: WSCP Actions to Reduce Customer Use - Stage 2

Moderate Shortage: Savings up to 20%
1. All measures implemented in Stage 1 2. Voluntary conservation allotments/usage reductions (up to 20%) 3. Mandatory Conservation Rules and Restrictions and Prohibitions on End Uses (10-20%) 4. Usage in excess of customer baseline subject to drought penalty (13.35.090) 5. All Consumption Reduction Methods from Stage I and intensified as needed; additionally: 6. Use prohibitions 7. Voluntary outdoor irrigation restrictions including limiting number of watering days per week, and time when irrigation can occur (e.g., between 6:00 pm and 9:00 am)

Table 6-3: WSCP Actions to Reduce Customer Use - Stage 3

Severe Shortage: Savings up to 30%
1. All measures implemented in Stages 1 and 2 2. Some or all of the following: • Adherence to customer baselines and actual water use reductions water allocations and mandatory conservation rules; • Water usage goals established by an authorized government agency or official; • Customer water usage in excess of baseline to be monitored and recorded • Water use prohibitions can include restrictions of days and daytime hours for watering, excessive watering resulting in gutter flooding, using a hose without a positive shutoff device, use of decorative fountains with non-recirculating pumps, washing down sidewalks or patios, not repairing leaks in a timely manner, etc. (up to 30%) 3. Monitor water production weekly for compliance with necessary reductions; 4. All activities are intensified and production is monitored daily for compliance with necessary reductions. (up to 30%) 5. All Consumption Reduction Methods from Stage 2 and intensified as needed; additionally: • Reduce pressure in water lines; Flow restriction • Mandatory rationing • Incentives to reduce water consumption; Excess use penalty • Percentage reduction by customer type (combined up to 30%) 6. Penalties and Charges for Excessive Use, including penalties for not reducing consumption, charges for excess use under 13.35.090

Table 6-4: WSCP Actions to Reduce Customer Use - Stage 4

Critical Shortage: Savings up to 40%
1. All measures implemented in Stages 1-3 2. All activities are intensified and production is monitored daily for compliance with necessary reductions. (up to 40%) 3. All Consumption Reduction Methods from Stage 3 and intensified as needed; additionally: • Restrict building permits; Restrict for only priority uses 4. Penalties and Charges for Excessive Use, including penalties for not reducing consumption, charges for excess use (up to 40%) • Continue monitoring and addressing water use above baseline with penalties under 13.35.090 5. Catastrophic Event (Supply reduction up to 40%): Implement Applicable Actions for Catastrophic Events

Table 6-5: WSCP Actions to Reduce Customer Use - Stage 5

Shortage Crisis: Savings up to 50%
8. All measures implemented in Stages 1-4 9. Source of supply for the System is severely curtailed to the level that requires each customer to restrict their water use for only human health and safety purposes (up to 50%) 10. All activities are intensified and production is monitored daily for compliance with necessary reductions (up to 50%) 11. All Consumption Reduction Methods from previous stages and intensified as needed 12. Possible reductions in customer baselines and actual water use reductions (up to 50%) 13. Usage in excess of customer baseline to be charged at regular rate plus an additional drought emergency surcharge amount (up to 50%) Update current water shortage condition response measures based on Council approvals and direction, state policy directives, emergency conditions, or to improve customer response 14. Catastrophic Event (Supply reduction up to 50%): Implement Applicable Actions for Catastrophic Events (such as boil water order) - Continue water monitoring for reduction from baseline with potential penalties under Ordinance 13.35.090

Table 6-6: WSCP Actions to Reduce Customer Use - Stage 6

Emergency Shortage: Savings greater than 50%
1. All measures implemented in Stages 1-5 2. Source of supply for the System is severely curtailed to the level that requires each customer to restrict their water use for only human health and safety purposes (>50%) 3. All activities are intensified and production is monitored continually for compliance with necessary reductions (up to >50%) 4. All Consumption Reduction Methods from previous stages and intensified as needed 5. Possible reductions in customer baselines and actual water use reductions (up to >50%) 6. Usage in excess of customer baseline to be charged at regular rate plus an additional drought emergency surcharge amount (up to >50%) 7. Update current water shortage condition response measures based on Council approvals and direction, state policy directives, emergency conditions, or to improve customer response 8. Catastrophic Event (Supply reduction greater than 50%): Implement Applicable Actions for Catastrophic Events. Continue water monitoring for reduction from baseline with potential penalties under Ordinance 13.35.090

6.4.2 Demand Reduction Actions

The City has identified a range of available and feasible customer demand reduction actions that can be used adaptively and implemented with progressively greater intensity to meet the supply shortage challenges faced under each water shortage condition. These demand reduction actions are identified by the associated water shortage stage in which they may be implemented. Other response actions not specified in this Plan may also be identified by the City to implement the essential purposes of this Plan or the UWMP (see CWC 10632.2).

Table 6-1 summarizes Benicia Demand Reduction Actions associated with each water shortage stage and shortage level, provides an estimate of the action's effectiveness as related to that stage.

6.4.3 Mandatory Prohibitions

This section is required to identify any mandatory prohibitions against specific water use practices that are in addition to state-mandated prohibitions and appropriate to the local conditions. Benicia adopted a regulation to prohibit water waste, Chapter 13.35 of the Municipal Code, which is updated simultaneously with this UWMP. The ordinance prohibits intentional or unintentional water waste and unreasonable uses of water and encourages beneficial water use. Certain prohibited activities are also listed among the demand reduction actions on Table 6-1.

6.4.4 Emergency Operations Plan for Catastrophic Water Shortages

This section identifies actions to be undertaken by Benicia to prepare for, and implement during, a catastrophic interruption of water supplies. In addition to climate, other events that can cause water supply shortages are earthquakes, chemical spills, dam failures, canal breaks, waterline ruptures, and energy outages at treatment and pumping facilities, which could cause a water shortage severe enough to trigger a Stage 1-6 water supply shortage condition.

The City has an adopted an Emergency Operations Plan, which provides procedures and guidance to City personnel in responding to emergency situations including catastrophic events, both natural and manmade. The plan provides procedures for preparing, mobilizing, and employing City resources and coordinating outside resources during an emergency. The City provides periodic training, including simulated events and responses to keep City personnel fully trained on implementation of emergency procedures. Mobilization is consistent with Standardized Emergency Management and the Incident Command System.

In addition to specific actions to be undertaken during a catastrophic event, Benicia performs maintenance activities, such as annual inspections for earthquake safety, and budgets for emergency items, such as auxiliary generators, to prepare for potential events.

Table 6-7 is a summary of actions cross-referenced against specific catastrophes for three of the most common possible catastrophic events: regional power outage (such as Public Safety Power Shutoff or "PSPS" events), natural disasters (such as earthquake, flood or storm damage, or fire), and malevolent acts.

Table 6-7: Summary of Actions for Catastrophic Events

Possible Catastrophe	Summary of Potential Actions
Regional Power Outage	15. Isolate areas that will take the longest to repair and/or present a public health threat. Arrange to provide emergency water. 16. Establish water distribution points and ration water if necessary. 17. If water service is restricted, attempt to provide potable water tankers or bottled water to the area. 18. Make arrangements to conduct bacteriological tests, in order to determine possible contamination. 19. Utilize backup power supply to operate pumps in conjunction with elevated storage.
Natural Disaster	20. Assess the condition of the water supply system. 21. Complete the damage assessment checklist for reservoirs, water treatment plants, system transmission and distribution. 22. Coordinate with Governor's Office of Emergency Services utilities group or fire City to identify immediate firefighting needs. 23. Isolate areas that will take the longest to repair and/or present a public health threat. Arrange to provide emergency water. 24. Prepare report of findings, report assessed damages, advise as to materials of immediate need and identify priorities including hospitals, schools and other emergency operation centers. 25. Take actions to preserve storage. 26. Determine any health hazard of the water supply and issue any "Boil Water Order" or "Unsafe Water Alert" notification to the customers. 27. Cancel the order or alert information after completing comprehensive water quality testing. 28. Make arrangements to conduct bacteriological tests, in order to determine possible contamination.
Malevolent acts	29. Assess threat or actual intentional contamination of the water system. 30. Notify local law enforcement to investigate the validity of the threat. 31. Get notification from public health officials if potential water contamination 32. Determine any health hazard of the water supply and issue any "Boil Water Order" or "Unsafe Water Alert" notification to the customers, if necessary. 33. Assess any structural damage from an intentional act. 34. Isolate areas that will take the longest to repair and or present a public health threat. 35. Arrange to provide emergency water.

6.4.5 Seismic Risk Assessment and Mitigation Plan

Beginning January 2020, CWC Section 10632.5 mandates urban water suppliers include in their UWMP a seismic risk assessment and mitigation plan to assess the vulnerability of each of the various facilities of a water system and mitigate those vulnerabilities. This requirement can be met by submittal of a copy of the most recent adopted local hazard mitigation plan or multi-hazard mitigation plan under the federal Disaster Mitigation Act of 2000 (Public Law 106-390) if the local hazard mitigation plan or multi-hazard mitigation plan addresses seismic risk.

Benicia intends to submit a copy of the Solano County Local Multi-Hazard Mitigation Plan (LMHMP 2012), which addresses seismic risk, landslides, and Dam Failure, and Drought, among other items, in Solano County, including the City's entire service area.

The LMHMP concludes that earthquake likelihood in Solano County is a "significant concern" with a past occurrence of earthquakes exceeding 6.0 occurring once every seven years.[71]

6.5. Communication Protocols

The City maintains an established and effective communications program to inform its customers, neighbors, and other stakeholders of water service issues, updates, and policies. Implementation of the WSCP will utilize the existing communication program structure to inform customers and others of the declared shortage stage and respective actions and restrictions in place.

The City Council meetings addressing the Annual Assessment and any potential water shortage declaration will be noticed using normal City Council meeting public notification procedures. The meeting will also be announced through regular press release protocols.

Once a shortage stage as been declared by the City Council, the City will notify its customers and others through a range of efforts. The stage and restrictions will be identified in a press release, customer billing statements, and posted on the City's website. Specifically, the City's website will be updated to feature the shortage declaration, restrictions, and resources available to customers from the City and other entities to help meet the restrictions. Subsequent City Council meetings will include a review of the shortage condition, customer response results, and discussion and recommendations for potential modifications. The City will also coordinate with the neighboring public agencies to declare a local emergency with respect to anticipated water supplies and demands in the event conditions necessitate.

The City's communications protocols may include, but are not limited to, some or all of the following locally relevant actions. These communications protocols will be used at the discretion of City staff based on then-current and anticipated water shortage conditions:

- Publishing information on Benicia's website.
- Staffing a telephone hotline.
- Providing bill inserts and direct mailings above and beyond those legally required.

[71] LMHMP at 5-47

- Directly calling customers.
- Developing materials for non-English speaking customers.
- Preparing social media posts to communicate Benicia actions.
- Advertising actions on other local audio and video media.
- Coordinating voluntary and mandatory water conservation activities with other local and regional governing bodies.
- Using the WaterSmart system to directly email customers.

6.6. Compliance and Enforcement

The City's Emergency Water Conservation Plan has significant compliance and enforcement options. Section 13.35.090 allows the City to assess a drought penalty where water use exceeds a baseline established by the City. Although the baseline may be contested and exceptions for the drought penalty may occur, the City Council has the authority to use this mechanism to assure compliance with the identified drought stages.

In addition, Section 13.35.120 provides significant compliance and enforcement actions for the City of Benicia in implementing its water shortage planning. Financial penalties, flow restrictors, and disconnected water service are among the options available to the City to ensure compliance with the required water shortage actions. Appeals processes are also available for those that are subject to the enforcement provisions of the Municipal Code.

6.7. Legal Authorities

The City is empowered to implement and enforce its WSCP under its organizing statutes and through use of its Emergency Water Conservation Plan in the City's Municipal Code.

In addition, the City is able to exercise general powers granted to water distributors in CWC §§350-359. CWC §350 authorizes the governing body of a distributor of a public water supply to declare a water shortage emergency whenever it finds and determines that the ordinary demands and requirements of water consumers cannot be satisfied without depleting the water supply of the distributor to the extent there would be insufficient water for human consumption, sanitation, and fire protection. Upon a finding of such an emergency condition, the distributor can adopt such regulations and restrictions on the delivery and consumption of water as will conserve the water supply for the greatest public benefit, with particular regard to domestic use, sanitation, and fire protection (CWC §353). The regulations and restrictions remain in force and effect until the supply of water available for distribution within such area has been replenished or augmented, and restrictions may include the right to deny new service connections and discontinue service for willful violations (CWC §355 and §356). The City also coordinates with the Solano County Water Agency and Solano County within which it provides water supply services for the possible proclamation of a "local emergency" under California Government Code, California Emergency Services Act (Article 2, Section 8558).

6.8. Financial Consequences of WSCP

The Act requires an analysis of the impacts of implementation of this WSCP and likely financial consequences to the City. This section addresses aspects of revenue reduction, expense increases, and additional costs that may arise, and identifies financial response actions.

6.8.1 Revenue and Expenditure Impacts

Benicia has established water rates that support its on-going operation and maintenance activities, as well as the capital projects required to provide a safe and reliable water supply to its customers. Water rates are tied to Benicia's customers' normal water consumption activities, which will be reduced through voluntary or mandatory water conservation by customers. Thus, in times of shortage, there will be revenue reductions to Benicia. In addition to the revenue reductions, Benicia will also experience an increase in expenses resulting from augmented communication actions, increased enforcement activities, and the administration of water shortage management actions identified in the WSCP.

When a drought or water shortage occurs, the City's costs 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 Water Shortage Contingency Plan. Staff will regularly report the identified and anticipated revenue and expenditure impacts and recommend appropriate responses to the City Council.

6.8.2 Drought Rate Structures and Surcharges

As conservation measures and requirements increase and the water supply decreases, the City will potentially see a reduction in revenue. To combat this and help pay for the expenses discussed above, the City Council is authorized to adopt a "drought surcharge" per Municipal Code 13.35.100.

Drought surcharges may be adopted by resolution of the City Council at the time of imposition and will remain until drought-related costs are recovered. Drought surcharges would be discontinued when triggered water shortage conditions are deactivated and no longer in effect.

6.9. Monitoring and Reporting

The City will conduct regular monitoring and reporting to ensure WSCP implementation is effective and responsive to conditions as they unfold. The City will then use this information to restore and maintain the water supply and demand balance. Similar to the supply and demand projections used to establish a shortage condition, the City will monitor the same data to determine effectiveness and efficacy.

Monitoring activity is expected to include, but not be limited to:

- Gathering monthly or bi-weekly customer water use data.
- Preparing technical assessments of customer water use and identifying deficiencies.

- Analyzing trends in water supply availability, including meteorological events, regional water supply coordination actions, and statewide regulatory trends.
- Assessing water conservation activities and the effectiveness of enforcement actions as applicable to achieving conservation objectives.

City staff will report to decision makers at least quarterly on status and results. Data reporting will include preparation of written reports and presentations, as necessary, for Benicia management meetings and other public meetings summarizing key information and data, including but not limited to:

- Actual water demands compared to projected demands by customer class and in total.
- Actual supply availability and utilized compared to projected availability for each supply source.
- Projected supply availability for next 12 months for each supply source.
- Monthly reporting of water production and conservation, as required by the State Water Resources Control Board.

These and other data will be regularly evaluated by staff to assess the effectiveness of response measures and to identify the need for any changes or modifications to the declared water shortage stage or actions based on the results. With regard to monitoring and reporting, City staff may determine the need for additional monitoring and reporting measures, or the need to develop or amend ordinances, or update the WSCP as a whole. Any WSCP update or modification will be conducted through the City Council meeting process, unless specific conditions require otherwise.

6.10. Re-evaluation and Improvement Procedures

Benicia will continually review and assess its procedures for implementing the WSCP. Specifically, Benicia will use the monitoring and reporting protocols identified above as a quality assurance and quality control measure to understand the effectiveness of water conservation activities. These re-evaluation and improvement procedures will include developing reports, memoranda, and presentations that assess the effectiveness of water conservation actions and the WSCP. These materials will be provided to Benicia's customers and decision-makers for consideration. Public comments on the published materials and management considerations should be incorporated into the development and implementation of future actions. These protocols will be continually assessed and updated by Benicia management staff.

6.11. Special Water Feature Distinction

For purposes of water shortage contingency planning and implementation, the City defines as "special water features" those that are artificially supplied with water, including ponds, lakes, waterfalls, and fountains. Such special water features are considered distinct from swimming pools and spas (as defined in subdivision (a) of Section 115921 of the Health and Safety Code).

Water shortage response actions will focus on health and safety issues and balancing continuation of these uses with the severity of the water shortage condition. The relative total water use from these sources is a consideration for how special water features and swimming pool uses could be curtailed

during specific water shortage conditions. For instance, when swimming pool filling and refilling would exceed a customer's use allocation under the various drought stages in the Municipal Code, then these actions are prohibited and can be subject to drought penalties and other City enforcement actions. Benicia determined that special water features are a relatively small discretionary use but may be restricted under all identified water shortage condition.

6.12. Plan Adoption, Submittal, and Availability

The WSCP has been adopted, submitted, and is available as required by the Urban Water Management Planning Act. As a stand-alone document, the WSCP is also subject to the following separate adoption, submittal, and availability processes, and whenever it is separately amended or revised in the future. Benicia may refine or amend this WSCP as necessary and in compliance with the normal public notice and adoption. Benicia has followed all applicable law in adopting the WSCPs. The current adopted WSCP shall be available to City customers and to Solano County Water Agency and Solano County within 30 days of its adoption. A copy of the current WSCP is available for public inspection during business hours at City Hall located at 250 East L Street, Benicia (subject to current COVID 19 restrictions). The current WSCP is posted and available for download here:
https://www.ci.benicia.ca.us/index.asp?SEC=C093A405-81FC-4A74-A441-04402BD7F860

Appendix 1 – Water Quality Assessment

The City of Benicia continually monitors the water quality within its system and, as noted in Chapter 3, manages its water assets to address imported water quality issues. The City treats the water derived from the Sacramento River Watershed and Solano Project system with appropriate treatment actions that meet all state and federal guidelines. The Table below shows the most recent water quality Consumer Confidence Report completed by the City.

Water Quality Standards	Goal Level	Max Level	North Bay Aqueduct		Lake Berryessa		Lake Herman		Treated Water	
			Range	Average	Range	Average	Range	Average	Range	Average
Primary Standards										
Aluminum	0.6	1	.2-.7	0.5		0.22		0.13		ND
Arsenic	0.004	10	2.7-3.8	3.3		3.2		7.9		ND
Fluoride	1	2	0-.2	0.08		ND		0.27	.1-1	0.8
Chromium	100	50	0-15	3.8		ND		ND		ND
Hexavalent Chromium	n/a	n/a		ND		ND		ND		ND
Cadmium	0.04	5	0-2.3	0.6		ND		ND		ND
Barium	2	1	0-.08	0.04		ND		ND		ND
Lead	0.2	15	5-23	28		ND		ND		ND
Coliform	0	5% Positive	present in source		present in source		present in source			ND
Trihalomethane	n/a	80		ND		ND		ND	38-73	59
Haloacetic Acids	n/a	60		n/a		n/a		n/a	9.9-19	16
Secondary Standards										
Aluminum	n/a	200	220-650	480		220		130		ND
Color	n/a	15	84-369	203		40		25		ND
Iron	n/a	300	494-1,740	985		370		220		ND
Manganese	500	50	34-102	59		ND		22		ND
Odor	n/a	3	3-4	4		ND		1		1
Turbidity	n/a	TT	5-29	15		12		15	.01-.3	0.03
TDS	n/a	1,000	150-331	209		200		350	106-840	237
E.C.	n/a	1,600	229-533	349		340		580	168-1,424	400
Chloride	n/a	500	15-55	30		5.9		34		8.8
Sulfate	n/a	500	15-54	30		21		48		28
Additional Constituents Analyzed										
Boron	n/a	1,000	140-230	165		n/a		n/a		n/a
Vanadium	n/a	50	4-6	5		n/a		n/a		n/a
Calcium	n/a	n/a	13-27	19		18		36		11
Free Chlorine	n/a	4		n/a		n/a		n/a		
Hardness	n/a	n/a	85-137	107		164		190	59-198	112
Magnesium	n/a	n/a	10-26	16		29		24		7.5
Potassium	n/a	n/a	2-3	2.2		1.4		n/a		n/a
Sodium	n/a	n/a	18-61	33		10		54		27
Alkalinity	n/a	n/a	84-120	101		150		200	69-180	110