Attachment 1

WATER SUPPLY ALTERNATIVES PLAN

for the City of Santa Rosa

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Woodard & Curran

City of Santa Rosa

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ACRONYMS AND ABBREVIATIONS

AF	acre-foot
AFY	acre-feet per year
AOP	advanced oxidation process
ASR	Aquifer Storage and Recovery
AWPF	Advanced Water Purification Facility
BAF	biological activated filtration
BPU	Board of Public Utilities
City	City of Santa Rosa
CII	Commercial, industrial, and-institutional
DPR	direct potable reuse
FAT	full advanced treatment
gpf	gallons per flush
gpm	gallons per minute
GSP	Groundwater Sustainability Plan
IPR	Indirect Potable Reuse
LTP	Laguna Treatment Plant
MF	microfiltration
MGD	million gallons per day
O&M	Operations and Maintenance
SFR	Single family residential
State Board	State Water Resources Control Board
SWA	surface water augmentation
UWMP	Urban Water Management Plan
WSAP	Water Supply Alternatives Plan

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EXECUTIVE SUMMARY

1. INTRODUCTION

1.1 Our Water Future: Purpose of the Water Supply Alternatives Plan

The City of Santa Rosa (City) wishes to expand and diversify its potable water supply portfolio to enhance its resiliency to mitigate the potential impacts of future water supply shortages caused by severe and/or prolonged droughts or catastrophic service interruptions. Currently, the City's Water Department (Santa Rosa Water) meets approximately 5-7 percent of its annual urban potable water demand from municipal wells and relies on Sonoma Water supplies for the remaining 93-95 percent. As a result of this dependency, if Sonoma Water were to experience a supply shortage or an interruption in service, the City's public water system will have a water supply shortage.

The City is particularly concerned about the impacts of drought. Over the past 20 years, the Sonoma County region has experienced three multi-year droughts: 2007-2009, 2013-2016, and 2020-2022. In response, Sonoma Water called for water use reductions, triggering the City to require its customers to reduce potable water use by 20 percent. Regional climate change assessments project that local droughts will likely become more severe and more frequent. Likewise, local water use analysis shows demand hardening (permanent reductions in water use by customers). Given these realities, Santa Rosa Water wishes to increase water supply resiliency and reliability by increasing the diversity and production capacity of its water supply portfolio.

As a result, Santa Rosa Water launched the Our Water Future project in May of 2022 and undertook development of this Water Supply Alternatives Plan (WSAP) in September 2022 to identify an adaptive approach to diversifying Santa Rosa's water supply portfolio and production capacity over time. The WSAP provides a variety of water supply portfolios for Santa Rosa Water to consider when planning future strategic investments and projects for increasing water supply resiliency and reliability. The WSAP is not intended to be a prescriptive document, but rather an adaptive guide for Santa Rosa Water to use as it embarks on water supply and infrastructure planning for Santa Rosa's future.

2. APPROACH TO DEVELOPING THE WATER SUPPLY ALTERNATIVES PLAN

2.1 Goal

The first objective of the Our Water Future project was establishing a water supply resiliency and reliability goal for Santa Rosa's future. Discussions with Santa Rosa Water staff (referred to as the Water Team), an external group of community leaders (referred to as the Stakeholder Group), the community at large, and the Board of Public Utilities (BPU) yielded the following framework outlining what the goal should accomplish:

1. *Guide Decision Making*: The goal should provide essential guidance to make informed decisions concerning the scale and scope of the resiliency portfolio.
2. *Improve Water Resiliency*: The goal should reduce the City's reliance on Sonoma Water supplies and enhance the City's potable water supply resiliency.

3. *Mitigate Shortages*: The goal should help mitigate potential shortages in Sonoma Water supply and minimize service interruptions during dry periods.
4. *Meet Peak Day Demand Locally*: The goal should help the City meet a portion of peak day demand using local supply.
5. *Allow for Flexibility and Adaptability*: The goal should be percentage based, thereby making it easier to adjust if future conditions change the amount of supply needed.

Thus, the water supply goal is to diversify and increase Santa Rosa Water's potable water supplies to reduce dependence on Sonoma Water, particularly to mitigate the impacts of future supply shortages or disruptions in service. New supplies would augment existing City groundwater production capacity (approximately 1,300 AFY, with an average of 2 million gallons per day (MGD) over approximately 6.5 months per year) to achieve the following targets outlined in **Table ES-1** below.

Table ES-1: Water Supply Targets for Santa Rosa's Water Future Goal

Mitigating Droughts	Mitigating Natural Disasters & Catastrophic Events	Mitigating Peak Day Demand
Meet 30% of City's water demand with municipal supplies to mitigate impacts of Russian River supply shortages (e.g., due to prolonged and/or severe drought). Based on current City demand projections, the volume of water required to meet this is 7,500 acre-feet per year (AFY) by 2045.	Provide 50% of normal domestic/indoor demand for potable water with municipal supplies during Russian River supply disruption. Based on current City demand projections, the volume of water required to meet this is 9 MGD by 2045.	Meet 30 percent of peak month average day demand for potable water with municipal supplies. Based on current City demand projections, the volume of water required to meet this is 9 MGD by 2045.

2.2 Analysis Methodology

The analysis methodology described briefly below was developed with input from the Water Team, Stakeholder Group, community, and BPU. After compiling a list of supply options with stakeholder input, Santa Rosa Water implemented pre-screening, screening, and feasibility analyses to identify the best candidates for achieving its water supply goal. **Figure ES-1** shows the overall steps in the analysis process.

Figure ES-1: Analysis Methodology Flowchart

- **Pre-screening:** Prior to in-depth analysis, all supply options were subjected to a high-level pre-screening to identify and remove options deemed infeasible or substantially similar to existing and anticipated reginal efforts or other supply options considered in the analysis.
- **Screening Analysis:** After pre-screening, all viable water supply options were screened for high-level assessments of cost-effectiveness and scalability.[1, 2] The screening tool helped determine the conceptual performance of each supply option in areas such as water yield and capital cost and removed options that were not cost-effective. Furthermore, the screening tool analyzed supply options in two hypothetical scenarios: baseline and maximum production. The baseline scenario assumed each water supply option would be operated in a realistic capacity (more in dry years, less in normal supply years) that aimed to minimize operational costs, in contrast to the maximum production scenario that assumed water supply options would be operated to maximize water production via nonstop (24/7) operation.
- **Detailed Feasibility Analysis:** Following the screening analysis, the short-listed supply options underwent a detailed feasibility analysis that involved developing eight evaluation criteria, assigning numerical weights reflecting community priorities to each criterion, and using a detailed rubric to issue each option a score between 0 to 2, with 2 being most favorable. A score of 0 signals that the option is not as responsive to a criterion or does not perform as well as the other options, while a score of 2 indicates that the option performs very well. A full description of the feasibility analysis and its findings are included in **Appendix A**.

3. WATER SUPPLY OPTIONS

To prepare for the feasibility analysis, Santa Rosa Water compiled an initial list of water supply options gathered from the Water Team, Stakeholder Group, community, and BPU. The final list of supply options includes a broad range of water supply sources such as groundwater, purified recycled water, recycled water, desalinated water, stormwater, and aggressive water efficiency programs. Each supply type has nested supply options that differ in project description, water capacity, and geography.

Table ES-2 lists the water supply options that were considered in the feasibility analysis. **Chapter 3** includes descriptions of each water supply option.

[1] Water supply options assessed in the feasibility analysis were developed at a conceptual level to estimate potential water supply costs. The cost estimates are considered Class 5 per the Association for the Advancement of Cost Engineering International guidelines as they are rough order of magnitude. Actual project costs would be expected to fall within +50 percent to -15 percent of the cost estimate.

[2] Scalability refers to how much water Santa Rosa Water could produce from the option now and how much water it could possibly produce in the future. An option with low scalability would yield similar amounts of water now and in the future.

Table ES-2: Initial List of Water Supply Options

Supply Type	Supply Option Name
Groundwater	GW-1: Additional Groundwater Extraction Wells GW-2: Convert Emergency Wells to Production Wells GW-3: Aquifer Storage and Recovery (ASR) Wells GW-4: Regional Groundwater Extraction Wells GW-5: Regional ASR Wells
Purified Recycled Water	PR-1: Direct Potable Reuse (DPR) Advanced Water Purification Facility (AWPF) at Laguna Treatment Plant (LTP) PR-2: Satellite DPR AWPF PR-3a: Indirect Potable Reuse (IPR) AWPF at LTP into Groundwater Basin PR-3b: IPR AWPF at LTP into Lake Ralphine PR-3c: IPR AWPF at LTP into Lake Sonoma PR-4: Regional DPR AWPF at LTP
Recycled Water	RW-1: Expand City's Urban Non-Potable Recycled Water System
Desalination	DE-1: Regional Brackish Desalination DE-2: Ocean Desalination
Stormwater	SW-1: Stormwater Storage in Aquifer SW-2: Stormwater Storage in Lake Ralphine SW-3: Regional Stormwater
Efficiency Programs	E-1: Efficiency Programs

4. ANALYSIS OF WATER SUPPLY OPTIONS

4.1 Pre-Screening Results:

The 18 initial supply options were subjected to pre-screening to remove infeasible options or those that overlap with existing or planned efforts in the region. Five supply options, GW-4, GW-5, PR-3b, SW-2, and SW-3, were identified in this process and not advanced for further study.

Two options (PR-3b and SW-2) would rely on Lake Ralphine for storage. However, Lake Ralphine lacks sufficient capacity for storage, and expansion would require raising the existing dam, displacing adjacent recreational areas, and encroaching upon residential neighborhoods and unfavorable topography. Therefore, PR-3b and SW-2 were deemed infeasible and did not continue to the screening process.

Santa Rosa expects options GW-4, GW-5, and SW-3 will be moving forward regionally under the leadership of Sonoma Water, the Santa Rosa Plain Groundwater Sustainability Agency (GSA), and the

Russian River Water Forum. Santa Rosa is deeply involved in regional efforts as a primary water contractor to Sonoma Water, as an active member of the GSA Board and the GSA Board's Advisory Committee, and as an active member of the Planning Group for the Russian River Water Forum. The City is committed to continue working with these and other partners on regional efforts to enhance regional water supply resiliency and groundwater basin sustainability as opportunities arise. **Table ES-3** summarizes the reasons for removal during pre-screening.

Table ES-3: Supply Options Removed During Pre-Screening

Category	Supply Option	Reason for Removal
Groundwater	GW-4: Regional groundwater extraction wells	Regional groundwater projects are likely to move forward as Sonoma Water continues to increase its water supply reliability efforts and the City is committed to participate as a water contractor. However, GW-4, in its current form, would likely require a recharge element to comply with the Santa Rosa Plain Groundwater Sustainability Agency (GSA) sustainability efforts. Therefore, GW-4 overlaps substantially with local and regional ASR supply options. Additionally, this supply option does not reduce reliance on the Sonoma Water distribution system. Thus, this option was not carried forward to the screening analysis.
	GW-5: Regional ASR wells	Regional ASR projects are likely to move forward as Sonoma Water continues to increase its water supply reliability efforts and as the GSA pursues long-term groundwater basin sustainability. The City is committed to working with its partners on these future regional ASR projects. However, GW-5, in its current form, does not reduce reliance on the Sonoma Water distribution system. Therefore, this supply option did not advance to the screening analysis.
Purified Recycled Water	PR-3b: IPR AWPF at LTP via Lake Ralphine	Lake Ralphine lacks sufficient capacity to store purified water for the minimum required 2-month retention period. Expansion would require raising the existing dam, displacing adjacent recreational areas, and encroaching upon residential neighborhoods and unfavorable topography. Therefore, this supply option was deemed infeasible and did not continue to the screening process.
Stormwater	SW-2: Capture stormwater and store in Lake Ralphine (or alternate site)	Lake Ralphine lacks sufficient capacity to store captured stormwater. Expansion would require raising the existing dam, displacing adjacent recreational areas, and encroaching upon residential neighborhoods and unfavorable topography. Likewise, prior City review of planning, water systems, and topography has failed to identify a suitable alternative surface water site. Therefore, this supply option was deemed infeasible and did not continue to the screening process.
	SW-3: Regional stormwater	SW-3 would have substantial overlap with regional stormwater projects for water supply resiliency, flood control, and groundwater sustainability. As a water contractor with Sonoma Water and as an engaged participant in the GSA, the City will participate in future regional stormwater projects implemented by Sonoma Water and/or the GSA. Due to these factors, this supply option was not advanced to the screening analysis.

4.2 Screening Analysis Results:

Following pre-screening, the 13 remaining supply options were input into a screening tool that analyzed the conceptual performance of the supply options in two hypothetical scenarios: baseline and maximum production. This process produced technical data regarding each supply option, removing an additional six supply options deemed to be not cost-effective. These options included PR-1, PR-3a, PR-3c, RW-1, DE-1, and DE-2. **Table ES-4** presents the supply options removed during the screening process with a brief rationale for why they were removed.

Table ES-4: Supply Options Removed During the Screening Analysis

Category	Supply Option	Reason for Removal
Purified Recycled Water	PR-1: DPR AWPF at LTP	This supply option was removed because it is not cost-effective based on Santa Rosa's current and projected water supply needs.[1]
	PR3a: IPR AWPF at LTP via Delta Pond	This supply option was removed because it is not cost-effective based on Santa Rosa's current and projected water supply needs.
	PR-3c: IPR AWPF at LTP via Lake Sonoma	This supply option was removed because it is not cost-effective based on Santa Rosa's current and projected water supply needs. Additionally, it does not reduce Santa Rosa's reliance on Sonoma Water.
Non-potable Recycled Water	RW-1: Expand City's non-potable recycled water system	This supply option was removed because it does not provide the City with potable water and is not cost-effective based on the City's current and projected water supply needs.
Desalination[2]	DE-1: Regional brackish desalination	This supply option was removed because it is not cost-effective based on the City's current and projected water supply needs. While future circumstances could improve its performance, it does not reduce the City's reliance on regional partner involvement (i.e., Marin Municipal Water District) and the Sonoma Water system). Additionally, it currently faces significant permitting and regulatory challenges and uncertainties.
	DE-2: Ocean desalination	This supply option was removed because its high operational and energy costs are not currently cost-effective based on the City's current and projected water supply needs. Additionally, it currently faces significant permitting and regulatory challenges and uncertainties; However future circumstances could improve its performance.

Notes:

(1) Despite PR-1 being marginally more cost-effective than PR-2, the latter was chosen to advance because it more closely aligns with the City's goals to be less reliant on the Sonoma Water system and would require less siting constraint than if the AWPF was collocated at LTP. Additionally, it is important to note that less cost-effective supply options were carried forward to provide a broader suite of options and greater diversity of potential supplies.

(2) **Appendix I** discusses the reason for removing desalination as a supply option and outlines how changes to future circumstances could improve desalination's viability and trigger the City to reassess its potential as a supply option.

Desalination presents substantial challenges that are not fully captured in the brief summary of the screening process for cost effectiveness and scalability. The WSAP presents an ideal opportunity to document in greater detail what was learned about desalination in the process of conducting the study, why DE-1 and DE-2 did not advance, and which changing circumstances in the future could trigger reassessing one or both desalination options to determine if they have become more viable. Therefore, additional discussion and analysis of the desalination options DE-1 and DE-2 have been compiled and included as **Appendix I**.

Appendix I also provides an assessment of how DE-1 and DE-2 would have scored in the feasibility analysis, more detailed information about the reasons these options did not advance at this time, and the primary triggers (or changing circumstances) that could help the City determine whether and when it might be advantageous to reconsider desalination in the future. In addition, Portfolio 4 includes reminders to reassess whether to trigger a reassessment of desalination at key decision points.

4.3 Detailed Feasibility Analysis Results

Upon completion of the screening analysis, the remaining seven water supply options advanced to the detailed feasibility study. During this process, supply options were graded using eight evaluation criteria and assigned a numerical score of 0 through 2, with 2 being most favorable. A score of 0 indicates that an option is not as responsive to a criterion or does not perform as well as the other options, while a score of 2 indicates that the option performs very well. The production potential of each option was considered individually and not limited to the targets in the goal, to assess a wide range of capacity. **Table ES-5** displays the result of the feasibility analysis and the scores of each supply option.

Table ES-5: Summary of Supply Option Scores

Criterion	Groundwater			Purified Recycled Water		Stormwater	E-1: Efficiency Programs
	GW-1: Add Extraction Wells	GW-2: Convert Emergency Wells	GW-3: City ASR Wells	PR-2: Satellite DPR	PR-4: Regional DPR	SW-1: Stormwater Storage in Aquifer	
Cost effectiveness [$/AF]	2 [$840/AF]	2 [$540/AF]	2 [$2,600/AF]	0 [$3,900/AF]	0 [$3,200/AF]	0 [$3,500/AF]	1 [$2,800/AF]
Scalability [Yield in AFY]	2 [6,734 – 10,080 AFY]	0 [1,744 – 2,462 AFY]	1 [3,634 – 5,130 AFY]	2 [3,019 – 10,065 AFY]	2 [3,019 – 10,065 AFY]	1 [2,600 – 10,080 AFY]	1 [2,145 AFY]
Resiliency	1	1	2	2	2	1	1
Equity	1	1	1	1	1	1	2
Environmental performance	1	2	1	0	1	1	2
Legal, permitting, & regulatory	1	2	0	0	0	1	2
City control & interagency coordination	2	2	1	2	0	2	2
Multi-benefit	0	0	1	0	0	2	1
Total Unweighted	10	10	9	7	6	9	12
Total Weighted	32	26	29	21	22	19	30

5. PORTFOLIOS

For the WSAP, Santa Rosa Water elected to use portfolios instead of individual supply options because they offer the dual benefits of diversification and flexibility. This enables Santa Rosa to diversify the risk of each water supply option, periodically assess the performance of each portfolio, and, if necessary, pivot between supply options to adequately address water supply needs. The WSAP includes four portfolios for the City to consider for its water future, to achieve its targets by augmenting existing City groundwater production capacity (approximately 1,300 AFY, with an average of 2 MGD for about 6.5 months per year) with new supplies. Each portfolio is comprised of water supply options that underwent the detailed feasibility analysis described above and in greater detail in **Chapter 4**. Scoring was influential in the formation of portfolios but was not the only determining factor. Generally speaking, supply options that scored well are included or considered in multiple portfolios; however, some supply options that did not score as highly are included in portfolios to further diversify the range of supply options. **Table ES-6** provides an overview of the supply options included in each portfolio.

Table ES-6: Draft Portfolio Compositions

Option	**Description**	**Portfolio 1 Most Economical**	**Portfolio 2 Fastest**	**Portfolio 3 Most Water**	**Portfolio 4 Most Adaptive**
GW-1	Add Extraction Wells (Up to 12)		✓	✓	✓
GW-2	Convert Emergency Wells to Production Wells	✓	✓	✓	✓
GW-3	Aquifer Storage & Recovery Wells				**Consider**
PR-2	Satellite Direct Potable Reuse			✓	**Consider**
PR-4	Regional Direct Potable Reuse at Laguna Treatment Plant				**Consider**
SW-1	Stormwater Storage in Aquifer			**Consider**	**Consider**
E-1	Efficiency Programs	✓	✓	✓	✓

5.1 Portfolio 1: Most Economical

The first portfolio's theme focuses on meeting the City's water supply goals in the most economical way. Portfolio 1 integrates two options: enhanced efficiency measures (E-1) and conversion of existing emergency groundwater wells to production wells (GW-2). While this portfolio could meet the 7,500 AFY water supply goal based on water capacity, it is estimated to realistically provide about 4,600 AFY. Because E-1 has no capital costs, this portfolio's total capital costs are equivalent to the costs for GW-2. Annual Operations and Management (O&M) costs are equal to the costs needed to run the efficiency program (E-1) and the incremental cost to operate and maintain the former emergency wells as new production wells. **Table ES-7** presents estimated cost, yield, and scalability information for the portfolio components.

Table ES-7: Portfolio 1 Composition

Portfolio 1	Water Capacity[1] (AFY)	Estimated Yield (AFY)[2]	Total Capital Costs	Annual O&M Costs	Scalability[3]
E-1	1,500 – 4,500	2,145	$0	$6,000,000	1
GW-2	1,500 – 3,000	2,462	$12,000,000	$530,000	0
TOTAL	**3,000 – 7,500**	**4,607**	**$12,000,000**	**$6,530,000**	

Notes:

(1) Water capacity refers to the range of water supply that could be achieved if the water supply option were implemented.

(2) Estimated yield is an estimate of the amount of water that would be supplied by the option based on certain operating and/or implementation assumptions. More information on these assumptions is included in Appendix A.

(3) Scalability for each of the portfolio components refers to the degree to which an option could provide a different amount of water now and in the future. Scalability was assigned a numerical score of 0 through 2, with 0 indicating an option is not as responsive to a criterion or does not perform as well as the other options and 2 indicating that the option performs very well.

In this portfolio's conceptual timeline, both projects would be implemented at the same time. E-1 would begin with developing new programs, increasing the uptake of existing water efficiency programs, and hiring the additional staff needed to implement those programs. GW-2 would begin with technical studies to determine the conversion design for the emergency wells and environmental documentation to cover the work under the California Environmental Quality Act (CEQA). A key aspect of the technical studies would be focused on sustainable yield, to ensure that conversion of the standby wells to production wells would not adversely affect groundwater basin sustainability.

5.2 Portfolio 2: Fastest

The second portfolio focuses on achieving fast implementation of the portfolio's projects to quickly meet the City's water supply goal. Portfolio 2 is comprised of enhanced efficiency measures (E-1), converting emergency groundwater wells to production wells (GW-2), and constructing 12 new production wells (GW-1), all of which can begin relatively quickly and proceed simultaneously. When compared to Portfolio 1, this portfolio offers more water supply and would reduce the risk of the City falling short of its water supply goals. The City recognizes that establishing 12 new wells (GW-1) could result in exceeding the cumulative production targets of 7,500 AFY and 9 MGD by 2045. By carefully monitoring aggregated production capacity before considering each new well, Santa Rosa Water would avoid developing more groundwater facilities than needed to achieve its targets. **Table ES-8** presents estimated cost, yield, and scalability information for the portfolio components.

Table ES-8: Portfolio 2 Composition

Portfolio 2	Water Capacity[1] (AFY)	Estimated Yield (AFY)[2]	Total Capital Costs	Annual O&M Costs	Scalability[3]
E-1	1,500 – 4,500	2,145	$0	$6,000,000	1
GW-2	1,500 – 3,000	2,462	$12,000,000	$530,000	0
GW-1	5,040 – 10,080	10,080	$96,500,000	$3,900,000	2
TOTAL	**8,040 – 17,580**	**14,687**	**$108,500,000**	**$10,430,000**	

Notes:

(1) Water capacity refers to the range of water supply that could be achieved if the water supply option were implemented.

(2) Estimated yield is an estimate of the amount of water that would be supplied by the option based on certain operating and/or implementation assumptions. More information on these assumptions is included in Appendix A. By carefully monitoring actual aggregated production capacity before considering new projects, the City would avoid developing more supply facilities than needed to achieve the targets.

(3) Scalability for each of the portfolio components refers to the degree to which an option could provide a different amount of water now and in the future. Scalability was assigned a numerical score of 0 through 2, with 0 indicating low scalability compared to other options and 2 indicating a high degree of scalability.

Implementation of Portfolio 2 is very similar to that of Portfolio 1 in that E-1 and GW-2 are implemented right away. Portfolio 2 differs in that GW-1 will also start immediately with siting studies aimed at identifying the best locations for new groundwater wells. However, one potential drawback of this portfolio and its guiding theme is that Santa Rosa Water may risk overbuilding by drilling new production wells before the benefits of GW-2 and E-1 are realized.

5.3 Portfolio 3: Most Water

The third portfolio focuses on maximizing water supply reliability by including a diverse array of supply options. Portfolio 3 incorporates the three supply options included in Portfolio 2 (E-1, GW-2, GW-1), and adds PR-2 (satellite direct potable reuse) and SW-1 (stormwater capture and reuse). Since this portfolio aims to maximize water production from a varied selection of supply options, even the lower bound of Portfolio 3's capacity far exceeds the City's cumulative production targets of 7,500 AFY and 9 MGD. However, the City recognizes that a full buildout would likely surpass its target and, therefore, Portfolio 3 is unlikely to be fully executed. By carefully monitoring aggregated production capacity before considering each new source, Santa Rosa Water would avoid developing more facilities than needed to achieve its water supply targets. **Table ES-9** presents estimated cost, yield, and scalability information for the portfolio components.

Table ES-9: Portfolio 3 Composition

Portfolio 3	Water Capacity[1] (AFY)	Estimated Yield (AFY)[2]	Total Capital Costs	Annual O&M Costs	Scalability[3]
E-1	1,500 – 4,500	2,145	$0	$6,000,000	1
GW-2	1,500 – 3,000	2,462	$12,000,000	$530,000	0
GW-1	5,040 – 10,080	10,080	$96,500,000	$3,900,000	2
PR-2	8,000 – 10,065	10,065	$314,000,000	$12,030,000	2
SW-1	5,000 – 10,080	10,080	$222,500,000	$8,390,000	1
TOTAL	**21,040 – 37,725**	**34,832**	**$645,000,000**	**$30,850,000**	

Notes:

(1) Water capacity refers to the range of water supply that could be achieved if the water supply option were implemented.

(2) Estimated yield is an estimate of the amount of water that would be supplied by the option based on certain operating and/or implementation assumptions. More information on these assumptions is included in Appendix A. By carefully monitoring actual aggregated production capacity before considering new projects, the City would avoid developing more supply facilities than needed to achieve the targets.

(3) Scalability for each of the portfolio components refers to the degree to which an option could provide a different amount of water now and in the future. Scalability was assigned a numerical score of 0 through 2, with 0 indicating low scalability compared to other options and 2 indicating a high degree of scalability.

The conceptual timeline for Portfolio 3 begins similarly to Portfolio 2, with options E-1, GW-2, and GW-1 implemented right away. To maximize the amount of water available, PR-2 also begins immediately with planning studies, followed by CEQA and other permitting/regulatory processes which are anticipated to be extensive for a direct potable reuse project. Design and construction of the satellite direct potable reuse facility would begin directly following regulatory and environmental approvals.

In contrast to the prior two portfolios, Portfolio 3 introduces a degree of flexibility with the phasing of SW-1, which is why it is noted as "consider" in the portfolio. Planning studies and stormwater modeling for SW-1 would begin immediately, in line with the timing of the other elements of this portfolio. However, further work on SW-1 would pause until the yield performance of E-1, GW-2, and GW-1 is established. Depending on the need for additional water at that time, Santa Rosa Water may decide to move into design and construction of SW-1. This timeline enables staff to plan for some level of flexibility as this portfolio also works to maximize water availability**.**

5.4 Portfolio 4: Most Adaptive

The fourth portfolio focuses on adaptability, building upon the flexibility introduced in Portfolio 3, by providing the most flexible path forward of all the portfolios. This portfolio incorporates interactions among the various supply options to afford Santa Rosa Water additional opportunities to reassess and adjust its needs when pursuing new water supply sources in the future. Portfolio 4 includes largely the same elements as Portfolio 3: enhanced efficiency measures (E-1), converting emergency groundwater wells to production wells (GW-2), constructing new production wells (GW-1), satellite direct potable reuse (PR-2), and stormwater capture and reuse (SW-1). There are several defining features of Portfolio 4 that distinguish it from Portfolio 3. One crucial difference is the addition of ASR elements (GW-3) to GW-1 (referred to as GW-1+ in the table below). Furthermore, Portfolio 4 allows for the consideration of LTP as a location for a direct potable reuse facility (PR-1) and considers a regional direct potable reuse option (PR-4) when studying PR-2 (referred to as PR-2+ in the table below). Most critically, Portfolio 4 incorporates "adaptive pathways" for its implementation to maximize flexibility. As such, the City would carefully monitor aggregated production capacity before considering new projects to avoid developing more supply facilities than needed to achieve the targets outlined in the goal.

In alignment with the portfolio's theme of adaptability, Portfolio 4 offers flexibility via adaptive implementation pathways. One potential implementation pathway (a baseline scenario) would begin as the other WSAP portfolios do, with E-1, GW-2, and GW-1+ beginning right away. Siting studies for GW-1+ would identify and prioritize locations that could be suitable for both extraction and injection wells. SW-1 studies would also begin since stormwater could potentially be used for an ASR well within GW-1+. Once siting studies are complete for GW-1+, this component would pause while E-1 and GW-2 advance. Work on GW-1+ would continue when Santa Rosa Water had developed a better understanding of the actual yield of E-1 and GW-2. This would allow staff to right-size GW-1+ by only constructing what is required to meet the remaining need for water. Depending on the need for water provided by GW-1+, SW-1 would continue with design and construction to provide any stormwater required for injection as part of GW-1+.

The start time for PR-2+ coincides with the anticipated release of final guidelines on direct potable reuse from the State Water Resources Control Board (State Board), potentially by spring 2024 but likely several years later to adopt amendments or adjustments based on the experiences of early implementers. This portfolio advises that Santa Rosa Water may wish to wait to begin planning studies on PR-2+ until these regulations are a bit more established, in order to provide the most realistic planning and design criteria. Once planning studies for PR-2+ are complete, work on this component would pause until the actual yield for GW-1+ is established and the need for PR-2+ is better understood. This would allow Santa Rosa Water to scale PR-2+ to meet any remaining water needs. Another benefit of pausing the further planning of PR-2+ is to allow time for staff to study the best location and to assess and develop any regional partnerships that may support the scalability of this component. There may also be opportunities to use water available under SW-1 to supply PR-2+, if there is additional SW-1 water available after its potential use in GW-1+. Furthermore, the phasing of PR-2+ enables the City to reassess the viability of alternative supply options at various key decision points, allowing for the reconsideration of supply options like desalination if changing future circumstances would improve potential performance.

Table ES-10 presents cost, yield, and scalability information for Portfolio 4. Because this portfolio is structured around adaptability, the estimated cost and capacity figures would only be reached if the entire portfolio were built. Due to flexibility offered by this portfolio, these figures are likely to be much lower.

Table ES-10: Portfolio 4 Composition

Portfolio 4	Water Capacity[1] (AFY)	Estimated Yield (AFY)[2]	Total Capital Costs	Annual O&M Costs	Scalability[3]
E-1	1,500 – 4,500	2,145	$0	$6,000,000	1
GW-2	1,500 – 3,000	2,462	$12,000,000	$530,000	0
GW-1+[4]	5,040 – 10,080	10,080	$96,500,000	$3,900,000	2
PR-2+[5]	8,000 – 10,065	10,065	$314,000,000	$12,030,000	2
SW-1	5,000 – 10,080	10,080	$222,500,000	$8,390,000	1
TOTAL	**21,040 – 37,725**	**34,832**	**$645,000,000**	**$30,850,000**	

Notes:

(1) Water capacity refers to the range of water supply that could be achieved if the water supply option were implemented.

(2) Estimated yield is an estimate of the amount of water that would be supplied by the option based on certain operating and/or implementation assumptions. More information on these assumptions is included in Appendix A. By carefully monitoring actual aggregated production capacity before considering new projects, the City would avoid developing more supply facilities than needed to achieve the targets.

(3) Scalability for each of the portfolio components refers to the degree to which an option could provide a different amount of water now and in the future. Scalability was assigned a numerical score of 0 through 2, with 0 indicating low scalability compared to other options and 2 indicating a high degree of scalability.

(4) GW-1+ indicates that the component includes aquifer storage and recovery elements. The information presented for GW-1+ is consistent with GW-1, though Santa Rosa Water acknowledges that if ASR wells were incorporated into this supply component, capacity, yield, and costs would very likely change.

(5) PR-2+ indicates that the component could incorporate studying and potentially developing a regional approach to direct potable reuse (PR-4). Santa Rosa Water acknowledges that capacity, yield, and costs would very likely change should a regional project move forward. Additionally, PR-2+ allows for reassessment at key decision points if changing circumstances have improved the viability of alternative supply option, such as desalination.

A more detailed version of the baseline conceptual implementation timeline for Portfolio 4 is included in **Appendix F**.

6. NEXT STEPS

The WSAP presents a variety of potential pathways that Santa Rosa Water may follow as it plans for its water future. Based on discussions with stakeholders, Portfolio 4 appears to offer the most benefits, primarily because it is most responsive to the City's initial goals and provides the most flexibility to adapt to changing conditions in the future. If Santa Rosa Water decided to adopt Portfolio 4, staff could begin by following several key steps.

- Identify funding sources to support early project work and establish scoping to better understand costs and determine which work will be completed by Santa Rosa Water staff and which work will be opened for bidding. Also, Santa Rosa Water could begin planning for the initial capital expenditures that will come as GW-1+ and GW-2 advance.
- Begin implementing the early stages of E-1, GW-2, and GW-1+. For E-1, Santa Rosa Water staff can rely on extensive staff experience in efficiency programs to begin internal implementation plans and identify internal and external funding opportunities. Because Santa Rosa Water has already acquired some funding for emergency well conversion, it may be able to begin hydrogeologic studies and confirm the CEQA coverage required for GW-2. Once hydrogeologic studies are completed, they will support the environmental documentation process and enable the State Board and interagency coordination (including Public Trust Review) to begin regulatory approvals. Furthermore, staff could prepare its siting study for GW-1+ by identifying potential sites that could be eligible for extraction only and ASR wells and begin conducting field investigations of promising sites. During this step, results from the modeling and siting study work for SW-1 can be folded into the process so staff can determine if ASR wells with stormwater is a viable path forward.
- Begin discussions with the GSA to coordinate strategies that align GW-2 and GW-1+ with the mandate for groundwater sustainability detailed in the Groundwater Sustainability Plan (GSP). As both a member of the GSA Board and the Board's Advisory Committee, Santa Rosa is deeply committed to ensuring groundwater basin sustainability.
- Begin work on PR-2 by tracking the draft guidelines from the State Board before beginning a treatment study to identify the processes needed to produce and use water through direct potable reuse. Additionally, begin initial planning studies for SW-1 including stormwater modeling, a siting study, and a treatment study.

Regardless of the path forward, staff must consider the following four areas that are subject to dynamic change as Santa Rosa Water continues to plan for its water future: funding, technology, regulations, and regional efforts. Monitoring advancements and opportunities in these areas will help staff remain agile and able to quickly adapt its water supply planning efforts.

1. Implementing any of portfolios outlined in the WSAP would require varying levels of funding and funding strategies. Santa Rosa Water typically funds capital projects through some combination of grants, bonds, connection fees, and water rates. State and federal agencies often award grants or low-interest loans and this funding source will likely be instrumental if Santa Rosa Water considers implementing direct potable reuse. Likewise, Santa Rosa Water may opt to issue bonds to raise capital, as it has previously done for large projects. Finally, Santa Rosa Water could review

connection fees and water rates to develop a new fee and/or rate schedule to support continued investment in its water infrastructure and operations and maintenance. However, the WSAP only provides a snapshot in time. Factors such as advances in technology, regulatory changes, worsening drought severity and/or frequency, and increases in wholesale water rates all contribute to the cost-effectiveness of water supply options. Thus, Santa Rosa Water should continuously re-analyze the cost-effectiveness of projects and make adjustments that enable the best options to move forward.

2. Technological advances continue to influence the way in which water suppliers select and implement water supply projects. Both direct and indirect advancements in areas including wastewater treatment, energy efficiency, and artificial intelligence may substantially impact the feasibility and cost-effectiveness of water supply options. Staying informed about technological developments will help Santa Rosa Water remain agile and adjust its water supply planning to more effectively manage its water resources and continue to improve resiliency.

3. Regulations at the local, state, and federal levels continue to greatly impact water resources planning. Emerging water quality concerns, such as microplastics and per- and polyfluoroalkyl substances (PFAS), are nascent areas for regulation that will likely impact how Santa Rosa Water implements water supply projects. Staff should continue to monitor regulatory developments that would have the potential to alter the course of water supply components in the WSAP.

4. As a primary water contractor to Sonoma Water and a member of the GSA Board, the GSA's Advisory Committee, and the Russian River Water Forum, Santa Rosa is actively involved in a number of regional efforts and is committed to continue working with regional partners to enhance regional water sustainability and resiliency. With thoughtful planning, the City has positioned itself to stay informed about and seek opportunities to work with partners on mutually beneficial water supply projects.

1. INTRODUCTION

1.1 Background

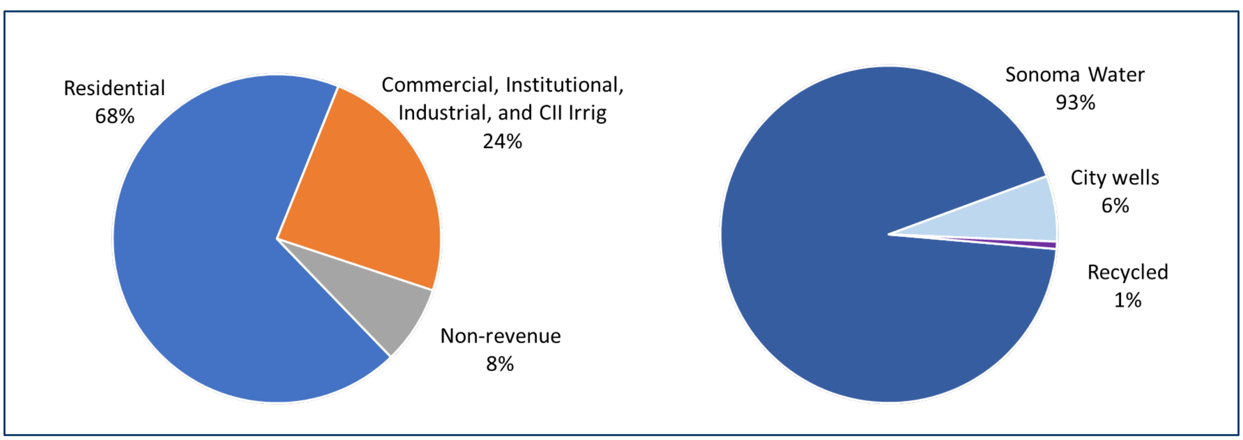
The City of Santa Rosa's Water Department (Santa Rosa Water) is responsible for delivering high-quality, reliable water to roughly 54,000 metered connections. Utilizing an extensive network of 600 miles of pipes, Santa Rosa Water supplies drinking water to 176,000 residents and thousands of local businesses and institutions. Santa Rosa Water also manages a comprehensive wastewater system with 600 miles of pipelines leading to the Laguna Treatment Plant (LTP). The LTP not only treats wastewater from Santa Rosa, but also processes wastewater from neighboring areas including Sebastopol, Cotati, Rohnert Park, and South Park Sanitation District. The LTP produces about seven billion gallons of high-quality recycled water annually, used for agricultural, urban irrigation, and delivered to Calpine to generate clean energy through steam production.

The City's 2020 Urban Water Management Plan (UWMP) includes details about Santa Rosa's planned water supplies and projected demands through 2045 during an average water year, a single dry year, and dry five-year periods. As documented in the UWMP, Santa Rosa Water has three existing and planned sources of water: entitlement limit of 29,100 acre-feet per year (AFY) from Sonoma County Water Agency (Sonoma Water), 2,300 AFY of local groundwater supply from City wells, and 140 AFY of recycled water supply from the City's Regional Water Reuse System. Sonoma Water is the primary source, accounting for approximately 93 percent of the City's total supply. This water originates primarily from the Russian River which benefits from natural filtration through the riverbed to meet or exceed water quality standards.

The UWMP concludes that the City's three supply sources would be sufficient to meet projected water demands through 2045 in average rainfall years and even below average rainfall years. However, in severely dry years, water supplies would not be sufficient to meet projected ordinary water demands of Santa Rosa Water's customers. If the City were to experience a water shortage of 30 percent or more, water customers would be required to adhere to strict, site-specific water allocations (water rationing) and new development would be required to offset new demand for water to achieve a net zero impact.

Figure 1-1 below shows 2020 water use in Santa Rosa and the water supply sources.

Figure 1-1: Santa Rosa Water Use by End Use and Supply Type (2020)



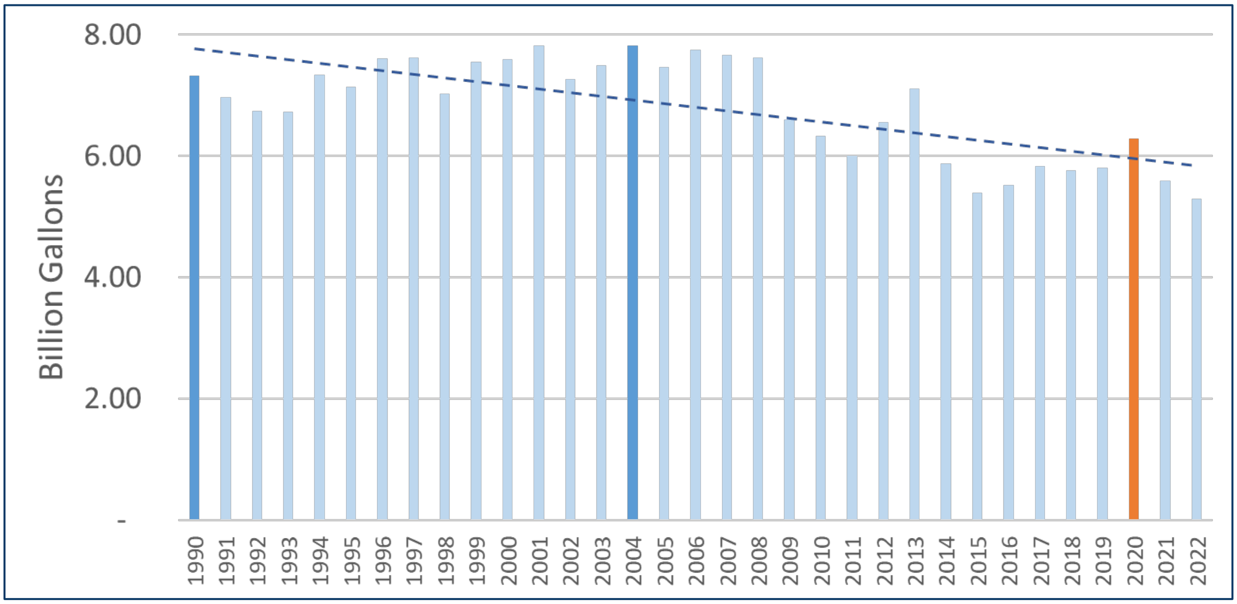
Over two-thirds (68 percent) of the water used in Santa Rosa is for residential purposes. About 24 percent is used by businesses and other institutions, with the remaining eight percent of water use categorized as non-revenue water for firefighting and system maintenance.

Santa Rosa Water has a long-standing strong commitment to water supply planning and efficiency. The City gradually began to develop its municipal water supply system in 1896 to serve residents within the corporate city limits. In 1947, the City acquired a privately owned water company that had served portions of Santa Rosa under a franchise agreement for nearly 75 years. At that time, the City ensured that all water service connections throughout its jurisdiction had meters. The City's water supply sources at that time included Lake Ralphine, natural springs, and wells. Over the next 10 years, the City saw rapid population growth and projections that growth would continue. This spurred Santa Rosa to contract with Sonoma Water and connect to its new water supply system in 1959, to secure a reliable and clean water supply from the Russian River.

The City first implemented water conservation efforts during the severe drought experienced in 1976 to 1978. In 1991, Santa Rosa Water hired its first professional water conservation manager and began to offer ongoing water use efficiency rebates and assistance. Since that time, Santa Rosa Water has fully staffed and funded water use efficiency programs to help the community use water wisely during wet years and dry years. In addition, Santa Rosa Water has a long history of charging water customers based on their water usage, which also encourages careful water consumption. Since the State adopted the Urban Water Management Planning Act in 1983, Santa Rosa has been developing and updating long-term water supply plans with a 25-year planning horizon every five years; the City also adopted its first Water Shortage Contingency Plan in 1992, which is updated with the Urban Water Management Plan every five years. Furthermore, the City has been an early implementer of State water efficient development standards, including adopting the first Water Efficient Landscape Ordinance in 1993 and early "Cal Green" building and plumbing codes in 1995. The City also adopted a Water Waste Ordinance in 1999 to prohibit waste of water due to customer plumbing leaks and runoff from landscape irrigation. The City actively enforces the ordinance and also closely monitors its own water distribution system for leaks and makes repairs quickly to prevent waste.

Over the last 30 years, water use in Santa Rosa has seen a remarkable decline despite significant population growth. **Figure 1-2** below shows total water use (sales to customers and nonrevenue water use) in Santa Rosa from 1990 to 2022. Comparing water use in 2020 (orange bar) to drought years like 1990 and peak use in 2004 (blue bars), Santa Rosa has seen a reduction in water use of 14 percent and 20 percent, respectively. During this same period, the population in Santa Rosa increased 57 percent.

Figure 1-2: Water Use in Santa Rosa (1990 – 2022)



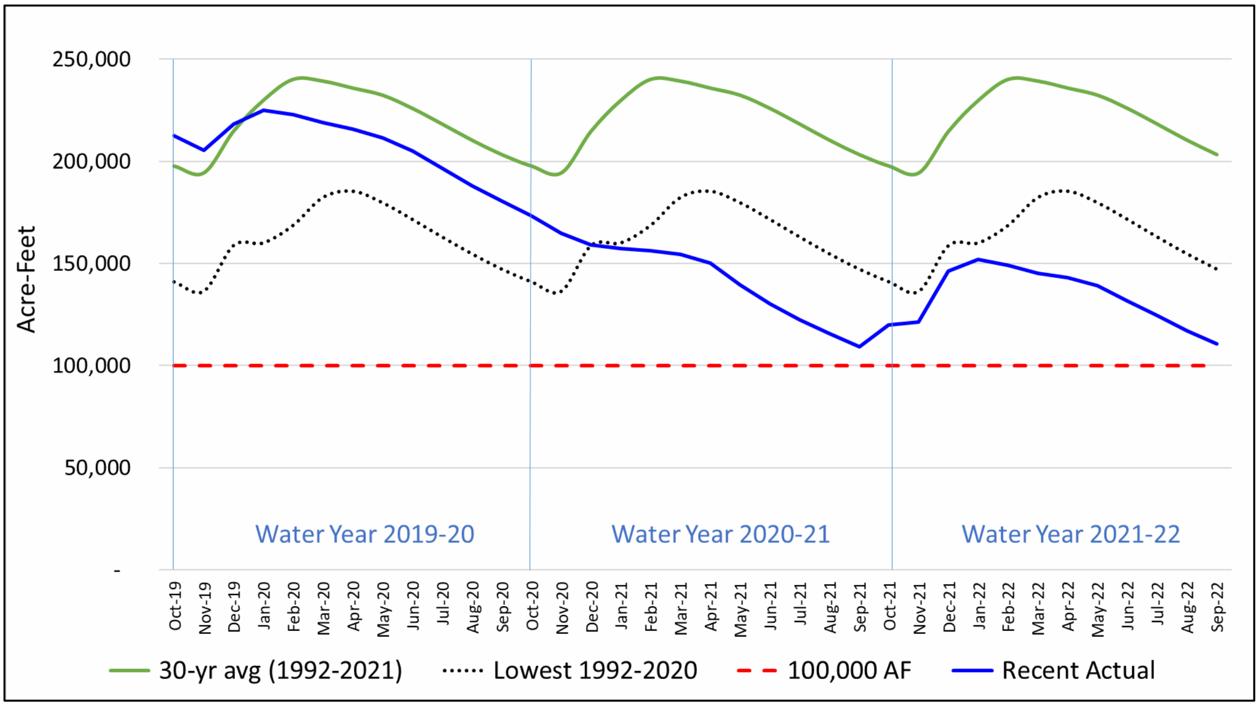
This reduction in water use can be attributed to Santa Rosa Water's successful expansion of its conservation initiatives, including staffing its water use efficiency team and providing customer assistance, rebates, and incentives to promote water-saving practices. These efforts along with early adoption of State building and plumbing codes have resulted in a decrease in the number of gallons used per person per day (gallons per capita per day, or GPCD) from 177 GPCD in 1990 to 97 GPCD in 2020, marking a significant 45 percent reduction in use per person. The residential sector has contributed to this, with a 45 percent decrease in average daily use from 120 GPCD in 1990 to 65 GPCD in 2020. Santa Rosa's community has become more water-efficient, resulting in a significant reduction in water use despite considerable population growth in the last 30 years.

In typical years with average rainfall, Santa Rosa's current water supply meets the needs of its customers through 2045 and beyond, due to the significant water efficiency improvements and the City's adoption of water efficient building and plumbing codes, as highlighted above. Future projections indicate that even with a potential 48 percent increase in residents compared to 2005, water demand is estimated to be only 9 percent higher by 2045, reflecting the continued effectiveness of water use efficiency measures and water efficiency building and plumbing codes. While Santa Rosa's water supply is very reliable during average and slightly below-average rainfall years, its heavy dependence on Sonoma Water and the Russian River system poses risks during prolonged or very severe droughts as well as catastrophic events that could interrupt supply delivery from Sonoma Water.

California's most recent drought (2020-2022) is the second most severe on record in the Sonoma County region and resulted in critically low water storage in Lake Sonoma. **Figure 1-3** shows water supply levels in Lake Sonoma. The green line represents the average monthly water storage over a thirty-year period, while the dotted black line shows the lowest month of any year from 1992 to 2020. Most of the lowest months occurred in the last decade, indicating increased water scarcity. The red dashed line indicates a critical threshold of 100,000 acre-feet. If storage falls below this level, Sonoma Water may be required by the State to reduce water diversions by 30 percent or more. This would necessitate the City implementing its Water Shortage Contingency Plan (WSCP) with mandated reductions in water use, which could include water rationing. In this most recent drought beginning in 2020, Lake Sonoma water supply storage levels remained consistently below the 30-year average (the green line) for nearly three years, below the lowest months (the dotted black line) for nearly two years and drew dangerously close to the critical threshold (the red line) at the end of water years 2021 and 2022, before winter precipitation replenished supply reserves.

While Santa Rosa is well-prepared for normal and slightly below-average rainfall years, the most recent drought highlights the importance of addressing water supply planning and resiliency to ensure sustainable water management for the future.

Figure 1-3: Lake Sonoma Water Supply Storage



1.2 Our Water Future: Purpose of the Water Supply Alternatives Plan

The City wishes to diversify and increase its potable urban water supply portfolio to enhance its resiliency to mitigate the impacts of future water supply shortages due to severe and/or prolonged droughts or service interruptions that could occur in catastrophic events. Currently Santa Rosa Water can meet about 6-7 percent of its annual urban demand for potable water using municipal wells and relies on Sonoma Water to provide the remaining 93-94 percent of potable supply for urban customers (non-potable recycled water for urban irrigation within a small section of Santa Rosa's municipal jurisdiction accounts for less than one percent of demand). As a result of this dependency, if Sonoma Water experiences a supply shortage or an interruption in service, Santa Rosa's public water system will have a water supply shortage.

Santa Rosa is particularly concerned about drought impacts. In the past 20 years the Sonoma County region has experienced three multi-year droughts: 2007-2009, 2013-2016, and 2020-2022. In response, Sonoma Water worked with its water contractors to establish was use reduction targets, triggering Santa Rosa to declare water shortage conditions that required its customers to reduce potable water use by 20 percent each time. Santa Rosa's customers successfully reduced water use during each drought. When water supply conditions returned to normal, the Santa Rosa community did not return to pre-drought rates of use, resulting in a significant decrease in per capita water use of approximately 38 percent (compared to 2006). Regional climate change assessments warn that local droughts will likely become more severe (hotter, drier, longer) and more frequent, and local water use analysis shows demand hardening (permanent decreases in per capita use). Given these realities, Santa Rosa Water wishes to increase water supply resiliency and reliability by increasing the diversity and production capacity of its water supply portfolio.

To determine the best path forward, Santa Rosa Water launched the Our Water Future Project in May of 2022 and undertook development of this Water Supply Alternatives Plan in September of 2022 to identify an adaptive approach to diversifying Santa Rosa's water supply portfolio and production capacity over time. The project scope of work has included soliciting input from an interdisciplinary team of Water staff, a group of external Stakeholder Group consisting of leaders from wide range of organizations and interests, the community at large, and the Board of Public Utilities.

The primary objectives of this Plan and the work supporting the Plan are to:

- Determine the appropriate amount of new water supply required to minimize the risk of water shortages in Santa Rosa,
- Explore various water supply options that warrant further study,
- Establish criteria for assessing the suitability of these supply options for the Santa Rosa community, and
- Outline various portfolios or mixes of the most suitable supply options Santa Rosa Water could consider in its future planning efforts.

The Water Supply Alternatives Plan (WSAP) provides a menu of water supply options and portfolios for Santa Rosa Water to consider when planning future strategic investments and projects for increasing water supply resiliency and reliability. The Plan is not intended to be a prescriptive document, but rather an adaptive guide for Santa Rosa to use as it embarks on water supply and infrastructure planning for Santa Rosa's water future.

1.2.1 Coordination with Regional Efforts

As described above, the WSAP is designed to outline options that Santa Rosa Water can take to increase its resiliency and mitigate the impacts of water shortages due to droughts or interruptions in service from Sonoma Water. While the WSAP does consider regional options, Santa Rosa Water acknowledges that a number of regional efforts are currently underway or being considered which may contribute to meeting Santa Rosa's water supply goals. Examples include Sonoma Water's Regional Water Supply Resiliency Study, the GSA's future groundwater sustainability projects outlined in its GSP, and multi-agency water-supply resiliency solutions that respond to PG&E's planned decommissioning of the Potter Valley Project and the associated Eel River diversion into the upper Russian River. These options are not included in the WSAP because they are moving forward under the leadership of Sonoma Water, the Santa Rosa Plain

Groundwater Sustainability Agency (GSA), and the Russian River Water Forum, all of which already include Santa Rosa's involvement as a primary water contractor to Sonoma Water, as a member of the GSA Board and the Board's Advisory Committee, and as a member of the Planning Group for the Russian River Water Forum. The City is committed to continue working with these and other partners to enhance regional sustainability as future opportunities arise.

1.3 Water Supply Alternatives Plan Organization

The **Acknowledgements** page provides a list of the participants who generously committed their time and energy to contribute to this effort over nearly a year, from October 2022 through September 2023. **Chapter 2** describes the processes used to engage these participants and integrate their input.

From October through December 2022, the project team worked with the Water Team, Stakeholder Group, community, and Board of Public Utilities to gather their input on the water supply resiliency goal, list of potential water supply options to be studied, evaluation criteria for analyzing the feasibility of each supply option, and the study methodology. **Chapter 2** also provides additional details about the development of these study parameters and presents the final goal statement, list of supply options, and criteria for the study.

With the study parameters finalized, the feasibility study was conducted to assess a wide range of water supply sources, described in **Chapter 3**, and then develop alternative portfolios (mixes) of the most feasible options for achieving Santa Rosa Water's long-term urban water supply goal. The study results were discussed in detail with the Water Team, Stakeholder Group, community, and Board of Public Utilities to gather their input and refine the study as needed. The study and findings are discussed in **Chapter 4** and the full feasibility study report is attached as **Appendix A.** The supply portfolio alternatives are described in detail in **Chapter 5**.

To move forward, Santa Rosa Water will need to determine the best portfolio to begin pursuing, while tracking and adjusting to changes in funding sources, technology, regulations, as well as regional efforts and opportunities. **Chapter 6** discusses next steps that Santa Rosa Water may wish to undertake as it moves forward toward achieving its water supply resiliency and reliability goals.

2. APPROACH TO DEVELOPING THE WATER SUPPLY ALTERNATIVES PLAN

Santa Rosa's Our Water Future effort began by establishing water supply goals, an extensive list of water supply options, and evaluation criteria, collectively referred to as the "study parameters." These study parameters were established through a collaborative process with four groups of participants: Santa Rosa Water staff (referred to as the Water Team), an external group of community leaders (referred to as the Stakeholder Group), the community at large, and the Board of Public Utilities (BPU). Once the study parameters were established, Santa Rosa Water further developed the supply options to prepare them for analysis. Work then involved the use of pre-screening and screening tools and evaluation criteria designed to slate a short-list of supply options. The following subsections describe the study parameters, analysis methodology, and stakeholder involvement.

2.1 Water Supply Goals

The first task of the WSAP focused on setting goals to understand how much and under what conditions water is needed in the future to mitigate drought and catastrophic Sonoma Water service interruptions. Discussions during the goal development process with the Water Team, Stakeholder Group, community, and BPU yielded the following insights about what the water supply goal should do:

1. *Guide Decision Making*: The goal should provide essential guidance to make informed decisions concerning the scale and scope of the resiliency portfolio, thereby supporting effective water management.
2. *Improve Water Resiliency*: The goal should result in reduced reliance on Sonoma Water supplies, thereby enhancing Santa Rosa's potable water supply resiliency and supporting a more stable and dependable water system for the Santa Rosa community.
3. *Mitigate Shortages*: The goal should help mitigate potential shortages in Sonoma Water supply and minimize interruptions in service during dry periods.
4. *Meet Peak Day Demand Locally*: The goal should help meet a portion of Santa Rosa's projected peak day demand using local supply.
5. *Allow for Flexibility and Adaptability*: The goal should be percentage based, thereby making it easier to adjust if future conditions change the amount of supply needed.

Based on this input, the water supply goal for the WSAP effort is to diversify and increase Santa Rosa's potable water supplies to reduce dependence on Sonoma Water, particularly during Sonoma Water supply shortages or disruption in delivery. New supplies would augment existing City groundwater production capacity (approximately 1,300 AFY, with an average of 2 million gallons per day (MGD) over 7 to 9 months per year) to achieve three targets included in this goal, as outlined in **Table 2-1** below.

For the purposes of the WSAP, Santa Rosa Water assumes that potential water supply options would need to provide an aggregated total of 7,500 AFY and 9 MGD of supply by 2045, either individually or collectively in conjunction with Santa Rosa's existing groundwater well capacity (approximately 1,300 AFY, with an average of 2 MGD over approximately 6.5 months per year). The water supplies would generally be used in response to droughts or disruptive events since Santa Rosa's existing water supplies (Sonoma Water, groundwater wells, and recycled water) are more than sufficient to meet demand in normal years. As noted above, these goals allow for flexibility in the future; should projected future demands change, the percentage-based goals can be adjusted to arrive at new volumetric goals.

Table 2-1: Water Supply Goals for the Water Supply Alternatives Plan

Mitigating Droughts	Mitigating Natural Disasters & Catastrophic Events	Mitigating Peak Day Demand
Meet 30% of City's water demand with municipal supplies to mitigate impacts of Russian River supply shortages (e.g., due to prolonged and/or severe drought). Based on current City demand projections, the volume of water required to meet this is 7,500 AFY by 2045.	Provide 50% of normal domestic/indoor demand for potable water with municipal supplies during Russian River supply disruption. Based on current City demand projections, the volume of water required to meet this is 9 MGD by 2045.	Meet 30 percent of peak month average day demand for potable water with municipal supplies. Based on current City demand projections, the volume of water required to meet this is 9 MGD by 2045.

2.2 Water Supply Options

Water supply options that are included in this effort were compiled from a number of sources, including discussions with the Water Team, Stakeholder Group, community, and BPU. The final list of supply options includes a broad diversity of options from the type of water supply to their scale (in AFY and geography).

Table 2-2 lists the water supply options that are part of the WSAP. More information about each of the supply options is presented in **Chapter 3**.

Table 2-2: Initial List of Water Supply Options

Supply Type	Supply Option Name
Groundwater	GW-1: Additional Groundwater Extraction Wells GW-2: Convert Emergency Wells to Production Wells GW-3: Aquifer Storage and Recovery (ASR) Wells GW-4: Regional Groundwater Extraction Wells GW-5: Regional ASR Wells
Purified Recycled Water	PR-1: Direct Potable Reuse (DPR) with Advanced Water Purification Facility (AWPF) at Laguna Treatment Plant (LTP) PR-2: Satellite DPR with AWPF PR-3a: Indirect Potable Reuse (IPR) with AWPF LTP into Groundwater Basin PR-3b: IPR with AWPF LTP into Lake Ralphine PR-3c: IPR with AWPF at LTP into Lake Sonoma PR-4: Regional DPR with AWPF at LTP
Recycled Water	RW-1: Expand City's Urban Non-Potable Recycled Water System
Desalination	DE-1: Regional Brackish Desalination DE-2: Ocean Desalination
Stormwater	SW-1: Stormwater Treatment and Storage in Aquifer SW-2: Stormwater Storage in Lake Ralphine with Treatment SW-3: Regional Stormwater
Efficiency Programs	E-1: Efficiency Programs

2.3 Analysis Methodology

After compiling a final list of supply options with stakeholder input, Santa Rosa Water implemented three processes: pre-screening, screening, and feasibility analysis. Each step is described briefly in the following sections and analysis results are presented in **Chapter 4**. As shown below, **Figure 2-1** illustrates the overall steps in the analysis process.

Figure 2-1: Analysis Methodology Flowchart

2.3.1 Pre-Screening

Prior to the screening and detailed feasibility analyses, all supply options were subjected to a high-level pre-screening to identify and remove options deemed infeasible or substantially similar to existing or proposed supply options. The options passing the pre-screening were advanced to the screening analysis.

2.3.2 Screening Analysis

The purpose of the screening analysis was to gather preliminary data on feasible supply options to focus the scope of the subsequent detailed feasibility analysis. All potential water supply options were screened using two key criteria: high-level assessments of cost-effectiveness and scalability.[1, 2] A screening tool was developed and used in the analysis to help determine the conceptual performance of each supply option in areas such as water yield and capital cost. A critical component of the screening analysis and a key input in the tool included cost estimates for each supply option. The screening tool analyzed two scenarios: baseline and maximum production. The baseline scenario assumed realistic operation (more in dry years, less in normal supply years) to minimize operational costs. Conversely, the maximum production scenario assumed the goal of maximizing water production via 24/7 operation. More information on the screening tool and the methodology for determining capital cost estimates is included in the feasibility study report, attached as **Appendix A**.

2.3.3 Detailed Feasibility Analysis

Following the screening analysis, the remaining supply options underwent a detailed feasibility analysis. This step involved developing evaluation criteria, adding numerical weights to each criterion, and scoring the projects against each criterion. In consultation with stakeholders, eight evaluation criteria were used to score the supply options. Each criterion was assigned a weight that corresponds to a score multiplier so the analysis could reflect community priorities about the relative importance of each criterion.

Once evaluation criteria and weights were established, Santa Rosa Water developed a detailed rubric so water supply options could be scored against the qualitative criteria. The numerical system provides a score of 0 through 2, with 2 being most favorable. A score of 0 indicates that an option is not as responsive to a criterion or does not perform as well as the other options, while a score of 2 indicates that the option performs very well. The evaluation criteria scoring rubric used for the evaluation of the short-listed supplemental supply options is summarized in **Table 2-3**. More information on the development of the evaluation criteria and the weights is included in **Appendix A**.

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[1] Water supply options assessed in the feasibility analysis were developed at a conceptual level to estimate potential water supply costs. The cost estimates are considered Class 5 per the Association for the Advancement of Cost Engineering International guidelines as they are rough order of magnitude. Actual project costs would be expected to fall within +50 percent to -15 percent of the cost estimate.
[2] Scalability refers to how much water Santa Rosa Water could produce from the option now and how much water it could possibly produce in the future. An option with low scalability would yield similar amounts of water now and in the future.

Table 2-3: Evaluation Criteria Scoring Rubric

Criterion	Evaluation Metric	Quantitative Score	Qualitative Score: 0	Qualitative Score: 1	Qualitative Score: 2	Weight	Score Multiplier
Cost effectiveness	Quantitative calculation of life-cycle costs, based on the baseline scenario per the project goals (e.g., five-year drought occurring on average every 10 years).	$/AF	>$3,000/AF under baseline scenario	Between $2,000/AF and $3,000/AF under baseline scenario	< $2,000/AF under baseline scenario	High + Screening Criterion	5
Scalability	Qualitative assessment of ability to provide sufficient supply to satisfy goals, i.e., achieve desired level of service for each scenario; secondarily, ability to scale further to address future uncertainty.	Yield (AFY)	Low flexibility: No ability, or minimal ability, to scale down production when supply is not needed.	Moderate flexibility: Some ability to scale production up or down depending on need for supply but would require significant effort or construction of new facility phases.	High flexibility: Production can be easily scaled up or down depending on need without significant investment.	High + Screening Criterion	5
Resiliency	Qualitative assessment of performance in the face of future uncertainty; for example, future regulations, energy costs, hydrology. The best options will suffer only modest degradation of performance if future conditions are worse than anticipated while inferior options will show marked degradation if planning assumptions aren't met.	Change in costs due to energy prices and hydrology scenarios can be accounted for quantitatively. These would feed into the qualitative scores.	Substantial change in cost-effectiveness under changing energy and hydrology conditions.	Moderate change in cost-effectiveness under changing energy and hydrology conditions.	Little or no change in cost-effectiveness under changing energy and hydrology conditions.	High	3
Equity	Qualitative assessment of any disproportionate impacts on vulnerable communities.	N/A	Would have the potential for a disproportionate impact (such as providing different water supply sources to certain parts of City).	Would have no impact on vulnerable communities.	Would have a benefit to vulnerable communities.	High	3
Environmental performance	Qualitative assessment of potential environmental impacts not already included in permitting/regulatory compliance (e.g., level of GHG emissions).	N/A	Unknown or high potential for environmental impacts (e.g., large project footprint, high energy use, or location in undeveloped area).	Moderate potential for environmental impacts (e.g., medium or unknown project footprint, moderate energy use, unknown project location).	Limited potential for environmental impacts (e.g., small project footprint, low energy use, location in existing developed area).	High	3
Legal, permitting, and regulatory	Qualitative assessment of complexity/effort to address legal issues (e.g., water rights), obtain necessary permits, and comply with regulations	N/A	High complexity/effort: Requires major permitting/ regulatory effort, with little or no established precedent to follow.	Moderate complexity/effort: May have major permitting/ regulatory effort permits, etc., but there is an established process to follow.	Low complexity/effort: Permitting/ regulatory steps are known, and projects of this type are routinely implemented.	Med	1
City control and interagency coordination	Qualitative assessment of level of City control and coordination with potential partner agencies, if any (e.g., agreements needed for regional projects).	N/A	Coordination required with partner agencies that City does not already work with.	Coordination required with partner agencies that City already works with.	No need for coordination with other parties.	Med	1
Multi-benefit	Qualitative assessment of benefits provided in addition to water supply.	N/A	No other benefits provided.	One additional benefit would be provided by the project.	Two or more additional benefits would be provided by the project.	Med	1

2.4 Collaboration and Stakeholder Involvement

Table 2-4 summarizes the series of meetings held with four distinct groups to gather input on the study parameters. The first group, referred to as the Water Team, was composed of Santa Rosa Water staff from five Division (Engineering Services, Environmental Services, Local Operations, Regional Operations, and Water Resources) covering a range of disciplines and subject matter expertise (e.g., water resources planning, asset management and planning, wastewater treatment, water recycling, stormwater and environmental compliance, water use efficiency, and water and sewer operations). The second group, referred to as the Stakeholder Group, included leaders of local interest organizations (e.g., resource agencies, business and economic interests, environmental and climate action organizations, community service and social justice nonprofits, and local resources agencies). The third group is referred to as "the community." Interactive community meetings, open to all and held virtually, were advertised via social media, email, bill inserts, and postings on the City website. Lastly, the study parameters were reviewed by the BPU, which provides oversight of and direction for the management and operation of the Santa Rosa Water's water and wastewater facilities. The **Acknowledgements** page provides a list of the participants who generously committed their time and energy to contribute to this effort over nearly a year, from October 2022 through September 2023. **Appendix B** includes links to all of the recorded public meetings.

Feedback from the Water Team, Stakeholder Group, community, and BPU was incorporated into the study parameters, resulting in the final water supply goal, water supply options, and evaluation criteria and methodology.

Table 2-4: Stakeholder and Community Outreach Meeting Summary

Meeting	Date	Topics
Water Team Meeting #1	October 17, 2022	Project overview; introduction of study parameters (water supply goals, water supply options, evaluation criteria, and methodology); input on study parameters.
Community Meeting #1	October 26, 2022	Overview of Santa Rosa water supplies; project background and overview; introduction of water supply goals, supply options, and evaluation criteria; polling questions, input on study parameters, and question and answer time.
Stakeholder Group Meeting #1	November 16, 2022	Overview of Santa Rosa water supplies; project background and overview; high-level group discussion of study parameters, and input on study parameters.
Stakeholder Group Meeting #2	December 14, 2022	Project update; group discussion of proposed study parameters, and input on the refined study parameters.
Water Team Meeting #2	December 15, 2022	Proposed study parameters; input on final refinements of study parameters, and input on the refined study parameters.
Board of Public Utilities Meeting #1	January 19, 2023	BPU direction on proposed study parameters.
Community Meeting #2	January 25, 2023	Project update; review of proposed study parameters; question and answer time.

Meeting	Date	Topics
Water Team Meeting #3	May 17, 2023	Project update on options development and refinement, screening analysis; input on draft study results and portfolio approach.
Stakeholder Group Meeting #3	May 24, 2023	Project update on options development and screening analysis; input on draft study results and portfolio approach.
Community Meeting #3	June 26, 2023	Project update; review of water supply option analysis and introduction to portfolios; question and answer time.
Water Team Meeting #4	July 6, 2023	Project update on portfolio development; input on draft portfolios and implementation pathways.
Stakeholder Group Meeting #4	July 18, 2023	Project update on portfolio development; input on draft portfolios.
Water Team Meeting #5	August 14, 2023	Review of Draft Water Supply Alternatives Plan.
Board of Public Utilities Meeting #2	August 17, 2023	Project update on options development and screening analysis; BPU direction on portfolios.
Community Meeting #4	August 28, 2023	Project update; review of Draft Water Supply Alternatives Plan; question and answer time.
City Council Meeting #1	September 26, 2023	Project update on options development and screening analysis; Council direction on portfolios.
Board of Public Utilities Meeting #3	October 5, 2023	Draft Water Supply Alternatives Plan presented to BPU.
Board of Public Utilities Meeting #4	October 19, 2023	Final Water Supply Alternatives Plan presented to BPU.
City Council Meeting #2	October 24, 2023	Final Water Supply Alternatives Plan presented to City Council.

3. WATER SUPPLY OPTIONS

To prepare for the feasibility analysis, Santa Rosa Water compiled an initial list of water supply options which was refined with input from the Water Team, Stakeholder Group, community, and BPU. This section summarizes each of the evaluated water supply options, listed in **Table 3-1**. More detailed information about each option is included in **Appendix A**.

Table 3-1: Summary of Water Supply Options

Supply Type	Supply Option Name
Groundwater	GW-1: Additional Groundwater Extraction Wells GW-2: Convert Emergency Wells to Production Wells GW-3: Aquifer Storage and Recovery (ASR) Wells GW-4: Regional Groundwater Extraction Wells GW-5: Regional ASR Wells
Purified Recycled Water	PR-1: DPR AWPF at LTP PR-2: Satellite DPR AWPF PR-3a: IPR AWPF at LTP into Groundwater Basin PR-3b: IPR AWPF at LTP into Lake Ralphine PR-3c: IPR AWPF at LTP into Lake Sonoma PR-4: Regional DPR AWPF at LTP
Recycled Water	RW-1: Expand City's Urban Non-Potable Recycled Water System
Desalination	DE-1: Regional Brackish Desalination DE-2: Ocean Desalination
Stormwater	SW-1: Stormwater Storage in Aquifer SW-2: Stormwater Storage in Lake Ralphine SW-3: Regional Stormwater
Efficiency Programs	E-1: Efficiency Programs

3.1.1 Groundwater

The feasibility analysis considered five groundwater supply options, summarized below. More detailed information on each option is included in **Appendix A**. All groundwater supply options will be closely coordinated with the GSA to support groundwater basin sustainability as outlined in the GSP.

GW-1 Additional Groundwater Extraction Wells

This supply option would construct up to 12 additional production wells, wellhead disinfection, and iron and manganese treatment (if necessary) to connect to Santa Rosa's existing potable water distribution system. For the sake of estimating costs, the study assumes a general location for the extraction wells and associated infrastructure (within the City's Southeast Greenway Area, north of Hoen Avenue). Approximately 3,000 linear feet (LF) of 20-inch pipe and a 240 horsepower (hp) pump station would be required to convey the extracted groundwater to the Sonoma Water aqueduct for distribution.

GW-2: Convert Existing Emergency Wells into Production Wells

This supply option would rehabilitate Santa Rosa's three existing emergency wells into production wells: the Leete Well, Carley Well, and Peter Springs Well. The Leete Well is currently out of service due to concerns over a possible casing separation and rehabilitation is currently in design. The Carley and Peter Springs wells have the capacity to provide Santa Rosa with approximately 1 MGD of groundwater capacity on a stand-by-emergency basis.

GW-3: Local Aquifer and Storage Recovery (ASR) Wells

This supply option involves constructing up to six aquifer storage and recovery (ASR) wells which inject water directly into the groundwater aquifer during wet periods for later recovery and use during dry periods and/or during peak demands when additional supplies are needed. Due to the underground storage nature of ASR projects, this supply is more resilient than other alternative storage methods such as surface recharge or storage, which experience water losses due to evaporation. A phased approach can be followed to develop a pilot ASR project to understand local conditions and ensure there are no "fatal flaws" before a full-scale ASR implementation. The number of wells to meet the demand would vary depending on well capacities; for the WSAP, a 500 gallons per minute (gpm) capacity and 500 feet well depth was assumed.

GW-4: Regional Groundwater Extraction Wells

This supply option involves constructing new production wells outside City limits (in neighboring jurisdictions) where the geology may allow for greater well yields than within the City's jurisdiction. This option assumes that the potential partner is a Sonoma Water contractor who receives sufficient Sonoma Water contract supplies to make them open to a partial trade with the City. Provided this, a paper exchange could be completed where Santa Rosa takes a portion of the partner's Sonoma Water allocation, and the pumped groundwater is used directly by the partner. The paper exchange option would not reduce regional reliance on the Sonoma Water system overall. Based on historical Sonoma Water deliveries, potential candidates could be Petaluma, North Marin Water District, Rohnert Park, and possibly City of Sonoma or Valley of the Moon Water District. This option also assumes that Santa Rosa would find a partner for whom well yields of 1,000 gpm or more could be achieved, in order to provide a benefit over existing pumping rates of City wells.

GW-5: Regional Aquifer Storage and Recovery

This supply option proposes the development of a regional ASR project in collaboration with one or more agencies in the region to use Sonoma Water and ASR water supplies conjunctively. As a regional effort, ASR wells could be installed in the most feasible and promising aquifers in the region. Logistically, Santa Rosa Water could either connect directly to the ASR wells or engage in a paper exchange to utilize participating agencies' surface water supplies from Sonoma Water while partnering agencies pump the same amount from the ASR wells. Implementation would require identifying feasible ASR well locations, connections to existing distribution systems, regional coordination and agreements, and the possible need for additional water rights.

3.1.2 Purified Recycled Water

The WSAP includes six purified recycled water supply options, summarized below. More detailed information on each option is included in **Appendix A**.

PR-1: DPR AWPF at LTP

This supply option would purify the tertiary effluent at a proposed AWPF co-located at LTP for direct distribution to Santa Rosa's potable water system. Operationally, the City would convey its tertiary effluent via a proposed 24-inch pipeline to a newly constructed AWPF at LTP sized to meet the projected 9 MGD peak monthly supply needs. The AWPF would be capable of meeting anticipated DPR regulations and would be equipped with a 1.8 million gallon equalization basin, conventional full advanced treatment (FAT) plus ozone/biological activated filtration (BAF), a microfiltration (MF) station, a reverse osmosis (RO) system, ultraviolet (UV) /advanced oxidation process (AOP), an RO brine disposal system, and ancillary facilities. The AWPF waste streams would return to LTP headworks while purified water would be conveyed to a newly constructed 20-inch product water pipeline and pump station for distribution to Santa Rosa's potable water system, potentially using existing Sonoma Water infrastructure.

PR-2: Satellite DPR AWPF

This supply option would purify tertiary effluent at a proposed satellite AWPF located at Stone Farm, City owned agricultural leased land, for direct distribution to the Santa Rosa's potable water system. Operationally, the City would convey its tertiary effluent via a proposed 24-inch pipeline to a newly constructed satellite AWPF sized to meet the projected 9 MGD peak monthly supply need. The AWPF would be capable of meeting anticipated DPR regulations and would be equipped with a 1.8-million-gallon equalization basin, conventional FAT plus ozone/BAF, an MF station, an RO system, UV/AOP, an RO brine disposal system, and ancillary facilities. The AWPF waste streams would return to the nearest sewer via a proposed 10-inch pipeline while purified water would be conveyed to a newly constructed 20-inch product water pipeline and pump station for distribution to the Santa Rosa's potable water system, potentially using existing Sonoma Water infrastructure.

PR-3a: IPR AWPF at LTP into Groundwater Basin

This supply option would purify the City's tertiary effluent at a proposed AWPF co-located at LTP for indirect distribution to Santa Rosa's potable water system after groundwater augmentation at Delta Pond. Operationally, the City would convey its tertiary effluent via a proposed 24-inch pipeline to a newly constructed AWPF at LTP sized to meet the projected 9 MGD peak monthly supply needs. The AWPF would be capable of meeting anticipated GWA IPR regulations and would be equipped with a 1.8 million gallon equalization basin, conventional FAT, a MF station, an RO system, UV/AOP, an RO brine disposal system, and ancillary facilities. The AWPF waste streams would return to LTP headworks while purified water would be conveyed via a proposed 22-inch pipeline to Delta Pond where it will be injected into the aquifer via ASR wells for a minimum retention time of 2-months and later extraction for potable use.

PR-3b: IPR AWPF at LTP via Lake Ralphine

This supply option would purify the City's tertiary effluent at a proposed AWPF co-located at LTP for indirect distribution to Santa Rosa's potable water system after surface water augmentation (SWA) via Lake Ralphine. Operationally, the City would convey its tertiary effluent via a proposed 24-inch pipeline to a newly constructed AWPF at LTP sized to meet the projected 9 MGD peak monthly supply needs. The AWPF would be capable of meeting anticipated SWA IPR regulations and would be equipped with a 1.8 million gallon equalization basin, conventional FAT, an MF station, an RO system, UV/AOP, an RO brine disposal system, and ancillary facilities. The AWPF waste streams would return to LTP headworks while purified water would be conveyed via a proposed pipeline to Lake Ralphine where it would remain for a minimum retention time of 2-months.

PR-3c: IPR AWPF at LTP via Lake Sonoma

This supply option would purify the City's tertiary effluent at a proposed AWPF co-located at LTP for indirect distribution to Santa Rosa's potable water system after SWA via Lake Sonoma. Operationally, the City would convey its tertiary effluent via a proposed 24-inch pipeline to a newly constructed AWPF at LTP sized to meet the projected 9 MGD peak monthly supply needs. The AWPF would be capable of meeting anticipated SWA IPR regulations and would be equipped with a 1.8 million gallon equalization basin, conventional FAT, an MF station, an RO system, UV/AOP, an RO brine disposal system, and ancillary facilities. The AWPF waste streams would return to LTP headworks while purified water would be conveyed to Lake Sonoma via a proposed 22-inch pipeline within the existing Geysers pipeline corridor/easement. Once at Lake Sonoma, the purified water would become part of Sonoma Water's system.

PR-4: Regional DPR AWPF at LTP

This supply option would purify the City's tertiary effluent at a proposed AWPF co-located at LTP for direct distribution to regional partners within the Sonoma Water system. Operationally, the City would convey its tertiary effluent via a proposed 24-inch pipeline to a newly constructed AWPF at LTP sized to meet the projected 9 MGD peak monthly supply needs. The AWPF would be capable of meeting anticipated DPR regulations and would be equipped with a 1.8 million gallon equalization basin, conventional FAT plus ozone/BAF, an MF station, an RO system, UV/AOP, an RO brine disposal system, and ancillary facilities. The AWPF waste streams would return to LTP headworks while purified water would be conveyed via Sonoma Water's 48-inch Cotati Pipeline for delivery to another regional partner in a paper exchange for the partnering agency's Sonoma Water allocation.

3.1.3 Recycled Water

The WSAP includes one recycled water supply option, summarized below. More detailed information on this option is included in **Appendix A**.

RW-1: Expand City's Urban Non-Potable Recycled Water System

This supply option would increase the amount of Santa Rosa urban water reuse generated via recycled water from Santa Rosa, Cotati, and Rohnert Park. The Santa Rosa Urban Reuse Project Feasibility Study identified 4 phases of expansion: 1) Phase 1 West, including pipelines located in northwest Santa Rosa extending from either the west transmission main or the West College Facility; 2) Phase 1 South, including pipelines generally located in southeast Santa Rosa extending from the south transmission main; 3) Phase 2 South, including pipelines extending from Phase 1 South system into southwest Santa Rosa to connect south and west systems; 4) Phase 2 West, including pipelines extending from Phase 1 West to interconnect with the south system. However, RW-1 would not provide a new source of potable drinking water required for severe water shortages to emergencies.

3.1.4 Desalination

The WSAP includes two water desalination supply options, summarized below. More detailed information on each option is included in **Appendix A**.

DE-1: Regional Brackish Water Desalination

This supply option would see Santa Rosa Water partner with Marin Water in the construction of a brackish water desalination facility at Marin Water's Pelican Way Site to augment both Marin Water's local supply and the City's Sonoma Water supply via water transfers. The proposed desalination facility would have an initial capacity of 5 to 10 MGD that could eventually be expandable to 15 MGD. Operationally, the facility would perform screened intake in the North San Francisco Bay and an onshore pump station would convey raw water to the treatment facility via an HDPE pipeline on or under the bay floor. Following treatment, desalinated water would be conveyed to Marin Water's distribution system. Under this scheme, Marin Water and Santa Rosa Water would enter into a paper exchange that would see Santa Rosa receive 9 MGD of Marin Water's Sonoma Water allocation and the desalinated water would be used directly by Marin Water.

DE-2: Ocean Desalination

This supply option would construct a seawater desalination facility sized to produce 9 MGD required to meet Santa Rosa's projected 9 MGD peak month demands. For costing purposes, a general location for ocean desalination was estimated, however, a full sitting study would be required to determine the most feasible and optimal location for the facility. The screened intake would be offshore with an onshore pump station near the desalination site. Following treatment, desalinated water would be conveyed to Santa Rosa via a newly constructed 24-inch pipeline.

3.1.5 Stormwater

The WSAP includes three stormwater supply options, summarized below. More detailed information on each option is included in **Appendix A**.

SW-1: Stormwater Storage in Aquifer

This supply option proposes the construction of a diversion structure within Santa Rosa Creek to divert excess winter stormwater flows to new spreading basins for storage within the Santa Rosa aquifer. The diversion location would be within Santa Rosa Creek near existing USGS stream gage 11466320 due to its proximity to Delta Pond for potential storage prior to aquifer recharge via spreading basins and ASR wells.

A preliminary stream gage determined the allowable diversion volume from Santa Rosa Creek during the months of December through March would be all flows above the 90th percentile of stormwater volume within the creek unless the diversion amount is 20 percent of the day's flow. This supply option assumes maximum annual usage of 7,500 AFY to allow for sufficient aquifer recharge. Captured stormwater would be treated at a 9 MGD conventional treatment plant before injection via ASR wells.

SW-2: Stormwater Storage in Lake Ralphine or Alternate Site

This supply option would capture excess winter stormwater flows for surface storage. Lake Ralphine was suggested as a potential storage option; however, it currently holds only 500 AF. Therefore, it would require substantial augmentation including raising the existing dam and displacing adjacent recreational areas. Furthermore, surrounding topography and residential neighborhoods make expanding Lake Ralphine infeasible. A review of City planning work did not yield alterative surface storage sites.

SW-3: Regional Stormwater

This supply option proposes developing a regional stormwater project in collaboration with one or more agencies in the region. Several regional projects are underway and could be bolstered with City partnership. Potential regional partners include Marin Municipal Water District, North Marin Water District, the City of Petaluma, Sonoma Water, and the San Francisco Estuary Institute.

3.1.6 Efficiency Programs

The WSAP includes one efficiency program that aims to decrease water demand rather than increase water supply. More detailed information on this option is included in **Appendix A**.

E-1: Efficiency Programs

While water use efficiency measures do not provide a new source of drinking water supply to mitigate the impacts of drought and emergencies, efficiency programs can reduce water demand over time. This option proposes a series of citywide efficiency measures designed to reduce customer water demands and supplement existing efficiency programs. These programs include: 1) enhanced rebates for commercial, industrial, and institutional (CII) turf removals, 2) enhanced rebates for single-family residential (SFR) turf removals, and 3) a new City-funded toilet direct install program that includes installation of high efficiency faucet aerators and showerheads. If full participation is achieved, the CII turf enhanced rebate program could remove up to 400,000 square feet of turf per year for a potential total of up to 16.3 million square feet of turf removed over the project lifespan of 41 years. Additionally, the SFR turf enhanced rebate program could remove up to 1 million square feet per year for a potential total of up to 42.7 million square feet of turf removed over the project lifespan of 43 years. Furthermore, Santa Rosa Water estimates that it could replace up to 45,600 1.6 gallons per flush (gpf) toilets in City residences with more efficient 0.8 gpf toilets over 15 years. Moreover, this program could directly install up to 3,000 sets of high efficiency water fixtures per year for 15 years. However, full voluntary participation is unlikely and therefore more conservative estimates were calculated.

4. ANALYSIS OF WATER SUPPLY OPTIONS

4.1 Pre-Screening Outcome

Before beginning in-depth analysis, an initial pre-screening process was performed to identify and remove supply options deemed infeasible or substantially similar to other options. Five supply options displayed in **Table 4-1** were identified and not subjected to further study.

Table 4-1: Supply Options Removed During Pre-Screening

Category	Supply Option	Reason for Removal
Groundwater	GW-4: Regional groundwater extraction wells	Regional groundwater projects are likely to move forward as Sonoma Water continues to increase its water supply reliability efforts and the City is committed to participate as a water contractor. However, GW-4, in its current form, would likely require a recharge element to comply with the Santa Rosa Plain Groundwater Sustainability Agency (GSA) sustainability efforts. Therefore, GW-4 overlaps substantially with local and regional ASR supply options. Additionally, this supply option does not reduce reliance on the Sonoma Water distribution system. Thus, this option was not carried forward to the screening analysis.
	GW-5: Regional ASR wells	Regional ASR projects are likely to move forward as Sonoma Water continues to increase its water supply reliability efforts and as the GSA pursues long-term groundwater basin sustainability. The City is committed to working with its partners on these future regional ASR projects. However, GW-5, in its current form, does not reduce reliance on the Sonoma Water distribution system. Therefore, this supply option did not advance to the screening analysis.
Purified Recycled Water	PR-3b: IPR AWPF at LTP via Lake Ralphine	Lake Ralphine lacks sufficient capacity to store purified water for the minimum required 2-month retention period. Expansion would require raising the existing dam, displacing adjacent recreational areas, and encroaching upon residential neighborhoods and unfavorable topography. Therefore, this supply option was deemed infeasible and did not continue to the screening process.
Stormwater	SW-2: Capture stormwater and store in Lake Ralphine (or alternate site)	Lake Ralphine lacks sufficient capacity to store captured stormwater. Expansion would require raising the existing dam, displacing adjacent recreational areas, and encroaching upon residential neighborhoods and unfavorable topography. Likewise, prior City review of planning, water systems, and topography has failed to identify a suitable alternative surface water site. Therefore, this supply option was deemed infeasible and did not continue to the screening process.
	SW-3: Regional stormwater	SW-3 would have substantial overlap with regional stormwater projects for water supply resiliency, flood control, and groundwater sustainability. As a water contractor with Sonoma Water and as an engaged participant in the GSA, the City will participate in future regional stormwater projects implemented by Sonoma Water and/or the GSA. Due to these factors, this supply option was not advanced to the screening analysis.

4.2 Screening Analysis Result

Following initial pre-screening, 13 supply options were input into a screening tool that analyzed the conceptual performance of the supply options in two hypothetical scenarios: baseline and maximum production. The list of supply options submitted for screening is included in **Table 4-2** and includes both City and regional projects aiming to increase supply as well as efficiency programs designed to reduce demand over time.

Table 4-2: Screened List of Water Supply Options

Supply Type	Supply Option Name
Groundwater	GW-1: Additional Groundwater Extraction Wells GW-2: Convert Emergency Wells to Production Wells GW-3: Aquifer Storage and Recovery (ASR) Wells
Purified Recycled Water	PR-1: DPR AWPF at LTP PR-2: Satellite DPR AWPF PR-3a: IPR AWPF at LTP into Groundwater Basin PR-3c: IPR AWPF at LTP into Lake Sonoma PR-4: Regional DPR AWPF at LTP
Recycled Water	RW-1: Expand City's Urban Non-Potable Recycled Water System
Desalination	DE-1: Regional Brackish Desalination DE-2: Ocean Desalination
Stormwater	SW-1: Stormwater Storage in Aquifer
Efficiency Programs	E-1: Efficiency Programs

The screening process produced technical data regarding each supply option, removing an additional six supply options. These options included PR-1, PR-3a, PR-3c, RW-1, DE-1, and DE-2. **Table 4-3** presents the supply options removed during the screening process with a brief rationale for why they were removed.

Table 4-3: Supply Options Removed During the Screening Analysis

Category	Supply Option	Reason for Removal
Purified Recycled Water	PR-1: DPR AWPF at LTP	This supply option was removed because it is not cost-effective based on Santa Rosa's current and projected water supply needs.[1]
	PR3a: IPR AWPF at LTP via Delta Pond	This supply option was removed because it is not cost-effective based on Santa Rosa's current and projected water supply needs.
	PR-3c: IPR AWPF at LTP via Lake Sonoma	This supply option was removed because it is not cost-effective based on Santa Rosa's current and projected water supply needs. Additionally, it does not reduce Santa Rosa's reliance on Sonoma Water.
Non-potable Recycled Water	RW-1: Expand City's non-potable recycled water system	This supply option was removed because it does not provide the City with potable water and is not cost-effective based on the City's current and projected water supply needs.
Desalination[2]	DE-1: Regional brackish desalination	This supply option was removed because it is not cost-effective based on the City's current and projected water supply needs. While future circumstances could improve its performance, it does not reduce the City's reliance on regional partner involvement (i.e., Marin Municipal Water District) and the Sonoma Water system). Additionally, it currently faces significant permitting and regulatory challenges and uncertainties.
	DE-2: Ocean desalination	This supply option was removed because its high operational and energy costs are not currently cost-effective based on the City's current and projected water supply needs. Additionally, it currently faces significant permitting and regulatory challenges and uncertainties. However, future circumstances could improve its performance.

Notes:

(1) Despite PR-1 being marginally more cost-effective than PR-2, the latter was chosen to advance because it more closely aligns with the City's goals to be less reliant on the Sonoma Water system and would require less siting constraint than if the AWPF was collocated at LTP.

(2) **Appendix I** discusses the reason for removing desalination as a supply option and outlines how changes to future circumstances could improve desalination's viability and trigger the City to reassess its potential as a supply option.

Desalination presents substantial challenges that are not fully captured in the brief summary of the screening process. The WSAP presents an ideal opportunity to document in greater detail what was learned about desalination during the process of conducting the study, why DE-1 and DE-2 did not advance, and which changing circumstances in the future could trigger reassessing the viability of one or both desalination supply options at key decision points. Therefore, additional discussion and analysis of the desalination options DE-1 and DE-2 have been compiled and included as **Appendix I**.

Appendix I provides an assessment of how DE-1 and DE-2 would have scored in the feasibility analysis, more detailed information about the reasons these options did not advance at this time, and the primary triggers (or changing circumstances) that could help the City determine under what future circumstances it might be advantageous to reconsider desalination. In addition, Portfolio 4 includes reminders to periodically reassess the viability of desalination at key decision points.

Table 4-4 summarizes the results of the screening analysis for all 13 supply options assessed. The table depicts technical information about each supply option considered during screening, whether the option advanced to the feasibility study, and reasoning as to why certain options were advanced or removed. A total of seven water supply options were selected to move forward to the detailed feasibility analysis.

Table 4-4: Screening Analysis Results Summary

Category	Supply Option	Technical Information		Moving Forward?	Reasoning for Screening Out or Advancing
Groundwater	GW-1: Local groundwater extraction wells	**Yield**	10,080 AFY	Yes	This supply option proceeded to the feasibility analysis because it offers a proven and effective method of water production that Santa Rosa Water staff is familiar with and equipped to manage.
		Total Capital Cost	$96,400,000		
		Annualized Capital Cost	$3,400,000		
		Annual O&M	$3,165,000		
		Unit Cost of Water	$700/AF		
	GW-2: Convert emergency wells to production wells	**Yield**	2,462 AFY	Yes	This supply option moved forward because it is the most cost-effective, fastest to implement, and Santa Rosa Water staff is already familiar with the wells that would be converted.
		Total Capital Cost	$11,590,000		
		Annualized Capital Cost	$409,000		
		Annual O&M	$705,000		
		Cost of Water	$452/AF		
	GW-3: Local ASR wells	**Yield**	5,130 AFY	Yes	This supply option advanced because it provides Santa Rosa with a reliable water supply and also promotes the health and sustainability of the Santa Rosa Plain Subbasin by avoiding overdraft.
		Total Capital Cost	$81,050,000		
		Annualized Capital Cost	$2,860,000		
		Annual O&M	$9,420,000		
		Cost of Water	$2,400/AF		

Category	Supply Option	Technical Information		Moving Forward?	Reasoning for Screening Out or Advancing
Purified Recycled Water	PR-1: DPR AWPF at LTP	**Yield**	10,065 AFY	No	This supply option was removed because it is not cost-effective based on Santa Rosa's current and projected water supply needs.
		Total Capital Cost	$289,400,000		
		Annualized Capital Cost	$10,200,000		
		Annual O&M	$3,670,000		
		Cost of Water	$2,050/AF		
	PR-2: Satellite DPR AWPF	**Yield**	10,065 AFY	Yes	This supply option was advanced because purified recycled water offers greater diversity of potential supplies and enhances Santa Rosa's water resilience.
		Total Capital Cost	$314,060,000		
		Annualized Capital Cost	$11,070,000		
		Annual O&M	$10,440,000		
		Cost of Water	$2,150/AF		
	PR3a: IPR AWPF at LTP via Delta Pond	**Yield**	10,065 AFY	No	This supply option was removed because it is not cost-effective based on Santa Rosa's current and projected water supply needs.
		Total Capital Cost	$419,330,000		
		Annualized Capital Cost	$14,785,000		
		Annual O&M	$12,700,000		
		Cost of Water	$2,730/AF		
	PR-3c: IPR AWPF at LTP via Lake Sonoma	**Yield**	10,065 AFY	No	This supply option was removed because it is not cost-effective based on Santa Rosa's current and projected water supply needs. Additionally, it does not reduce Santa Rosa's reliance on Sonoma Water.
		Total Capital Cost	$562,130,000		
		Annualized Capital Cost	$19,800,000		
		Annual O&M	$6,320,000		
		Cost of Water	$3,350/AF		

Category	Supply Option	Technical Information		Moving Forward?	Reasoning for Screening Out or Advancing
	PR-4: Regional DPR AWPF at LTP	**Yield**	10,065 AFY	Yes	This supply option was advanced because it would incorporate regional partners and could be appropriately scaled to adapt to changing technology, water demands, and partnerships.
		Total Capital Cost	$246,960,000		
		Annualized Capital Cost	$8,700,000		
		Annual O&M	$9,620,000		
		Cost of Water	$1,850/AF		
Non-potable Recycled Water	RW-1: Expand City's existing urban non-potable recycled water system	**Yield**	3,000 AFY	No	This supply option was removed because it does not provide Santa Rosa with potable water and is not cost-effective based on Santa Rosa's current and projected water supply needs.
		Total Capital Cost	$214,000,000		
		Annualized Capital Cost	$4,390,000		
		Annual O&M	$1,300,000		
		Cost of Water	$8,800/AF		
Desalination	DE-1: Regional brackish desalination	**Yield**	10,080 AFY	No	This supply option was removed because it is not cost-effective based on Santa Rosa's current and projected water supply needs. Additionally, it does not reduce Santa Rosa's reliance on Sonoma Water.
		Total Capital Cost	$180,770,000		
		Annualized Capital Cost	$6,370,000		
		Annual O&M	$2,000,000		
		Cost of Water	$1,200/AF		
	DE-2: Ocean desalination	**Yield**	10,080 AFY	No	This supply option was removed because it is not cost-effective based on Santa Rosa's current and projected water supply needs.
		Total Capital Cost	$378,070,000		
		Annualized Capital Cost	$13,330,000		
		Annual O&M	$5,520,000		
		Cost of Water	$2,700/AF		

Category	Supply Option	Technical Information		Moving Forward?	Reasoning for Screening Out or Advancing
Stormwater	SW-1: Capture stormwater and store in aquifer for later potable use	**Yield**	10,080 AFY	Yes	This supply option advanced to further analysis because it would provide Santa Rosa with a sustainable water supply via stormwater that would otherwise be discharged into non-potable bodies of water.
		Total Capital Cost	$222,500,000		
		Annualized Capital Cost	$4,740,000		
		Annual O&M	$3,600,000		
		Unit Cost of Water	$1,135/AF		
Efficiency Programs	E-1: Add aggressive efficiency programs to reduce demand	**Yield**	2,145 AFY	Yes	The enhanced efficiency programs are highly symbiotic with any supply option because they focus on reducing water demand and reinforce existing City water efficiency programs.
		Annual O&M	$6,000,000		

4.3 Detailed Feasibility Analysis Results

Upon completion of the screening analysis, seven water supply options advanced to the detailed feasibility analysis which included evaluating and scoring the short-listed water supply options. A numerical system was used for rating (scoring) each short-listed option against each criterion and against each other. The numerical system provides a score of 0 through 2, with 2 being most favorable. A score of 0 signals that an option is not as responsive to a criterion or does not perform as well as the other options, while a score of 2 indicates that the option performs very well. The score is based on knowledge of the project area, engineering judgment, and experience on past projects. The evaluation criteria scoring rubric used for the evaluation of the short-listed supplemental supply options is summarized in **Table 2-3**, a summary of the shortlist supply scores is shown in **Table 4-5**. Detailed scoring descriptions are found in the following subsections.

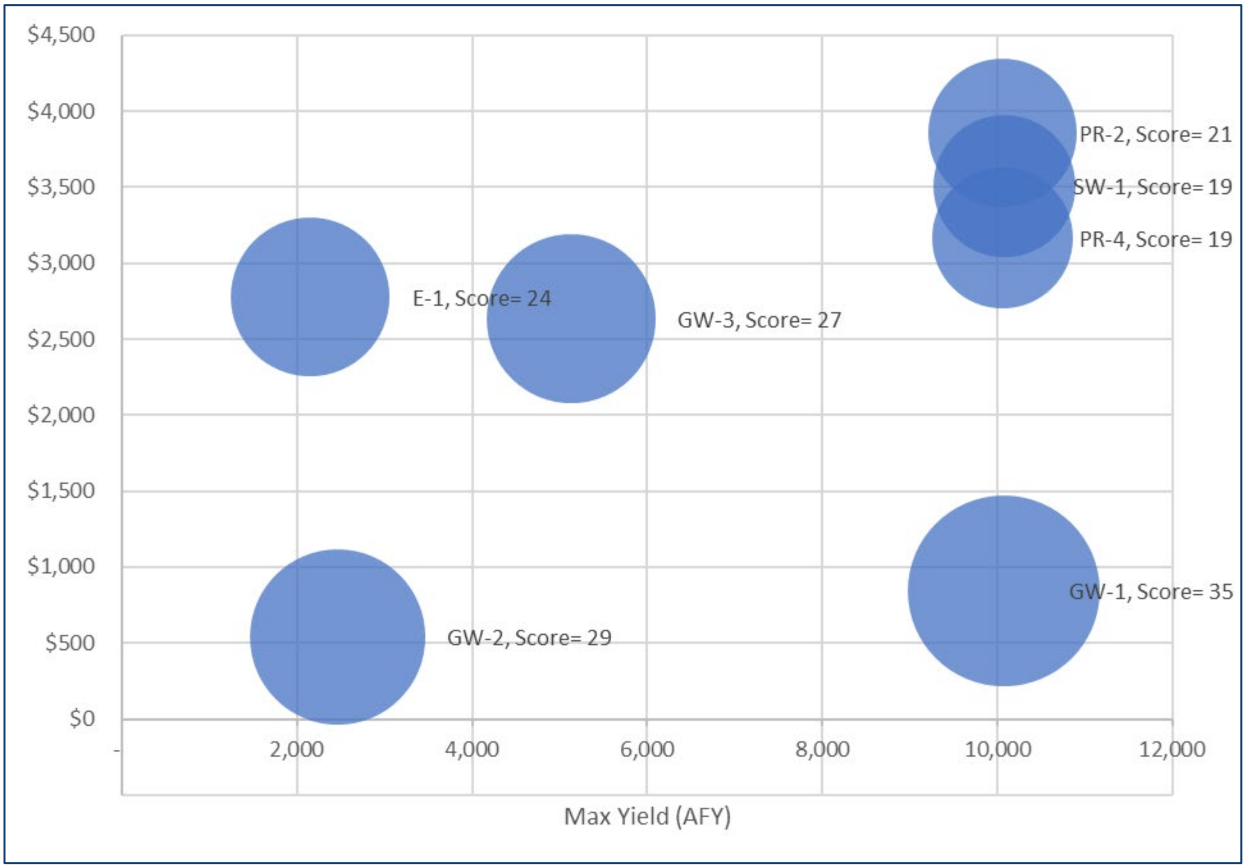
Table 4-5: Summary of Supply Option Scores

Criterion	Groundwater			Purified Recycled Water		Stormwater	E-1: Efficiency Programs
	GW-1: Add Extraction Wells	GW-2: Convert Emergency Wells	GW-3: City ASR Wells	PR-2: Satellite DPR	PR-4: Regional DPR	SW-1: Stormwater Storage in Aquifer	
Cost effectiveness * [$/AF]	2 [$840/AF]	2 [$540/AF]	2 [$2,600/AF]	0 [$3,900/AF]	0 [$3,200/AF]	0 [$3,500/AF]	1 [$2,800/AF]
Scalability [Yield in AFY]	2 [6,734 - 10,080 AFY]	0 [1,744 - 2,462 AFY]	1 [3,634 - 5,130 AFY]	2 [3,019 - 10,065 AFY]	2 [3,019 - 10,065 AFY]	1 [2,600 - 10,080 AFY]	1 [2,145 AFY]
Resiliency	1	1	2	2	2	1	1
Equity	1	1	1	1	1	1	2
Environmental performance	1	2	1	0	1	1	2
Legal, permitting, and regulatory	1	2	0	0	0	1	2
City control and interagency coordination	2	2	1	2	0	2	2
Multi-benefit	0	0	1	0	0	2	1
Total Unweighted	10	10	9	7	6	9	12
Total Weighted	32	26	29	21	22	19	30

* Costs shown reflect a realistic baseline usage scenario and include both capital and operating costs.

Figure 4-1 shows cost-effectiveness under baseline operations[1] along with maximum yield and incorporates the weighted scores of each supply option in the bubble sizes (as summarized **Table 4-5**).

Figure 4-1: Cost-Effectiveness vs Max Yield (with Weighted Score)



Notes:

Water Supply options:

- GW-1: Additional Groundwater Extraction Wells
- GW-2: Convert Emergency Wells to Production Wells
- GW-3: Aquifer Storage and Recovery (ASR) Wells
- PR-2: Satellite Direct Potable Reuse (DPR) with Advanced Water Purification Facility (AWPF)
- PR-4: Regional DPR with AWPF at Laguna Treatment Plant
- SW-1: Stormwater Storage in Aquifer
- E-1: Efficiency Programs

[1] The baseline scenario used by the screening tool assumed each water supply option would be operated in a realistic capacity that aimed to minimize operational costs, in contrast to the maximum production scenario that assumed water supply options would be operated to maximize water production via nonstop (24/7) operation.

4.3.1 Groundwater Options

The detailed scoring and rationale for the groundwater options are provided in **Table 4-6**, **Table 4-7**, and **Table 4-8** on the following pages below.

Table 4-6: Detailed Scoring for Option GW-1

Criterion	Description	Score
Cost effectiveness	Under the baseline scenario, actual costs are estimated at $843/AF, making this option one of the least expensive studied, and less expensive than the current Sonoma Water supply which is $1,200/AF.	2
Scalability	As evaluated, this option includes construction of 12 wells to meet Santa Rosa's supply goals. However, Santa Rosa Water need not construct all 12 wells initially, and could potentially build fewer even in the long run if well yield is higher than estimated. Generally, this option could be scaled or phased to best fit City needs.	2
Resiliency	Moderate resiliency. Pumping costs would increase with rising power costs. Cost-effectiveness could decrease under certain hydrologic conditions, but groundwater availability may not be severely impacted unless there is a long-term change in hydrology.	1
Equity	The additional groundwater supply would have no impact on vulnerable communities. The additional groundwater supply would be available to Santa Rosa to offset purchased water from Sonoma Water.	1
Environmental performance	The new extraction wells would be located in Santa Rosa within the Southeast Greenway area. Construction of 12 wells would have moderate potential for environmental impacts.	1
Legal, permitting, and regulatory	Well construction would likely require some permitting and regulatory compliance but would not require unusual efforts.	1
City control and interagency coordination	While coordination with Sonoma Water and the other GSAs in Santa Rosa Plain would be required, the scope and timing of the work would be generally at Santa Rosa Water's discretion.	2
Multi-benefit	No other benefits provided.	0

Table 4-7: Detailed Scoring for Option GW-2

Criterion	Description	Score
Cost effectiveness	Based on conceptual analyses, the rehabilitation of the three existing emergency wells would provide up to 2,462 AFY of additional groundwater supply. The baseline scenario average cost of water is approximately $541/AF, the least expensive of all options studied.	2
Scalability	This option lends itself to phasing since well rehabilitation could occur one well at a time. However, the overall scale of the project would fall far short of Santa Rosa's projected 7,500 AFY need.	0
Resiliency	Moderate resiliency. Pumping costs would increase with rising power costs. Cost-effectiveness could decrease under certain hydrologic conditions, but groundwater availability may not be severely impacted unless there is a long-term change in hydrology.	1
Equity	The additional groundwater supply would have no impact on vulnerable communities. The additional groundwater supply would be available to Santa Rosa to offset purchased water from Sonoma Water.	1
Environmental performance	The rehabilitation of the existing wells would have minimal potential for environmental impacts.	2
Legal, permitting, and regulatory	Santa Rosa Water has previously completed similar permitting/ regulatory efforts required for approval to convert from emergency use to active supply (i.e., 2005 Farmer's Lane well).	2
City control and interagency coordination	No interagency coordination would be required.	2
Multi-benefit	No other benefits provided.	0

Table 4-8: Detailed Scoring for Option GW-3

Criterion	Description	Score
Cost effectiveness	Based on conceptual level cost estimates, construction of six ASR wells would provide up to 5,130 AFY of additional groundwater supply. The baseline scenario average cost of water is approximately $2,632/AF which includes purchase of water ASR.	2
Scalability	The extraction wells included in this option could be constructed in phases to best fit City needs. At buildout, the option could provide most of Santa Rosa's supplemental needs.	1
Resiliency	Moderate resiliency. Pumping and injection costs would increase with rising power costs. Cost-effectiveness could decrease under certain hydrologic conditions, but the ability to inject water into the aquifer would improve resiliency relative to extraction-only options.	2
Equity	The additional groundwater supply would have no impact on vulnerable communities. The additional groundwater supply would be available to Santa Rosa to offset purchased water from Sonoma Water.	1
Environmental performance	The new ASR wells would be located in a less developed area west of the City. Construction of six wells would have moderate potential for environmental impacts.	1
Legal, permitting, and regulatory	While ASR projects are increasingly common, they pose more significant permitting and regulatory requirements.	0
City control and interagency coordination	Coordination would be required with GSAs in Santa Rosa Plain and with Sonoma Water to coordinate with other ASR programs underway.	1
Multi-benefit	This option would enable conjunctive management of surface water and groundwater, which allows for greater flexibility in optimizing surface water and groundwater use (which represents an additional benefit beyond strict water supply).	1

4.3.2 Purified Recycled Water Options

The detailed scoring and rationale for the purified recycled water options are listed in **Table 4-9** and **Table 4-10.**

Table 4-9: Detailed Scoring for Option PR-2

Criterion	Description	Score
Cost effectiveness	Under the baseline scenario the average cost of water is approximately $3,854/AF, making it the most expensive option. Additionally, the option involves a financial upfront commitment for capital so even if future circumstances changed the obligation to pay for the project would continue unabated.	0
Scalability	The AWPF included in this option could be constructed in phases to best fit City needs. The AWPF could be scaled down 30% in low demand periods.	2
Resiliency	High resiliency. The ability to purify tertiary treated water into potable supply would improve resiliency, even in times of drought or future hydrologic uncertainty.	2
Equity	The additional purified water supply would have no impact on the City's vulnerable communities as it will meet or exceed drinking water standards.	1
Environmental performance	The satellite DPR AWPF would be located in a less developed area within City limits. Construction of the AWPF and extensive conveyance facilities may have moderate to high potential for environmental impacts.	0
Legal, permitting, and regulatory	High permitting/regulatory effort would be required as discussed in **Appendix A**. The main challenges in pursuing DPR include the lack of regulatory certainty and the lack of permitting precedents.	0
City control and interagency coordination	No significant interagency coordination would be required.	2
Multi-benefit	This option would provide a potable supply benefit but would reduce tertiary water availability for the Geysers and for the non-potable customers.	0

Table 4-10: Detailed Scoring for Option PR-4

Criterion	Description	Score
Cost effectiveness	Under the baseline scenario the average cost of water is approximately $3,166/AF, making it among the most expensive options. Additionally, the option involves a financial upfront commitment for capital so even if future circumstances changed the obligation to pay for the project would continue unabated.	0
Scalability	The AWPF included in this option could be constructed in phases to best fit City needs. The AWPF could be scaled down 30% in low demand periods.	2
Resiliency	High resiliency. The ability to purify tertiary treated water into potable supply would improve resiliency, even in times of drought or future hydrologic uncertainty.	2
Equity	The additional purified water supply would have no impact on the City's vulnerable communities.	1
Environmental performance	The DPR AWPF would be located on the City-owned LTP property. Construction of the AWPF and purified water conveyance facilities would have low to moderate potential for environmental impacts.	1
Legal, permitting, and regulatory	High permitting/regulatory effort would be required as discussed in **Appendix A**. The main challenges in pursuing DPR include the lack of regulatory certainty and the lack of permitting precedents.	0
City control and interagency coordination	Coordination with a regional partner for the paper exchange would be required in addition to continuing coordination with Sonoma Water if its aqueduct were used for distribution.	0
Multi-benefit	This option would provide a potable supply benefit but would reduce tertiary water availability for the Geysers and for the non-potable customers.	0

4.3.3 Stormwater Capture

The detailed scoring and rationale for SW-1 is listed in **Table 4-11**.

Table 4-11: Detailed Scoring for Option SW-1

Criterion	Description	Score
Cost Effectiveness	The baseline scenario average cost of water is approximately $3,500/AF, making it among the most expensive options.	0
Scalability	While the diversion structure, spreading basins (or injection wells) and extraction wells included in this option could be constructed in phases, the treatment plant, if needed, would require significant cost up-front that could not be recovered even if changes in future conditions reduced the need for the project.	1
Resiliency	Moderate resiliency. While the ability to store water in the aquifer would improve resiliency, there are significant uncertainties in the project's performance, specifically its yield in drought years.	1
Equity	The additional groundwater supply would have no impact on vulnerable communities. The recharge areas for the project may tend to focus construction impacts on less-developed, less affluent areas, which could reduce flooding in those areas.	1
Environmental performance	The new diversion structure, spreading basins and extraction wells would be located in a less developed area within City limits. Construction of the twelve wells would have moderate potential for environmental impacts.	1
Legal, permitting, and regulatory	Some permitting/regulatory effort would be required, but stormwater diversion projects are increasingly common and would not require outsize legal, permitting, or regulatory effort to implement.	1
City control and interagency coordination	No interagency coordination would be required.	2
Multi-benefit	This option would enable conjunctive management of surface water and groundwater, which allows for greater flexibility in optimizing surface water and groundwater use (which represents an additional benefit beyond strict water supply).	2

4.3.4 Efficiency Programs

The detailed scoring and rationale for the Efficiency Programs option is provided in **Table 4-12**.

Table 4-12: Detailed Scoring for Option E-1

Criterion	Description	Score
Cost effectiveness	As summarized above, based on cost estimates provided by Santa Rosa Water, efficiency program would provide water savings at a cost of approximately $2,780/AF under the Baseline Scenario. This makes it less expensive than the options involving major costs for water treatment (e.g., PR-2, PR-4, SW-1) but more expensive than the groundwater options.	1
Scalability	Water savings could be increased depending on the scale of the program and number of customers that could be reached. Once water savings are achieved, they are considered to be relatively secure because they are built into the landscapes/fixtures, which have typically become more efficient with time due to plumbing codes and price signals.	1
Resiliency	Performance of efficiency measures would not degrade with changes in future regulations, energy costs or hydrology. However, the option does not provide "new water" that would help mitigate catastrophic loss of the Sonoma Water supply.	1
Equity	Direct installation programs reduce barriers to participation by low-income residents and organizations and agencies managing low-income and subsidized housing that have not been able to participate in rebate programs in the past due to upfront costs.	2
Environmental performance	The program would have little to no adverse environmental impact and would provide a potential environmental benefit by reducing water consumption.	2
Legal, permitting, and regulatory	Large-scale construction would not be needed. Physical changes as a result of the project would include toilet and fixture replacements, and relandscaping in existing developed areas. Work would need to be completed by qualified contractors, but additional permitting and regulatory requirements would not be anticipated for this option.	2
City control and interagency coordination	No interagency coordination would be required.	2
Multi-benefit	In addition to providing water savings, the program would provide a cost savings to customers by helping them to reduce their water use.	1

4.3.5 Cost Sensitivity Analysis

The screening tool allows the supply option costs to be estimated under a variety of scenarios. The baseline scenario was modified to assess supply option performance under multiple hydrologic scenarios (**Figure 4-2**), and multiple Sonoma Water dry-year reduction levels (**Figure 4-3**). In that figure, scenarios SW-35 and SW-40 represent dry-year reductions of 35 percent and 40 percent respectively, versus a base scenario of 30 percent.

In general, most supply options would be more cost-effective in a drier hydrologic scenario because more water would be produced to meet normal demand during Sonoma Water supply shortages. The wetter hydrologic scenario contains more wet years than the baseline, but also contains more dry years (as summarized in **Table 4-13**). Therefore, for some options, the wetter scenario is also more cost-effective than the baseline scenario. All supply options become more cost-effective if greater dry-year Sonoma Water reductions are assumed.

Figure 4-2: Supply Option Cost Performance with Varying Hydrology ($/AF)

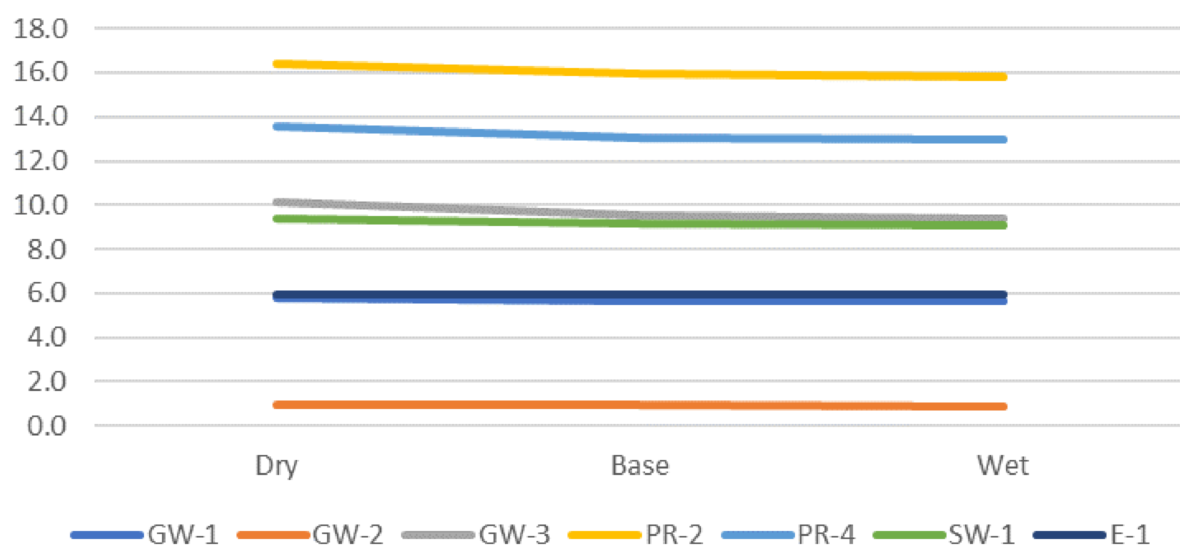
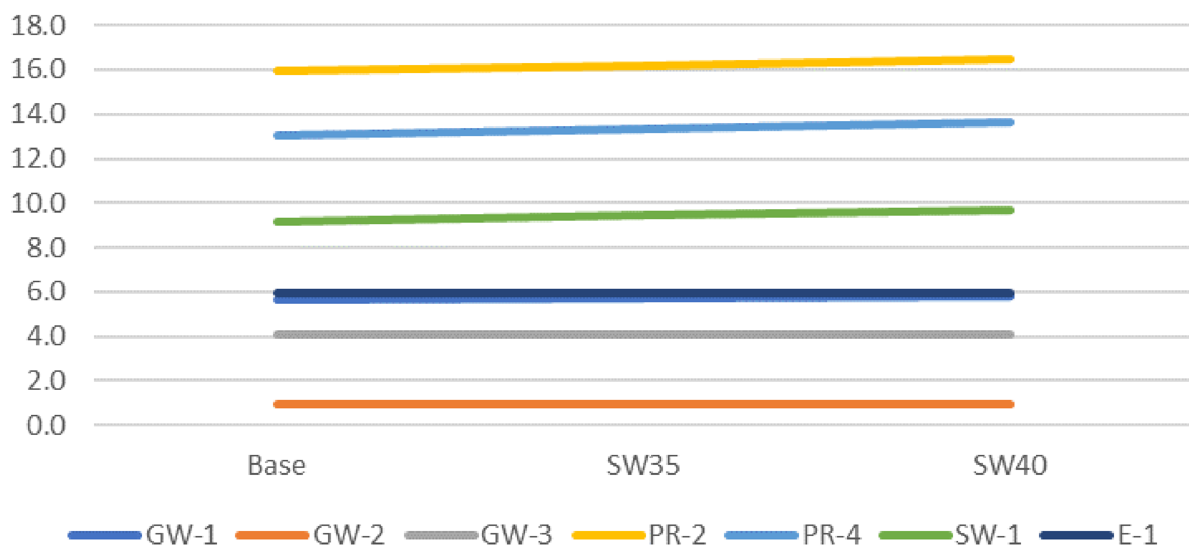


Table 4-13: Distribution of Water Year Types in Hydrologic Scenarios

Hydrologic Scenario	Year Types by Percent		
	Wet	**Normal**	**Dry**
Wet	37%	29%	34%
Historic	33%	37%	30%
Dry	23%	30%	47%

Figure 4-3: Supply Option Cost Performance with Varying Sonoma Water Cutbacks ($M/yr)



SW35: Scenario in which dry-year Sonoma Water supply reduction is 35% of baseline usage rather than the Base assumption of 30% reduction.

SW40: Scenario in which dry-year Sonoma Water supply reduction is 40% of baseline usage.

Although this analysis focused on hydrologic scenarios and Sonoma Water cutbacks, reflecting Santa Rosa's goals of addressing climate change and Sonoma Water reliance, future work could use other variables to test cost-sensitivity (such as price of power, interest rate, and demand reduction percent).

4.4 Analysis Summary

There are several key takeaways from the analysis of supply options that Santa Rosa Water should consider as it continues to embark on planning for Santa Rosa's water future.

- **Future conditions:** Certain assumptions were made during the development of the WSAP about future hydrology, Sonoma Water supply reductions, cost of Sonoma Water supplies, and customer demand/conservation. Actual future conditions may be different which may change conclusions about the potential best fit water supplies. Options that could be implemented in phases may help provide resiliency against uncertainty while minimizing capital outlay.

- **Operational assumptions:** This analysis incorporated reasonable operational assumptions into the baseline scenario. The cost per AF of water is sensitive to those assumptions. Generally, the cost per AF for a supplemental supply will be reduced as usage increases. However, many of the options cost more than the existing Sonoma Water supply, which may vary in the future.

- **Sensitivity:** This analysis considered the impact of changing hydrology and reduced Sonoma Water dry-year allocations under the baseline scenario. The supply options generally become more cost-effective under more pessimistic scenarios (drier hydrology and higher Sonoma Water cutbacks) because more water is produced via the new options. However, the relative rankings of the supply options do not vary substantially with these changes to the baseline condition.

5. PORTFOLIOS

5.1 Overview of Portfolios

For the WSAP, Santa Rosa Water elected to use portfolios instead of individual supply options because they offer the dual benefits of diversification and flexibility. This enables Santa Rosa to diversify the risk of each water supply option, periodically assess the performance of each portfolio, and, if necessary, pivot between supply options to adequately address water supply needs. This WSAP presents four portfolios that Santa Rosa Water can consider as it plans for its water future, to achieve its targets by augmenting existing City groundwater production capacity (approximately 1,300 AFY, with an average of 2 MGD when operated about 6.5 months per year) with new supplies. The following sections summarize the portfolios, including estimated cost and yield information and how that portfolio might be implemented. Each portfolio is built around a theme that represents the portfolio's primary focus: economics, implementation speed, water maximization, and adaptability, respectively.

The four portfolios were compiled by weighing a variety of factors including prescreening, screening, and feasibility analyses that applied evaluation criteria to specific options. While the scoring was not the final determining factor of a supply option's inclusion in a portfolio, scores did help inform the composition of portfolios. Supply options that scored well are included or considered in multiple portfolios, however some supply options that did not score as highly are included in portfolios to further diversify the range of supply options. Water efficiency (E-1) is included in all portfolios, reflecting Santa Rosa's goals of water use efficiency and environmental protection. While E-1 would reduce overall demand thereby reducing the volume of new water needed to achieve Santa Rosa's goals. However, efficiency cannot address another key aspect of Santa Rosa's goal which is resilience against a catastrophic interruption of Sonoma Water supply. Therefore, all portfolios contain new water supply source options in addition to efficiency programs (E-1). The City also recognizes that developing all supply options included in Portfolios 2, 3, or 4 would result in exceeding the cumulative production targets outlined in the water supply resiliency goal. By carefully monitoring aggregated production capacity before considering each new source, Santa Rosa Water can avoid developing more facilities than needed to achieve the City's goal.

Table 5-1 provides an overview of which supply options are included in each portfolio.

Table 5-1: Draft Portfolio Compositions

Option	Description	Portfolio 1 Most Economical	Portfolio 2 Fastest	Portfolio 3 Most Water	Portfolio 4 Most Adaptive
GW-1	Add Extraction Wells (Up to 12)		✓	✓	✓
GW-2	Convert Emergency Wells to Production Wells	✓	✓	✓	✓
GW-3	Aquifer Storage & Recovery Wells				**Consider**
PR-2	Satellite Direct Potable Reuse			✓	**Consider**
PR-4	Regional Direct Potable Reuse at Laguna Treatment Plant				**Consider**
SW-1	Stormwater Storage in Aquifer			**Consider**	**Consider**
E-1	Efficiency Programs	✓	✓	✓	✓

5.2 Portfolio 1: Most Economical

The first portfolio focuses on meeting Santa Rosa's water supply goals in the most economical way. Portfolio 1 integrates two options: enhanced efficiency measures (E-1) and conversion of existing emergency groundwater wells to production wells (GW-2).

Table 5-2 presents estimated cost, yield, and scalability information for the portfolio components. Water capacity refers to the range of potential water supply that could be achieved if the option were implemented. Estimated yield is an estimate of the amount of water that would be supplied by the option based on certain implementation and operating assumptions. While this portfolio could meet the 7,500 AFY water supply goal based on water capacity, it is estimated to more realistically provide about 4,600 AFY. Because E-1 has no capital costs, this portfolio's total capital costs are equivalent to the costs for GW-2. Annual O&M costs are equal to the costs needed to run the efficiency program (E-1) and the incremental cost to operate and maintain the former emergency wells as new production wells.

Figure 5-1 presents the cost and yield performance for this portfolio.

Table 5-2: Portfolio 1 Composition

Portfolio 1	Water Capacity[1] (AFY)	Estimated Yield (AFY)[2]	Total Capital Costs	Annual O&M Costs	Scalability[3]
E-1	1,500 – 4,500	2,145	$0	$6,000,000	1
GW-2	1,500 – 3,000	2,462	$12,000,000	$530,000	0
TOTAL	**3,000 – 7,500**	**4,607**	**$12,000,000**	**$6,530,000**	

Notes:

(1) Water capacity refers to the range of water supply that could be achieved if the water supply option were implemented.

(2) Estimated yield is an estimate of the amount of water that would be supplied by the option based on certain operating and/or implementation assumptions. More information on these assumptions is included in Appendix A.

(3) Scalability for each of the portfolio components refers to the degree to which an option could provide a different amount of water now and in the future. Scalability was assigned a numerical score of 0 through 2, with 0 indicating low scalability compared to other options and 2 indicating a high degree of scalability.

A conceptual implementation timeline for this portfolio is presented in

Figure 5-2. In this conceptual timeline, both projects included in Portfolio 1 would be implemented at the same time. E-1 would begin with developing the water efficiency programs and hiring the staff needed to implement those programs. GW-2 would begin with technical studies to determine the conversion design for the emergency wells and environmental documentation to cover the work under the California Environmental Quality Act (CEQA). A key aspect of the technical studies would be focused on sustainable yield, to ensure that conversion of the standby wells to production wells did not adversely affect the aquifer. The various decision points along the implementation timelines for each supply option represent various points at which Santa Rosa Water adjust the project scope. A more detailed version of the conceptual implementation timeline is included in **Appendix C**.

Figure 5-1: Portfolio 1 Cost and Yield Performance

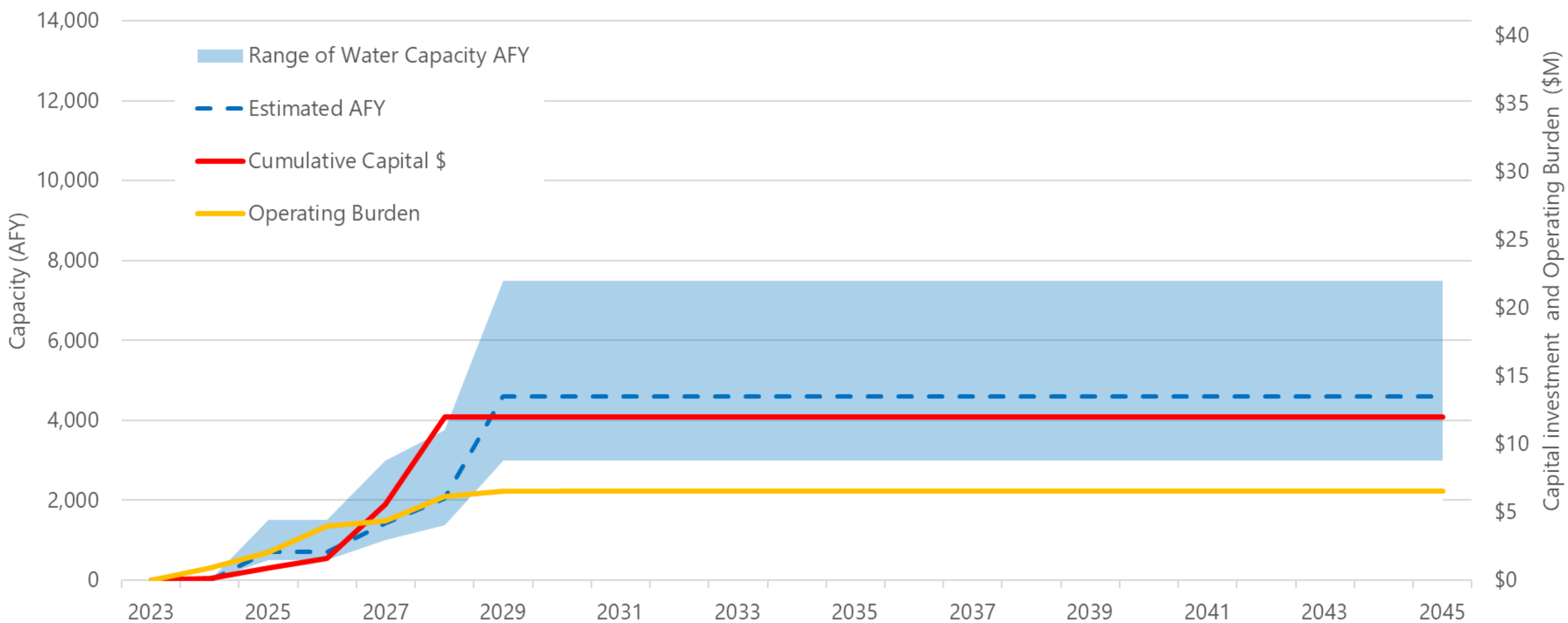
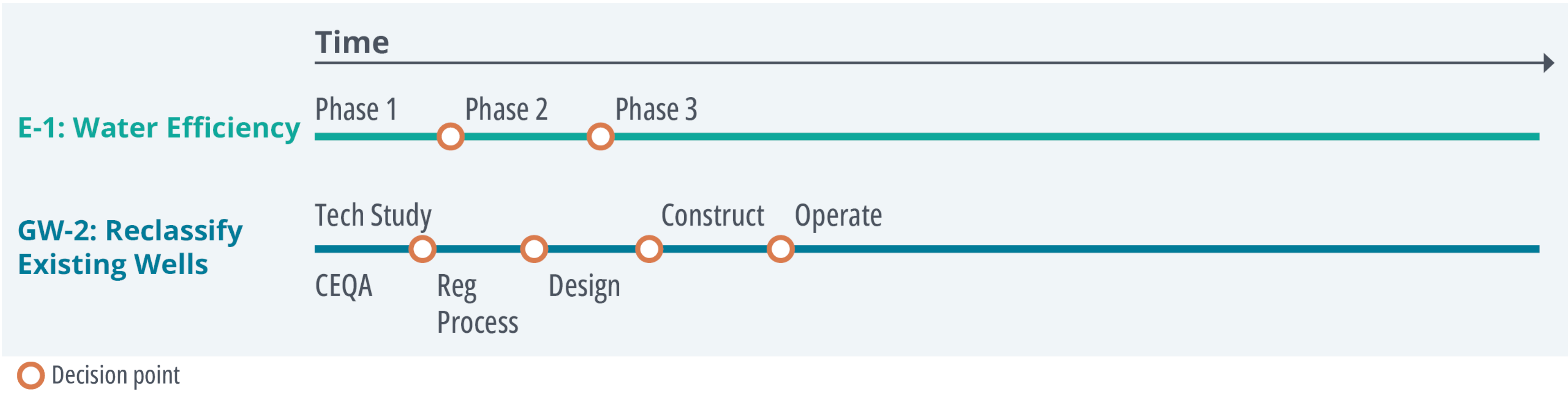


Figure 5-2: Portfolio 1 Implementation Concept



5.3 Portfolio 2: Fastest

Portfolio 2 focuses on implementation speed. It includes enhanced efficiency measures (E-1), converting emergency groundwater wells to production wells (GW-2), and constructing new production wells (GW-1). Of the supply options considered, these three options in combination can begin relatively quickly and proceed simultaneously. When compared to Portfolio 1, this portfolio offers more water supply and would reduce the risk of Santa Rosa falling short of its water supply goals.

Table 5-3 presents estimated cost, yield, and scalability information for the portfolio components. Water capacity for this portfolio ranges from roughly 8,000 to 17,500 AFY; estimated total yield is approximately 14,700 AFY, more than three times that of Portfolio 1. The capital costs ($108.5 million) are nearly five times that of Portfolio 1, due to the addition of GW-1 to this portfolio. Annual O&M costs are approximately $10.5 million, roughly 60% higher than those in Portfolio 1.

Figure 5-3 presents the cost and yield performance for this portfolio.

Table 5-3: Portfolio 2 Composition

Portfolio 2	Water Capacity[1] (AFY)	Estimated Yield (AFY)[2]	Total Capital Costs	Annual O&M Costs	Scalability[3]
E-1	1,500 – 4,500	2,145	$0	$6,000,000	1
GW-2	1,500 – 3,000	2,462	$12,000,000	$530,000	0
GW-1	5,040 – 10,080	10,080	$96,500,000	$3,900,000	2
TOTAL	**8,040 – 17,580**	**14,687**	**$108,500,000**	**$10,430,000**	

Notes:

(1) Water capacity refers to the range of water supply that could be achieved if the water supply option were implemented.
(2) Estimated yield is an estimate of the amount of water that would be supplied by the option based on certain operating and/or implementation assumptions. More information on these assumptions is included in Appendix A.
(3) Scalability for each of the portfolio components refers to the degree to which an option could provide a different amount of water now and in the future. Scalability was assigned a numerical score of 0 through 2, with 0 indicating low scalability compared to other options and 2 indicating a high degree of scalability.

A conceptual implementation timeline for this portfolio is presented in **Figure 5-4.** Implementation of Portfolio 2 is very similar to that of Portfolio 1 in that E-1 and GW-2 are implemented right away. Given that the guiding theme for this portfolio is implementation speed, GW-1 is also shown starting immediately with siting studies focused aimed at identifying the best locations for new groundwater wells. As for GW-2, sustainability would be a key focus of technical studies; however, GW-1 would have more options to explore to meet that goal, including various site selection and well screen intervals. One potential drawback of this portfolio and its guiding theme is that Santa Rosa Water would need to commit resources to GW-1 before the benefits of GW-2 and E-1 are realized. This may risk overbuilding GW-1 by drilling more wells than would be needed to meet the 7,500 AFY water supply goal. A more detailed version of the conceptual implementation timeline is included in **Appendix D**.

Figure 5-3: Portfolio 2 Cost and Yield Performance

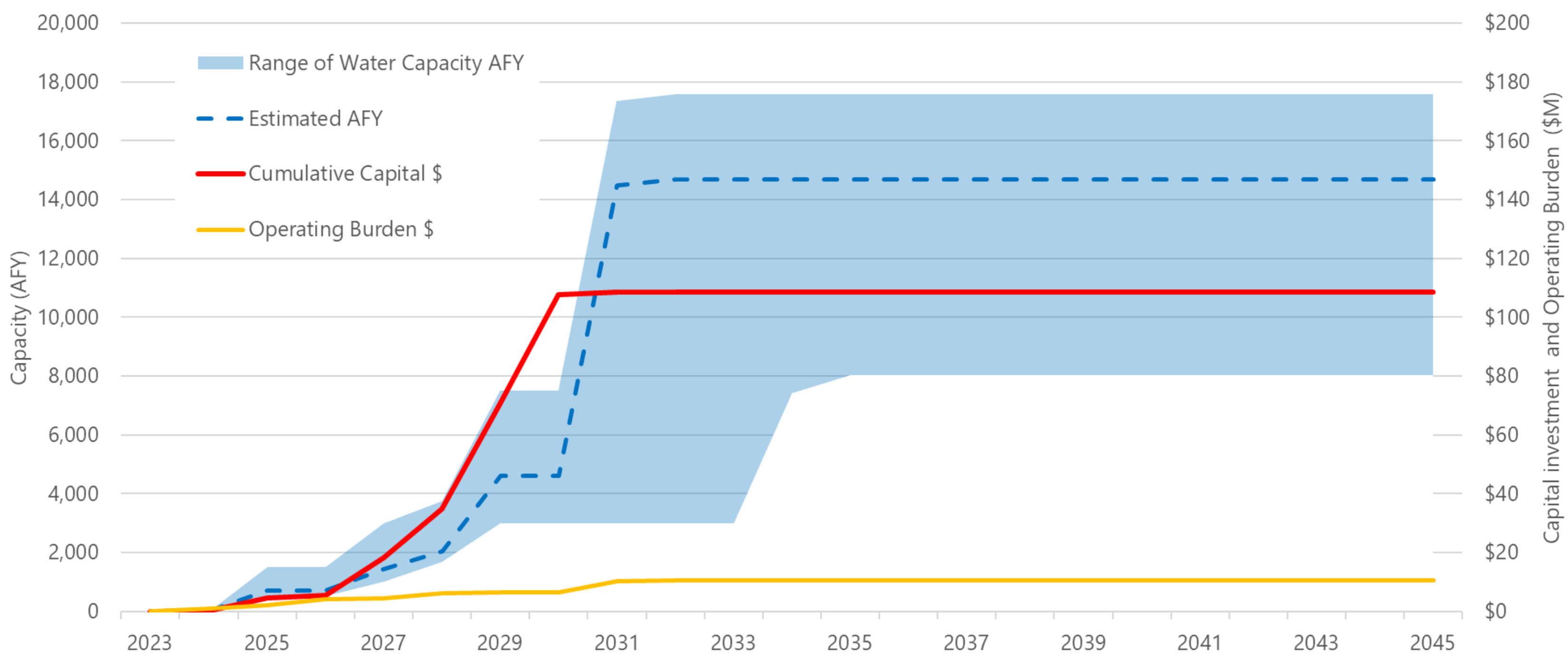
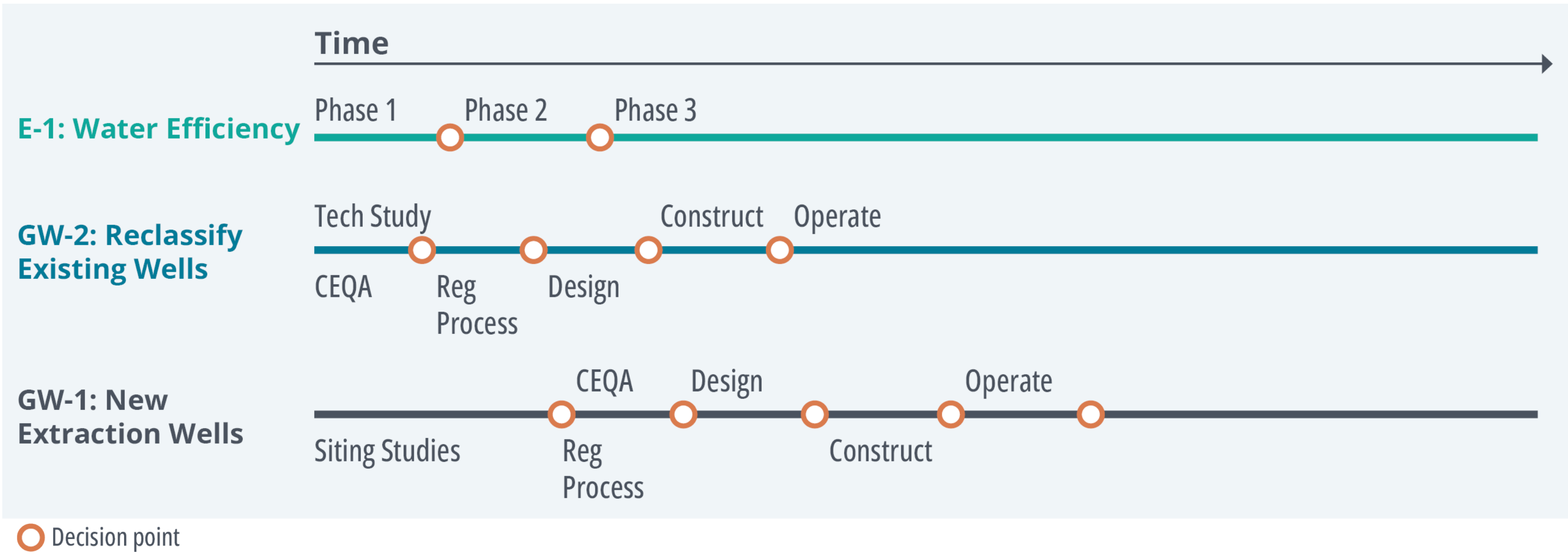


Figure 5-4: Portfolio 2 Implementation Concept



5.5 Portfolio 3: Most Water

Portfolio 3 focuses on maximizing water supply reliability by including more diverse supply options than the prior two portfolios. It incorporates the three supply options included in Portfolio 2 (E-1, GW-2, GW-1), and adds PR-2 (satellite direct potable reuse) and SW-1 (stormwater capture and reuse).

Table 5-4 presents estimated cost, yield, and scalability information for the portfolio components. Estimated yield for this portfolio is approximately 34,800 AFY while water capacity ranges from about 21,000 to 38,700. Even the lower bound of this range is far more than Santa Rosa's current estimate of need; the portfolio's theme of maximizing supply is based on the fact that one or more supply options could encounter unforeseen delays or suffer less yield than even lower-bound estimates. Capital costs ($645 million) are significantly more than the prior two portfolios as a result of PR-2 and SW-1. Annual O&M costs are approximately $31 million, about three times higher than those in Portfolio 2.

Figure 5-5 presents the cost and yield performance for this portfolio.

Table 5-4: Portfolio 3 Composition

Portfolio 3	Water Capacity[1] (AFY)	Estimated Yield (AFY)[2]	Total Capital Costs	Annual O&M Costs	Scalability[3]
E-1	1,500 – 4,500	2,145	$0	$6,000,000	1
GW-2	1,500 – 3,000	2,462	$12,000,000	$530,000	0
GW-1	5,040 – 10,080	10,080	$96,500,000	$3,900,000	2
PR-2	8,000 – 10,065	10,065	$314,000,000	$12,030,000	2
SW-1	5,000 – 10,080	10,080	$222,500,000	$8,390,000	1
TOTAL	**21,040 – 37,725**	**34,832**	**$645,000,000**	**$30,850,000**	

Notes:

(1) Water capacity refers to the range of water supply that could be achieved if the water supply option were implemented.

(2) Estimated yield is an estimate of the amount of water that would be supplied by the option based on certain operating and/or implementation assumptions. More information on these assumptions is included in Appendix A.

(3) Scalability for each of the portfolio components refers to the degree to which an option could provide a different amount of water now and in the future. Scalability was assigned a numerical score of 0 through 2, with 0 indicating low scalability compared to other options and 2 indicating a high degree of scalability.

A conceptual implementation timeline for this portfolio is presented in **Figure 5-6**. This concept shows Portfolio 3 beginning very similarly to Portfolio 2, with options E-1, GW-2, and GW-1 beginning right away. To maximize the amount of water available to Santa Rosa, PR-2 also begins immediately with planning studies, followed by CEQA and other permitting/regulatory processes which are anticipated to be extensive for a direct potable reuse project[1]. Design and construction of the satellite direct potable reuse facility would begin directly following regulatory and environmental approvals.

In contrast to the prior two portfolios, Portfolio 3 begins to introduce some degree of flexibility with the phasing of SW-1. Planning studies and stormwater modeling for SW-1 would begin immediately, in line with the timing of the other elements of this portfolio. However, further work on SW-1 would pause until the yield performance of E-1, GW-2, and GW-1 is established. Depending on the need for additional water at that time, Santa Rosa Water may decide to move into design and construction of SW-1. Given that the estimated yield of this portfolio without SW-1 (~24,700) is more than three times what Santa Rosa Water estimates is the amount of water needed to meet its projected supply goals (7,500), it's very unlikely that Santa Rosa would need the water provided by SW-1. Regardless, the conceptual implementation timeline shows how Santa Rosa Water could begin to plan for some level of flexibility as this portfolio also works to maximize water availability. A more detailed version of the conceptual implementation timeline is included in **Appendix E**.

[1] In July 2023, the State Water Resources Control Board released draft guidelines for direct potable reuse implementation. Final guidelines are anticipated in Spring 2024.

Figure 5-5: Portfolio 3 Cost and Yield Performance

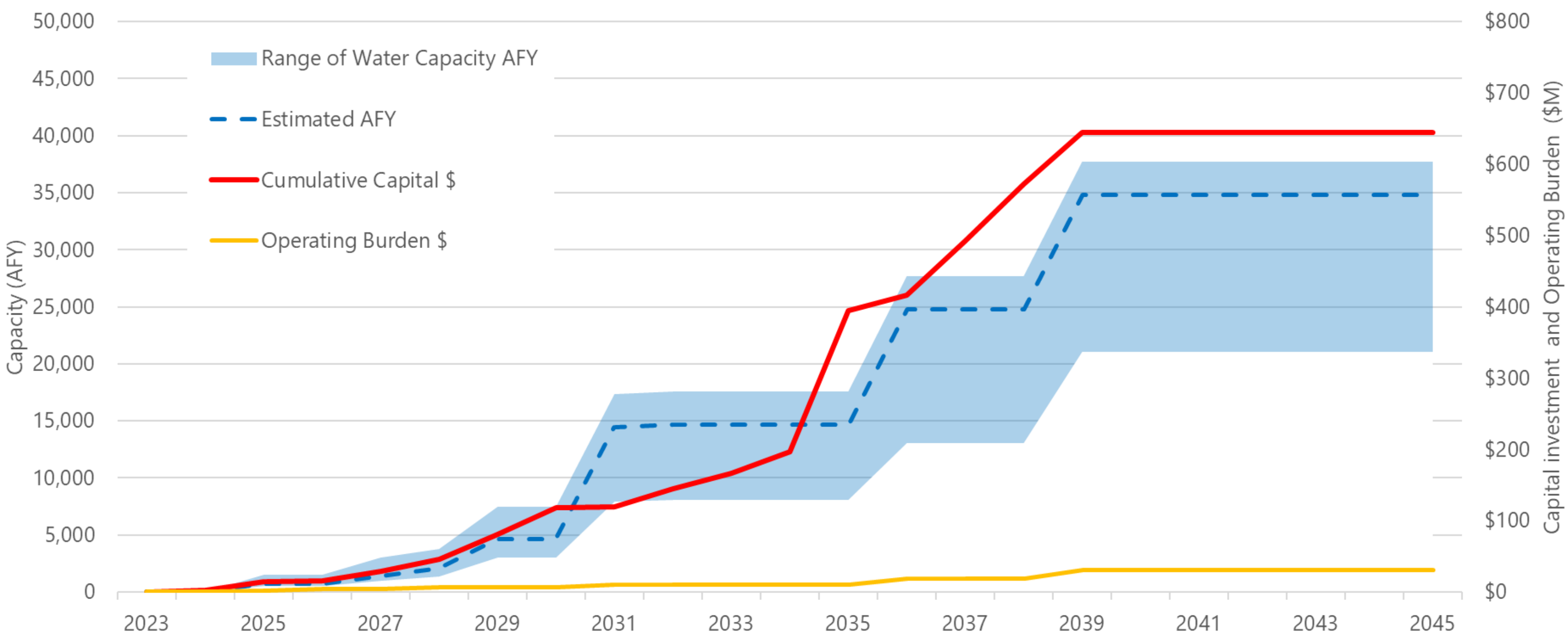
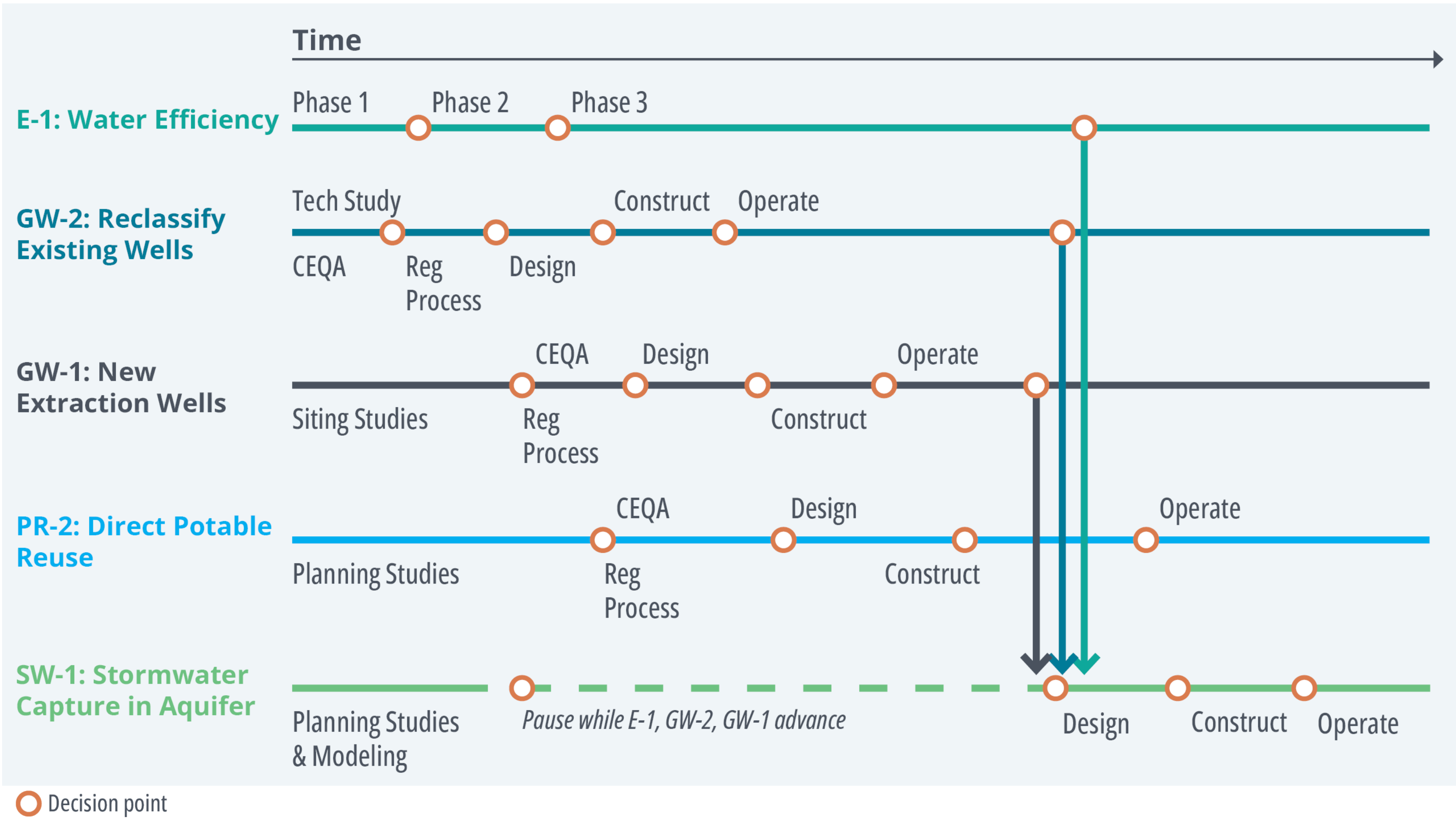


Figure 5-6: Portfolio 3 Implementation Concept



5.7 Portfolio 4: Most Adaptive

Building on the flexibility introduced in Portfolio 3, Portfolio 4 provides the most flexible, or adaptive, path forward of the WSAP portfolios. This portfolio incorporates interactions among the various supply options to afford Santa Rosa Water additional opportunities to assess its water supply needs and adjust appropriately when pursuing new water supply sources in the future. Portfolio 4 includes largely the same elements as Portfolio 3: enhanced efficiency measures (E-1), converting emergency groundwater wells to production wells (GW-2), constructing new production wells (GW-1), satellite direct potable reuse (PR-2), and stormwater capture and reuse (SW-1). The defining features of Portfolio 4 that make it distinct from Portfolio 3 are the addition of aquifer storage and recovery (ASR) to GW-1 (adding elements of GW-3 and shown as GW-1+), and the consideration of LTP as a location (PR-1) for a direct potable reuse facility and consideration of a regional direct potable reuse option (PR-4) when studying PR-2 (shown as PR-2+). Most critically, Portfolio 4 incorporates "adaptive pathways" for its implementation to maximize flexibility. These adaptive pathways allow the City to periodically reassess portfolio performance at key decision points. If future circumstances have improved the feasibility of alternative supply options, such as desalination, then it is possible that the City may utilize the flexibility of Portfolio 4 and elect to pivot in pursuit these newly viable options.

Table 5-5 presents estimated cost, yield, and scalability information for Portfolio 4 components. Because the components of Portfolio 4 are similar to that of Portfolio 3, the yield and cost characteristics are largely the same as Portfolio 3. Estimated yield is approximately 34,800 AFY while water capacity ranges from about 21,000 to 38,700. Capital costs ($645 million) are significant and annual O&M costs are approximately $31 million. Because this portfolio is structured around adaptability, these figures would only be reached if the entire portfolio were built (a baseline scenario); in practice and as a result of taking advantage of the flexibility offered by this portfolio, these figures are likely to be much lower.

Figure 5-7 presents the cost and yield performance for this portfolio in its baseline form.

Table 5-5: Portfolio 4 Composition

Portfolio 4	Water Capacity[1] (AFY)	Estimated Yield (AFY)[2]	Total Capital Costs	Annual O&M Costs	Scalability[3]
E-1	1,500 – 4,500	2,145	$0	$6,000,000	1
GW-2	1,500 – 3,000	2,462	$12,000,000	$530,000	0
GW-1+[4]	5,040 – 10,080	10,080	$96,500,000	$3,900,000	2
PR-2+[5]	8,000 – 10,065	10,065	$314,000,000	$12,030,000	2
SW-1	5,000 – 10,080	10,080	$222,500,000	$8,390,000	1
TOTAL	**21,040 – 37,725**	**34,832**	**$645,000,000**	**$30,850,000**	

Notes:

(1) Water capacity refers to the range of water supply that could be achieved if the water supply option were implemented.
(2) Estimated yield is an estimate of the amount of water that would be supplied by the option based on certain operating and/or implementation assumptions. More information on these assumptions is included in Appendix A.
(3) Scalability for each of the portfolio components refers to the degree to which an option could provide a different amount of water now and in the future. Scalability was assigned a numerical score of 0 through 2, with 0 indicating the option had a low scalability compared to other options and 2 indicating it had a high degree of scalability.
(4) GW-1+ indicates that the component includes aquifer storage and recovery elements. The information presented for GW-1+ is consistent with GW-1, though Santa Rosa Water acknowledges that if ASR wells were incorporated into this supply component, capacity, yield, and costs would very likely change.
(5) PR-2+ indicates that the component could incorporate studying LTP as the location (PR-1) and potentially developing a regional approach to direct potable reuse (PR-4). Santa Rosa Water acknowledges that capacity, yield, and costs would very likely change should a regional project move forward. Furthermore, the phasing of PR-2+ enables the City to reassess the viability of alternative supply options, such as desalination, at various key decision points if changing future circumstances would improve potential performance.

As mentioned, a key aspect of this portfolio's theme of adaptability is flexibility of implementation. One potential implementation pathway (a baseline scenario) for this portfolio is presented in **Figure 5-8**. Portfolio 4 would begin as the other WSAP portfolios do, with E-1, GW-2, and GW-1+ beginning right away. Siting studies for GW-1+ would identify and prioritize locations that could be suitable for both extraction and injection wells. SW-1 studies would also begin since stormwater could potentially be used for an ASR well within GW-1+. Once siting studies are complete for GW-1+, this component would pause while E-1 and GW-2 advance. Work on GW-1+ would continue when Santa Rosa Water had developed a better understanding of the actual yield of E-1 and GW-2. This would allow staff to right-size GW-1+ by only constructing what is required to meet the remaining need for water. Depending on the need for water provided by GW-1+, SW-1 would continue with design and construction to provide any stormwater required for injection as part of GW-1+.

The start time for PR-2+ coincides with the anticipated release of final guidelines on direct potable reuse from the State Water Resources Control Board (State Board). While final guidelines are expected spring 2024, it is likely that it will take the State Board several more years to make any amendments or adjustments based on the experiences of early implementers. This portfolio advises that Santa Rosa Water may wish to wait to begin planning studies on PR-2+ until these regulations are a bit more established, in order to provide the most realistic planning and design criteria for Santa Rosa's purposes. Once planning studies for PR-2+ are complete, work on this component would pause until the actual yield for GW-1+ is established and the need for PR-2+ is better understood. This would allow Santa Rosa Water to scale PR-2+ to meet any remaining water needs. Another benefit of pausing the further planning of PR-2+ is to allow time for staff to assess and develop any regional partnerships that may support the scalability of this component. There may also be opportunities to use water available under SW-1 to supply PR-2+, if there is additional SW-1 water available after its potential use in GW-1+.

A more detailed version of the baseline conceptual implementation timeline for Portfolio 4 is included in **Appendix F**.

Figure 5-7: Portfolio 4 Cost and Yield Performance (Baseline Scenario)

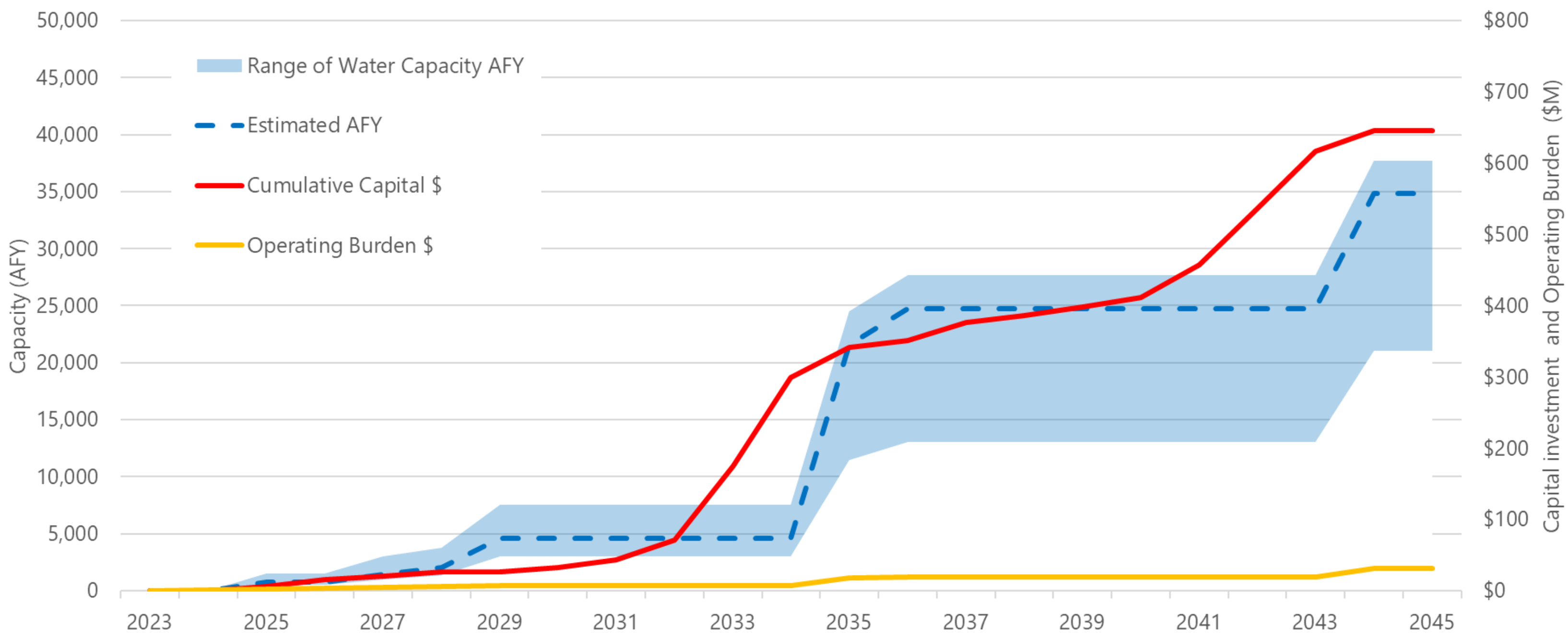
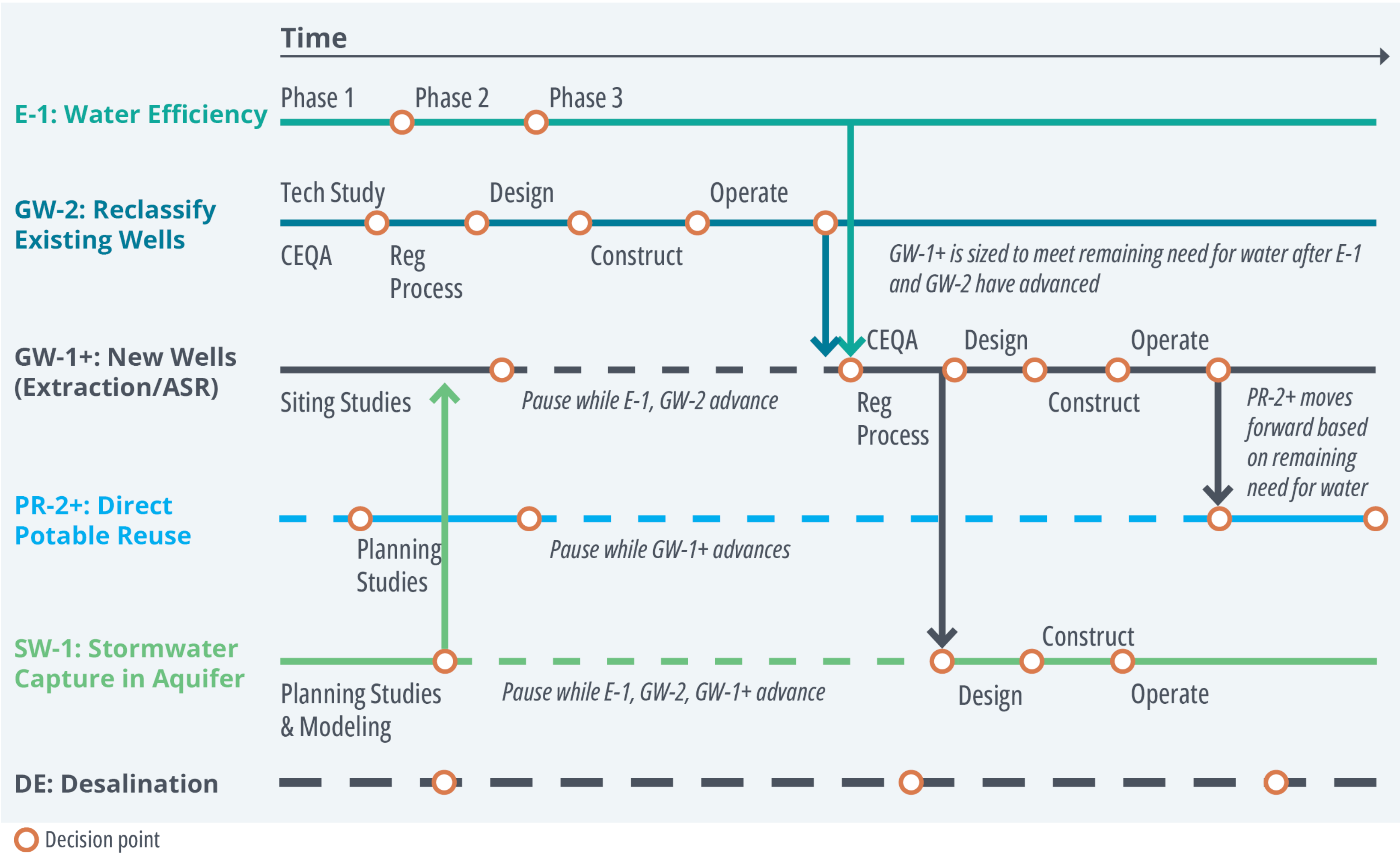


Figure 5-8: Portfolio 4 Implementation Concept (Baseline Scenario)



The baseline scenario for Portfolio 4 assumes that all components are implemented at their studied capacity and as outlined in **Chapter 3**. While this baseline is helpful to understand the logic behind the sequencing of various components and their interactions, it is not a realistic picture of how the portfolio would actually be implemented. As shown in **Table 5-5** and **Figure 5-7** above, the baseline scenario would result in significantly more water than is needed to meet Santa Rosa's water supply goals. In practice, this would mean that Santa Rosa Water would have committed more financial resources to build infrastructure than was needed to meet its water supply goals.

As shown below, **Figure 5-9** (cost and yield performance) and **Figure 5-10** (implementation timeline) present a more realistic implementation scenario (an alternative scenario) for Portfolio 4. This scenario begins as the baseline does: E-1, GW-2, GW-1+, and SW-1 beginning immediately; planning studies for SW-1 inform the siting and planning for GW-1+; and planning studies for PR-2 begin when State Board regulations are a bit more established, then work would pause while E-1, GW-2, and GW-1 advance. This scenario begins to deviate from the baseline scenario if, after GW-2 and E-1 are established, the remaining need for water is able to be met with GW-1. In this scenario, PR-2 and SW-1 would not advance past the initial planning stages because GW-1 is able to meet the remaining water need with extraction wells alone. In the end, this scenario would look very similar to Portfolio 2, with both portfolios implementing E-1, GW-2, and GW-1. The added benefit of this Portfolio 4 scenario is that staff would also be equipped with planning studies for direct potable reuse and stormwater capture. Having these studies in hand positions Santa Rosa to quickly leverage potential opportunities for funding and/or regional partnerships, and also hedges risk in case the other portfolio elements are delayed. A more detailed version of the alternative conceptual implementation timeline for Portfolio 4 is included in **Appendix G**.

Two variants of the alternative scenario are presented in **Figure 5-11** and **Figure 5-12**. In the first variant, SW-1 is able to provide water cost-effectively to GW-1+, and design and construction of those elements continues alongside the design and construction of GW-1+. PR-2+ does not move past initial planning studies. In the second variant, SW-1 does not move past the initial planning stage because there is not sufficient water to achieve cost-effectiveness. However, during the pause in PR-2+ after the initial planning studies, regional partners have come forward and GW-1 is found not to close the remaining supply gap. As a result, PR-2+ continues with design and construction. In this iteration, Santa Rosa's involvement would be consistent with its specific need for water, even if PR-2+ is sized closer to as it is presented in the WSAP.

Figure 5-9: Portfolio 4 Cost and Yield Performance (Alternative Scenario)

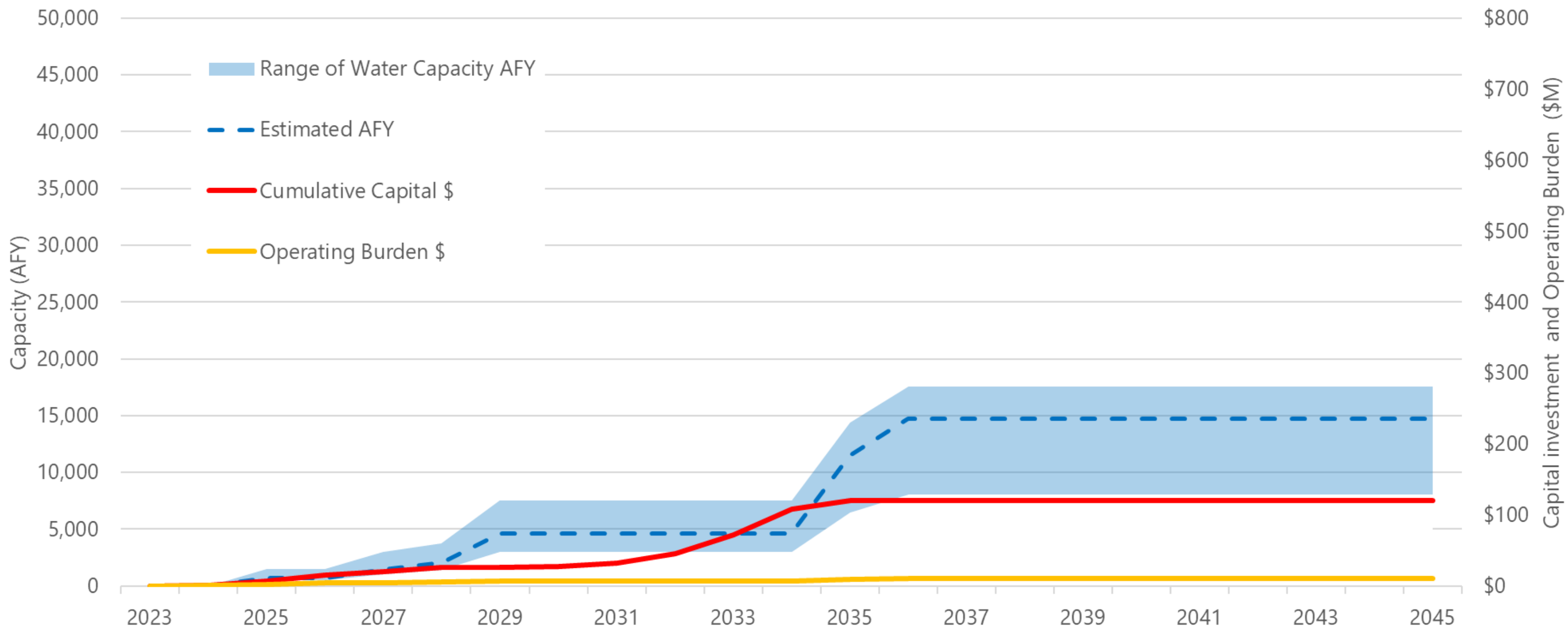


Figure 5-10: Portfolio 4 Implementation Concept (Alternative Scenario)

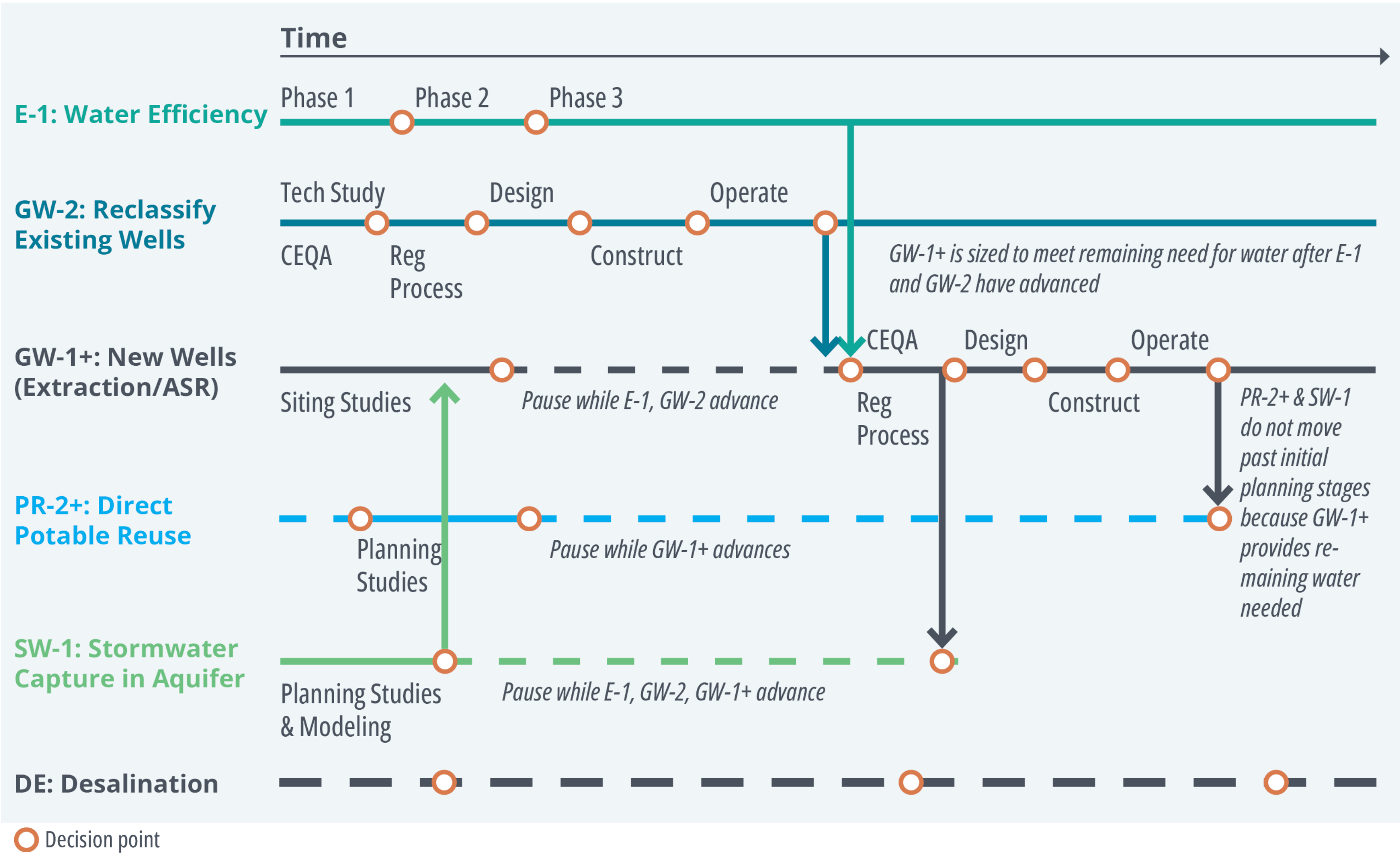


Figure 5-11: Portfolio 4 Implementation Concept (Alternative Scenario, 1st Variant)

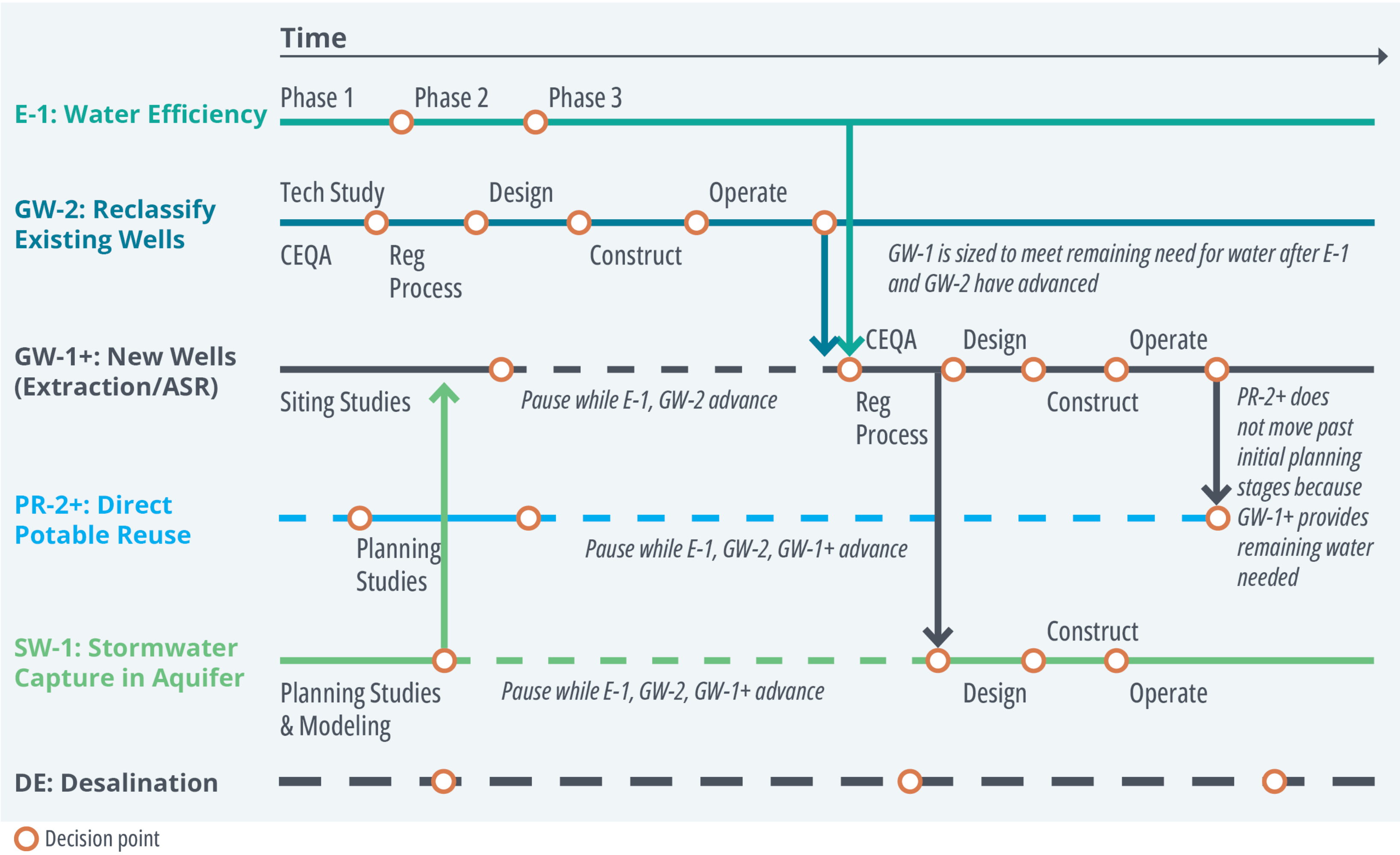
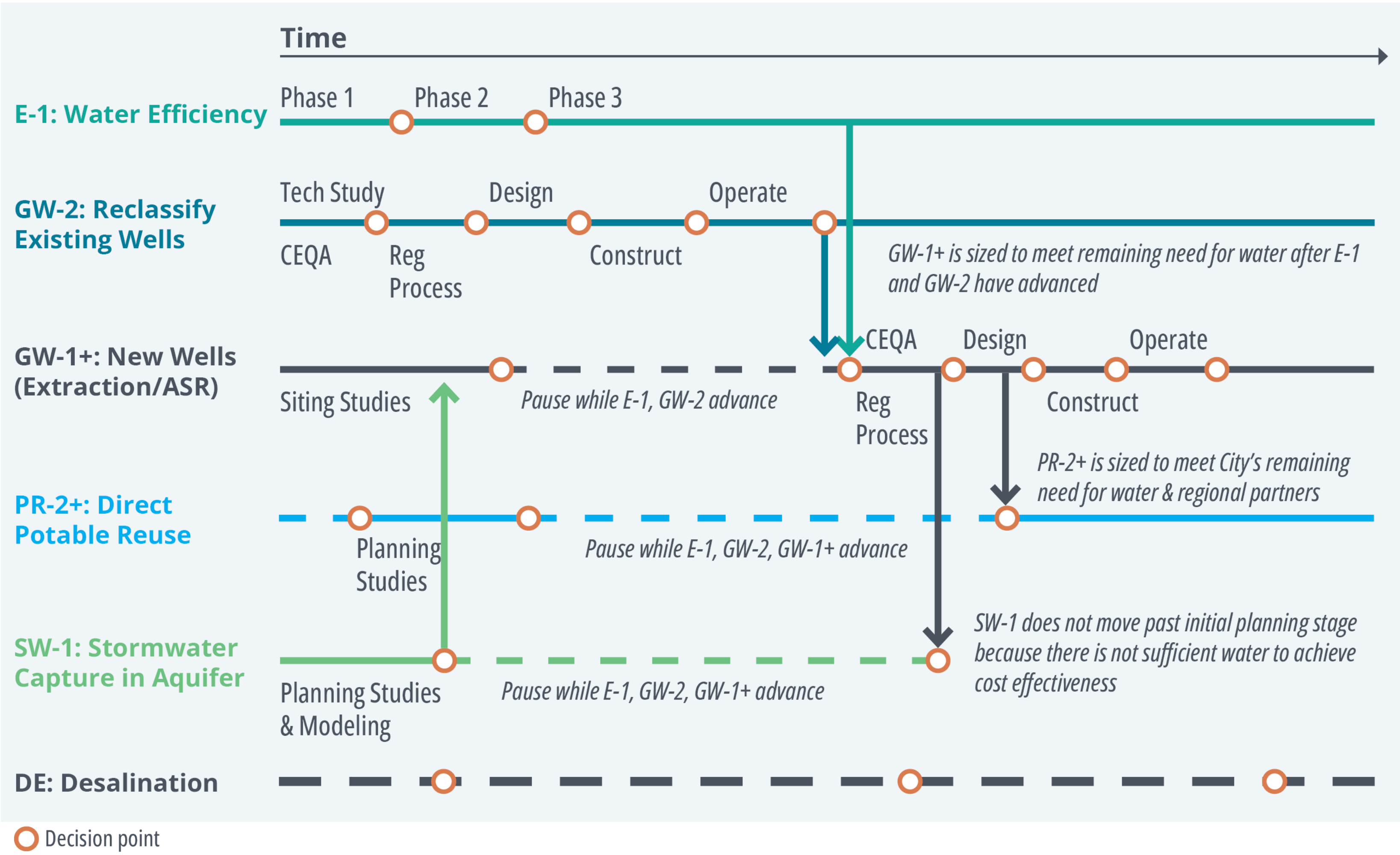


Figure 5-12: Portfolio 4 Implementation Concept (Alternative Scenario, 2nd Variant)



5.8 Summary of Portfolios

The following three figures compare the five portfolios (the primary four portfolios and the Alternative Scenario of Portfolio 4) in the areas of yield and capital costs. **Figure 5-13** shows the cumulative estimated water yield for each of the four portfolios through 2045 and is consistent with the blue dotted line in the cost and yield performance graphs for each of the portfolios presented in the prior sections. **Figure 5-14** shows the capital funding needs for each of the portfolios by year. **Figure 5-15** presents the cumulative capital cost for each by year and is consistent with the red line on the prior cost and yield performance graphs. **Figure 5-16** shows the net operating burden, or full annualized cost, for each portfolio by year; the full annualized cost includes operating cost and debt service. For the purpose of these graphs, Santa Rosa Water needed to make assumptions about the sequencing and timing of project implementation elements; these assumptions are estimates and would be adjusted if Santa Rosa Water moved forward with implementing any portfolio or portfolio components. These assumptions are included in **Appendix C** (Portfolio 1), **Appendix D** (Portfolio 2), **Appendix E** (Portfolio 3), **Appendix F** (Portfolio 4 Baseline), and **Appendix G** (Portfolio 4 Alternative).

As shown in **Figure 5-13**, each of the portfolios begin providing the same amount of yield until Portfolios 2 and 3 split off in 2031, representing an estimate of when GW-1 would begin providing water. Portfolio 3 begins to deviate from Portfolio 2 in 2036 when SW-1 would start providing water. In Portfolio 3, water from PR-2 would begin in 2039. Portfolios 1 and 4 (Baseline and Alternative) mimic each other until 2035 when GW-1+ begins to provide water, both from extraction only wells and from ASR wells using stormwater from SW-1. In Portfolio 4 Baseline, PR-2 comes online in 2043 and provides the final increase in water.

The financial information for the portfolios shown in **Figure 5-14**, **Figure 5-15**, and **Figure 5-16**, as noted above, is based on the assumptions made regarding the timing and sequencing of implementation steps. Portfolios 1 and 2 are difficult to see in Figure 5-13 because they follow the same path as other portfolios (Portfolio 1 follows Portfolio 4 Baseline and Portfolio 2 follows Portfolio 3) from 2027 until capital investments are complete (in 2028 for Portfolio 1 and 2031 for Portfolio 2). Portfolio 3 sees a large spike in capital required around 2035 due to investments needed in PR-2. The 2022-23 operating budget for Santa Rosa Water was set at roughly $21 million; **Figure 5-16** shows that any of the WSAP portfolios will require a significant increase in Santa Rosa Water's annual operating budget. At the low end in 2040, Portfolio 1 would result in a roughly $7 million, or 33 percent, increase. At the high end in 2040, Portfolio 3 would result in an approximately $31 million (148 percent) increase.

Across the three financial figures, the Baseline scenario for Portfolio 4 has a more gradual level of investment than Portfolio 3 because of its more adaptive approach; Portfolio 4's Alternative scenario shows more scaled back investments than either Portfolio 3 or Portfolio 4's Baseline scenario because neither PR-2 nor SW-1 advance past the planning stages so this scenario operates similarly to Portfolio 2. Adaptive planning as seen in Portfolio 4 offers Santa Rosa a number of important benefits:

- *Each project is implemented with a well-defined understanding of its milestones*. Milestones offer Santa Rosa Water an opportunity to refine the remaining aspects of the project to meet current needs. For example, the phased approach to E-1. Depending on the success of various conservation programs, staff can adjust its future efficiency work to meet shifting water use patterns or changing regulatory requirements around end use. Santa Rosa Water can also leverage these milestones to complete activities that will inform future work; for example, reassessing water demands to confirm project size before investing in design.

- *Timing and scale of later projects are informed by the performance of earlier projects*. In Portfolio 4, PR-2 only moves forward based on the remaining need for water. It may be that no additional water is needed by that time and PR-2 does not move forward (1st variant of Portfolio 4, **Figure 5-11**). In another case, additional water may be needed, but not nearly the amount scoped in the WSAP for PR-2. At that point, Santa Rosa Water may opt to move forward with direct potable reuse, but in a very scaled back manner (second variant of Portfolio 2, **Figure 5-12**).
- *Early, inexpensive tasks are completed off the critical path*. In both Portfolios 3 and 4, planning studies for PR-2 are completed early, even though its timing and scale depends on the performance of other projects like GW-1+. The same approach is used for SW-1 planning studies and stormwater modeling. This allows Santa Rosa Water to take a more measured approach to addressing the supply gap, while simultaneously positioning itself to quicky leverage favorable regulatory environments or funding opportunities.

Figure 5-13: Cumulative Estimated Water Yield (AFY)

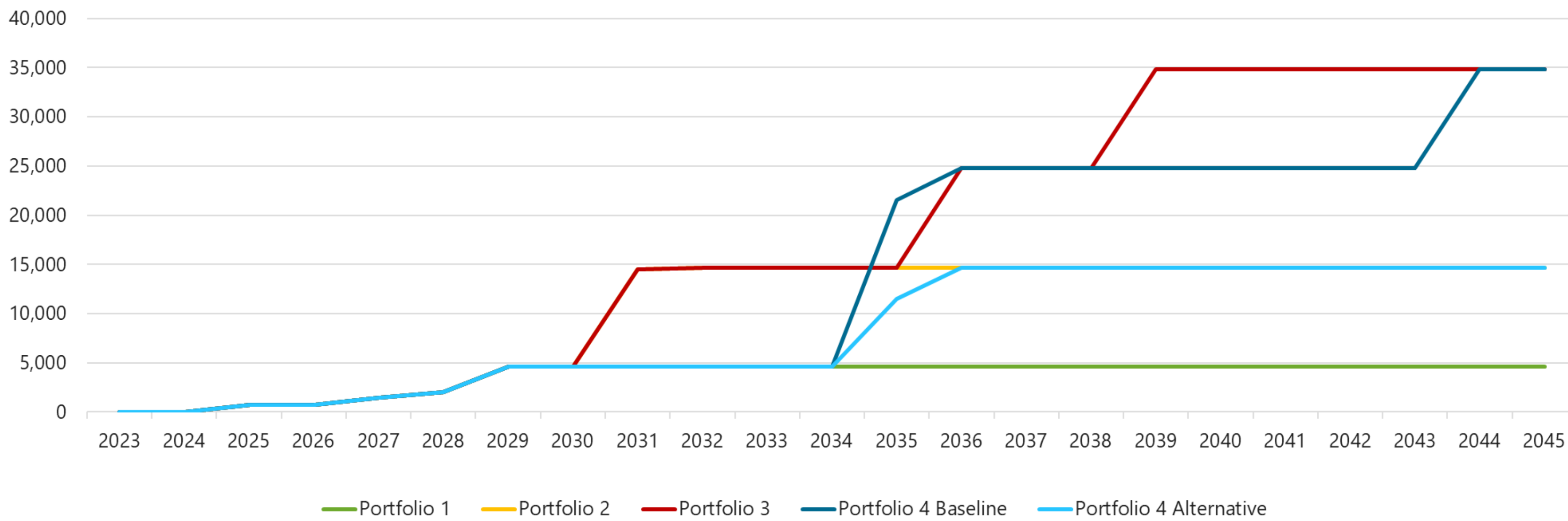


Figure 5-14: Capital Funding Needs by Year ($M/Year)

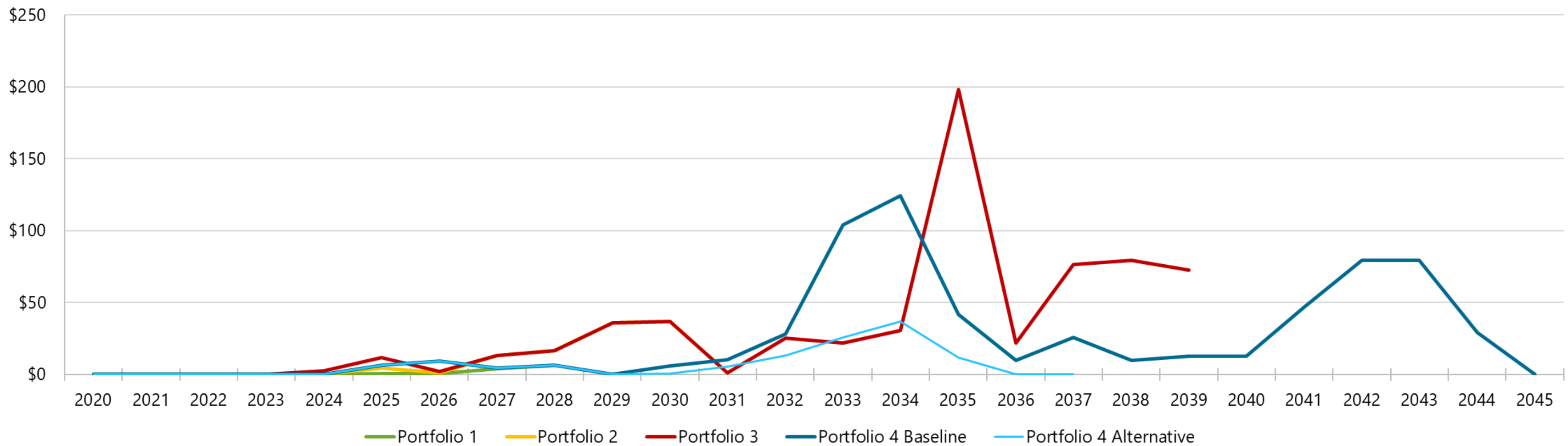


Figure 5-15: Cumulative Capital Investment ($M/Year)

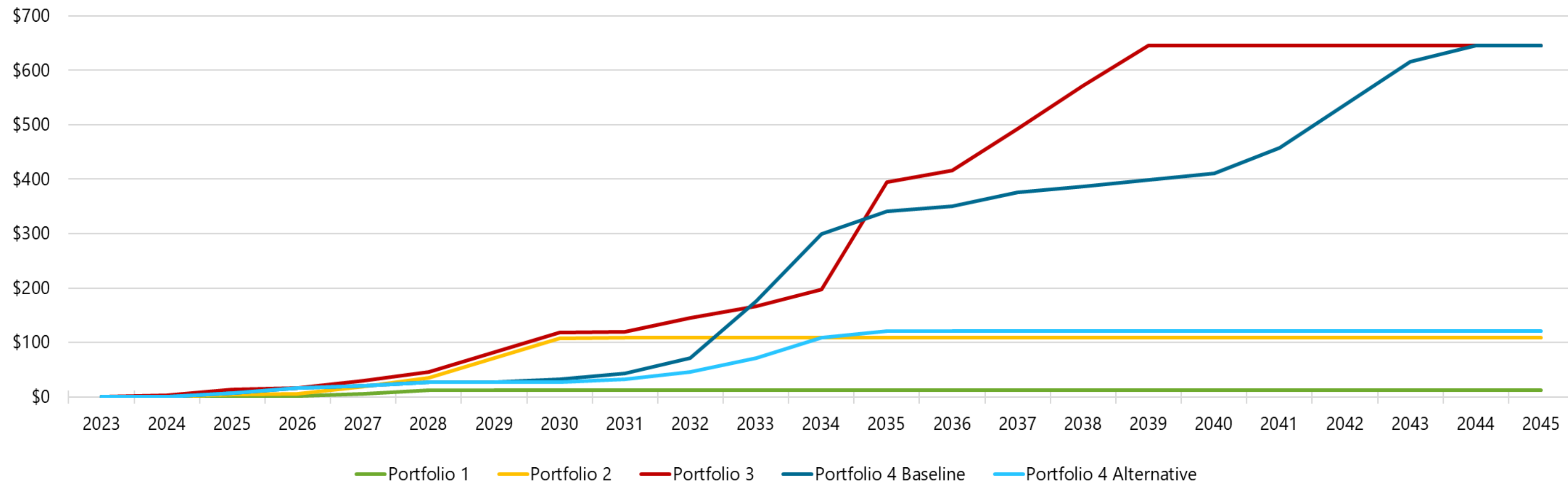
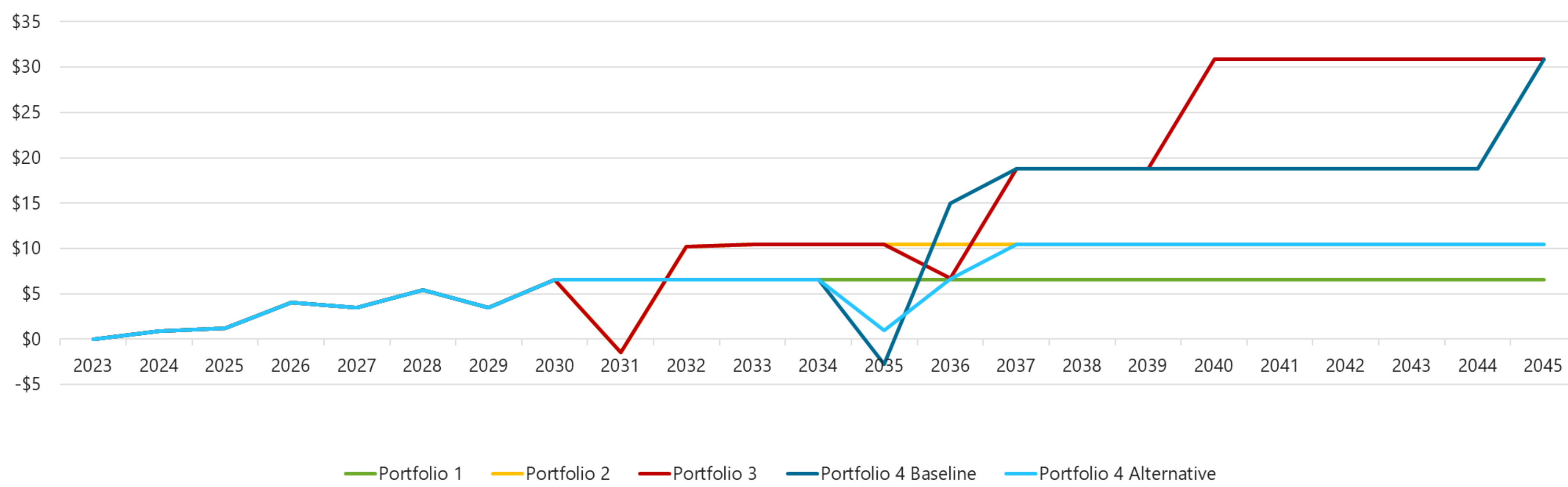


Figure 5-16: Net Operating Burden ($M/Year)[1]



[1] Portfolios 2, 3, and 4 Baseline all experience a negative net operating burden, or an operating savings, as a result of water supply projects that reduce the purchase of Sonoma Water (GW-1 and SW-1 in these cases).

6. NEXT STEPS

The WSAP presents a number of potential pathways that Santa Rosa Water could take as it continues to plan for its water future. Based on discussions with stakeholders, Portfolio 4 appears to offer the most benefits to Santa Rosa Water, including that its most responsive to its original goals and provides the most flexibility to adapt to changing conditions in the future. If Santa Rosa Water chooses to make progress on Portfolio 4, staff could begin with the following steps:

- Identify funding for initial activities and plan for CIP funding. Santa Rosa Water would first need to identify funding to support early work which is outlined in the bullet points below. This would include scoping the work to better understand costs and determining which work would be completed by staff and which work would be conducted by one or more consulting firms. Santa Rosa Water could also begin planning for the initial capital expenditures that will come as GW-1+ and GW-2 advance. This would likely mean adopting CIP funding for these elements, which would require some lead time.

- Plan for Phase 1 of E-1. Because Santa Rosa Water has extensive experience implementing efficiency programs, work to further E-1 will be familiar to staff. This would likely include preparing an internal implementation plan for programs under Phase 1 and the development and maintenance of internal and external funding opportunities that could be used to support implementation.

- Begin hydrogeologic studies for GW-2 and determine CEQA pathway. Santa Rosa Water has already identified some funding for converting emergency wells to full time production wells. As a result, staff could begin hydrogeologic studies earlier as a result. Simultaneously, staff could confirm the CEQA coverage needed for GW-2. Once completed, the hydrogeologic studies would support the environmental documentation needed for GW-2. Regulatory approvals with the State Board and interagency coordination (including Public Trust Review) could also begin once hydrogeologic studies were complete. Additionally, Santa Rosa Water would coordinate with the Santa Rosa Plain GSA to ensure groundwater basin sustainability.

- Prepare siting study for GW-1+. The siting study for GW-1 could begin with a desktop effort to identify all potential sites that could be eligible for extraction only and which could include ASR wells. Santa Rosa Water could apply a screening process to these sites to narrow down the list and conduct field investigations of top ranked sites. During this step, results from the modeling and siting study work for SW-1 could be folded into the process so staff could assess at that time if ASR wells with stormwater would be a viable path forward. This step would also include discussions with Santa Rosa Plain GSA to coordinate strategies for basin sustainability.

- Track direct potable reuse regulations and initiate planning studies for PR-2+. Santa Rosa Water could begin work on PR-2 by tracking the draft guidelines from the State Board and consider the best location, explore potential regional partnerships, and begin engaging with likely early adopters. Once the State has finalized regulations, staff could begin a treatment study to identify the processes needed to produce and use water through direct potable reuse. Santa Rosa Water could consider engaging with the San Francisco Public Utilities Commission and the Los Angeles Department of Public Works to learn about the best approach, as both agencies that have conducted treatment pilots for direct potable reuse.

- Conduct modeling and siting study for SW-1. Initial planning studies for SW-1 include stormwater modeling, a siting study, and a treatment study. This work would help Santa Rosa Water determine the amount, location, and timing of stormwater and how it might be treated for use in GW-1+ or in some other project. Initial scope and cost development could occur at the completion of this work.

Some of these items, such as planning for Phase 1 of E-1 and the hydrogeologic and siting studies for GW-2 and GW-1+, would also apply to the other WSAP portfolios. If Santa Rosa Water decided to embark on a different portfolio or path, this work would still provide benefit and support that new pathway.

Regardless of the path forward, Santa Rosa Water will need to consider the following four areas that are subject to dynamic change, as it plans for its water future: funding, technology, regulations, and regional efforts. Monitoring advancements and opportunities in these areas will help Santa Rosa Water remain agile and able to quickly adapt its water supply planning efforts.

Funding

Implementing any of portfolios outlined in the WSAP would require varying levels of funding and funding strategies, both in initial capital cost and annual operation and maintenance. Santa Rosa Water typically funds its capital projects through some combination of connection fees (for infrastructure), water rates (and periodic rate increases), grants, and bonds. These mechanisms, in addition to state revolving fund loans, could also be used to fund the water supply options and/or portfolios presented in the WSAP.

Grants/Loans: State and federal agencies often provide grants or low-interest loans to fund water projects. Santa Rosa Water has a successful history of securing grants. This funding mechanism will likely be an important source, particularly if Santa Rosa Water considers implementing direct potable reuse. In July 2022, the State Board released draft regulations for DPR implementation. Given the State's focus on enhancing water supply resiliency throughout California, funding may become available in the future to support implementation of these projects.

Bonds: Santa Rosa Water may opt to issue bonds to raise capital for water projects as it has for large projects such as the new UV system currently being installed for disinfecting recycled water. Bonds are a form of debt where bondholders provide money in exchange for periodic interest payments and the return of the principal amount at the end of the bond period. Because bonds are usually repaid using revenue from water rates over an extended period, bonds can be a useful tool to avoid large spikes in water rates for customers.

Connection Fees and Water Rates: To support continued investment in its water infrastructure and operations and maintenance of existing infrastructure, Santa Rosa Water uses connection fees and water rates. Santa Rosa Water reviews connection fees and water rates periodically and develops new fee and/or rate schedules based on studies. Due to Proposition 218, the Right to Vote on Taxes Act (1996), public water systems must demonstrate that any proposed fee and/or rate increases are necessary to cover the costs of providing water services, including the capital investments required for new projects.

Santa Rosa Water is keenly aware that in a successfully implemented water project, benefits must be equal to or outweigh the costs. During development of water supply projects, staff would continually weigh the anticipated costs of each project (e.g., financial, environmental) against the estimated benefits (e.g., reduced impacts of water shortages, increased local control). Purposefully balancing the costs and benefits of any project helps Santa Rosa make informed decisions that align with the broader interests of the community, foster responsible water resource management, and ensure a resilient water supply system for the future.

The WSAP provides a snapshot in time of the cost effectiveness of the included water supply options. Factors such as regulatory changes, advances in technology, worsening drought severity and/or frequency, and increases in Sonoma Water's wholesale water rates all contribute to the cost-effectiveness of potential water supply projects. As part of the further development of any WSAP elements, Santa Rosa Water is committed to re-analyzing the cost-effectiveness of projects and making adjustments so that the best options continue to move towards implementation.

To provide funding context for capital and operations and management costs, Santa Rosa Water's annual budget for fiscal year 2023-2024 is included as **Appendix H**.

Technology

Technological advances have and will continue to change the way in which water suppliers select and implement water supply projects. Such past examples include advancements in wastewater treatment that opened opportunities for purple pipe recycled water and paved the way for potable reuse. Another example is automated metering infrastructure (AMI), which the Santa Rosa Water began implementing in 2016 and has helped manage end user demand and quickly identify system leaks. While these are direct examples of how water-related technology has shaped project implementation, there are also other examples of more indirect technological advances that may impact how Santa Rosa Water continues to plan future water supply. One example is advancements in energy generation. As recently as 10 years ago, energy prices made desalination often prohibitively expensive and only cost-effective at very large scales. With technological advancements in the energy industry, the prevailing concern with desalination has shifted from energy use to one around brine disposal.

Artificial intelligence (AI) is another area of technological advancement that will likely impact water supply planning. The industry has already seen some of this influence with smart irrigation systems that can process weather data and soil moisture information to optimize water use in agriculture and landscaping. Advancements in AI may impact how water quality is monitored or support siting for stormwater infrastructure as these projects consider how climate change will alter the frequency and timing of stormwater runoff. Staying informed about technological developments will help Santa Rosa remain agile and adjust its water supply planning to effectively manage its water resources and continue to improve resiliency.

Regulations

A third area that will continue to greatly impact water resources planning is regulations at the local, state, and federal levels. Recent examples include Sonoma County's amended Well Ordinance and the State Board's draft direct potable reuse guidelines, both of which will shape how Santa Rosa Water implements any new groundwater or potable reuse projects.

A more nascent area for regulations is around emerging water quality concerns, particularly microplastics and per- and polyfluoroalkyl substances (PFAS). PFAS are referred to as "forever chemicals" because they do not break down in nature; since the beginning of their widespread use in the 1950's, they have been used in thousands of products for non-stick or stain-resistant purposes. The U.S. Environmental Protection Agency released proposed maximum containment levels (MCLs) for six different PFAS in March 2023; the California Division of Drinking Water (DDW) has yet to set MCLs for PFAS. Final MCLs and other PFAS-related regulatory requirements may impact how Santa Rosa Water implements water supply projects. One potential impact may be on the final siting or well-head treatment required for groundwater wells. If substantial well-head treatment is ultimately required, it may shift the cost-effectiveness of GW-1+ and GW-2. Staff should continue to monitor regulatory developments that would have the potential to alter the course of water supply components in the WSAP.

Regional Efforts

As discussed in Section 1.2.1, the City is involved in a number of regional water supply reliability efforts, including Sonoma Water's regional water supply and resiliency efforts, the GSA's development and implementation of a its groundwater sustainability plan, and the Russian River Water Forum's efforts to secure water supply resiliency as PG&E moves forward with decommissioning the Potter Valley Project and potentially impacts the associated Eel River diversion. The City is committed to continue working with these and other partners to enhance regional sustainability in the future as opportunities arise. There are also a number of neighboring water suppliers which have individually invested in studying and planning for their own long-term water supply resiliency and reliability. As these efforts evolve and advance throughout the region, Santa Rosa Water is well positioned to stay informed about and seek opportunities to work with partners on mutually beneficial water supply projects. For example, there could be opportunities for Santa Rosa Water to adjust SW-1 to increase economies of scale or to form a partnership for PR-2 which could lead the development of a regional direct potable reuse facility (similar to PR-4).

This concludes the Water Supply Alternatives Plan. This document is not intended to be prescriptive, but rather an adaptive guide for Santa Rosa Water to use as it begins water supply and infrastructure planning for Santa Rosa's future.

7. REFERENCES

City of Santa Rosa. (2018, February). Regional Water Reuse System Master Plan.

City of Santa Rosa. (2021, June). 2020 Urban Water Management Plan.

State Water Resources Control Board. (2021, August 17). A Proposed Framework of Regulating Direct Potable Reuse in California Addendum, version 8-17-2021.

The Technical Memorandum included in Appendix A includes a more robust list of references used for that work.

APPENDIX A: FEASIBILITY ANALYSIS TECHNICAL MEMORANDUM

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APPENDIX I: MEMORANDUM ON DESALINATION SUPPLY OPTIONS IN THE WATER SUPPLY FEASIBILITY ANALYSIS

APPENDIX A: FEASIBILITY ANALYSIS TECHNICAL MEMORANDUM

Woodard & Curran

TECHNICAL MEMORANDUM

TO: Colin Close

PREPARED BY: Jennifer Kidson, Martha de Maria y Campos

REVIEWED BY: Xavier Irias, Christy Kennedy, Katie Cole

DATE: August 31, 2023

RE: Santa Rosa Water Supply Alternatives Plan Feasibility Analysis Findings, Task 7

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ACRONYMS AND ABBREVIATIONS

AACEI	Association for the Advancement of Cost Engineering International
AF	acre-foot
AFY	acre-feet per year
AOP	advanced oxidation process
ASR	Aquifer Storage and Recovery
AWPF	Advanced Water Purification Facility
BAF	biological activated filtration
BPU	Board of Public Utilities
City	City of Santa Rosa
CII	Commercial, industrial, institutional
DPR	direct potable reuse
FAT	full advanced treatment
gpf	gallons per flush
gpm	gallons per minute
GSP	Groundwater Sustainability Plan
GWR	groundwater recharge
IPR	Indirect Potable Reuse
LTP	Laguna Treatment Plant
MF	microfiltration
MGD	million gallons per day
O&M	Operations and Maintenance
Regional System	Santa Rosa Regional Water Reuse System
RO	reverse osmosis
RWA	raw water augmentation
SFR	Single family residential
SWA	surface water augmentation
TM	Technical Memorandum
TWA	treated water augmentation
UF	Ultra filtration
UWMP	Urban Water Management Plan
WSAP	Water Supply Alternatives Plan

APPENDICES

Appendix A: Cost Details
Appendix B: Screening Tool Detail (Baseline Scenario)
Appendix C: Memorandum on Desalination Supply Options in the Water Supply Feasibility Analysis

EXECUTIVE SUMMARY

Purpose and Background

The City of Santa Rosa (City) is in the process of preparing a Water Supply Alternatives Plan (WSAP). Ultimately, the WSAP will provide a menu of water supply options and portfolios for the City to consider when planning future strategic investments and projects. The planning process for the WSAP includes engaging a broad base of stakeholders in establishing water supply goals, identifying potential conceptual-level water supply options, establishing evaluation criteria for these options, and conducting a feasibility analysis of the supply options. Participants include the Water Team (Deputy Directors and key staff), an external Stakeholder Group (leaders from a range of community organizations, resource agencies, environmental groups, and social service providers), the community at large through webinars and public meetings, and the Board of Public Utilities (BPU). This Technical Memorandum (TM) summarizes the results of the feasibility analysis.

Study Methods

The WSAP effort began by establishing water supply goals, supply options, and evaluation criteria, collectively referred to as the "study parameters." City staff and other stakeholders participated directly in this process during late 2022 based on their input, and the study parameters were finalized in early 2023. In brief, the study parameters include:

- Water Supply Goal: Diversify and increase city potable water supplies to reduce dependence on Sonoma Water, particularly during Russian River supply shortages during droughts or due to emergency disruption in delivery. Targets established in conjunction with the stakeholders were:
    - Minimize impact of shortages due to droughts – be able to provide 30 percent of annual water demand with City supplies to mitigate droughts (about 7,500 acre-feet per year (AFY) capacity in 2045)
    - Minimize impacts of disruption in Sonoma Water service – be able to provide 50 percent of normal indoor demand with City supplies for catastrophic events (about 9 million gallons per day (MGD) in 2045)
    - Minimize impacts of peak demand – be able to provide 30 percent of peak month, average day demand from City supplies from late spring through early fall (about 9 MGD in 2045)

- Water Supply Options: **Table ES-1**, below, summarizes the 18 water supply options that were considered.

- The following evaluation criteria were selected and assigned relative weights:
    - Cost-effectiveness and scalability (high weight). These two criteria were also used as screening criteria to determine which water supply options merited full feasibility analysis. This screening step was implemented as part of the study parameters in order to focus the feasibility analysis on the most promising water supply options.
    - Resiliency, equity, and environmental performance (high weight).
    - Legal, permitting, and regulatory; City control and interagency coordination; and multi-benefit (medium weight).

Table ES-1: Water Supply Options

Supply Type	Supply Option Name
Groundwater	GW-1: Construct Additional Groundwater Extraction Wells GW-2: Convert Emergency Wells to Production Wells GW-3: Construct Aquifer Storage and Recovery (ASR) Wells GW-4: Construct Regional Groundwater Extraction Wells GW-5: Construct Regional ASR Wells
Purified Recycled Water	PR-1: Direct Potable Reuse (DPR) with Advanced Water Purification Facility (AWPF) at Laguna Treatment Plant (LTP) PR-2: Satellite DPR with AWPF PR-3a: Indirect Potable Reuse (IPR) with AWPF LTP into Groundwater Basin PR-3b: IPR with AWPF LTP into Lake Ralphine PR-3c: IPR with AWPF at LTP into Lake Sonoma PR-4: Regional DPR with AWPF at LTP
Recycled Water	RW-1: Expand City's Non-Potable Recycled Water System
Desalination	DE-1: Regional Brackish Desalination DE-2: Ocean Desalination
Stormwater	SW-1: Stormwater Treatment and Storage in Aquifer SW-2: Stormwater Storage in Lake Ralphine with Treatment SW-3: Regional Stormwater
Efficiency Programs	E-1: Efficiency Programs

Acronyms:
AWPF – Advanced Water Purification Facility
ASR – Aquifer Storage and Recovery
DPR – Direct Potable Reuse
IPR – Indirect Potable Reuse
LTP – Laguna Treatment Plant

Screening Analysis

Following identification of the study parameters, a pre-screening analysis was conducted to narrow the list of 18 water supply options for screening. Five options were set aside, and 13 options were advanced to the screening step. Each of the water supply options was developed at a conceptual level to estimate potential water supply yield and costs. Cost estimates in this document are considered Class 5 per Association for the Advancement of Cost Engineering International (AACEI) guidelines, i.e., conceptual. Actual project costs would be expected to fall within +50 percent to -15 percent of the cost estimate.

Based on the yield and costs, cost-effectiveness of each water supply option was evaluated under two general scenarios:

- Maximum production: This scenario assumed that each water supply option would be operated to maximize water supply and meet as much of the water supply goal as possible, regardless of whether shortages would be present requiring additional supply.
- "Baseline" scenario: This scenario assumed that each water supply option would be operated in a way that minimized operational costs. This is a more realistic scenario than the "maximum production" scenario.

The results of the screening analysis are summarized in **Table ES-2** below.

Table ES-2: Screening Analysis Results Summary

Option	Maximum Yield		Baseline Usage		Carried forward for full Feasibility Analysis?
	Acre-Feet/Year	$/Acre-Foot	Avg Acre-Feet/Year	$/Acre-Foot*	
GW-1: Construct Additional Groundwater Extraction Wells	10,080	$700	6,734	$840	Yes
GW-2: Convert Emergency Wells to Production Wells	2,462	$500	1,744	$540	Yes
GW-3: Construct Aquifer Storage and Recovery (ASR) Wells	5,130	$900	3,634	$1,100	Yes
PR-1: Direct Potable Reuse (DPR) with Advanced Water Purification Facility (AWPF) at Laguna Treatment Plant (LTP)	10,065	$2,000	4,131	$3,600	No
PR-2: Satellite DPR with AWPF	10,065	$2,100	4,131	$3,900	Yes
PR-3a: IPR with AWPF at LTP into Groundwater Basin	10,065	$2,500	4,131	$4,800	No
PR-3c: IPR with AWPF at LTP into Lake Sonoma	10,065	$3,700	4,131	$6,400	No
PR-4: Regional DPR with AWPF at LTP	10,065	$1,800	4,131	$3,200	Yes
RW-1: Expand City's Non-Potable Recycled Water System	3,000	$2,900	900	$9,800	No
DE-1: Regional Brackish Desalination	10,080	$1,100	4,441	$2,000	No
DE-2: Ocean Desalination	10,080	$2,600	4,441	$4,500	No
SW-1: Stormwater Storage in Aquifer	10,080	$1,400	2,618	$3,500	Yes
E-1: Efficiency Programs	2,145	$2,800	2,145	$2,800	Yes

Notes:

The following options are not shown in the table as they were eliminated from further consideration prior to completing the detailed cost/yield analysis: GW-4, GW-5, PR-3b, SW-2 and SW-3. All of the water supply options considered in this study are described in more detail in Section 3.1.

* Costs include capital and operating costs consistent with a realistic baseline usage scenario.

Acronyms:

- AWPF - Advanced Water Purification Facility
- ASR – Aquifer Storage and Recovery
- DPR – Direct Potable Reuse
- IPR – Indirect Potable Reuse
- LTP – Laguna Treatment Plant

Feasibility Analysis

The water supply options that passed the screening analysis were then scored based on the evaluation criteria established with input from stakeholders, the BPU, the community, and City staff. A numeric score was assigned for each criterion using a 3-point scale from 0 to 2, with 2 being the most favorable. A score of zero implies that an option is not responsive to a criterion or performs relatively poorly compared to the other options, while a score of 2 implies that the option performs very well.

The raw scores were then weighted consistent with the relative importance of each criterion described earlier, e.g., cost and scalability were assigned very high weight, permitting ease medium weight, etc. The specific weights are as follows:

- Cost-effectiveness and scalability: 5x multiplier
- Resiliency, equity, and environmental performance: 3x multiplier
- Legal, permitting, and regulatory; City control and interagency coordination; and multi-benefit: 1x multiplier

Table ES-3, below, table summarizes the results of the feasibility scoring:

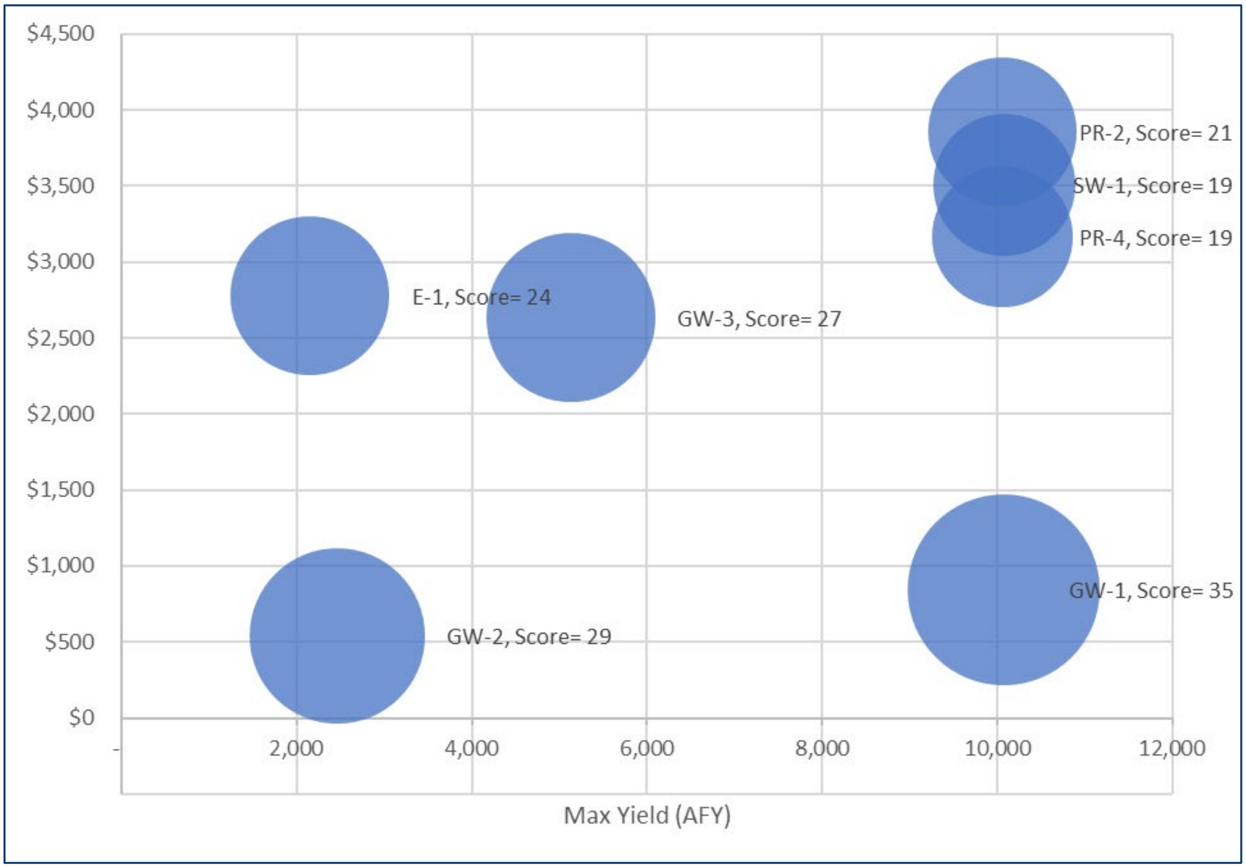
Table ES-3: Summary of Supply Option Scores

Criterion	Groundwater			Purified Recycled Water		Stormwater	
	GW-1: Add Extraction Wells	GW-2: Convert Emergency Wells	GW-3: City ASR Wells	PR-2: Satellite DPR	PR-4: Regional DPR	SW-1: Stormwater Storage in Aquifer	E-1: Efficiency Programs
Cost effectiveness* [$/AF]	2 [$840/AF]	2 [$540/AF]	2 [$1,100/AF]	0 [$3,900/AF]	0 [$3,200/AF]	0 [$3,500/AF]	1 [$2,800/AF]
Scalability [Yield in AFY]	2 [5,880 - 10,080 AFY]	0 [1,436 - 2,462 AFY]	1 [2,993 - 5,130 AFY]	2 [3,019 - 10,065 AFY]	2 [3,019 - 10,065 AFY]	1 [1,008 - 10,080 AFY]	1 [2,145 AFY]
Resiliency	1	1	2	2	2	1	1
Equity	1	1	1	1	1	1	2
Environmental performance	1	2	1	0	1	1	2
Legal, permitting, and regulatory	1	2	0	0	0	1	2
City control and interagency coordination	2	2	1	2	0	2	2
Multi-benefit	0	0	1	0	0	2	1
Total Unweighted	*10*	10	9	7	6	9	12
Total Weighted	***32***	***26***	**29**	**21**	**22**	**19**	**30**

* Costs include capital and operating costs consistent with a realistic baseline usage scenario.

As shown in **Figure ES-1-1**, most supply options did not score substantially differently from one another.

Figure ES-1-1: Cost-Effectiveness vs Max Yield (with Weighted Score)



Notes: Water Supply options:

- E-1: Efficiency Programs
- GW-1: Construct Additional Groundwater Extraction Wells
- GW-2: Convert Emergency Wells to Production Wells
- GW-3: Construct Aquifer Storage and Recovery (ASR) Wells
- PR-2: Satellite Direct Potable Reuse (DPR) with Advanced Water Purification Facility (AWPF)
- PR-4: Regional DPR with AWPF at Laguna Treatment Plant
- SW-1: Stormwater Storage in Aquifer

The feasibility analysis also assessed supply option performance under a range of future conditions beyond the baseline scenario. Performance of the options was examined under varying future hydrologic conditions, and varying Sonoma Water dry-year allocations were evaluated. In general, as future conditions become less favorable, a supplemental water supply is used more and becomes more cost-effective.

Conclusions

This Feasibility Analysis reveals several key considerations for the City as it conducts future water supply planning:

This Feasibility Analysis reveals several key considerations for the City as it conducts future water supply planning:

- **Future conditions:** Depending on the City's assumptions about future hydrology, Sonoma Water cutbacks, cost of Sonoma Water supplies, and customer demand/conservation, the City may reach different conclusions about the potential best fit water supplies. For example, if the City assumes a less conservative scenario (e.g., business as usual), the amount of new water needed may be relatively modest, in which case the City would be well served by bridging that gap with a small number of new wells, which could be added one by one as the need arises. On the other hand, if the City assumes a more conservative scenario in which existing water supplies decrease, a broader range of options could be considered, including options such as potable reuse that would be run continuously once implemented. Options that could be implemented in phases (e.g., rehabilitating one well at a time, rather than 3 at once) may help provide resiliency while minimizing capital outlay.

- **Operational assumptions:** Similar to future conditions, the City would need to consider its operational philosophy for a new supply source. If the City elects to operate a new supply on a 24/7 basis, this would reduce the cost per AF of water but could also increase total operational costs.

- **Sensitivity:** This analysis considered the impact of changing hydrology and reduced Sonoma Water dry-year allocations. The supply options generally become more cost-effective under more pessimistic scenarios (drier hydrology and higher Sonoma Water cutbacks) because more water is produced via the new options. However, the analysis indicates that the relative rankings of the supply options do not vary substantially with changes to the baseline condition.

The next step of the WSAP project will be to propose portfolio options (mixes of water supply options to achieve the goals) based on the findings in this TM. This will involve developing portfolio alternatives and analyzing them to further assess the water supply options that passed the screening analysis. The portfolio analysis may consider downscaled versions of some supply options and will consider potential groupings of supply options that would allow the City to optimize different areas such as resiliency, supply volume, cost, and consistency with the multiple goals.

1. PURPOSE AND BACKGROUND

On August 10, 2022, the City of Santa Rosa (City) contracted with Woodard & Curran to prepare the City's Water Supply Alternatives Plan (WSAP). Ultimately, the WSAP will provide a menu of water supply options and portfolios for the City to consider when planning future strategic investments and projects for increasing water supply resiliency and reliability.

The planning process for the WSAP includes establishing water supply goals, identifying potential conceptual-level water supply options, establishing evaluation criteria for these options, and conducting a feasibility analysis of the supply options. This Technical Memorandum (TM) summarizes the results of the feasibility analysis and supporting work.

To increase the City's water supply resiliency and reliability during a drought year or interruption of the Russian River supply, supplemental water is needed. Water conservation and recycled water alone or combined would not generate sufficient water to meet normal water needs through 2045 during a reasonable, worst-case drought event. This TM explores a number of supply options including expansion of existing groundwater supplies, groundwater banking/exchange projects, construction of new purified recycled water projects, construction of a new ocean desalination plant, participation in the development of a regional desalination plant, and stormwater capture along with additional efficiency programs. These options include both local and collaborative regional efforts that would require the City to partner with one or more local water agencies. Each supplemental supply component would provide different amounts of water. When combined with one another in various portfolios (mixes of water supplies) and various levels of water conservation and existing water supplies, new water supplies would help to meet projected normal water needs throughout the planning period.

2. STUDY PARAMETERS AND METHODS

The WSAP effort began by establishing water supply goals, supply options, and evaluation criteria, collectively referred to as the "study parameters." The following subsections describe the development of the study parameters and list the final parameters which acted as the foundation for the feasibility study.

2.1 Collaborative Development of Study Parameters

The study parameters were established through a collaborative process with four groups of participants: the City, stakeholders, the community, and BPU.

Table 2-1 summarizes the series of meetings held with four distinct groups to gather input on the study parameters. The first group, referred to as the Water Team, was composed of City staff from multiple divisions (e.g., water resources planning, wastewater treatment and water recycling, stormwater and environmental compliance, water efficiency, and water and sewer operations). The second group, referred to as the Stakeholder Group, included leaders of local interest organizations (e.g., environmental groups, community associations, social justice organizations, local business groups, agricultural interests, and resource agencies). The third group is referred to as "the community". Community meetings were open to all and held virtually. Community meetings were advertised via social media, email, bill inserts, and postings on the City website. Lastly, the study parameters were reviewed by the City's BPU, which provides oversight of and direction for the management and operation of the City's water and wastewater facilities.

The project team incorporated feedback from the Water Team, Stakeholder Group, the community, and the BPU into the study parameters, resulting in the final water supply goal, water supply options, and evaluation criteria and methodology. These study parameters guided the feasibility analysis.

Table 2-1: Stakeholder and Community Outreach Meeting Summary

Meeting	Date	Topics
Water Team Meeting #1	October 17, 2022	Project overview; introduction of study parameters (water supply goals, water supply options, evaluation criteria, and methodology); input on study parameters.
Community Meeting #1	October 26, 2022	Overview of Santa Rosa water supplies; project background and overview; introduction of water supply goals, supply options, and evaluation criteria; polling questions, input on study parameters, and question and answer time.
Stakeholder Group Meeting #1	November 16, 2022	Overview of Santa Rosa water supplies; project background and overview; high-level group discussion of study parameters, and input on study parameters.
Stakeholder Group Meeting #2	December 14, 2022	Project update; group discussion of proposed study parameters, and input on the refined study parameters.
Water Team Meeting #2	December 15, 2022	Proposed study parameters; input on final refinements of study parameters, and input on the refined study parameters.
Board of Public Utilities study session	January 19, 2023	BPU direction on proposed study parameters.
Community Meeting #2	January 25, 2023	Project update; review of proposed study parameters; question and answer time.
Water Team Meeting #3	May 17, 2023	Project update on options development and refinement, screening analysis; input on draft study results and portfolio approach.
Stakeholder Group Meeting #3	May 24, 2023	Project update on options development and screening analysis; input on draft study results and portfolio approach.
Water Team Meeting #4	July 6, 2023	Project update and input on feasibility analysis and draft portfolios.
Stakeholder Group Meeting #4	July 18, 2023	Project update and input on feasibility analysis and draft portfolios.
Water Team Meeting #5	August 14, 2023	Project update and input on early draft of plan.
Board of Public Utilities study session	August 17, 2023	BPU direction on feasibility analysis and draft portfolios.

2.2 Water Supply Goal

The City's water supply goal for the WSAP effort is as follows:

Diversify and increase city potable water supplies to reduce dependence on Sonoma Water, particularly during Sonoma Water supply shortages or disruption in delivery:

- **Mitigating Droughts:** Meet 30 percent of city's water demand with city supplies to mitigate impacts of Russian River supply shortages (e.g., due to prolonged and/or severe drought). This goal assumes strict limits on, or banning of, landscape irrigation in severe droughts.
- **Mitigating Natural Disasters and Catastrophic Events:** Provide half of normal domestic/indoor demand for potable water with city supplies during Russian River supply disruption. Critical facilities would be prioritized for health and safety. Landscape irrigation would be prohibited.
- **Mitigating Peak Day Demand:** Meet 30 percent of peak month average day demand for potable water with city supplies.

Based on current City demand projections, the volume of water required to meet these goals in 2045 would be:

- 7,500 acre-feet per year (AFY) (30 percent of the City's annual water demand)
- 9 million gallons per day (MGD) (which equates to half of normal indoor demand, or 30 percent of peak month average day demand)

This TM assumes that potential water supply options would need to provide 7,500 AFY and 9 MGD of supply for the City, either individually or collectively. The water supply(ies) would generally be used in response to droughts or disruptive events, since in normal years the City's supplies are adequate.

During the goal development process, the following rationale was cited for selecting the goal:

- Provides guidance to support decision making regarding magnitude of resiliency portfolio.
- Increases city potable water supply resiliency and reduces demand on Sonoma Water supplies.
- Mitigates shortages in Sonoma Water supply and interruptions in service.
- Increases ability to meet a portion of peak day demand using local supply.
- Could be achieved over time with a mix of supplies.
- Allows for adjustments to volume target if demands are lower/higher than anticipated (percentage-based goals).
- Integrates input from the Water Team, Stakeholder Group, and the community.

2.3 Water Supply Options

Based on review of existing information and discussions with the City's Water Team, Stakeholder Group, community, and BPU, a list of water supply options was established, as summarized in **Table 2-2**.

Potential water supply options and facilities were identified based on the City's existing facilities and planning efforts already underway. Sources of information included, but were not limited to, the following:

- City of Santa Rosa 2020 Urban Water Management Plan (UWMP)
- City of Santa Rosa 2020 Water Master Plan Update
- City of Santa Rosa 2018 Regional Water Reuse System Master Plan

- City of Santa Rosa Subregional Water Resources Recovery Facilities Master Plan
- Groundwater Sustainability Plan (GSP) Santa Rosa Plain Groundwater Subbasin
- City of Santa Rosa Groundwater Master Plan
- Recycled water agreements
- Desalination white papers
- Peer agency work from Sonoma Water, North Marin, and Marin Municipal on water supplies, as well as UWMPs
- Well test boring results
- City of Santa Rosa Water Use Efficiency water savings workbook
- Recycled water pond storage capacities
- GIS Info: City parcels; stormwater, recycled water, wastewater, and water distribution facilities; well locations

The City's rationale for the selected suite of water supply options is listed below. The list of options achieves the following:

- Retains a broad diversity of options.
- Includes City and Regional projects.
- Includes aggressive efficiency incentives to reduce demand over time.
- Integrates input from Water Team, Stakeholder Group, and the Community.

Table 2-2: Water Supply Options

Supply Type	Supply Option Name
Groundwater	GW-1: Construct Additional Groundwater Extraction Wells GW-2: Convert Emergency Wells to Production Wells GW-3: Construct Aquifer Storage and Recovery (ASR) Wells GW-4: Construct Regional ASR Wells GW-5: Construct Regional Groundwater Extraction Wells
Purified Recycled Water	PR-1: Direct Potable Reuse (DPR) with Advanced Water Purification Facility (AWPF) at Laguna Treatment Plant (LTP) PR-2: Satellite DPR with AWPF PR-3a: Indirect Potable Reuse (IPR) with AWPF LTP into Groundwater Basin PR-3b: IPR with AWPF LTP into Lake Ralphine PR-3c: IPR with AWPF at LTP into Lake Sonoma PR-4: Regional DPR with AWPF at LTP
Recycled Water	RW-1: Expand City's Non-Potable Recycled Water System
Desalination	DE-1: Regional Brackish Desalination DE-2: Ocean Desalination
Stormwater	SW-1: Stormwater Treatment and Storage in Aquifer SW-2: Stormwater Storage in Lake Ralphine with Treatment SW-3: Regional Stormwater
Efficiency Programs	E-1: Efficiency Programs

The water supply options then went through a screening analysis to focus the list of options to undergo detailed feasibility analysis. This process is described in Section 2.5. All of the supply options are described in further detail in Section 3.1.

2.4 Evaluation Criteria and Metrics

To assess the feasibility of each water supply option, a list of evaluation criteria and associated metrics and weights were established. After beginning the WSAP process with a list of approximately 16 individual criteria, the list was consolidated and refined with stakeholder input to a focused list of evaluation criteria to be used in the feasibility analysis. The criteria and their descriptions are provided in **Table 2-3**.

Table 2-3: Evaluation Criteria, Metrics, and Weights

Criterion	Description	Proposed Metric	Weight
Cost effectiveness	Quantitative calculation of life-cycle costs, based on future scenarios per the project goals (e.g., five-year drought occurring on average every 10 years).	Life cycle cost effectiveness for key scenarios ($/acre-foot) (quantitative)	High
Scalability	Qualitative assessment of ability to provide sufficient supply to satisfy goals, i.e., achieve desired level of service for each scenario; secondarily, ability to scale further to address future uncertainty.	Volume of water provided (AFY/MGD) (quantitative) Ability to meet goals, and secondarily to increase production later, without undue effort/cost increase (qualitative)	High
Resiliency	Qualitative assessment of performance in the face of future uncertainty; for example, future regulations, energy costs, hydrology. The best options will suffer only modest degradation of performance if future conditions are worse than anticipated while inferior options will show marked degradation if planning assumptions aren't met.	Performance in the face of uncertainty (qualitative)	High
Equity	Qualitative assessment of any disproportionate impacts on vulnerable communities.	Level of disproportionate impact on vulnerable communities (qualitative)	High
Environmental performance	Qualitative assessment of potential environmental impacts not already included in permitting/regulatory compliance (e.g., level of GHG emissions).	Magnitude of potential impact (qualitative)	High
Legal, permitting, and regulatory	Qualitative assessment of complexity/effort to address legal issues (e.g., water rights), obtain necessary permits, and comply with regulations	Level of complexity and effort to address (qualitative)	Medium
City control and interagency coordination	Qualitative assessment of level of City control and coordination with potential partner agencies, if any (e.g., agreements needed for regional projects).	Level of City control and coordination with potential partner agencies, if any (qualitative)	Medium
Multi-benefit	Qualitative assessment of benefits provided in addition to water supply.	Benefits provided in addition to water supply (qualitative)	Medium

The selected criteria achieve the following:

- Captures key considerations that differentiate projects.
- Consolidates criteria where appropriate. (For example, individual criteria for construction and operations costs were consolidated into the overall cost-effectiveness metric.)
- Removes criteria that would pose a fatal flaw if not met. (For example, water quality was removed from the list of criteria because a supply option that would not provide adequate water quality would not merit further analysis.)
- Removes criteria that did not need to stand alone. (For example, a criterion for "ability to integrate with existing distribution systems" was removed since facilities required to integrate into the existing system would be captured as part of a supply option and its costs.)
- Integrates input from Water Team, Stakeholder Group, the community, and BPU.

Additionally, each criterion was assigned a metric and weight so the feasibility analysis could reflect City priorities about the relative importance of each criterion. Weights and metrics are summarized in **Table 2-3**. The evaluation metrics and weights achieve the following:

- Emphasizes key considerations such as cost, resiliency, and equity via weighting.
- Enables comparisons based on qualitative factors such as permitting/regulatory considerations.
- Provides enough detail for meaningful comparison, given level of available information.
- Integrates input from Water Team, Stakeholder Group, BPU, and the community.

Based on Water Team, BPU, and Stakeholders Group input, all criteria included on the final list were weighted as "high" or "medium" because criteria of lower importance had been removed from the criteria list. The final list of evaluation criteria represents a focused list of key considerations.

As part of the detailed feasibility analysis, a detailed rubric was developed to allow water supply options to be scored against the qualitative criteria (described further in Section 2.5.3).

2.5 Screening Analysis

Prior to detailed analysis, all supply options were subjected to a high-level pre-screening to identify and remove options deemed infeasible or substantially similar to existing and anticipated reginal efforts or other supply options considered in the analysis to remove options deemed infeasible or substantially similar to existing or anticipated regional efforts. After pre-screening, a screening step was implemented to yield a focused and manageable "short list" of water supply options to undergo detailed analysis. Some options were removed from consideration prior to screening based on obvious flaws. The workflow is shown in **Figure 2-1**. Each water supply option listed in **Table 2-2** was evaluated against two key criteria: cost-effectiveness and scalability (yield). The screening analysis involved a high-level assessment of these two criteria in order to determine which supply options are most promising for the City and document the reasoning by which certain supply options should advance for further detailed analysis, or not. The screening process allowed the City to identify any non-starter options early on and focus the remaining analysis. The results of the screening analysis are described further in Section 3.2.

Figure 2-1: Screening and Feasibility Analysis Process

2.5.1 Screening Tool

The screening analysis was accomplished with the aid of a spreadsheet model. The model was used to determine the conceptual performance of each supply option. Specifically, the model evaluated the volume of water that would be supplied under various hydrologic, regulatory, and operational scenarios, and determined the associated unit cost for each supply option based on its projected usage. The screening tool included a number of default assumptions and options, referred to as the baseline scenario, as summarized in **Table 2-4**. Each of these variables can be manipulated in the model to evaluate changing conditions (e.g., higher energy prices).

Table 2-4: Baseline Screening Analysis Parameters and Assumptions

Parameter	Default Value	Source Notes
2045 demand	25,000 AFY	Provided by City
Sonoma Water nominal allotment	29,100 AFY	Provided by City. In dry years, allotment is subject to reduction based on a percent of baseline demand, which is significantly lower than nominal allotment.
Current groundwater firm capacity	1,300 AFY	Provided by City
Discount rate	2.5%	Federal water resources planning discount rate for FY 2023. This rate is used to compute the present-day equivalent cost of future cash flows.
Price of energy	$200/megawatt hour	Prevailing price in California (note that time of use surcharges were not considered in this high-level analysis)
First year of simulation	2045	Water supply goal. Assumes water supply is available in 2045, at which point the model begins its 50-year simulation.
Planning horizon	50 years	Typical water infrastructure planning horizon
Sonoma Water reduction in dry years	30%	Provided by City. The dry-year Sonoma Water supply is assumed to be 70% of baseline purchases, which in turn are baseline demands less non-Sonoma supplies including existing groundwater plus the water supply option being modeled.
Demand reduction in dry years	10%	Provided by City
Hydrology	Historical replay (beginning in 1920)	United States Geological Survey Russian River Historical Data

A final key model parameter was the assumed hydrologic scenario. The model uses hydrologic scenarios to determine the distribution of normal, dry, and wet years modeled, which in turn determine the volume of supplemental supply required over the planning horizon. The model included the following hydrological scenarios: historical hydrology with selectable starting year (total range from 1911 to 2013); a synthetic hydrology which assumes a greater proportion of dry years; and a synthetic hydrology which assumes a greater proportion of wet years. The synthetic hydrologies employ a blend of inter-year randomness and first-order autoregression to capture the tendency of dry years to appear in runs, and thus cause droughts. The goal of using synthetic hydrologies is not to predict future climate, but rather to evaluate the performance of various water supply options under a variety of potential futures.

Model inputs included the following for each water supply option (except for options that were screened out at the conceptual stage):

- Maximum and minimum supply option yields in normal, wet, and dry years in acre-feet per year (AFY).
- Marginal operation and maintenance cost in normal, wet, and dry years as dollars per acre-foot $/AF). These costs include energy costs as appropriate, and purchase cost of water for the ASR option (GW-3).
- Fixed operations and maintenance costs ($/year).
- Capital costs ($).
- Storage capacity included in the supply option as acre-feet (AF)
- Leave-behind percentage (if applicable) (%).

The key model output is cost-effectiveness ($/AF) for a supply option under the chosen scenario. Cost-effectiveness is determined within a given model scenario and is based on actual volume used from the supply source. The cost-effectiveness accounts for the water year type, potential required water allocations (reductions from normal use during water shortages) from Sonoma Water, and demand reduction during dry years (whether imposed by the state, imposed by the City, or done voluntarily), assumed demand, supply from existing wells, and any storage associated with the water supply option. The cost tables in Section 3.1 include the cost-effectiveness of each water supply option under the baseline scenario.

In addition, by varying the model parameters such as hydrology and demand reduction percent, the cost-sensitivity of each supply option could be evaluated under a range of conditions.

2.5.2 Capital Cost Estimate Methodology

A key component of the screening analysis included compiling cost estimates for each supply option on the initial list. The high-level cost estimates presented in this TM were developed from bid tabulations, information obtained from previous studies, and experience on other projects. Life cycle costs presented in this TM include planning level construction costs and operations and maintenance (O&M) costs. The Association for the Advancement of Cost Engineering International (AACEI) developed metrics to classify estimating accuracy through project development. The cost estimates presented in this document are considered Class 5 for a planning-level feasibility study estimate. Based on AACEI guidelines, actual project costs are typically within +50 percent to -15 percent of the planning-level cost estimate. However, there could be additional uncertainty not modeled in the initial estimates. Project feasibility and funding should consider the inherent level of uncertainty associated with planning level cost estimates.

Each planning level cost estimate includes an estimating contingency of 50 percent. Implementation costs were estimated at 40 percent for legal and administration, engineering design, engineering services during construction and construction management. The annual O&M cost estimate includes electricity, labor and maintenance costs.

Project costs were calculated in 2023 dollars using the January 2023 Construction Cost Index for San Francisco, 15498.78. Annual Project costs are amortized using a 2.5 percent interest rate over a 50-year period.

2.5.3 Feasibility Scoring Methodology

Upon completion of the screening analysis, Woodard & Curran completed the feasibility analysis by evaluating and scoring the short-listed water supply options. This step of the analysis built upon the evaluation criteria established during development of the study parameters (**Table 2-3**). The evaluation process included developing criteria for the projects, adding numerical weights to each criterion, and scoring the projects against each criterion. The numerical system provides a score of zero through 2, with 2 being most favorable. A score of zero implies that an option is not responsive to a criterion or performs relatively poorly compared to the other options, while a score of 2 implies that the option performs very well. Applying a weight allows the ranking to better reflect the priorities of the City and its stakeholders, showing the relative importance of each criterion. The evaluation criteria scoring rubric used for the evaluation of the short-listed supplemental supply options is summarized in **Table 2-5**.

Table 2-5: Evaluation Criteria Scoring Rubric

Criterion	Proposed Evaluation Metric	Quantitative Score	Qualitative Score: 0	Qualitative Score: 1	Qualitative Score: 2	Weight	Score Multiplier
Cost effectiveness	Quantitative calculation of life-cycle costs, based on the baseline scenario per the project goals (e.g., five-year drought occurring on average every 10 years).	$/AF	>$3,000/AF under baseline scenario	Between $2,000/AF and $3,000/AF under baseline scenario	< $2,000/AF under baseline scenario	High + Screening Criterion	5
Scalability	Qualitative assessment of ability to provide sufficient supply to satisfy goals, i.e., achieve desired level of service for each scenario; secondarily, ability to scale further to address future uncertainty.	Yield (AFY)	Low flexibility: No ability, or minimal ability, to scale down production when supply is not needed.	Moderate flexibility: Some ability to scale production up or down depending on need for supply but would require significant effort or construction of new facility phases.	High flexibility: Production can be easily scaled up or down depending on need without significant investment.	High + Screening Criterion	5
Resiliency	Qualitative assessment of performance in the face of future uncertainty; for example, future regulations, energy costs, hydrology. The best options will suffer only modest degradation of performance if future conditions are worse than anticipated while inferior options will show marked degradation if planning assumptions aren't met.	Change in costs due to energy prices and hydrology scenarios can be accounted for quantitatively. These would feed into the qualitative scores.	Substantial change in cost-effectiveness under changing energy and hydrology conditions.	Moderate change in cost-effectiveness under changing energy and hydrology conditions.	Little or no change in cost-effectiveness under changing energy and hydrology conditions.	High	3
Equity	Qualitative assessment of any disproportionate impacts on vulnerable communities.	N/A	Would have the potential for a disproportionate impact (such as providing different water supply sources to certain parts of City).	Would have no impact on vulnerable communities.	Would have a benefit to vulnerable communities.	High	3
Environmental performance	Qualitative assessment of potential environmental impacts not already included in permitting/regulatory compliance (e.g., level of GHG emissions).	N/A	Unknown or high potential for environmental impacts (e.g., large project footprint, high energy use, or location in undeveloped area).	Moderate potential for environmental impacts (e.g., medium or unknown project footprint, moderate energy use, unknown project location).	Limited potential for environmental impacts (e.g., small project footprint, low energy use, location in existing developed area).	High	3
Legal, permitting, and regulatory	Qualitative assessment of complexity/effort to address legal issues (e.g., water rights), obtain necessary permits, and comply with regulations	N/A	High complexity/effort: Requires major permitting/ regulatory effort, with little or no established precedent to follow.	Moderate complexity/effort: May have major permitting/ regulatory effort permits, etc., but there is an established process to follow.	Low complexity/effort: Permitting/ regulatory steps are known, and projects of this type are routinely implemented.	Med	1
City control and interagency coordination	Qualitative assessment of level of City control and coordination with potential partner agencies, if any (e.g., agreements needed for regional projects).	N/A	Coordination required with partner agencies that City does not already work with.	Coordination required with partner agencies that City already works with.	No need for coordination with other parties.	Med	1
Multi-benefit	Qualitative assessment of benefits provided in addition to water supply.	N/A	No other benefits provided.	One additional benefit would be provided by the project.	Two or more additional benefits would be provided by the project.	Med	1

3. FINDINGS

3.1 Water Supply Option Descriptions

This section describes each of the evaluated supplemental supply options, listed in **Table 3-1**. The options remained substantially the same as those listed in **Table 2-2**, with a numbering system applied and some revisions to the option titles. The preliminary level concepts were developed closely with the Water Team, as well as with input from the Stakeholder Group, BPU, and the community. Preliminary-level cost estimates are also summarized in the following subsections, where applicable. Additionally, the results of the screening tool's baseline scenario average cost of water are presented in the following subsections. A summary of the results is provided in Section 3-2 Screening Analysis Results (see Table 3-35).

Table 3-1: Summary of Water Supply Options

Supply Type	Supply Option Name
Groundwater	GW-1: Construct Additional Groundwater Extraction Wells GW-2: Convert Emergency Wells to Production Wells GW-3: Construct ASR Wells GW-4: Construct Regional Groundwater Extraction Wells GW-5: Construct Regional ASR Wells
Purified Recycled Water	PR-1: DPR Advanced Water Purification Facility (AWPF) at LTP PR-2: Satellite DPR AWPF PR-3a: IPR AWPF at LTP into Groundwater Basin PR-3b: IPR AWPF at LTP into Lake Ralphine PR-3c: IPR AWPF at LTP into Lake Sonoma PR-4: Regional DPR AWPF at LTP
Recycled Water	RW-1: Expand City's Non-Potable Recycled Water System
Desalination	DE-1: Regional Brackish Desalination DE-2: Ocean Desalination
Stormwater	SW-1: Stormwater Storage in Aquifer SW-2: Stormwater Storage in Lake Ralphine SW-3: Regional Stormwater
Efficiency Programs	E-1: Efficiency Programs
Baseline	No Project Option, Continue to Import from Sonoma Water

3.1.1 Groundwater Supply Options

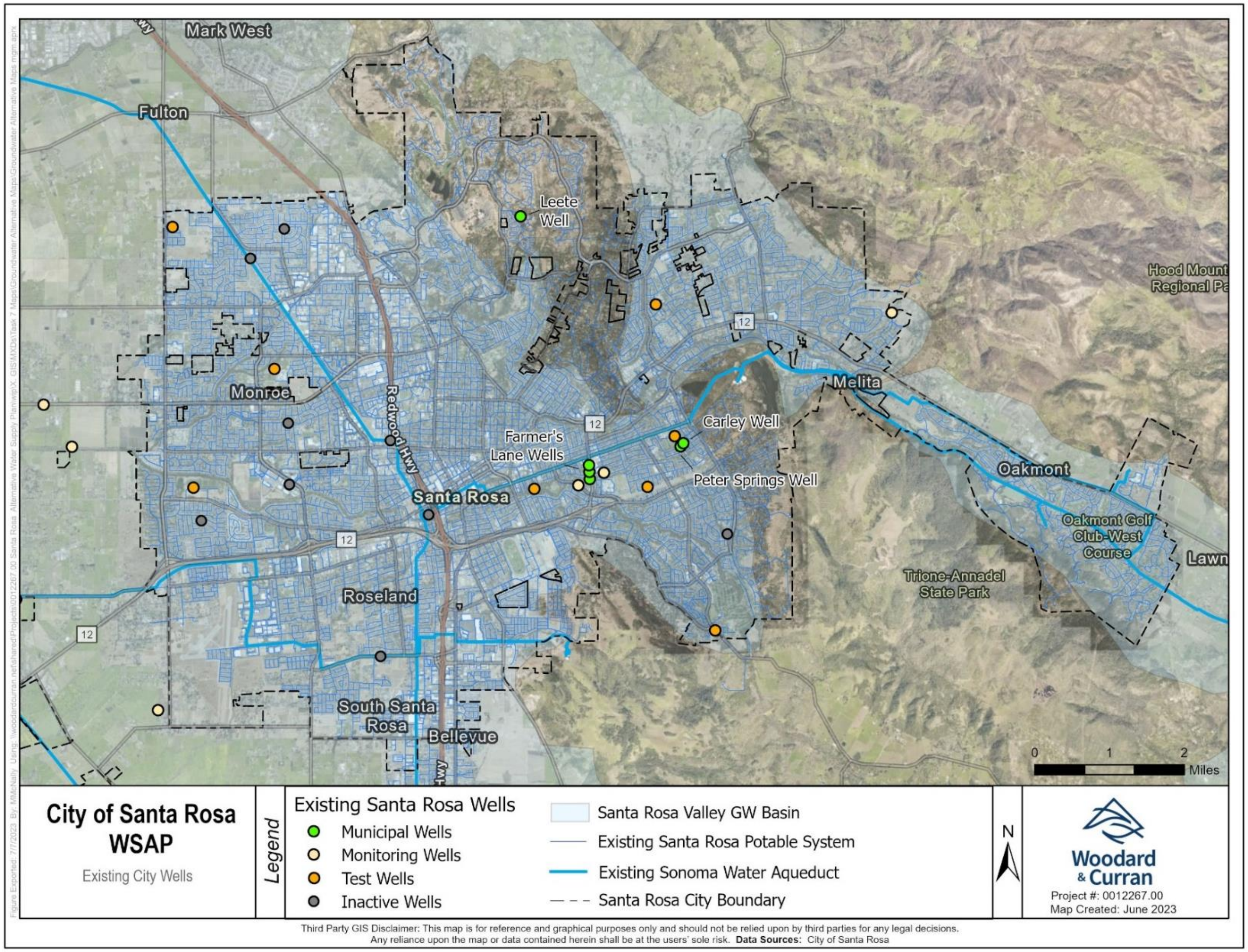
The City has a total of six municipal groundwater wells, all within the Santa Rosa Plain Subbasin.[1] These wells are shown in **Figure 3-1**.

Two of the City's municipal wells (Carley and Peter Springs Wells) are currently operated primarily to serve an adjacent park and school for landscape irrigation but are also available and approved by the California Division of Drinking Water for emergency potable use on standby status. Two of the wells (Farmers Lane Wells No. W4-1 and W4-2) are on active status. One well is operated to provide landscape irrigation water supply only (Farmers Lane Well No. W4-3), and one well is used for emergency potable purposes only (Leete Well). In addition, a new emergency water supply well facility is currently being built at A Place to Play Park, with anticipated completion in calendar year 2023.

For all groundwater supply options developed, it is assumed that groundwater pumping would occur seasonally in the spring and summer months. In dry years, it is assumed that pumping would occur for a greater portion of the year.

[1] Note that the City has two other municipal wells that are either out of service or inactive: Freeway Well (W3) is out of service due to groundwater contamination caused by others; Sharon Park Well (W6) is inactive due to severe sanding.

Figure 3-1: Existing City Wells



GW-1: Local Groundwater Extraction Wells

Supply option GW-1 proposes to construct additional production wells, wellhead disinfection, and iron and manganese treatment (if necessary) to connect to the City's existing potable water distribution system. Based on existing well data for the City, an estimated 9 wells would be required to provide 7,500 AFY (i.e., to meet the City's water supply goal 30 percent of the annual water demand), and 12 wells would be required to meet 30 percent of the peak month average day demand (9 MGD), based on a per-well capacity of ~500 gpm.[1]

For this conceptual-level analysis, the following potential limiting factors for the GW-1 supply option were identified:

- Identification of appropriate locations for new wells. For this preliminary analysis, City-owned property was assumed as the location of the new groundwater extraction wells. For this preliminary analysis a 500-foot well depth was assumed. The City has both deep and medium deep wells in the vicinity.
- Well pumping capacity. For this preliminary analysis, well capacity was assumed to be 500 gpm.
- Potential well interference. The proposed wells are assumed to be constructed with even spacing to avoid potential well interference.
- Sustainability. The City's wells generally have very stable non-pumping groundwater levels, with artesian conditions reported for Farmers 1, 2, and Leete wells. However, additional studies would be needed to verify sustainable yields.

The 12 proposed extraction wells are assumed to be located within the City's Greenway Area, north of Hoen Avenue. **Figure 3-2** shows the proposed extraction well location zone and conveyance pipelines connecting to the Sonoma Water Aqueduct for distribution throughout the City's R6R1 pressure zone. The 12 extraction wells would be constructed to be evenly spaced within the Greenway Area. Approximately 3,000 linear feet (LF) of 20-inch pipe and a 240 horsepower (hp) pump station would be required to convey the extracted groundwater to the Sonoma Water aqueduct for distribution. This conceptual option assumes the 12 wells to be connected to each other and one 20-inch water main connecting from the well zone to the City's distribution system via Sonoma Water's aqueduct as shown. Based on discussions with City staff, pumping into the aqueduct would not currently be an option; this configuration would require engaging in negotiations with Sonoma Water in the future.

The proposed infrastructure as part of GW-1 supply option may include:

- Well equipment including well head, pump, well house building for 12 wells
- Conveyance pipelines
- Electrical service for each well
- Treatment systems for disinfection, manganese and iron onsite, if needed
- Backup generator for power outage

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[1] For simplicity, this analysis assumes construction of 12 new wells. Other possible approaches could include converting emergency wells to production, in combination with new wells, to meet the 9 MGD goal, if GW-2 is not pursued. The City also has Freeway Well and Sharon Park Well, but they don't appear feasible at this time due to site and water quality constraints.

- Backwashing treatment system (assumes disposal to nearby sanitary sewer)

The total preliminary capital cost for option GW-1, including all infrastructure listed, is approximately $96 million. A summary of the GW-1 capital cost is shown in **Table 3-2.** Additional cost detail can be found in Appendix A.

Table 3-2: Preliminary Capital Cost, Supply Option GW-1

Component	Description	Cost, in 2023 Dollars
New Well Construction	12 extraction wells, ~500 gpm capacity, 500 feet deep, includes well head, casing, well pump and equipment, electrical service, disinfection, backup generator, well housing ($3.5 million per well)	$42,000,000
Groundwater Conveyance Line	20-inch diameter; 3,000 linear feet linear feet	$2,225,000
Groundwater Pump Station	240 horsepower	$1,560,000
Potable System Connection		$100,000
Estimating Contingency	50% of raw construction costs	$22,950,000
Implementation	40% of total construction costs	$27,540,000
Total Capital Cost		**$96,380,000**
Annualized Capital Cost	Annualized over 50 years, 2.5% interest	$3,398,000

The O&M cost of the project was estimated on a per AF basis for scalability. The GW-1 option has a fixed annual O&M cost of $500,000 and an annual marginal O&M cost of approximately $264/ AF. Annual O&M costs will vary depending on the production of the extraction wells. The estimated annual O&M costs for the maximum potential yield of 10,080 AFY is approximately $3 million. **Table 3-3** summarizes the annual O&M costs for option GW-1. Under the Baseline Scenario, as modeled by the screening tool, actual production would be less, resulting in a somewhat higher cost per AF. Constructing fewer wells would reduce the cost per AF under the Baseline Scenario but would not necessarily meet the 9 MGD goal.

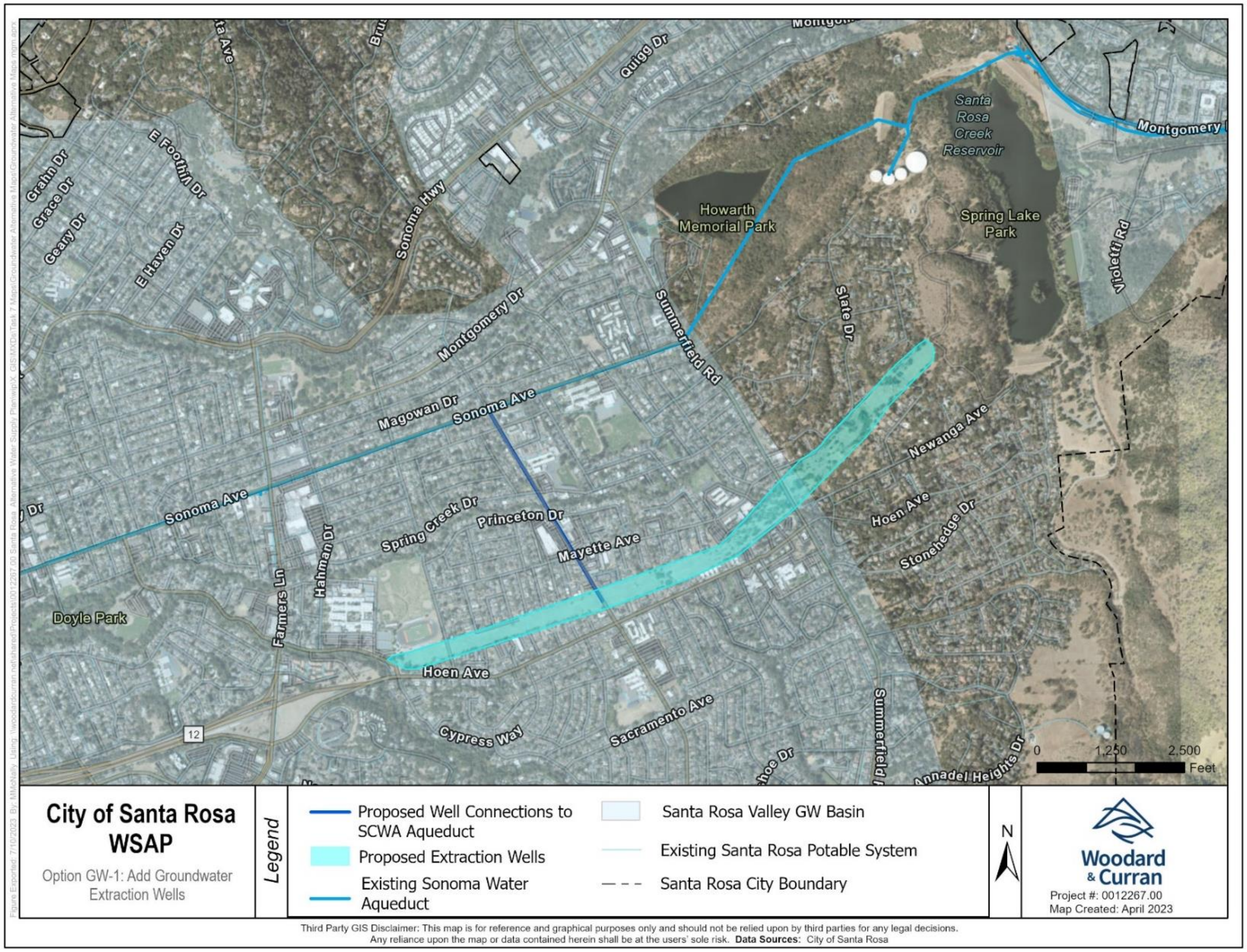
Table 3-3: Preliminary Annual O&M Cost, Supply Option GW-1

Component	Description	Cost, $2023
Marginal Cost	Marginal costs include power consumption, labor, chemical addition, water/sewer fees	$264/ AF
Fixed Cost	Fixed costs include routine maintenance practices, water quality testing, Santa Rosa Plain Groundwater Sustainability Agency fees	$501,000
	Average cost of water (Baseline Scenario)[1]	$843/ AF
	Annual O&M (10,080 AFY)[2]	$3,165,000
	Cost of water (10,080 AFY)[2]	$700/ AF

Notes:

1. See Section 2.5 for description of baseline scenario, in which 6,734 AFY are used. That baseline is based on operating wells at least from April through October in all years, i.e., at a minimum of 7/12 of full capacity, and more as needed in dry years. The cited costs include capital and operating costs for the baseline usage scenario.
2. The maximum supply yield of 10,080 AFY assumes 24/7 operation of all supply option infrastructure. While this scenario does not reflect realistic operations because it would produce more water than the City would use, and because it does not reflect downtime for maintenance. The baseline scenario is more informative as to likely unit costs.

Figure 3-2: Supply Option GW-1



GW-2: Convert Existing Emergency Wells into Production Wells

Supply option GW-2 proposes to rehabilitate the City's three existing emergency wells into production wells. The three emergency wells for the City include the Leete Well, Carley Well, and Peter Springs Well, as shown in **Figure 3-1**.[1] The Leete Well is currently out of service due to concerns over a possible casing separation, rehabilitation is currently in design. The Carley and Peter Springs wells have the capacity to provide the City with approximately 1 MGD of groundwater capacity on a stand-by-emergency basis.

For this conceptual-level analysis, the following potential limiting factors for the GW-2 supply option were identified:

- Well pumping capacity: Leete, Peter Springs, and Carley standby/emergency supply wells have a pumping capacity of 240, 500 and 700 gpm, respectively. The GW-2 option will provide up to 2,462 AFY of additional supply.
- Technical studies to verify that long-term use of the wells would be sustainable.
- Permitting considerations to allow for water supply from the Leete, Peter Springs, and Carley wells.

The proposed infrastructure rehabilitation and upgrades as part of GW-2 supply option may include:

- Rehabilitation of the three emergency wells, using mechanical and chemical methods
- Redevelopment of the wells
- Well house improvements for the wells, including a pump and motor, a pre-packaged disinfection system with eyewash, and a SCADA connection
- Site improvements including electrical, plumbing, and mechanical
- Instrumentation and control

The total preliminary capital cost for option GW-2, including the improvements listed, is approximately $11.6 million. A summary of the GW-2 capital cost is shown in **Table 3-4**. Additional cost details can be found in Appendix A.

[1] For simplicity, this analysis assumes rehabilitation of the three existing emergency supply wells. Other possible approaches could include rehabilitating existing inactive wells to production status (such as Freeway Well and Sharon Park Well), in combination with rehabilitation of the existing emergency wells, to provide additional supply. However at this time, Freeway Well and Sharon Park Well do not appear feasible due to water quality concerns.

Table 3-4: Preliminary Capital Cost, Supply Option GW-2

Component	Description	Cost, $2023
Well Rehabilitation and Upgrades	Rehabilitation and redevelopment of the three-emergency stand-by wells, well house improvements, instrumentation and control	$5,520,000
Estimating Contingency	50% of raw construction costs	$2,760,000
Implementation	40% of total construction costs	$3,310,000
Total Capital Cost		**$11,590,000**
Annualized Capital Cost	Annualized over 50 years, 2.5% interest	$409,000

The O&M cost of the project was estimated on a per AF basis for scalability. The GW-2 option has a fixed annual O&M cost of $123,000 and an annual marginal O&M cost of approximately $236/ AF. Annual O&M costs will vary depending on the production of the converted wells. The estimated annual O&M costs for the maximum potential yield of 2,462 AFY is approximately $705,000. **Table 3-5** summarizes the annual O&M costs for option GW-2. Under the Baseline Scenario, as modeled by the screening tool, actual production would be less than 2,462 AFY, resulting in a greater cost per AF.

Table 3-5: Preliminary Annual O&M Cost, Supply Option GW-2

Component	Description	Cost, $2023
Marginal Cost	Marginal costs include power consumption, labor, chemical addition, water/sewer fees	$236/ AF
Fixed Cost	Fixed costs include routine maintenance practices, water quality testing, Santa Rosa Plain Groundwater Sustainability Agency fees	$123,000
	Average cost of water (Baseline Scenario)[1]	$540/ AF
	Annual O&M (2,462 AFY)[2]	$705,000
	Cost of water (2,462 AFY)[2]	$452/ AF

Notes:

1. See Section 2.5 for description of baseline scenario, under which 1,744 AFY are used. That baseline is based on operating wells at least from April through October in all years, i.e., at a minimum of 7/12 of full capacity, and more in dry years as needed. Costs for the baseline scenario include capital and operating costs.
2. The maximum supply yield of 2,462 AFY assumes 24/7 operation of all supply option infrastructure. This scenario may not reflect realistic operations.

GW-3: Local Aquifer Storage and Recovery (ASR) Wells

An additional groundwater supply option is GW-3, which proposes to inject water directly into the groundwater aquifer for later recovery and use. Water is typically injected during wet periods when there is supply available (e.g., potable water) and extracted during dry periods and/or during peak demands when additional supplies are needed. GW-3 could include injecting excess potable supplies when available into the groundwater basin.

ASR offers advantages as a method to increase water supply for drought mitigation. Due to the underground storage nature of ASR projects, this supply is more resilient than other alternative storage methods such as surface recharge or storage, which experience water losses due to evaporation. A phased approach can be followed to develop a pilot ASR project to understand local conditions and ensure there are no "fatal flaws" before a full-scale ASR implementation. The number of wells to meet the demand would vary depending on well capacities, for this conceptual-level analysis, a 500 gpm capacity and 500 feet well depth was assumed.

For this conceptual-level analysis, the following potential limiting factors for the GW-3 supply option were identified:

- Appropriate site selection for ASR wells; right-of-way issues.
- Hydrogeologic constraints with aquifer potential for injection, storage, and extraction of water.
    - Well capacities range 400-1,000 gpm or greater. Assumed 500 gpm for this level of analysis based on existing City well information.
    - Well depths range from 300-1,000 feet. Assumed 500 feet for this level of analysis based on existing City well information. (Note that actual well depth could be deeper depending on hydrogeologic conditions; for reference, Sonoma Water wells range from about 800 to 1,000 feet deep (Sonoma Water, n.d.)).
- Source of water for injection
- Chemical properties of source water versus native groundwater and potential reactions due to mixing
- Retention time or storage capacity of aquifer prior to injection
- Regulatory constraints and compliance with environmental requirements with injection of water into groundwater
- Pre-treatment of water prior to injection for storage to meet regulatory requirements
- Disinfection and potential treatment prior to distribution (high concentrations of iron and manganese were noted in this area)
- Extensive monitoring of water levels and quality and reporting

Preliminary review of Airborne Electromagnetic survey data available from the Department of Water Resources (DWR) shows potential target areas along the western boundary of the subbasin that appear promising for ASR (California Department of Water Resources, 2022). **Figure 3-3** below shows potential ASR well areas within the City's boundary. Additional areas would be considered as well, if this option is chosen for further development.

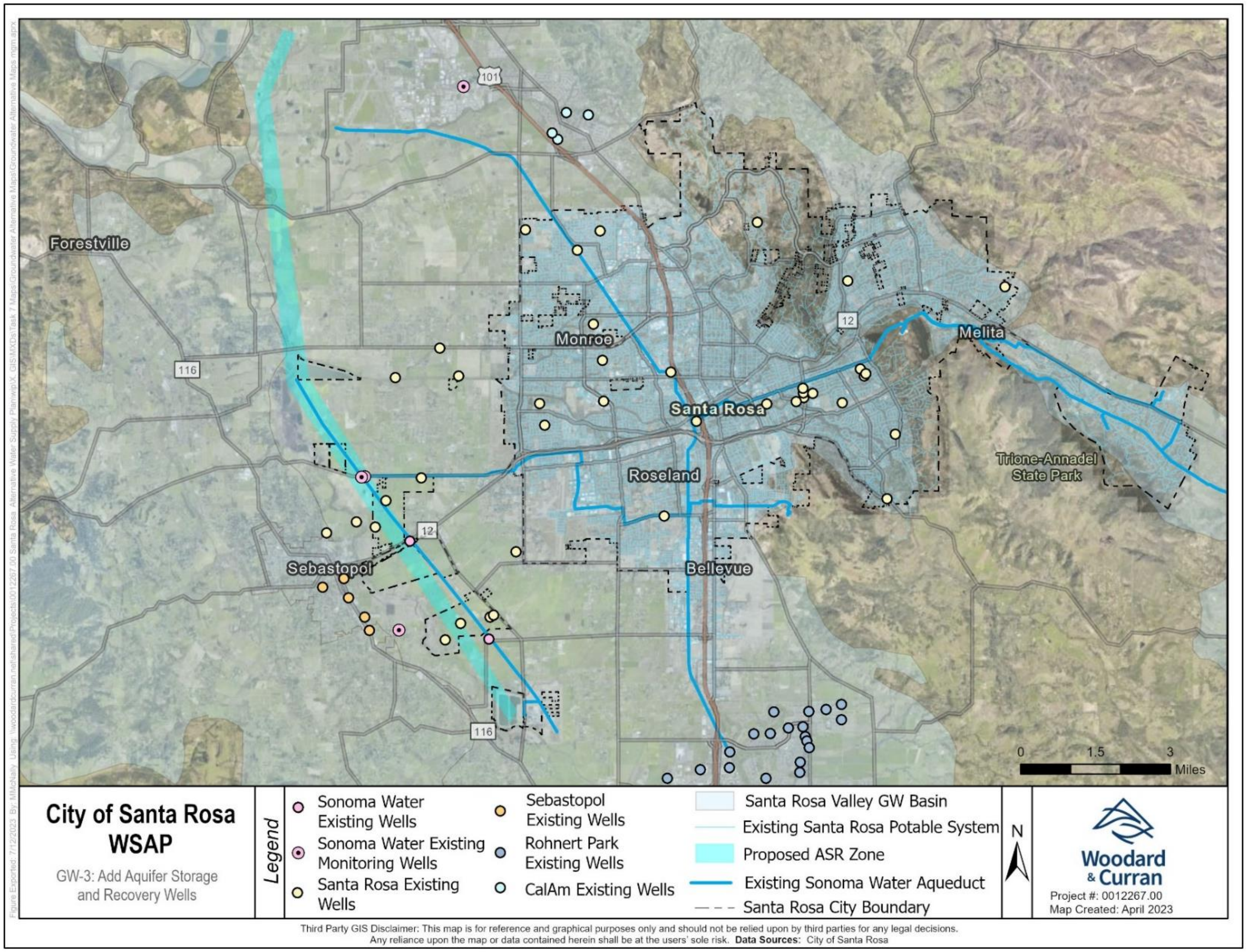
In the Santa Rosa Plain Subbasin, groundwater generally flows westward from recharge areas in the mountains into the west side of the subbasin. The shallow aquifer generally extends from the water table to depths ranging from 150 feet to 200 feet below land surface (Santa Rosa Plain Groundwater Sustainability Agency, 2021). Elevations in the deeper zone aquifers are approximately 10 to 40 feet lower than groundwater elevations in the shallow aquifer system in the Subbasin (Santa Rosa Plain Groundwater Sustainability Agency, 2021). The shallow aquifer is present over the entire extent of the subbasin and generally present under unconfined or semiconfined conditions. Shallow wells in this area (with depths ranging from 90 to 167 ft below land surface) do not show enough injection capacity with groundwater levels being close to the land surface.

For the concept-level analysis for this feasibility analysis, the proposed six ASR wells were assumed to be constructed within the intermediate/deep aquifer (although the City could elect to include both shallow and deep ASR wells in order to minimize mounding of groundwater levels in areas with lower storage coefficients). The deep aquifer occurs under confined or semiconfined conditions with groundwater levels generally 20 feet lower in this area compared to the shallow aquifer system. The proposed well area is also home to existing dedicated shallow monitoring wells (three wells SRP0713, SRP0355, and SRP0357) and deep monitoring wells (SRP0347, SRP0359, and SRP0725) established as part of the Santa Rosa Plain GSP. These existing wells can be used for future monitoring of local conditions in support of future ASR implementation for sustainable management of the basin. Wells in this area are generally completed in the Wilson Grove Formation (formerly known as the Merced Formation). The Wilson Grove Formation is a sand-dominated formation exposed in the western Santa Rosa Plain Subbasin. Further hydrogeologic investigations would be needed to confirm local conditions.

The potential ASR and conveyance infrastructure required for GW-3 would be:

- Well equipment including well head, pump, and well house building for six ASR wells
- Conveyance pipelines
- Electrical service for each well
- Treatment systems for disinfection and if needed for manganese and iron
- Backup generator for power outage
- Backwashing treatment system (assumes disposal to nearby sanitary sewer)
- Dechlorination prior to injection

Figure 3-3: Supply Option GW-3



The total preliminary capital cost for option GW-3, including the improvements listed, is approximately $81 million. A summary of the GW-3 capital cost is shown in **Table 3-6**. Additional cost details can be found in Appendix A.

Table 3-6: Preliminary Capital Cost, Supply Option GW-3

Component	Description	Cost, $2023
ASR Well Construction	Six ASR (injection/extraction) wells, 500 feet deep, well head, casing, well pump and equipment ($5 million/ well)	$30,000,000
Groundwater Conveyance Line	16-inch diameter; 12,000 linear feet	$7,120,000
Groundwater Pump Station	210 horsepower	$1,365,000
Potable system connection		$100,000
Estimating Contingency	50% of raw construction costs	$19,300,000
Implementation	40% of total construction costs	$23,160,000
Total Capital Cost		**$81,050,000**
Annualized Capital Cost	Annualized over 50 years, 2.5% interest	$2,858,000

The O&M cost of the project was estimated on a per AF basis for scalability. The GW-3 option has a fixed annual O&M cost of $121,000 and an annual marginal O&M cost of approximately $1,813, which includes the cost to purchase water from Sonoma Water for injection. Annual O&M costs will vary depending on the production of the ASR wells. The estimated annual O&M costs for the maximum potential yield of 5,130 AFY is approximately $9.42 million. **Table 3-7** summarizes the annual O&M costs for option GW-3. Under the Baseline Scenario, as modeled by the screening tool, actual production would be less than 5,130 AFY, resulting in a greater cost per AF. Installing fewer ASR wells would reduce the cost per AF under the Baseline Scenario.

Table 3-7: Preliminary Annual O&M Cost, Supply Option GW-3

Component	Description	Cost, $2023
Marginal Cost	Marginal costs include power consumption, labor, chemical addition, water/sewer fees, purchase of water for injection.	$1,813/ AF
Fixed Cost	Fixed costs include routine maintenance practices, water quality testing, Santa Rosa Plain Groundwater Sustainability Agency fees	$121,000
	Average cost of water (Baseline Scenario)[1]	$2,600/ AF
	Annual O&M (5,130 AFY)[2]	$9,420,000
	Cost of water (5,130 AFY)[2]	$2,400/ AF

Notes:

1. See Section 2.5 for description of baseline scenario, under which on average 3,634 AFY would be used. That baseline is based on operating wells at least from April through October in all years, i.e., at a minimum of 7/12 of full capacity, and more in dry years as needed. Cited costs include operating and capital.
2. The maximum supply yield of 5,130 AFY assumes 24/7 operation of all supply option infrastructure. This scenario may not reflect realistic operations. Cited costs include operating and capital.

GW-4: Regional Groundwater Extraction Wells

Option GW-4 consists of constructing new production wells outside the City limits (in neighboring jurisdictions) where the geology may allow for greater well yields than within the City. Provided that the wells are located in or near another Sonoma Water contractor agency's jurisdiction, a paper exchange could be completed where the City takes a portion of the partner's Sonoma Water allocation, and the pumped groundwater is used directly by the partner. The paper exchange option would not reduce regional reliance on the Sonoma Water system overall.

Implementation of option GW-4 would require identification of possible well locations, connections to existing distribution systems, regional coordination and agreements, and possible need for regulatory approvals. Components that would need to be constructed could include:

- Well equipping including well head, pump, well house building and equipment
- Conveyance pipelines
- Electrical service for each well
- Treatment systems for manganese and iron onsite, if needed
- Backup generator for power outage
- Backwashing treatment system (assumes disposal to nearby sanitary sewer)

This option assumes that the potential partner would need to be a Sonoma Water contractor who receives sufficient Sonoma Water contract supplies to make them open to a partial trade with Santa Rosa. Based on historical Sonoma Water deliveries, potential candidates could be Petaluma, North Marin Water District, Rohnert Park, and possibly City of Sonoma or Valley of the Moon Water District. This option also assumes that the City would find a partner for whom well yields of 1,000 gpm or more could be achieved, in order to provide a benefit over existing pumping rates of City wells. Based on an initial review of information from Urban Water Management Plans of potential partners and DWR Bulletin 118, the Sonoma Valley Subbasin may provide enough yield to meet this threshold. The City of Sonoma and Valley of the Moon Water District are located within the Sonoma Valley Subbasin. Each of these agencies typically receives around 2,000 AFY or less from Sonoma Water. Based on these figures, it is assumed that 3,000 AFY at most would be available for trading, which would provide a portion of the City's water supply goal of 7,500 AFY.

Were such a project to be implemented, it is assumed that in wet years with sufficient Sonoma Water allocations, no groundwater pumping would occur. In normal years, pumping would occur in summer months, and in dry years, pumping would occur for a greater portion of the year. According to the Sonoma Valley Basin GSP, groundwater levels in the subbasin are generally stable but have some persistent pumping depressions, and groundwater in storage declined by about 900 AFY during 2012-2018. Therefore, it is assumed that any increase in groundwater extraction in Sonoma Valley would need to be offset by some form of recharge, and without recharge the project may not be compatible with groundwater management practices. Adding a recharge component to this supply option would likely yield a project similar to the Regional Aquifer Storage and Recovery option described in GW-5. Therefore, this supply option was not carried forward for detailed cost analysis or feasibility scoring.

GW-5: Regional Aquifer Storage and Recovery

Supply option GW-5 proposes developing a regional ASR project in collaboration with one or more agencies in the region and using Sonoma Water supplies and ASR water conjunctively. ASR wells can be constructed in the aquifer most feasible and promising in the region. Potential options would include: 1) the City connecting to ASR wells directly, and 2) the City utilizing participating agencies' surface water supplies from Sonoma Water while partnering agencies pump from ASR wells by the same amount in lieu of taking Sonoma Water supply.

Implementation of this supply option would require identification of feasible ASR well locations, connections to existing distribution systems, regional coordination and agreements, and possible need for additional water rights.

Overall, a regional ASR project would include similar components as a local ASR project. In addition, the City would be part of future regional ASR projects implemented by Sonoma Water (and possibly by the GSA) by default. For example, Sonoma Water has been in the process of evaluating feasibility of ASR in the Sonoma Valley Subbasin, including a pilot test in 2018 (Santa Rosa Plain Groundwater Sustainability Agency, 2021). Because many project elements and implementation considerations for regional ASR would be similar to the local ASR option above (GW-3), and because the City would effectively be participating in possible future ASR projects implemented by Sonoma Water, this option did not undergo any further separate technical analysis.

3.1.2 Purified Recycled Water Supply Options

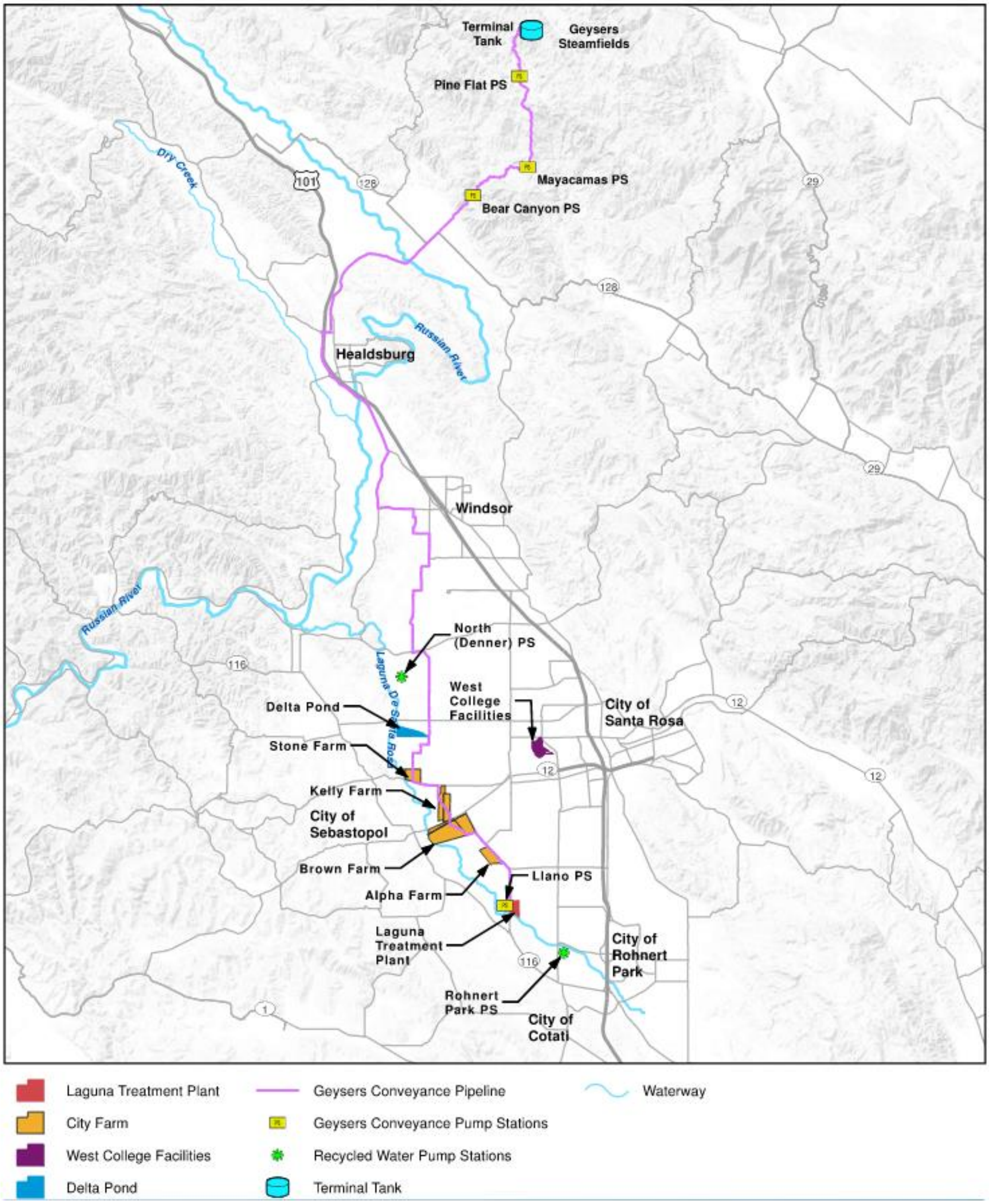
The City operates the LTP for the Santa Rosa Regional Water Reuse System (Regional System). **Figure 3-4** depicts the location of the wastewater treatment facilities and the Regional System key facilities. LTP is a tertiary level treatment facility that has an overall average daily flow of 15.1 MGD and average dry weather flow of 13.6 MGD in 2020. LTP is permitted for 21.34 MGD average daily dry weather flow and takes wastewater from homes, businesses, and industry located within the Cities of Santa Rosa, Rohnert Park, Sebastopol, and Cotati, and the South Park Sanitation District. Over 500 miles of underground pipes bring wastewater to the LTP where water goes through three stages of treatment prior to disinfection, storage, and reuse. The water is treated to the highest non-potable level recognized in State water recycling regulations (Title 22 Tertiary).

The Regional System provides recycled water to the City of Rohnert Park for its urban reuse program for irrigation at many Rohnert Park schools, parks, and businesses, as well as Sonoma State University. In Santa Rosa, recycled water is used within the City's urban growth boundary for landscape irrigation at City facilities (including the municipal services center, bus transfer station, Finley Park, and A Place to Play sports complex), as well as multi-family residential complexes, institutions, and business parks.

Depending upon the amount of rainfall in any given year, approximately 98 to 100 percent of the Regional System's recycled water is reused for urban landscapes, rural agricultural irrigation, and the Geysers Recharge Project. The volume of Title 22 tertiary water produced by the City in recent years (2019 through 2022) is summarized in **Figure 3-5**; it should be noted that 2020-2022were historically dry years.

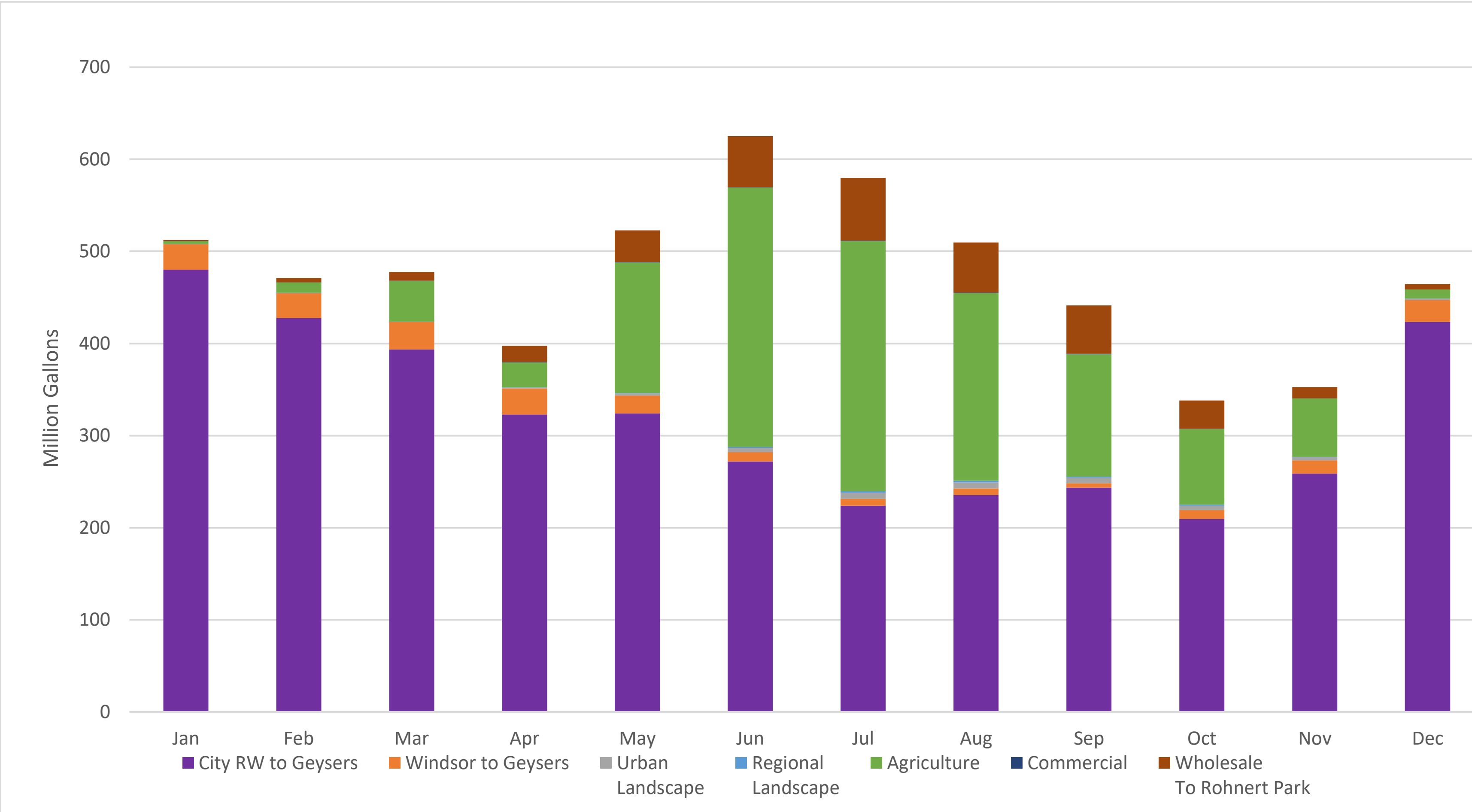
The purified recycled water options (also known as potable reuse) are limited by the reliable volume of tertiary effluent available given its existing use by current customers. For this level of study, it was assumed the City would size the AWPF to meet its 9 MGD peak month supply needs. This requires instantaneous flows as high as 11.4 MGD. That value is less than the average dry-weather flow available in 2020 of 13.6 MGD. However, should this option (or others involving purified water) move forward, an analysis of daily low flows would be needed to verify that the assumed amount of equalization storage was sufficient to allow the plant to run at full rate even during days and hours of low wastewater flows.

Figure 3-4: Regional System Facilities



Source: Regional Water Reuse System Master Plan (City of Santa Rosa, 2018)

Figure 3-5: Average Recycled Water Use (2019-2022)

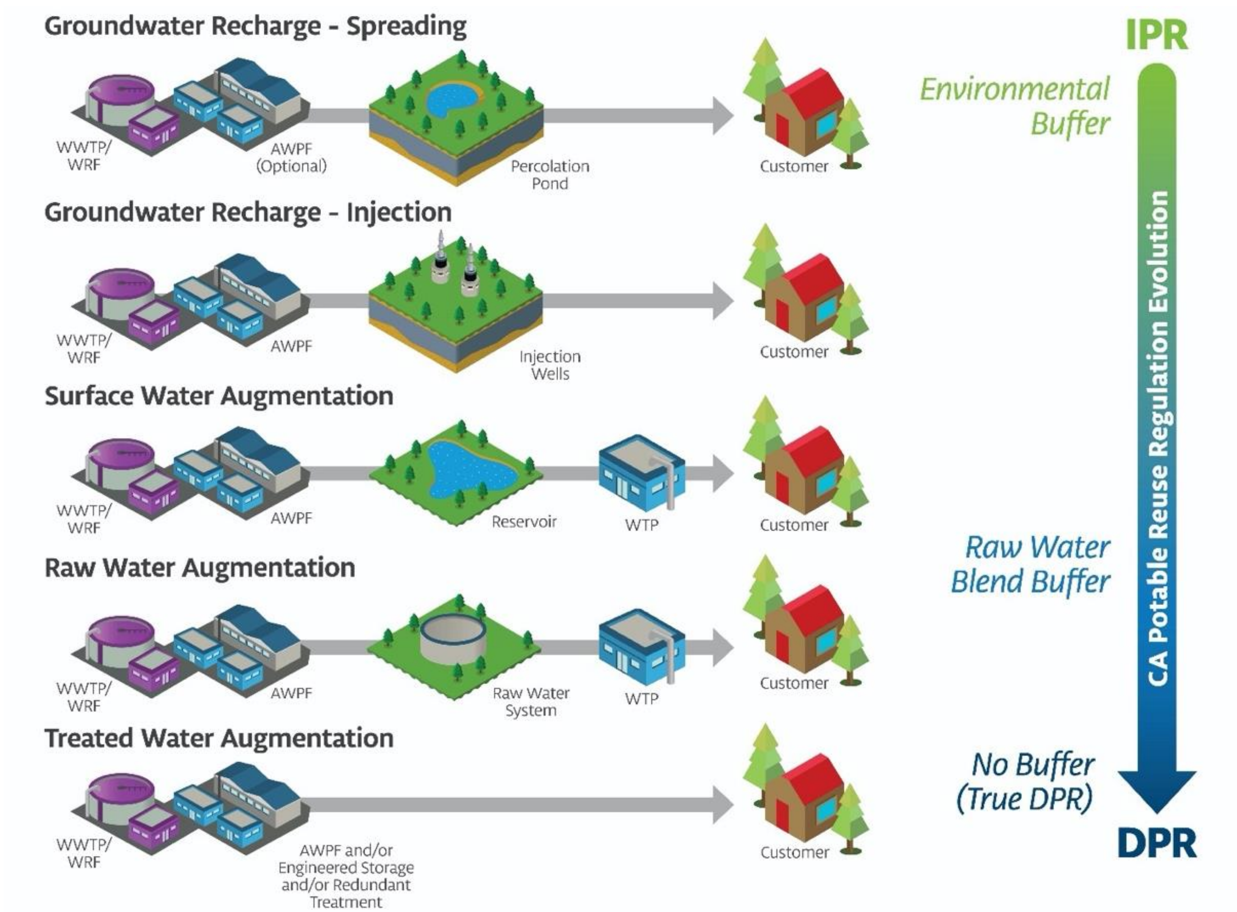


Source: Recycled Water Flows - Volume and User Type by Month 2019-2022 (City of Santa Rosa, 2023)

Potable Reuse Approaches

The spectrum of potable reuse approaches is commonly distinguished by the degree of separation between the treatment and ultimate consumption of purified water. This separation may be physical (e.g., when purified water travels through a groundwater aquifer), temporal (e.g., when water is retained in a tank or a reservoir), or both. IPR projects are characterized by the use of one of two environmental buffers—a groundwater aquifer or a surface water reservoir—that increase the separation between treatment and consumers. DPR projects are defined by the absence of a significant environmental buffer. The State of California recognizes five forms of IPR and DPR that are depicted in **Figure 3-6**, all requiring a multitude of pathogen and chemical control requirements.

Figure 3-6: Forms of Potable Reuse in California



3.1.2.1.1 Indirect Potable Reuse

The first form of IPR distinguished by California regulations is groundwater recharge (GWR), which can be achieved by two different approaches: surface spreading and subsurface injection (Title 22, Chapter 3, Articles 5.1 and 5.2, respectively). The second form of IPR is surface water augmentation (SWA) which introduces purified water directly into a surface water reservoir that is used as a source of domestic drinking water supply.

One of the benefits of pursuing IPR projects in California is the regulatory certainty associated with the existence of final, adopted regulations for both GWR and SWA. This streamlines the permitting process by providing clarity on the requirements for IPR implementation. In the case of GWR, there are also multiple precedents given that permitted California GWR projects have been producing water for nearly 60 years. Based on this experience, the regulatory community has first-hand knowledge of the challenges with GWR allowing them to adapt the requirements to address these needs.

3.1.2.1.2 Direct Potable Reuse

The State Water Resources Control Board released draft criteria for DPR in March 2021 and revised criteria in August 2021 (State Water Resources Control Board, 2021). The draft criteria include stricter requirements than IPR to compensate for the protections that are lost from bypassing the environmental buffer. The criteria can be broken down into four major categories: 1) pathogen control, 2) chemical control, 3) monitoring and control, and 4) technical, managerial, and financial capacity.

Compared to IPR, DPR projects have stricter requirements for nearly all of these categories. One example of this difference is the level of treatment needed for IPR and DPR. Most categories of IPR require full advanced treatment (FAT), which is the treatment of the entire flow of water through both reverse osmosis (RO) and an advanced oxidation process (AOP). The draft DPR criteria specify higher levels of treatment, namely, pre-treatment with ozone and biological activated carbon (BAC) followed by FAT.

State regulations define two types of DPR—raw water augmentation (RWA) and treated water augmentation (TWA)—that are differentiated depending on whether the reuse project is providing a raw source water upstream of a surface water treatment plant, or a finished water directly into a public water system's distribution system. RWA also encompasses projects that provide raw source water into an environmental buffer that cannot meet the IPR requirements. Despite the differences between RWA and TWA, the draft DPR criteria contain a single set of requirements to cover both forms. The State's DPR Expert Panel—who is currently reviewing the public health protectiveness of the draft DPR criteria—has asked the State Board to provide separate criteria for these two forms. If the future regulations do not include separate requirements, then it is possible that projects designed for RWA may also have the flexibility to pursue TWA (and vice versa).

One benefit of DPR is that it does not restrict projects to areas with access to groundwater aquifers or reservoirs. Many agencies in California are considering the RWA form of DPR to continue leveraging investments they have made in existing treatment plant infrastructure. The main challenges in pursuing DPR include the lack of regulatory certainty (though draft criteria are on track to be finalized by the end of 2023) and the lack of permitting precedents.

Table 3-8 summarizes the flow requirements for the proposed DPR and IPR AWPFs assumed for this study.

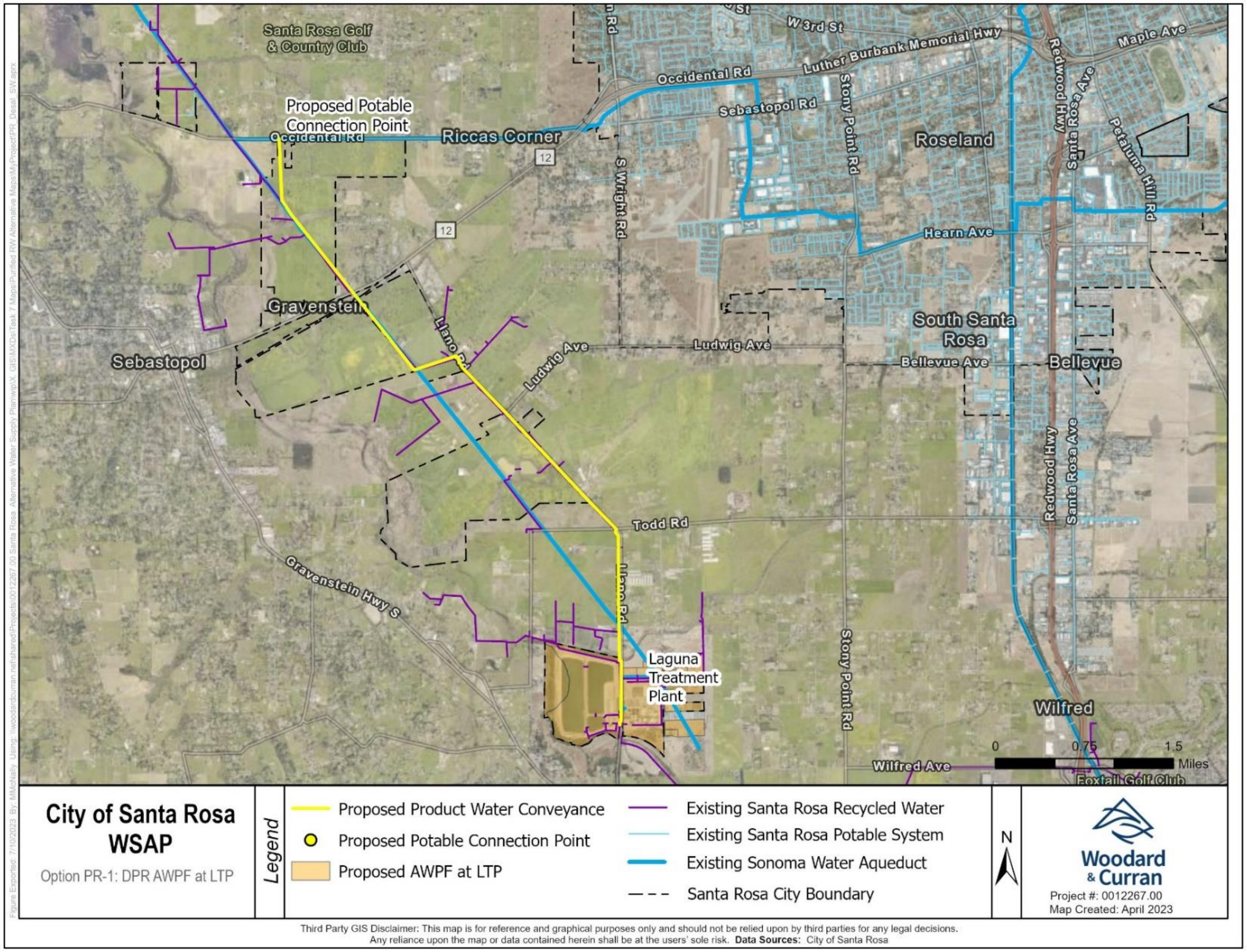
Table 3-8: Preliminary AWPF Flow Summaries

Parameter	Units	DPR Maximum Treatment Flow	IPR Maximum Treatment Flow
Production Capacity	MGD	9.0	9.0
System Feed	MGD	11.6	11.4
Ozone/Biological Activated Filtration (BAF)			
Assumed Recovery	%	*98*	--
Feed	MGD	11.60	--
Brine	MGD	0.23	--
Effluent	MGD	11.37	--
Microfiltration System (MF)			
Assumed Recovery	%	*93*	*93*
Feed	MGD	11.37	11.40
Backwash	MGD	0.80	0.80
Effluent	MGD	10.6	10.6
Reverse Osmosis (RO) System			
Assumed Recovery	%	*85*	*85*
Feed	MGD	10.6	10.6
Brine	MGD	1.59	1.59
Effluent	MGD	9.0	9.0
Ultraviolet-Peroxide Disinfection (Ultraviolet/Advanced Oxidation Process - UV/AOP)			
Assumed Recovery	%	*100*	*100*
Feed	MGD	9.0	9.0
Effluent	MGD	9.0	9.0
Free Chlorine Disinfection			
Assumed Recovery	%	*100*	--
Feed	MGD	9.0	--
Effluent	MGD	9.0	--

PR-1: DPR AWPF at LTP

Option PR-1 would convey the City's tertiary effluent to an AWPF co-located at the City's existing LTP and return AWPF waste streams to the LTP headworks. The concept 9 MGD AWPF would include treatment processes in compliance with future anticipated regulations for TWA. The purified water would be conveyed to Sonoma Water's 36-inch Kawana Pipeline for distribution to the City's potable water system. PR-1 is limited by the reliable volume of tertiary effluent available. For this level of study, it was assumed the City would size the AWPF to meet its 9 MGD peak month supply needs. **Figure 3-7** shows the PR-1 concept, including the AWPF and conveyance infrastructure to the proposed potable connection point along Occidental Road.

Figure 3-7: Supply Option PR-1



Components that would need to be constructed as part of PR-1 include:

- 24-inch tertiary water pipeline from LTP to AWPF
- 1.8 million gallon equalization basin
- AWPF to meet anticipated DPR regulations, conventional FAT plus ozone/ BAF
    - Ozone/BAF
    - Microfiltration system (MF)
    - Reverse Osmosis (RO) system
    - UV/AOP
    - RO brine disposal system (Evaporator and Crystallizer)
    - Ancillary facilities
- 20-inch product water pipeline and pump station to potable connection point
- Potable connection infrastructure

The total preliminary capital cost for option PR-1, including all infrastructure listed, is approximately $289 million. A summary of the PR-1 capital cost is shown in **Table 3-9**. Additional cost detail can be found in Appendix A.

Table 3-9: Preliminary Capital Cost, Supply Option PR-1

Component	Description	Cost, $2023
Equalization	1,820,000 gallon equalization basin prior to feeding AWPF	$2,275,000
Tertiary Water Pipeline	24-inch diameter; assumed 500 linear feet	$445,000
9 MGD DPR AWPF	Ozone, BAF, Ultra Filtration (UF)/Micro Filtration (MF), RO, chemical storage and feed systems, sitework, piping, structures, waste disposal to headworks	$100,659,000
Brine Disposal	Brine evaporator and crystallizer for zero liquid discharge	$10,730,000
Purified Water Line	20-inch diameter; 26,330 linear feet	$19,528,000
Purified Water Pump Station	625 horsepower	$4,063,000
Potable system connection		$100,000
Estimating Contingency	50% of raw construction costs	$68,900,000
Implementation	40% of total construction costs	$82,680,000
Total Capital Cost		**$289,380,000**
Annualized Capital Cost	Annualized over 50 years, 2.5% interest	$10,203,000

The O&M cost of the project was estimated on a per AF basis for scalability. The PR-1 option has a fixed annual O&M cost of $873,000 and an annual marginal O&M cost of approximately $927/ AF. Annual O&M costs will vary depending on the production of the AWPF. It is assumed the AWPF could be turned down to a production capacity of 30 percent during low demand periods. The estimated annual O&M

costs for the maximum potential yield of 10,065 AFY is approximately $10.2 million. **Table 3-10** summarizes the annual O&M costs for option PR-1.

Table 3-10: Preliminary Annual O&M Cost, Supply Option PR-1

Component	Description	Cost, $2023
Marginal Cost	Marginal costs include power consumption, labor, and chemical addition	$927/ AF
Fixed Cost	Fixed costs include routine maintenance practices, water quality testing	$873,000
	Average cost of water (Baseline Scenario)[1]	$3,600/AF
	Annual O&M (10,065 AFY)[2]	$10,200,000
	Cost of water (10,065 AFY)[2]	$2,050/ AF
	Annual O&M (3,019 AFY)[3]	$3,671,000
	Cost of water (3,019 AFY)[3]	$4,600/ AF

Notes:

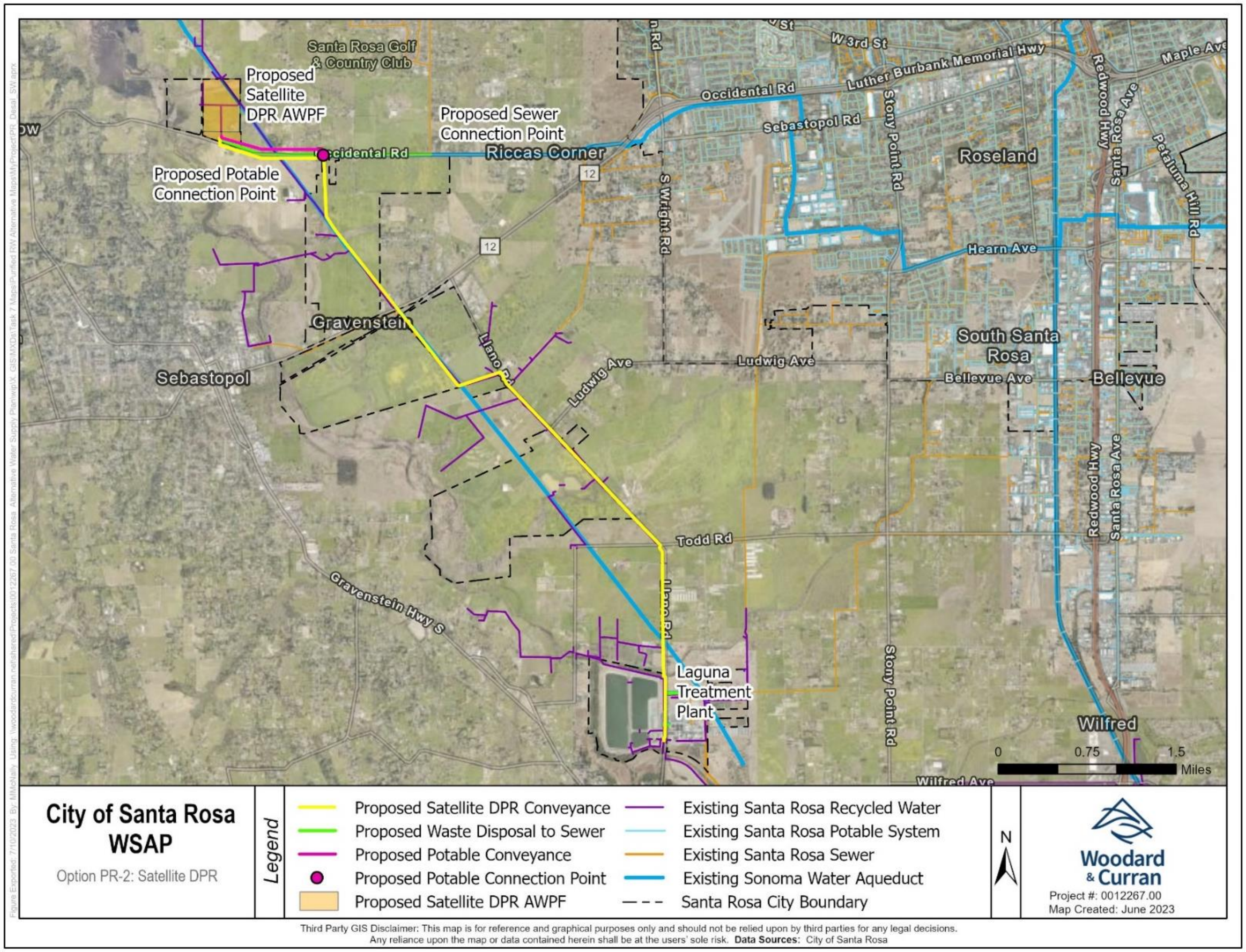
1. See Section 2.5 for description of baseline scenario, under which on average 4,131 AFY are produced by PR-1. Costs including operating and capital.
2. The maximum supply yield of 10,065 AFY assumes 24/7 operation of all supply option infrastructure. This scenario may not reflect realistic operations because it would produce more water than the City would use, which causes the unit cost of water to appear artificially low.
3. The minimal yield of 3,019 AFY assumes 30 percent turndown of the AWPF's maximum yield to provide a range of supply available for the PR options.

PR-2: Satellite DPR AWPF

Option PR-2 would convey the City's tertiary effluent to a satellite AWPF and return AWPF waste streams to the nearest sewer. The AWPF would include treatment processes in compliance with future anticipated regulations for TWA. The purified water would be conveyed to Sonoma Water's 36-inch diameter pipeline for distribution to the City's potable water system. The satellite AWPF is assumed to be located on City-owned agricultural leased land, Stone Farm. Although siting the AWPF as a satellite facility allows the City to reduce the purified water conveyance facilities, the satellite AWPF requires more ancillary facilities to support operations staff than if the AWPF were sited within the existing LTP.

For this level of study, it was assumed the City would size the AWPF to meet its 9 MGD peak month supply needs. The tertiary effluent to feed the AWPF would be conveyed to the satellite AWPF through new conveyance infrastructure assuming the existing Geysers pipeline corridor/ easement. The purified water would be conveyed to Sonoma Water's aqueduct for distribution to the City as shown in **Figure 3-8.**

Figure 3-8: Supply Option PR-2



Components that would need to be constructed as part of PR-2 include:

- 24-inch tertiary water pipeline from LTP to AWPF
- 400 horsepower tertiary water pump station
- 1.8 million gallon equalization basin
- AWPF to meet anticipated DPR regulations, conventional FAT plus ozone/BAC
    - Ozone/BAC
    - MF/Spell out (UF) System
    - RO System
    - UV/AOP
    - RO brine disposal system (Evaporator and Crystallizer)
    - Ancillary facilities
    - 10-inch AWPF waste disposal to nearest sewer with capacity
- 20-inch purified water pipeline
- 250 horsepower pump station to potable connection point
- Potable connection infrastructure

The total preliminary capital cost for option PR-2, including all infrastructure listed, is approximately $314 million. A summary of the PR-2 capital cost is shown in **Table 3-11**. Additional cost detail can be found in Appendix A.

Table 3-11: Preliminary Capital Cost, Supply Option PR-2

Component	Description	Cost, $2023
Equalization	1,820,000 gallon equalization basin	$2,275,000
Tertiary Water Pipeline	24-inch diameter; 30,100 linear feet	$26,789,000
9 MGD DPR AWPF	Ozone, BAC, MF, RO, chemical storage and feed systems, sitework, piping, structures, waste disposal to nearest sewer	$103,191,000
Brine Disposal	Brine evaporator and crystallizer for zero liquid discharge	$10,730,000
Purified Water Line	20-inch diameter; 26,330 linear feet	$1,520,000
Purified Water Pump Station	250 horsepower	$1,625,000
Potable system connection		$100,000
Estimating Contingency	50% of raw construction costs	$74,780,000
Implementation	40% of total construction costs	$89,730,000
Total Capital Cost		**$314,060,000**
Annualized Capital Cost	Annualized over 50 years, 2.5% interest	$11,073,000

The O&M cost of the project was estimated on a per AF basis for scalability. The PR-2 option has a fixed annual O&M cost of $954,000 and an annual marginal O&M cost of approximately $943/ AF. Annual O&M costs will vary depending on the production of the AWPF. It is assumed the AWPF could be turned down to a production capacity of 30 percent during low demand periods. The estimated annual O&M costs for the maximum potential yield of 10,065 AFY is approximately $10.4 million. **Table 3-12** summarizes the annual O&M costs for option PR-2.

Table 3-12: Preliminary Annual O&M Cost, Supply Option PR-2

Component	Description	Cost, $2023
Marginal Cost	Marginal costs include power consumption, labor, and chemical addition	$943/ AF
Fixed Cost	Fixed costs include routine maintenance practices, water quality testing	$954,000
	Average cost of water (Baseline Scenario)[1]	$3,900/ AF
	Annual O&M (10,065 AFY)[2]	$10,443,000
	Cost of water (10,065 AFY)[2]	$2,150/ AF
	Annual O&M (3,019 AFY)[3]	$3,800,000
	Cost of water (3,019 AFY)[3]	$5,000/ AF

Notes:

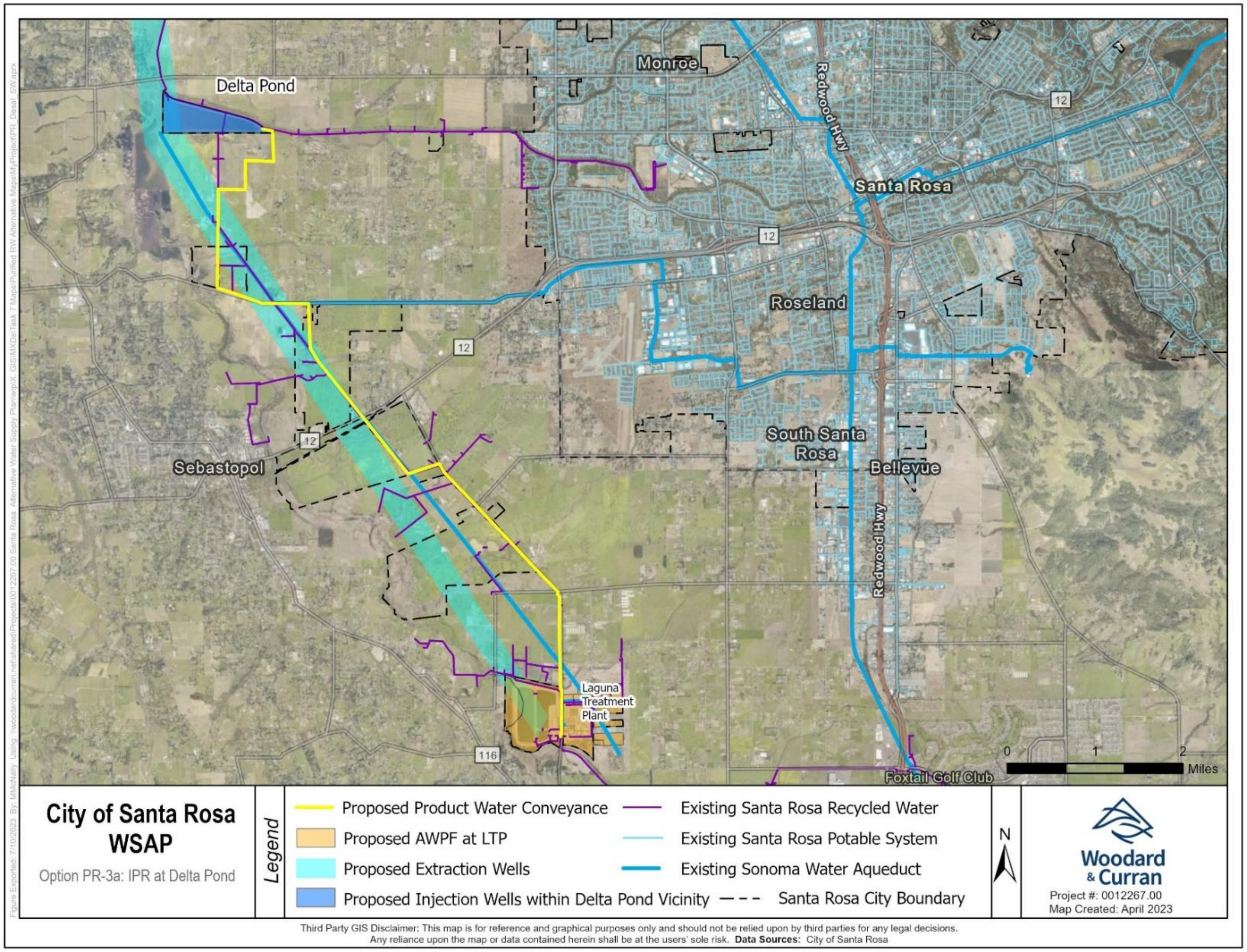
1. See Section 2.5 for description of baseline scenario, under which on average 4,131 AFY are produced. Costs include operating and capital.
2. The maximum supply yield of 10,065 AFY assumes 24/7 operation of all supply option infrastructure. This scenario may not reflect realistic operations because it would produce more water than the City would use, which causes the unit cost of water to appear artificially low.
3. The minimal yield of 3,019 AFY assumes 30 percent turndown of the AWPF's maximum yield to provide a range of supply available for the PR options.

PR-3a: IPR AWPF at LTP, Ground Water Augmentation (GWA) via Delta Pond

Option PR-3a would convey the City's tertiary effluent to an AWPF at LTP and return AWPF waste stream to the headworks at LTP. The AWPF would include treatment processes in compliance with regulations for GWR. The purified water would be conveyed to the City-owned Delta Pond, after the minimum retention time of 2-months in the groundwater aquifer, the recharged groundwater could then be extracted. The purified water would be injected into and later extracted from the groundwater aquifer via new ASR wells. The same capital cost assumptions for the GW-3 option were applied for the 12 new ASR wells. For this level of study, it was assumed the City would size the AWPF to meet its 9 MGD peak month supply needs .

As shown in **Figure 3-9**, the 9 MGD AWPF would be co-located at LTP and the purified water would be conveyed to the Delta Pond area through new conveyance infrastructure assuming use of the existing Geysers pipeline corridor/ easement.

Figure 3-9: Supply Option PR-3a



Components that would need to be constructed as part of PR-3a include:

- 24-inch tertiary water pipeline from LTP to AWPF
- 1.8 million gallon equalization basin
- AWPF to meet IPR GWA regulations, conventional FAT
    - MF System
    - RO System
    - UV/AOP
    - RO brine disposal system (Evaporator and Crystallizer)
    - Ancillary facilities
    - 8-inch AWPF waste disposal to LTP headworks
- 22-inch purified water pipeline
- 490 horsepower pump station to Delta Pond
- ASR wells

The total preliminary capital cost for option PR-3a, is approximately $419 million. A summary of the PR-3a capital cost is shown in **Table 3-13**. Additional cost detail can be found in Appendix A.

Table 3-13: Preliminary Capital Cost, Supply Option PR-3a

Component	Description	Cost, $2023
Equalization	1,820,000 gallon equalization basin	$2,275,000
Tertiary Water Pipeline	24-inch diameter; assumed 500 linear feet	$445,000
9 MGD IPR AWPF	UF, RO, chemical storage and feed systems, sitework, piping, structures, waste disposal to headworks	$89,390,000
Brine Disposal	Brine evaporator and crystallizer for zero liquid discharge	$10,760,000
Purified Water Line to Delta Pond	22-inch diameter; 41,220 linear feet	$33,628,700
Purified Water Pump Station	490 horsepower	$3,185,000
New Well Construction	12 ASR wells (injection/ extraction) wells, 500 gpm capacity, 500 feet deep, well head, casing, well pump and equipment ($5 million/ well)	$60,000,000
Estimating Contingency	50% of raw construction costs	$99,840,000
Implementation	40% of total construction costs	$119,810,000
Total Capital Cost		**$419,330,000**
Annualized Capital Cost	Annualized over 50 years, 2.5% interest	$14,785,000

The O&M cost of the project was estimated on a per AF basis for scalability. The PR-3a option has a fixed annual O&M cost of $1,069,000 and an annual marginal O&M cost of approximately $936/ AF. Annual O&M costs will vary depending on the production of the AWPF. It is assumed the AWPF could be turned down to a production capacity of 30 percent during low demand periods. The estimated annual O&M costs for the maximum potential yield of 10,065 AFY is approximately $12.7 million. **Table 3-14** summarizes the annual O&M costs for option PR-3a.

Table 3-14: Preliminary Annual O&M Cost, Supply Option PR-3a

Component	Description	Cost, $2023
Marginal Cost	Marginal costs include power consumption, labor, and chemical addition	$936/ AF
Fixed Cost	Fixed costs include routine maintenance practices, water quality testing	$1,069,000
	Average cost of water (Baseline Scenario)[1]	$4,800/AF
	Annual O&M (10,065 AFY)[2]	$12,700,000
	Cost of water (10,065 AFY)[2]	$2,730/AF
	Annual O&M (3,019 AFY)[3]	$4,558,000
	Cost of water (3,019 AFY)[3]	$6,400/AF

Notes:

1. See Section 2.5 for description of baseline scenario, under which on average 4,131 AFY of water would be produced. Costs include capital and operating.
2. The maximum supply yield of 10,065 AFY assumes 24/7 operation of all supply option infrastructure. This scenario may not reflect realistic operations.
3. The minimal yield of 3,019 AFY assumes 30 percent turndown of the AWPF's maximum yield to provide a range of supply available for the PR options.

PR-3b: IPR AWPF at LTP, SWA via Lake Ralphine

Option PR-3b would convey the City's tertiary effluent to an AWPF at LTP and return AWPF waste stream to the headworks at LTP. The AWPF would include treatment processes in compliance with regulations for SWA. After preliminary retention calculations it was determined that Lake Ralphine would not provide the minimum required 2-month retention time to quality as IPR per California regulations. Therefore, option PR-3b would qualify as a DPR and would likely yield a project similar to the PR-1 option described above. Therefore, this supply option was not carried forward for detailed cost analysis or feasibility scoring.

PR-3c: IPR AWPF at LTP, SWA via Lake Sonoma

Option PR-3c would convey the City's tertiary effluent to an AWPF at LTP and return AWPF waste stream to the headworks at LTP. The AWPF would include treatment processes in compliance with regulations for SWA. The purified water would be conveyed to Lake Sonoma through a new purified water line assuming the existing Geysers pipeline corridor/ easement and extending to Lake Sonoma as shown in **Figure 3-10**.

For this level of study, it was assumed the City would size the AWPF to meet its 9 MGD peak month supply needs

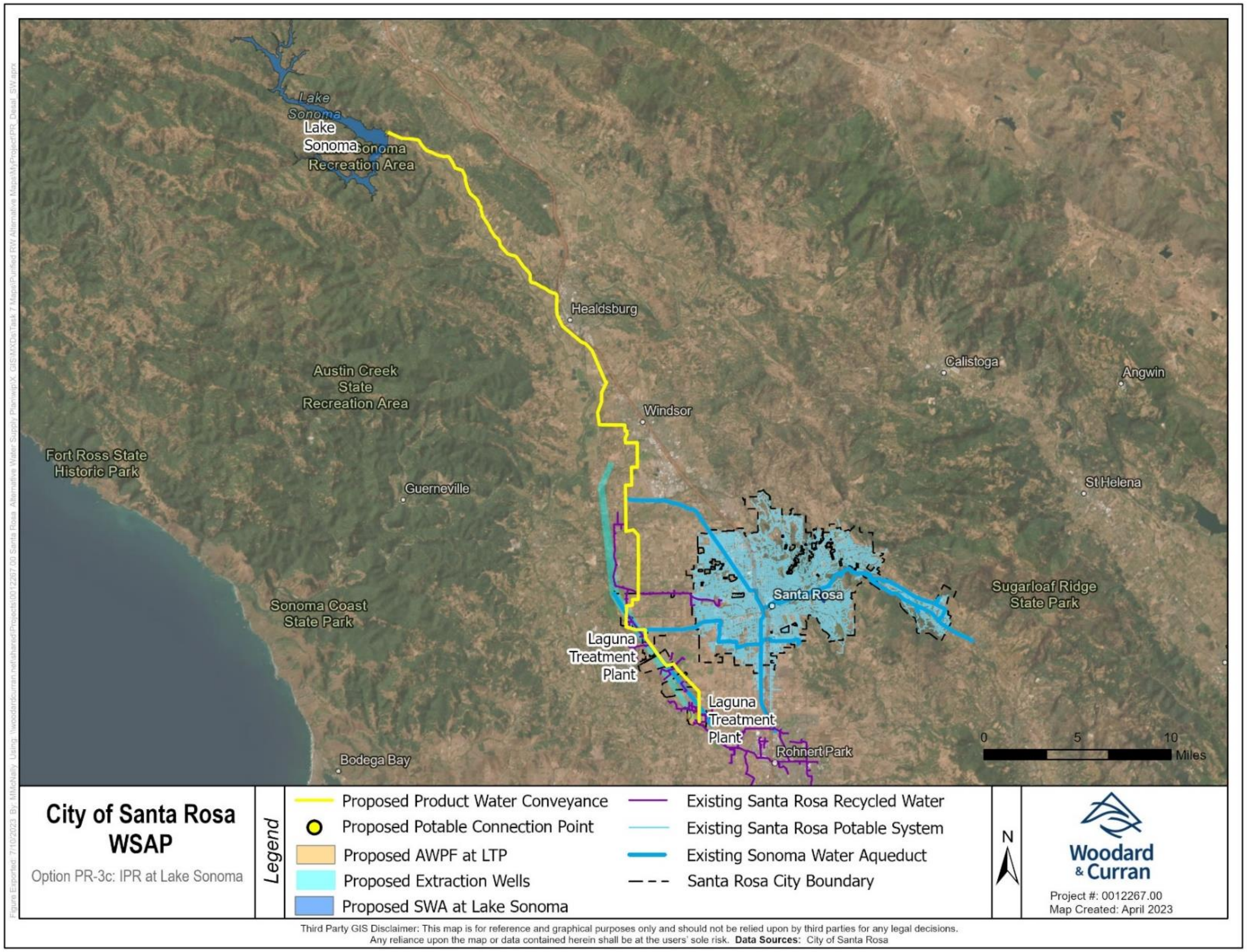
The AWPF would be located at LTP, and the purified water would be conveyed to Lake Sonoma through new conveyance infrastructure . Water would be withdrawn from Lake Sonoma using Sonoma Water's existing infrastructure.

Components that would need to be constructed as part of option PR-3c include:

- 24-inch tertiary water pipeline from LTP to AWPF
- 1.8 million gallon equalization basin
- AWPF to meet IPR GWA regulations, conventional FAT
    - MF system
    - RO system
    - UV/AOP
    - RO brine disposal system (Evaporator and Crystallizer)
    - Ancillary facilities
    - 8-inch AWPF waste disposal to LTP headworks
- 22-inch purified water pipeline
- 2,600 horsepower pump station to Lake Sonoma

This option incorporates some assumptions that would need to be vetted and refined if the option were implemented. Among them is an assumption that sufficient space exists in Lake Sonoma, and that withdrawing the water from Lake Sonoma could be done with existing infrastructure. Both of these issues would likely add cost and-or reduce yield to the option. However, given the very high cost of the option even without those burdens, the issues were not fully explored in the current study.

Figure 3-10: Supply Option PR-3c



The total preliminary capital cost for option PR-3c is approximately $650 million. A summary of the PR-3c capital cost is shown in **Table 3-15**. Additional cost detail can be found in Appendix A.

Table 3-15: Preliminary Capital Cost, Supply Option PR-3c

Component	Description	Cost, $2023
Equalization	1,820,000 gallon equalization basin	$2,275,000
Tertiary Water Pipeline	24-inch diameter; assumed 500 linear feet	$445,000
9 MGD IPR AWPF	UF, RO, chemical storage and feed systems, sitework, piping, structures, waste disposal to headworks	$89,390,000
Brine Disposal	Brine evaporator and crystallizer for zero liquid discharge	$10,760,000
Purified Water Line to Lake Sonoma	22-inch diameter; 181,300 linear feet	$147,910,600
Purified Water Pump Station	2,600 horsepower	$16,900,000
Estimating Contingency	50% of raw construction costs	$133,840,000
Implementation	40% of total construction costs	$160,610,000
Total Capital Cost		**$562,130,000**
Annualized Capital Cost	Annualized over 50 years, 2.5% interest	$19,800,000

The O&M cost of the project was estimated on a per AF basis for scalability. The PR-3c option has a fixed annual O&M cost of $1,790,000 and an annual marginal O&M cost of approximately $1,200/ AF. Annual O&M costs will vary depending on the production of the AWPF. It is assumed the AWPF could be turned down to a production capacity of 30 percent during low demand periods. The estimated annual O&M costs for the maximum potential yield of 10,065 AFY is approximately $15.9 million. **Table 3-16** summarizes the annual O&M costs for option PR-3c.

Table 3-16: Preliminary Annual O&M Cost, Supply Option PR-3c

Component	Description	Cost, $2023
Marginal Cost	Marginal costs include power consumption, labor, and chemical addition	$1,200/ AF
Fixed Cost	Fixed costs include routine maintenance practices, water quality testing	$1,786,000
	Average cost of water (Baseline Scenario)[1]	$6,430/AF
	Annual O&M (10,065 AFY)[2]	$13,870,000
	Cost of water (10,065 AFY)[2]	$3,350/ AF
	Annual O&M (4,131 AFY)[3]	$6,319,000
	Cost of water (4,131 AFY)[3]	$6,430/AF

Notes:

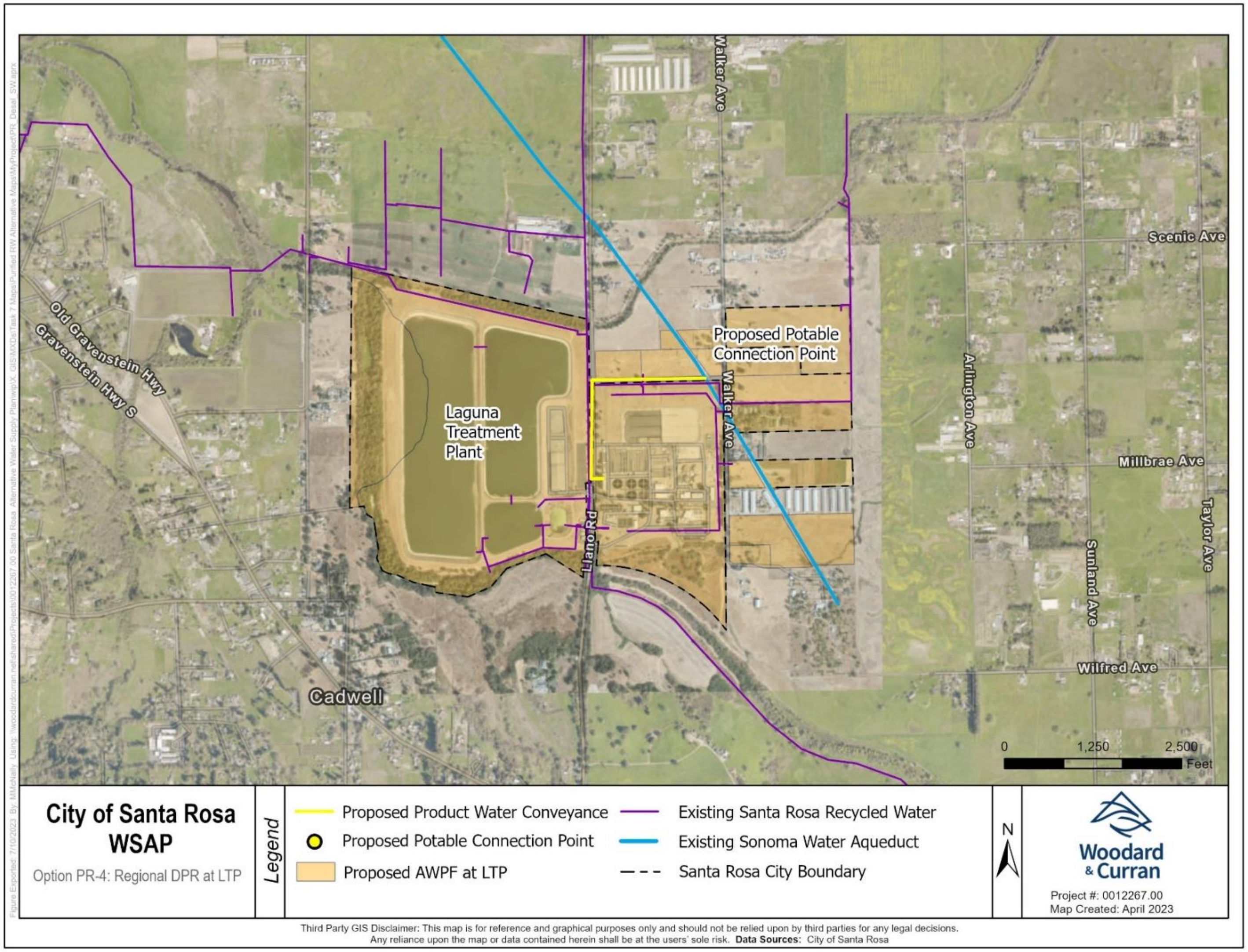
1. See Section 2.5 for description of baseline scenario, under which on average 4,131 AFY would be produced. Operating and capital costs are included.
2. The maximum supply yield of 10,065 AFY assumes 24/7 operation of all supply option infrastructure. This scenario may not reflect realistic operations.
3. The minimal yield of 3,019 AFY assumes 30 percent turndown of the AWPF's maximum yield to provide a range of supply available for the PR options.

PR-4: Regional DPR AWPF at LTP

Similar to Option PR-1, PR-4 would convey the City's tertiary effluent to an AWPF located at the LTP and return AWPF waste stream to the LTP headworks. The AWPF would include treatment processes in compliance with future anticipated regulations for TWA. The purified water would be conveyed to Sonoma Water's 48-inch diameter aqueduct for regional distribution, as shown in **Figure 3-11**.

Under the PR-4 project concept, the purified water could be delivered to another party rather than used directly by the City, and a paper exchange could be completed whereby the City receives water in return. The paper exchange option would not reduce reliance on the Sonoma Water system overall.

Figure 3-11: Supply Option PR-4



Components that would need to be constructed as part of PR-4 include:

- 24-inch tertiary water pipeline from LTP to AWPF
- 1.8 million gallon equalization basin
- AWPF to meet anticipated DPR regulations, conventional FAT plus ozone/ BAC
    - Ozone/BAC
    - MF System
    - RO System
    - UV/AOP
    - RO brine disposal system (Evaporator and Crystallizer)
    - Ancillary facilities
- 20-inch product water pipeline and pump station to potable connection point
- Potable connection infrastructure

The total preliminary capital cost for option PR-4, including all infrastructure listed, is approximately $247 million. A summary of the PR-4 capital cost is shown in **Table 3-17**. Additional cost detail can be found in Appendix A.

Table 3-17: Preliminary Capital Cost, Supply Option PR-4

Component	Description	Cost, $2023
Equalization	1,820,000 gallon equalization basin prior to feeding AWPF	$2,275,000
Tertiary Water Pipeline	24-inch diameter; assumed 500 linear feet	$445,000
9 MGD DPR AWPF	Ozone, BAF, UF, RO, chemical storage and feed systems, sitework, piping, structures, waste disposal to headworks	$100,659,000
Brine Disposal	Brine evaporator and crystallizer for zero liquid discharge	$10,730,000
Purified Water Line	20-inch diameter; 2,200 linear feet	$1,631,700
Purified Water Pump Station	270 horsepower	$1,755,000
Potable system connection		$100,000
Estimating Contingency	50% of raw construction costs	$58,800,000
Implementation	40% of total construction costs	$70,560,000
Total Capital Cost		**$246,960,000**
Annualized Capital Cost	Annualized over 50 years, 2.5% interest	$8,707,000

The O&M cost of the project was estimated on a per AF basis for scalability. The PR-4 option has a fixed annual O&M cost of $714,000 and an annual marginal O&M cost of approximately $885/ AF. Annual O&M costs will vary depending on the production of the AWPF. It is assumed the AWPF could be turned down to a production capacity of 30 percent during low demand periods. The estimated annual O&M

costs for the maximum potential yield of 10,065 AFY is approximately $9.6 million. **Table 3-18** summarizes the annual O&M costs for option PR-4.

Table 3-18: Preliminary Annual O&M Cost, Supply Option PR-4

Component	Description	Cost, $2023
Marginal Cost	Marginal costs include power consumption, labor, and chemical addition	$885/ AF
Fixed Cost	Fixed costs include routine maintenance practices, water quality testing	$714,000
	Average cost of water (Baseline Scenario)[1]	$3,200/AF
	Annual O&M (10,065 AFY)	$9,625,000
	Cost of water (10,065 AFY)	$1,850/ AF
	Annual O&M (3,019 AFY)	$3,387,000
	Cost of water (3,019 AFY)	$4,000/ AF

Notes:

1. See Section 2.5 for description of baseline scenario, under which an average of 4,131 AFY would be produced. Operating and capital costs are included.
2. The maximum supply yield of 10,065 AFY assumes 24/7 operation of all supply option infrastructure. This scenario may not reflect realistic operations because it would produce more water than the City would use, which causes the unit cost of water to appear artificially low.
3. The minimal yield of 3,019 AFY assumes 30 percent turndown of the AWPF's maximum yield to provide a range of supply available for the PR options.

The costs presented for PR-4 would represent the total cost of the supply option. Were a regional partner to be identified, the costs would be distributed between the City and its partner(s), and the City presumably would not bear the entire project cost.

3.1.3 Non-Potable Recycled Water Option

As discussed in Section 3.1.2, the City is responsible for the operation and management of the Regional System. The Regional System operates the LTP, oversees the Industrial Pretreatment Program, and operates and maintains the recycled water system for more than 225,000 residents and 6,500 businesses for the Cities of Cotati, Rohnert Park, Santa Rosa, and Sebastopol, and the South Park Sanitation District and portions of unincorporated Sonoma County. As managing partner of the Regional System, the City is responsible for operating the system economically and safely and for planning for future regulatory changes and growth.

RW-1: Recycled Water System Expansion

Option RW-1 would increase the amount of urban reuse within Santa Rosa, Cotati, and Rohnert Park supplied by recycled water. The Santa Rosa Urban Reuse Project Feasibility Study identified the following phases, each with a capacity of 250 MGY (City of Santa Rosa, 2007). The total expansion would yield an additional 3,000 AFY for distribution. The four phases of the expansion are:

- Phase 1 West: pipelines generally located in northwest Santa Rosa extending from either the west transmission main or the West College Facility. Diurnal storage may be included in Phase 1 West and would be located between elevation 300 and 400 feet in the Fountaingrove area.
- Phase 1 South: pipelines generally located in southeast Santa Rosa extending from the south transmission main. Diurnal storage may be included in Phase 1 South and would be located between elevation 300 and 400 feet within the Santa Rosa Urban Growth Boundary or in the southeast of Santa Rosa area.
- Phase 2 South: pipelines extending from the Phase 1 South system into southwest Santa Rosa. Connections between the south and west system may be made during this phase. Diurnal storage may be included in Phase 2 South and would be located between elevation 300 and 400 feet or at lower elevations in northwest Rohnert Park or west of Cotati.
- Phase 2 West: pipelines extending from the Phase 1 West system to interconnect with the south system. Diurnal storage may be included in Phase 2 West and would be located between elevation 300 and 400 feet or at lower elevations near the Geysers pipeline or east of Rohnert Park.

The total preliminary capital cost for option RW-1, escalated from the Santa Rosa Urban Reuse Project Feasibility Study in 2006 to 2023 dollars is approximately $214 million. The O&M cost of the project was estimated at $1.3M/year by prorating based on the City's FY2020- 2021 Wastewater Resource Distribution Expenditure. The average cost of water for the Baseline Scenario (see **Section 2.5**) is approximately $8,800/ AF. Expanding use of recycled water would not provide a new source of potable drinking water for severe water shortages or emergencies (irrigation would be significantly restricted or banned).

3.1.4 Desalinated Water Supply Options

Marin Municipal Water District (Marin Water) is also considering alternatives for supplemental water supplies with the City of Petaluma, garnering potential for regional partnerships between Marin Water, Petaluma, and the City. The City's service area is too far from saline water sources and the local groundwater supply does not require desalination. Alternative water supplies Marin Water is currently evaluating include a potential temporary or long-term seawater desalination facility (using brackish bay water) or a brackish groundwater desalination facility. This section evaluated a partnership between Marin Water and the City for a regional brackish bay water desalination facility and the concept of the City's own ocean desalination facility.

DE-1: Regional Brackish Water Desalination

Option DE-1 would allow the City and Marin Water to partner in constructing a desalination facility to augment Marin Water's local water supply and the City's Sonoma Water supply via water transfers. A full-scale facility could have an initial capacity of 5 MGD or 10 MGD and be expandable up to 15 MGD. The full-scale facility could be located at the Marin Water Pelican Way Site in San Rafael as shown in **Figure 3-12**. The screened intake would be offshore with an on-shore pump station near the Marin Water Pelican Way Site. The bay water intake would include passive screens. The intake screens would be connected to an onshore wet well and pump station via an HDPE pipeline on and under the bay floor. The intake pump station would deliver raw water to the treatment facilities located at either or both the maintenance yard and parking lot sites. The 15 MGD long-term full-scale desalination facilities require approximately 6.5 acres of space. Treated water from the desalination facilities would be delivered to the Marin Water distribution system in San Rafael.

Provided that the desalination facility would be within the jurisdiction of Marin Water, a paper exchange could be completed where the City receives 9 MGD of Marin Water's Sonoma Water allocation, and the desalinated water is used directly by Marin Water. Since the Sonoma Water aqueduct would be an integral component of operations, the paper exchange option would not reduce reliance on the Sonoma Water system overall, but it would reduce overall reliance on the Russian River.

The City's total preliminary capital cost for option DE-1 is approximately $181 million. A summary of the DE-1 capital cost is shown in **Table 3-19**. Additional cost detail can be found in Appendix A.

Table 3-19: Preliminary Capital Cost, Supply Option DE-1

Component	Description	City Cost, $2023
Brackish Water Intake	Intake Screens, Pipeline and Pumps, Raw Water Pipe to facility	$8,178,000
Desalination Plant	Rapid Mix Strainers, UF and Building, Filtrate and Backwash Supply Tanks, RO Feed Pump Station, 1st pass RO and Building, Permeate Tank, Chlorine Contact Tank, Chemical Facilities, Backwash Equalization Basin, Gravity Thickener, Centrifuges, O&M Building, Sitework/Piping, Electrical, Instrumentation and Controls	$71,559,000
Brine Disposal	Brine Pump Station, Brine Transmission Line	$3,444,000
Distribution	Distribution Booster Pumps, Treated Water Line	$2,899,200
Estimating Contingency	50% of raw construction costs	$43,040,000
Implementation	40% of total construction costs	$51,650,000
Total Capital Cost		**$180,770,000**
Annualized Capital Cost	Annualized over 50 years, 2.5% interest	$6,374,000

The O&M cost of the project was estimated on a per AF basis for scalability. The DE-1 option has a fixed annual O&M cost of $909,000 and an annual marginal O&M cost of approximately $401/ AF. Annual O&M costs will vary depending on the production of the desalination facility. It is assumed the desal facility could be turned down to a production capacity of 30 percent during low demand periods. The estimated annual O&M costs for the maximum potential yield of 10,080 AFY is approximately $5 million. **Table 3-20** summarizes the City's portion of the estimated annual O&M costs for option DE-1.

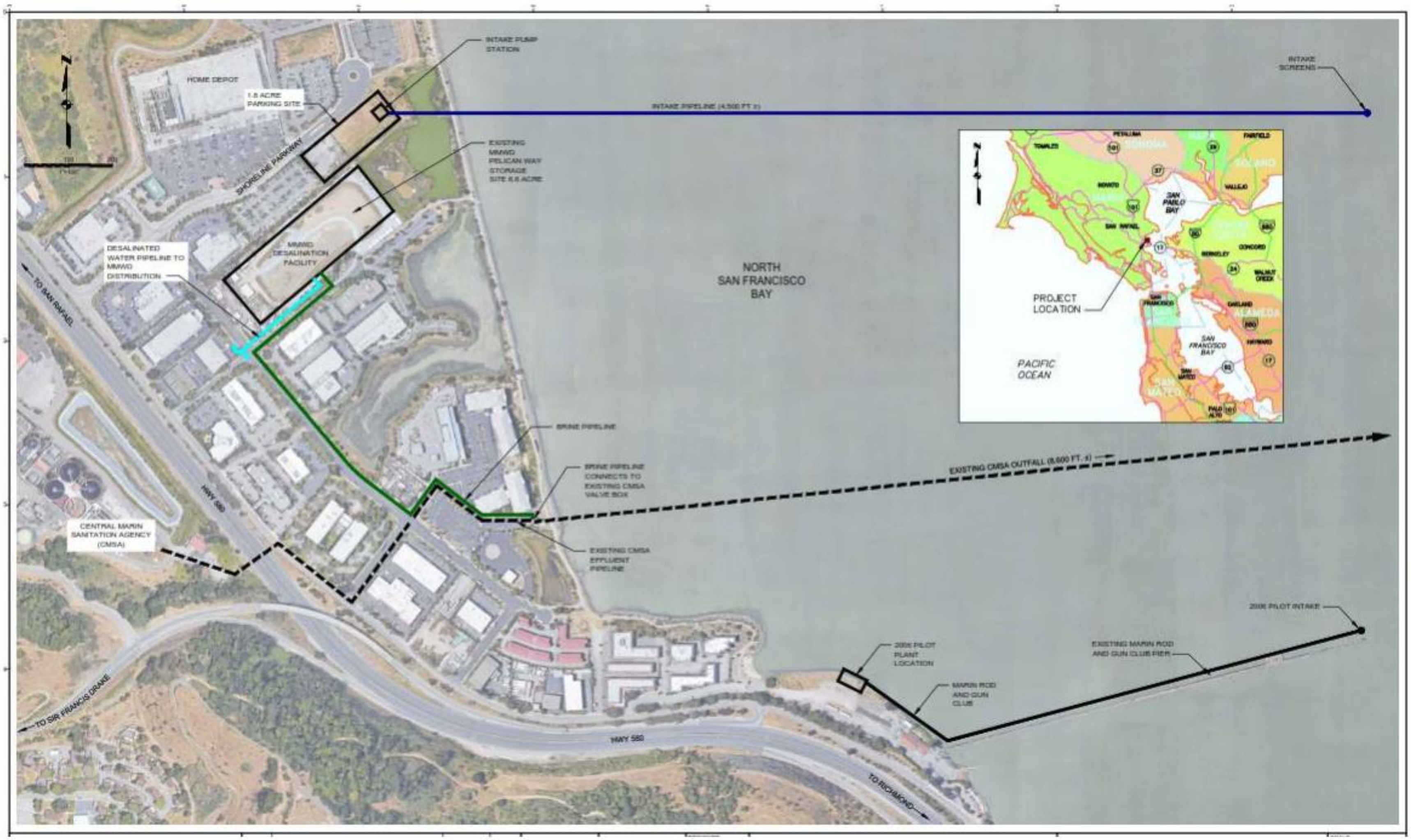
Table 3-20: Preliminary Annual O&M Cost, Supply Option DE-1

Component	Description	Cost, $2023
Marginal Cost	Marginal costs include power consumption, labor, and chemical addition	$401/ AF
Fixed Cost	Fixed costs include routine maintenance practices, water quality testing	$909,000
	Average cost of water (Baseline Scenario)[1]	$2,041/AF
	Annual O&M (10,080 AFY)[2]	$4,954,000
	Cost of water (10,080 AFY)[2]	$1,200/ AF
	Annual O&M (3,360 AFY)[3]	$2,005,000
	Cost of water (3,360 AFY)[3]	$2,500/ AF

Notes:

1. See Section 2.5 for description of baseline scenario, under which an average of 4,441 AFY would be produced. Capital and operating costs are included.
2. The maximum supply yield of 10,080 AFY assumes 24/7 operation of all supply option infrastructure. This scenario may not reflect realistic operations.
3. The minimal yield of 3,360 AFY assumes 30 percent turndown of the desalination plant's maximum yield to provide a range of supply available for the DE options.

Figure 3-12: Supply Option DE-1



Source: Marin Water Desalination Supply Study Draft Technical Memorandum (Marin Municipal Water District, 2021)

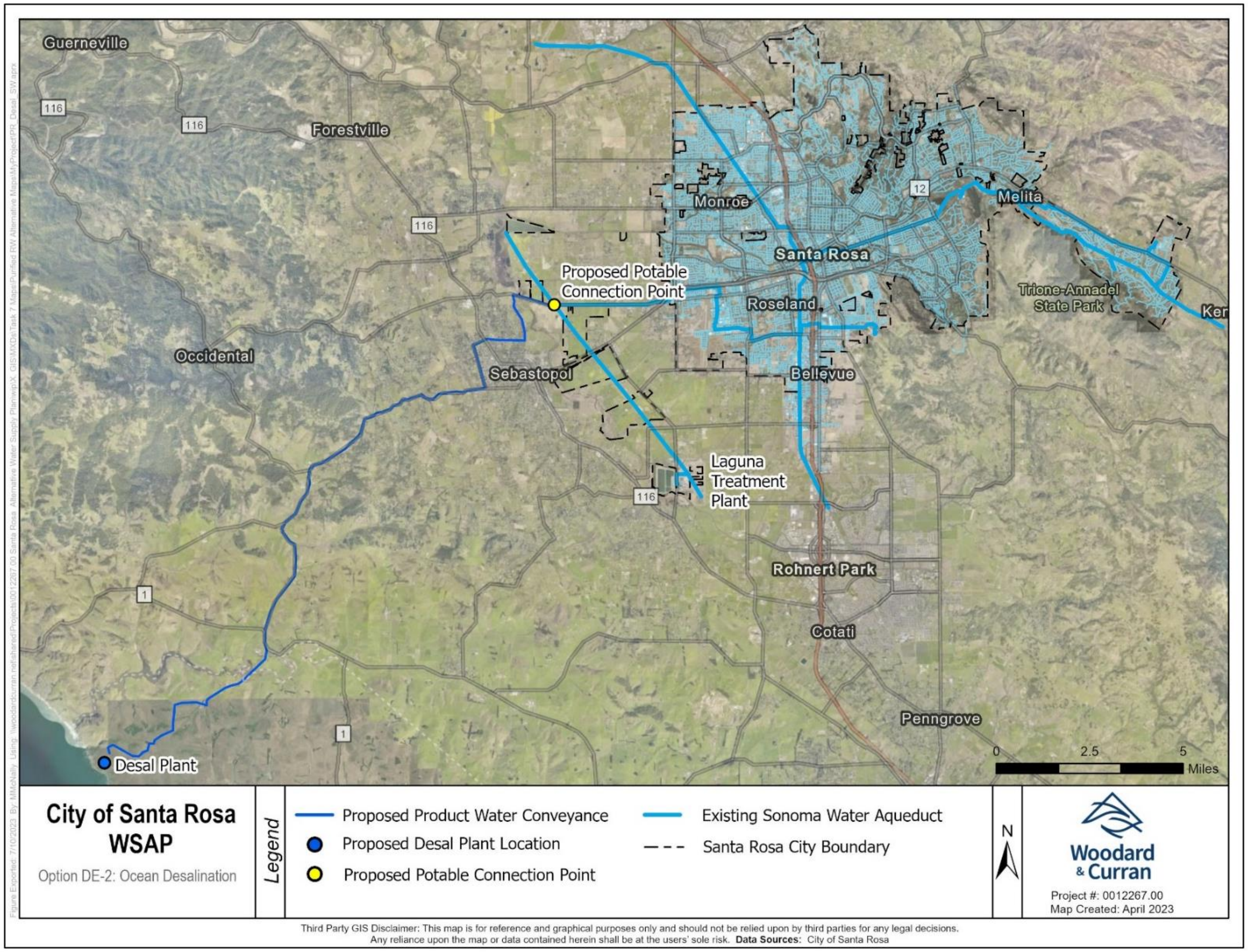
DE-2: Ocean Desalination

Option DE-2 would construct a seawater desalination facility to increase the City's local water supply. The desalination facility would be sized to produce 9 MGD to meet the City's peak month demands. The screened intake would be offshore with an onshore pump station near the desalination site. For costing purposes only, a general location for ocean desalination option was estimated. For purposes of this study, the conceptual full-scale facility was assumed to be located offshore along Bodega Bay as shown in **Figure 3-13**. A full siting study would be required to determine the most feasible and optimal location for the seawater desalination facility if brought forward through the screening process.

Components that would need to be constructed for DE-2 include:

- The 9 MGD desalination facilities:
  - Intake Screens, Pipeline and Pumps
  - Raw Water Pipe to facility
  - Rapid Mix Strainers
  - UF System including Filtrate and Backwash Supply Tanks
  - RO Feed Pump Station
  - RO System and permeate tank
  - Chlorine Contact Tank
  - Chemical Facilities
  - Backwash Equalization Basin
  - Gravity Thickener
  - Centrifuges
  - Ancillary facilities
- Brine disposal
  - 290 horsepower pump station
  - 24-inch Brine Transmission Line
- Potable Water Distribution
  - 1,880 horsepower pump station
  - 24-inch potable water pipeline

Figure 3-13: Supply Option DE-2



The capital cost estimate for option DE-2 is also based on a recent draft cost estimate from the 2021 Marin Water Desalination Supply Study (Marin Municipal Water District, 2021). The total preliminary capital cost for option DE-2 is approximately $378 million. A summary of the DE-2 capital cost is shown in **Table 3-21**. Additional cost details can be found in Appendix A.

Table 3-21: Preliminary Capital Cost, Supply Option DE-2

Component	Description	City Cost, $2023
Seawater Intake	Intake Screens, Pipeline and Pumps 30-inch; 2,000 linear feet Raw Water Pipe to facility	$10,167,000
Desalination Plant	Rapid Mix Strainers, UF and Building, Filtrate and Backwash Supply Tanks, RO Feed Pump Station, 1st pass RO and Building, Permeate Tank, Chlorine Contact Tank, Chemical Facilities, Backwash Equalization Basin, Gravity Thickener, Centrifuges, O&M Building, Sitework/Piping, Electrical, Instrumentation and Controls	$71,560,000
Brine Disposal	290 horsepower Brine Pump Station 24-inch; 2,000 linear feet Brine Transmission Line	$3,665,000
Distribution	1,880 horsepower Distribution Pump Station 24-inch; 92,600 linear feet Treated Water Line	$94,634,000
Estimating Contingency	50% of raw construction costs	$90,020,000
Implementation	40% of total construction costs	$108,020,000
Total Capital Cost		**$378,070,000**
Annualized Capital Cost	Annualized over 50 years, 2.5% interest	$13,330,000

The O&M cost of the project was estimated on a per AF basis for scalability. The DE-2 option has a fixed annual O&M cost of $1,604,000 and an annual marginal O&M cost of approximately $1,165/ AF. Annual O&M costs will vary depending on the production of the desalination facility. It is assumed the desal facility could be turned down to a production capacity of 30 percent during low demand periods. The estimated annual O&M costs for the maximum potential yield of 10,080 AFY is approximately $13.3 million. **Table 3-22** summarizes the City's portion of the estimated annual O&M costs for option DE-2.

Table 3-22: Preliminary Annual O&M Cost, Supply Option DE-2

Component	Description	Cost, $2023
Marginal Cost	Marginal costs include power consumption, labor, and chemical addition	$1,165/ AF
Fixed Cost	Fixed costs include routine maintenance practices, water quality testing	$1,604,000
Average cost of water (Baseline Scenario)[1]		$4,500/ AF
Annual O&M (10,080 AFY)[2]		$13,330,000
Cost of water (10,080 AFY)[2]		$2,700/ AF
Annual O&M (3,360 AFY)[3]		$5,520,000
Cost of water (3,360 AFY)[3]		$5,600/ AF

Notes:

1. See Section 2.5 for description of baseline scenario, under which an average of 4,441 AFY would be produced. Capital and operating costs are included.
2. The maximum supply yield of 10,080 AFY assumes 24/7 operation of all supply option infrastructure. This scenario may not reflect realistic operations.
3. The minimal yield of 3,360 AFY assumes 30 percent turndown of the desalination plant's maximum yield to provide a range of supply available for the desalination options.

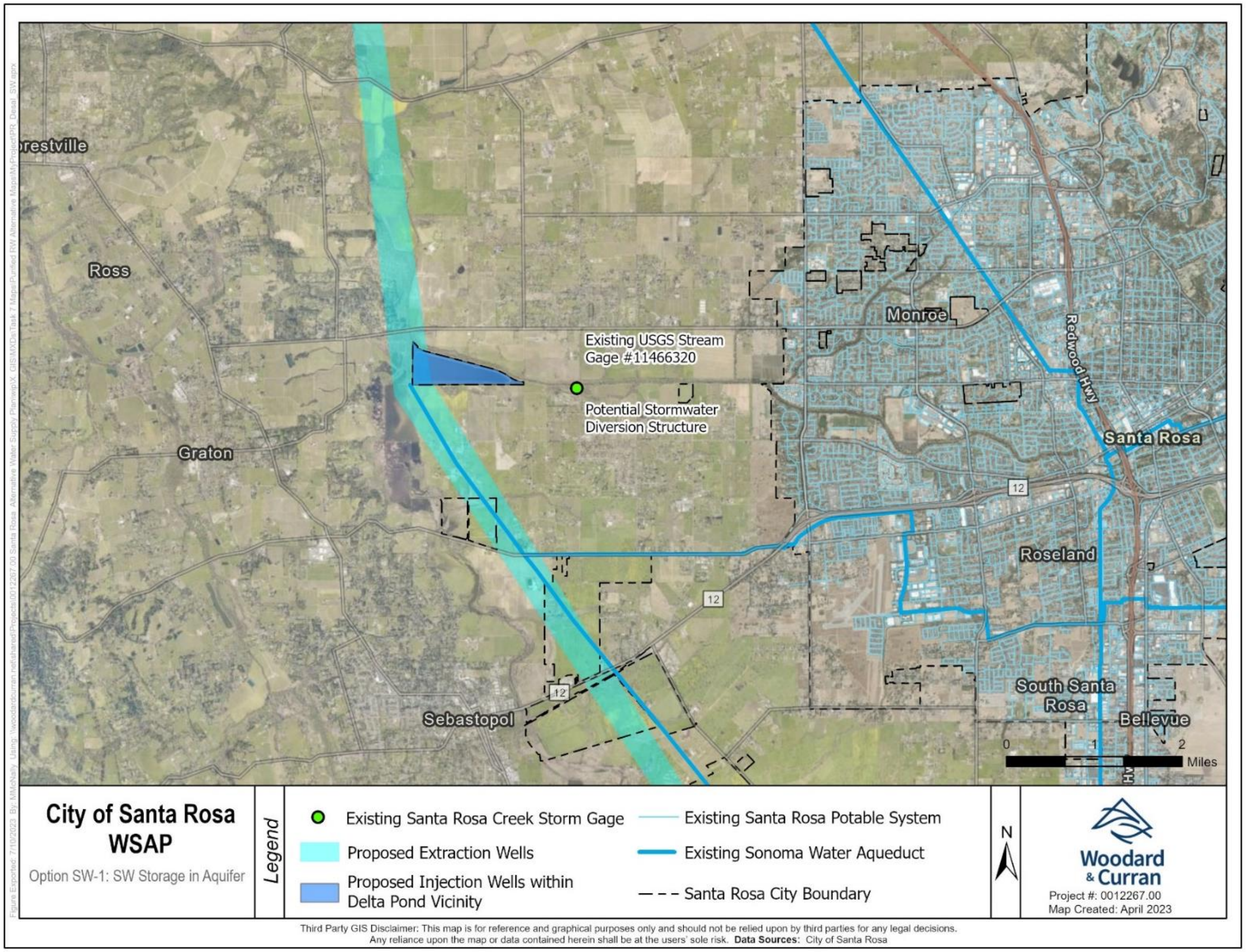
3.1.5 Stormwater Capture Options

SW-1: Capture Excess Winter Flows in Aquifer Storage

Option SW-1 proposes to construct a diversion structure within Santa Rosa Creek to divert excess winter flows to new spreading basins (it may be determined after future investigations that injection wells will be required for groundwater recharge) for storage within the Santa Rosa aquifer to increase the City's local water supply. The diversion location for this study was assumed to be within Santa Rosa Creek near the existing USGS stream gage 11466320 due to its proximity to Delta Pond for potential storage prior to aquifer recharge via proposed spreading basins in the vicinity (see **Figure 3-14**). For the 9 MGD supply, 12 new extraction wells would be required. The same assumptions for the GW-1 option were applied for the proposed extraction wells.

A preliminary stream gage analysis was performed to determine the allowable diversion volume from Santa Rosa Creek. The allowable stream diversion period lies within the months of December through March. This level of analysis assumed that all flows above the 90th percentile of stormwater volume within the creek can be diverted unless the diversion amount is greater than 20 percent of the day's flow (in which case, this analysis capped the diversion volume at 20 percent of that day's flow). Based on dry year data from 1999 to 2023, the allowable diversion volume between the months of December through March can range from 1,200 to 212,640 AF. For purposes of the current study, it was assumed that adequate volumes are available on average to support the maximum annual usage of 7,500 AFY, accounting for the need to withdraw less than the amount recharged, and that sufficient aquifer storage exists to buffer intra-year and inter-year supply variations.

Figure 3-14: Supply Option SW-1



Components that would need to be constructed as part of option SW-1 include:

- Stormwater diversion structure including pumps, pipes
- Spreading basins in the Delta Pond vicinity
- 12 new extraction wells and conveyance
- Treatment plant providing conventional treatment (coagulation, flocculation, sedimentation, filtration); this is a conservative assumption and would need further exploration if the alternative were carried forward.

The total preliminary capital cost for option SW-1 is approximately $223million. A summary of the SW-1 capital cost is shown in **Table 3-23**. Additional cost details can be found in Appendix A.

Table 3-23: Preliminary Capital Cost, Supply Option SW-1

Component	Description	Cost, $2023
Santa Rosa Creek Diversion	Diversion Structure, including pumps, spreading basins	$18,144,000
New Well Construction	12 extraction wells, 500 gpm capacity, 500 feet deep, well head, casing, well pump and equipment	$42,000,000
Treatment to Stormwater Prior to Recharge	9 MGD conventional treatment plant	$42,000,000
Groundwater Conveyance	20-inch; 3,000 linear feet	$2,225,000
Groundwater Pump Station	240 horsepower	$1,560,000
Potable Connection		$100,000
Estimating Contingency	50% of raw construction costs	$52,980,000
Implementation	40% of total construction costs	$38,420,000
Total Capital Cost		**$222,500,000**
Annualized Capital Cost	Annualized over 50 years, 2.5% interest	4,741,000

The O&M cost of the project was estimated on a per AF basis for scalability. The SW-1 option has a fixed annual O&M cost of $542,000 and an annual marginal O&M cost of approximately $303/ AF. Annual O&M costs will vary depending on the amount of water diverted from Santa Rosa Creek during winter. The estimated annual O&M costs for the maximum potential yield of 10,080 AFY is approximately $3.6 million. Table 3-24 summarizes the estimated annual O&M costs for option SW-1.

Table 3-24: Preliminary Annual O&M Cost, Supply Option SW-1

Component	Description	Cost, $2023
Marginal Cost	Marginal costs include power consumption, labor, and chemical addition	$303/ AF
Fixed Cost	Fixed costs include routine maintenance practices, water quality testing	$542,000
	Average cost of water (Baseline Scenario)[1]	$3,500/ AF
	Annual O&M (10,080 AFY)[2]	$3,600,000
	Cost of water (10,080 AFY)[2]	$1,135/ AF

Notes:

1. See Section 2.5 for description of baseline scenario, under which on average 2,600 AFY are produced. Costs include capital and operating.

   This baseline estimate of usage is uncertain as it would depend on adequate stormwater being captured and banked to support that level of usage. If this alternative were to be further developed, more detailed modeling would need to be performed.

2. The maximum supply yield of 10,080 AFY assumes 24/7 operation of all supply option infrastructure. This scenario may not reflect realistic operations. This is particularly true for this option, since its operation would be subject to a host of unknowns including hydrologic variations on the intra-seasonal and inter-seasonal timescales that would affect supply availability. Some of those variations, e.g., low stormwater availability, could be temporally correlated with Russian River droughts, thus limiting supplemental supply when it is most needed.

SW-2: Capture Excess Winter Flows in Surface Storage (Lake Ralphine or Alternate)

This option explored the possibility of capturing excess winter stormwater flows for surface storage. The City does not currently have unused surface storage. Lake Ralphine holds slightly under 500 AF and served as a historical water supply source for the City (through the late 1950's) and is currently used for recreation. A review of prior City planning work and City water systems and topography did not yield any alternative surface water sites for further exploration.

In order to store surface water in Lake Ralphine, the existing dam would need to be raised, which would displace the existing recreational areas (picnic areas, ball fields, etc.), which are highly valued by the community and City. The size of a potential reservoir would be limited due to surrounding topography and presence of residential neighborhoods surrounding the reservoir. Even an enlarged Lake Ralphine would likely fill naturally during wet periods, limiting its utility for providing additional stormwater storage in wet months. Furthermore, Lake Ralphine is not used for drinking water supply, meaning that a new water treatment plant would need to be constructed in order to use Lake Ralphine for drinking water supply. Given that enlarging Lake Ralphine would not provide a large water storage benefit and would have substantial financial and social costs (requiring a new treatment plant, impacting City recreational facilities), this supply option did not advance to undergo cost estimation.

SW-3: Regional Stormwater

Supply option SW-3 proposes developing a regional stormwater project in collaboration with one or more agencies in the region. There are several regional stormwater programs underway that could be bolstered with City partnership and/or used to generate new ideas for a regional project. One such example is a project being explored by North Marin Water District which involves diverting stormwater into Stafford Lake. More information about regional efforts is included in the following plans:

Marin Municipal Water District

- Water Resiliency projects: https://www.marinwater.org/WaterSupplyResiliency

North Marin Water District

- Local Water Supply Enhancement Study https://nmwd.com/save-water/new-water-supplies/

Petaluma

- Integrated Water Master Plan https://cityofpetaluma.org/iwmp/

Sonoma Water

- Drought Resiliency Project https://www.sonomawater.org/DroughtResiliency
- Regional Water Supply Resiliency Study
    - Presentation slides, May 1, 2023
      https://www.sonomawater.org/media/PDF/About/WAC/2023_05/Item%207%20-%202023%20Resiliency%20Update.pdf
    - Presentation slides, May 2, 2023
      https://www.sonomawater.org/media/PDF/About/WAC/2022_05/7.1.%20SonomaWater_ResiliencyStudy%20WAC%20Update_2022_0502.pdf
    - Report: Accelerated 2021-2022 Drought Resiliency Analysis, April 27, 2022
      https://www.sonomawater.org/media/PDF/About/WAC/2022_05/7.2.%20Sonoma%20Water%20Resiliency%20Study%20-%20Drought%20Analysis%20TM%20FINAL%20DRAFT.pdf
    - Presentation slides, Drought Options Update, Feb 7, 2023
      https://www.sonomawater.org/media/PDF/About/WAC/2022_02/12.%20SonomaWater_ResiliencyStudy_WAC_Update_2022_0207_REDUCED.pdf
    - Presentation slides, Nov 1, 2021
      https://www.sonomawater.org/media/PDF/About/WAC/2021_11/Presentation-%20Sonoma%20Water%20Resiliency%20Study.pdf
    - Memo, July 29, 2021
      https://www.sonomawater.org/media/PDF/About/WAC/2021_08/9.%20SRP%20Drought%20Resiliency%20Project%20WACTAC%20memo.pdf

San Francisco Estuary Institute

- Laguna de Santa Rosa restoration master plan

Implementation of this supply option would require identification of feasible detention storage and recharge locations, regional coordination and agreements, and possible need for additional water rights. Because many project elements and implementation considerations for regional stormwater would be similar to the local stormwater option above (SW-1 and SW-2), and because the City would effectively be participating in possible future regional stormwater projects implemented by Sonoma Water, this option did not undergo any further separate technical analysis.

3.1.6 Efficiency Programs

E-1: Efficiency Programs

Efficiency measures would not provide a new source of drinking water supply to mitigate the impacts of drought and emergencies, but these programs would reduce demand over time as efficiency measures penetrate the City's customer base. The efficiency program would include a suite of efficiency measures, which are evaluated as a single program, which would be implemented City-wide. These measures are:

- Commercial, industrial, institutional (CII) turf removals,
- Single-family residential (SFR) turf removals,
- Toilet direct installs, and
- Fixture direct installs (kitchen aerators, bathroom aerators, and showerheads).

Along with these aggressive efficiency measures, the City's existing efficiency programs would continue, such as indoor water use efficiency surveys, landscape water use efficiency surveys, and rebates for high-efficiency washing machines, graywater use, and other practices (City of Santa Rosa, 2021). The water savings that can be achieved by the efficiency measures would be limited by factors such as: the number of inefficient toilets and fixtures remaining that could be replaced, the area of turfgrass present, and the extent to which the retrofits/relandscaping could penetrate the market (i.e., number of customers willing/able to participate). For the purposes of this study, program budget was not considered to be a limitation.

The City provided information regarding the estimated costs and water savings that could be achieved via the efficiency program (City of Santa Rosa, 2022) if 100 percent participation were achieved. Full participation voluntarily is unlikely, though the City Code could be updated to mandate changes which may achieve near full participation. In total, up to 5,700 AFY of water savings could be achieved over about the next 40 years with full participation. Descriptions of each efficiency measure, including key assumptions, are summarized below:

- **CII turf removals:** CII turf removals would remove approximately 16.3 million square feet of turf over about 41 years. A replacement rate of 400,000 square feet per year is assumed (based on 100 sites participating per year, removing an average of 4,000 square feet each). The rebate offered would be $1.50 per square foot of turf removed. Water savings would be about 31 gallons per square foot per year, and the assumed life expectancy of the water savings is 15 years (although this may be higher since customers rarely relandscape back to turf). This measure would yield a lifetime savings of up to 23,000 AF.

- **SFR turf removals:** SFR turf removals would remove approximately 42.7 million square feet of turf over about 43 years. A replacement rate of 1 million square feet per year is assumed (1,200 homes participating per year, removing an average of 833 square feet each). The rebate offered would be $1.50 per square foot of turf removed. Water savings would be about 11 gallons per square foot per year and the assumed life expectancy of the water savings is 15 years (although this may be higher since customers rarely relandscape back to turf). This measure would yield a lifetime savings of up to 22,000 AF.

- **Toilet direct installs:** The City would replace existing 1.6 gallons per flush (gpf) or greater toilets customers with 0.8 gpf toilets in Santa Rosa residences. It is assumed that 45,600 toilets could be replaced over 15 years, at a rate of approximately 3,000 toilets per year. The life expectancy of the toilet is assumed to be 15 years. In total, toilet replacements would achieve a lifetime water savings of about 6,219 AF. It is assumed that future toilet replacements by residents would maintain the water savings as plumbing codes continue to require greater water efficiency.
- **Fixture direct installs:** The City would replace/install kitchen faucet aerators, bathroom faucet aerators, and 1.5 gpm showerheads. One set of fixtures would consist of one kitchen sink aerator, two-bathroom sink aerators, and two showerheads. It is assumed that 3,000 sets of fixtures could be installed per year over 15 years (about 45,600 households in total). In total, updated fixtures would achieve a lifetime water savings of about 16,000 AF. It is assumed that future fixture replacements by residents would maintain the water savings as plumbing codes continue to require greater water efficiency.

Efficiency program costs would include costs of turf rebates, toilets, and fixtures, labor costs to install toilets and fixtures, and City staff time to implement the program (including outreach to expand the reach of the program). The total lifetime program cost is approximately $169 million, with a lifetime water savings of up to 67,000 AF. At the completion of the program, water savings per year would be up to 5,700 AF. However, given the large levels of uncertainty, an annual savings of 2,145 AFY was assumed, based on estimates of anticipated voluntary participation provided by the City.

Additional detail on data sources and assumptions can be found in Appendix A.

3.2 Screening Analysis Results

All potential water supply options were screened using two key criteria: high-level assessments of cost-effectiveness and scalability. Supply options that performed well in the screening analysis were moved forward to undergo more detailed feasibility analysis and to be scored against each criterion identified in the Study Parameters (Section 2.4).

Table 3-25 summarizes the results of the screening analysis. A total of seven water supply options have been selected to move forward for more detailed feasibility analysis.

Table 3-25: Screening Analysis Results Summary

Category	Supply Option	Moving Forward?	Reasoning for Screening Out
Groundwater	GW-1: Add local groundwater extraction wells	Yes	N/A
	GW-2: Convert emergency wells to production wells	Yes	N/A
	GW-3: Add local ASR wells	Yes	N/A
	GW-4: Regional groundwater extraction wells	No	Regional groundwater extraction is unlikely to be accepted without including a recharge element, which would result in a project similar to the local and regional ASR options. Thus, this option is not carried forward on its own.
	GW-5: Regional ASR wells	No	Because many project elements and implementation considerations for Regional ASR would be similar to the local ASR option above, this option would not undergo separate technical analysis.
Purified Recycled Water	PR-1: DPR AWPF at LTP	No	Not cost-effective based on City's current needs.
	PR-2: Satellite DPR AWPF	Yes	Note: Although the option may be less cost-effective than others carried forward, the City desires to further advance a purified recycled water option in order to provide a broader suite of options and greater diversity to potential supplies.
	PR3a: IPR AWPF at LTP via Delta Pond	No	Not cost-effective based on City's current needs.
	PR-3b: IPR AWPF at LTP via Lake Ralphine	No	Not cost-effective based on City's current needs.
	PR-3c: IPR AWPF at LTP via Lake Sonoma	No	Not cost-effective based on City's current needs.
	PR-4: Regional DPR AWPF at LTP	Yes	Note: A regional purified recycled water project appears most promising in terms of cost-effectiveness. Changing technology, supply needs, and partnerships could make this option worth future consideration.

Category	Supply Option	Moving Forward?	Reasoning for Screening Out
Non-potable Recycled Water	RW-1: Expand City's existing non-potable recycled water system	No	Not cost-effective based on City's current needs and does not address potable water needs in supply-limited circumstances like drought and catastrophic supply interruptions.
Desalination	DE-1: Regional brackish desalination	No	Not cost-effective based on City's current needs and does not reduce reliance on Somona Water (in the event of a catastrophic supply interruption) because of the water transfer involved in this supply option. Implementation is contingent upon the substantial involvement of partners, including Sonoma Water. More information on desalination as a supply and triggers for its reconsideration is included in Appendix C.
	DE-2: Ocean desalination	No	Not cost-effective based on City's current needs. The required pipeline from the ocean to Santa Rosa's service area contributes significantly to the cost. More information on desalination as a supply and triggers for its reconsideration is included in Appendix C.
Stormwater	SW-1: Capture stormwater and store in aquifer for later potable use	Yes	N/A
	SW-2: Store in enlarged Lake Ralphine (or alternate) and construct water treatment plant for later potable use	No	The space needed to expand Lake Ralphine to increase the cost-effectiveness of this option is not available and constructing new surface water storage is not cost-effective at this time. Additional work should be completed to confirm the yield available for this option before committing to the costs of an additional facility required to treat the stormwater prior to use.
	SW-3: Regional stormwater	No	Because many project elements and implementation considerations for Regional stormwater would be similar to the local stormwater options above and are being carried forward through other technical teams as present, this option would not undergo separate technical analysis. This does not prohibit the City from continuing to participate in existing regional stormwater efforts nor does preclude future partnerships on new regional stormwater efforts.
Efficiency Programs	E-1: Add aggressive incentives for efficiency programs to reduce demand (in addition to existing programs)	Yes	N/A

3.3 Feasibility Analysis Results

Upon completion of the screening analysis, the feasibility analysis was completed, which included evaluating and scoring the short-listed water supply options. A numerical system was used for rating (scoring) each short-listed option against each criterion and against each other. The numerical system provides a score of 0 through 2, with 2 being most favorable. The score is based on knowledge of the project area, engineering judgment, and experience on past projects. The evaluation criteria scoring rubric used for the evaluation of the short-listed supplemental supply options is summarized in **Table 2-5**, a summary of the shortlist supply scores is shown in **Table 3-26**. Detailed scoring descriptions are found in the following subsections.

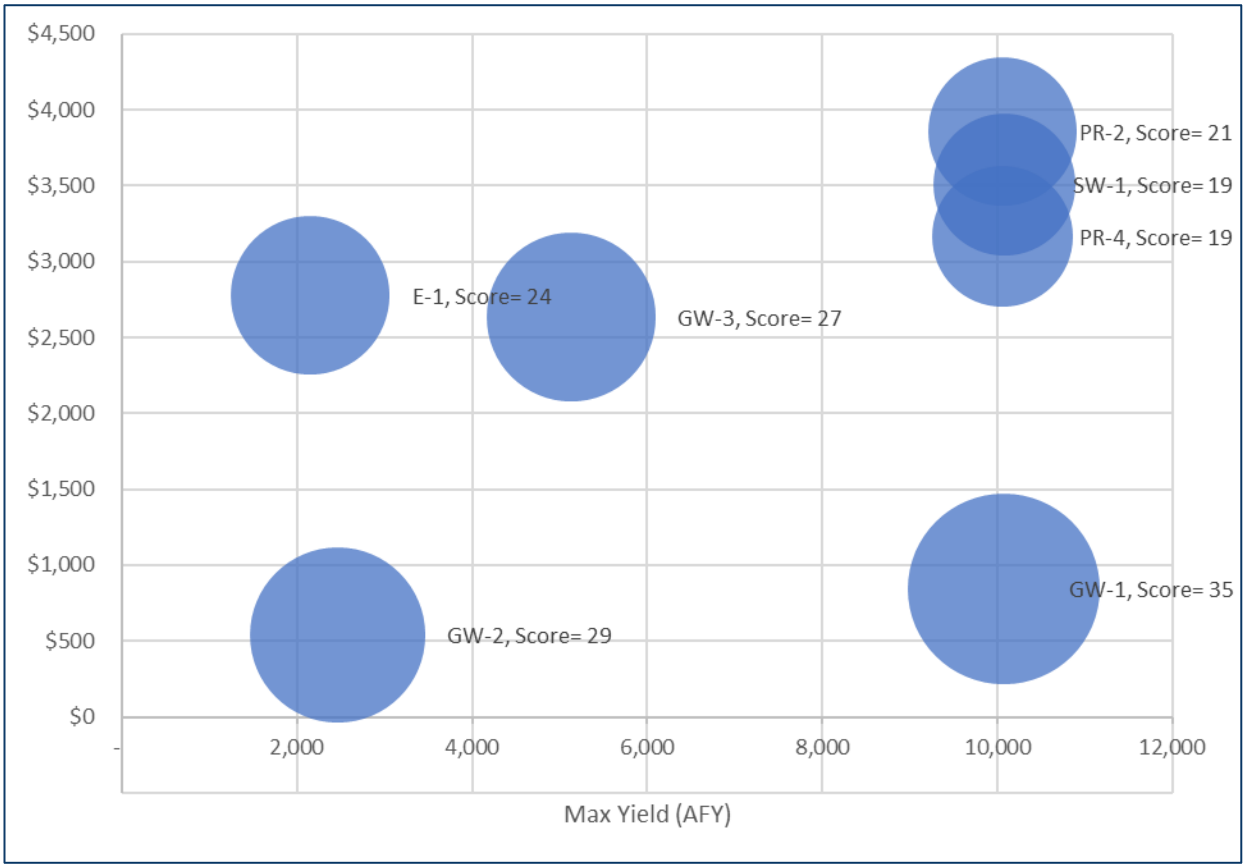
Table 3-26: Summary of Supply Option Scores

Criterion	Groundwater			Purified Recycled Water		Stormwater	E-1: Efficiency Programs
	GW-1: Add Extraction Wells	GW-2: Convert Emergency Wells	GW-3: City ASR Wells	PR-2: Satellite DPR	PR-4: Regional DPR	SW-1: Stormwater Storage in Aquifer	
Cost effectiveness * [$/AF]	2 [$840/AF]	2 [$540/AF]	2 [$1,100/AF]	0 [$3,900/AF]	0 [$3,200/AF]	0 [$3,500/AF]	1 [$2,800/AF]
Scalability [Yield in AFY]	2 [5,880 - 10,080 AFY]	0 [1,436 - 2,462 AFY]	1 [2,993 - 5,130 AFY]	2 [3,019 - 10,065 AFY]	2 [3,019 - 10,065 AFY]	1 [1,008 - 10,080 AFY]	1 [2,145 AFY]
Resiliency	1	1	2	2	2	1	1
Equity	1	1	1	1	1	1	2
Environmental performance	1	2	1	0	1	1	2
Legal, permitting, and regulatory	1	2	0	0	0	1	2
City control and interagency coordination	2	2	1	2	0	2	2
Multi-benefit	0	0	1	0	0	2	1
Total Unweighted	10	10	9	7	6	9	12
Total Weighted	32	26	29	21	22	19	30

* Costs shown reflect a realistic baseline usage scenario and include both capital and operating costs.

Figure 3-15 shows cost-effectiveness under baseline operations along with maximum yield and incorporates the weighted scores of each supply option in the bubble sizes (as summarized in **Table 3-26**).

Figure 3-15: Cost-Effectiveness vs Max Yield (with Weighted Score)



Notes: Water Supply options:

- E-1: Efficiency Programs
- GW-1: Construct Additional Groundwater Extraction Wells
- GW-2: Convert Emergency Wells to Production Wells
- GW-3: Construct Aquifer Storage and Recovery (ASR) Wells
- PR-2: Satellite Direct Potable Reuse (DPR) with Advanced Water Purification Facility (AWPF)
- PR-4: Regional DPR with AWPF at Laguna Treatment Plant
- SW-1: Stormwater Storage in Aquifer

3.3.1 Groundwater Options

The detailed scoring and rationale for the groundwater options are provided in **Table 3-27**, **Table 3-28** and **Table 3-29** on the following pages below.

Table 3-27: Detailed Scoring for Option GW-1

Criterion	Description	Score
Cost effectiveness	Under the baseline scenario, actual costs are estimated at $843/AF, making this option one of the least expensive studied, and less expensive than the current Sonoma Water supply which is $1,200/AF.	2
Scalability	As evaluated, this option includes construction of 12 wells to meet the City's supply goals. However, the City need not construct all 12 wells initially, and could potentially build fewer even in the long run if well yield is higher than estimated. Generally, this option could be scaled or phased to best fit City needs.	2
Resiliency	Moderate resiliency. Pumping costs would increase with rising power costs. Cost-effectiveness could decrease under certain hydrologic conditions, but groundwater availability may not be severely impacted unless there is a long-term change in hydrology.	1
Equity	The additional groundwater supply would have no impact on vulnerable communities. The additional groundwater supply would be available to the City to offset purchased water from Sonoma Water.	1
Environmental performance	The new extraction wells would be located in the City within the City's Greenway Area. Construction of 12 wells would have moderate potential for environmental impacts.	1
Legal, permitting, and regulatory	Well construction would likely require some permitting and regulatory compliance but would not require unusual efforts.	1
City control and interagency coordination	While coordination with Sonoma Water and the other GSAs in Santa Rosa Plain would be required, the scope and timing of the work would be generally at the City's discretion.	2
Multi-benefit	No other benefits provided.	0

Table 3-28: Detailed Scoring for Option GW-2

Criterion	Description	Score
Cost effectiveness	Based on conceptual analyses, the rehabilitation of the three existing emergency wells would provide up to 2,462 AFY of additional groundwater supply. The baseline scenario average cost of water is approximately $541/AF, the least expensive of all options studied.	2
Scalability	This option lends itself to phasing since well rehabilitation could occur one well at a time. However, the overall scale of the project would fall far short of the City's 7,500 AFY need.	0
Resiliency	Moderate resiliency. Pumping costs would increase with rising power costs. Cost-effectiveness could decrease under certain hydrologic conditions, but groundwater availability may not be severely impacted unless there is a long-term change in hydrology.	1
Equity	The additional groundwater supply would have no impact on vulnerable communities. The additional groundwater supply would be available to the City to offset purchased water from Sonoma Water.	1
Environmental performance	The rehabilitation of the existing wells would have minimal potential for environmental impacts.	2
Legal, permitting, and regulatory	The City has previously completed similar permitting/ regulatory efforts required for approval to convert from emergency use to active supply (i.e., 2005 Farmer's Lane well).	2
City control and interagency coordination	No interagency coordination would be required.	2
Multi-benefit	No other benefits provided.	0

Table 3-29: Detailed Scoring for Option GW-3

Criterion	Description	Score
Cost effectiveness	Based on conceptual level cost estimates, construction of six ASR wells would provide up to 5,130 AFY of additional groundwater supply. The baseline scenario average cost of water is approximately $2,632/AF which includes purchase of water ASR.	2
Scalability	The extraction wells included in this option could be constructed in phases to best fit City needs. At buildout, the option could provide most of the City's supplemental needs.	1
Resiliency	Moderate resiliency. Pumping and injection costs would increase with rising power costs. Cost-effectiveness could decrease under certain hydrologic conditions, but the ability to inject water into the aquifer would improve resiliency relative to extraction-only options.	2
Equity	The additional groundwater supply would have no impact on vulnerable communities. The additional groundwater supply would be available to the City to offset purchased water from Sonoma Water.	1
Environmental performance	The new ASR wells would be located in a less developed area within the City limits. Construction of six wells would have moderate potential for environmental impacts.	1
Legal, permitting, and regulatory	While ASR projects are increasingly common, they pose more significant permitting and regulatory requirements.	0
City control and interagency coordination	Coordination would be required with GSAs in Santa Rosa Plain and with Sonoma Water to coordinate with other ASR programs underway.	1
Multi-benefit	This option would enable conjunctive management of surface water and groundwater, which allows for greater flexibility in optimizing surface water and groundwater use (which represents an additional benefit beyond strict water supply).	1

3.3.2 Purified Recycled Water Options

The detailed scoring and rationale for the purified recycled water options are listed in **Table 3-30** and **Table 3-31.**

Table 3-30: Detailed Scoring for Option PR-2

Criterion	Description	Score
Cost effectiveness	Under the baseline scenario the average cost of water is approximately $3,854/AF, making it the most expensive option. Additionally, the option involves a financial upfront commitment for capital so even if future circumstances changed the obligation to pay for the project would continue unabated.	0
Scalability	The AWPF included in this option could be constructed in phases to best fit City needs. The AWPF could be scaled down 30% in low demand periods.	2
Resiliency	High resiliency. The ability to purify tertiary treated water into potable supply would improve resiliency, even in times of drought or future hydrologic uncertainty.	2
Equity	The additional purified water supply would have no impact on the City's vulnerable communities as it will meet or exceed drinking water standards.	1
Environmental performance	The satellite DPR AWPF would be located in a less developed area within the City limits. Construction of the AWPF and extensive conveyance facilities may have moderate to high potential for environmental impacts.	0
Legal, permitting, and regulatory	High permitting/regulatory effort would be required as discussed in **Section 3.1.2.1.2.** The main challenges in pursuing DPR include the lack of regulatory certainty and the lack of permitting precedents.	0
City control and interagency coordination	No significant interagency coordination would be required.	2
Multi-benefit	This option would provide a potable supply benefit but would reduce tertiary water availability for the Geysers and for the non-potable customers.	0

Table 3-31: Detailed Scoring for Option PR-4

Criterion	Description	Score
Cost effectiveness	Under the baseline scenario the average cost of water is approximately $3,166/AF, making it among the most expensive options. Additionally, the option involves a financial upfront commitment for capital so even if future circumstances changed the obligation to pay for the project would continue unabated.	0
Scalability	The AWPF included in this option could be constructed in phases to best fit City needs. The AWPF could be scaled down 30% in low demand periods.	2
Resiliency	High resiliency. The ability to purify tertiary treated water into potable supply would improve resiliency, even in times of drought or future hydrologic uncertainty.	2
Equity	The additional purified water supply would have no impact on the City's vulnerable communities.	1
Environmental performance	The DPR AWPF would be located on the City-owned LTP property. Construction of the AWPF and purified water conveyance facilities would have low to moderate potential for environmental impacts.	1
Legal, permitting, and regulatory	High permitting/regulatory effort would be required as discussed in **Section 3.1.2.1.2.** The main challenges in pursuing DPR include the lack of regulatory certainty and the lack of permitting precedents.	0
City control and interagency coordination	Coordination with a regional partner for the paper exchange would be required in addition to continuing coordination with Sonoma Water if its aqueduct were used for distribution.	0
Multi-benefit	This option would provide a potable supply benefit but would reduce tertiary water availability for the Geysers and for the non-potable customers.	0

3.3.3 Stormwater Capture

The detailed scoring and rationale for SW-1 is listed in **Table 3-32**.

Table 3-32: Detailed Scoring for Option SW-1

Criterion	Description	Score
Cost Effectiveness	The baseline scenario average cost of water is approximately $3,500/AF, making it among the most expensive options.	0
Scalability	While the diversion structure, spreading basins (or injection wells) and extraction wells included in this option could be constructed in phases, the treatment plant, if needed, would require significant cost up-front that could not be recovered even if changes in future conditions reduced the need for the project.	1
Resiliency	Moderate resiliency. While the ability to store water in the aquifer would improve resiliency, there are significant uncertainties in the project's performance, specifically its yield in drought years.	1
Equity	The additional groundwater supply would have no impact on vulnerable communities. The recharge areas for the project may tend to focus construction impacts on less-developed, less affluent areas, which could reduce flooding in those areas.	1
Environmental performance	The new diversion structure, spreading basins and extraction wells would be located in a less developed area within the City limits. Construction of the twelve wells would have moderate potential for environmental impacts.	1
Legal, permitting, and regulatory	Some permitting/regulatory effort would be required, but stormwater diversion projects are increasingly common and would not require outsize legal, permitting, or regulatory effort to implement.	1
City control and interagency coordination	No interagency coordination would be required.	2
Multi-benefit	This option would enable conjunctive management of surface water and groundwater, which allows for greater flexibility in optimizing surface water and groundwater use (which represents an additional benefit beyond strict water supply).	2

3.3.4 Efficiency Programs

The detailed scoring and rationale for the Efficiency Programs option is provided in **Table 3-33**.

Table 3-33: Detailed Scoring for Option E-1

Criterion	Description	Score
Cost effectiveness	As summarized above, based on cost estimates provided by the City, efficiency program would provide water savings at a cost of approximately $2,780/AF under the Baseline Scenario. This makes it less expensive than the options involving major costs for water treatment (e.g., PR-2, PR-4, SW-1) but more expensive than the groundwater options.	1
Scalability	Water savings could be increased depending on the scale of the program and number of customers that could be reached. Once water savings are achieved, they are considered to be relatively secure because they are built into the landscapes/fixtures, which have typically become more efficient with time due to plumbing codes and price signals.	1
Resiliency	Performance of efficiency measures would not degrade with changes in future regulations, energy costs or hydrology. However, the option does not provide "new water" that would help mitigate catastrophic loss of the Sonoma Water supply.	1
Equity	Direct installation programs reduce barriers to participation by low-income residents and organizations and agencies managing low-income and subsidized housing that have not been able to participate in rebate programs in the past due to upfront costs.	2
Environmental performance	The program would have little to no adverse environmental impact and would provide a potential environmental benefit by reducing water consumption.	2
Legal, permitting, and regulatory	Large-scale construction would not be needed. Physical changes as a result of the project would include toilet and fixture replacements, and relandscaping in existing developed areas. Work would need to be completed by qualified contractors, but additional permitting and regulatory requirements would not be anticipated for this option.	2
City control and interagency coordination	No interagency coordination would be required.	2
Multi-benefit	In addition to providing water savings, the program would provide a cost savings to customers by helping them to reduce their water use.	1

3.3.5 Cost Sensitivity Analysis

The screening tool allows the supply option costs to be estimated under a variety of scenarios. The baseline scenario was modified to assess supply option performance under multiple hydrologic scenarios (**Figure 3-16**), and multiple Sonoma Water dry-year reduction levels (**Figure 3-17**). In that figure, scenarios SW-35 and SW-40 represent dry-year reductions of 35 percent and 40 percent respectively, versus a base scenario of 30 percent.

In general, most supply options would be more cost-effective in a drier hydrologic scenario because more water would be produced to meet normal demand during Sonoma Water water shortages. The wetter hydrologic scenario contains more wet years than the baseline, but also contains more dry years (as summarized in **Table 3-34**). Therefore, for some options, the wetter scenario is also more cost-effective than the baseline scenario. All supply options become more cost-effective if greater dry-year Sonoma Water reductions are assumed.

Figure 3-16: Supply Option Cost Performance with Varying Hydrology ($/AF)

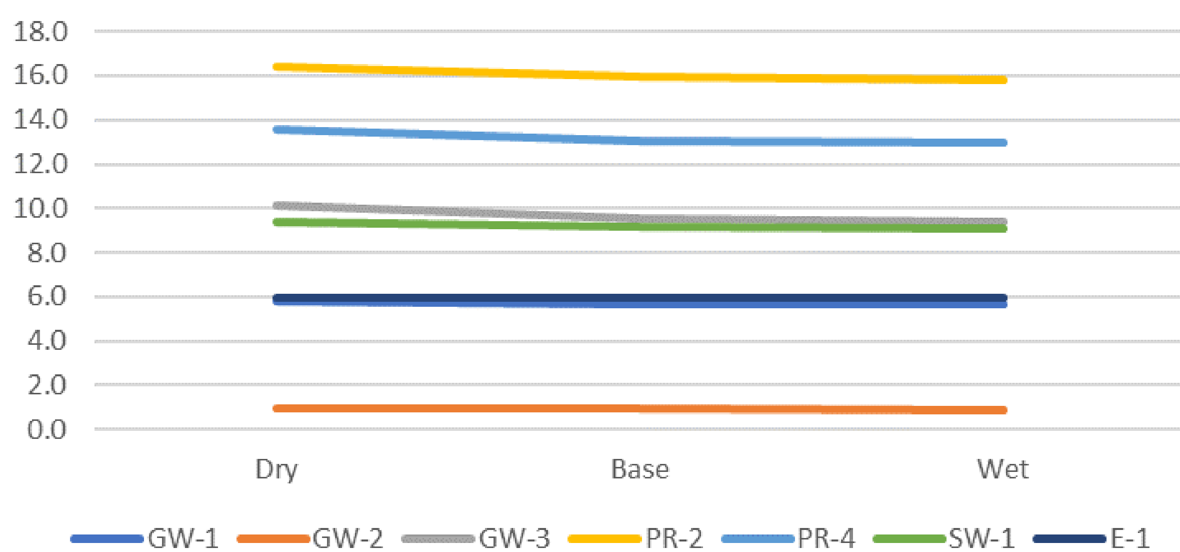
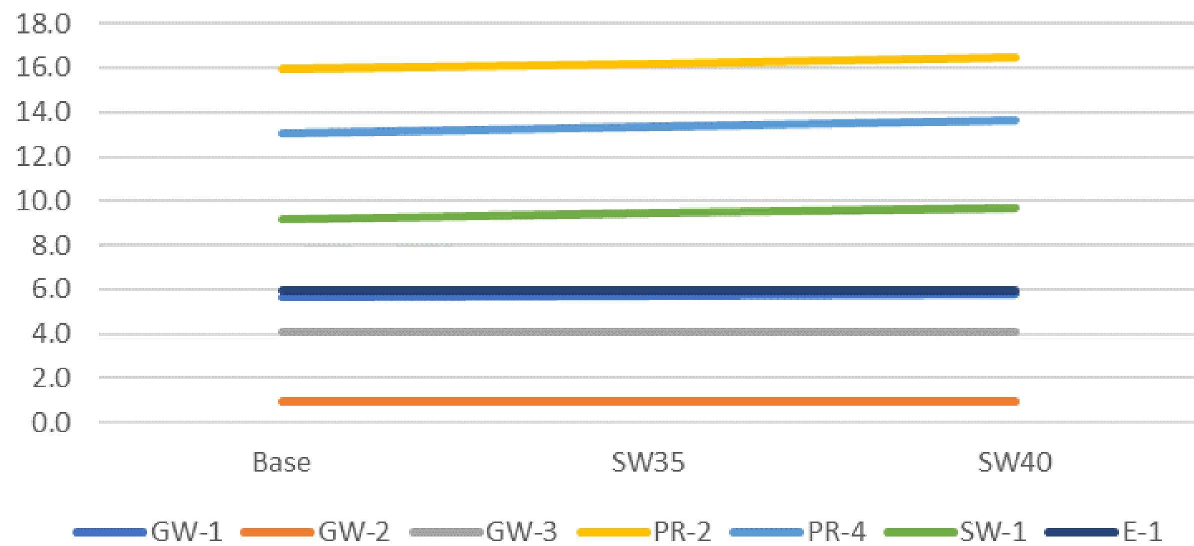


Table 3-34: Distribution of Water Year Types in Hydrologic Scenarios

Hydrologic Scenario	Year Types by Percent		
	Wet	**Normal**	**Dry**
Wet	37%	29%	34%
Historic	33%	37%	30%
Dry	23%	30%	47%

Figure 3-17: Supply Option Cost Performance with Varying Sonoma Water Cutbacks ($M/yr)



SW35: Scenario in which dry-year Sonoma Water supply reduction is 35% of baseline usage rather than the Base assumption of 30% reduction.

SW40: Scenario in which dry-year Sonoma Water supply reduction is 40% of baseline usage.

Although this analysis focused on hydrologic scenarios and Sonoma Water cutbacks, reflecting the City's goals of addressing climate change and Sonoma Water reliance, future work could use other variables to test cost-sensitivity (such as price of power, interest rate, and demand reduction percent).

4. CONCLUSIONS

This Feasibility Analysis reveals several key considerations for the City to account for as the Water Supply Plan moves forward:

- **Future conditions:** Depending on the City's assumptions about future hydrology, Sonoma Water supply reductions, cost of Sonoma Water supplies, and customer demand/conservation, the City may reach different conclusions about the potential best fit water supplies. For example, if the City assumes more optimistic future conditions, the amount of new water needed may be relatively modest, in which case the City would be well served by bridging that gap with a small number of new wells, which could be added one by one as the need arises. On the other hand, if the City assumes more pessimistic future conditions in which existing water supplies decrease, a broader range of options could be considered, including options such as potable reuse that would be run continuously once implemented. Options that could be implemented in phases (e.g., rehabilitating one well at a time, rather than 3 at once) may help provide resiliency against that type of uncertainty while minimizing capital outlay.

- **Operational assumptions:** This analysis has incorporated reasonable operational assumptions into the baseline scenario. The cost per AF of water is sensitive to those assumptions. Generally, the cost per AF for a supplemental supply will be reduced as that supply is used more. However, many of the options cost more than the existing Sonoma Water supply.

- **Sensitivity:** This analysis considered the impact of changing hydrology and reduced Sonoma Water dry-year allocations under the baseline scenario. The supply options generally become more cost-effective under more pessimistic scenarios (drier hydrology and higher Sonoma Water cutbacks) because more water is produced via the new options. However, the analysis indicates that the relative rankings of the supply options do not vary substantially with changes to the baseline condition.

The next step of the WSAP will involve a portfolio analysis, which will further assess the water supply options that passed the screening analysis. The portfolio analysis will consider downscaled versions of some supply options and will consider potential groupings of supply options that would allow the City to optimize different areas such as resiliency, supply volume, and cost.

5. REFERENCES

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APPENDIX A: COST DETAILS

Santa Rosa Water Supply Options

July 2023

Option GW-1a: Groundwater Extraction Wells

Basis of estimate:

Construct additional production wells and wellhead treatment if necessary and tie into the existing distribution system. The no. of wells to meet the demand would be 9 wells for the drought demand of 7,500 AFY and 12 wells for the peak demand of 9 MGD (or 10,000 AFY), based on the well capacity of 500 gpm. The costs were built upon existing City O&M data and well rehab of Leete Well.

	Size	Units	Qty	Unit	Unit Cost	Subtotal
Additional Wells						
New Well Construction	500	gpm	12	per well	$3,500,000	42,000,000
Product Water Distribution						
Product Water Line	20	in	3,000	per inch-dia LF	$37	2,225,000
Product Water Pump Station			240	HP	$6,500	1,560,000
Potable Connection			1	LS	$100,000	100,000
Raw Construction Cost						**45,890,000**
Construction Contingency				50%		22,950,000
Total Construction Cost						**68,840,000**
Implementation Cost				40%		27,540,000
Total Capital Cost						**96,380,000**

Annual Operations & Maintenance Cost (9 mgd production)						**Annual O&M**
Variable O&M	**AFY**	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Product Water Pump Station		6,000	118	1,405,080	$0.20	281,016
Extraction Wells	10,080				$54	547,865
Extraction Well Energy Use	10,080				$182	1,834,401
Fixed O&M			**Construction Cost**		**Unit Cost**	
Extraction Wells					$443,119	443,119
Pump Stations			1,560,000		3.0%	46,800
Pipelines			2,225,000		0.5%	11,125
Total Annual Operations & Maintenance Cost						**3,164,326**
Annualized Capital Cost					0.03526	3,398,000
Total Annualized Cost						**6,562,326**
					Max Project Yield (AFY)	**10,080**
					MAX $/AF	**651**

Annual Operations & Maintenance Cost (0 mgd production)						**Annual O&M**
Variable O&M	**AFY**	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Product Water Pump Station		0	118	0	$0.20	-
Extraction Wells	0				$54	-
Extraction Well Energy Use	0				$182	-
Fixed O&M	**Qty**	**Unit**	**Construction Cost**		**Unit Cost**	
Extraction Wells					$443,119	443,119
Pump Stations			1,560,000		3.0%	46,800
Pipelines			2,225,000		0.5%	11,125
Total Annual Operations & Maintenance Cost						**501,044**
Annualized Capital Cost					0.03526	3,398,000
Total Annualized Cost						**3,899,044**
					Min Project Yield (AFY)	**5,880**
					MIN $/AF	**663**

Santa Rosa Water Supply Options

July 2023

Option GW-2: Convert existing emergency wells into groundwater extraction wells

Basis of estimate:

Assumes 3 existing emergency wells rehabilitated to become prdocution wells for the City. Assumes the costs to rehabilitate the Leete well. Historic yield for the 3 wells is 2,462 AFY.

	Size	Units	Qty	Unit	Unit Cost	Subtotal
Well Rehabilitation						
Well Construction			3	per well	$1,440,000	4,320,000
Product Water Distribution						
Product Water Line		in		per inch-dia LF	$37	-
Product Water Pump Station				HP	$6,500	-
Potable Connection				LS	$100,000	-
Iron and Manganese Treatment			2	per well	$600,000	1,200,000
Raw Construction Cost						**5,520,000**
Construction Contingency				50%		2,760,000
Total Construction Cost						**8,280,000**
Implementation Cost				40%		3,310,000
Total Capital Cost						**11,590,000**

Annual Operations & Maintenance Cost (2.19 mgd production)						**Annual O&M**
Variable O&M	**AFY**	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
				0	$0.20	-
Extraction Wells	2,462				$54	133,814
Extraction Well Energy Use	2,462				$182	448,045
Fixed O&M			**Construction Cost**		**Unit Cost**	
Wells					$110,780	110,780
Pump Stations			-		3.0%	-
Pipelines			-		0.5%	-
Treatment			1,200,000		1.0%	12,000
Total Annual Operations & Maintenance Cost						**704,639**
Annualized Capital Cost					0.03526	409,000
Total Annualized Cost						**1,113,639**
					Max Project Yield (AFY)	**2,462**
					MAX $/AF	**452**

Annual Operations & Maintenance Cost (0 mgd production)						**Annual O&M**
Variable O&M	**AFY**	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Product Water Pump Station		0	118	0	$0.20	-
Extraction Wells	0				$54	-
Extraction Well Energy Use	0				$182	-
Fixed O&M	**Qty**	**Unit**	**Construction Cost**		**Unit Cost**	
Extraction Wells					$110,780	110,780
Pump Stations			-		3.0%	-
Pipelines			-		0.5%	-
Total Annual Operations & Maintenance Cost						**110,780**
Annualized Capital Cost					0.03526	409,000
Total Annualized Cost						**519,780**
					Min Project Yield (AFY)	**1,436**
					MIN $/AF	**362**

Santa Rosa Water Supply Options

July 2023

Option GW-3: ASR Wells

Basis of estimate:

Constructs six ASR wells in Delta Pond area and wellhead treatment if necessary and tie into the existing distribution system. The costs were built upon existing City O&M data and well rehab of Leete Well.

	Size	Units	Qty	Unit	Unit Cost	Subtotal
ASR						
New Well Construction			6	per well	$5,000,000	30,000,000
Product Water Distribution						
Product Water Line	16	in	12,000	per inch-dia LF	$37	7,120,000
Product Water Pump Station			210	HP	$6,500	1,365,000
Potable Connection			1	LS	$100,000	100,000
Raw Construction Cost						**38,590,000**
Construction Contingency				50%		19,300,000
Total Construction Cost						**57,890,000**
Implementation Cost				40%		23,160,000
Total Capital Cost						**81,050,000**

Annual Operations & Maintenance Cost (4.6 mgd production)						**Annual O&M**
Variable O&M	**AFY**	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Product Water Pump Station		3,180	118	744,660	$0.20	148,932
ASR Well	5,130				$65	334,589
ASR Well Energy Use	5,130				$218	1,120,295
Fixed O&M	**Qty**	**Unit**	**Construction Cost**		**Unit Cost**	
Pump Stations			1,365,000		3.0%	40,950
Pipelines			7,120,000		0.5%	35,600
ASR Well					$44,312	44,312
Total Annual Operations & Maintenance Cost						**1,724,678**
Annualized Capital Cost					0.03526	2,858,000
Total Annualized Cost						**4,582,678**
					Max Project Yield (AFY)	**5,130**
					MAX $/AF	**893**

Annual Operations & Maintenance Cost (0 mgd production)						**Annual O&M**
Variable O&M	**AFY**	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Product Water Pump Station		0	118	0	$0.20	-
ASR Well	5,130				$65	334,589
ASR Well Energy Use	5,130				$218	1,120,295
Fixed O&M	**Qty**	**Unit**	**Construction Cost**		**Unit Cost**	
Pump Stations			1,365,000		3.0%	40,950
Pipelines			7,120,000		0.5%	35,600
ASR Well					$44,312	44,312
Total Annual Operations & Maintenance Cost						**1,575,746**
Annualized Capital Cost					0.03526	2,858,000
Total Annualized Cost						**4,433,746**
					Min Project Yield (AFY)	**2,993**
					MIN $/AF	**1,482**

Santa Rosa Water Supply Options

July 2023

Option PR-1: DPR at LTP

Basis of estimate:

Option PR-1 would convey the City's tertiary effluent to an AWPF located at the LTP and return AWPF waste stream to the LTP headworks. The AWPF would include treatment processes in compliance with future anticipated regulations for treated water augmentation. The purified water would be conveyed to SCWA's 48-inch diameter aqueduct for distribution to the City's potable water system. PR-1 is limited by the reliable volume of tertiary effluent available, assuming the City would be reducing flow to the Geysers by prioritizing recycled water to its existing irrigation customers and the AWPF. For this level of study it was assumed the City would size the AWPF to meet its 9 MGD peak month supply needs and provide any remaining tertiary water to its existing irrigation customers and then to the Geysers.

	Size	Units	Qty	Unit	Unit Cost	Subtotal
Equalization			1,820,000	per gallon	$1.25	2,275,000
Tertiary to AWTF						
Tertiary Water Line to AWPF	24	in	500	per inch-dia LF	$37	445,000
Tertiary Pump Station				HP	$6,500	-
AWTF - DPR						
Ozone	11.4	MGD			$530,000	6,025,000
BAF	11.4	MGD			$480,000	5,457,000
MF/UF	10.6	MGD			$1,940,000	20,510,000
Interprocess Tank			220,000	per gallon	$1.25	275,000
RO	9.0	MGD			$2,340,000	21,028,000
Chemicals (Storage and Feed Systems)	9.0	MGD			$200,000	1,797,000
Sitework/Piping/Structures	9.0	MGD			$5,050,000	45,381,000
Waste Disposal to Headworks at LTP	10	in	500	per inch-dia LF	$37	185,400
Brine Disposal						
Zero Liquid Discharge			9.0	per MGD	$1,194,000	10,730,000
Product Water Distribution						
Product Water Line	20	in	26,330	per inch-dia LF	$37	19,528,100
Product Water Pump Station			625	HP	$6,500	4,062,500
Potable Connection			1	LS	$100,000	100,000
Raw Construction Cost						**137,800,000**
Construction Contingency				50%		68,900,000
Total Construction Cost						**206,700,000**
Implementation Cost				40%		82,680,000
Total Capital Cost						**289,380,000**

Annual Operations & Maintenance Cost (9 mgd production)						**Annual O&M**
Variable O&M	**QTY**	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Tertiary Pump Station						
Product Water Pump Station		6,241	297	3,669,660	$0.20	733,932
FAT System				7,157,231	$0.20	1,431,446
Ozone/ BAF System				2,004,332	$0.20	400,866
Evaporator				27,178,376	$0.20	5,435,675
Crystallizer				4,982,702	$0.20	996,540
FAT System - Chemicals	1				$326,250	326,250
Ozone/ BAF System - Chemicals	1				$2,250	2,250
Fixed O&M			**Construction Cost**		**Unit Cost**	
Treatment			63,750,000		1.0%	637,500
Storage			2,550,000		0.5%	12,750
Pump Stations			4,062,500		3.0%	121,875
Pipelines			20,158,500		0.5%	100,793
Total Annual Operations & Maintenance Cost						**10,199,878**
Annualized Capital Cost					0.03526	10,203,000
Total Annualized Cost						**20,402,878**
					Max Project Yield (AFY)	**10,065**
					MAX $/AF	**2,027**

Annual Operations & Maintenance Cost (2.7 mgd production)						**Annual O&M**
Variable O&M	**QTY**	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Tertiary Pump Station						-
Product Water Pump Station		1,872	297	1,100,880	$0.20	220,176
FAT System				2,147,169	$0.20	429,434
Ozone/ BAF System				601,300	$0.20	120,260
Evaporator				8,153,513	$0.20	1,630,703
Crystallizer				1,494,811	$0.20	298,962
FAT System - Chemicals	1				$97,875	97,875
Ozone/ BAF System - Chemicals	1				$675	675
Fixed O&M			**Construction Cost**		**Unit Cost**	
Treatment			63,750,000		1.0%	637,500
Storage			2,550,000		0.5%	12,750
Pump Stations			4,062,500		3.0%	121,875
Pipelines			20,158,500		0.5%	100,793
Total Annual Operations & Maintenance Cost						**3,671,002**
Annualized Capital Cost					0.03526	10,203,000
Total Annualized Cost						**13,874,002**
					Min Project Yield (AFY)	**3,019**
					MIN $/AF	**4,595**

Santa Rosa Water Supply Options

July 2023

Option PR-2: Satellite DPR

Basis of estimate:

Option PR-2 would convey the City's tertiary effluent to a satellite AWPF and return AWPF waste stream to the nearest sewer. The AWPF would include treatment processes in compliance with future anticipated regulations for treated water augmentation. The purified water would be conveyed to SCWA's 48-inch diameter aqueduct for distribution to the City's potable water system. The satellite AWPF is assumed to be located on City-owned agricultural leased land, Stone Farm for its proximity to the 48-inch aqueduct. For this level of study it was assumed the City would size the AWPF to meet its 9 MGD peak month supply needs and provide any remaining tertiary water to its existing irrigation customers and then to the Geysers.

	Size	Units	Qty	Unit	Unit Cost	Subtotal
Equalization			1,820,000	per gallon	$1.25	2,275,000
Tertiary to Satellite AWTF						
Tertiary Water Line to DPR	24	in	30,100	per inch-dia LF	$37	26,789,000
Tertiary Pump Station			510	HP	$6,500	3,315,000
AWTF - DPR						
Ozone	11.4	MGD			$530,000	6,025,000
BAF	11.4	MGD			$480,000	5,457,000
MF/UF	10.6	MGD			$1,940,000	20,510,000
Interprocess Tank			220,000	per gallon	$1.25	275,000
RO	9.0	MGD			$2,340,000	21,028,000
Chemicals (Storage and Feed Systems)	9.0	MGD			$200,000	1,797,000
Sitework/Piping/Structures	9.0	MGD			$5,050,000	45,381,000
Waste Disposal to Sewer	10	in	7,330	per inch-dia LF	$37	2,718,200
Brine Disposal						
Zero Liquid Discharge			9.0	per MGD	$1,194,000	10,730,000
Product Water Line	20	in	2,050	per inch-dia LF	$37	1,520,400
Product Water Pump Station			250	HP	$6,500	1,625,000
Potable Connection			1	LS	$100,000	100,000
Raw Construction Cost						**149,550,000**
Construction Contingency				50%		74,780,000
Total Construction Cost						**224,330,000**
Implementation Cost				40%		89,730,000
Total Capital Cost						**314,060,000**

Annual Operations & Maintenance Cost (9 mgd production)					**Annual O&M**
Variable O&M	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Tertiary Pump Station	8,056	188	3,005,730	$0.20	601,000
Product Water Pump Station	6,241	120	1,477,080	$0.20	295,000
FAT System			7,157,231	$0.20	1,431,446
Ozone/ BAF System			2,004,332	$0.20	400,866
Evaporator			27,178,376	$0.20	5,435,675
Crystallizer			4,982,702	$0.20	996,540
FAT System - Chemicals			1	$326,250	326,250
Ozone/ BAF System - Chemicals			1	$2,250	2,250
Fixed O&M		**Construction Cost**		**Unit Cost**	
Treatment		63,750,000		1.0%	637,500
Storage		2,550,000		0.5%	12,750
Pump Stations		4,940,000		3.0%	148,200
Pipelines		31,027,600		0.5%	155,138
Total Annual Operations & Maintenance Cost					**10,442,616**
Annualized Capital Cost				0.03526	11,073,000
Total Annualized Cost					**21,515,616**
				Max Project Yield (AFY)	**10,065**
				MAX $/AF	**2,138**

Annual Operations & Maintenance Cost (2.7 mgd production)					**Annual O&M**
Variable O&M	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Tertiary Pump Station	2,417	188	901,710	$0.20	180,000
Product Water Pump Station	1,872	120	443,160	$0.20	89,000
FAT System			2,147,169	$0.20	429,434
Ozone/ BAF System			601,300	$0.20	120,260
Evaporator			8,153,513	$0.20	1,630,703
Crystallizer			1,494,811	$0.20	298,962
FAT System - Chemicals			1	$97,875	97,875
Ozone/ BAF System - Chemicals			1	$675	675
Fixed O&M		**Construction Cost**		**Unit Cost**	
Treatment		63,750,000		1.0%	637,500
Storage		2,550,000		0.5%	12,750
Pump Stations		4,940,000		3.0%	148,200
Pipelines		31,027,600		0.5%	155,138
Total Annual Operations & Maintenance Cost					**3,800,497**
Annualized Capital Cost				0.03526	11,073,000
Total Annualized Cost					**14,873,497**
				Min Project Yield (AFY)	**3,019**
				MIN $/AF	**4,926**

Santa Rosa Water Supply Options

July 2023

Option PR-3a: IPR to Delta Pond (GWA)

Basis of estimate:

Option PR-3a would convey the City's tertiary effluent to an AWPF at LTP and return AWPF waste stream to the headworks at LTP. The AWPF would include treatment processes in compliance with regulations for groundwater recharge. The purified water would be conveyed to a repurposed Delta Pond or a new nearby pond for infiltration; after the minimum retention time of 2-months in the groundwater aquifer, the recharged groundwater could then be extracted. For the 9 MGD supply, 12 new extraction wells would be required. The same assumptions for the GW-1 option were applied for these extraction wells. For this level of study it was assumed the City would size the AWPF to meet its 9 MGD peak month supply needs and provide any remaining tertiary water to its existing irrigation customers and then to the Geysers.

	Size	Units	Qty	Unit	Unit Cost	Subtotal
Equalization			1,820,000	per gallon	$1.25	2,275,000
Tertiary to AWTF						
Tertiary Water Line to IPR	24	in	500	per inch-dia LF	$37	445,000
Tertiary Pump Station				HP	$6,500	-
AWTF - IPR						
Ozone		MGD			$530,000	-
BAF		MGD			$480,000	-
MF/UF	10.6	MGD			$1,940,000	20,568,000
Interprocess Tank			221,000	per gallon	$1.25	276,000
RO	9.0	MGD			$2,340,000	21,087,000
Chemicals (Storage and Feed Systems)	9.0	MGD			$200,000	1,802,000
Sitework/Piping/Structures	9.0	MGD			$5,050,000	45,509,000
Waste Disposal to Headworks	8	in	500	per inch-dia LF	$37	148,300
Brine Disposal						
Zero Liquid Discharge			9.0	per MGD	$1,194,000	10,760,000
Product Water Distribution						
Product Water Line	22	in	41,220	per inch-dia LF	$37	33,628,700
Product Water Pump Station			490	HP	$6,500	3,185,000
Potable Connection				LS	$100,000	-
ASR Wells						
New Well Construction	500	gpm	12	per well	$5,000,000	60,000,000
Raw Construction Cost						**199,680,000**
Construction Contingency				50%		99,840,000
Total Construction Cost						**299,520,000**
Implementation Cost				40%		119,810,000
Total Capital Cost						**419,330,000**

Annual Operations & Maintenance Cost (9 mgd production)						**Annual O&M**
Variable O&M	**AFY**	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Tertiary Pump Station						
Product Water Pump Station		6,241	234	2,892,420	$0.20	578,000
FAT System				7,157,231	$0.20	1,431,446
Ozone/ BAF System					$0.20	-
Evaporator				27,178,376	$0.20	5,435,675
Crystallizer				4,982,702	$0.20	996,540
FAT System - Chemicals				1	$326,250	326,250
Ozone/ BAF System - Chemicals					$2,250	-
ASR Well	10,065				$65	656,445
ASR Well Energy Use	10,065				$218	2,197,955
Fixed O&M			**Construction Cost**		**Unit Cost**	
Treatment			52,415,000		1.0%	524,150
Storage			2,551,000		0.5%	12,755
Pump Stations			3,185,000		3.0%	95,550
Pipelines			34,222,000		0.5%	171,110
ASR Wells					$265,872	265,872
Total Annual Operations & Maintenance Cost						**12,691,749**
Annualized Capital Cost					0.03526	14,785,000
Total Annualized Cost						**27,476,749**
					Max Project Yield (AFY)	**10,065**
					MAX $/AF	**2,730**

Annual Operations & Maintenance Cost (2.7 mgd production)						**Annual O&M**
Variable O&M	**AFY**	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Tertiary Pump Station						-
Product Water Pump Station		1,872	234	867,690	$0.20	174,000
FAT System				2,147,169	$0.20	429,434
Ozone/ BAF System					$0.20	-
Evaporator				8,153,513	$0.20	1,630,703
Crystallizer				1,494,811	$0.20	298,962
FAT System - Chemicals					$97,875	97,875
Ozone/ BAF System - Chemicals					$675	-
ASR Well	3,024				$65	197,232
ASR Well Energy Use	3,024				$218	660,384
Fixed O&M			**Construction Cost**		**Unit Cost**	
Treatment			52,415,000		1.0%	524,150
Storage			2,551,000		0.5%	12,755
Pump Stations			3,185,000		3.0%	95,550
Pipelines			34,222,000		0.5%	171,110
ASR Wells					$265,872	265,872
Total Annual Operations & Maintenance Cost						**4,558,026**
Annualized Capital Cost					0.03526	14,785,000
Total Annualized Cost						**19,343,026**
					Min Project Yield (AFY)	**3,019**
					MIN $/AF	**6,406**

Santa Rosa Water Supply Options

July 2023

Option PR-3c: IPR to Lake Sonoma

Basis of estimate:

Option PR-3c would convey the City's tertiary effluent to an AWPF at LTP and return AWPF waste stream to the headworks at LTP. The AWPF would include treatment processes in compliance with regulations for surface water augmentation. The purified water would be conveyed to Lake Sonoma through a new purified water line extending to the Lake assuming the existing Geyser's pipeline corridor/ easement. After the minimum retention time of 2-months in the surface water body, the water could then be recovered using Sonoma Water's existing infrastructure via the Russian River. For this level of study it was assumed the City would size the AWPF to meet its 9 MGD peak month supply needs and provide any remaining tertiary water to its existing irrigation customers and then to the Geysers.

	Size	Units	Qty	Unit	Unit Cost	Subtotal
Equalization			1,820,000	per gallon	$1.25	2,275,000
Tertiary to AWTF						
Tertiary Water Line to IPR	24	in	500	per inch-dia LF	$37	445,000
Tertiary Pump Station				HP	$6,500	-
AWTF - IPR						
Ozone		MGD			$530,000	-
BAF		MGD			$480,000	-
MF/UF	10.6	MGD			$1,940,000	20,568,000
Interprocess Tank			221,000	per gallon	$1.25	276,000
RO	9.0	MGD			$2,340,000	21,087,000
Chemicals (Storage and Feed Systems)	9.0	MGD			$200,000	1,802,000
Sitework/Piping/Structures	9.0	MGD			$5,050,000	45,509,000
Waste Disposal to Headworks	8	in	500	per inch-dia LF	$37	148,300
Brine Disposal						
Zero Liquid Discharge			9.0	per MGD	$1,194,000	10,760,000
Purified Water Distribution to Lake Sonoma						
Product Water Line	22	in	181,300	per inch-dia LF	$37	147,910,600
Product Water Pump Station			2,600	HP	$6,500	16,900,000
Potable Connection				LS	$100,000	-
Raw Construction Cost						**267,680,000**
Construction Contingency				50%		133,840,000
Total Construction Cost						**401,520,000**
Implementation Cost				40%		160,610,000
Total Capital Cost						**562,130,000**

Annual Operations & Maintenance Cost (9 mgd production)						**Annual O&M**
Variable O&M		**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Tertiary Pump Station						
Product Water Pump Station		6,258	1,233	15,278,040	$0.20	3,056,000
FAT System				7,157,231	$0.20	1,431,446
Ozone/ BAF System					$0.20	-
Evaporator				27,178,376	$0.20	5,435,675
Crystallizer				4,982,702	$0.20	996,540
FAT System - Chemicals	1				$326,250	326,250
Ozone/ BAF System - Chemicals					$2,250	-
0	1				$837,511	837,511
Fixed O&M			**Construction Cost**		**Unit Cost**	
Treatment			52,415,000		1.0%	524,150
Storage			2,551,000		0.5%	12,755
Pump Stations			16,900,000		3.0%	507,000
Pipelines			148,503,900		0.5%	742,520
Total Annual Operations & Maintenance Cost						**13,869,847**
Annualized Capital Cost					0.03526	19,820,000
Total Annualized Cost						**33,689,847**
					Max Project Yield (AFY)	**10,065**
					MAX $/AF	**3,347**

Annual Operations & Maintenance Cost (2.7 mgd production)						**Annual O&M**
Variable O&M		**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Product Water Pump Station		1,877	1,233	4,583,430	$0.20	917,000
FAT System				2,147,169	$0.20	429,434
Ozone/ BAF System					$0.20	-
Evaporator				8,153,513	$0.20	1,630,703
Crystallizer				1,494,811	$0.20	298,962
FAT System - Chemicals	1				$97,875	97,875
Ozone/ BAF System - Chemicals					$675	-
0	1				$587,422	587,422
Fixed O&M			**Construction Cost**		**Unit Cost**	
Treatment			52,415,000		1.0%	524,150
Storage			2,551,000		0.5%	12,755
Pump Stations			16,900,000		3.0%	507,000
Pipelines			148,503,900		0.5%	742,520
Total Annual Operations & Maintenance Cost						**5,747,820**
Annualized Capital Cost					0.03526	19,820,000
Total Annualized Cost						**25,567,820**
					Min Project Yield (AFY)	**3,019**
					MIN $/AF	**8,468**

Santa Rosa Water Supply Options

July 2023

Option PR-4: DPR at LTP

Basis of estimate:

Option PR-4 would convey the City's tertiary effluent to an AWPF located at the LTP and return AWPF waste stream to the LTP headworks. The AWPF would include treatment processes in compliance with future anticipated regulations for treated water augmentation. The purified water would be conveyed to SCWA's 48-inch diameter aqueduct for regional distribution south of the City. PR-4 is limited by the reliable volume of tertiary effluent available, assuming the City would be reducing flow to the Geysers by prioritizing recycled water to its existing irrigation customers and the AWPF. For this level of study it was assumed the City would size the AWPF to meet its 9 MGD peak month supply needs and provide any remaining tertiary water to its existing irrigation customers and then to the Geysers.

	Size	Units	Qty	Unit	Unit Cost	Subtotal
Equalization			1,820,000	per gallon	$1.25	2,275,000
Tertiary to AWTF						
Tertiary Water Line to AWPF	24	in	500	per inch-dia LF	$37	445,000
Tertiary Pump Station				HP	$6,500	-
AWTF - DPR						
Ozone	11.4	MGD			$530,000	6,025,000
BAF	11.4	MGD			$480,000	5,457,000
MF/UF	10.6	MGD			$1,940,000	20,510,000
Interprocess Tank			220,000	per gallon	$1.25	275,000
RO	9.0	MGD			$2,340,000	21,028,000
Chemicals (Storage and Feed Systems)	9.0	MGD			$200,000	1,797,000
Sitework/Piping/Structures	9.0	MGD			$5,050,000	45,381,000
Waste Disposal to Headworks at LTP	10	in	500	per inch-dia LF	$37	185,400
Brine Disposal						
Zero Liquid Discharge			9.0	per MGD	$1,194,000	10,730,000
Product Water Distribution						
Product Water Line	20	in	2,200	per inch-dia LF	$37	1,631,700
Product Water Pump Station			270	HP	$6,500	1,755,000
Potable Connection			1	LS	$100,000	100,000
Raw Construction Cost						**117,600,000**
Construction Contingency				50%		58,800,000
Total Construction Cost						**176,400,000**
Implementation Cost				40%		70,560,000
Total Capital Cost						**246,960,000**

Annual Operations & Maintenance Cost (9 mgd production)						**Annual O&M**
Variable O&M	**QTY**	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Tertiary Pump Station						
Product Water Pump Station		6,241	128	1,587,780	$0.20	317,556
FAT System				7,157,231	$0.20	1,431,446
Ozone/ BAF System				2,004,332	$0.20	400,866
Evaporator				27,178,376	$0.20	5,435,675
Crystallizer				4,982,702	$0.20	996,540
FAT System - Chemicals	1				$326,250	326,250
Ozone/ BAF System - Chemicals	1				$2,250	2,250
Fixed O&M			**Construction Cost**		**Unit Cost**	
Treatment			63,750,000		1.0%	637,500
Storage			2,550,000		0.5%	12,750
Pump Stations			1,755,000		3.0%	52,650
Pipelines			2,262,100		0.5%	11,311
Total Annual Operations & Maintenance Cost						**9,624,795**
Annualized Capital Cost					0.03526	8,707,000
Total Annualized Cost						**18,331,795**
					Max Project Yield (AFY)	**10,065**
					MAX $/AF	**1,821**

Annual Operations & Maintenance Cost (2.7 mgd production)						**Annual O&M**
Variable O&M	**QTY**	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Tertiary Pump Station						-
Product Water Pump Station		1,872	128	476,370	$0.20	95,274
FAT System				2,147,169	$0.20	429,434
Ozone/ BAF System				601,300	$0.20	120,260
Evaporator				8,153,513	$0.20	1,630,703
Crystallizer				1,494,811	$0.20	298,962
FAT System - Chemicals	1				$97,875	97,875
Ozone/ BAF System - Chemicals	1				$675	675
Fixed O&M			**Construction Cost**		**Unit Cost**	
Treatment			63,750,000		1.0%	637,500
Storage			2,550,000		0.5%	12,750
Pump Stations			1,755,000		3.0%	52,650
Pipelines			2,262,100		0.5%	11,311
Total Annual Operations & Maintenance Cost						**3,387,393**
Annualized Capital Cost					0.03526	8,707,000
Total Annualized Cost						**12,094,393**
					Min Project Yield (AFY)	**3,019**
					MIN $/AF	**4,006**

Santa Rosa Water Supply Options		June 2023	
Option RW-1: Recycled Water Expansion			
Basis of estimate:			
Complete the nonpotable recycled water expansion project evaluated in the Santa Rosa Urban Reuse Project Feasibility Study.			
			2023 Cost
Santa Rosa Urban Reuse Project		$	214,011,000
Total Capital Cost		**$**	**214,011,000**
Annualized Capital Cost	0.03526	$	7,546,000
Annual O&M Cost		$	1,270,000
Total Annualized Cost		**$**	**8,816,000**
	Yield (AFY)		**3000**
	$/AF		**2939**

Santa Rosa Water Supply Options

July 2023 | June 2023

Option DE-1: Regional Desalination

Basis of estimate:

The cost estimate for this option is based on a recent cost estimate from the 2021 MMWD Desalination Supply Study. This option is for a regional desalination plant to be located the MMWD's Pelican Way Maintenance Yard facility in San Rafael, CA. The MMWD study was based on 15 MGD. It's assumed that Santa Rosa would "buy in" for up to 9 MGD of that 15 MGD and would pay a prorated share of capital and O&M costs.

	Size	Units	Qty	Unit	Unit Cost	Full Project Subtotal	City Portion Subtotal
Intake							
Intake Screens, Pipeline and Pumps	15	MGD	1	LS	$13,236,000	13,236,000	7,941,600
Raw Water Pipe	15	MGD	1	LS	$394,000	394,000	236,400
Desalination Plant							
Rapid Mix	15	MGD	1	LS	$2,033,000	2,033,000	1,219,800
Strainers, UF and Building	15	MGD	1	LS	$17,668,000	17,668,000	10,600,800
Filtrate and Backwash Supply Tanks	15	MGD	1	LS	$217,000	217,000	130,200
RO Feed Pump Station	15	MGD	1	LS	$4,025,000	4,025,000	2,415,000
1st pass RO and Building, Permeate Tank	15	MGD	1	LS	$32,591,000	32,591,000	19,554,600
Chlorine Contact Tank	15	MGD	1	LS	$993,000	993,000	595,800
Chemical Facilities	15	MGD	1	LS	$11,134,000	11,134,000	6,680,400
Backwash Equalization Basin	15	MGD	1	LS	$430,000	430,000	258,000
Gravity Thickener	15	MGD	1	LS	$2,390,000	2,390,000	1,434,000
Centrifuges	15	MGD	1	LS	$6,810,000	6,810,000	4,086,000
O&M Building	15	MGD	1	LS	$5,301,000	5,301,000	3,180,600
Sitework/Piping	15	MGD	1	LS	$18,861,000	18,861,000	11,316,600
Electrical	15	MGD	1	LS	$11,208,000	11,208,000	6,724,800
Instrumentation and Controls	15	MGD	1	LS	$5,604,000	5,604,000	
Brine Disposal							
Brine Pump Station	15	MGD	1	LS	$3,977,000	3,977,000	2,386,200
Brine Transmission Line	15	MGD	1	LS	$1,763,000	1,763,000	1,057,800
Distribution							
Distribution Booster Pumps	15	MGD	1	LS	$4,504,000	4,504,000	2,702,400
Treated Water Line	15	MGD	1	LS	$328,000	328,000	196,800
Raw Construction Cost						**143,470,000**	**82,720,000**
Construction Contingency				50%		71,740,000	41,360,000
Total Construction Cost						**215,210,000**	**124,080,000**
Implementation Cost				40%		86,080,000	49,630,000
Total Capital Cost						**301,290,000**	**173,710,000**

Annual Operations & Maintenance Cost (15 mgd production)						**Annual O&M**	**Annual O&M**
Variable O&M	**gpm**	**TDH**	**AFY**	**kwh-yr**	**Unit Cost**		
Desalination Facility			16,800	27,384,000	$0.20	5,476,800	3,286,080
Distribution Booster Pumps	10,417	200		4,125,600	$0.20	825,120	495,072
Brine Pump Station	11,111	100		2,200,320	$0.20	440,064	264,038
Fixed O&M			**Construction Cost**		**Unit Cost**		
Treatment			78,291,000		1.0%	782,910	469,746
Storage			430,000		0.5%	2,150	1,290
Pump Stations			21,717,000		3.0%	651,510	390,906
Pipelines			15,721,000		0.5%	78,605	47,163
Total Annual Operations & Maintenance Cost						**8,257,159**	**4,954,295**
Annualized Capital Cost					0.03526	10,623,000	6,125,000
Total Annualized Cost						**18,880,159**	**11,079,295**
					Max Project Yield (AFY)	**16,800**	**10,080**
					MAX $/AF	**1,124**	**1,099**

Annual Operations & Maintenance Cost (5 mgd production)						**Annual O&M**	**Annual O&M**
Variable O&M	**gpm**	**TDH**	**AFY**	**kwh-yr**	**Unit Cost**		
Desalination Facility			5,600	9,128,000	$0.20	1,825,600	1,095,360
Distribution Booster Pumps	3,472	200		1,375,200	$0.20	275,040	165,024
Brine Pump Station	4,028	100		797,580	$0.20	159,516	95,710
Fixed O&M			**Construction Cost**		**Unit Cost**		
Treatment			78,291,000		1.0%	782,910	469,746
Storage			430,000		0.5%	2,150	1,290
Pump Stations			21,717,000		3.0%	651,510	390,906
Pipelines			15,721,000		0.5%	78,605	47,163
Total Annual Operations & Maintenance Cost						**3,340,775**	**2,004,465**
Annualized Capital Cost					0.03526	10,623,000	6,125,000
Total Annualized Cost						**13,963,775**	**8,129,465**
					Min Project Yield (AFY)	**2,240**	**3,360**
					MIN $/AF	**6,234**	**2,419**

Santa Rosa Water Supply Options

June 2023

Option DE-2: Ocean Desalination — Full Project

Basis of estimate:

The cost estimate for this option is based on a recent cost estimate from the 2021 MMWD Desalination Supply Study. This option is for a Santa Rosa owned desalination plant to be located south of Bodega Bay. The MMWD Study was based on 15 mgd, it is assumed Santa Rosa only needs to supply 9mgd, the costs were scaled from the 15 mgd plant down to a 9mgd plant.

	Size	Units	Qty	Unit	Unit Cost	Subtotal
Intake						
Intake Screens, Pipeline and Pumps	9	MGD	1	LS	$7,942,000	7,942,000
Raw Water Pipe	30	in	2,000	inch-dia LF	$37	2,225,000
Desalination Plant						
Rapid Mix	9	MGD	1	LS	$1,220,000	1,220,000
Strainers, UF and Building	9	MGD	1	LS	$10,601,000	10,601,000
Filtrate and Backwash Supply Tanks	9	MGD	1	LS	$130,000	130,000
RO Feed Pump Station	9	MGD	1	LS	$2,415,000	2,415,000
1st pass RO and Building, Permeate Tank	9	MGD	1	LS	$19,555,000	19,555,000
Chlorine Contact Tank	9	MGD	1	LS	$596,000	596,000
Chemical Facilities	9	MGD	1	LS	$6,680,000	6,680,000
Backwash Equalization Basin	9	MGD	1	LS	$258,000	258,000
Gravity Thickener	9	MGD	1	LS	$1,434,000	1,434,000
Centrifuges	9	MGD	1	LS	$4,086,000	4,086,000
O&M Building	9	MGD	1	LS	$3,181,000	3,181,000
Sitework/Piping	9	MGD	1	LS	$11,316,000	11,316,000
Electrical	9	MGD	1	LS	$6,725,000	6,725,000
Instrumentation and Controls	9	MGD	1	LS	$3,363,000	3,363,000
Brine Disposal						
Brine Pump Station			290	HP	$6,500	1,885,000
Brine Transmission Line	24	in	2,000	inch-dia LF	$37	1,780,000
Distribution						
Distribution Pump Station			1,880	HP	$6,500	12,220,000
Treated Water Line	24	in	92,600	inch-dia LF	$37	82,414,000
Raw Construction Cost						**180,030,000**
Construction Contingency				50%		90,020,000
Total Construction Cost						**270,050,000**
Implementation Cost				40%		108,020,000
Total Capital Cost						**378,070,000**

Annual Operations & Maintenance Cost (9mgd production)						**Annual O&M**
Variable O&M	**gpm**	**TDH**	**AFY**	**kwh-yr**	**Unit Cost**	
Desalination Facility			10,080	45,964,800	$0.20	9,192,960
Distribution Pump Station	6,250	893		11,055,060	$0.20	2,211,012
Brine Pump Station	7,107	122		1,714,410	$0.20	342,882
Fixed O&M			**Construction Cost**		**Unit Cost**	
Treatment			46,975,000		1.0%	469,750
Storage			258,000		0.5%	1,290
Pump Stations			22,047,000		3.0%	661,410
Pipelines			94,361,000		0.5%	471,805
Total Annual Operations & Maintenance Cost						**13,351,109**
Annualized Capital Cost					0.03526	13,330,000
Total Annualized Cost						**26,681,109**
					Max Project Yield (AFY)	**10,080**
					MAX $/AF	**2,647**

Annual Operations & Maintenance Cost (5mgd production)						**Annual O&M**
Variable O&M	**gpm**	**TDH**	**AFY**	**kwh-yr**	**Unit Cost**	
Desalination Facility			5,600	25,536,000	$0.20	5,107,200
Distribution Pump Station	3,472	893		6,141,690	$0.20	1,228,338
Brine Pump Station	4,028	122		971,550	$0.20	194,310
Fixed O&M			**Construction Cost**		**Unit Cost**	
Treatment			46,975,000		1.0%	469,750
Storage			258,000		0.5%	1,290
Pump Stations			22,047,000		3.0%	661,410
Pipelines			94,361,000		0.5%	471,805
Total Annual Operations & Maintenance Cost						**8,134,103**
Annualized Capital Cost					0.03526	13,330,000
Total Annualized Cost						**21,464,103**
					Min Project Yield (AFY)	**3,360**
					MIN $/AF	**7,941**

Santa Rosa Water Supply Options

July 2023

Option SW-1: Divert and store in Aquifer

Basis of estimate:

The cost estimate for this option is based on a recent cost estimate from Del Puerto. This option is for a stormwater diversion structure within Santa Rosa Creek to store water in the aquifer. This option assumes spreading basins for percolation into the aquifer and new extraction wells.

	Size	Units	Qty	Unit	Unit Cost	Subtotal
Santa Rosa Creek Water Diversion						
Diversion Structure, including pumps, spreading basins			10,080	per AF	$1,800	18,144,000
Conventional Treatment Plant	9	MGD	1	LS	$41,925,000	41,925,000
Extraction Wells						
New Well Construction	500	gpm	12	per well	$3,500,000	42,000,000
Product Water Distribution						
Product Water Line	20	in	3,000	per inch-dia LF	$37	2,225,000
Product Water Pump Station			240	HP	$6,500	1,560,000
Potable Connection			1	LS	$100,000	100,000
Raw Construction Cost						**105,950,000**
Construction Contingency				50%		52,980,000
Total Construction Cost						**158,930,000**
Implementation Cost				40%		63,570,000
Total Capital Cost						**222,500,000**

Annual Operations & Maintenance Cost (9 mgd production)						**Annual O&M**
Variable O&M	**AFY**	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Diversion Energy Costs	10,080				$16	163,296
Treatment					$418,755	418,755
Product Water Pump Station		6,000	118	465,750	$0.20	93,150
Extraction Wells	10,080				$236	2,382,266
Fixed O&M			**Construction Cost**		**Unit Cost**	
Treatment					$418,755	418,755
Semi-Annual Basin Clearing					$21,200	21,200
Well Inspections					$10,000	10,000
Operational Labor Costs					$10,000	10,000
Extraction Wells					$443,119	443,119
Pump Stations			1,560,000		3.0%	46,800
Pipelines			2,225,000		0.5%	11,125
Total Annual Operations & Maintenance Cost						**4,018,467**
Annualized Capital Cost					0.03526	7,845,000
Total Annualized Cost						**11,863,467**
					Max Project Yield (AFY)	**10,080**
					MAX $/AF	**1,177**

Annual Operations & Maintenance Cost (0 mgd production)						**Annual O&M**
Variable O&M	**AFY**	**GPM**	**TDH (ft)**	**kwh-yr**	**Unit Cost**	
Diversion Energy Costs	0				$16	-
Treatment					$0	-
Product Water Pump Station		0	118	0	$0.20	-
Extraction Wells	0				$236	-
Fixed O&M			**Construction Cost**		**Unit Cost**	
Treatment					$418,755	418,755
Semi-Annual Basin Clearing*					$21,200.00	21,200
Well Inspections					$10,000.00	10,000
Operational Labor Costs					$10,000.00	10,000
Extraction Wells					$443,119	443,119
Pump Stations			1,560,000		3.0%	46,800
Pipelines			2,225,000		0.5%	11,125
Total Annual Operations & Maintenance Cost						**961,000**
Annualized Capital Cost					0.03526	7,845,000
Total Annualized Cost						**8,806,000**
					Min Project Yield (AFY)	**1,008**
					MIN $/AF	**8,736**

APPENDIX B: SCREENING TOOL DETAIL (BASELINE SCENARIO)

Global modeling parameters and assumptions
apply to all scenarios, all options unless otherwise noted.

Global values

2045 Demand (AF/Y)	**25,000**	25,000 was given value
Max historic demand	23,993	in 2004, not used in calcs
max active savings	7,584	Table 4-1 UWMP; not used in calcs
Sonom Water nominal allotment (AF/Y)	**29,100**	should be constant
Sonoma Water peak historic draft (AF/Y)	20,693	just for info, not used in calcs
Current groundwater firm capacity (AF/Y)	**1,300**	
Default Sonoma Water $/AF	**1,200**	

discount rate	**2.5%**
price of power ($/MWh)	**$200**
first year of simulation	**2045**
planning horizon (yrs)	**50**

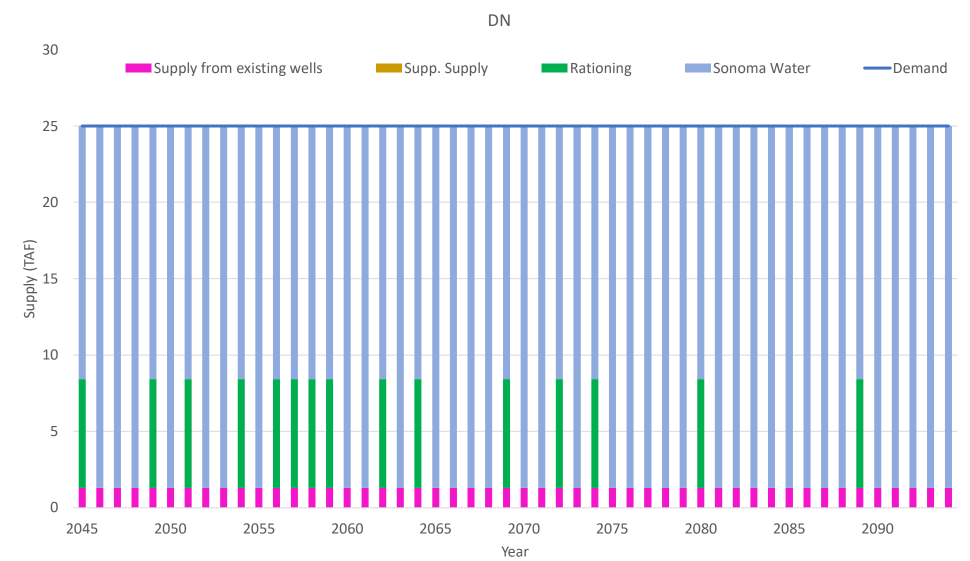
Sonoma cutback and state-imposed rationing by year type

Year type	SCWA Cutback	State-imposed Rationing
Wet	**0%**	**0%**
Normal	**0%**	**0%**
Dry	**30%**	**10%**

Choose an option to model, and a scenario to model it against. Those are the only two inputs on this sheet!

Option :	DN	Do nothing
Storage (AF):	0	as entered in Options definition
Storage threshold ($/AF):	0	(n/a)
Capital cost ($M/yr)	0.00	as entered in Options definition
Fixed OMR ($M/yr)	0.00	as entered in Options definition
Fixed capital + OMR ($M/yr)	0.00	sum of amoritized capital plus fixed OMR

Scenario:	2	Replay it again Sam, historic hydrology with base year 1920
Hydrology type:	Historic	
Base year:	1920	Base year of historic replay
Synthetic hydrology ID:	n/a	
Synthetic hydrology index:	n/a	
Sonoma reductions by year type: Wet	0%	
Normal	0%	
Dry	30%	



SUMMARY OF RESULTS

Years with any rationing	15	out of 50 years
Years with rationing over state levels	15	
Max rationing	28%	based on nominal demand
Max AFY supplemental supply	0	AF/yr
Avg Sonoma Water	21,567	AF/yr
Avg Sonoma Water Cost	25.9	$M/yr

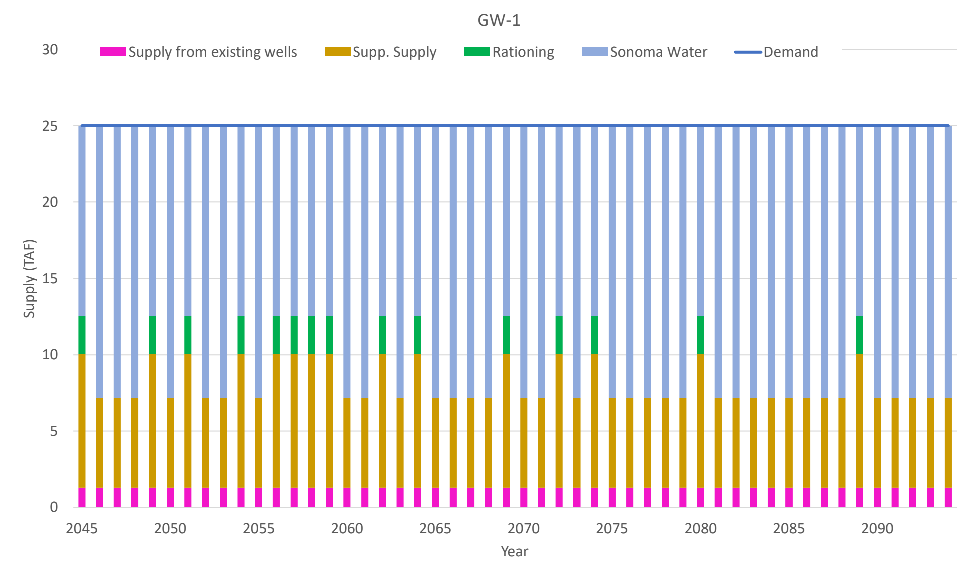
Average AFY supplemental	0	based on scenario usage year-by-year, shown below
Max supplemental AFY	0	
Average marginal OMR $M/yr	0.00	based on scenario usage year-by-year, shown below
Average total $M/yr for supp. Supply	0.00	combining with fixed costs shown above
Average $/AF supplemental	$0	
Avg total cost including supplement + Sonoma	25.9	$M/yr
Average OMR $/yr	0.00	sum of fixed and marginal OMR

Year	*Year type*	*Sonoma Water % redu for year type*	*Demand*	*Supply from existing wells*	*Min supp AF*	*Max supp AF*	*Baseline demand for SW*	*Sonoma Water max avail (AF)*	*State-imposed rationing for year type*	*Eff demand AF*	*Sonoma Water*	*Sonoma Water cost $M*	*Supply deficit AF*	*Supp supply Marginal cost $/AF*	*Supp supply used for demand (AF)*	*AF Residual shortage (surplus)*	*Needed rationing based on supply*	*Actual rationing level*	*Rationing*	*Supp. Supply*
2045	Dry	30%	25,000	1,300	0	0	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	0	4,610	28%	28%	7,110	0
2046	Wet	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2047	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2048	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2049	Dry	30%	25,000	1,300	0	0	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	0	4,610	28%	28%	7,110	0
2050	Wet	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2051	Dry	30%	25,000	1,300	0	0	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	0	4,610	28%	28%	7,110	0
2052	Wet	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2053	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2054	Dry	30%	25,000	1,300	0	0	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	0	4,610	28%	28%	7,110	0
2055	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2056	Dry	30%	25,000	1,300	0	0	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	0	4,610	28%	28%	7,110	0
2057	Dry	30%	25,000	1,300	0	0	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	0	4,610	28%	28%	7,110	0
2058	Dry	30%	25,000	1,300	0	0	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	0	4,610	28%	28%	7,110	0
2059	Dry	30%	25,000	1,300	0	0	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	0	4,610	28%	28%	7,110	0
2060	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2061	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2062	Dry	30%	25,000	1,300	0	0	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	0	4,610	28%	28%	7,110	0
2063	Wet	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2064	Dry	30%	25,000	1,300	0	0	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	0	4,610	28%	28%	7,110	0
2065	Wet	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2066	Wet	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2067	Wet	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2068	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2069	Dry	30%	25,000	1,300	0	0	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	0	4,610	28%	28%	7,110	0
2070	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2071	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2072	Dry	30%	25,000	1,300	0	0	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	0	4,610	28%	28%	7,110	0
2073	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2074	Dry	30%	25,000	1,300	0	0	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	0	4,610	28%	28%	7,110	0
2075	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2076	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2077	Wet	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2078	Wet	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2079	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2080	Dry	30%	25,000	1,300	0	0	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	0	4,610	28%	28%	7,110	0
2081	Wet	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2082	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2083	Wet	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2084	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2085	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2086	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2087	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2088	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2089	Dry	30%	25,000	1,300	0	0	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	0	4,610	28%	28%	7,110	0
2090	Wet	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2091	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2092	Wet	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2093	Normal	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2094	Wet	0%	25,000	1,300	0	0	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0

Choose an option to model, and a scenario to model it against. Those are the only two inputs on this sheet!

Option :	GW-1	Add groundwater extraction wells
Storage (AF):	0	as entered in Options definition
Storage threshold ($/AF):	0	(n/a)
Capital cost ($M/yr)	3.40	as entered in Options definition
Fixed OMR ($M/yr)	0.50	as entered in Options definition
Fixed capital + OMR ($M/yr)	3.90	sum of amortized capital plus fixed OMR

Scenario:	2	Replay it again Sam, historic hydrology with base year 1920
Hydrology type:	Historic	
Base year:	1920	Base year of historic replay
Synthetic hydrology ID:	n/a	
Synthetic hydrology index:	n/a	
Sonoma reductions by year type: Wet	0%	
Normal	0%	
Dry	30%	



SUMMARY OF RESULTS

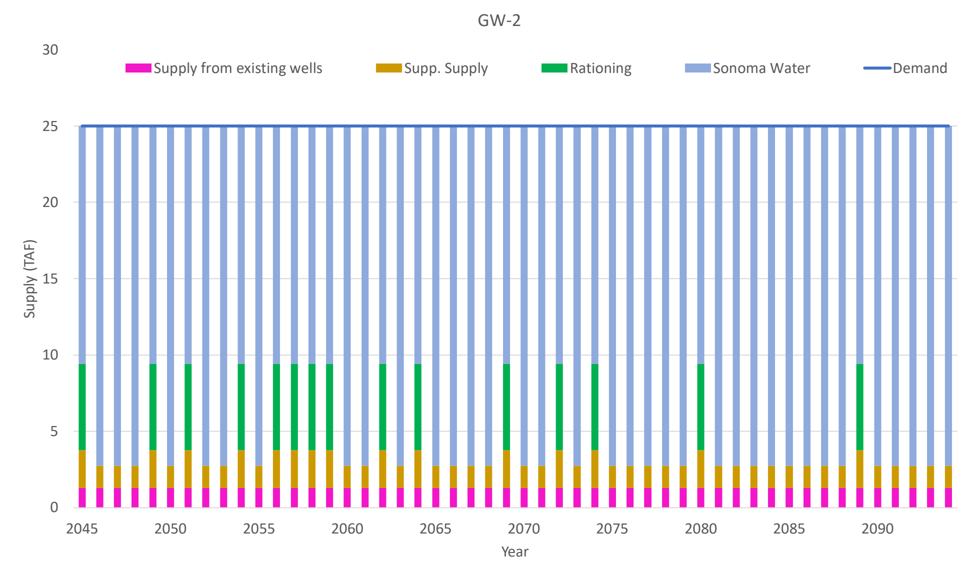
Years with any rationing	15	out of 50 years
Years with rationing over state levels	0	
Max rationing	10%	based on nominal demand
Max AFY supplemental supply	8,726	AF/yr
Avg Sonoma Water	16,216	AF/yr
Avg Sonoma Water Cost	19.5	$M/yr
Average AFY supplemental	6,734	based on scenario usage year-by-year, shown below
Max supplemental AFY	8,726	
Average marginal OMR $M/yr	1.78	based on scenario usage year-by-year, shown below
Average total $M/yr for supp. Supply	5.68	combining with fixed costs shown above
Average $/AF supplemental	$843	
Avg total cost including supplement + Sonoma	25.1	$M/yr
Average OMR $/yr	2.28	sum of fixed and marginal OMR

Year	*Year type*	*Sonoma Water % redu for year type*	*Demand*	*Supply from existing wells*	*Min supp AF*	*Max supp AF*	*Baseline demand for SW*	*Sonoma Water max avail (AF)*	*State-imposed rationing for year type*	*Eff demand AF*	*Sonoma Water*	*Sonoma Water cost $M*	*Supply deficit AF*	*Supp supply Marginal cost $/AF*	*Supp supply used for demand (AF)*	*AF Residual shortage (surplus)*	*Needed rationing based on supply*	*Actual rationing level*	*Rationing*	*Supp. Supply*
2045	Dry	30%	25,000	1,300	5,880	10,080	17,820	12,474	10%	22,500	12,474	15.0	8,726	$264	8,726	0	5%	10%	2,500	8,726
2046	Wet	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2047	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2048	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2049	Dry	30%	25,000	1,300	5,880	10,080	17,820	12,474	10%	22,500	12,474	15.0	8,726	$264	8,726	0	5%	10%	2,500	8,726
2050	Wet	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2051	Dry	30%	25,000	1,300	5,880	10,080	17,820	12,474	10%	22,500	12,474	15.0	8,726	$264	8,726	0	5%	10%	2,500	8,726
2052	Wet	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2053	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2054	Dry	30%	25,000	1,300	5,880	10,080	17,820	12,474	10%	22,500	12,474	15.0	8,726	$264	8,726	0	5%	10%	2,500	8,726
2055	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2056	Dry	30%	25,000	1,300	5,880	10,080	17,820	12,474	10%	22,500	12,474	15.0	8,726	$264	8,726	0	5%	10%	2,500	8,726
2057	Dry	30%	25,000	1,300	5,880	10,080	17,820	12,474	10%	22,500	12,474	15.0	8,726	$264	8,726	0	5%	10%	2,500	8,726
2058	Dry	30%	25,000	1,300	5,880	10,080	17,820	12,474	10%	22,500	12,474	15.0	8,726	$264	8,726	0	5%	10%	2,500	8,726
2059	Dry	30%	25,000	1,300	5,880	10,080	17,820	12,474	10%	22,500	12,474	15.0	8,726	$264	8,726	0	5%	10%	2,500	8,726
2060	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2061	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2062	Dry	30%	25,000	1,300	5,880	10,080	17,820	12,474	10%	22,500	12,474	15.0	8,726	$264	8,726	0	5%	10%	2,500	8,726
2063	Wet	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2064	Dry	30%	25,000	1,300	5,880	10,080	17,820	12,474	10%	22,500	12,474	15.0	8,726	$264	8,726	0	5%	10%	2,500	8,726
2065	Wet	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2066	Wet	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2067	Wet	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2068	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2069	Dry	30%	25,000	1,300	5,880	10,080	17,820	12,474	10%	22,500	12,474	15.0	8,726	$264	8,726	0	5%	10%	2,500	8,726
2070	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2071	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2072	Dry	30%	25,000	1,300	5,880	10,080	17,820	12,474	10%	22,500	12,474	15.0	8,726	$264	8,726	0	5%	10%	2,500	8,726
2073	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2074	Dry	30%	25,000	1,300	5,880	10,080	17,820	12,474	10%	22,500	12,474	15.0	8,726	$264	8,726	0	5%	10%	2,500	8,726
2075	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2076	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2077	Wet	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2078	Wet	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2079	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2080	Dry	30%	25,000	1,300	5,880	10,080	17,820	12,474	10%	22,500	12,474	15.0	8,726	$264	8,726	0	5%	10%	2,500	8,726
2081	Wet	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2082	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2083	Wet	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2084	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2085	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2086	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2087	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2088	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2089	Dry	30%	25,000	1,300	5,880	10,080	17,820	12,474	10%	22,500	12,474	15.0	8,726	$264	8,726	0	5%	10%	2,500	8,726
2090	Wet	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2091	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2092	Wet	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2093	Normal	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880
2094	Wet	0%	25,000	1,300	5,880	10,080	17,820	17,820	0%	25,000	17,820	21.4	5,880	$264	5,880	0	0%	0%	0	5,880

Choose an option to model, and a scenario to model it against. Those are the only two inputs on this sheet!

Option :	GW-2	Convert emergency wells to production wells
Storage (AF):	0	as entered in Options definition
Storage threshold ($/AF):	0	(n/a)
Capital cost ($M/yr)	0.41	as entered in Options definition
Fixed OMR ($M/yr)	0.12	as entered in Options definition
Fixed capital + OMR ($M/yr)	0.53	sum of amoritized capital plus fixed OMR

Scenario:	2	Replay it again Sam, historic hydrology with base year 1920
Hydrology type:	Historic	
Base year:	1920	Base year of historic replay
Synthetic hydrology ID:	n/a	
Synthetic hydrology index:	n/a	
Sonoma reductions by year type: Wet	0%	
Normal	0%	
Dry	30%	



SUMMARY OF RESULTS

Years with any rationing	15	out of 50 years
Years with rationing over state levels	15	
Max rationing	23%	based on nominal demand
Max AFY supplemental supply	2,462	AF/yr
Avg Sonoma Water	20,260	AF/yr
Avg Sonoma Water Cost	24.3	$M/yr
Average AFY supplemental	1,744	based on scenario usage year-by-year, shown below
Max supplemental AFY	2,462	
Average marginal OMR $M/yr	0.41	based on scenario usage year-by-year, shown below
Average total $M/yr for supp. Supply	0.94	combining with fixed costs shown above
Average $/AF supplemental	$541	
Avg total cost including supplement + Sonoma	25.3	$M/yr
Average OMR $/yr	0.53	sum of fixed and marginal OMR

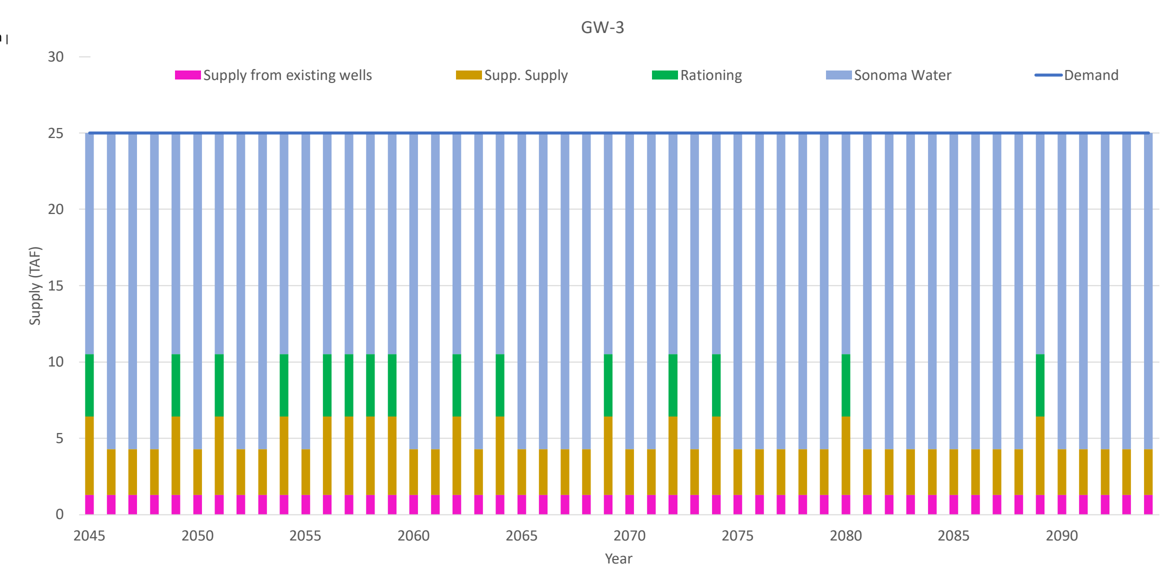
Year	*Year type*	*Sonoma Water % redu for year type*	*Demand*	*Supply from existing wells*	*Min supp AF*	*Max supp AF*	*Baseline demand for SW*	*Sonoma Water max avail (AF)*	*State-imposed rationing for year type*	*Eff demand AF*	*Sonoma Water*	*Sonoma Water cost $M*	*Supply deficit AF*	*Supp supply Marginal cost $/AF*	*Supp supply used for demand (AF)*	*AF Residual shortage (surplus)*	*Needed rationing based on supply*	*Actual rationing level*	*Rationing*	*Supp. Supply*
2045	Dry	30%	25,000	1,300	1,436	2,462	22,264	15,585	10%	22,500	15,585	18.7	5,615	$236	2,462	3,153	23%	23%	5,653	2,462
2046	Wet	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2047	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2048	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2049	Dry	30%	25,000	1,300	1,436	2,462	22,264	15,585	10%	22,500	15,585	18.7	5,615	$236	2,462	3,153	23%	23%	5,653	2,462
2050	Wet	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2051	Dry	30%	25,000	1,300	1,436	2,462	22,264	15,585	10%	22,500	15,585	18.7	5,615	$236	2,462	3,153	23%	23%	5,653	2,462
2052	Wet	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2053	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2054	Dry	30%	25,000	1,300	1,436	2,462	22,264	15,585	10%	22,500	15,585	18.7	5,615	$236	2,462	3,153	23%	23%	5,653	2,462
2055	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2056	Dry	30%	25,000	1,300	1,436	2,462	22,264	15,585	10%	22,500	15,585	18.7	5,615	$236	2,462	3,153	23%	23%	5,653	2,462
2057	Dry	30%	25,000	1,300	1,436	2,462	22,264	15,585	10%	22,500	15,585	18.7	5,615	$236	2,462	3,153	23%	23%	5,653	2,462
2058	Dry	30%	25,000	1,300	1,436	2,462	22,264	15,585	10%	22,500	15,585	18.7	5,615	$236	2,462	3,153	23%	23%	5,653	2,462
2059	Dry	30%	25,000	1,300	1,436	2,462	22,264	15,585	10%	22,500	15,585	18.7	5,615	$236	2,462	3,153	23%	23%	5,653	2,462
2060	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2061	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2062	Dry	30%	25,000	1,300	1,436	2,462	22,264	15,585	10%	22,500	15,585	18.7	5,615	$236	2,462	3,153	23%	23%	5,653	2,462
2063	Wet	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2064	Dry	30%	25,000	1,300	1,436	2,462	22,264	15,585	10%	22,500	15,585	18.7	5,615	$236	2,462	3,153	23%	23%	5,653	2,462
2065	Wet	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2066	Wet	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2067	Wet	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2068	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2069	Dry	30%	25,000	1,300	1,436	2,462	22,264	15,585	10%	22,500	15,585	18.7	5,615	$236	2,462	3,153	23%	23%	5,653	2,462
2070	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2071	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2072	Dry	30%	25,000	1,300	1,436	2,462	22,264	15,585	10%	22,500	15,585	18.7	5,615	$236	2,462	3,153	23%	23%	5,653	2,462
2073	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2074	Dry	30%	25,000	1,300	1,436	2,462	22,264	15,585	10%	22,500	15,585	18.7	5,615	$236	2,462	3,153	23%	23%	5,653	2,462
2075	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2076	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2077	Wet	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2078	Wet	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2079	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2080	Dry	30%	25,000	1,300	1,436	2,462	22,264	15,585	10%	22,500	15,585	18.7	5,615	$236	2,462	3,153	23%	23%	5,653	2,462
2081	Wet	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2082	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2083	Wet	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2084	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2085	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2086	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2087	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2088	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2089	Dry	30%	25,000	1,300	1,436	2,462	22,264	15,585	10%	22,500	15,585	18.7	5,615	$236	2,462	3,153	23%	23%	5,653	2,462
2090	Wet	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2091	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2092	Wet	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2093	Normal	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436
2094	Wet	0%	25,000	1,300	1,436	2,462	22,264	22,264	0%	25,000	22,264	26.7	1,436	$236	1,436	0	0%	0%	0	1,436

Choose an option to model, and a scenario to model it against. Those are the only two inputs on this sheet!

Option :	GW-3	Add ASR wells
Storage (AF):	5,000	as entered in Options definition
Storage threshold ($/AF):	500	supplemental supply is only used for discretionary storage puts when ;
Capital cost ($M/yr)	2.86	as entered in Options definition
Fixed OMR ($M/yr)	0.12	as entered in Options definition
Fixed capital + OMR ($M/yr)	2.98	sum of amoritized capital plus fixed OMR
Scenario:	2	Replay it again Sam, historic hydrology with base year 1920
Hydrology type:	Historic	
Base year:	1920	Base year of historic replay
Synthetic hydrology ID:	n/a	
Synthetic hydrology index:	n/a	
Sonoma reductions by year type: Wet	0%	
Normal	0%	
Dry	30%	

SUMMARY OF RESULTS

Years with any rationing	15	out of 50 years
Years with rationing over state levels	15	
Max rationing	16%	based on nominal demand
Max AFY supplemental supply	5,130	AF/yr
Avg Sonoma Water	18,844	AF/yr
Avg Sonoma Water Cost	22.6	$M/yr
Average AFY supplemental	3,634	based on scenario usage year-by-year, shown below
Max supplemental AFY	5,130	
Average marginal OMR $M/yr	6.59	based on scenario usage year-by-year, shown below
Average total $M/yr for supp. Supply	9.57	combining with fixed costs shown above
Average $/AF supplemental	$2,632	
Avg total cost including supplement + Sonoma	32.2	$M/yr
Average OMR $/yr	6.71	sum of fixed and marginal OMR

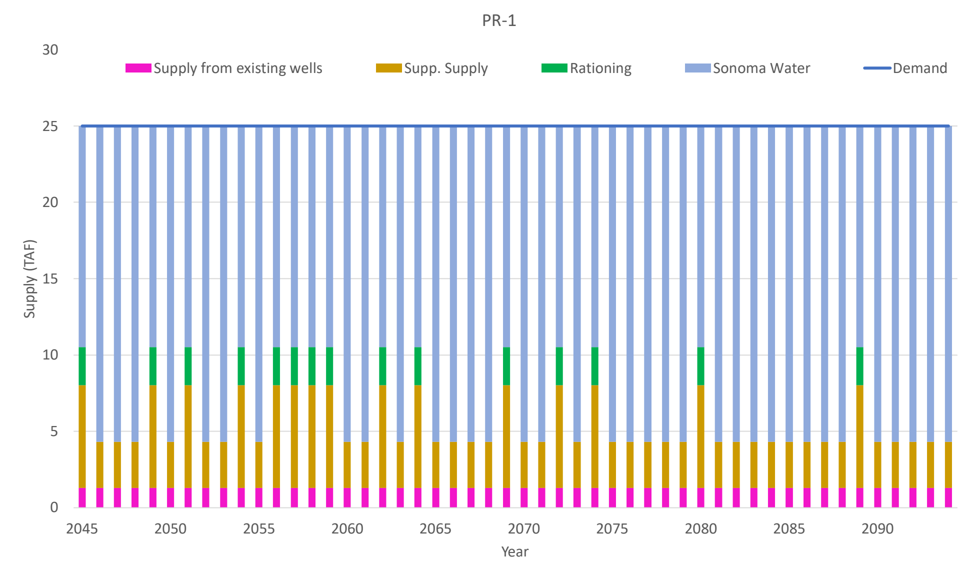


Year	Year type	Sonoma Water % redu for year type	Demand	Supply from existing wells	Min supp AF	Max supp AF	Baseline demand for SW	Sonoma Water max avail (AF)	State-imposed rationing for year type	Eff demand AF	Sonoma Water	Sonoma Water cost $M	Supply deficit AF	Supp supply Marginal cost $/AF	Supp supply used for demand (AF)	AF Residual shortage (surplus)	Needed rationing based on supply	Actual rationing level	Rationing	Supp. Supply	Supplemental Supply Marginal Cost $M	Take from storage (AF)
2045	Dry	30%	25,000	1,300	2,993	5,130	20,708	14,495	10%	22,500	14,495	17.4	6,705	$1,813	5,130	1,575	16%	16%	4,075	5,130	9.30	0
2046	Wet	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2047	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2048	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2049	Dry	30%	25,000	1,300	2,993	5,130	20,708	14,495	10%	22,500	14,495	17.4	6,705	$1,813	5,130	1,575	16%	16%	4,075	5,130	9.30	0
2050	Wet	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2051	Dry	30%	25,000	1,300	2,993	5,130	20,708	14,495	10%	22,500	14,495	17.4	6,705	$1,813	5,130	1,575	16%	16%	4,075	5,130	9.30	0
2052	Wet	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2053	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2054	Dry	30%	25,000	1,300	2,993	5,130	20,708	14,495	10%	22,500	14,495	17.4	6,705	$1,813	5,130	1,575	16%	16%	4,075	5,130	9.30	0
2055	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2056	Dry	30%	25,000	1,300	2,993	5,130	20,708	14,495	10%	22,500	14,495	17.4	6,705	$1,813	5,130	1,575	16%	16%	4,075	5,130	9.30	0
2057	Dry	30%	25,000	1,300	2,993	5,130	20,708	14,495	10%	22,500	14,495	17.4	6,705	$1,813	5,130	1,575	16%	16%	4,075	5,130	9.30	0
2058	Dry	30%	25,000	1,300	2,993	5,130	20,708	14,495	10%	22,500	14,495	17.4	6,705	$1,813	5,130	1,575	16%	16%	4,075	5,130	9.30	0
2059	Dry	30%	25,000	1,300	2,993	5,130	20,708	14,495	10%	22,500	14,495	17.4	6,705	$1,813	5,130	1,575	16%	16%	4,075	5,130	9.30	0
2060	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2061	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2062	Dry	30%	25,000	1,300	2,993	5,130	20,708	14,495	10%	22,500	14,495	17.4	6,705	$1,813	5,130	1,575	16%	16%	4,075	5,130	9.30	0
2063	Wet	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2064	Dry	30%	25,000	1,300	2,993	5,130	20,708	14,495	10%	22,500	14,495	17.4	6,705	$1,813	5,130	1,575	16%	16%	4,075	5,130	9.30	0
2065	Wet	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2066	Wet	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2067	Wet	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2068	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2069	Dry	30%	25,000	1,300	2,993	5,130	20,708	14,495	10%	22,500	14,495	17.4	6,705	$1,813	5,130	1,575	16%	16%	4,075	5,130	9.30	0
2070	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2071	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2072	Dry	30%	25,000	1,300	2,993	5,130	20,708	14,495	10%	22,500	14,495	17.4	6,705	$1,813	5,130	1,575	16%	16%	4,075	5,130	9.30	0
2073	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2074	Dry	30%	25,000	1,300	2,993	5,130	20,708	14,495	10%	22,500	14,495	17.4	6,705	$1,813	5,130	1,575	16%	16%	4,075	5,130	9.30	0
2075	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2076	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2077	Wet	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2078	Wet	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2079	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2080	Dry	30%	25,000	1,300	2,993	5,130	20,708	14,495	10%	22,500	14,495	17.4	6,705	$1,813	5,130	1,575	16%	16%	4,075	5,130	9.30	0
2081	Wet	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2082	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2083	Wet	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2084	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2085	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2086	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2087	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2088	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2089	Dry	30%	25,000	1,300	2,993	5,130	20,708	14,495	10%	22,500	14,495	17.4	6,705	$1,813	5,130	1,575	16%	16%	4,075	5,130	9.30	0
2090	Wet	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2091	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2092	Wet	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2093	Normal	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0
2094	Wet	0%	25,000	1,300	2,993	5,130	20,708	20,708	0%	25,000	20,708	24.8	2,993	$1,813	2,993	0	0%	0%	0	2,993	5.42	0

Choose an option to model, and a scenario to model it against. Those are the only two inputs on this sheet!

Option :	PR-1	DPR at Laguna Treatment Plant
Storage (AF):	0	as entered in Options definition
Storage threshold ($/AF):	0	(n/a)
Capital cost ($M/yr)	10.20	as entered in Options definition
Fixed OMR ($M/yr)	0.87	as entered in Options definition
Fixed capital + OMR ($M/yr)	11.08	sum of amoritized capital plus fixed OMR

Scenario:	2	Replay it again Sam, historic hydrology with base year 1920
Hydrology type:	Historic	
Base year:	1920	Base year of historic replay
Synthetic hydrology ID:	n/a	
Synthetic hydrology index:	n/a	
Sonoma reductions by year type: Wet	0%	
Normal	0%	
Dry	30%	



SUMMARY OF RESULTS

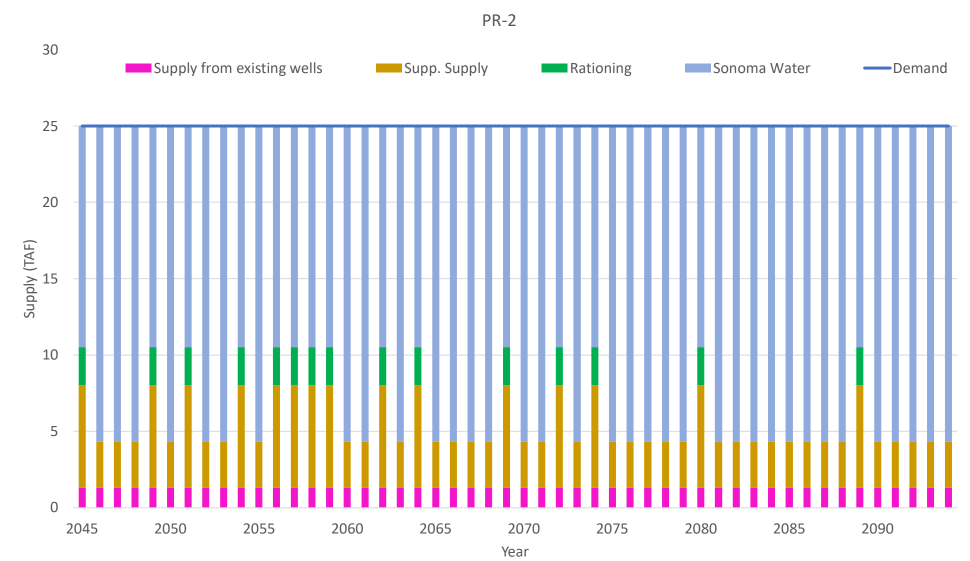
Years with any rationing	15	out of 50 years
Years with rationing over state levels	0	
Max rationing	10%	based on nominal demand
Max AFY supplemental supply	6,724	AF/yr
Avg Sonoma Water	18,819	AF/yr
Avg Sonoma Water Cost	22.6	$M/yr
Average AFY supplemental	4,131	based on scenario usage year-by-year, shown below
Max supplemental AFY	6,724	
Average marginal OMR $M/yr	3.83	based on scenario usage year-by-year, shown below
Average total $M/yr for supp. Supply	14.90	combining with fixed costs shown above
Average $/AF supplemental	$3,608	
Avg total cost including supplement + Sonoma	37.5	$M/yr
Average OMR $/yr	4.70	sum of fixed and marginal OMR

Year	*Year type*	*Sonoma Water % redu for year type*	*Demand*	*Supply from existing wells*	*Min supp AF*	*Max supp AF*	*Baseline demand for SW*	*Sonoma Water max avail (AF)*	*State-imposed rationing for year type*	*Eff demand AF*	*Sonoma Water*	*Sonoma Water cost $M*	*Supply deficit AF*	*Supp supply Marginal cost $/AF*	*Supp supply used for demand (AF)*	*AF Residual shortage (surplus)*	*Needed rationing based on supply*	*Actual rationing level*	*Rationing*	*Supp. Supply*
2045	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$927	6,724	0	0%	10%	2,500	6,724
2046	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2047	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2048	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2049	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$927	6,724	0	0%	10%	2,500	6,724
2050	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2051	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$927	6,724	0	0%	10%	2,500	6,724
2052	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2053	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2054	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$927	6,724	0	0%	10%	2,500	6,724
2055	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2056	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$927	6,724	0	0%	10%	2,500	6,724
2057	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$927	6,724	0	0%	10%	2,500	6,724
2058	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$927	6,724	0	0%	10%	2,500	6,724
2059	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$927	6,724	0	0%	10%	2,500	6,724
2060	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2061	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2062	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$927	6,724	0	0%	10%	2,500	6,724
2063	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2064	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$927	6,724	0	0%	10%	2,500	6,724
2065	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2066	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2067	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2068	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2069	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$927	6,724	0	0%	10%	2,500	6,724
2070	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2071	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2072	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$927	6,724	0	0%	10%	2,500	6,724
2073	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2074	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$927	6,724	0	0%	10%	2,500	6,724
2075	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2076	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2077	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2078	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2079	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2080	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$927	6,724	0	0%	10%	2,500	6,724
2081	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2082	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2083	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2084	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2085	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2086	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2087	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2088	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2089	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$927	6,724	0	0%	10%	2,500	6,724
2090	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2091	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2092	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2093	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019
2094	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$927	3,019	0	0%	0%	0	3,019

Choose an option to model, and a scenario to model it against. Those are the only two inputs on this sheet!

Option :	PR-2	Satellite DPR (from RW line)
Storage (AF):	0	as entered in Options definition
Storage threshold ($/AF):	0	(n/a)
Capital cost ($M/yr)	11.07	as entered in Options definition
Fixed OMR ($M/yr)	0.95	as entered in Options definition
Fixed capital + OMR ($M/yr)	12.03	sum of amoritized capital plus fixed OMR

Scenario:	2	Replay it again Sam, historic hydrology with base year 1920
Hydrology type:	Historic	
Base year:	1920	Base year of historic replay
Synthetic hydrology ID:	n/a	
Synthetic hydrology index:	n/a	
Sonoma reductions by year type: Wet	0%	
Normal	0%	
Dry	30%	



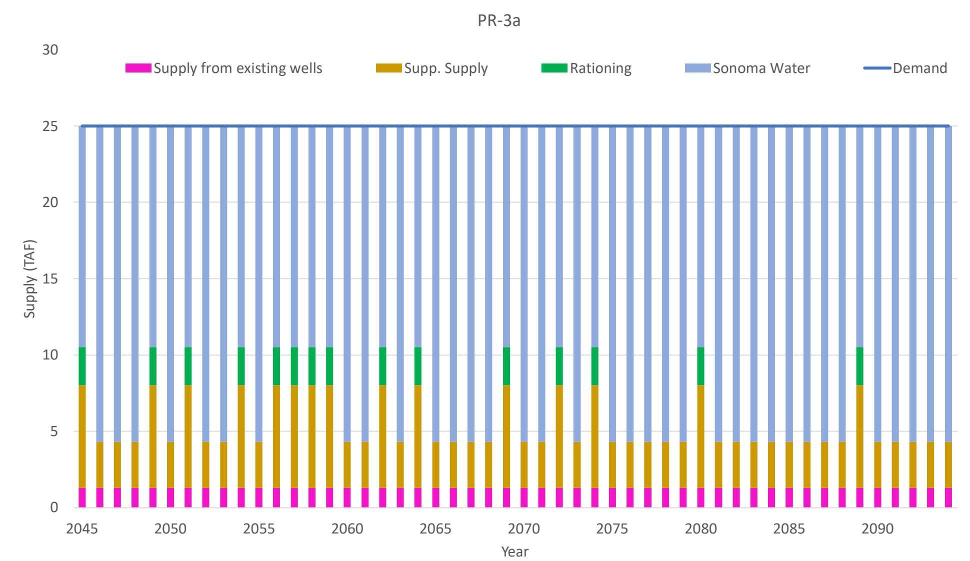
SUMMARY OF RESULTS

Years with any rationing	15	out of 50 years
Years with rationing over state levels	0	
Max rationing	10%	based on nominal demand
Max AFY supplemental supply	6,724	AF/yr
Avg Sonoma Water	18,819	AF/yr
Avg Sonoma Water Cost	22.6	$M/yr
Average AFY supplemental	4,131	based on scenario usage year-by-year, shown below
Max supplemental AFY	6,724	
Average marginal OMR $M/yr	3.89	based on scenario usage year-by-year, shown below
Average total $M/yr for supp. Supply	15.92	combining with fixed costs shown above
Average $/AF supplemental	$3,854	
Avg total cost including supplement + Sonoma	38.5	$M/yr
Average OMR $/yr	4.85	sum of fixed and marginal OMR

Year	*Year type*	*Sonoma Water % redu for year type*	*Demand*	*Supply from existing wells*	*Min supp AF*	*Max supp AF*	*Baseline demand for SW*	*Sonoma Water max avail (AF)*	*State-imposed rationing for year type*	*Eff demand AF*	*Sonoma Water*	*Sonoma Water cost $M*	*Supply deficit AF*	*Supp supply Marginal cost $/AF*	*Supp supply used for demand (AF)*	*AF Residual shortage (surplus)*	*Needed rationing based on supply*	*Actual rationing level*	*Rationing*	*Supp. Supply*
2045	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$943	6,724	0	0%	10%	2,500	6,724
2046	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2047	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2048	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2049	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$943	6,724	0	0%	10%	2,500	6,724
2050	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2051	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$943	6,724	0	0%	10%	2,500	6,724
2052	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2053	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2054	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$943	6,724	0	0%	10%	2,500	6,724
2055	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2056	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$943	6,724	0	0%	10%	2,500	6,724
2057	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$943	6,724	0	0%	10%	2,500	6,724
2058	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$943	6,724	0	0%	10%	2,500	6,724
2059	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$943	6,724	0	0%	10%	2,500	6,724
2060	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2061	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2062	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$943	6,724	0	0%	10%	2,500	6,724
2063	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2064	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$943	6,724	0	0%	10%	2,500	6,724
2065	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2066	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2067	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2068	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2069	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$943	6,724	0	0%	10%	2,500	6,724
2070	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2071	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2072	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$943	6,724	0	0%	10%	2,500	6,724
2073	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2074	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$943	6,724	0	0%	10%	2,500	6,724
2075	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2076	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2077	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2078	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2079	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2080	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$943	6,724	0	0%	10%	2,500	6,724
2081	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2082	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2083	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2084	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2085	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2086	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2087	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2088	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2089	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$943	6,724	0	0%	10%	2,500	6,724
2090	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2091	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2092	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2093	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019
2094	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$943	3,019	0	0%	0%	0	3,019

Choose an option to model, and a scenario to model it against. Those are the only two inputs on this sheet!

Option :	PR-3a	IPR to Delta Pond
Storage (AF):	0	as entered in Options definition
Storage threshold ($/AF):	0	(n/a)
Capital cost ($M/yr)	14.78	as entered in Options definition
Fixed OMR ($M/yr)	1.07	as entered in Options definition
Fixed capital + OMR ($M/yr)	15.85	sum of amoritized capital plus fixed OMR
Scenario:	2	Replay it again Sam, historic hydrology with base year 1920
Hydrology type:	Historic	
Base year:	1920	Base year of historic replay
Synthetic hydrology ID:	n/a	
Synthetic hydrology index:	n/a	
Sonoma reductions by year type: Wet	0%	
Normal	0%	
Dry	30%	



SUMMARY OF RESULTS

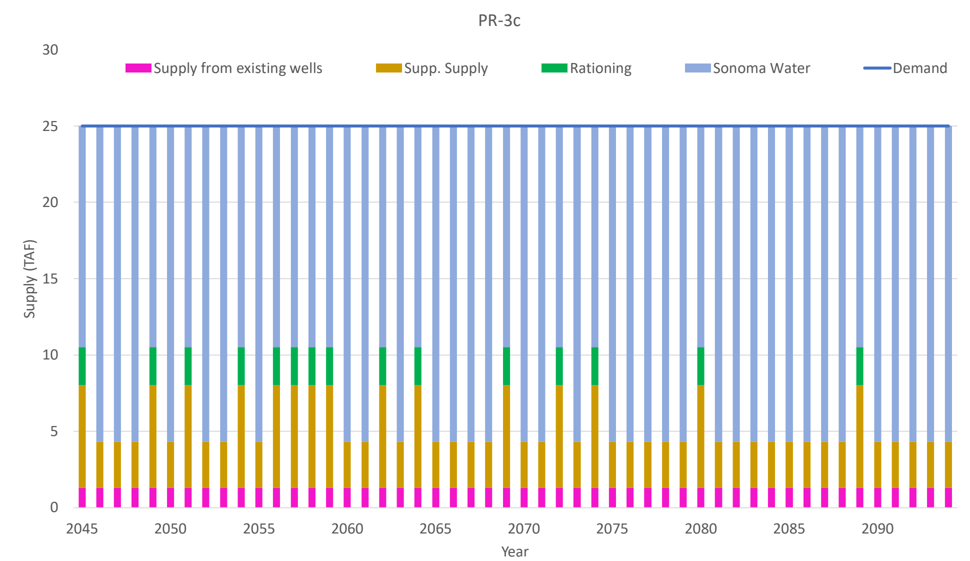
Years with any rationing	15	out of 50 years
Years with rationing over state levels	0	
Max rationing	10%	based on nominal demand
Max AFY supplemental supply	6,724	AF/yr
Avg Sonoma Water	18,819	AF/yr
Avg Sonoma Water Cost	22.6	$M/yr
Average AFY supplemental	4,131	based on scenario usage year-by-year, shown below
Max supplemental AFY	6,724	
Average marginal OMR $M/yr	3.87	based on scenario usage year-by-year, shown below
Average total $M/yr for supp. Supply	19.72	combining with fixed costs shown above
Average $/AF supplemental	$4,775	
Avg total cost including supplement + Sonoma	42.3	$M/yr
Average OMR $/yr	4.94	sum of fixed and marginal OMR

Year	*Year type*	*Sonoma Water % redu for year type*	*Demand*	*Supply from existing wells*	*Min supp AF*	*Max supp AF*	*Baseline demand for SW*	*Sonoma Water max avail (AF)*	*State-imposed rationing for year type*	*Eff demand AF*	*Sonoma Water*	*Sonoma Water cost $M*	*Supply deficit AF*	*Supp supply Marginal cost $/AF*	*Supp supply used for demand (AF)*	*AF Residual shortage (surplus)*	*Needed rationing based on supply*	*Actual rationing level*	*Rationing*	*Supp. Supply*
2045	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$936	6,724	0	0%	10%	2,500	6,724
2046	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2047	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2048	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2049	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$936	6,724	0	0%	10%	2,500	6,724
2050	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2051	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$936	6,724	0	0%	10%	2,500	6,724
2052	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2053	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2054	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$936	6,724	0	0%	10%	2,500	6,724
2055	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2056	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$936	6,724	0	0%	10%	2,500	6,724
2057	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$936	6,724	0	0%	10%	2,500	6,724
2058	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$936	6,724	0	0%	10%	2,500	6,724
2059	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$936	6,724	0	0%	10%	2,500	6,724
2060	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2061	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2062	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$936	6,724	0	0%	10%	2,500	6,724
2063	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2064	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$936	6,724	0	0%	10%	2,500	6,724
2065	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2066	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2067	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2068	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2069	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$936	6,724	0	0%	10%	2,500	6,724
2070	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2071	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2072	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$936	6,724	0	0%	10%	2,500	6,724
2073	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2074	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$936	6,724	0	0%	10%	2,500	6,724
2075	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2076	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2077	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2078	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2079	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2080	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$936	6,724	0	0%	10%	2,500	6,724
2081	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2082	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2083	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2084	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2085	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2086	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2087	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2088	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2089	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$936	6,724	0	0%	10%	2,500	6,724
2090	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2091	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2092	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2093	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019
2094	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$936	3,019	0	0%	0%	0	3,019

Choose an option to model, and a scenario to model it against. Those are the only two inputs on this sheet!

Option :	PR-3c	IPR to Lake Sonoma
Storage (AF):	0	as entered in Options definition
Storage threshold ($/AF):	0	(n/a)
Capital cost ($M/yr)	19.82	as entered in Options definition
Fixed OMR ($M/yr)	1.79	as entered in Options definition
Fixed capital + OMR ($M/yr)	21.61	sum of amoritized capital plus fixed OMR

	Scenario:	2	Replay it again Sam, historic hydrology with base year 1920
	Hydrology type:	Historic	
	Base year:	1920	Base year of historic replay
	Synthetic hydrology ID:	n/a	
	Synthetic hydrology index:	n/a	
Sonoma reductions by year type:	**Wet**	0%	
	Normal	0%	
	Dry	30%	



SUMMARY OF RESULTS

Years with any rationing	15	out of 50 years
Years with rationing over state levels	0	
Max rationing	10%	based on nominal demand
Max AFY supplemental supply	6,724	AF/yr
Avg Sonoma Water	18,819	AF/yr
Avg Sonoma Water Cost	22.6	$M/yr

Average AFY supplemental	4,131	based on scenario usage year-by-year, shown below
Max supplemental AFY	6,724	
Average marginal OMR $M/yr	4.96	based on scenario usage year-by-year, shown below
Average total $M/yr for supp. Supply	26.57	combining with fixed costs shown above
Average $/AF supplemental	$6,431	
Avg total cost including supplement + Sonoma	49.1	$M/yr
Average OMR $/yr	6.75	sum of fixed and marginal OMR

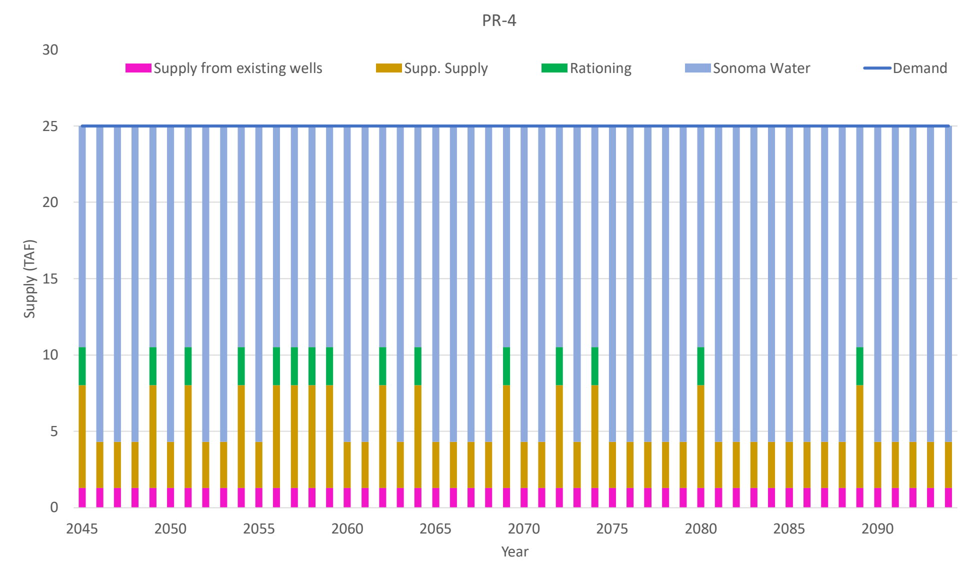
Year	*Year type*	*Sonoma Water % redu for year type*	*Demand*	*Supply from existing wells*	*Min supp AF*	*Max supp AF*	*Baseline demand for SW*	*Sonoma Water max avail (AF)*	*State-imposed rationing for year type*	*Eff demand AF*	*Sonoma Water*	*Sonoma Water cost $M*	*Supply deficit AF*	*Supp supply Marginal cost $/AF*	*Supp supply used for demand (AF)*	*AF Residual shortage (surplus)*	*Needed rationing based on supply*	*Actual rationing level*	*Rationing*	*Supp. Supply*
2045	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$1,201	6,724	0	0%	10%	2,500	6,724
2046	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2047	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2048	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2049	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$1,201	6,724	0	0%	10%	2,500	6,724
2050	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2051	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$1,201	6,724	0	0%	10%	2,500	6,724
2052	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2053	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2054	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$1,201	6,724	0	0%	10%	2,500	6,724
2055	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2056	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$1,201	6,724	0	0%	10%	2,500	6,724
2057	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$1,201	6,724	0	0%	10%	2,500	6,724
2058	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$1,201	6,724	0	0%	10%	2,500	6,724
2059	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$1,201	6,724	0	0%	10%	2,500	6,724
2060	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2061	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2062	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$1,201	6,724	0	0%	10%	2,500	6,724
2063	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2064	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$1,201	6,724	0	0%	10%	2,500	6,724
2065	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2066	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2067	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2068	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2069	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$1,201	6,724	0	0%	10%	2,500	6,724
2070	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2071	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2072	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$1,201	6,724	0	0%	10%	2,500	6,724
2073	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2074	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$1,201	6,724	0	0%	10%	2,500	6,724
2075	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2076	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2077	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2078	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2079	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2080	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$1,201	6,724	0	0%	10%	2,500	6,724
2081	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2082	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2083	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2084	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2085	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2086	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2087	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2088	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2089	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$1,201	6,724	0	0%	10%	2,500	6,724
2090	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2091	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2092	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2093	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019
2094	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$1,201	3,019	0	0%	0%	0	3,019

Choose an option to model, and a scenario to model it against. Those are the only two inputs on this sheet!

Option :	PR-4	Regional DPR at LTP
Storage (AF):	0	as entered in Options definition
Storage threshold ($/AF):	0	(n/a)
Capital cost ($M/yr)	8.71	as entered in Options definition
Fixed OMR ($M/yr)	0.71	as entered in Options definition
Fixed capital + OMR ($M/yr)	9.42	sum of amoritized capital plus fixed OMR
Scenario:	2	Replay it again Sam, historic hydrology with base year 1920
Hydrology type:	Historic	
Base year:	1920	Base year of historic replay
Synthetic hydrology ID:	n/a	
Synthetic hydrology index:	n/a	
Sonoma reductions by year type: Wet	0%	
Normal	0%	
Dry	30%	

SUMMARY OF RESULTS

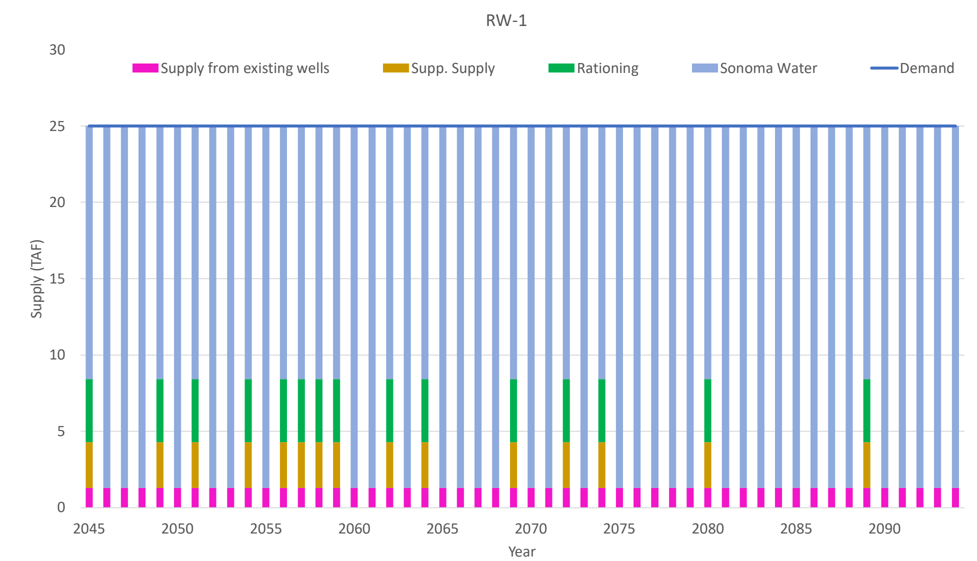
Years with any rationing	15	out of 50 years
Years with rationing over state levels	0	
Max rationing	10%	based on nominal demand
Max AFY supplemental supply	6,724	AF/yr
Avg Sonoma Water	18,819	AF/yr
Avg Sonoma Water Cost	22.6	$M/yr
Average AFY supplemental	4,131	based on scenario usage year-by-year, shown below
Max supplemental AFY	6,724	
Average marginal OMR $M/yr	3.66	based on scenario usage year-by-year, shown below
Average total $M/yr for supp. Supply	13.08	combining with fixed costs shown above
Average $/AF supplemental	$3,166	
Avg total cost including supplement + Sonoma	35.7	$M/yr
Average OMR $/yr	4.37	sum of fixed and marginal OMR



Year	Year type	Sonoma Water % redu for year type	Demand	Supply from existing wells	Min supp AF	Max supp AF	Baseline demand for SW	Sonoma Water max avail (AF)	State-imposed rationing for year type	Eff demand AF	Sonoma Water	Sonoma Water cost $M	Supply deficit AF	Supp supply Marginal cost $/AF	Supp supply used for demand (AF)	AF Residual shortage (surplus)	Needed rationing based on supply	Actual rationing level	Rationing	Supp. Supply
2045	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$885	6,724	0	0%	10%	2,500	6,724
2046	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2047	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2048	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2049	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$885	6,724	0	0%	10%	2,500	6,724
2050	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2051	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$885	6,724	0	0%	10%	2,500	6,724
2052	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2053	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2054	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$885	6,724	0	0%	10%	2,500	6,724
2055	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2056	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$885	6,724	0	0%	10%	2,500	6,724
2057	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$885	6,724	0	0%	10%	2,500	6,724
2058	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$885	6,724	0	0%	10%	2,500	6,724
2059	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$885	6,724	0	0%	10%	2,500	6,724
2060	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2061	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2062	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$885	6,724	0	0%	10%	2,500	6,724
2063	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2064	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$885	6,724	0	0%	10%	2,500	6,724
2065	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2066	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2067	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2068	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2069	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$885	6,724	0	0%	10%	2,500	6,724
2070	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2071	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2072	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$885	6,724	0	0%	10%	2,500	6,724
2073	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2074	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$885	6,724	0	0%	10%	2,500	6,724
2075	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2076	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2077	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2078	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2079	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2080	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$885	6,724	0	0%	10%	2,500	6,724
2081	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2082	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2083	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2084	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2085	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2086	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2087	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2088	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2089	Dry	30%	25,000	1,300	3,019	10,065	20,681	14,476	10%	22,500	14,476	17.4	6,724	$885	6,724	0	0%	10%	2,500	6,724
2090	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2091	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2092	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2093	Normal	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019
2094	Wet	0%	25,000	1,300	3,019	10,065	20,681	20,681	0%	25,000	20,681	24.8	3,019	$885	3,019	0	0%	0%	0	3,019

Choose an option to model, and a scenario to model it against. Those are the only two inputs on this sheet!

Option :	RW-1	Nonpotable Recycled Expansion
Storage (AF):	0	as entered in Options definition
Storage threshold ($/AF):	0	(n/a)
Capital cost ($M/yr)	7.55	as entered in Options definition
Fixed OMR ($M/yr)	1.27	as entered in Options definition
Fixed capital + OMR ($M/yr)	8.82	sum of amoritized capital plus fixed OMR
Scenario:	2	Replay it again Sam, historic hydrology with base year 1920
Hydrology type:	Historic	
Base year:	1920	Base year of historic replay
Synthetic hydrology ID:	n/a	
Synthetic hydrology index:	n/a	
Sonoma reductions by year type: Wet	0%	
Normal	0%	
Dry	30%	



SUMMARY OF RESULTS

Years with any rationing	15	out of 50 years
Years with rationing over state levels	15	
Max rationing	16%	based on nominal demand
Max AFY supplemental supply	3,000	AF/yr
Avg Sonoma Water	21,567	AF/yr
Avg Sonoma Water Cost	25.9	$M/yr
Average AFY supplemental	900	based on scenario usage year-by-year, shown below
Max supplemental AFY	3,000	
Average marginal OMR $M/yr	0.00	based on scenario usage year-by-year, shown below
Average total $M/yr for supp. Supply	8.82	combining with fixed costs shown above
Average $/AF supplemental	$9,795	
Avg total cost including supplement + Sonoma	34.7	$M/yr
Average OMR $/yr	1.27	sum of fixed and marginal OMR

Year	*Year type*	*Sonoma Water % redu for year type*	*Demand*	*Supply from existing wells*	*Min supp AF*	*Max supp AF*	*Baseline demand for SW*	*Sonoma Water max avail (AF)*	*State-imposed rationing for year type*	*Eff demand AF*	*Sonoma Water*	*Sonoma Water cost $M*	*Supply deficit AF*	*Supp supply Marginal cost $/AF*	*Supp supply used for demand (AF)*	*AF Residual shortage (surplus)*	*Needed rationing based on supply*	*Actual rationing level*	*Rationing*	*Supp. Supply*
2045	Dry	30%	25,000	1,300	0	3,000	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	3,000	1,610	16%	16%	4,110	3,000
2046	Wet	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2047	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2048	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2049	Dry	30%	25,000	1,300	0	3,000	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	3,000	1,610	16%	16%	4,110	3,000
2050	Wet	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2051	Dry	30%	25,000	1,300	0	3,000	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	3,000	1,610	16%	16%	4,110	3,000
2052	Wet	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2053	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2054	Dry	30%	25,000	1,300	0	3,000	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	3,000	1,610	16%	16%	4,110	3,000
2055	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2056	Dry	30%	25,000	1,300	0	3,000	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	3,000	1,610	16%	16%	4,110	3,000
2057	Dry	30%	25,000	1,300	0	3,000	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	3,000	1,610	16%	16%	4,110	3,000
2058	Dry	30%	25,000	1,300	0	3,000	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	3,000	1,610	16%	16%	4,110	3,000
2059	Dry	30%	25,000	1,300	0	3,000	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	3,000	1,610	16%	16%	4,110	3,000
2060	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2061	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2062	Dry	30%	25,000	1,300	0	3,000	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	3,000	1,610	16%	16%	4,110	3,000
2063	Wet	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2064	Dry	30%	25,000	1,300	0	3,000	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	3,000	1,610	16%	16%	4,110	3,000
2065	Wet	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2066	Wet	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2067	Wet	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2068	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2069	Dry	30%	25,000	1,300	0	3,000	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	3,000	1,610	16%	16%	4,110	3,000
2070	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2071	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2072	Dry	30%	25,000	1,300	0	3,000	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	3,000	1,610	16%	16%	4,110	3,000
2073	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2074	Dry	30%	25,000	1,300	0	3,000	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	3,000	1,610	16%	16%	4,110	3,000
2075	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2076	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2077	Wet	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2078	Wet	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2079	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2080	Dry	30%	25,000	1,300	0	3,000	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	3,000	1,610	16%	16%	4,110	3,000
2081	Wet	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2082	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2083	Wet	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2084	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2085	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2086	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2087	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2088	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2089	Dry	30%	25,000	1,300	0	3,000	23,700	16,590	10%	22,500	16,590	19.9	4,610	$0	3,000	1,610	16%	16%	4,110	3,000
2090	Wet	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2091	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2092	Wet	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2093	Normal	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0
2094	Wet	0%	25,000	1,300	0	3,000	23,700	23,700	0%	25,000	23,700	28.4	0	$0	0	0	0%	0%	0	0

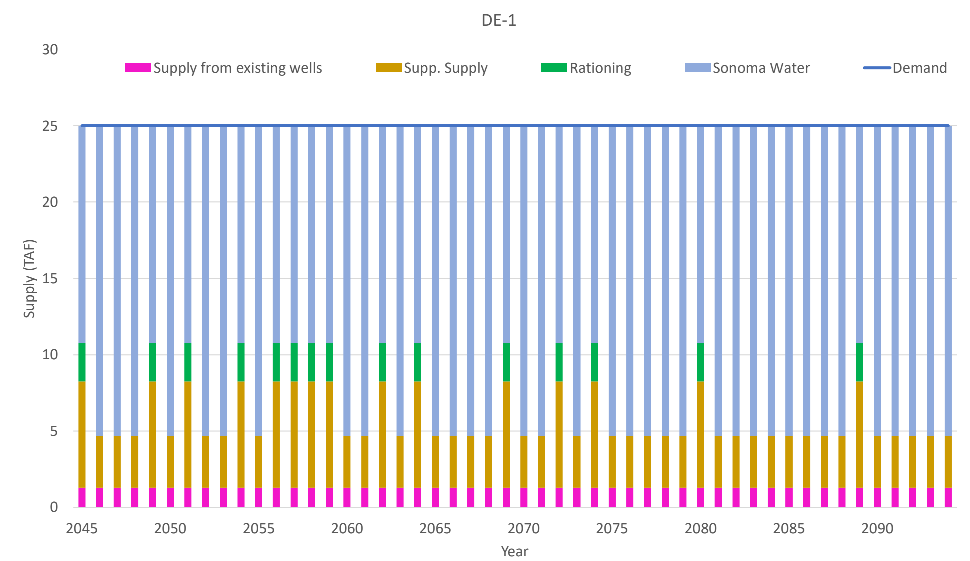
Choose an option to model, and a scenario to model it against. Those are the only two inputs on this sheet!

Option :	DE-1	Regional Desalination (MMWD)
Storage (AF):	0	as entered in Options definition
Storage threshold ($/AF):	0	(n/a)
Capital cost ($M/yr)	6.12	as entered in Options definition
Fixed OMR ($M/yr)	0.91	as entered in Options definition
Fixed capital + OMR ($M/yr)	7.03	sum of amoritized capital plus fixed OMR

Scenario:	2	Replay it again Sam, historic hydrology with base year 1920
Hydrology type:	Historic	
Base year:	1920	Base year of historic replay
Synthetic hydrology ID:	n/a	
Synthetic hydrology index:	n/a	
Sonoma reductions by year type: Wet	0%	
Normal	0%	
Dry	30%	

SUMMARY OF RESULTS

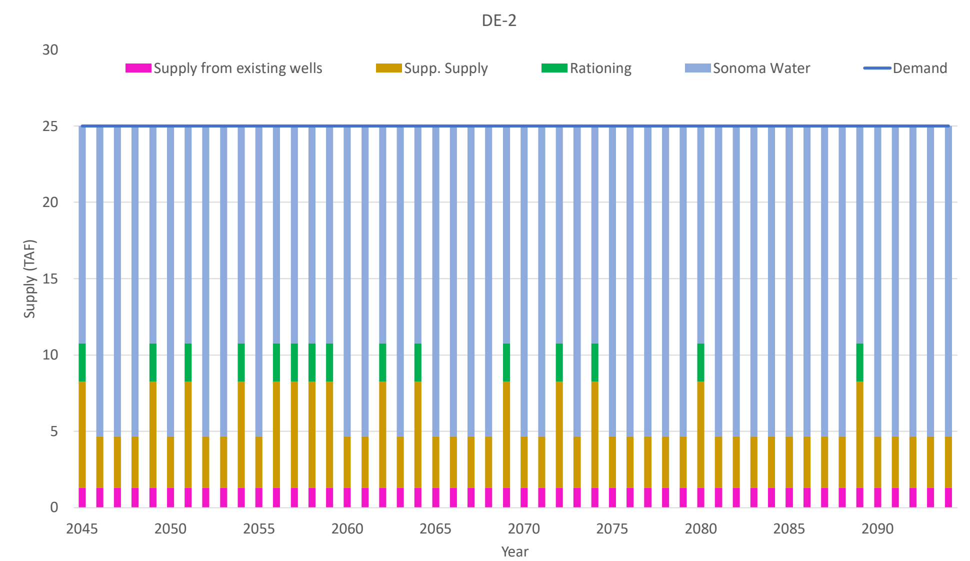
Years with any rationing	15	out of 50 years
Years with rationing over state levels	0	
Max rationing	10%	based on nominal demand
Max AFY supplemental supply	6,962	AF/yr
Avg Sonoma Water	18,509	AF/yr
Avg Sonoma Water Cost	22.2	$M/yr
Average AFY supplemental	4,441	based on scenario usage year-by-year, shown below
Max supplemental AFY	6,962	
Average marginal OMR $M/yr	1.78	based on scenario usage year-by-year, shown below
Average total $M/yr for supp. Supply	8.82	combining with fixed costs shown above
Average $/AF supplemental	$1,985	
Avg total cost including supplement + Sonoma	31.0	$M/yr
Average OMR $/yr	2.69	sum of fixed and marginal OMR



Year	*Year type*	*Sonoma Water % redu for year type*	*Demand*	*Supply from existing wells*	*Min supp AF*	*Max supp AF*	*Baseline demand for SW*	*Sonoma Water max avail (AF)*	*State-imposed rationing for year type*	*Eff demand AF*	*Sonoma Water*	*Sonoma Water cost $M*	*Supply deficit AF*	*Supp supply Marginal cost $/AF*	*Supp supply used for demand (AF)*	*AF Residual shortage (surplus)*	*Needed rationing based on supply*	*Actual rationing level*	*Rationing*	*Supp. Supply*
2045	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$401	6,962	0	0%	10%	2,500	6,962
2046	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2047	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2048	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2049	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$401	6,962	0	0%	10%	2,500	6,962
2050	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2051	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$401	6,962	0	0%	10%	2,500	6,962
2052	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2053	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2054	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$401	6,962	0	0%	10%	2,500	6,962
2055	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2056	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$401	6,962	0	0%	10%	2,500	6,962
2057	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$401	6,962	0	0%	10%	2,500	6,962
2058	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$401	6,962	0	0%	10%	2,500	6,962
2059	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$401	6,962	0	0%	10%	2,500	6,962
2060	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2061	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2062	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$401	6,962	0	0%	10%	2,500	6,962
2063	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2064	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$401	6,962	0	0%	10%	2,500	6,962
2065	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2066	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2067	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2068	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2069	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$401	6,962	0	0%	10%	2,500	6,962
2070	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2071	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2072	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$401	6,962	0	0%	10%	2,500	6,962
2073	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2074	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$401	6,962	0	0%	10%	2,500	6,962
2075	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2076	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2077	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2078	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2079	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2080	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$401	6,962	0	0%	10%	2,500	6,962
2081	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2082	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2083	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2084	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2085	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2086	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2087	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2088	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2089	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$401	6,962	0	0%	10%	2,500	6,962
2090	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2091	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2092	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2093	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360
2094	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$401	3,360	0	0%	0%	0	3,360

Choose an option to model, and a scenario to model it against. Those are the only two inputs on this sheet!

Option :	DE-2	Ocean Desalination
Storage (AF):	0	as entered in Options definition
Storage threshold ($/AF):	0	(n/a)
Capital cost ($M/yr)	13.33	as entered in Options definition
Fixed OMR ($M/yr)	1.60	as entered in Options definition
Fixed capital + OMR ($M/yr)	14.93	sum of amoritized capital plus fixed OMR
Scenario:	2	Replay it again Sam, historic hydrology with base year 1920
Hydrology type:	Historic	
Base year:	1920	Base year of historic replay
Synthetic hydrology ID:	n/a	
Synthetic hydrology index:	n/a	
Sonoma reductions by year type: Wet	0%	
Normal	0%	
Dry	30%	



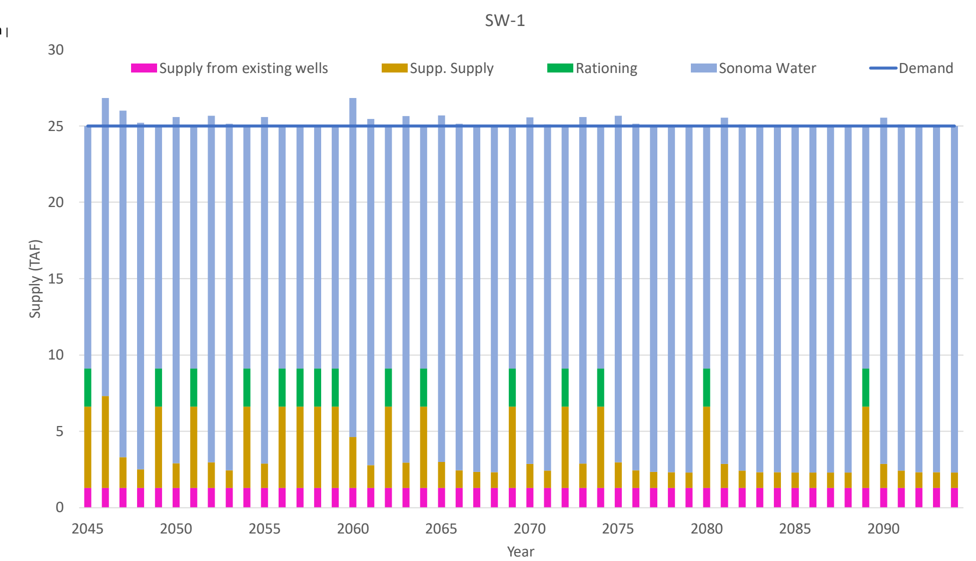
SUMMARY OF RESULTS

Years with any rationing	15	out of 50 years
Years with rationing over state levels	0	
Max rationing	10%	based on nominal demand
Max AFY supplemental supply	6,962	AF/yr
Avg Sonoma Water	18,509	AF/yr
Avg Sonoma Water Cost	22.2	$M/yr
Average AFY supplemental	4,441	based on scenario usage year-by-year, shown below
Max supplemental AFY	6,962	
Average marginal OMR $M/yr	5.17	based on scenario usage year-by-year, shown below
Average total $M/yr for supp. Supply	20.11	combining with fixed costs shown above
Average $/AF supplemental	$4,528	
Avg total cost including supplement + Sonoma	42.3	$M/yr
Average OMR $/yr	6.78	sum of fixed and marginal OMR

Year	*Year type*	*Sonoma Water % redu for year type*	*Demand*	*Supply from existing wells*	*Min supp AF*	*Max supp AF*	*Baseline demand for SW*	*Sonoma Water max avail (AF)*	*State-imposed rationing for year type*	*Eff demand AF*	*Sonoma Water*	*Sonoma Water cost $M*	*Supply deficit AF*	*Supp supply Marginal cost $/AF*	*Supp supply used for demand (AF)*	*AF Residual shortage (surplus)*	*Needed rationing based on supply*	*Actual rationing level*	*Rationing*	*Supp. Supply*
2045	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$1,165	6,962	0	0%	10%	2,500	6,962
2046	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2047	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2048	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2049	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$1,165	6,962	0	0%	10%	2,500	6,962
2050	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2051	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$1,165	6,962	0	0%	10%	2,500	6,962
2052	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2053	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2054	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$1,165	6,962	0	0%	10%	2,500	6,962
2055	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2056	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$1,165	6,962	0	0%	10%	2,500	6,962
2057	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$1,165	6,962	0	0%	10%	2,500	6,962
2058	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$1,165	6,962	0	0%	10%	2,500	6,962
2059	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$1,165	6,962	0	0%	10%	2,500	6,962
2060	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2061	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2062	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$1,165	6,962	0	0%	10%	2,500	6,962
2063	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2064	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$1,165	6,962	0	0%	10%	2,500	6,962
2065	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2066	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2067	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2068	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2069	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$1,165	6,962	0	0%	10%	2,500	6,962
2070	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2071	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2072	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$1,165	6,962	0	0%	10%	2,500	6,962
2073	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2074	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$1,165	6,962	0	0%	10%	2,500	6,962
2075	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2076	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2077	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2078	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2079	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2080	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$1,165	6,962	0	0%	10%	2,500	6,962
2081	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2082	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2083	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2084	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2085	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2086	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2087	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2088	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2089	Dry	30%	25,000	1,300	3,360	10,080	20,340	14,238	10%	22,500	14,238	17.1	6,962	$1,165	6,962	0	0%	10%	2,500	6,962
2090	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2091	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2092	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2093	Normal	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360
2094	Wet	0%	25,000	1,300	3,360	10,080	20,340	20,340	0%	25,000	20,340	24.4	3,360	$1,165	3,360	0	0%	0%	0	3,360

Choose an option to model, and a scenario to model it against. Those are the only two inputs on this sheet!

Option :	SW-1	Stormwater stored in aquifer
Storage (AF):	5,000	as entered in Options definition
Storage threshold ($/AF):	500	supplemental supply is only used for discretionary storage puts when
Capital cost ($M/yr)	7.84	as entered in Options definition
Fixed OMR ($M/yr)	0.54	as entered in Options definition
Fixed capital + OMR ($M/yr)	8.39	sum of amoritized capital plus fixed OMR
Scenario:	2	Replay it again Sam, historic hydrology with base year 1920
Hydrology type:	Historic	
Base year:	1920	Base year of historic replay
Synthetic hydrology ID:	n/a	
Synthetic hydrology index:	n/a	
Sonoma reductions by year type: Wet	0%	
Normal	0%	
Dry	30%	



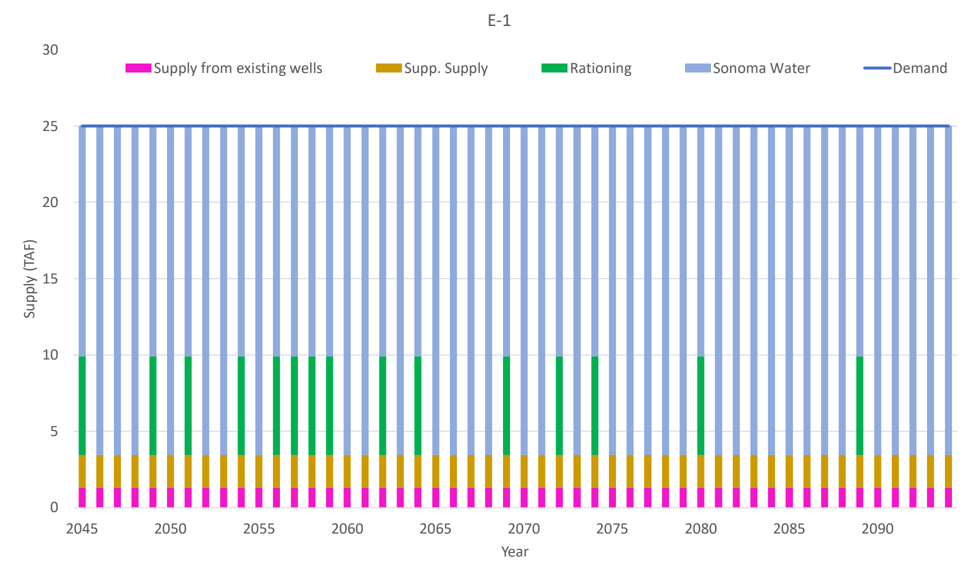
SUMMARY OF RESULTS

Years with any rationing	15	out of 50 years
Years with rationing over state levels	0	
Max rationing	10%	based on nominal demand
Max AFY supplemental supply	6,008	AF/yr
Avg Sonoma Water	20,650	AF/yr
Avg Sonoma Water Cost	24.8	$M/yr
Average AFY supplemental	2,618	based on scenario usage year-by-year, shown below
Max supplemental AFY	6,008	
Average marginal OMR $M/yr	0.79	based on scenario usage year-by-year, shown below
Average total $M/yr for supp. Supply	9.18	combining with fixed costs shown above
Average $/AF supplemental	$3,507	
Avg total cost including supplement + Sonoma	34.0	$M/yr
Average OMR $/yr	1.34	sum of fixed and marginal OMR

Year	*Year type*	*Sonoma Water % redu for year type*	*Demand*	*Supply from existing wells*	*Min supp AF*	*Max supp AF*	*Baseline demand for SW*	*Sonoma Water max avail (AF)*	*State-imposed rationing for year type*	*Eff demand AF*	*Sonoma Water*	*Sonoma Water cost $M*	*Supply deficit AF*	*Supp supply Marginal cost $/AF*	*Supp supply used for demand (AF)*	*AF Residual shortage (surplus)*	*Needed rationing based on supply*	*Actual rationing level*	*Rationing*	*Supp. Supply*
2045	Dry	30%	25,000	1,300	1,008	10,080	22,692	15,884	10%	22,500	15,884	19.1	5,316	$303	5,316	0	0%	10%	2,500	5,316
2046	Wet	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	6,008
2047	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	2,008
2048	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,208
2049	Dry	30%	25,000	1,300	1,008	10,080	22,692	15,884	10%	22,500	15,884	19.1	5,316	$303	5,316	0	0%	10%	2,500	5,316
2050	Wet	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,599
2051	Dry	30%	25,000	1,300	1,008	10,080	22,692	15,884	10%	22,500	15,884	19.1	5,316	$303	5,316	0	0%	10%	2,500	5,316
2052	Wet	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,677
2053	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,142
2054	Dry	30%	25,000	1,300	1,008	10,080	22,692	15,884	10%	22,500	15,884	19.1	5,316	$303	5,316	0	0%	10%	2,500	5,316
2055	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,586
2056	Dry	30%	25,000	1,300	1,008	10,080	22,692	15,884	10%	22,500	15,884	19.1	5,316	$303	5,316	0	0%	10%	2,500	5,316
2057	Dry	30%	25,000	1,300	1,008	10,080	22,692	15,884	10%	22,500	15,884	19.1	5,316	$303	5,316	0	0%	10%	2,500	5,316
2058	Dry	30%	25,000	1,300	1,008	10,080	22,692	15,884	10%	22,500	15,884	19.1	5,316	$303	5,316	0	0%	10%	2,500	5,316
2059	Dry	30%	25,000	1,300	1,008	10,080	22,692	15,884	10%	22,500	15,884	19.1	5,316	$303	5,316	0	0%	10%	2,500	5,316
2060	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	3,328
2061	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,472
2062	Dry	30%	25,000	1,300	1,008	10,080	22,692	15,884	10%	22,500	15,884	19.1	5,316	$303	5,316	0	0%	10%	2,500	5,316
2063	Wet	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,652
2064	Dry	30%	25,000	1,300	1,008	10,080	22,692	15,884	10%	22,500	15,884	19.1	5,316	$303	5,316	0	0%	10%	2,500	5,316
2065	Wet	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,688
2066	Wet	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,144
2067	Wet	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,035
2068	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,013
2069	Dry	30%	25,000	1,300	1,008	10,080	22,692	15,884	10%	22,500	15,884	19.1	5,316	$303	5,316	0	0%	10%	2,500	5,316
2070	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,560
2071	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,118
2072	Dry	30%	25,000	1,300	1,008	10,080	22,692	15,884	10%	22,500	15,884	19.1	5,316	$303	5,316	0	0%	10%	2,500	5,316
2073	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,581
2074	Dry	30%	25,000	1,300	1,008	10,080	22,692	15,884	10%	22,500	15,884	19.1	5,316	$303	5,316	0	0%	10%	2,500	5,316
2075	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,674
2076	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,141
2077	Wet	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,035
2078	Wet	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,013
2079	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,009
2080	Dry	30%	25,000	1,300	1,008	10,080	22,692	15,884	10%	22,500	15,884	19.1	5,316	$303	5,316	0	0%	10%	2,500	5,316
2081	Wet	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,559
2082	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,118
2083	Wet	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,030
2084	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,012
2085	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,009
2086	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,008
2087	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,008
2088	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,008
2089	Dry	30%	25,000	1,300	1,008	10,080	22,692	15,884	10%	22,500	15,884	19.1	5,316	$303	5,316	0	0%	10%	2,500	5,316
2090	Wet	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,559
2091	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,118
2092	Wet	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,030
2093	Normal	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,012
2094	Wet	0%	25,000	1,300	1,008	10,080	22,692	22,692	0%	25,000	22,692	27.2	1,008	$303	1,008	0	0%	0%	0	1,009

Choose an option to model, and a scenario to model it against. Those are the only two inputs on this sheet!

Option :	E-1	Efficiency programs
Storage (AF):	0	as entered in Options definition
Storage threshold ($/AF):	0	(n/a)
Capital cost ($M/yr)	5.96	as entered in Options definition
Fixed OMR ($M/yr)	0.00	as entered in Options definition
Fixed capital + OMR ($M/yr)	5.96	sum of amoritized capital plus fixed OMR
Scenario:	2	Replay it again Sam, historic hydrology with base year 1920
Hydrology type:	Historic	
Base year:	1920	Base year of historic replay
Synthetic hydrology ID:	n/a	
Synthetic hydrology index:	n/a	
Sonoma reductions by year type: Wet	0%	
Normal	0%	
Dry	30%	



SUMMARY OF RESULTS

Years with any rationing	15	out of 50 years
Years with rationing over state levels	15	
Max rationing	26%	based on nominal demand
Max AFY supplemental supply	2,145	AF/yr
Avg Sonoma Water	19,615	AF/yr
Avg Sonoma Water Cost	23.5	$M/yr
Average AFY supplemental	2,145	based on scenario usage year-by-year, shown below
Max supplemental AFY	2,145	
Average marginal OMR $M/yr	0.00	based on scenario usage year-by-year, shown below
Average total $M/yr for supp. Supply	5.96	combining with fixed costs shown above
Average $/AF supplemental	$2,778	
Avg total cost including supplement + Sonoma	29.5	$M/yr
Average OMR $/yr	0.00	sum of fixed and marginal OMR

Year	*Year type*	*Sonoma Water % redu for year type*	*Demand*	*Supply from existing wells*	*Min supp AF*	*Max supp AF*	*Baseline demand for SW*	*Sonoma Water max avail (AF)*	*State-imposed rationing for year type*	*Eff demand AF*	*Sonoma Water*	*Sonoma Water cost $M*	*Supply deficit AF*	*Supp supply Marginal cost $/AF*	*Supp supply used for demand (AF)*	*AF Residual shortage (surplus)*	*Needed rationing based on supply*	*Actual rationing level*	*Rationing*	*Supp. Supply*
2045	Dry	30%	25,000	1,300	2,145	2,145	21,555	15,088	10%	22,500	15,088	18.1	6,112	$0	2,145	3,966	26%	26%	6,466	2,145
2046	Wet	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2047	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2048	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2049	Dry	30%	25,000	1,300	2,145	2,145	21,555	15,088	10%	22,500	15,088	18.1	6,112	$0	2,145	3,966	26%	26%	6,466	2,145
2050	Wet	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2051	Dry	30%	25,000	1,300	2,145	2,145	21,555	15,088	10%	22,500	15,088	18.1	6,112	$0	2,145	3,966	26%	26%	6,466	2,145
2052	Wet	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2053	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2054	Dry	30%	25,000	1,300	2,145	2,145	21,555	15,088	10%	22,500	15,088	18.1	6,112	$0	2,145	3,966	26%	26%	6,466	2,145
2055	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2056	Dry	30%	25,000	1,300	2,145	2,145	21,555	15,088	10%	22,500	15,088	18.1	6,112	$0	2,145	3,966	26%	26%	6,466	2,145
2057	Dry	30%	25,000	1,300	2,145	2,145	21,555	15,088	10%	22,500	15,088	18.1	6,112	$0	2,145	3,966	26%	26%	6,466	2,145
2058	Dry	30%	25,000	1,300	2,145	2,145	21,555	15,088	10%	22,500	15,088	18.1	6,112	$0	2,145	3,966	26%	26%	6,466	2,145
2059	Dry	30%	25,000	1,300	2,145	2,145	21,555	15,088	10%	22,500	15,088	18.1	6,112	$0	2,145	3,966	26%	26%	6,466	2,145
2060	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2061	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2062	Dry	30%	25,000	1,300	2,145	2,145	21,555	15,088	10%	22,500	15,088	18.1	6,112	$0	2,145	3,966	26%	26%	6,466	2,145
2063	Wet	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2064	Dry	30%	25,000	1,300	2,145	2,145	21,555	15,088	10%	22,500	15,088	18.1	6,112	$0	2,145	3,966	26%	26%	6,466	2,145
2065	Wet	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2066	Wet	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2067	Wet	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2068	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2069	Dry	30%	25,000	1,300	2,145	2,145	21,555	15,088	10%	22,500	15,088	18.1	6,112	$0	2,145	3,966	26%	26%	6,466	2,145
2070	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2071	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2072	Dry	30%	25,000	1,300	2,145	2,145	21,555	15,088	10%	22,500	15,088	18.1	6,112	$0	2,145	3,966	26%	26%	6,466	2,145
2073	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2074	Dry	30%	25,000	1,300	2,145	2,145	21,555	15,088	10%	22,500	15,088	18.1	6,112	$0	2,145	3,966	26%	26%	6,466	2,145
2075	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2076	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2077	Wet	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2078	Wet	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2079	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2080	Dry	30%	25,000	1,300	2,145	2,145	21,555	15,088	10%	22,500	15,088	18.1	6,112	$0	2,145	3,966	26%	26%	6,466	2,145
2081	Wet	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2082	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2083	Wet	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2084	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2085	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2086	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2087	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2088	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2089	Dry	30%	25,000	1,300	2,145	2,145	21,555	15,088	10%	22,500	15,088	18.1	6,112	$0	2,145	3,966	26%	26%	6,466	2,145
2090	Wet	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2091	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2092	Wet	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2093	Normal	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145
2094	Wet	0%	25,000	1,300	2,145	2,145	21,555	21,555	0%	25,000	21,555	25.9	2,145	$0	2,145	0	0%	0%	0	2,145

APPENDIX C: MEMORANDUM ON DESALINATION SUPPLY OPTIONS IN THE WATER SUPPLY FEASIBILITY ANALYSIS

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MEMORANDUM

DATE: August 31, 2023

RE: Desalination Supply Options in the Water Supply Feasibility Analysis

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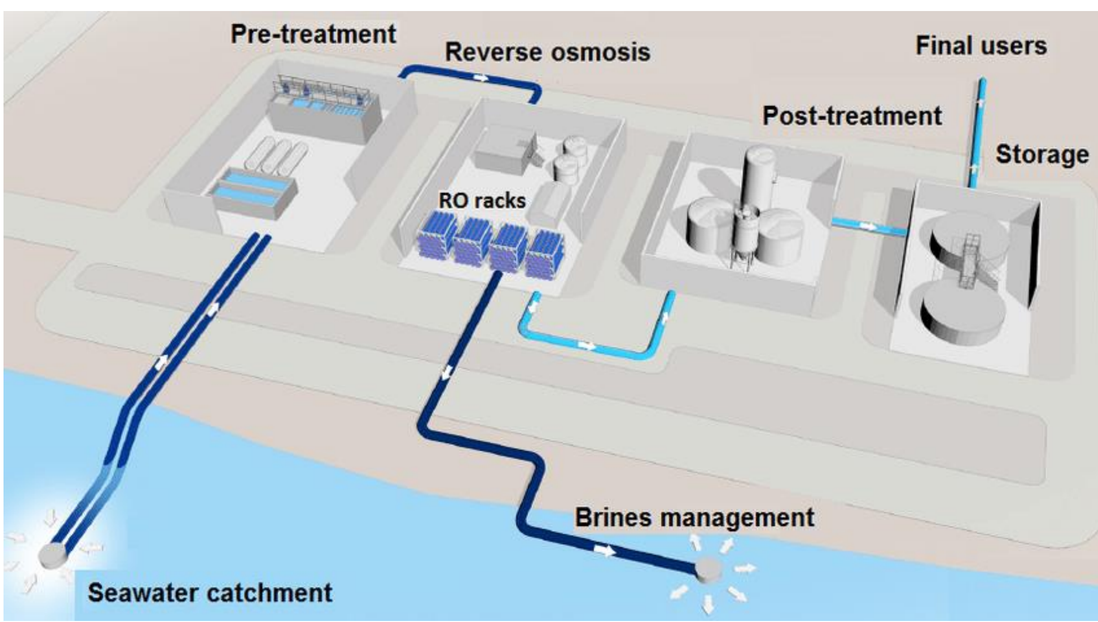
This memorandum provides additional context for desalination as a potential water supply for the feasibility analysis conducted for the City of Santa Rosa's Water Supply Alternatives Plan (WSAP).

Strengths and Weaknesses of Desalination as a Water Supply Source

Desalination is the process of removing salts from seawater or brackish water. Generally, salty water is piped from its location to the desalination facility, which requires a significant amount of power to run the treatment components. While there are a number of technologies used for treatment, reverse osmosis is the most common. Once the salts are removed, the water undergoes further adjustments so that it can be introduced into the existing system via storage tanks and pipelines. Depending on the proximity of the desalination facility to the end users, the pipeline could be significant and require one or more pump stations to convey the water to a point where it can be introduced into the distribution system. Another pipeline is required to dispose of the brine that is created during the treatment process. **Figure 1** shows the general process of an ocean desalination facility.

FIGURE 1: EXAMPLE DIAGRAM OF OCEAN DESALINATION FACILITY



Source: Perez-Zuniga, et.al. September 2020. Fault detection and isolation system based on structural analysis of an industrial seawater reverse osmosis desalination plant.

As with any supply type, desalination has a variety of strengths and weaknesses.

Strengths

- Immune to drought and variations in hydrologic conditions that are a concern for surface water (e.g., lakes and streams), stormwater, and groundwater supply options, thus providing a continuous supply of water.
- Local source for coastal communities located in Mediterranean climates that experience more frequent boom-bust water cycles and for communities with large local sources of brackish water, such as salty groundwater.
- Benefits from advancements in treatment technology, energy efficiency, and availability of renewable energy sources.
- Scalable to meet water needs given that its source (in the case of ocean desalination) is nearly unlimited.
- Desalination facilities perform optimally when running at full capacity, benefiting from economies of scale and lowering the cost of desalinated water.

Weaknesses

- Extensive permitting requirements that can take a decade or more to resolve, particularly for ocean desalination facilities. For example, both the Carlsbad facility and the new recently approved Monterey facility took over 10 years to permit and secure approvals from the California Coastal Commission[1]. Recently, the Coastal Commission denied a permit to a proposed facility in Huntington Beach, a project that has been in development for over 20 years[2]. While there have been some positive signs relative to permitting, including the Governor's stated interest in desalination and the streamlined permitting process proposed by the State Water Resources Control Board, there remains significant uncertainty given the multiple permitting agencies involved[3].
- Financial capital required to build desalination facilities can be in the hundreds of millions of dollars. The recently completed Claude "Bud" Lewis Carlsbad Desalination Plant in Carlsbad, California cost nearly $1 billion, well above initial estimates of $300 million[4].
- Carries high annual operating costs due to the energy required in salt removal and treatment.

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[1] Becker, Rachel. CalMatters. 17 November 2022. Another California desalination plant approved – the most contentious one yet.

[2] James, Ian. Los Angeles Times. 12 May 2022. California Coastal Commission rejects plan for Poseidon desalination plant.

[3] State Water Resources Control Board. Ocean Plan Requirements for Seawater Desalination Facilities.

[4] Dawid, Irvin. Planetizen. 2 November 2016. What Happened to all those Desalination Plants Proposed for California?

- Expensive membrane replacement (every three to five years) is critical to maintaining the health of desalination facilities, further contributing to large operation & maintenance costs. In addition, membranes can be "fouled" by algal blooms due to warming oceans, requiring more frequent maintenance, repair, and replacement costs.
- Environmental concerns associated with the high greenhouse gas emissions footprint due to substantial energy required for treatment, particularly if the facility is supplied with fossil fuels.
- Environmental concerns associated with waste disposal. Desalination processes generate waste referred to as "brine," which can contain highly concentrated salts, heavy metals, cleaning chemical residues, and treatment reaction by-products. Oftentimes, this waste stream is heated, which can cause concerns for the local environment when its discharged. Current reverse osmosis technology can recover only 50% of water entering treatment for ocean desalination facilities and 85% for brackish water facilities. This means that for an ocean desalination project, every 10 gallons of water treated would result in 5 gallons of brine requiring disposal. If future regulations require waste treatment before disposal, project costs would increase significantly.
- Vulnerable to certain climate change related impacts, including rising sea levels and warming ocean temperatures (for ocean desalination projects). By their location alone, ocean desalination projects need to account for rising sea levels, which can be addressed during the design phase of a project. Warming ocean temperatures can create algal blooms, which can hasten the fouling of treatment components. One such example is the Carlsbad desalination facility, which experienced shut-downs and ultimately needed to move intakes and make process changes due to an algal bloom[1].
- Poor turndown capacity which keeps baseline costs high. Desalination facilities must maintain production levels at a minimum of 30% of capacity or risk the facility's long-term health and performance. Thus, even in periods when no water from the facility may be needed, the plant must continue producing water and incurring the associated operating costs.

Review of Desalination Options Considered for Santa Rosa

As discussed above, an ideal user for desalinated water is one that lives near the source water body and has a consistent demand that can be met with the supply. Santa Rosa has neither of these qualities: it is not proximate to the ocean nor to another significant source of brackish water and its most significant need for water is during drought or catastrophic events, neither of which occur every year. Despite these challenges and others listed above, the feasibility analysis does consider two desalination supply options: a regional brackish water desalination facility (DE-1) and an ocean desalination facility (DE-2). The two options are further described in the following paragraphs.

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[1] Rivard, Ry. Voice of San Diego. 29 August 2017. Desal plant is producing less water than promised.

DE-1: Regional Brackish Water Desalination

Option DE-1 was conceived as a way to potentially reduce the major operating and capital costs associated with desalination. The defining aspect of the option is treatment of brackish water instead of ocean water, since that would have the potential to greatly lower costs.

However, because Santa Rosa is not located near a large brackish water source, DE-1 cannot move forward without significant involvement from major partners. Santa Rosa would not own or operate the facility so these partners would need to be a driving force in the implementation of any regional brackish water facility. Marin Water, a viable partner for such a project, has been evaluating desalination since the early 1980's. In its recently released Strategic Water Supply Assessment, Marin Water discusses a Petaluma Brackish Regional Desalination project which it notes as being a late addition to the document and using a number of assumptions to develop its concept and costs[1].

Option DE-1 would be implemented as follows:

- MMWD would construct a brackish water desalination plant, using funds provided by Santa Rosa to oversize the plant beyond MMWD's own needs. In essence, Santa Rosa would have a certain percent stake in the project.
- Santa Rosa would pay MMWD for its share of capital and operating costs. Those costs would include operations even in wet and normal years, which are substantial because current desalination plants need to be run at about 30% of capacity to maintain their readiness.
- Rather than physically transporting the water from the treatment plant to Santa Rosa, Santa Rosa would trade water, such that water which MMWD would otherwise have taken from the Sonoma Water system would instead be taken by Santa Rosa.

Several aspects of the project impact its current viability:

1. Technical questions. The supply of brackish water has not been established, and may be insufficient even for MMWD's needs, let alone for MMWD plus Santa Rosa. The cost and other technical aspects are not well developed.
2. MMWD may not build the project or may not wish to partner with Santa Rosa. This highlights a unique aspect of this option among the 18 options studied as part of water supply feasibility analysis: while many of the 18 options could potentially be enhanced with regional partnerships, DE-1 stands alone as the only option that simply could not move forward without a regional partner driving the project.
3. The technical and legal bases of the necessary water trade have not been established. The proposed trade would occur in dry years and thus be limited to the amount of water that MMWD would be allowed to purchase from Sonoma Water in a dry year. In

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[1]Marin Water. May 2023. Strategic Water Supply Assessment. https://www.marinwater.org/sites/default/files/2023-06/MMWD_SWSA_Final%20Draft%20Report.pdf

the most recent drought, Sonoma Water reduced MMWD's supply to about 85% of its minimum take-or-pay amount, or about 4.5 TAF[1]. This falls short of Santa Rosa's need for water. Further, MMWD's contractual right to trade any water it would otherwise purchase from Sonoma Water has not been established.

4. The project would rely entirely on Sonoma Water infrastructure for its operations. This is at odds with the WSAP goal of improving Santa Rosa's resilience to delivery interruptions from Sonoma Water.

Over time, many of the aspects listed above may resolve, although the fundamental mismatch between the option and the WSAP goal of increased self-sufficiency would remain. The next desalination option, DE-2, was conceived to overcome that concern.

DE-2: Ocean Desalination

Option DE-2 includes the construction and operation of an ocean desalination facility, located roughly 17 miles west of Santa Rosa in Bodega Bay. In contrast to DE-1, this option would be owned and operated by Santa Rosa and serve water directly to City customers, thereby addressing the WSAP goal of providing increased self-sufficiency to the City.

DE-2 has the benefit of a largely unlimited, drought-proof water supply source and, as a result, any facility could be sized to meet whatever need exists. However, there is a minimum practical project size from both a cost and water yield perspective: certain economies of scale would favor a slightly larger project over a slightly smaller project and the City would want to ensure that such a facility would be able to provide a large portion of the water needed. As noted in the water supply feasibility analysis, Santa Rosa does not require a large amount of water in every year type; water is only needed during drought and any catastrophic interruptions of Russian River supply. Even though water wouldn't be needed in an average year, the City would be required to run the desalination facility at 30% capacity to keep the components from souring, a concept referred to as turn-down capacity.

Running such a desalination facility 24/7 incurs very high operational and energy costs, one of the driving factors for DE-2's high unit cost of water. Also impacting the capital costs of this option is the massive amount of infrastructure required to build this facility and convey the treated water back to Santa Rosa. The pipeline conveying the water to Santa Rosa is over 17 miles, requiring significant initial investment to build and more long-term O&M costs, particularly when that pipeline would require replacement. This pipeline also has the potential to cross sensitive habitat, which would likely require substantial mitigation and permitting costs. Given its location, pipeline design must also account for significant topography challenges and fault zones.

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[1] Marin Water Board meeting packet May 18, 2021 item 7: Due to the dry conditions and reservoir levels Sonoma Water will reduce allocations to their retail customers, including MMWD beginning in July. From July through September MMWD will be restricted to 4-MGD and a slight increase in October to 4.6-MGD. Staff expects that reduced allocation may continue if rainfall is below average in the fall. [In the event, heavy rain in October 2021 ended the restrictions.]

Given its already high cost, DE-2 was not analyzed in detail so the currently estimated costs are considered to be best-case with current technology. If detailed studies are done, several technical areas would be analyzed which could result in increased estimated costs. Such technical areas include plant siting, establishing how brine would be disposed, routing the pipeline or tunnel, and providing line power to the plant. Any one of these facets of facility design could drive costs upward from the estimates included in the water supply feasibility analysis.

Despite the challenges outlined in this memo, future conditions may prompt reconsideration of desalination by Santa Rosa. Those potential future conditions are discussed in the last section of this memo.

Scoring Desalination as a Supply

If the two desalination options had advanced past the screening phase of the analysis, they would have been scored as shown in **Table 1** for DE-1 (Regional Brackish) and **Table 2** for DE-2 (Ocean). Because of the challenges discussed above, neither option scores well in environmental performance and legal, permitting, and regulatory. DE-2 scores favorably in city control and interagency coordination since the option is a city-controlled project. For cost effectiveness, DE-1 scores more favorably with a unit cost of water less than half that of DE-2.

In the future, there may be circumstances that would alter the individual criterion scores, resulting in a better overall score for desalination in Santa Rosa. Triggers that should cause the City to reconsider desalination as a supply are discussed in the next section. **Table 3** is a reproduction of the summary scoring table presented in the water supply feasibility analysis with the addition of the two desalination scores. DE-2 (Ocean) has the least total weighted score of the options (18); DE-1 (Regional Brackish) has the least total unweighted score (5) but the same total weighted score as PR-2 (Satellite DPR). While these two overall scores are the same, potable reuse as a supply option is better suited to Santa Rosa than desalination as highlighted in the "Purified Water vs Desalination" side bar above.

TABLE 1: DETAILED SCORING FOR OPTION DE-1 (REGIONAL BRACKISH)

Criterion	Description	Score
Cost effectiveness	Based on conceptual level cost estimates, a brackish water desalination facility would provide a minimum of 3,360 AFY with an average cost of water of at least $2,000/AF.	1
Scalability	A brackish water desalination facility could be constructed in modular phases to best fit City water needs. Additionally, the facility could be scaled down 30% in low demand periods. However, the facility's scalability would potentially be limited not only by the yield of the project itself, but by the terms imposed by potentially multiple project partners. potentially be limited not only by the yield of the project itself, but by the terms imposed by potentially multiple project partners.	1
Resiliency	Low resiliency. While the ability to desalinate brackish water into potable supply would improve resiliency in times of drought or future hydrologic uncertainty, under this supply option, Santa Rosa would be receiving a partnering agency's Sonoma Water allocation rather than desalinated water.	0
Equity	The additional desalinated water supply would have no impact on vulnerable communities. Because this option relies on a water transfer, ratepayers would be responsible for contributing to the construction of the desalination facility while ultimately receiving water from Sonoma Water.	1
Environmental performance	The construction and operation of a brackish water desalination facility would have a high potential for environmental impacts due to its high energy demands and brine production.	0
Legal, permitting, and regulatory	High permitting/regulatory effort would be required to construct a brackish water desalination facility.	0
City control and interagency coordination	Coordination with a regional partner for the paper exchange would be required in addition to continuing coordination with Sonoma Water if its aqueduct were used for distribution.	0
Multi-benefit	No other benefits provided.	0

TABLE 2: DETAILED SCORING FOR OPTION DE-2 (OCEAN)

Criterion	Description	Score
Cost effectiveness	Under the baseline scenario cost estimate, a seawater desalination facility would provide a minimum of 3,360 AFY with an average cost of water of approximately $4,500/AF. This compares to $1,300/AF for the existing Sonoma Water supply.	0
Scalability	While the ocean offers an infinitely scalable water supply, a seawater desalination facility would need to be constructed at full capacity rather than in phases because it would require the construction of a properly sized pipeline to convey desalinated water to the City. Additionally, the facility would need to run at 30% capacity even when not needed to meet City water supply.	1
Resiliency	Moderate resiliency. The ability to desalinate seawater into potable supply would improve resiliency, even in times of drought or future hydrologic uncertainty. However, this supply option is highly sensitive to rising energy costs, decreasing overall cost-effectiveness. The desalination process is also subject to disruption from ocean conditions such as red tides, which are expected to worsen in future years due to climate change.	1
Equity	The additional desalinated water supply would have no impact on the City's vulnerable communities. However, the City would need to consider potential equity issues if desalinated water were to be delivered to only a portion of its residents.	1
Environmental performance	The construction and operation of a seawater desalination facility would have a high potential for environmental impacts due to its high energy demands and brine production.	0
Legal, permitting, and regulatory	High permitting/regulatory effort would be required to construct a seawater desalination facility.	0
City control and interagency coordination	No significant interagency coordination would be required.	2
Multi-benefit	No other benefits provided.	0

TABLE 3: SUMMARY OF SUPPLY OPTION SCORES WITH DESALINATION OPTIONS

Criterion	Groundwater			Purified Recycled Water		Desalination		Stormwater	
	GW-1: Add Extraction Wells	GW-2: Convert Emergency Wells	GW-3: City ASR Wells	PR-2: Satellite DPR	PR-4: Regional DPR	DE-1: Brackish Desal	DE-2: Ocean Desal	SW-1: Stormwater Storage in Aquifer	E-1: Efficiency Programs
Cost effectiveness * [$/AF]	2 [$840/AF]	2 [$540/AF]	2 [$1,100/AF]	0 [$3,900/AF]	0 [$3,200/AF]	1 [$2,000/AF]	0 [$4,500/AF]	0 [$3,500/AF]	1 [$2,800/AF]
Scalability [Yield in AFY]	2 [5,880 - 10,080 AFY]	0 [1,436 - 2,462 AFY]	1 [2,993 - 5,130 AFY]	2 [3,019 - 10,065 AFY]	2 [3,019 - 10,065 AFY]	1 [3,360 - 10,080 AFY]	1 [3,360 - 10,080 AFY]	1 [1,008 - 10,080 AFY]	1 [2,145 AFY]
Resiliency	1	1	2	2	2	0	1	1	1
Equity	1	1	1	1	1	1	1	1	2
Environmental performance	1	2	1	0	1	0	0	1	2
Legal, permitting, and regulatory	1	2	0	0	0	0	0	1	2
City control & interagency coordination	2	2	1	2	0	0	2	2	2
Multi-benefit	0	0	1	0	0	0	0	2	1
Total Unweighted	**10**	**10**	**9**	**7**	**6**	**3**	**5**	**9**	**12**
Total Weighted	**32**	**26**	**29**	**21**	**22**	**13**	**13**	**19**	**30**

* Costs shown reflect a realistic baseline usage scenario and include both capital and operating costs.

Triggers for Reconsidering Desalination in the Future

While the water supply feasibility analysis does not show the desalination options advancing past the screening phase, the City may, at some point in the future, determine that work to further desalination as a supply for Santa Rosa is warranted. Triggers that might cause the City to reconsider desalination include:

- **Technology that reduces baseline operating costs**. As discussed in this memo, desalination has poor turndown capacity; current technology requires that plants be operated at a minimum of 30% capacity. This results in significant annual operating costs to keep the plant "healthy" while waiting for times when its water is really needed (i.e., during droughts and catastrophic supply interruptions). Advancements in turndown capacity would reduce baseline operating costs and decrease the unit cost of water, particularly for DE-2.
- **Less expensive energy prices which reduces operating costs**. Because desalination plants require significant amounts of energy, their operating costs are heavily influenced by the cost of energy. The assumption used for costing desalination options in the water supply feasibility analysis was $0.20/kWh. Should there be a sustained drop in price, operating costs would decrease, perhaps making the unit cost of water of ocean desalination more comparable with other supply options.
- **Project configuration that yields direct water to Santa Rosa**. DE-1 is configured as a regional brackish water desalination project that results in a water transfer, wherein Santa Rosa would accept additional Sonoma Water. While this configuration would reduce regional reliance on the Russian River system, it would not reduce the City's reliance on Sonoma Water. The City could reconsider regional desalination if such a project were to provide desalinated water directly to Santa Rosa, thus reducing the City's reliance on water from the Russian River system.
- **Technology that improves water recovery.** With current technology, ocean desalination facilities have roughly 50% recovery; brackish facilities have up to 85% recovery. In either case, there is still a significant brine management and disposal challenge. This is one area where the industry is already seeing the impact of technological advances. In a recent City of Santa Monica pilot project, new technology increased recovery from 80% to 90%[1]. Santa Rosa should monitor advancements in this area as this new technology becomes more widely applied.

Prior to committing implementation funding to additional water supply projects, City staff should revisit these triggers to determine if any developments or changes in these areas warrant a closer look at a desalination project for Santa Rosa. The Water Supply Alternatives Plan integrates the suggested revisit points in the discussion of Portfolio 4.

[1] Sawicki, Emily. Santa Monica Daily Press. 21 January 2022. New water projects set to expand local supply.

APPENDIX B: LINKS TO RECORDED MEETINGS

List of Recorded Meetings

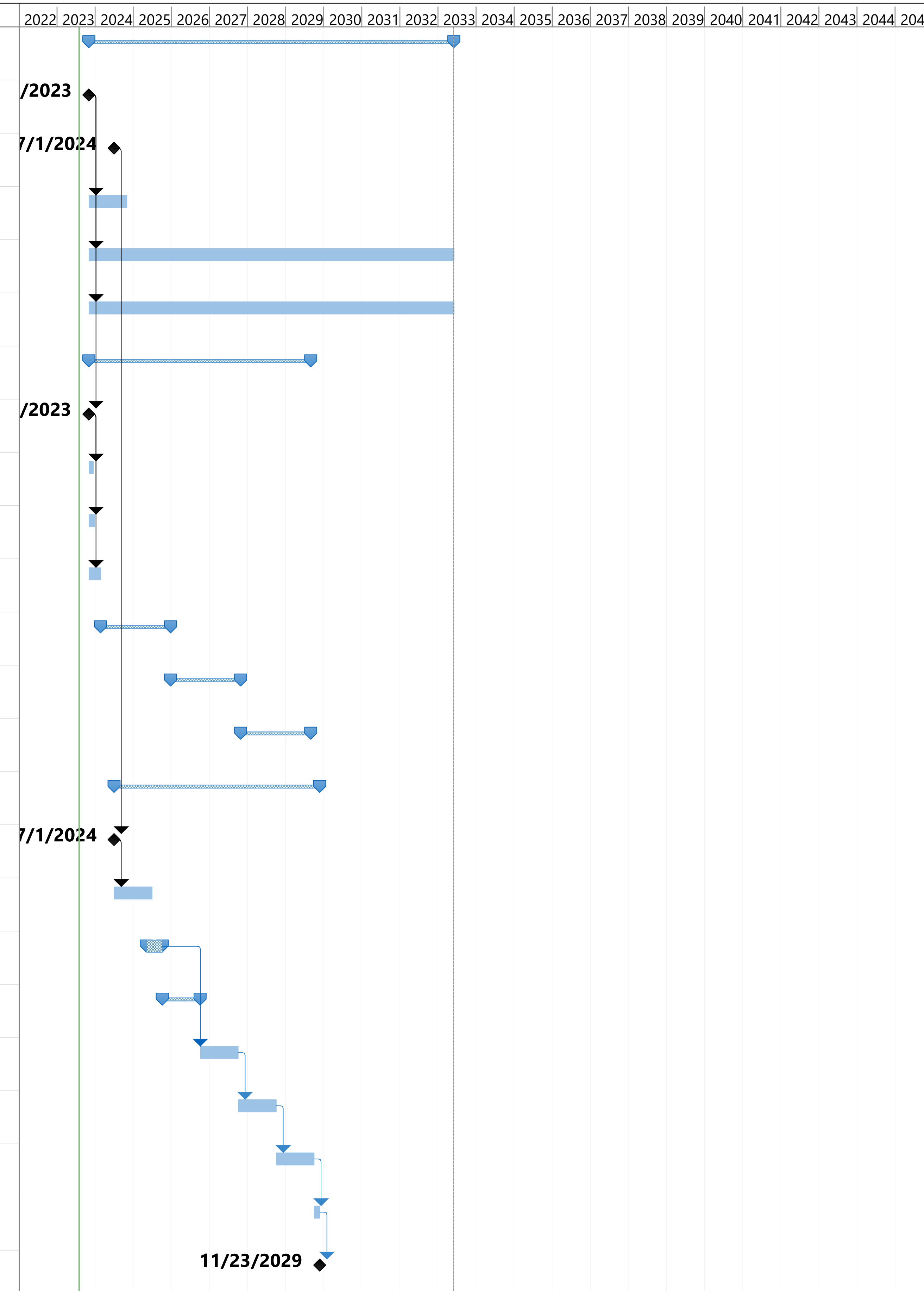
Date	Forum	Recording Link
April 28, 2022	**City Council/Board of Public Utilities Liaison Subcommittee** Staff presented the project concept and received input.	Video Recording
May 19, 2022	**Board of Public Utilities** Staff presented the project concept, received input, and requested approval to release a Request for Proposals for consultant assistance.	Video Recording
Sept. 15, 2022	**Board of Public Utilities** Staff presented an update on the consultant selection process, final scope of work, schedule, and next steps.	Video Recording
Oct. 13, 2022	**Subregional Wastewater Technical Advisory Committee** Staff presented information about the Santa Rosa's water use history, water supplies, and the project purpose, goals, scope of work, and community engagement. Staff requested that the SubTAC appoint a member to serve on the project Stakeholder Group over the next year.	Video Recording
Oct. 26, 2022	**Community Webinar #1** The project team presented background information, the project purpose and approach, water supply goals, water supply options to be studied, and the criteria and methods for studying the options.	Video Recording
Jan. 19, 2023	**Board of Public Utilities** The project team conducted a study session and requested input from the Board and public on the water resiliency goals, water supply options, and criteria for assessing the feasibility of the options.	Video Recording

Date	Forum	Recording Link
Jan. 25, 2023	**Community Webinar #2** The project team updated the community on the water supply resiliency goals, water supply options, and the criteria and methods for studying them.	Video Recording
Feb. 9, 2023	**Subregional Wastewater Technical Advisory Committee** Staff and the project team presented an update on the water supply resiliency goals, water supply options, and the criteria and methods for studying them.	Video Recording
June 26, 2023	**Community Webinar #3** Staff and the project team updated the community on the water supply options study results, and discussed next steps, including develop portfolios (mixes) of water supply options and developing an adaptive plan for increasing the City's water supply resiliency and reliability.	Video Recording
Aug 17, 2023	**Board of Public Utilities** The project team provided a study session and requested input from the Board and public on the results of the study of water supply options and proposed portfolios (mixes of water supply options).	Video Recording (Go to Item 3.1)

APPENDIX C: PORTFOLIO 1 EXAMPLE SCHEDULE

Portfolio 1

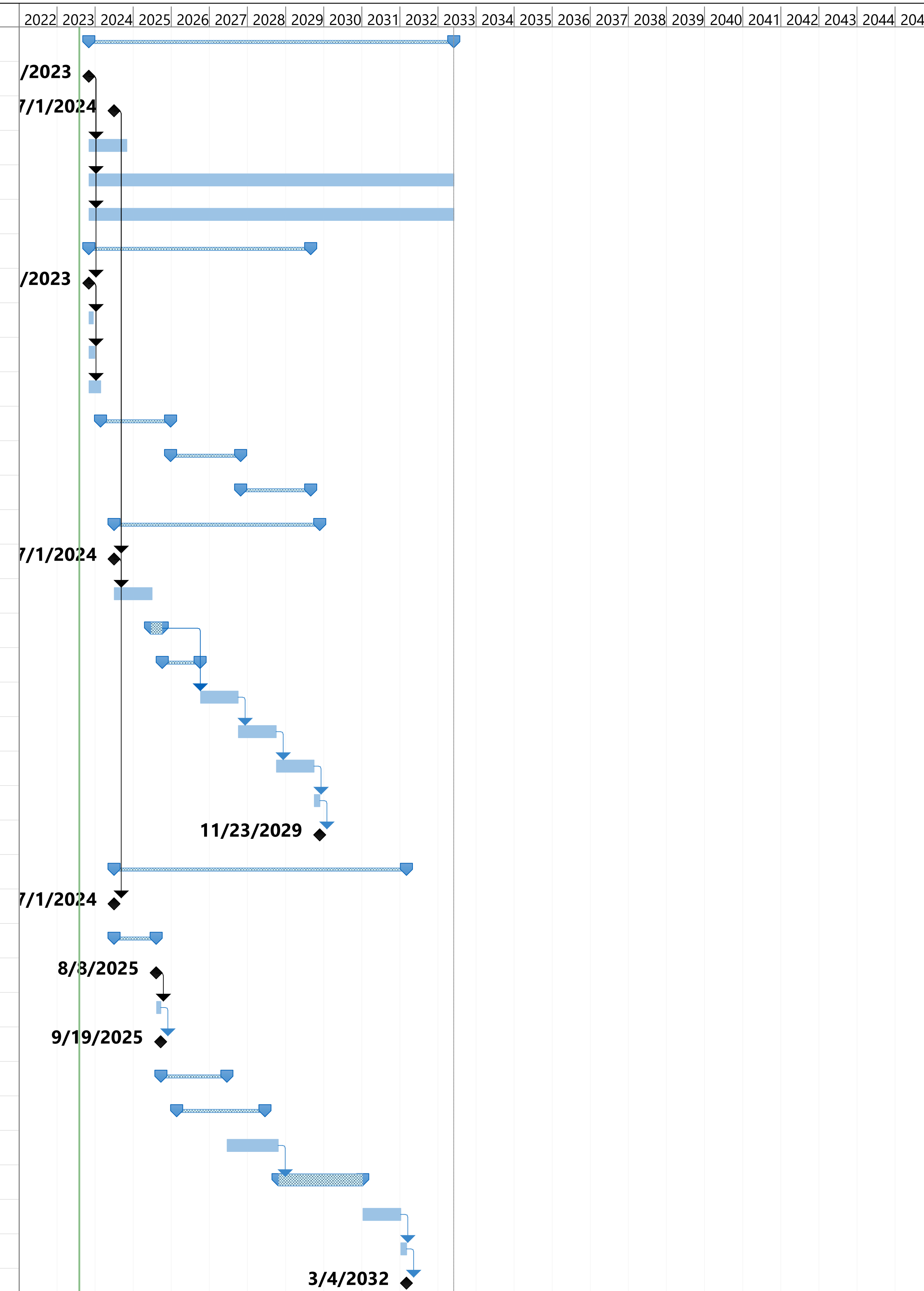
ID	Task Name	Duration	Start	Finish
1	**Program Management**	**500 wks**	**Wed 11/1/23**	**Tue 5/31/33**
2	Water Supply Plan accepted	0 wks	Wed 11/1/23	Wed 11/1/23
3	Adopt CIP funding initial capital elements	0 wks	Mon 7/1/24	Mon 7/1/24
4	Update GWMP	52 wks	Wed 11/1/23	Tue 10/29/24
5	Manage Water Supply Elements	500 wks	Wed 11/1/23	Tue 5/31/33
6	Outreach	500 wks	Wed 11/1/23	Tue 5/31/33
7	**E-1 Water Use Efficiency**	**304 wks**	**Wed 11/1/23**	**Tue 8/28/29**
8	NTP	0 wks	Wed 11/1/23	Wed 11/1/23
9	Update Staffing Reso as Required	6 wks	Wed 11/1/23	Tue 12/12/23
10	Review external funding opportunities	8 wks	Wed 11/1/23	Tue 12/26/23
11	Finalize plan	16 ewks	Wed 11/1/23	Wed 2/21/24
12	Phase 1	**96 wks**	**Wed 2/21/24**	**Wed 12/24/25**
17	Phase 2	**96 wks**	**Wed 12/24/25**	**Wed 10/27/27**
22	Phase 3	**96 wks**	**Wed 10/27/27**	**Tue 8/28/29**
27	**GW-2 Convert Ex Wells**	**282 wks**	**Mon 7/1/24**	**Fri 11/23/29**
28	NTP	0 wks	Mon 7/1/24	Mon 7/1/24
29	Hydrogeologic Studies	52 wks	Mon 7/1/24	Fri 6/27/25
30	CEQA Notice of Exemption	22 wks	Mon 5/5/25	Sun 10/5/25
35	Regulatory Approvals & Interagency Coordination	**52 wks**	**Mon 10/6/25**	**Fri 10/2/26**
38	Design	52 wks	Mon 10/5/26	Fri 10/1/27
39	Construction	52 wks	Mon 10/4/27	Fri 9/29/28
40	Initial Operations	52 wks	Mon 10/2/28	Fri 9/28/29
41	Assess Performance	8 wks	Mon 10/1/29	Fri 11/23/29
42	Determine Remaining Need for Water	0 wks	Fri 11/23/29	Fri 11/23/29



APPENDIX D: PORTFOLIO 2 EXAMPLE SCHEDULE

Portfolio 2

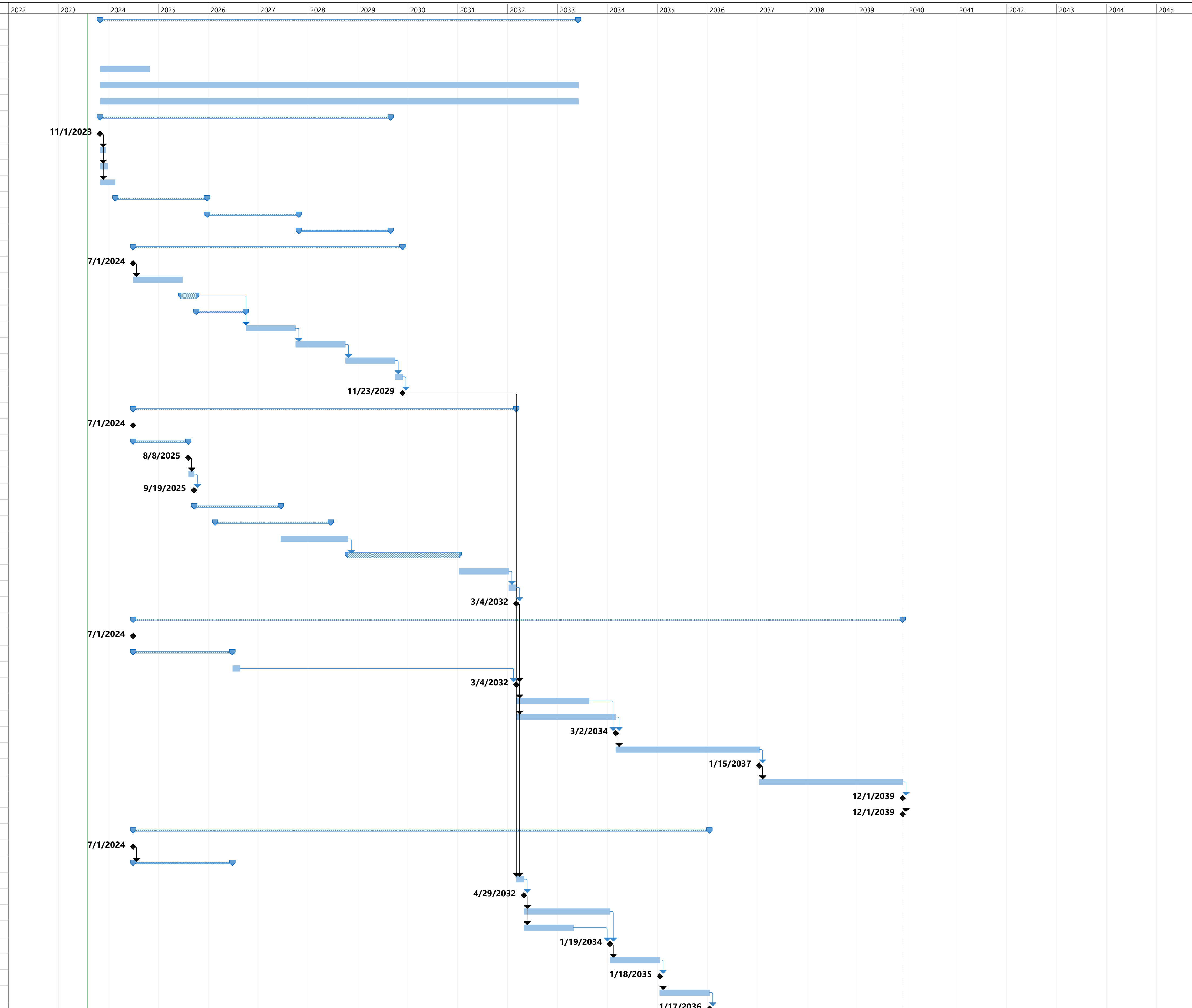
ID	Task Name	Duration	Start	Finish
1	**Program Management**	**500 wks**	**Wed 11/1/23**	**Tue 5/31/33**
2	Water Supply Plan accepted	0 wks	Wed 11/1/23	Wed 11/1/23
3	Adopt CIP funding initial capital elements	0 wks	Mon 7/1/24	Mon 7/1/24
4	Update GWMP	52 wks	Wed 11/1/23	Tue 10/29/24
5	Manage Water Supply Elements	500 wks	Wed 11/1/23	Tue 5/31/33
6	Outreach	500 wks	Wed 11/1/23	Tue 5/31/33
7	**E-1 Water Use Efficiency**	**304 wks**	**Wed 11/1/23**	**Tue 8/28/29**
8	NTP	0 wks	Wed 11/1/23	Wed 11/1/23
9	Update Staffing Reso as Required	6 wks	Wed 11/1/23	Tue 12/12/23
10	Review external funding opportunities	8 wks	Wed 11/1/23	Tue 12/26/23
11	Finalize plan	16 ewks	Wed 11/1/23	Wed 2/21/24
12	Phase 1	**96 wks**	**Wed 2/21/24**	**Wed 12/24/25**
17	Phase 2	**96 wks**	**Wed 12/24/25**	**Wed 10/27/27**
22	Phase 3	**96 wks**	**Wed 10/27/27**	**Tue 8/28/29**
27	**GW-2 Convert Ex Wells**	**282 wks**	**Mon 7/1/24**	**Fri 11/23/29**
28	NTP	0 wks	Mon 7/1/24	Mon 7/1/24
29	Hydrogeologic Studies	52 wks	Mon 7/1/24	Fri 6/27/25
30	CEQA	16 wks	Mon 6/16/25	Sun 10/5/25
35	Regulatory Approvals & Interagency Coordination	**52 wks**	**Mon 10/6/25**	**Fri 10/2/26**
38	Design	52 wks	Mon 10/5/26	Fri 10/1/27
39	Construction	52 wks	Mon 10/4/27	Fri 9/29/28
40	Initial Operations	52 wks	Mon 10/2/28	Fri 9/28/29
41	Assess Performance	8 wks	Mon 10/1/29	Fri 11/23/29
42	Determine Remaining Need for Water	0 wks	Fri 11/23/29	Fri 11/23/29
43	**GW-1 New Wells**	**400.8 wks**	**Mon 7/1/24**	**Thu 3/4/32**
44	Initial NTP	0 wks	Mon 7/1/24	Mon 7/1/24
45	Siting Studies	**58 wks**	**Mon 7/1/24**	**Fri 8/8/25**
52	Site(s) selected	0 wks	Fri 8/8/25	Fri 8/8/25
53	Budget and scope updated	6 wks	Mon 8/11/25	Fri 9/19/25
54	NTP #2	0 wks	Fri 9/19/25	Fri 9/19/25
55	CEQA	**90.8 wks**	**Mon 9/22/25**	**Thu 6/17/27**
73	Regulatory Approvals & Interagency Coordination	**120.8 wks**	**Fri 2/20/26**	**Thu 6/15/28**
83	Design	70 wks	Fri 6/18/27	Thu 10/19/28
84	Construction	116 wks	Fri 10/20/28	Thu 1/9/31
88	Initial Operations	52 wks	Fri 1/10/31	Thu 1/8/32
89	Assess Performance	8 wks	Fri 1/9/32	Thu 3/4/32
90	Determine Remaining Need for Water	0 wks	Thu 3/4/32	Thu 3/4/32



APPENDIX E: PORTFOLIO 3 EXAMPLE SCHEDULE

Portfolio 3

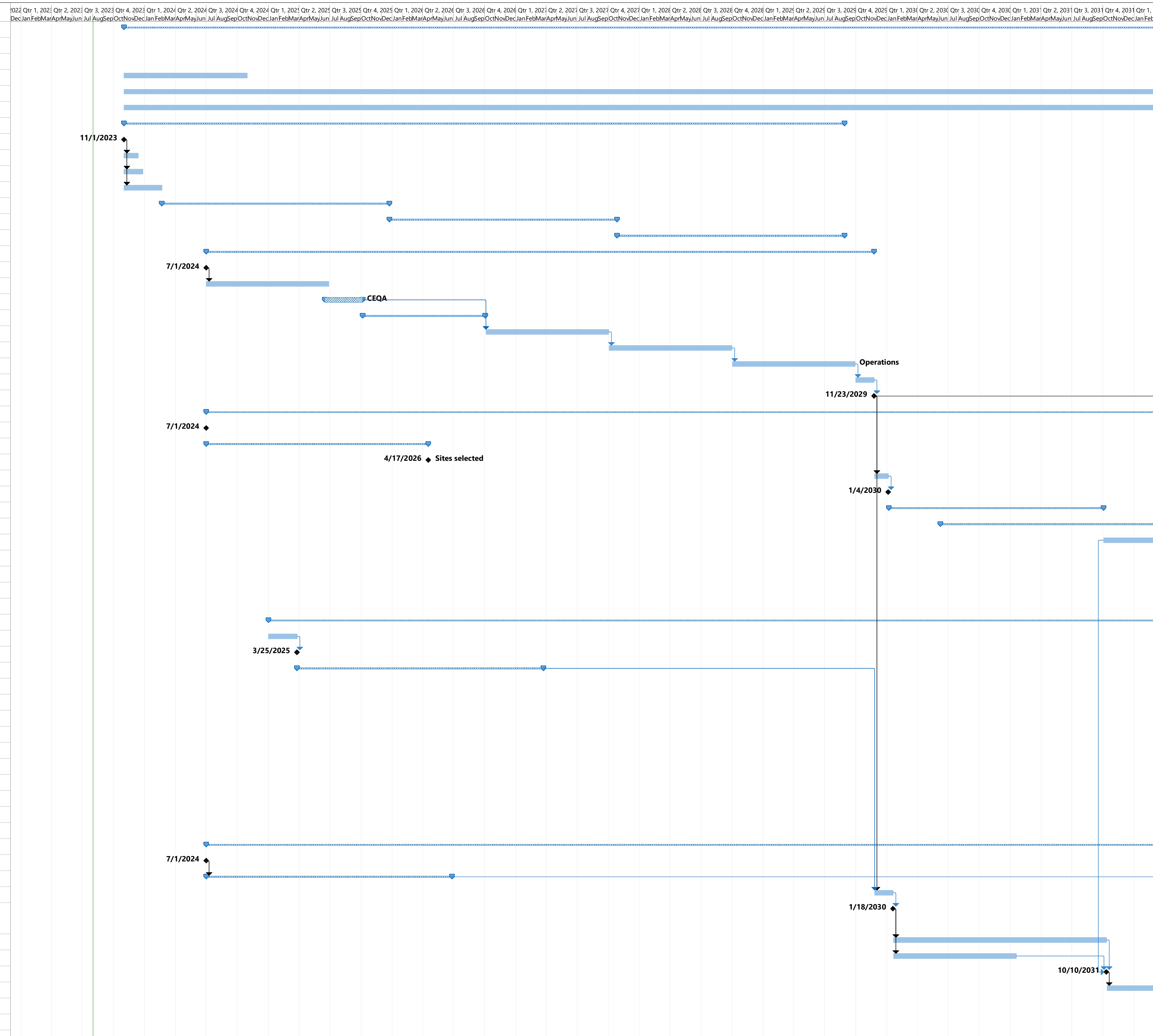
ID	Task Name	Duration	Start
1	**Program Management**	**500 wks**	**Wed 11/1/23**
2	Water Supply Plan accepted	0 wks	Wed 11/1/23
3	Adopt CIP funding initial capital elements	0 wks	Mon 7/1/24
4	Update GWMP	52 wks	Wed 11/1/23
5	Manage Water Supply Elements	500 wks	Wed 11/1/23
6	Outreach	500 wks	Wed 11/1/23
7	**E-1 Water Use Efficiency**	**304 wks**	**Wed 11/1/23**
8	NTP	0 wks	Wed 11/1/23
9	Update Staffing Reso as Required	6 wks	Wed 11/1/23
10	Review external funding opportunities	8 wks	Wed 11/1/23
11	Finalize plan	16 ewks	Wed 11/1/23
12	Phase 1	**96 wks**	**Wed 2/21/24**
17	Phase 2	**96 wks**	**Wed 12/24/25**
22	Phase 3	**96 wks**	**Wed 10/27/27**
27	**GW-2 Convert Ex Wells**	**282 wks**	**Mon 7/1/24**
28	NTP	0 wks	Mon 7/1/24
29	Hydrogeologic Studies	52 wks	Mon 7/1/24
30	CEQA	16 wks	Mon 6/16/25
35	Regulatory Approvals & Interagency Coordination	**52 wks**	**Mon 10/6/25**
38	Design	52 wks	Mon 10/5/26
39	Construction	52 wks	Mon 10/4/27
40	Initial Operations	52 wks	Mon 10/2/28
41	Assess Performance	8 wks	Mon 10/1/29
42	Determine Remaining Need for Water	0 wks	Fri 11/23/29
43	**GW-1 New Wells**	**400.8 wks**	**Mon 7/1/24**
44	Initial NTP	0 wks	Mon 7/1/24
45	Siting Studies	**58 wks**	**Mon 7/1/24**
52	Site(s) selected	0 wks	Fri 8/8/25
53	Budget and scope updated	6 wks	Mon 8/11/25
54	NTP #2	0 wks	Fri 9/19/25
55	CEQA	**90.8 wks**	**Mon 9/22/25**
73	Regulatory Approvals & Interagency Coordination	**120.8 wks**	**Fri 2/20/26**
83	Design	70 wks	Fri 6/18/27
84	Construction	116 wks	Fri 10/20/28
88	Initial Operations	52 wks	Fri 1/10/31
89	Assess Performance	8 wks	Fri 1/9/32
90	Determine Remaining Need for Water	0 wks	Thu 3/4/32
91	**PR-2 Direct Potable Reuse**	**804.8 wks**	**Mon 7/1/24**
92	NTP for Planning Phase only	0 wks	Mon 7/1/24
93	Initial Planning studies	**104 wks**	**Mon 7/1/24**
98	Re-assess Needs	8 wks	Mon 6/29/26
99	NTP for Detailed Planning	0 wks	Thu 3/4/32
100	CEQA	76 wks	Fri 3/5/32
101	Permitting	104 wks	Fri 3/5/32
102	NTP for Design Phase	0 wks	Thu 3/2/34
103	Design	150 wks	Fri 3/3/34
104	NTP for Construction Phase	0 wks	Thu 1/15/37
105	Construction	150 wks	Fri 1/16/37
106	In service	0 wks	Thu 12/1/39
107	Determine Remaining Need for Water	0 wks	Thu 12/1/39
108	**SW-1 Stormwater Capture in Aquifer**	**602.8 wks**	**Mon 7/1/24**
109	NTP for Planning Phase only	0 wks	Mon 7/1/24
110	Initial Planning Studies	**104 wks**	**Mon 7/1/24**
115	Re-assess Needs	8 wks	Fri 3/5/32
116	NTP for Detailed Planning	0 wks	Thu 4/29/32
117	CEQA	90 wks	Fri 4/30/32
118	Permitting	52 wks	Fri 4/30/32
119	NTP for Design Phase	0 wks	Thu 1/19/34
120	Design	52 wks	Fri 1/20/34
121	NTP for Construction Phase	0 wks	Thu 1/18/35
122	Construction	52 wks	Fri 1/19/35
123	In service	0 wks	Thu 1/17/36



APPENDIX F: PORTFOLIO 4 EXAMPLE SCHEDULE (BASELINE SCENARIO)

Portfolio 4

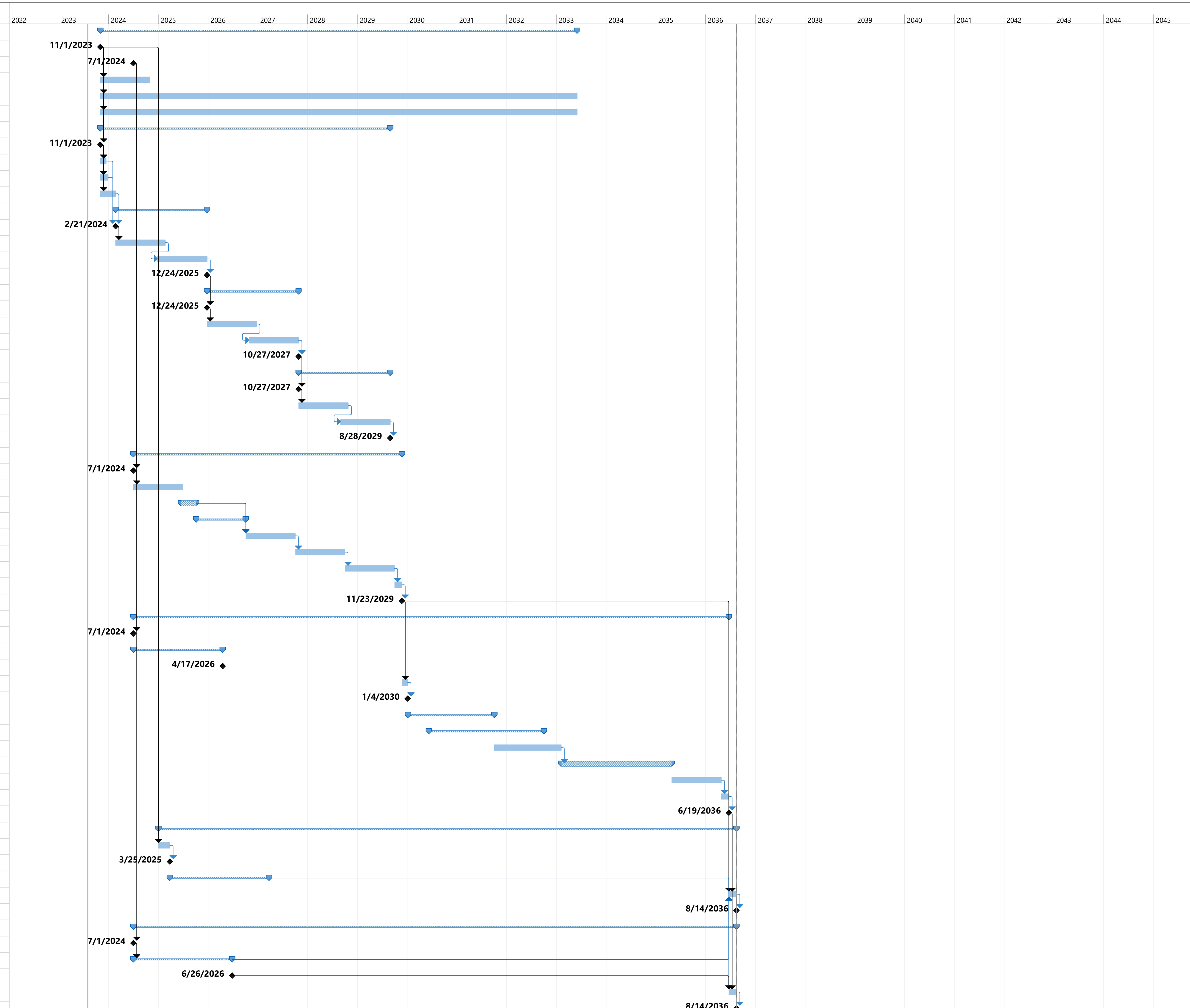
ID	Task Name	Duration	Start	Finish	Predecessors
1	Program Management	500 wks	Wed 11/1/23	Tue 5/31/33	
2	Water Supply Plan accepted	0 wks	Wed 11/1/23	Wed 11/1/23	
3	Adopt CIP funding initial capital elements	0 wks	Mon 7/1/24	Mon 7/1/24	
4	Update GWMP	52 wks	Wed 11/1/23	Tue 10/29/24	2
5	Manage Water Supply Elements	500 wks	Wed 11/1/23	Tue 5/31/33	2
6	Outreach	500 wks	Wed 11/1/23	Tue 5/31/33	2
7	E-1 Water Use Efficiency	304 wks	Wed 11/1/23	Tue 8/28/29	
8	NTP	0 wks	Wed 11/1/23	Wed 11/1/23	2
9	Update Staffing Reso as Required	6 wks	Wed 11/1/23	Tue 12/12/23	8
10	Review external funding opportunities	8 wks	Wed 11/1/23	Tue 12/26/23	8
11	Finalize plan	16 ewks	Wed 11/1/23	Wed 2/21/24	8
12	Phase 1	96 wks	Wed 2/21/24	Wed 12/24/25	
17	Phase 2	96 wks	Wed 12/24/25	Wed 10/27/27	
22	Phase 3	96 wks	Wed 10/27/27	Tue 8/28/29	
27	GW-2 Convert Ex Wells	282 wks	Mon 7/1/24	Fri 11/23/29	
28	NTP	0 wks	Mon 7/1/24	Mon 7/1/24	3
29	Hydrogeologic Studies	52 wks	Mon 7/1/24	Fri 6/27/25	28
30	CEQA	16 wks	Mon 6/16/25	Sun 10/5/25	
35	Regulatory Approvals & Interagency Coordination	52 wks	Mon 10/6/25	Fri 10/2/26	
38	Design	52 wks	Mon 10/5/26	Fri 10/1/27	36,30
39	Construction	52 wks	Mon 10/4/27	Fri 9/29/28	38
40	Initial Operations	52 wks	Mon 10/2/28	Fri 9/28/29	39
41	Assess Performance	8 wks	Mon 10/1/29	Fri 11/23/29	40
42	Determine Remaining Need for Water	0 wks	Fri 11/23/29	Fri 11/23/29	41
43	GW-1+ New Wells (ASR and-or Extraction)	624.8 wks	Mon 7/1/24	Thu 6/19/36	
44	Initial NTP	0 wks	Mon 7/1/24	Mon 7/1/24	3
45	Siting Studies	94 wks	Mon 7/1/24	Fri 4/17/26	
53	Site(s) selected	0 wks	Fri 4/17/26	Fri 4/17/26	52
54	Budget and scope updated	6 wks	Mon 11/26/29	Fri 1/4/30	42
55	NTP #2	0 wks	Fri 1/4/30	Fri 1/4/30	54
56	CEQA	90.8 wks	Mon 1/7/30	Thu 10/2/31	
74	Regulatory Approvals & Interagency Coordination	120.8 wks	Fri 6/7/30	Thu 9/30/32	
84	Design	70 wks	Fri 10/3/31	Thu 2/3/33	73
85	Construction	116 wks	Fri 2/4/33	Thu 4/26/35	83,84
89	Initial Operations	52 wks	Fri 4/27/35	Thu 4/24/36	88
90	Assess Performance	8 wks	Fri 4/25/36	Thu 6/19/36	89
91	Determine Remaining Need for Water	0 wks	Thu 6/19/36	Thu 6/19/36	90
92	PR-2 Direct Potable Reuse	1010.4 wks	Wed 1/1/25	Thu 5/12/44	
93	Assess Final Regulations	12 wks	Wed 1/1/25	Tue 3/25/25	2
94	NTP for Planning Phase only	0 wks	Tue 3/25/25	Tue 3/25/25	93
95	Initial Planning studies	104 wks	Wed 3/26/25	Tue 3/23/27	
100	Re-assess Needs	8 wks	Fri 6/20/36	Thu 8/14/36	99,42,91,112
101	NTP for Detailed Planning	0 wks	Thu 8/14/36	Thu 8/14/36	100
102	CEQA	76 wks	Fri 8/15/36	Thu 1/28/38	101
103	Permitting	104 wks	Fri 8/15/36	Thu 8/12/38	101
104	NTP for Design Phase	0 wks	Thu 8/12/38	Thu 8/12/38	102,103
105	Design	150 wks	Fri 8/13/38	Thu 6/27/41	104
106	NTP for Construction Phase	0 wks	Thu 6/27/41	Thu 6/27/41	105
107	Construction	150 wks	Fri 6/28/41	Thu 5/12/44	106
108	In service	0 wks	Thu 5/12/44	Thu 5/12/44	107
109	Determine Remaining Need for Water	0 wks	Thu 5/12/44	Thu 5/12/44	108
110	SW-1 Stormwater Capture in Aquifer	566 wks	Mon 7/1/24	Fri 5/4/35	
111	NTP for Planning Phase only	0 wks	Mon 7/1/24	Mon 7/1/24	3
112	Initial Planning Studies	104 wks	Mon 7/1/24	Fri 6/26/26	111
117	Re-assess Needs	8 wks	Mon 11/26/29	Fri 1/18/30	116,95,42
118	NTP for Detailed Planning (assume synergy with GW-1 was identified)	0 wks	Fri 1/18/30	Fri 1/18/30	117
119	CEQA	90 wks	Mon 1/21/30	Fri 10/10/31	118
120	Permitting	52 wks	Mon 1/21/30	Fri 1/17/31	118
121	NTP for Design Phase	0 wks	Fri 10/10/31	Fri 10/10/31	119,120,84SS
122	Design	70 wks	Mon 10/13/31	Fri 2/11/33	121
123	NTP for Construction Phase	0 wks	Fri 2/11/33	Fri 2/11/33	122
124	Construction	116 wks	Mon 2/14/33	Fri 5/4/35	123
125	In service	0 wks	Fri 5/4/35	Fri 5/4/35	124



APPENDIX G: PORTFOLIO 4 EXAMPLE SCHEDULE (ALTERNATIVE SCENARIO)

Portfolio 4 variant

ID	Task Name	Duration	Start
1	Program Management	**500 wks**	**Wed 11/1/23**
2	Water Supply Plan accepted	0 wks	Wed 11/1/23
3	Adopt CIP funding initial capital elements	0 wks	Mon 7/1/24
4	Update GWMP	52 wks	Wed 11/1/23
5	Manage Water Supply Elements	500 wks	Wed 11/1/23
6	Outreach	500 wks	Wed 11/1/23
7	E-1 Water Use Efficiency	304 wks	Wed 11/1/23
8	NTP	0 wks	Wed 11/1/23
9	Update Staffing Reso as Required	6 wks	Wed 11/1/23
10	Review external funding opportunities	8 wks	Wed 11/1/23
11	Finalize plan	16 ewks	Wed 11/1/23
12	Phase 1	**96 wks**	**Wed 2/21/24**
13	NTP	0 wks	Wed 2/21/24
14	Onboard initial staff	52 ewks	Wed 2/21/24
15	Initial implementation	52 ewks	Wed 12/25/24
16	Phase 1 savings online	0 ewks	Wed 12/24/25
17	Phase 2	**96 wks**	**Wed 12/24/25**
18	NTP Phase 2	0 wks	Wed 12/24/25
19	Onboard Phase 2 staff	52 ewks	Wed 12/24/25
20	Second phase implementation	52 ewks	Wed 10/28/26
21	Phase 2 savings online	0 wks	Wed 10/27/27
22	Phase 3	**96 wks**	**Wed 10/27/27**
23	NTP Phase 3	0 wks	Wed 10/27/27
24	Onboard Phase 3 staff	52 wks	Wed 10/27/27
25	Phase 3 Implementation	52 wks	Wed 8/30/28
26	Phase 3 savings online	0 wks	Tue 8/28/29
27	GW-2 Convert Ex Wells	282 wks	Mon 7/1/24
28	NTP	0 wks	Mon 7/1/24
29	Hydrogeologic Studies	52 wks	Mon 7/1/24
30	CEQA	16 wks	Mon 6/16/25
35	Regulatory Approvals & Interagency Coordination	**52 wks**	**Mon 10/6/25**
38	Design	52 wks	Mon 10/5/26
39	Construction	52 wks	Mon 10/4/27
40	Initial Operations	52 wks	Mon 10/2/28
41	Assess Performance	8 wks	Mon 10/1/29
42	Determine Remaining Need for Water	0 wks	Fri 11/23/29
43	GW-1+ New Wells (ASR and-or Extraction)	624.8 wks	Mon 7/1/24
44	Initial NTP	0 wks	Mon 7/1/24
45	Siting Studies	**94 wks**	**Mon 7/1/24**
53	Site(s) selected	0 wks	Fri 4/17/26
54	Budget and scope updated	6 wks	Mon 11/26/29
55	NTP #2	0 wks	Fri 1/4/30
56	CEQA	**90.8 wks**	**Mon 1/7/30**
74	Regulatory Approvals & Interagency Coordination	**120.8 wks**	**Fri 6/7/30**
84	Design	70 wks	Fri 10/3/31
85	Construction	116 wks	Fri 2/4/33
89	Initial Operations	52 wks	Fri 4/27/35
90	Assess Performance	8 wks	Fri 4/25/36
91	Determine Remaining Need for Water	0 wks	Thu 6/19/36
92	PR-2 Direct Potable Reuse	606.4 wks	Wed 1/1/25
93	Assess Final Regulations	12 wks	Wed 1/1/25
94	NTP for Planning Phase only	0 wks	Tue 3/25/25
95	Initial Planning studies	**104 wks**	**Wed 3/26/25**
100	Re-assess Needs	8 wks	Fri 6/20/36
101	Project suspended since other options meet needs	0 wks	Thu 8/14/36
102	SW-1 Stormwater Capture in Aquifer	**632.8 wks**	**Mon 7/1/24**
103	NTP for Planning Phase only	0 wks	Mon 7/1/24
104	Initial Planning Studies	**104 wks**	**Mon 7/1/24**
109	Assume no synergy with GW-1 exists, project pauses	0 wks	Fri 6/26/26
110	Reconsider after other options in place	8 wks	Fri 6/20/36
111	Project suspended since other options meet needs	0 wks	Thu 8/14/36



APPENDIX H: SANTA ROSA WATER’S RECENT BUDGETS FOR OPERATIONS AND CAPITAL PROJECTS

Budget Review - Department Expenditures By Program (BUD0109)

Santa Rosa Water Expenditures by Program	2019-20 Actual	2020-21 Actual	2021-22 Actual	2022-23 Actual	2023-24 Current Budget
Administration	4,391,348	4,758,812	7,865,232	7,638,892	9,663,170
Purchase of Water	16,509,170	17,355,962	15,437,921	12,255,230	17,833,000
Storm Water and Creeks	2,071,496	2,123,052	2,136,786	2,218,252	2,788,806
Water Resources	967,635	1,063,955	1,172,372	1,064,852	1,253,398
Water O&M	15,500,866	16,495,238	17,376,493	14,948,245	21,637,649
Local Wastewater O&M	10,633,746	11,690,420	11,818,549	9,704,859	13,871,941
Wastewater Resource Recovery	22,576,722	24,042,689	24,959,785	20,675,644	31,726,010
Wastewater Resource Distribution	6,743,223	7,167,529	7,296,000	3,927,072	8,630,181
Debt Service	25,694,593	81,340,032	26,806,421	27,663,493	27,668,524
Engineering Resources	3,260,668	3,539,122	3,522,035	3,002,271	3,610,531
Subtotal	$108,349,467	$169,576,811	$118,391,594	$103,098,810	$138,683,210
CIP and O&M Projects	$30,081,714	$52,431,560	$35,790,769	$253,855,624	$37,739,929
TOTAL	$138,431,181	$222,008,371	$154,182,363	$356,954,434	$176,423,139

APPENDIX I: MEMORANDUM ON DESALINATION SUPPLY OPTIONS IN THE WATER SUPPLY FEASIBILITY ANALYSIS

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MEMORANDUM

DATE: August 31, 2023

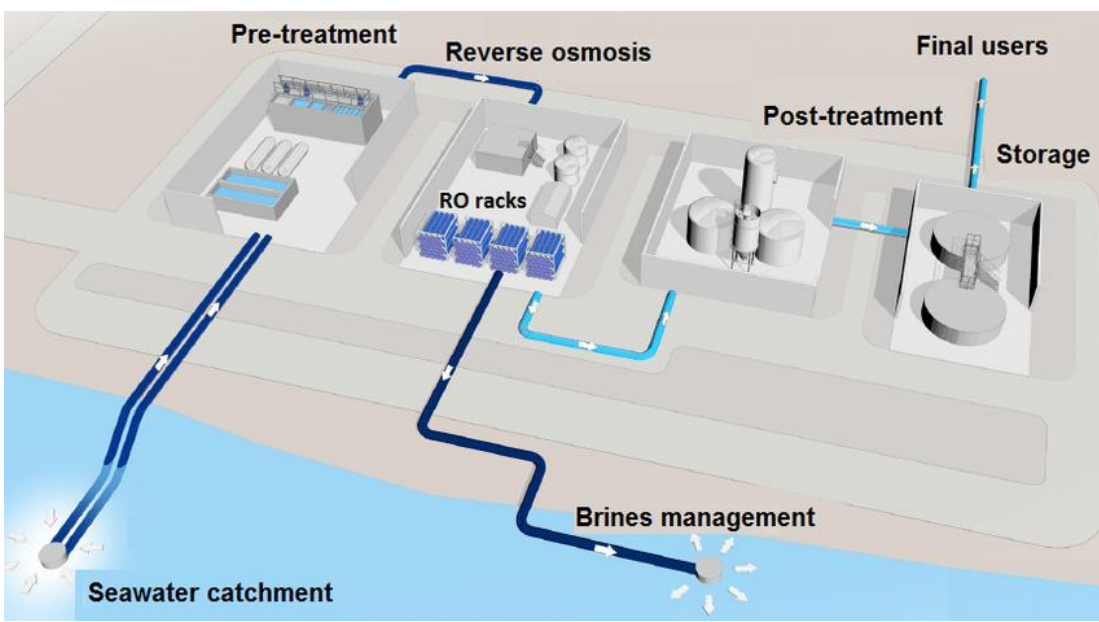
RE: Desalination Supply Options in the Water Supply Feasibility Analysis

This memorandum provides additional context for desalination as a potential water supply for the feasibility analysis conducted for the City of Santa Rosa's Water Supply Alternatives Plan (WSAP).

Strengths and Weaknesses of Desalination as a Water Supply Source

Desalination is the process of removing salts from seawater or brackish water. Generally, salty water is piped from its location to the desalination facility, which requires a significant amount of power to run the treatment components. While there are a number of technologies used for treatment, reverse osmosis is the most common. Once the salts are removed, the water undergoes further adjustments so that it can be introduced into the existing system via storage tanks and pipelines. Depending on the proximity of the desalination facility to the end users, the pipeline could be significant and require one or more pump stations to convey the water to a point where it can be introduced into the distribution system. Another pipeline is required to dispose of the brine that is created during the treatment process. **Figure 1** shows the general process of an ocean desalination facility.

FIGURE 1: EXAMPLE DIAGRAM OF OCEAN DESALINATION FACILITY



Source: Perez-Zuniga, et.al. September 2020. Fault detection and isolation system based on structural analysis of an industrial seawater reverse osmosis desalination plant.

As with any supply type, desalination has a variety of strengths and weaknesses.

Strengths

- Immune to drought and variations in hydrologic conditions that are a concern for surface water (e.g., lakes and streams), stormwater, and groundwater supply options, thus providing a continuous supply of water.
- Local source for coastal communities located in Mediterranean climates that experience more frequent boom-bust water cycles and for communities with large local sources of brackish water, such as salty groundwater.
- Benefits from advancements in treatment technology, energy efficiency, and availability of renewable energy sources.
- Scalable to meet water needs given that its source (in the case of ocean desalination) is nearly unlimited.
- Desalination facilities perform optimally when running at full capacity, benefiting from economies of scale and lowering the cost of desalinated water.

Weaknesses

- Extensive permitting requirements that can take a decade or more to resolve, particularly for ocean desalination facilities. For example, both the Carlsbad facility and the new recently approved Monterey facility took over 10 years to permit and secure approvals from the California Coastal Commission[1]. Recently, the Coastal Commission denied a permit to a proposed facility in Huntington Beach, a project that has been in development for over 20 years[2]. While there have been some positive signs relative to permitting, including the Governor's stated interest in desalination and the streamlined permitting process proposed by the State Water Resources Control Board, there remains significant uncertainty given the multiple permitting agencies involved[3].
- Financial capital required to build desalination facilities can be in the hundreds of millions of dollars. The recently completed Claude "Bud" Lewis Carlsbad Desalination Plant in Carlsbad, California cost nearly $1 billion, well above initial estimates of $300 million[4].
- Carries high annual operating costs due to the energy required in salt removal and treatment.

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[1] Becker, Rachel. CalMatters. 17 November 2022. Another California desalination plant approved – the most contentious one yet.
[2] James, Ian. Los Angeles Times. 12 May 2022. California Coastal Commission rejects plan for Poseidon desalination plant.
[3] State Water Resources Control Board. Ocean Plan Requirements for Seawater Desalination Facilities.
[4] Dawid, Irvin. Planetizen. 2 November 2016. What Happened to all those Desalination Plants Proposed for California?

- Expensive membrane replacement (every three to five years) is critical to maintaining the health of desalination facilities, further contributing to large operation & maintenance costs. In addition, membranes can be "fouled" by algal blooms due to warming oceans, requiring more frequent maintenance, repair, and replacement costs.

- Environmental concerns associated with the high greenhouse gas emissions footprint due to substantial energy required for treatment, particularly if the facility is supplied with fossil fuels.

- Environmental concerns associated with waste disposal. Desalination processes generate waste referred to as "brine," which can contain highly concentrated salts, heavy metals, cleaning chemical residues, and treatment reaction by-products. Oftentimes, this waste stream is heated, which can cause concerns for the local environment when its discharged. Current reverse osmosis technology can recover only 50% of water entering treatment for ocean desalination facilities and 85% for brackish water facilities. This means that for an ocean desalination project, every 10 gallons of water treated would result in 5 gallons of brine requiring disposal. If future regulations require waste treatment before disposal, project costs would increase significantly.

- Vulnerable to certain climate change related impacts, including rising sea levels and warming ocean temperatures (for ocean desalination projects). By their location alone, ocean desalination projects need to account for rising sea levels, which can be addressed during the design phase of a project. Warming ocean temperatures can create algal blooms, which can hasten the fouling of treatment components. One such example is the Carlsbad desalination facility, which experienced shut-downs and ultimately needed to move intakes and make process changes due to an algal bloom[1].

- Poor turndown capacity which keeps baseline costs high. Desalination facilities must maintain production levels at a minimum of 30% of capacity or risk the facility's long-term health and performance. Thus, even in periods when no water from the facility may be needed, the plant must continue producing water and incurring the associated operating costs.

Review of Desalination Options Considered for Santa Rosa

As discussed above, an ideal user for desalinated water is one that lives near the source water body and has a consistent demand that can be met with the supply. Santa Rosa has neither of these qualities: it is not proximate to the ocean nor to another significant source of brackish water and its most significant need for water is during drought or catastrophic events, neither of which occur every year. Despite these challenges and others listed above, the feasibility analysis does consider two desalination supply options: a regional brackish water desalination facility (DE-1) and an ocean desalination facility (DE-2). The two options are further described in the following paragraphs.

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[1] Rivard, Ry. Voice of San Diego. 29 August 2017. Desal plant is producing less water than promised.

DE-1: Regional Brackish Water Desalination

Option DE-1 was conceived as a way to potentially reduce the major operating and capital costs associated with desalination. The defining aspect of the option is treatment of brackish water instead of ocean water, since that would have the potential to greatly lower costs.

However, because Santa Rosa is not located near a large brackish water source, DE-1 cannot move forward without significant involvement from major partners. Santa Rosa would not own or operate the facility so these partners would need to be a driving force in the implementation of any regional brackish water facility. Marin Water, a viable partner for such a project, has been evaluating desalination since the early 1980's. In its recently released Strategic Water Supply Assessment, Marin Water discusses a Petaluma Brackish Regional Desalination project which it notes as being a late addition to the document and using a number of assumptions to develop its concept and costs[1].

Option DE-1 would be implemented as follows:

- MMWD would construct a brackish water desalination plant, using funds provided by Santa Rosa to oversize the plant beyond MMWD's own needs. In essence, Santa Rosa would have a certain percent stake in the project.
- Santa Rosa would pay MMWD for its share of capital and operating costs. Those costs would include operations even in wet and normal years, which are substantial because current desalination plants need to be run at about 30% of capacity to maintain their readiness.
- Rather than physically transporting the water from the treatment plant to Santa Rosa, Santa Rosa would trade water, such that water which MMWD would otherwise have taken from the Sonoma Water system would instead be taken by Santa Rosa.

Several aspects of the project impact its current viability:

1. Technical questions. The supply of brackish water has not been established, and may be insufficient even for MMWD's needs, let alone for MMWD plus Santa Rosa. The cost and other technical aspects are not well developed.
2. MMWD may not build the project or may not wish to partner with Santa Rosa. This highlights a unique aspect of this option among the 18 options studied as part of water supply feasibility analysis: while many of the 18 options could potentially be enhanced with regional partnerships, DE-1 stands alone as the only option that simply could not move forward without a regional partner driving the project.
3. The technical and legal bases of the necessary water trade have not been established. The proposed trade would occur in dry years and thus be limited to the amount of water that MMWD would be allowed to purchase from Sonoma Water in a dry year. In

[1]Marin Water. May 2023. Strategic Water Supply Assessment.
https://www.marinwater.org/sites/default/files/2023-06/MMWD_SWSA_Final%20Draft%20Report.pdf

the most recent drought, Sonoma Water reduced MMWD's supply to about 85% of its minimum take-or-pay amount, or about 4.5 TAF[1]. This falls short of Santa Rosa's need for water. Further, MMWD's contractual right to trade any water it would otherwise purchase from Sonoma Water has not been established.

4. The project would rely entirely on Sonoma Water infrastructure for its operations. This is at odds with the WSAP goal of improving Santa Rosa's resilience to delivery interruptions from Sonoma Water.

Over time, many of the aspects listed above may resolve, although the fundamental mismatch between the option and the WSAP goal of increased self-sufficiency would remain. The next desalination option, DE-2, was conceived to overcome that concern.

DE-2: Ocean Desalination

Option DE-2 includes the construction and operation of an ocean desalination facility, located roughly 17 miles west of Santa Rosa in Bodega Bay. In contrast to DE-1, this option would be owned and operated by Santa Rosa and serve water directly to City customers, thereby addressing the WSAP goal of providing increased self-sufficiency to the City.

DE-2 has the benefit of a largely unlimited, drought-proof water supply source and, as a result, any facility could be sized to meet whatever need exists. However, there is a minimum practical project size from both a cost and water yield perspective: certain economies of scale would favor a slightly larger project over a slightly smaller project and the City would want to ensure that such a facility would be able to provide a large portion of the water needed. As noted in the water supply feasibility analysis, Santa Rosa does not require a large amount of water in every year type; water is only needed during drought and any catastrophic interruptions of Russian River supply. Even though water wouldn't be needed in an average year, the City would be required to run the desalination facility at 30% capacity to keep the components from souring, a concept referred to as turn-down capacity.

Running such a desalination facility 24/7 incurs very high operational and energy costs, one of the driving factors for DE-2's high unit cost of water. Also impacting the capital costs of this option is the massive amount of infrastructure required to build this facility and convey the treated water back to Santa Rosa. The pipeline conveying the water to Santa Rosa is over 17 miles, requiring significant initial investment to build and more long-term O&M costs, particularly when that pipeline would require replacement. This pipeline also has the potential to cross sensitive habitat, which would likely require substantial mitigation and permitting costs. Given its location, pipeline design must also account for significant topography challenges and fault zones.

[1] Marin Water Board meeting packet May 18, 2021 item 7: Due to the dry conditions and reservoir levels Sonoma Water will reduce allocations to their retail customers, including MMWD beginning in July. From July through September MMWD will be restricted to 4-MGD and a slight increase in October to 4.6-MGD. Staff expects that reduced allocation may continue if rainfall is below average in the fall. [In the event, heavy rain in October 2021 ended the restrictions.]

Given its already high cost, DE-2 was not analyzed in detail so the currently estimated costs are considered to be best-case with current technology. If detailed studies are done, several technical areas would be analyzed which could result in increased estimated costs. Such technical areas include plant siting, establishing how brine would be disposed, routing the pipeline or tunnel, and providing line power to the plant. Any one of these facets of facility design could drive costs upward from the estimates included in the water supply feasibility analysis.

Despite the challenges outlined in this memo, future conditions may prompt reconsideration of desalination by Santa Rosa. Those potential future conditions are discussed in the last section of this memo.

Scoring Desalination as a Supply

If the two desalination options had advanced past the screening phase of the analysis, they would have been scored as shown in **Table 1** for DE-1 (Regional Brackish) and **Table 2** for DE-2 (Ocean). Because of the challenges discussed above, neither option scores well in environmental performance and legal, permitting, and regulatory. DE-2 scores favorably in city control and interagency coordination since the option is a city-controlled project. For cost effectiveness, DE-1 scores more favorably with a unit cost of water less than half that of DE-2.

In the future, there may be circumstances that would alter the individual criterion scores, resulting in a better overall score for desalination in Santa Rosa. Triggers that should cause the City to reconsider desalination as a supply are discussed in the next section. **Table 3** is a reproduction of the summary scoring table presented in the water supply feasibility analysis with the addition of the two desalination scores. DE-2 (Ocean) has the least total weighted score of the options (18); DE-1 (Regional Brackish) has the least total unweighted score (5) but the same total weighted score as PR-2 (Satellite DPR). While these two overall scores are the same, potable reuse as a supply option is better suited to Santa Rosa than desalination as highlighted in the “Purified Water vs Desalination” side bar above.

TABLE 1: DETAILED SCORING FOR OPTION DE-1 (REGIONAL BRACKISH)

Criterion	Description	Score
Cost effectiveness	Based on conceptual level cost estimates, a brackish water desalination facility would provide a minimum of 3,360 AFY with an average cost of water of at least $2,000/AF.	1
Scalability	A brackish water desalination facility could be constructed in modular phases to best fit City water needs. Additionally, the facility could be scaled down 30% in low demand periods. However, the facility's scalability would potentially be limited not only by the yield of the project itself, but by the terms imposed by potentially multiple project partners. potentially be limited not only by the yield of the project itself, but by the terms imposed by potentially multiple project partners.	1
Resiliency	Low resiliency. While the ability to desalinate brackish water into potable supply would improve resiliency in times of drought or future hydrologic uncertainty, under this supply option, Santa Rosa would be receiving a partnering agency's Sonoma Water allocation rather than desalinated water.	0
Equity	The additional desalinated water supply would have no impact on vulnerable communities. Because this option relies on a water transfer, ratepayers would be responsible for contributing to the construction of the desalination facility while ultimately receiving water from Sonoma Water.	1
Environmental performance	The construction and operation of a brackish water desalination facility would have a high potential for environmental impacts due to its high energy demands and brine production.	0
Legal, permitting, and regulatory	High permitting/regulatory effort would be required to construct a brackish water desalination facility.	0
City control and interagency coordination	Coordination with a regional partner for the paper exchange would be required in addition to continuing coordination with Sonoma Water if its aqueduct were used for distribution.	0
Multi-benefit	No other benefits provided.	0

TABLE 2: DETAILED SCORING FOR OPTION DE-2 (OCEAN)

Criterion	Description	Score
Cost effectiveness	Under the baseline scenario cost estimate, a seawater desalination facility would provide a minimum of 3,360 AFY with an average cost of water of approximately $4,500/AF. This compares to $1,300/AF for the existing Sonoma Water supply.	0
Scalability	While the ocean offers an infinitely scalable water supply, a seawater desalination facility would need to be constructed at full capacity rather than in phases because it would require the construction of a properly sized pipeline to convey desalinated water to the City. Additionally, the facility would need to run at 30% capacity even when not needed to meet City water supply.	1
Resiliency	Moderate resiliency. The ability to desalinate seawater into potable supply would improve resiliency, even in times of drought or future hydrologic uncertainty. However, this supply option is highly sensitive to rising energy costs, decreasing overall cost-effectiveness. The desalination process is also subject to disruption from ocean conditions such as red tides, which are expected to worsen in future years due to climate change.	1
Equity	The additional desalinated water supply would have no impact on the City's vulnerable communities. However, the City would need to consider potential equity issues if desalinated water were to be delivered to only a portion of its residents.	1
Environmental performance	The construction and operation of a seawater desalination facility would have a high potential for environmental impacts due to its high energy demands and brine production.	0
Legal, permitting, and regulatory	High permitting/regulatory effort would be required to construct a seawater desalination facility.	0
City control and interagency coordination	No significant interagency coordination would be required.	2
Multi-benefit	No other benefits provided.	0

TABLE 3: SUMMARY OF SUPPLY OPTION SCORES WITH DESALINATION OPTIONS

Criterion	Groundwater			Purified Recycled Water		Desalination		Stormwater	
	GW-1: Add Extraction Wells	**GW-2: Convert Emergency Wells**	**GW-3: City ASR Wells**	**PR-2: Satellite DPR**	**PR-4: Regional DPR**	**DE-1: Brackish Desal**	**DE-2: Ocean Desal**	**SW-1: Stormwater Storage in Aquifer**	**E-1: Efficiency Programs**
Cost effectiveness * [$/AF]	2 [$840/AF]	2 [$540/AF]	2 [$1,100/AF]	0 [$3,900/AF]	0 [$3,200/AF]	1 [$2,000/AF]	0 [$4,500/AF]	0 [$3,500/AF]	1 [$2,800/AF]
Scalability [Yield in AFY]	2 [5,880 - 10,080 AFY]	0 [1,436 - 2,462 AFY]	1 [2,993 - 5,130 AFY]	2 [3,019 - 10,065 AFY]	2 [3,019 - 10,065 AFY]	1 [3,360 - 10,080 AFY]	1 [3,360 - 10,080 AFY]	1 [1,008 - 10,080 AFY]	1 [2,145 AFY]
Resiliency	1	1	2	2	2	0	1	1	1
Equity	1	1	1	1	1	1	1	1	2
Environmental performance	1	2	1	0	1	0	0	1	2
Legal, permitting, and regulatory	1	2	0	0	0	0	0	1	2
City control & interagency coordination	2	2	1	2	0	0	2	2	2
Multi-benefit	0	0	1	0	0	0	0	2	1
Total Unweighted	**10**	**10**	**9**	**7**	**6**	**3**	**5**	**9**	**12**
Total Weighted	**32**	**26**	**29**	**21**	**22**	**13**	**13**	**19**	**30**

* Costs shown reflect a realistic baseline usage scenario and include both capital and operating costs.

Triggers for Reconsidering Desalination in the Future

While the water supply feasibility analysis does not show the desalination options advancing past the screening phase, the City may, at some point in the future, determine that work to further desalination as a supply for Santa Rosa is warranted. Triggers that might cause the City to reconsider desalination include:

- **Technology that reduces baseline operating costs**. As discussed in this memo, desalination has poor turndown capacity; current technology requires that plants be operated at a minimum of 30% capacity. This results in significant annual operating costs to keep the plant "healthy" while waiting for times when its water is really needed (i.e., during droughts and catastrophic supply interruptions). Advancements in turndown capacity would reduce baseline operating costs and decrease the unit cost of water, particularly for DE-2.
- **Less expensive energy prices which reduces operating costs**. Because desalination plants require significant amounts of energy, their operating costs are heavily influenced by the cost of energy. The assumption used for costing desalination options in the water supply feasibility analysis was $0.20/kWh. Should there be a sustained drop in price, operating costs would decrease, perhaps making the unit cost of water of ocean desalination more comparable with other supply options.
- **Project configuration that yields direct water to Santa Rosa**. DE-1 is configured as a regional brackish water desalination project that results in a water transfer, wherein Santa Rosa would accept additional Sonoma Water. While this configuration would reduce regional reliance on the Russian River system, it would not reduce the City's reliance on Sonoma Water. The City could reconsider regional desalination if such a project were to provide desalinated water directly to Santa Rosa, thus reducing the City's reliance on water from the Russian River system.
- **Technology that improves water recovery.** With current technology, ocean desalination facilities have roughly 50% recovery; brackish facilities have up to 85% recovery. In either case, there is still a significant brine management and disposal challenge. This is one area where the industry is already seeing the impact of technological advances. In a recent City of Santa Monica pilot project, new technology increased recovery from 80% to 90%[1]. Santa Rosa should monitor advancements in this area as this new technology becomes more widely applied.

Prior to committing implementation funding to additional water supply projects, City staff should revisit these triggers to determine if any developments or changes in these areas warrant a closer look at a desalination project for Santa Rosa. The Water Supply Alternatives Plan integrates the suggested revisit points in the discussion of Portfolio 4.

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[1] Sawicki, Emily. Santa Monica Daily Press. 21 January 2022. [New water projects set to expand local supply].