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NORTH MARIN WATER DISTRICT

Draft Local Water Supply Enhancement Study

NOVATO WATER SERVICE AREA

APRIL 2022

NORTH MARIN WATER DISTRICT

WEST YOST

WE SUPPORT OUR COMMUNITIES

WE ARE WATER FOCUSED

WE TAKE PRIDE IN WHAT WE DO

WE STRIVE TO BECOME OUR BEST

WE DO WHAT'S RIGHT

WE BELIEVE IN QUALITY

WE LISTEN

WE SOLVE CHALLENGING PROBLEMS

WE SEE THE BIGGER PICTURE

WE TAKE OWNERSHIP

WE COLLABORATE

WE HAVE FUN

WE ARE WEST YOST

WEST YOST
Water. Engineered.

DRAFT REPORT | April 2022

2022 Local Water Supply Enhancement Study

Novato Water Service Area

PREPARED JOINTLY BY

NORTH MARIN WATER DISTRICT

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2022 Local Water Supply Enhancement Study

Novato Water Service Area

Prepared for

North Marin Water District

Project No. 861-60-21-04

Project Manager: Rhodora Biagtan   Date

QA/QC Review: Elizabeth Drayer   Date

West Yost Water. Engineered.

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LIST OF ACRONYMS AND ABBREVIATIONS

µm	Micrometer (or micron)
AACE	Association for the Advancement of Cost Engineering
ABAG	Association of Bay Area Governments
AF	Acre-Feet
AFY	Acre-Feet per Year
AOP	Advanced Oxidation Process
ASR	Aquifer Storage Recovery
BIL	Bipartisan Infrastructure Law
Board	NMWD Board of Directors
BRIC	Building Resilient Infrastructure and Communities
CalOES	California Office of Emergency Services
CAP	Climate Action Plan
CDFW	California Department of Fish & Wildlife
CEQA	California Environmental Quality Act
cfs	Cubic Feet Per Second
City	City of Novato
CY	Cubic Yards
DDW	State Water Resources Control Board’s Division of Drinking Water

desal	Desalination
DSOD	Division of Safety of Dams
DWR	Department of Water Resources
EIR	Environmental Impact Report
FAT	Full Advanced Treatment
FEMA	Federal Emergency Management Agency
fps	Foot Per Second
GAC	Granular Activated Carbon
GHG	Greenhouse Gas Emissions
gpm	Gallons Per Minute
HMP	Hazard Mitigation Plan
HMPG	Hazard Mitigation Grant Program
I-Bank	California Infrastructure and Economic Development Bank
IJ	Independent Journal
IPR	Indirect Potable Reuse
IRWN	Integrated Regional Water Management
ISRF	The Infrastructure State Revolving Fund
IVGC	Indian Valley Golf Course
LF	Linear Feet
LGVSD	Las Gallinas Valley Sanitary District
MC	Million Gallons
MCPOSD	Marin County Parks and Open Space District
MFR	Multi-Family Residential
mg/L	Milligrams Per Liter
MGD	Million Gallons Per Day
MMWD	Marin Municipal Water District
NEPA	National Environmental Policy Act
NMWD	North Marin Water District
NOI	Notice of Intent
Novato Valley Basin	Novato Valley Groundwater Basin
NPV	Net Present Value
NSD	Novato Sanitary District
O&M	Operations and Maintenance
PDM	Pre-Disaster Mitigation
PHD	Peak Hour Demand
psi	Pounds Per Square Inch
PVC	Polyvinyl Chloride
Resiliency Study	Sonoma Water's Regional Water Supply Resiliency Study
RHNA	Regional Housing Needs Allocation
RO	Reverse Osmosis
RWC	Recycled Water Contribution
RWF	Recycled Water Facility

SF Bay	San Francisco Bay
SF Bay RWQCB	San Francisco Bay Regional Water Quality Control Board
SFR	Single Family Residential
Sonoma Water	Sonoma County Water Agency
State Water Board	State Water Resources Control Board
Study	Local Water Supply Enhancement Study
STP	Stafford Treatment Plant
TM	Technical Memorandum
TOC	Total Organic Carbon
U.S.	United States
USBR	United States Bureau of Reclamation
US-EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UV	Ultraviolet
UWMP	Urban Water Management Plan
WIFIA	Water Infrastructure Finance Innovation Act
WIIN	Water Infrastructure Improvements for the Nation
WWTP	Wastewater Treatment Plant

ES.1 PURPOSE AND OBJECTIVES

The North Marin Water District (NMWD) Local Water Supply Enhancement Study (Study) was prepared with the purpose to enhance NMWD's local water supplies and create a more resilient local water supply portfolio for its Novato water service area. It is intended to assist NMWD in making informed and prudent decisions towards expanding its local water supply. The Study identifies viable water alternatives based on quantitative and qualitative considerations that are important to NMWD. The Study also aligns with one of the goals of NMWD's 2018 Strategic Plan (GOAL 1. Water Supply, Quality, and Reliability).

The objective of this Study is to evaluate water supply alternatives to increase NMWD's current local water supply in its Novato service area by approximately 1,000 to 2,000 acre-feet per year (AFY). Criteria was developed as a part of this Study to evaluate each water supply alternative's feasibility. This Study builds on previous studies related to each water supply alternative. The following potential alternative water supplies have been evaluated as a part of this Study:

- Recycled Water System Expansion
- Indirect Potable Reuse
- Improve Stafford Treatment Plant (STP) Process Water Recapture Efficiency
- Divert Captured Stormwater Into Stafford Lake
- Increase Stafford Lake Storage Capacity
- Aquifer Storage Recovery in the Novato Basin
- Desalination

ES.2 PROJECTED WATER DEMANDS

NMWD's projected water demand through 2045 is summarized in Table ES-1. NMWD's water demand is expected to increase by 2,300 AF (an approximately 26 percent increase) over the next 25 years, primarily due to an increase in its service area population.

Table ES-1. Current and Projected Water Demands, AF

Water Type	2020	2025	2030	2035	2040	2045
Potable Water	7,992	9,866	10,031	10,245	10,254	10,284
Raw Water	202	218	218	218	218	218
Recycled Water	658	595	508	622	636	650
Total	**8,852**	**10,679**	**10,757**	**11,085**	**11,108**	**11,152**

Source: North Marin Water District. June 2021. 2020 Urban Water Management Plan. Table 4-1, Table 4-4, and Table 4-8.

NMWD is seeking to increase local water supply by a minimum of 1,000 AF to improve the resiliency of its current water supply portfolio and help meet projected water use shown in Table 2-3. NMWD's current and projected water supply portfolio is further discussed in Chapter 3.

ES.3 OVERVIEW OF POTENTIAL WATER SUPPLY ALTERNATIVES

This Study evaluates potential water supply alternatives to enhance NMWD's local water supply by approximately 1,000 to 2,000 AFY. Each alternative is evaluated in the subsequent chapters. The water supply alternatives include the following:

- Aquifer Storage Recovery in Novato Valley Basin
- Recycled Water System Expansion
- Indirect Potable Reuse
- Improve STP Process Water Recapture Efficiency
- Divert Captured Stormwater into Stafford Lake
- Increase Stafford Lake Storage Capacity
- Desalination

Each of these alternatives was evaluated using criteria developed with NMWD and detailed in Chapter 4. The alternatives were scored and ranked for feasibility of enhancing NMWD's local water supply portfolio. Findings and recommendations are provided in Chapter 12.

ES.4 EVALUATION METHODOLOGY

Each potential water supply alternative presents benefits and challenges, both quantitative and qualitative. The following six criteria were used to evaluate each alternative.

1. Water Supply Yield and Reliability
2. Cost per acre-foot
3. Operational Impacts
4. Regulations and Permitting
5. Public and Institutional Considerations
6. Other Considerations

To identify and prioritize feasible water supply alternatives for NMWD, the evaluation criteria were prioritized and scored. In this planning-level study, water supply yield and costs were evaluated quantitatively, while the other criteria were evaluated qualitatively, with the exception of other considerations. Some considerations are unique to each water supply alternative and are discussed in the Study, but not scored

The scoring methodology selected for the qualitative criteria is a 5-point rating scale assigning 1 through 5 to the criteria listed above. Each criterion has its own measurement but is scored using 1 (least advantageous) through 5 (most advantageous) based on the likelihood of success for the water supply alternative with respect to the criteria.

NMWD staff was asked to prioritize the qualitative criteria to identify the most important requirements for providing service to customers. A weighted scoring system was developed based on NMWD priorities. The weighted scores were used in addition to the water supply yield and cost criteria to rank each alternative to identify feasible projects.

ES.5 AQUIFER STORAGE RECOVERY

The potential for a local Aquifer Storage Recovery (ASR) program to store and recover treated surface water from the Novato Valley Groundwater Basin (Novato Valley Basin) was evaluated. Based on information available at this time, a local ASR program appears to be infeasible primarily due to the limited pumping and injection capacity of wells constructed in the basin and the limited storage capacity of the basin. Both of these limitations are a consequence of the limited saturated thickness of aquifer sediments and their low permeability. The limited capacity of potential ASR wells would result in a very low yield in comparison to the cost of a local ASR program.

ASR may be a viable alternative for providing supplemental supply to NMWD, if feasible in other nearby groundwater basins capable of storing treated surface water provided by Sonoma Water or other local agencies. The Sonoma Water Regional Water Supply Resiliency Study (Resiliency Study) includes an evaluation of ASR in the Santa Rosa Plain, Petaluma Valley and Sonoma Valley Basins. NMWD should continue to coordinate with Sonoma Water to stay current with the findings, conclusions and recommendations of the Resiliency Study and other regional studies pertinent to ASR, groundwater banking and conjunctive use. If feasible alternatives are identified, NMWD should consider participating in scoping and planning sessions with Sonoma Water and other local agencies as a next step towards developing projects and programs to improve regional water supply resiliency and reliability.

ES.6 RECYCLED WATER SYSTEM EXPANSION

The potential to expand the use of recycled water to offset the volume of potable water used for non-potable application was evaluated. Maximizing the use of recycled water for non-potable use would free up limited potable water resources. NMWD may expand its recycled water program by extending its recycled water distribution system and by expanding the potential uses for recycled

Expanding NMWD’s recycled water system could provide a potable water offset of up to 63 AFY if all proposed extension projects were constructed. This equates to a total potable water offset of 1,881 AF over 30 years. Four pipeline extensions were identified for an estimated cost of $13.1 million. The estimated total cost, including capital cost and operations and maintenance (O&M) cost, over a 30-year operating cycle is $7,900 per AF.

At this time, expansion of the recycled water distribution system is not recommended due to the high cost of new pipelines relative to the volume of potable water offset. NMWD should continue to explore opportunities to increase recycled water use from its existing system and to pursue opportunities to offset the cost of new recycled water pipelines.

ES.7 INDIRECT POTABLE REUSE

Indirect potable reuse of potentially available surplus wastewater effluent was evaluated to enhance NMWD's local water supply. Potable water from wastewater that has been treated through an advanced treatment process could be stored in the local Novato Valley Basin for groundwater replenishment, or stored in Stafford Lake for surface water augmentation. The California Division of Drinking Water (DDW) has established clear regulations for surface water source augmentation and groundwater replenishment—indirect potable reuse (IPR) storage options.

Neither of the two indirect potable reuse classifications (groundwater replenishment and surface water source augmentation) are found to be viable for NMWD when considering both locally available storage options, namely groundwater aquifers within NMWD's boundaries and Stafford Lake. Groundwater replenishment may be a viable water supply option should NMWD have regional storage available. The infrastructure requirements and costs for groundwater replenishment should be further reviewed if and when a viable aquifer storage option is identified.

The Sonoma Water Resiliency Study did not specifically identify indirect potable use as a Drought Management Option but did include ASR, groundwater banking and conjunctive use. If indirect potable reuse is identified in the future as a regional option, NMWD should consider participating in scoping and planning sessions with Sonoma Water and other local agencies as a next step towards developing project and programs to improve regional water supply resiliency and reliability if a viable aquifer storage option is identified.

ES.8 IMPROVE STP EFFICIENCY PROCESS WATER RECAPTURE EFFICIENCY

The potential for producing additional potable water from NMWD's STP by making efficiency improvements to the recapture of process water was evaluated. This water supply enhancement option is potentially viable. Additional plant-scale study is needed to confirm the feasibility of this alternative, which entails modifying the STP pretreatment process to reduce wastewater discharged to the collection system and thus allow for additional hours of STP operation to produce additional potable water from stored water in Stafford Lake. Relatively minor changes are needed to implement this alternative.

The recommended performance testing for the pre-treatment units are provided in Chapter 8. Should the performance testing confirm the feasibility of this alternative, NMWD could potentially realize an estimated additional water supply yield of 20 AF (in dry years) to 70 AFY (in wet years) at a unit cost of $70 to $240 per AF over a 30-year operating cycle, including capital cost and O&M. Even during a dry year, the higher yield may be achieved when the water supply to Stafford Lake is augmented – for instance, with imported water from Sonoma Water.

Should the performance testing indicate that implementing the pretreatment modifications would not be prudent, NMWD could explore other alternatives for STP process efficiency. West Yost's 2019 study identified four other alternatives apart from modifying the pretreatment units. NMWD is recommended to revisit these alternatives, specifically rehabilitating the reactor clarifier, should the performance testing of the pretreatment modifications confirm that the current alternative is not feasible.

ES.9 DIVERT CAPTURED STORMWATER INTO STAFFORD LAKE

The potential for diverting captured stormwater into Stafford Lake from the adjacent Leveroni Canyon and Bowman Canyon watersheds was evaluated. Five options, with variations, to capturing stormwater runoff from Leveroni Canyon and Bowman Canyon watersheds were considered under this water supply enhancement alternative. Further studies are required to explore the options and variations presented in this alternative. Costs for the options are comparably low relative to other water supply options evaluated in this Study. However, capturing water from Leveroni Canyon and Bowman Canyon presents challenges in regulations and permitting and has multi-faceted public and institutional considerations.

The five options include:

- **Option 1 - Leveroni Canyon:** Water from Leveroni Canyon would be captured and pumped to Stafford Lake.
- **Option 2 - Bowman Canyon:** Water from Bowman Canyon would be captured upstream of the confluence with Novato Creek and pumped to Stafford Lake.
- **Option 3 - Novato Creek (Leveroni and Bowman Canyons):** Water from both Leveroni and Bowman Canyons would be captured downstream of the confluence Bowman Canyon and Novato Creek and pumped to Stafford Lake.
- **Option 4 – Leveroni Canyon Dam:** Water from Leveroni Canyon would be captured with the use of a dam across Leveroni Canyon, just north of Novato Boulevard.
- **Option 5 – Bowman Canyon Dam:** Water from Bowman Canyon would be captured with the use of a dam across Bowman Canyon, approximately 300 feet north of Novato Boulevard.

All of the options require major infrastructure. Based on the assumptions used for this alternative, Options 1, 2, and 3 require a pump station and a 12-inch or 15-inch diameter force main. A basin could also be included to increase the captured stormwater runoff. Options 1, 2, and 3 could supply 93 to 629 AFY on average, without the basin; and 316 to 788 AFY, with the basin. This supply could be impacted by future climate change, but still would be relatively reliable. The estimated total cost, including capital cost and O&M cost over a 30-year operating cycle, ranges from $330 to $960 per AF for Options 1, 2, and 3.

Options 4 and 5 would require an earthen dam, pump station, 12-inch diameter force main, and any other facilities associated with a dam or reservoir. Option 4 would provide an estimated yield of 175 AFY and Option 5 would provide an estimated yield of 753 AFY. The estimated total cost, including capital cost and O&M cost over a 30-year operating cycle, is $1,700 per AF for Option 4 and $800 per AF for Option 5.

Further study is needed to identify the optimum stormwater capture and diversion option that can provide needed supply under various operational rules, Stafford Lake capacity limitations, and STP operational limitations. NMWD may consider expanding the study to evaluate combining this alternative with the expansion of Stafford Lake.

ES.10 INCREASE STAFFORD LAKE STORAGE CAPACITY

Two potential options to increase the Stafford Lake Storage Capacity were evaluated—the installation of an adjustable slide gate in the downstream Stafford Lake spillway notch, and sediment removal from the reservoir. This alternative would allow NMWD to store more water from runoff as well as water supplies from other sources, including Sonoma Water, and other potential water supply alternatives discussed in this Study.

The option to install a spillway notch slide gate to increase Stafford Lake storage capacity does not constitute major new infrastructure. It would provide approximately 726 AF of increased storage volume in Stafford Lake. The estimated total cost for this option, including capital cost and O&M cost over a 30 year operating cycle, is $90 per AF.

This option for sediment removal would provide up to about 551 AF of increased storage volume in Stafford Lake. The estimated total cost for this option, including capital cost over a 30-year operating cycle, is about $2,600 per AF. No annual O&M cost is required.

NMWD will need to coordinate closely with Marin County Parks and Open Space District during implementation of either option. Because Stafford Lake is a recreational area, both of the options will attract general public and stakeholder attention.

ES.11 DESALINATION

Local production of desalinated water from either brackish groundwater or the San Francisco Bay (SF Bay) water has been conceptually evaluated for this Study and found to be infeasible for NMWD. For desalinated water supply to be a viable option, NMWD would need to consider participating in a regional project.

As a water supply option, desalination (also referred to as desal) would have the benefit of providing a relatively reliable water supply to NMWD. However, the relatively small scale of a facility to supplement NWMD's water needs would likely result in a relatively high unit cost of water production. Further, a local desal facility would require NMWD-controlled access for both a raw water intake and membrane reject (brine) discharge; NMWD does not have sites available near the SF Bay for such a facility.

Any pursuit by NMWD of desal as a water supply alternative is recommended to be pursued as part of a long-term regional partnership with other agencies. However, other recent water supply studies in the region have not found desal to be an economical water supply alternative. Therefore, continued evaluation of desalination is recommended only if other, less expensive water supply alternatives are found to be infeasible.

ES.12 FINDINGS AND RECOMMENDATIONS

The purpose of this Study is to enhance NMWD's local water supplies and create a more resilient local water supply portfolio for its Novato service area, with the objective to increase NMWD's current local water supply by approximately 1,000 to 2,000 AFY. The potential water supply alternatives were evaluated quantitatively and qualitatively.

A summary of the evaluation of the seven local water supply enhancement alternatives considered in this Study is provided in Table ES-2. Variations were developed for several water supply alternatives to explore potential implementation and yield.

Three of the water supply alternatives were eliminated as infeasible options as detailed in their respective chapters: ASR, IPR, and Desalination. These water supply alternatives may be viable for NMWD through a regional partnership. MMWD and Sonoma Water are other water agencies in the region that have recently evaluated or are currently evaluating regional water supply reliability projects. Sonoma Water's Resiliency Study is in progress at time of preparation of this Study. NMWD is encouraged to continue coordinating with Sonoma Water to stay current with the findings, conclusions and recommendations of the Resiliency Study and other regional studies pertinent to ASR, IPR, and desal.

Table ES-3 summarizes the local water supply enhancement alternatives that may be feasible for NMWD based on the unit cost over the 30-year project period, estimated annual yield, and the qualitative weighted score. Implementation of these feasible water supply projects could potentially provide NMWD 991 AF to 1,584 AF of additional local water supply.

Should NMWD choose to pursue any of these alternatives, further studies are highly recommended as discussed in the respective chapters of each water supply alternative. Because most of these projects present significant capital investment, funding options are provided in Chapter 12.

Table ES-2. Summary Evaluation of Local Water Supply Alternatives

Local Water Supply Alternative			Quantitative Criteria		Qualitative Criteria				
			NPV of Total Cost, dollars per AF	Annual Yield, AFY	Water Supply Reliability	Operational Impacts	Regulations & Permitting	Public and Institutional Considerations	Weighted Qualitative Score
Local ASR[(a)]			11,000	15	3	3	2	2	2.7
Recycled Water System Expansion[(b)]		*Segment N-1*	5,300	17	5	4	4	5	**4.5**
		Segment N-2	6,600	23	5	4	4	5	**4.5**
		Segment C-1	22,000	4	5	4	4	5	**4.5**
		Segment C-2	8,600	19	5	4	4	5	**4.5**
Local Indirect Potable Reuse[(c)]			3,000	1,000 - 3,100	5	1	1	1	2.6
Improve Stafford Treatment Plant Process Water Recapture Efficiency[(d)]		*Pretreatment Modification*	70 - 240	20 - 70	4	5	5	5	4.6
		Pretreatment Modification and Ancillary Improvements[(e)]	1,500 - 5,200	20 - 70	5	5	5	5	**5**
Divert Captured Stormwater Into Stafford Lake[(f)]	*Without Basin[(g)]*	*Option 1. Leveroni Canyon*	710	245	3	4	2	4	3.2
		Option 2. Bowman Canyon	470	433	3	4	2	4	3.2
		Option 3. Novato Creek	330	628	3	4	2	4	3.2
	With Basin[(g)]	*Option 2. Bowman Canyon*	960	593	4	3	2	3	3.2
		Option 3. Novato Creek	730	788	4	3	2	3	3.2
	Option 4. Dam at Leveroni Canyon		1,700	175	3	3	2	2	2.7
	Option 5. Dam at Bowman Canyon		800	752	3	3	2	2	2.7
Increase Stafford Lake Storage Capacity[(h)]		*Spillway Notch Slide Gate[(i)]*	90	726	5	5	2	5	4.4
		Sediment Removal[(i)]	2,600	551	3	2	2	3	2.5
Desalination[(j)]			-	-	5	1	1	1	2.6

Notes:

(a) Cost estimate per ASR well.

(b) The recycled water expansion alternative received a high qualitative score of 4.5 but this score is supplemental to the quantitative criteria. This alternative is cost prohibitive and does not meet the needs of NMWD to offset enough potable water. The annual yields for the recycled water expansion are the annual volume of potable water that would be offset with each recycled water segment.

(c) Costs are provided for treatment system cost only. Does not include pipeline costs since well sites could not be identified.

(d) Costs are provided on a per treatment unit basis. Lower yield/higher costs are associated with dry years. Higher yield/lower costs are associated with typical years.

(e) The pretreatment modification plus ancillary improvements alternative received a high qualitative score of 5.0 but this score is supplemental to the quantitative criteria. This alternative is cost prohibitive due to the raw water intake modification and does not increase the annual yield compared to only implementing the pretreatment modifications.

(f) Costs do not include treatment of raw water captured into Stafford Lake. The lowest cost/highest yield for the option variation is provided.

(g) Yield and cost estimates for these options assumes that the total captured stormwater runoff is diverted to Stafford Lake and none would be lost over the Stafford Lake Spillway.

(h) This alternative increases storage capacity of Stafford Lake for improved reliability. NMWD has the ability to back feed up to 1,000 AFY of supply from Sonoma Water through NMWD's existing potable water system. This supply is available to NMWD during drought years and would allow NMWD to fully utilize the increased Stafford Lake storage capacity under this alternative. NMWD is currently evaluating infrastructure improvements to increase the volume of supply (up to 2,000 AFY) that can be back fed into Stafford Lake from Sonoma Water.

(i) This storage volume is assumed to be utilized 20 years of the 30-year operational cycle. Two-thirds of the 30-year operational cycle was assumed because Stafford Lake has spilled over the spillway two-thirds of the years over the last twenty-three years.

(j) This alternative water supply option was found to be infeasible as a local project. A cost estimate and annual supply yield was not determined.

Table ES-3. Feasible Local Water Supply Enhancement Alternatives

Local Water Supply Alternative	NPV of Total Cost per AF, dollars	Annual Yield (AFY)	Weighted Qualitative Score
Improve Stafford Treatment Plant Process Water Recapture Efficiency - Pretreatment Modification	70 - 170	20 - 70	4.6
Increase Stafford Lake Storage Capacity - Spillway Notch Slide Gate[(a)(b)]	90	726	4.4
Divert Captured Stormwater Into Stafford Lake	330 - 960	245 - 788	3.2

Notes:

(a) This increases storage capacity of Stafford Lake for improved reliability. NMWD has the ability to backfeed up to 1,000 AFY of supply from Sonoma Water through NMWD's existing potable water system. This supply is available to NMWD during drought years and would allow NMWD to fully utilize the increased Stafford Lake storage capacity under this alternative. NMWD is currently evaluating infrastructure improvements to increase the duration and the volume of supply (up to 2,000 AFY) that can be backfed into Stafford Lake from Sonoma Water.

(b) This storage volume is assumed to be utilized 20 years of the 30-year operational cycle. Two-thirds of the 30-year operational cycle was assumed because Stafford Lake has spilled over the spillway two-thirds of the years over the last twenty-three years.

Several established state and federal funding programs could potentially fund the recommended NMWD local water supply enhancement alternatives listed in Table 12-2. Relevant State funding programs include:

- Department of Water Resources (DWR) Integrated Regional Water Management (IRWM) Program
- DWR Drought Relief Funding Program
- SWRCB Water Recycling Funding Program
- California Infrastructure and Economic Development Bank (I-Bank) Infrastructure State Revolving Fund

Relevant federal funding programs applicable to the feasible projects include:

- Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure and Communities (BRIC) Grant Program
- FEMA Hazard Mitigation Grant Program (HMPG)
- United States Bureau of Reclamation (USBR) WaterSMART Drought Response Program
- USBR Title XVI Recycled Water Funding Program
- USBR Desalination Construction Funding
- United States Environmental Protection Agency (US EPA) Water Infrastructure Finance Innovation Act (WIFIA)

State and federal grant and low interest loan programs should be considered with implementation of any of NMWD’s feasible water supply enhancement projects. Grants and low-interest loans can help offset or reduce implementation costs, thus reducing impacts to ratepayers. However, competition for grants is often high and the application process can be resource intensive. Identifying potential grant opportunities early, taking steps towards positioning for the opportunity, and strategically selecting the opportunities that are most likely to be successful are key to maximize external funding.

CHAPTER 1
Introduction

1.1 BACKGROUND

The North Marin Water District (NMWD) serves a current (2020) population of approximately 62,000 people in the greater Novato area and unincorporated areas of Marin County in its Novato water service area (Figure 1-1). This population is expected to increase to approximately 69,500 people by 2045[1].

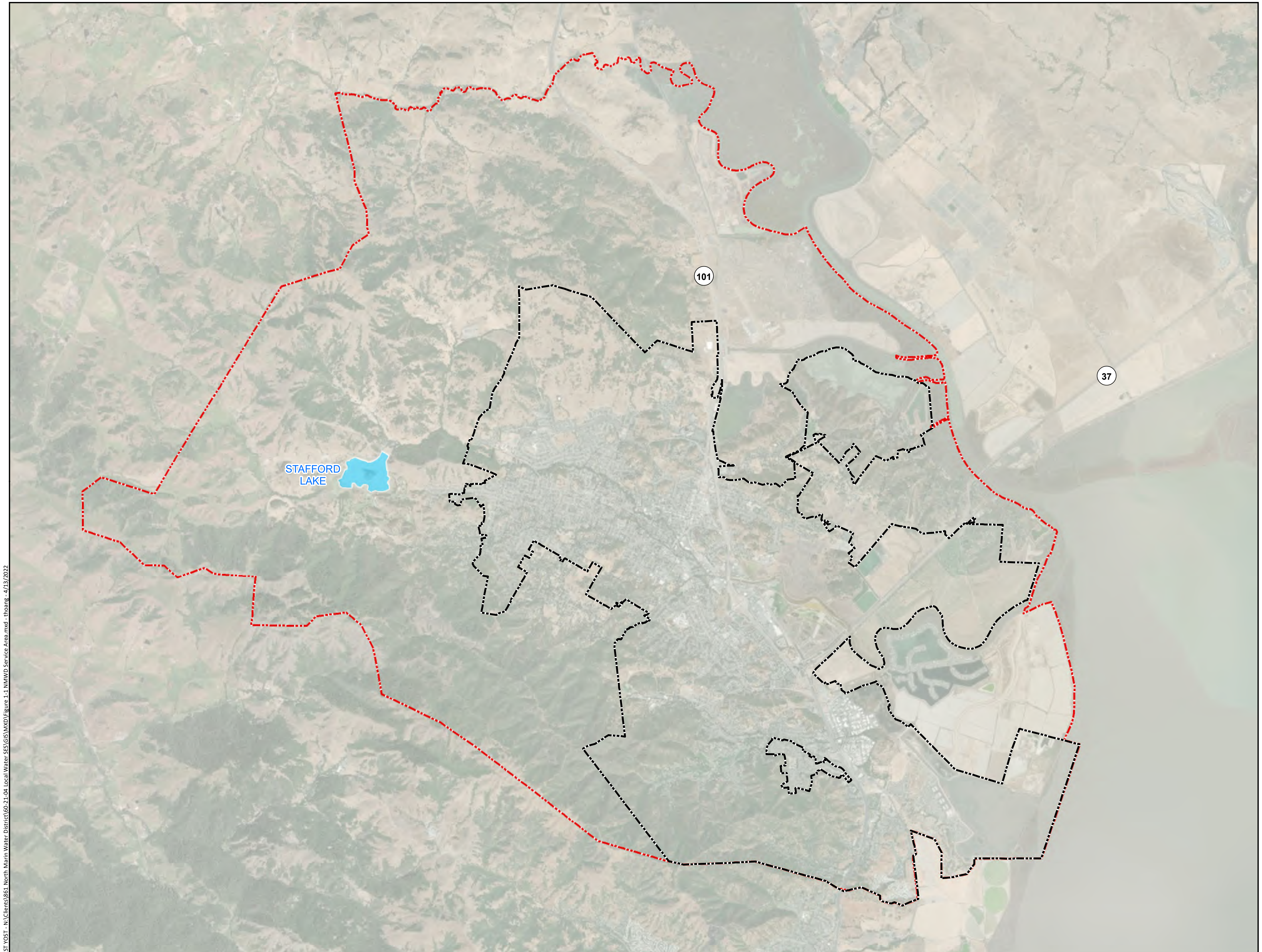
The NMWD water supply portfolio for its Novato service area consists of purchased water from the Sonoma Water County Agency (Sonoma Water) Russian River Project, local surface water from Stafford Lake, and recycled water for non-potable reuse. Purchased water from Sonoma Water supplies approximately 75 percent of the total NMWD water demand while the Stafford Lake surface water supplies approximately 20 percent. Recycled water purchased from Novato Sanitary District (NSD) and Las Gallinas Valley Sanitary District (LGVSD) provide up to 7 percent of NMWD's annual water supply for landscape irrigation and commercial automatic car washes.

Over time, NMWD has made significant investments and efforts in its water conservation program and its recycled water program to improve water resiliency. NMWD's recycled water program has helped reduce ultimate potable water demands in its Novato service area. Despite an almost 8 percent increase in population, total water use has decreased by over 25 percent since 2004.

The current drought conditions have required curtailment of water supply from the Russian River and resulted in the reduction of water supply produced from Stafford Lake. Water supply diversion from the Russian River was reduced by 20 percent in 2021 effective July 1, compared to the same period in 2020. In response, NMWD has enacted emergency water conservation ordinances and reactivated its residential recycled water fill station. Should the dry period persist for another year, Sonoma Water anticipates diversion reductions up to 30 percent. This event, in combination with the statewide drought from 2012 to 2016, has demonstrated NMWD's vulnerability to water shortage due to climate change.

This NMWD 2022 Local Water Supply Enhancement Study for the Novato Service Area (Study) has been prepared to identify viable water supply alternatives that may increase NMWD's water supply resiliency.

[1] North Marin Water District. June 2021. 2020 Urban Water Management Plan.



WEST YOST

Figure 1-1

North Marin Water District Service Area

Novato Water Service Area

North Marin Water District
Local Water Supply Enhancement Study

WEST YOST - N:\Clients\861 North Marin Water District\60-21-04 Local Water SES\GIS\MXD\Figure 1-1 NMWD Service Area.mxd - thoang - 4/13/2022

1.2 PURPOSE AND OBJECTIVE

The purpose of this Study is to enhance NMWD's local water supplies and create a more resilient local water supply portfolio for its Novato water service area. The Study was prepared to assist NMWD in making informed and prudent decisions towards expanding its local water supply. The Study identifies viable water alternatives based on quantitative and qualitative considerations that are important to NMWD. The Study also aligns with one of the goals of NMWD's 2018 Strategic Plan (GOAL 1. Water Supply, Quality, and Reliability).

The objective of this Study is to evaluate water supply alternatives to increase NMWD's current local water supply in the Novato service area by approximately 1,000 to 2,000 acre-feet per year (AFY). Criteria was developed as a part of this Study to evaluate the feasibility of each water supply alternative. This Study builds on previous studies related to each water supply alternative. The following potential alternative water supplies have been evaluated as a part of this Study:

- Recycled Water System Expansion
- Indirect Potable Reuse
- Improve Stafford Treatment Plant Process Water Recapture Efficiency
- Divert Captured Stormwater Into Stafford Lake
- Increase Stafford Lake Storage Capacity
- Aquifer Storage Recovery in the Novato Basin
- Desalination

1.3 COORDINATION WITH OTHER AGENCIES

During the course of the preparation of the Study, NMWD coordinated with the following agencies to develop potential water supply alternatives:

- Marin Municipal Water District – to identify partnership opportunities for desalination and for the proposed water supply pipeline across the Richmond-San Rafael Bridge
- Sonoma Water – to coordinate findings between this Study and Sonoma Water's Regional Water Supply Resiliency Study, currently in progress
- Marin County Flood Control and Water Conservation District– to identify partnership opportunities and develop a potentially multi-benefit project

NMWD has a longstanding, collaborative partnership with Sonoma Water. Sonoma Water is concurrently conducting a regional study to assess the existing and future water supply resiliency and adaption strategies. Preliminary results and recommendations from the Sonoma Water Regional Water Supply Resiliency Study[2] (Resiliency Study) have been incorporated into this Study, where applicable.

[2] Sonoma Water County Agency. June 2020. Sonoma Water Resiliency Study Work Plan

By enhancing the local water supply and partnering with other regional agencies, NMWD plans to develop a robust and resilient water supply portfolio.

1.4 PUBLIC ENGAGEMENT

During the course of the Study, NMWD ran public advertisements in the Marin Independent Journal (IJ) to keep the public informed of its progress, including the public workshop. NMWD has developed a dedicated *New Water Supplies* webpage, along with periodically posting water supply news stories on its website: www.nmwd.com. Copies of the public ads are included in Appendix A.

On January 25, 2022, NMWD conducted a duly-noticed public workshop with NMWD's Board of Directors (Board) and the general public. The workshop was held to engage the NMWD Board members and the general public in reviewing the potential water supply alternatives and in understanding the criteria used for their evaluation. The purpose of the public workshop was to obtain input from the Board members and public so that their concerns are noted and/or addressed, as allowed by the scope of the Study, prior to its completion. Minutes from the Board Workshop are included in Appendix B.

On April 26, 2022, the findings and recommendations of the Study was reviewed with the Board at a duly-noticed public workshop. In the workshop, the next steps were reviewed with the Board and the general public.

1.5 STUDY ORGANIZATION

The Local Water Supply Enhancement Study has been organized into the following chapters:

- Chapter 1: Introduction
- Chapter 2: Existing and Projected Water Use
- Chapter 3: Existing Water Supplies and Potential Future Water Supply Options
- Chapter 4: Evaluation Methodology
- Chapter 5: Aquifer Storage Recovery in the Novato Basin
- Chapter 6: Recycled Water System Expansion
- Chapter 7: Indirect Potable Reuse
- Chapter 8: Improve Stafford Treatment Plant Process Water Recapture Efficiency
- Chapter 9: Divert Captured Stormwater Into Stafford Lake
- Chapter 10: Increase Stafford Lake Storage Capacity
- Chapter 11: Desalination
- Chapter 12: Findings and Conclusions

Several appendices are also included to provide supplemental information collected to support the findings, conclusions, and recommendations in this Study. These appendices include the following:

- Appendix A: Public Notices
- Appendix B: January 25, 2022 Board Workshop Presentation and Minutes
- Appendix C: Russian River Emergency Regulation
- Appendix D: November 12, 2021 Memorandum -Backfeeding Russian River Water to Stafford Lake
- Appendix E: 2019 Stafford Treatment Plant Process Efficiency Improvements Study
- Appendix F: Cost Estimates
- Appendix G: 2021 Recycled Water Program Strategy Technical Memorandum
- Appendix H: Recycled Water Demands
- Appendix I: Future Recycled Water Retrofit Opportunities
- Appendix J: Leveroni Canyon and Bowman Canyon Watersheds Stormwater Runoff Capture Calculations
- Appendix K: Slide Gate Schematic
- Appendix L: Stafford Lake Elevation-Storage Curve
- Appendix M: Transmission System Hydraulic Evaluation for Supplemental Supplies

1.6 ACKNOWLEDGEMENTS

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- Brad Stompe, Distribution & Treatment Plant Supervisor, North Marin Water District
- Jeff Corda, Senior Water Distribution & Treatment Plant Operator, North Marin Water District
- Tim Fuette, Senior Engineer, North Marin Water District
- Roger Leventhal, Advisor from Marin County Flood Control & Water Conservation District
- Paul Sellier, Advisor from Marin Municipal Water District
- Jay Jasperse, Chief Engineer and Direct of Groundwater Management, Sonoma Water

CHAPTER 2
Existing and Projected Water Demands

The purpose of this chapter is to present existing and future water demands projected through buildout of the NMWD's Novato water service area. In June 2021, NMWD completed and adopted its 2020 Urban Water Management Plan (UWMP), which summarized the existing water use and developed projected water use to 2045. The 2020 UWMP considered the impacts of climate change, population, industry, and development as part of the projected water use. Existing and future water demands are required to understand the need and feasibility of each water supply alternative. In this chapter, NMWD's existing water use and projected water use are presented. Planned and approved future development is described.

2.1 EXISTING WATER DEMANDS

Water consumption within NMWD's Novato water service area can be categorized into the following sectors:

- Single Family Residential (SFR)
- Multi-Family Residential (MFR)
- Commercial
- Institutional and Governmental
- Landscape Irrigation
- Other

The SFR sector has historically presented the largest water demand, making up approximately 56 percent of water use between 2016 and 2020. NMWD also delivers raw water from the Stafford Lake to Marin County – Stafford Lake Park and the Indian Valley Golf Course for landscape irrigation. Raw water supply made up approximately 2 percent of the NMWD's average water supply between 2016 and 2020. Table 2-1 summarizes the percentage of average water consumption by sector from 2016 to 2020.

Table 2-1. Potable Water Consumption from 2016 through 2020

Water Type	Water Consumption[(a)], percent
Single Family Residential (SFR)	56.2
Multi-Family Residential (MFR)	14.0
Commercial	10.4
Institutional/Governmental	2.9
Landscape Irrigation	9.0
Other Potable	1.2
Water Losses	4.1
Raw Water	2.3
Recycled Water Make-Up	0.34
Total	**100%**

Source: North Marin Water District. June 2021. 2020 Urban Water Management Plan. Chart 4-1B.

Notes:
(a) The percentages do not exactly sum to 100% due to rounding.

NMWD has recycled water agreements with NSD and LGVSD. Under the agreements, NSD and LGVSD produce recycled water while NMWD distributes the recycled water to its water service area for non-potable use. Non-potable water is water that is not of drinking water quality and may serve other purposes such as recycled water used for landscape irrigation or at commercial car wash facilities. By expanding the recycled water system, the demand on the potable water system is decreased. Tertiary treated recycled water from NSD is delivered to the northern and central service areas of NMWD's water service area and recycled water from LGVSD is delivered to the southern service area. Annual recycled water demand was approximately 7 percent of the total average water demand from 2016 to 2020. Recycled water supply is supplemented with potable water (Recycled Water Make-Up) to meet demands, as necessary. Recycled water demands typically peak during the summer months as they are primarily related to landscape irrigation.

In 2020, NMWD delivered 8,852 acre-feet (AF) of water supply, which consisted of 7,992 AF of potable water, 202 AF of raw water, and 658 AF of recycled water. In 2021, NMWD delivered 9,327 AF of water supply, which consisted of 8,003 AF of potable water, 516 AF of raw water, and 808 AF of recycled water.

2.2 PLANNED FUTURE DEVELOPMENT

Per NMWD's 2020 UWMP, NMWD had approximately 61,700 people within its Novato water service area in 2020. NMWD's population is expected to increase to approximately 69,432 people by 2045. The population projection was calculated by applying City of Novato (City) Association of Bay Area Governments (ABAG) 2018 growth rates to the 2020 population estimate. The projected population includes an estimated population for area served outside the City boundary and was adjusted for the new housing units per the 2023-2031 Regional Housing Needs Allocation (RHNA) Proposed Methodology for the San Francisco Bay Area (ABAG, 2020). The projected land use is expected to be relatively consistent with current land uses. Table 2-2 summarizes the projected additional development through 2035.

Table 2-2. City of Novato – New Development Through 2035

Land Use	New Development Through 2035	Units
Residential[(a)]	2,090	Dwelling Units
Commercial[(b)]	559,432	Square Feet
Industrial[(b)]	467,677	Square Feet
Office[(b)]	646,353	Square Feet

Notes:

(a) Association of Bay Area Governments. October 2020. Regional Housing Needs Allocation Proposed Methodology: San Francisco Bay Area, 2023 – 2031. Appendix 3.

(b) City of Novato. October 2020. General Plan 2035. Table GP-4 Development Projections.

In December 2021, ABAG adopted its 2023 – 2031 RHNA. Per the 2023 – 2031 RHNA, the City is expected to construct approximately 2,090 dwelling units between 2023 to 2031. This accounts for the largest increase in projected population through 2045.

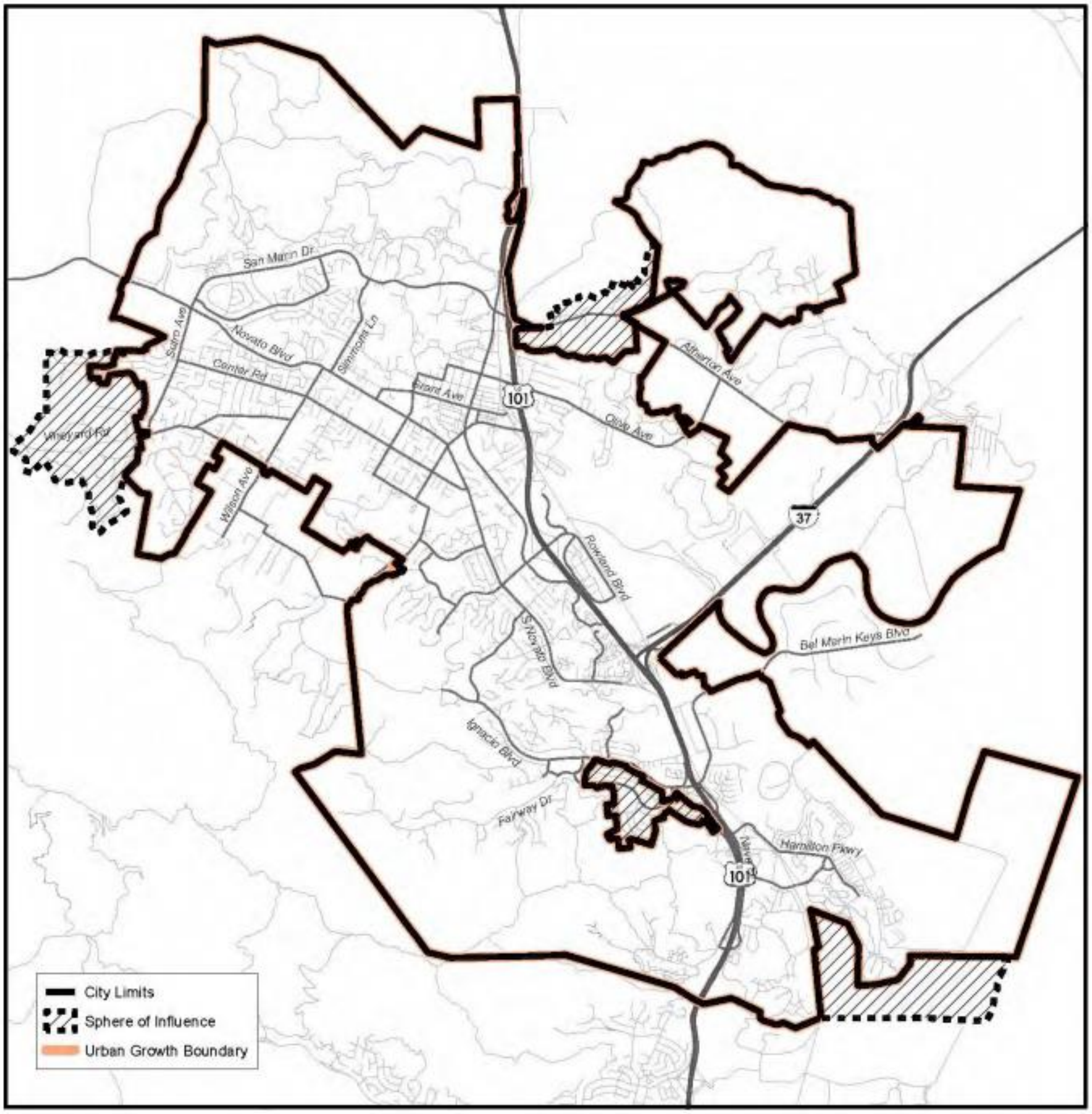

Figure 2-1. City of Novato Urban Growth Boundary and Sphere of Influence[1]

[1] City of Novato. October 2020. General Plan 2035. Figure GP-4.

2.3 PROJECTED WATER DEMANDS

The projected water demand through 2045 is summarized in Table 2-3. NMWD's water demand is expected to increase by 2,300 AF (an approximate 26 percent increase) over the next 25 years, primarily due to the projected increase in population.

Table 2-3. Current and Projected Water Demands, AF

Water Type	2020	2025	2030	2035	2040	2045
Potable Water	7,992	9,866	10,031	10,245	10,254	10,284
Raw Water	202	218	218	218	218	218
Recycled Water	658	595	508	622	636	650
Total	**8,852**	**10,679**	**10,757**	**11,085**	**11,108**	**11,152**

Source: North Marin Water District. June 2021. 2020 Urban Water Management Plan. Table 4-1, Table 4-4, and Table 4-8.

NMWD's 2020 UWMP incorporated data from the 2023 – 2031 RHNA to estimate projected residential water demands in its Novato service area. At the time of the 2020 UWMP preparation, the 2023 – 2031 RHNA had not yet been finalized. The projected water use incorporated the estimated dwelling units from a draft of the 2023 – 2031 RHNA released in October 2020. This draft projected the City would need to construct approximately 2,107 new dwelling units by 2031. The finalized 2023 – 2031 RHNA showed a 17-dwelling unit decrease from the previous draft for the City. As a result, the projected water demands would be slightly lower than those shown in Table 2-3, but not by a significant amount.

NMWD is seeking to increase local water supply by a minimum of 1,000 AF to improve the resiliency of its current water supply portfolio and help meet projected water use shown in Table 2-3. NMWD's current and projected water supply portfolio is further discussed in Chapter 3.

CHAPTER 3
Existing Water Supplies and Potential Future Water Supply Options

3.1 WATER SUPPLY OBJECTIVES

NMWD's water supply objectives are to enhance its local water supplies and create a more resilient and potentially diverse local water supply portfolio due to climate change and other factors. The objective of this Study is to evaluate water supply alternatives to increase NMWD's current local water supply by approximately 1,000 to 2,000 AFY.

Sonoma Water completed its October 2021 Climate Action Plan (CAP) to evaluate and understand the impacts of climate change on its water supply, flood management, and sanitation infrastructure and to create a road map for adaptation strategies. The CAP evaluated the historical climate trends and a range of future climate projections to develop and model scenarios of climate threats to the region. The region is susceptible to floods, droughts, wildfires, and other extreme meteorological and hydrological events.

Sonoma Water provides wholesale water supply to NMWD and other water retailers within Sonoma County and Marin County. Since NMWD obtains a significant portion of its water supply from Sonoma Water and is within close proximity to Sonoma County, NMWD's water supply portfolio is also impacted by climate change as described in the CAP.

The CAP projects the following climate change impacts to the Sonoma County region[1]:

- Increase in air temperature
- Increase in variability of precipitation
  - Increased winter precipitation
  - Decreased summer precipitation
- Increase in sea level rise
- Increase in severity and frequency of droughts
- Increase in flooding
- Increase in wildfires

The CAP summarizes adaption strategies to climate change for its water supply system as follows[2]:

- Improve water supply infrastructure resiliency
- Increase operational flexibility of water management facilities
- Improve system integration and regional resilience
- Improve watershed and natural resources management
- Advance science and technology

The CAP aids NMWD in understanding how climate change will affect its water supply portfolio and make informed decisions in enhancing its local water supplies due to the adverse effects of climate change. The

[1] Sonoma County Water Agency. October 2021. Climate Action Plan. Table 2. Synthesis of Projected Climate and Hydrologic Changes for the Russian River Watershed Region.

[2] Sonoma County Water Agency. October 2021. Climate Action Plan. Section 7 Adaptation Strategies.

proposed water supply alternatives, discussed in Section 3.3, incorporate different climate change adaptation strategies to enhance NMWD's local water supply and to create a more resilient and reliable water supply portfolio.

3.2 EXISTING WATER SUPPLIES

NMWD's existing water supply portfolio consists of purchased water from Sonoma Water, local water from Stafford Lake, and recycled water. Purchased water from Sonoma Water makes up about 75 percent of NMWD's potable water supply while supply from Stafford Lake makes up about 20 percent. NMWD is limited to receiving 14,100 AFY from Sonoma Water and is subject to curtailments when water supply from the Russian River is limited. For example, in response to the 2021 statewide drought, the State Water Resources Control Board (State Water Board) adopted an emergency regulation and issued a curtailment order (Appendix C) on June 15, 2021 to address dire drought conditions in the Russian River Watershed. The curtailment order restricted diversion of water from the Upper Russian River, except for minimum public health and safety needs and mandated a 20 percent reduction of Russian River water diversions for Sonoma Water in the lower Russian River.

Stafford Lake is considered NMWD's local water supply source. The lake captures runoff from 8.3 square miles of area, including land near the upper reaches of the Novato Creek. Stafford Lake has a capacity of 4,450 acre-feet and its water supply is dependent on rainfall and runoff into the lake.

Recycled water provides up to 7 percent of NMWD's annual water supply for landscape irrigation and commercial car wash operation. NMWD receives recycled water from NSD and the Las Gallinas Valley Sanitary District and is responsible for distributing the recycled water to customers within its water service area.

When a dry year is anticipated, NMWD has the option to purchase winter water flows from the Russian River and backfeed the water into Stafford Lake. This supplemental water, supplied by Sonoma Water for a cost of up to $400/AF, is treated water that is fed back through NMWD's potable water transmission system into Stafford Lake, and is then treated at the STP and returned to the distribution system for use during the dry season. As reported by the General Manager in a memorandum to the NMWD Board of Directors in November 2021 (Appendix D), NMWD purchased this supplemental supply seven times in the past 30 years, with volumes ranging from 130 AF to 1,100 AF. With increasing frequency of dry years due to climate change, NMWD anticipates more frequent purchase of winter water flows from Sonoma Water.

3.3 OVERVIEW OF POTENTIAL WATER SUPPLY ALTERNATIVES

This Study evaluates potential water supply alternatives to enhance NMWD's local water supply by approximately 1,000 to 2,000 AFY. Each alternative is evaluated in the subsequent chapters. The water supply alternatives include the following:

- Aquifer Storage Recovery in Novato Valley Basin
- Recycled Water System Expansion
- Indirect Potable Reuse
- Improve Stafford Treatment Plant Process Water Recapture Efficiency
- Divert Captured Stormwater into Stafford Lake
- Increase Stafford Lake Storage Capacity
- Desalination

Each of these alternatives were evaluated using criteria developed with NMWD and detailed in Chapter 4. The alternatives were scored and ranked for feasibility of enhancing NMWD's local water supply portfolio. Findings and recommendations are provided in Chapter 12.

3.3.1 Aquifer Storage Recovery in the Novato Valley Basin

ASR would allow NMWD to store water purchased from Sonoma Water, captured stormwater, or advance treated recycled water. West Yost evaluated the potential ASR water supply options by assessing the storage capacity, geochemistry, recovery rates, and the number of wells required to meet recovery objectives. The evaluation considered the use of ASR to provide water supply with quality similar to the Sonoma Water treated surface water.

Development and evaluation of this water supply option is detailed in Chapter 5.

3.3.2 Recycled Water System Expansion

Recycled water is a valuable, locally available, and sustainable water resource that plays a vital role in the NMWD's water supply portfolio. The use of recycled water offsets the volume of potable water used for non-potable application, thus freeing up limited potable water resources.

In light of the recent drought emergency, NMWD identified immediate near-term opportunities to expand recycled water use within its service area. NMWD retained West Yost to review NMWD's existing recycled water program and develop a road map and strategy for near-term actions and projects to expand recycled water use cost-effectively. This Study builds on that effort and considers opportunities for expanding recycled water use in the NMWD service area by connecting existing high-water use customers near the recycled water distribution system and looking at recycled water supply that could be used for an indirect potable reuse (IPR) program.

Development and evaluation of this water supply option is detailed in Chapter 6.

3.3.3 Indirect Potable Reuse

As part of this Study, West Yost assessed the availability of additional recycled water for developing an IPR program. IPR provides an opportunity to use highly treated recycled water to augment potable water supplies while eliminating several obstacles common with non-potable recycled water projects, such as the construction of costly storage and conveyance systems in urban areas.

While there are opportunities to add customers to the existing tertiary recycled water distribution system through in-fill, an IPR program could provide significantly more water at a competitive price, especially as it appears that most of the large water users located near the existing recycled water distribution system are already connected. This Study conceptually discusses and documents other potential potable reuse options, such as reservoir augmentation at Stafford Lake and raw water augmentation for comparison purposes.

Development and evaluation of this water supply option is detailed in Chapter 7.

3.3.4 Improve Stafford Treatment Plant Efficiency

West Yost built upon the results and recommendations made in the June 2019 Stafford Treatment Plant (STP) Efficiency Study (included as Appendix E). In the STP Efficiency Study, five different opportunities were identified to potentially increase the STP's net water production and recover water from treatment process waste streams. In this Study, one of the strategies identified in the STP Efficiency Study was further developed and evaluated in collaboration with NMWD staff. Specifically, the most significant amount of recoverable water identified in the STP Efficiency Study included the waste stream from pretreatment hydrocyclones.

Other ancillary improvements were also evaluated that would improve the reliability of the STP but not increase the water supply yield at the STP. These ancillary improvements include raw water intake modifications and replacement of the wastewater discharge pipeline.

Development and evaluation of this water supply option is detailed in Chapter 8.

3.3.5 Capture Stormwater into Stafford Lake

Capturing stormwater runoff from Bowman Canyon and Leveroni Canyon can increase the water supply from Stafford Lake. The Bowman Canyon and Leveroni Canyon watersheds are adjacent to the Stafford Lake watershed. Variations of this water supply alternative were considered, including diverting water from each watershed with and without a water supply/flood control basin, or constructing a dam at either Leveroni Canyon or Bowman Canyon to create a reservoir. The water collected in each evaluated reservoir would be pumped to Stafford Lake.

Development and evaluation of this water supply option is detailed in Chapter 9.

3.3.6 Increase Stafford Lake Storage Capacity

Expanding the capacity of Stafford Lake can provide NMWD with storage for additional water either purchased from Sonoma Water or captured local run-off. Additionally, in the future, the increased storage capacity could potentially be supplied by other local water sources, including treated groundwater, captured and treated stormwater, and/or advanced highly treated recycled water that meets potable reuse regulations and water quality requirements. For purposes of this Study, West Yost evaluated two alternatives to increase the water storage volume: (1) by the installation of a variable-level gate in the spillway notch be installed, and (2) by sediment removal.

Development and evaluation of this water supply option is detailed in Chapter 10.

3.3.7 Desalination

The potential of desalination of brackish groundwater and of Bay water for NMWD was considered at a conceptual level. This Study builds on the prior and on-going efforts of Marin Municipal Water District (MMWD) and Sonoma Water. MMWD conducted a desalination feasibility study more than 10 years ago and reviewed desalination as part of its Long-Term Water Supply Review in 2021. Sonoma Water's Regional Water Supply Resiliency Study (Resiliency Study), which evaluates the resiliency of its regional water system, is in progress. As part of the Resiliency Study, Sonoma Water assesses the feasibility of a regional project for developing desalination supply.

Because of its proximity to the NMWD, West Yost incorporated findings from the MMWD's desalination study and the Resiliency Study to evaluate the feasibility of this supply option for NMWD.

Development and evaluation of this water supply option is detailed in Chapter 11.

CHAPTER 4
Evaluation Methodology

This chapter provides a general overview of each criterion considered to evaluate the water supply alternatives. The following chapters will discuss each potential water supply alternative and evaluate each alternative using the criteria described herein. This chapter includes the following sections:

- Evaluation Criteria
- Scoring
- Prioritization

4.1 EVALUATION CRITERIA

Each potential water supply alternative presents benefits and challenges, both quantitative and qualitative. NMWD's preliminary criteria for evaluation included the following:

1. Cost
2. Hazards and risks
3. Water chemistry
4. Revenue or rate impacts
5. Water quality and treatment
6. Permitting and regulations (including water rights, environmental challenges, and California Environmental Quality Act (CEQA) Compliance requirements)
7. Public education and acceptance

These criteria were refined in collaboration with NMWD. The criteria were combined or revised as follows:

- Water Supply Yield and Reliability, discussed in Section 4.1.1, was added to address how much water each alternative could produce to meet NMWD's local water supply needs and qualitatively determine the likelihood of the alternative producing the anticipated yield. Under this criterion, the impact of climate change to the reliability of the alternative water supply is considered.
- Costs, Rate, and Revenue impacts were combined. As discussed in Section 4.1.2, capital and operating costs are evaluated together. Capital costs, replacement costs, and operating costs are translatable to rates. Revenue impacts will be relative to the volume of water generated by that water supply alternative.
- The Operational Impacts criterion, discussed in Section 4.1.3, was developed to address the impacts of each water supply alternative to the water treatment and distribution operations. The original criteria, water quality and treatment and water chemistry, were grouped together under this new criterion since those factors impact the operation of NMWD's water treatment and distribution system.
- Hazards and Risks were combined with Regulations and Permitting, discussed in Section 4.1.4, because the State has regulations and permitting requirements in place to manage hazards and risks associated with each alternative.
- Public Education and Acceptance was modified to be Public and Institutional Considerations, discussed in Section 4.1.5, to consider needed coordination, collaboration, partnerships, and support needed from other entities external to the NMWD.

- Other Considerations, discussed in Section 4.1.6, was added to discuss and document considerations that are relevant to each alternative that may not be addressed in the other criteria.

Thus, the following six criteria were used to evaluate each alternative.

1. Water Supply Yield and Reliability
2. Unit Cost
3. Operational Impacts
4. Regulations and Permitting
5. Public and Institutional Considerations
6. Other Considerations

To identify and prioritize feasible water supply alternatives for NMWD, the evaluation criteria were prioritized and scored. In this planning-level study, water supply yield and costs were evaluated quantitatively, while the other criteria were evaluated qualitatively, with the exception of other considerations. Each of the criterion are described in further detail below.

4.1.1 Water Supply Yield and Reliability

The water supply yield of each alternative was evaluated and quantified for how much it may potentially add to NMWD's local water supply portfolio. Some alternatives, such as improving the efficiency of the STP, may have limits on how much water they may add to local water supply. Some alternatives may not increase the local water supply but would reduce the demand on NMWD's potable water system. For example, expanding NMWD's recycled water system may shift irrigation demands from the potable water system to the recycled water system, decreasing the overall potable water demand.

The reliability of each water supply alternative is defined as the likelihood of that supply producing the anticipated yield and considers the risks that the alternative may not produce anticipated yield. The impacts of climate change on the reliability of each water supply alternative is considered qualitatively.

4.1.2 Unit Cost

Each water supply alternative will require new facilities or improvements to NMWD's existing facilities. A planning-level cost estimate was prepared for each water supply alternative. The total estimated cost per AF includes the capital cost, replacement cost, and operations and maintenance (O&M) cost. Estimated O&M cost includes additional labor, materials, energy, and chemicals that are needed for operation of the alternative water supply, as applicable, over a 30-year operational cycle. A net present value (NPV) analysis was performed over the 30-year operational cycle to calculate the total cost of each alternative, including the capital cost, future replacement costs and annual O&M costs. Unit costs (total cost over 30 years divided by the total supply yield over 30 years) were developed so each alternative may be objectively compared.

The Association for the Advancement of Cost Engineering (AACE) International publishes guidelines for classes of cost estimates and their expected accuracy ranges. Based on these guidelines, the preliminary cost estimate for each alternative is a Class 5 Estimate. Class 5 estimates are based on limited information and are generally prepared for strategic planning purposes, assessment of initial viability, evaluation of alternate schemes, and project screening. Typical accuracy ranges for Class 5 estimates are (-)20 to (-)50 percent on the low side and (+)30 to (+)50 percent on the high side.

The assumptions and contingencies used to prepare the cost estimates are included in Appendix F. The following general assumptions were used in estimating the project costs:

- A construction cost contingency of 40 percent was used, consistent with AACE International guidelines.
- Projects with capital costs less than $4 million are assumed to be constructed and implemented without financing.
- Projects over $4 million are assumed to be financed by NMWD at an interest rate of 3.5 percent for a 30-year period.
- An inflation rate of 3 percent was applied for future costs.
- An operational cycle of 30 years was used to estimate operating costs.

Because the water supply alternative project options vary significantly, project allowance percentage and operating contingency costs were developed specifically for each.

4.1.3 Operational Impacts

NMWD operates its facilities and system to maintain the high quality water it delivers to its customers. Under the operational impacts criterion, the impacts of the alternative supply to NMWD's water treatment and distribution system operations were evaluated. Under this criterion, the following items were considered, as applicable, for each water supply alternative:

- Challenges of potentially blending water supplies of different water quality at the treatment plant or within the distribution system;
- Need for additional chemicals to produce and maintain consistent high-quality water supply;
- The expected energy intensity of each water supply alternative; and,
- Additional staff resources and required certifications to operate proposed water supply facilities.

For example, introducing groundwater as a supply source could require additional chemicals to manage the differences in chemistry between existing surface water sources. An advanced treatment water facility may require additional staff resources with State-required certifications to operate the facility.

Operational impacts may present the need for additional resources associated with energy, chemicals, or personnel.

4.1.4 Regulations and Permitting

Applicable regulations and anticipated permitting requirements are evaluated for implementation of each water supply alternative. Depending on the water supply alternative option, construction permits, or long-term operating permits may be required for implementation and operation of a water supply project. Conformance with State regulations and permitting requirements protects the environment and public health and safety.

Under this criterion, potential environmental impacts of the alternative water supply are qualitatively considered along with conformance with CEQA. Permitting requirements and issuing agency, specific to each alternative, are also considered. For example, increasing the capacity of Stafford Lake by modifying its spillway would need review and approval by the California Division of Safety of Dams (DSOD). Implementation of an indirect potable reuse project by reservoir augmentation or groundwater augmentation would need review by the State Water Board.

Conforming with regulatory and permitting requirements can be challenging or straightforward, with potential cost and schedule impacts for projects. NMWD has established relationships with the following regulatory and permitting agencies:

- California Department of Fish & Wildlife (CDFW)
- State Water Board – Division of Drinking Water
- State Water Board – Division of Water Rights
- San Francisco Bay Regional Water Quality Control Board (SF Bay RWQCB)
- United States (U.S.) Army Corps of Engineers
- Division of Safety of Dams (DSOD)
- Department of Water Resources (DWR)

If an alternative water supply is implemented, NMWD will need to work with the relevant regulatory and permitting agencies.

4.1.5 Public and Institutional Considerations

Successful implementation of projects requires support from the public and stakeholders, and partnership and agreements with other entities. Public and institutional considerations associated with each water supply alternative may include any of the following:

- Public acceptance,
- Coordination and collaboration with other entities,
- Need for partnership or agreements with others, and
- Easements required from other entities.

Public and institutional considerations vary for each alternative. Public acceptance and support are necessary to move projects forward. For example, while public interest and acceptance have increased regarding non-potable reuse, indirect potable reuse of recycled water may still be challenging. Any of the alternative options that are perceived to have adverse environmental impacts, high energy consumption, or a large carbon footprint may face challenges from individuals or organizations.

Public and institutional considerations for projects can vary widely, along with the degree of their challenges. NMWD has developed long-standing relationships and partnerships with the following neighboring agencies through their history of coordination and collaboration:

- City of Novato
- County of Marin

- Novato Sanitary District
- Las Gallinas Valley Sanitary District
- Marin Municipal Water District
- Marin County Flood Control & Water Conservation District[1]
- Marin County Parks
  - Including Marin County Parks and Open Space District

NMWD works closely with the Marin County Community Development Agency and the City of Novato to plan for water services within its service area.

NMWD regularly participates in and is a member of the following regional entities:

- North Bay Water Reuse Authority,
- North Bay Watershed Association,
- Sonoma County Water Agency – Water Advisory Committee
  - Technical Advisory Committee

NMWD may require the support of any of these entities to implement projects associated with the selected water supply alternatives.

4.1.6 Other Considerations

Some considerations are unique to each water supply alternative, but are not addressed by any of the above criteria. Although they are part of the evaluation, they are not scored. Nonetheless, these considerations are important for the implementation of projects and are discussed in the Study.

4.2 SCORING

In Section 4.1, each of NMWD's evaluation criteria is defined. Table 4-1 summarizes the quantitative criteria, water supply yield and unit cost, which will be supported by the qualitative criteria, summarized in Table 4-2.

Table 4-1. Quantitative Scoring Criteria

Criterion	Measure	Units
Water Supply Yield	Quantitative	Annual Volume, acre-foot per year
Unit Cost	Quantitative	Dollars per acre-foot

The scoring methodology selected for the qualitative criteria is a 5-point rating scale assigning 1 through 5 to the different criterion listed in Table 4-2. Each criterion has its own measurement but is scored using

[1] A separate political subdivision of the State but staffed by County of Marin and the County Board of Supervisors serve as the District Board.

1 through 5 based on the likelihood of success for the water supply alternative with respect to the criteria. The scoring assigned to each criterion is defined as follows:

- 1 – Least advantageous
- 2 – Slightly less advantageous
- 3 – No change
- 4 – Slightly more advantageous
- 5 – Most advantageous

Table 4-2. Qualitative Criteria Scoring

Criterion	Measure	5-Point Rating Scale				
		1	2	3	4	5
Water Supply Reliability	Degree of Reliability	Least Reliable	Slightly Less Reliable	Moderately Reliable	Slightly More Reliable	Most Reliable
Operational Impacts	Operational Demands	Most Impacted	Slightly More Impacted	Moderately Impacted	Slightly Less Impacted	Least Impacted
Regulations and Permitting	Complexity	Most Complex	Slightly More Impacted	Moderately Complex	Slightly Less Complex	Least Complex
Public and Institutional Considerations	Challenges	Most Challenging	Slightly More Challenging	Moderately Challenging	Slightly Less Challenging	Least Challenging

4.3 PRIORITIZATION

During the course of this Study, NMWD staff was asked to prioritize the qualitative criteria. West Yost presented the priority of the criteria to the NMWD Board of Directors at its January 25, 2022 Public Workshop for this Study. The Board workshop also served to provide the public opportunity to comment. This process allows NMWD to make prudent decisions in meeting the most important requirements for its customers.

Table 4-3 presents the qualitative criteria which are weighted by priority and sum to 100 percent. The weighted scores were used in addition to the water supply yield and cost criteria to rank each alternative.

Table 4-3. Qualitative Criteria Priorities

Criterion	Weight, percent
Water Supply Reliability	40
Operational Impacts	30
Regulations and Permitting	20
Public and Institutional Considerations	10
Total	**100%**

CHAPTER 5
Aquifer Storage Recovery in Novato Valley Basin

This chapter presents the potential for and an evaluation of ASR in the local Novato Valley Groundwater Basin (Novato Valley Basin) to provide alternative water supply when treated surface water supplies are limited or unavailable to NMWD. As detailed herein, the feasibility of ASR is limited due to the characteristics of the groundwater basin. Consequently, consideration of new or reconditioned existing groundwater wells as a source of supply within the Novato Valley Basin is also very limited. An evaluation of this alternative has been conducted so that it may be compared with other potential water supply alternatives that may be available to NMWD.

5.1 ASR AS A WATER SUPPLY ALTERNATIVE

ASR may provide water supply with quality similar to treated surface water supplies when these supplies are limited or not available. ASR wells would be used to inject treated surface water from the distribution system into a suitable aquifer during times when surplus treated water is available. The same wells would be used to withdraw the stored water from the aquifer when the treated surface water supplies are limited or not available (Figure 5-1).

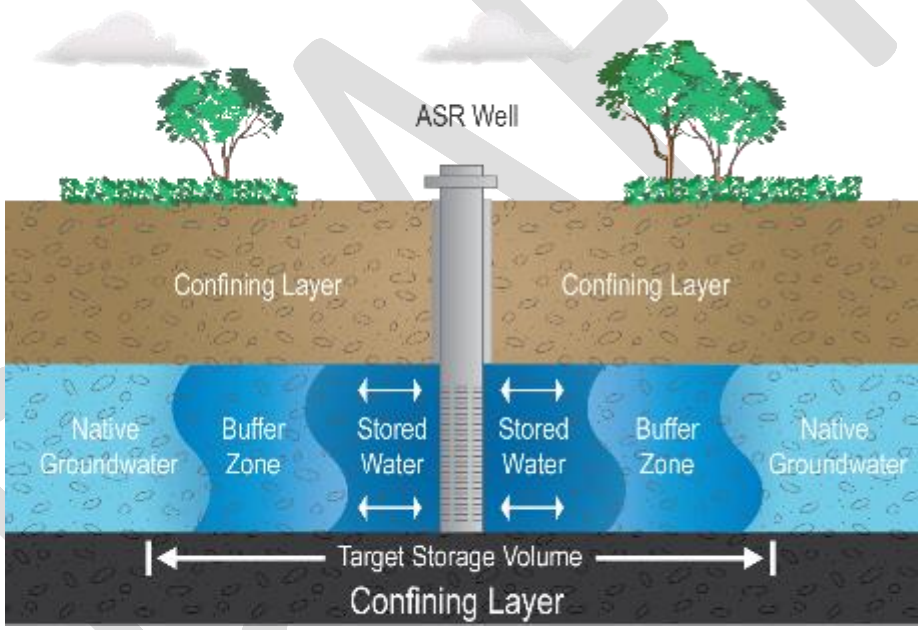

Figure 5-1. Conceptual ASR Schematic

The presence of a suitable aquifer is essential to ASR. The aquifer must have sufficient capacity to store the anticipated volume of treated surface water and sufficient permeability to enable ASR wells to operate at rates that meet storage and recovery needs and are economically feasible.

As a local water supply alternative, ASR would need to be implemented within the groundwater basin underlying the NMWD service area. Construction of ASR wells within the areas of the City of Novato overlying the groundwater basin would allow the use of existing water pipelines to convey treated water to the ASR wells and deliver water pumped from the wells to customers.

5.1.1 Novato Valley Groundwater Basin Characteristics

Figure 5-2 shows the NMWD and City of Novato service areas in relation to the underlying Novato Valley Basin (DWR Basin designation No. 2-30).[1]

The State of California designates and prioritizes 515 groundwater basins within the State and also recognizes that groundwater occurs in bedrock settings.[2] Groundwater within the designated groundwater basins exists in the pore spaces of relatively young, unconsolidated to weakly consolidated sediments deposited in the basins through sedimentary depositional processes. In bedrock settings, groundwater occurs in fractures, and less commonly, in open voids. Volumetrically, the vast majority of groundwater production in California is from designated groundwater basins.[3] Well yields in bedrock areas are unpredictable, typically very low, and susceptible to drought conditions because of the irregular nature of bedrock fractures and voids and the low storage capacity of these features. This is especially true of the Coast Range bedrock underlying NMWD's service area, which consists primarily of very low permeability rocks of the Franciscan Complex.[4]

In its 2019 groundwater basin prioritization, DWR designated Novato Valley Basin as low priority, which means that a Groundwater Sustainability Plan does not need to be prepared to guide management of the basin pursuant to the requirements of the 2014 Sustainable Groundwater Management Act.[5] The factors contributing to the low priority designation were the lack of public supply wells, low density of wells, limited irrigated area, limited groundwater use and limited potential for environmental impacts related to groundwater use. DWR's assignment of a low priority ranking reflects the limited availability and use of groundwater in the Novato Valley Basin.

The underlying aquifer is comprised of relatively young (Pleistocene to Holocene age) alluvial sediments of unconsolidated clay, silt, and sand with discontinuous lenses of gravel with reported thicknesses ranging from approximately 60 feet near the City of Novato to more than 200 feet near San Pablo Bay. Historical well production from sand and gravel layers 25 feet to 50 feet below ground surface averaged a flow rate of approximately 50 gallons per minute (gpm). Groundwater in the basin has relatively high total dissolved solids, and brackish water intrusion is a concern near San Pablo Bay. [6]

[1] California Department of Water Resources (DWR), 2004, California's Groundwater Bulletin 118, Individual Basin Description for the Novato Valley Basin, DWR Basin Designation 2-30, February 27, 2004.

[2] DWR, 2020, California's Groundwater Update, 2020, at: https://data.cnra.ca.gov/dataset/calgw_update2020, accessed February 2, 2022.

[3] DWR, 2020b, Sustainable Groundwater Management Act 2019 Basin Prioritization Process and Results, at https://gis.water.ca.gov/app/bp-dashboard/final/, accessed February 2, 2022.

[4] United States Geological Survey (USGS), 2020, Geologic map and map database of parts of Marin, San Francisco, Alameda, Contra Costa, and Sonoma Counties, California, Miscellaneous Field Studies, MF-2337, Version 1.0, accessed at: https://pubs.er.usgs.gov/publication/mf2337, February 2, 2022.

[5] DWR, 2020b.

[6] California Department of Water Resources (DWR), 1975, Sea-Water Intrusion in California, Inventory of Coastal Ground Water Basins, Bulletin 63-5, October.

Cardwell, G.T., 1958, Geology and Groundwater in the Santa Rosa and Petaluma Valley Areas, Sonoma County California, U.S. Geological Survey Water-Supply Paper 1427.

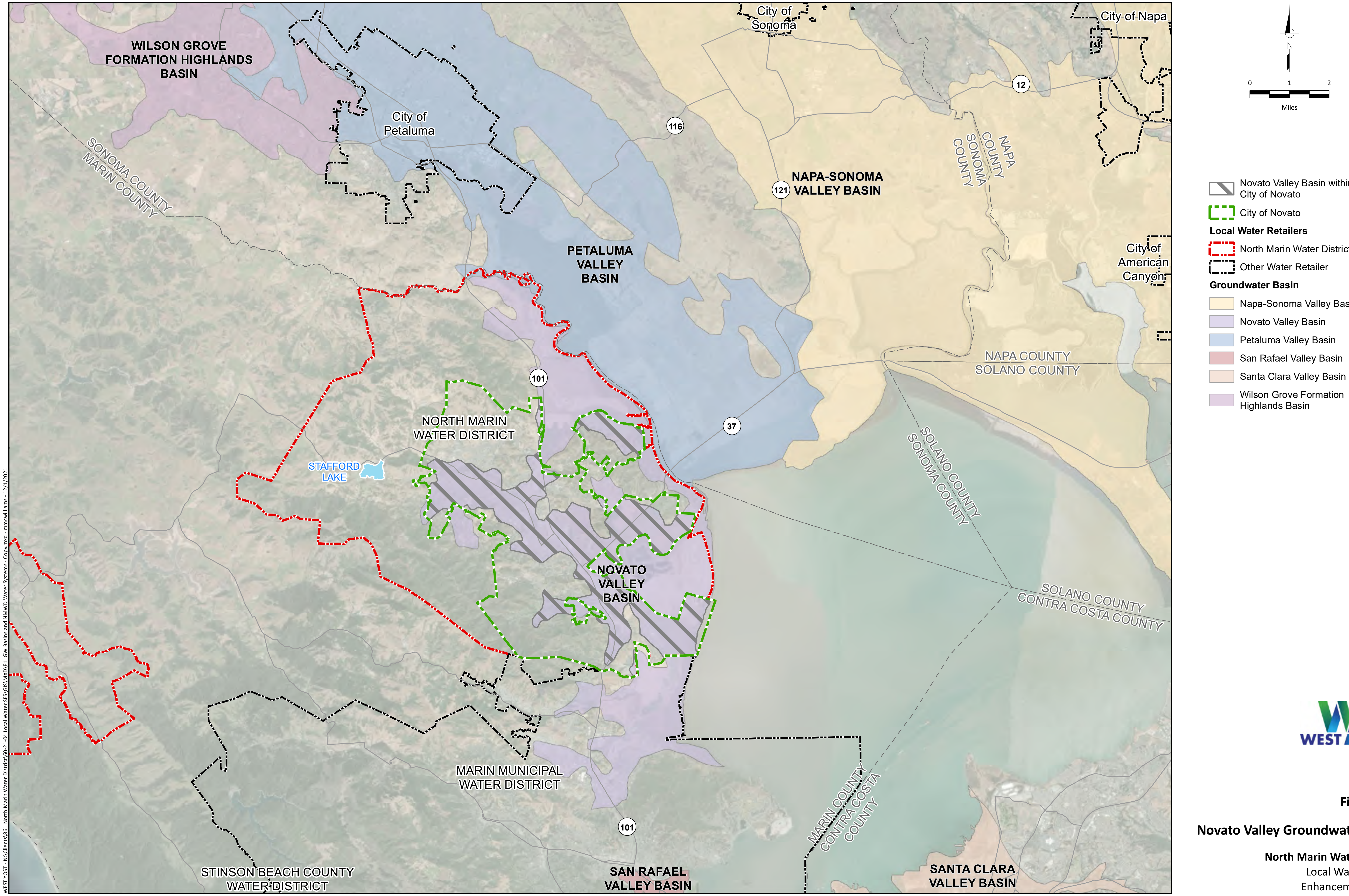

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Figure 5-2

Novato Valley Groundwater Basin

North Marin Water District
Local Water Supply
Enhancement Study

Groundwater was the sole source of supply in the Novato Valley area prior to construction of Stafford Dam and completion of the STP in 1952. Prior to 1948, groundwater was pumped from private wells, some of which were owned and operated by the Novato Water Company (a privately owned public utility). Novato Water Company provided municipal water service to the unincorporated Novato area consisting of approximately 500 customers. NMWD was formed and purchased the Novato Water Company in 1948 in response to severe water shortages resulting from rapid growth and the inability of the existing private wells to provide sufficient high-quality water supplies.[7]

NMWD constructed four additional municipal supply wells in the Novato area in 1950. Use of the wells for municipal supply was terminated in 1952, when the treated surface water supply from Stafford Lake became available. The construction and historical usage records for the private and municipal wells in the Novato area document that the wells ranged from approximately 40 feet to 90 feet in depth and typically had yields ranging from 25 to 50 gpm.[8]

The median well depth for the Novato Valley Basin is approximately 55 feet.[9] These well depths are consistent with the published DWR and United States Geological Survey (USGS) references cited above and provide a good estimate of the depth of the groundwater basin in the City of Novato, because the wells are thought to terminate at the top of bedrock.

Recent (October 2019 through October 2021) measurements of the depth to groundwater in central Novato ranged from 6 to 9 feet below ground surface.[10] Using this range of depths to groundwater and assuming the 40 feet to 90 feet depth of the older Novato wells as representative of the depth of the basin, the saturated thickness of basin-fill sediments ranges from approximately 30 feet to 85 feet within the Novato area.

5.1.2 Water Supply Yield and Reliability

A local ASR program in the Novato Valley Basin does not appear to be feasible because of the limited storage capacity and low permeability of the aquifer. The low ASR injection rates are the most limiting factor. Assuming an injection rate of 30 gpm (60 percent of the typical historical 50 gpm pumping rate) and the availability of treated surface water for injection for 110 days per year (e.g., from mid-November through March), then each ASR well would be capable of injecting approximately 15 AFY into the aquifer.

The storage capacity available for a local ASR program aquifer was not quantified in this Study due to the lack of data. However, storage capacity is likely to be significantly less than 1,000 AFY because the total estimated storage volume of the entire basin is estimated to be approximately 4,000 AF.[11] Only a fraction of the total storage of the basin would be available for ASR. Limitations in the availability of suitable ASR

[7] NMWD, 2022, NMWD website at https://nmwd.com/about/history, accessed February 2, 2022.

[8] NMWD, 2010, Old Novato Wells Abandonment Study, prepared by Edith M.S. Robbins, P.E., June 28.

[9] DWR, 2021, DWR Online System of Well Completion Reports at https://water.ca.gov/Programs/Groundwater-Management/Wells/Well-Completion-Reports, accessed September 15, 2021.

[10] DWR, 2022, DWR Water Data library at https://wdl.water.ca.gov/waterdatalibrary/Map.aspx, accessed February 22, 2022.

[11] T.C. Binkley Consulting Engineer. April 1960. Water Supply and Distribution Study North Marin Water District. Chapter 4 – Sources of Water Supply.

well sites, the extent of necessary conveyance infrastructure, and the potential for adverse impacts to other beneficial uses and users of the groundwater basin present siting and operational constraints.

5.1.3 Infrastructure Requirements

As discussed in Section 5.1.2, an ASR water supply option does not appear to be feasible for NMWD due to limited storage capacity and low permeability of the aquifer. For conceptual purposes, a local ASR project would require ASR wells and transmission pipelines would be required to transport treated water supply from the NMWD's water distribution system to the ASR wells. Each ASR well would be constructed to a depth of approximately 50 feet using 10-inch diameter 304 stainless steel casing and louvered well screen. The wells were assumed to have an injection capacity of 30 gpm and an extraction capacity of 50 gpm. When needed to supplement water supplies, the stored water would be recovered from the aquifer using the proposed ASR wells and pumped back into NMWD's potable water distribution system using the ASR well pumps. No treatment except for chlorination was assumed to be needed.

5.1.4 Implementation Timing

Although not considered to be feasible, a local ASR program could be implemented in approximately four to five years, including approximately one year for planning and permitting, one year for design, one to two years for ASR facility construction, and one year for baseline testing of the constructed ASR facilities. Thereafter, additional ASR wells could be constructed in phases. Permitting, design and construction of additional ASR wells would take approximately three years per phase.

5.2 WATER SUPPLY ALTERNATIVE EVALUATION

The potential benefits of ASR include the ability to store and then recover high-quality water when treated surface water supplies are limited or unavailable, improvements in local groundwater quality, and the ability to apply conjunctive use strategies to the management of the groundwater basin. Operational advantages of ASR wells are that the treated water is recoverable at the ASR well, and operation and maintenance are simplified relative to injection only wells because the installed pumping equipment is used to reduce the plugging that typically occurs in an injection only process, thereby restoring and maintaining well capacity and efficiency.

The primary challenges of a local ASR program in the Novato Valley Basin are the limited thickness, storage capacity, and permeability of the aquifer. The aquifer thickness limits well capacities because only shallow wells with limited intakes could be constructed. Because of the limited aquifer thickness and low permeability, the estimated ASR injection rate is approximately 30 gpm, and the estimated extraction rate is approximately 50 gpm. The limited thickness of the aquifer is also the primary factor limiting the aquifer's storage capacity.

Although an ASR water supply option does not appear to be feasible for NMWD, this project is evaluated at a conceptual level to allow comparison with other water supply alternatives.

5.2.1 Cost Estimate

A planning level cost estimate for the construction and operation of a local ASR project, along with assumptions, is provided in Table 5-1. The cost estimate is per ASR well with the following alternative specific assumptions:

- Project Allowance = 35 percent
- Operating Contingency = 35 percent
- The total cost for a local ASR project is only for the construction and operation of one ASR well. The cost estimate does not include other costs, such as well siting or property acquisition, to illustrate that an ASR program is cost-prohibitive for NMWD to pursue at a local level within the Novato Valley Basin without other added costs. Including these other costs would increase the unit cost per ASR well over the 30-year project period.

Appendix F provides a more detailed cost estimate for the local ASR alternative.

The total capital cost for an ASR well is estimated to be $3.4 million including the construction contingency and project allowance. The 30-year NPV replacement cost is estimated to be $0.6 million. Table 5-2 summarizes the ASR components that were assumed to be replaced and the frequency of replacement within the 30-year project horizon. The annual O&M cost is estimated to be $35,000, including the 35 percent operating contingency, for one ASR well. The 30-year NPV O&M cost is estimated to be $1.0 million using a 3.5 percent discount rate.

The total cost (total capital cost plus NPV costs) for the local ASR alternative is estimated to be $5.01 million per ASR well. Assuming seasonal injection and recovery of approximately 15 AFY, the additional yield over a 30-year period is estimated to be approximately 450 AF. The unit cost per ASR well is estimated to be approximately $11,200 per AF over a 30-year period.

Table 5-1. Total Estimated Per Well Costs for Local ASR Program

Cost Item	Estimated Cost, million dollars
Total Capital Cost[(a)]	3.40
Total Replacement Cost	0.60
Total O&M Cost[(b)]	1.01
NPV Total Cost	**$5.01**
Total Supply over 30 years[(c)], AF	450 AF
Unit Cost over 30 years, dollars/AF[(d)]	**$11,200/AF**

Notes:

(a) A per well base construction cost is estimated to be $1.8 million and assumes 10-inch diameter well, constructed to a depth of 50 feet. Assumes all required civil, mechanical, and electrical equipment for and municipal ASR well, including masonry building, plus ASR flow control valves, piping and mechanical and controls. Assumes conveyance pipeline length of 100 feet. Cost of land purchase or lease is not included. Wellhead treatment, except for chlorination is not included. The construction contingency was estimated to be 40 percent and the project allowance for planning, permitting, engineering, legal, and administrative costs was estimated to be 35 percent.

(b) The annual O&M base cost (no operating contingency) was estimated to be $25,000 per year per well and excludes power costs. Power costs are flow dependent and were estimated based on assumed unit energy use of approximately 89 kW-hour per acre-foot during injection and 170 kW-hour per acre-foot during extraction, and an average energy cost of $0.18 per kW-hour. These assumptions equate to an annual power cost of $679 per ASR well. An inflation rate of 3.0 percent and discount rate of 3.5 percent was applied to determine the net present value of the annual O&M costs over the 30-year project horizon. An operating contingency of 35 percent was applied to the O&M cost.

(c) Annual supply yield of 15 AFY assumes an injection rate of 30 gpm, the availability of treated surface water for injection for 110 days per year and an extraction rate of 50 gpm for a duration needed recover the water injected each year.

(d) Unit Cost = NPV Total Cost divided by the total supply yield over 30 years. Unit costs rounded up to the nearest 100 dollars.

Table 5-2. Estimated Year of Replacement and Frequency for ASR Components

ASR Component	Year of Replacement/Frequency
Cl_2 Injection System	1
Chemical Pumps	2
Water Level Transducer	3
Column Tube, Foot Valve, Flow Control Valve Hydraulic Pump, Air-Vacuum Release Valve	5
Well Rehabilitation, Pump Bowls, Motor Valves, Globe Valves	10
Flow Meters	12
Injection Flow Control Valve	15

5.2.2 Operational Impacts

A local ASR program would affect NMWD operations by adding the operation and maintenance of ASR wells to the existing treated surface water system. Routine operations would include coordinating with Sonoma Water to monitor the seasonal availability of treated surface water; scheduling injection and recovery of the available treated surface water; operating the wells during injection, extraction, and backflushing cycles; monitoring injection, extraction, and backflushing volumes and water quality; and compliance reporting, including additional requirements for consumer reporting. Maintenance activities would include intra-cycle backflushing of the wells to restore capacity, and rehabilitation and replacement of the wells, pumps, motors, and associated equipment.

Additional power requirements would be relatively low due to the limited capacity of the wells and relatively shallow pumping depths. Chemical costs would also be low and limited to chlorination of the recovered water at each ASR well if needed.

5.2.3 Regulations and Permitting

An ASR program would require compliance with CEQA and preparation of an Environmental Impact Report (EIR). The EIR process would involve a comprehensive evaluation of permitting requirements and approvals. The following regulatory approvals would be needed:

1. Water rights may need to be modified to allow underground storage.
2. To test and implement an ASR program, NMWD would need to file a Notice of Intent and receive a Notice of Applicability from the RWQCB for coverage under State Board Water Quality Order 2012-0010, General Waste Discharge Requirements for Aquifer Storage and Recovery Projects that Inject Drinking Water into Groundwater.
3. Drinking water source permits would need to be issued by the State Water Board - DDW for each new ASR well.
4. Well permits would be needed from the Marin County Environmental Health Services Division.

DDW and Marin County Environmental Health Services Division well standards require a 50-foot sanitary seal in municipal supply wells. Due to the limited thickness of saturated sediments in the Novato Valley Basin, an exception to these standards would be required.

5.2.4 Public and Institutional Considerations

A local ASR program would require coordination with Sonoma Water. Sonoma Water would need to lead any required efforts to petition the State Water Board for modification of their water rights to allow underground storage in the Novato Valley Basin. An agreement and coordination with Sonoma Water would be needed to forecast and manage delivery of Sonoma Water treated surface water to be stored underground.

Other public and institutional considerations associated with a local ASR program include potential concerns over well siting, and potential environmental impacts resulting from ASR well site development and ASR operations. These potential public and institutional concerns may be addressed through selection of acceptable ASR well sites and development of acceptable monitoring and mitigation measures during the CEQA process.

5.2.5 Other Considerations

Additional concerns with regard to a local ASR program include uncertainty over groundwater flow velocities, possible geochemical reactions, and the potential for environmental impacts.

Groundwater flow could cause movement of the treated surface water away from the ASR well through which the water is injected. Variations in groundwater flow velocities caused by heterogeneity in the aquifer could also cause mixing of the stored water and native groundwater. Both of these effects could reduce the amount of recoverable, high-quality treated surface water.

Geochemical reactions during injection and storage could lead to plugging or generation of dissolved constituents, such as metals or disinfection byproducts, which could violate drinking water standards. ASR operations could also cause mobilization of existing contaminant plumes.

Potential environmental impacts due to ASR operations include impacts to stream flow and riparian habitats, decreases in the depth to groundwater and associated impacts to drainage and other infrastructure. If excessive pumping were to occur, the Novato Valley Basin may potentially experience brackish water intrusion.

5.3 FINDINGS AND CONCLUSIONS

A local ASR program involving storage and recovery of treated surface water from the Novato Valley Basin appears to be infeasible based on the information available at this time. The primary reasons are the limited pumping and injection capacity of wells constructed in the basin and the limited storage capacity of the basin. Both of these limitations are a consequence of the limited saturated thickness of aquifer sediments and their low permeability. The limited capacity of potential ASR wells would result in a very low yield in comparison to the cost of a local ASR program.

ASR may be a viable alternative for providing supplemental supply to NMWD, if feasible in other nearby groundwater basins capable of storing treated surface water provided by Sonoma Water or other local agencies. The Resiliency Study includes an evaluation of ASR in the Santa Rosa Plain, Petaluma Valley and Sonoma Valley Basins. If feasible, ASR or other groundwater banking programs would improve the resiliency and reliability of the Sonoma Water supply delivered to NMWD.

NMWD should continue to coordinate with Sonoma Water to stay current with the findings, conclusions and recommendations of the Resiliency Study and other regional studies pertinent to ASR, groundwater banking and conjunctive use. If feasible alternatives are identified, NMWD should consider participating in scoping and planning sessions with Sonoma Water and other local agencies as a next step towards developing projects and programs to improve regional water supply resiliency and reliability.

CHAPTER 6
Recycled Water System Expansion

This Chapter presents the potential for expansion and includes an evaluation of NMWD's existing recycled water system, which distributes water for non-potable use. As detailed herein, recycled water may potentially offset current and future potable water demand thus expanding NMWD's local water supply.

6.1 EXPANSION OF RECYCLED WATER TO ENHANCE WATER SUPPLY

Expanding use of recycled water, offsets the volume of potable water used for non-potable application, thus freeing up limited potable water resources. NMWD may expand its recycled water program by extending its recycled water distribution system and by expanding the potential uses for recycled water.

6.1.1 Extension of Recycled Water Distribution Pipelines

NMWD currently delivers recycled water to customers in the City for outdoor irrigation use, dust control and construction activities, and commercial car washing. NMWD's existing recycled water system includes approximately 17 miles of distribution pipelines that deliver recycled water to just under 100 connections within the City. Proposed development within the City has increased significantly over the last few years. Planned new development within Novato and the conversion of existing outdoor landscapes from potable water to recycled water provide opportunity to expand the recycled water system and further reduce reliance on limited potable water supply for non-potable uses. This alternative evaluates the potential for expanding the distribution system to reach additional City customers.

6.1.2 Other Recycled Water Use Expansion Opportunities

Since NMWD began operation of its recycled water system, several potential new or expanded uses of recycled water have been identified by NMWD staff and/or by members of the community. For instance, NMWD has an established residential fill station as well as several commercial fill stations (via designated hydrant locations). The opportunities presented would increase accessibility of recycled water for residential landscaping and commercial use. The proposed expanded use applications would increase recycled water use but would also require additional staffing for program oversight and monitoring.

In 2021, NMWD staff retained West Yost to further assess these expansion opportunities. The required program changes, staffing needs, and additional studies were identified as part of the assessment. West Yost worked with NMWD staff to prioritize consideration and additional study of these applications. A copy of the prioritization memo[1] is included with this report as Appendix G. The recycled water expansion opportunities that were identified and evaluated include the following:

- Expansion of residential fill stations
- Privately-owned recycled water storage tanks
- Delivery of recycled water to residential customers for landscape application during drought periods
- Livestock watering

[1] West Yost. November 2021. Recycled Water Program Strategy Technical Memorandum.

Increasing the availability of recycled water through fill stations, privately-owned storage tanks, and customer delivery will help reduce potable water use, however, since these are not permanent connections to the recycled water system it is difficult to quantify the long-term potable water offset. These options are addressed in the prioritization memo. Additionally, livestock watering, a recycled water use not currently permitted by NMWD, has been proposed. NMWD will continue to assess these expansion options under separate studies.

6.2 EXISTING RECYCLED WATER SYSTEM

NMWD began planning for a phased recycled water program in the 2000's with the completion of the North Bay Water Reuse Phase 1 Feasibility Study (2005) and the Recycled Water Implementation Plan (May 2006) by Nute Engineering. The phased implementation plan identified three service areas - North, Central and South. Distribution pipelines have been constructed within each service area. NMWD receives recycled water from NSD and LGVSD. This section describes the recycled water facilities and service areas.

6.2.1 Recycled Water Supply

NMWD receives recycled water from three different local recycled water facilities (RWFs). NMWD has entered into inter-agency agreements with NSD and LGVSD for the production of disinfected tertiary recycled water. NMWD is responsible for the storage and distribution of recycled water. The following provides an overview of the RWFs.

- Deer Island Recycled Water Facility: The NMWD-owned and operated Deer Island RWF is a 0.5 million gallons per day (MGD) tertiary treatment plant located within the NMWD service area. The facility receives treated secondary effluent from NSD. This facility provides recycled water primarily to the Stone Tree Golf Club and Novato Fire Protection District Station #2, as well as two commercial fill stations located in the North Service Area.
- Davidson Street Recycled Water Facility: The NSD-owned and operated Davidson Street RWF, located at NSD, is a tertiary RWF with a firm recycled water capacity of 1.7 MGD (total capacity of 2.55 MGD). The Davidson Street RWF provides recycled water supply to the North and Central Service Area distribution system. An interconnection pipeline between the Davidson Street and Deer Island RWFs provides reliability of the recycled water supplies.
- Las Gallinas Valley Sanitary District Recycled Water Facility: The Las Gallinas Valley Sanitary District RWF was recently expanded to increase recycled water production capacity from 0.7 MGD (firm capacity) to 4.0 MGD (firm capacity). The LGVSD RWF provides recycled water supply to both Marin Municipal Water District and NMWD's South Service Area. Of the total 4.0 MGD capacity, 0.7 MGD is allocated NMWD.

In the 2021 fiscal year, NSD provided 665 AF and LGVSD provided 124 AF of recycled water within NMWD's service area.

6.2.2 Recycled Water Distribution and Storage Facilities

NMWD's recycled water distribution system includes approximately 17 miles of pipelines and four storage tanks with a total approximate storage capacity of 1.5 million gallons (MG). NMWD's storage tanks are used to provide storage of recycled water produced to supply peak irrigation demands in the summer months. Currently, the NMWD system has one on-demand booster pump station in the South service area.

NMWD's three general service areas are shown on Figure 6-1 and described as follows:

- **North Service Area:** Recycled water is conveyed from the Deer Island RWF to the Stone Tree Golf Course and the Novato Fire Department. In addition, an interconnection on Atherton Avenue between the Deer Island RWF and the NSD's Davidson Street RWF was constructed to improve the reliability of recycled water supplies. Recycled water is conveyed from NSD's Davidson Street Recycled Water Facility to users including Fireman's Fund Industrial Park, Hamann Ball Field, Valley Memorial Park cemetery, and two drive-through carwash stations. Recycled water storage is provided by the Plum Street Tank that has an operational storage capacity of 0.5 MG.
- **Central Service Area:** Recycled water is conveyed from the Davidson Street Treatment Facility to private and public landscape irrigation customers, including homeowner associations, Marin Country Club, Vintage Oaks Shopping Center and one drive-through carwash station. This service area includes 5.7 miles of recycled water pipelines, a below-grade crossing of Highway 101, and recycled water storage at the Norman Tank. The Norman Tank has an operational storage capacity of 0.5 MG. The North and Central service areas are interconnected at Slade Park to allow for redundant storage.
- **South Service Area:** Recycled water is conveyed from the LGVSD Recycled Water Facility to landscape irrigation customers located in the South Service Area (also referred to by NMWD as the Hamilton Area). Recycled water storage is provided by the Reservoir Hill Tank that has an operational storage capacity of 0.5 MG.

Figure 6-1

Existing Recycled Water System

North Marin Water District

Local Water Supply Enhancement Study

6.3 WATER SUPPLY YIELD AND RELIABILITY

This section describes the new recycled water demand estimated along the proposed pipeline extension and expected supply reliability.

6.3.1 New Recycled Water Demand

NMWD has identified new recycled water demand associated with planned development in Novato and with conversion of existing potable water sites to recycled water. This section provides a description of the potential new recycled water use based on new user demand information provided by NMWD[2].

New demand was categorized by customer location with each service area (North, Central, or South) and each customer location was assigned a unique identification number. Demands for existing irrigation sites located in the vicinity of planned development projects that could potentially be converted from potable water to recycled water use (also referred to as site retrofits) were also identified by NMWD. Proposed new pipeline segments to extend the recycled water distribution system to serve new development sites were developed based on the location of concentrated new customer locations.

Because the cost and effort for expanding the recycled water system could be significant, NMWD must consider the following factors when making its decision to expand[3]:

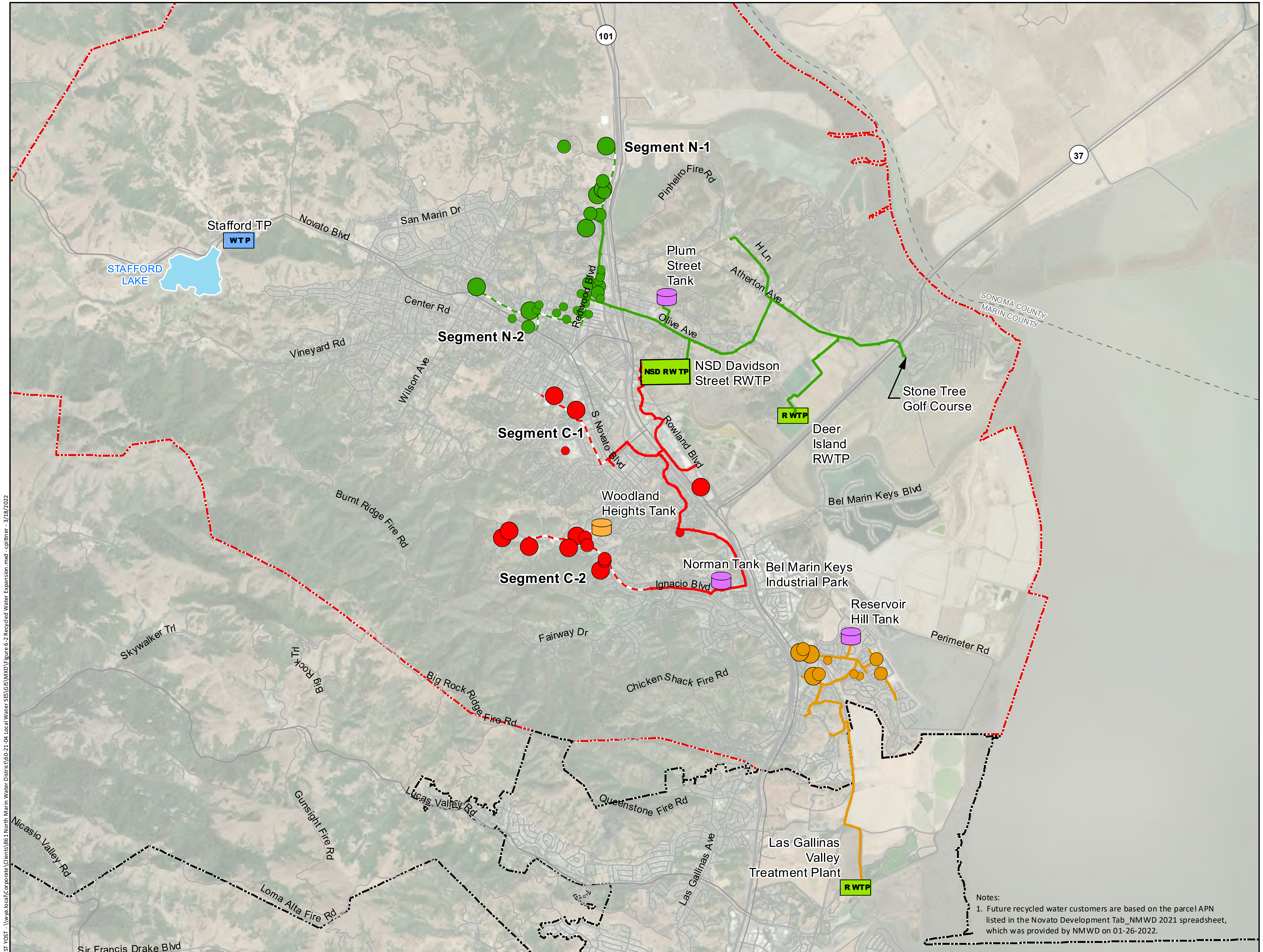
- Future customer location and proximity to the recycled water distribution system;
- Presence of substantial enough opportunities for use of non-potable water to warrant connection to recycled water distribution system; and
- Capacity of recycled water treatment facility and distribution system to meet available demand.

On Figure 6-2, the potential extension pipelines are presented. The alignments are summarized below:

- **Segment N-1:** Redwood Boulevard between Wood Hollow Drive and the Days Inn (Demand N-2)
- **Segment N-2:** Redwood Boulevard, Grant Avenue, and Virginia Avenue between Olive Avenue and Simmons Lane
- **Segment C-1:** Cambridge Street and Hill Road between South Novato Boulevard and Diablo Avenue
- **Segment C-2:** Ignacio Boulevard between Country Club Drive and the College of Marin (Demand C-3)

[2] Information provided by NMWD is primarily based on discussions with the City of Novato Planning Staff.

[3] North Marin Water District. June 2021. 2020 Urban Water Management Plan. Section 4.2.2



Less Than 1 AFY

1 - 3 AFY

Greater than 3 AFY

Central Service Area Pipeline

North Service Area Pipeline

South Service Area Pipeline

North Service Area Proposed Pipeline

Central Service Area Proposed Pipeline

RWTP Recycled Water Treatment Plant

Recycled Water Storage Tank

Proposed Recycled Water Storage Tank

North Marin Water District

Marin Municipal Water District

Notes:
1. Future recycled water customers are based on the parcel APN listed in the Novato Development Tab_NMWD 2021 spreadsheet, which was provided by NMWD on 01-26-2022.

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Figure 6-2

Recycled Water Expansion

North Marin Water District
Local Water Supply Enhancement Study

WEST YOST - \\wya.local\Corporate\Clients\861 North Marin Water District\60-21-04 Local Water SES\GIS\MXD\Figure 6-2 Recycled Water Expansion.mxd - cpittner - 3/18/2022

Demands for the 57 potential customers identified by NMWD are summarized by segment in Table 6-1. Appendix H includes a summary of all potential recycled water customers and their associated demand.

Table 6-1. Summary of Recycled Water Demands by Service Area

Potential Extension Segment	ID No.	Recycled Water Demand, AFY
North Service Area		
Segment N-1	N-1 to N-4, N-7 to N-9	17.0
Segment N-2	N-11 to N-18, N-26 to N-32	22.6
Existing Pipeline on Redwood Boulevard - New Users	N-10, N-19 to N-25	58.9
	North Service Area Subtotal	**98.43**
Central Service Area		
Segment C-1	C-13 to C-15	4.1
Segment C-2	C-3 to C-12	19.0
Existing Pipeline on Hill Street and Cambridge Street- New Users	C-1 and C-2	57.8
	Central Service Area Subtotal	**80.83**
South Service Area		
Existing Pipelines throughout Zone - New Users	S-1 to S-10	21.1
	South Service Area Subtotal	**21.05**
	Grand Total	**200.31**

Source: Provided in Appendix H.

AFY = acre-feet per year

6.3.1.1 Future Retrofit Opportunities

NMWD has received interest from an existing water customer located in the Bel Marin Keys Industrial Park that would like to use recycled water for its cooling system and as process water. The total estimated recycled water demand for the site is 10 AFY. The existing recycled water distribution systems do not extend to Bel Marin Keys. To reach the area, the South Service Area pipeline could be extended north and run along frontage roads parallel to Highway 101 and would then need to cross the SMART Train railroad track. Alternatively, the distribution system could be extended from the Central Service Area with an undercrossing beneath Highway 101. In either scenario, the highway and/or railroad crossing would add significant cost to a pipeline extension project serving Bel Marin Keys.

At this time, no additional potential customers have expressed interested in receiving recycled water. Due to the anticipated high construction cost that would result from the highway and/or railroad crossings, and relatively low identified demand in the area, expanding Bel Marin Keys is not included in this Study.

The City has informally discussed with NMWD a potential expansion from the existing distribution pipeline at Rowland Boulevard and Novato Boulevard to City Parks located approximately one mile north. This expansion requires the potential crossing of the Arroyo Avichi Creek. No formal planning or detailed discussions have taken place to date. This potential expansion could allow several customers identified along Segment N-2 or Segment C-2 to connect to the recycled water system.

In addition to the retrofit sites described earlier in this chapter, NMWD has identified other sites that could potentially be retrofitted in the future. These potential retrofit sites include 14 landscape irrigation sites and two car wash sites. NMWD has assessed each site and identified various challenges in connecting the sites. The status and key considerations for these sites is provided in Appendix I. NMWD will continue to consider retrofit of these sites in future analyses.

Note that as this Study is being finalized, the County of Marin has initiated the planning for the Housing Element of their General Plan Update. The City is expected to initiate their Housing Element in Spring 2022 as well. Determining new potential customers that may identified under these efforts is beyond the scope of this Study.

6.3.2 Supply Reliability

This section discusses the potential issues that could impact the availability of recycled water.

6.3.2.1 Climate Change Impact

Warmer weather, reduced rainfall, and erratic weather patterns all caused by climate change has the potential to impact recycled water supply. As a result of low rainfall and increased water demand during periods of higher temperatures, conservation measures typically increase resulting in a reduction of wastewater flows. Since recycled water is produced from highly treated wastewater, there is a direct relationship between reduced wastewater flows and available recycled water supply.

Currently recycled water demands within NMWD's service areas are approximately 10 percent of the total wastewater volume treated at NSD. Therefore, NMWD's available recycled water supply is not anticipated to be impacted by climate change.

6.3.2.2 Recycled Water Production

As described earlier in this chapter, the Davidson Street RWF provides recycled water to North and Central service areas. NSD treats a portion of wastewater from within its service area to tertiary standards. Treated wastewater that is not used for recycled water is discharged to San Pablo Bay in accordance with NSD's wastewater discharge permit. In 2020, NSD discharged 3,225 AF of treated wastewater to San Pablo Bay (NMWD 2020 Urban Water Management Plan). As recycled water demand increases, sufficient wastewater is available that could be used as a recycled water supply. Coordination between NSD and NMWD would be needed.

Recent improvements at the Davidson Street RWF increased the recycled water production capacity to a firm recycled waste capacity of 1.71 MGD (total capacity of 2.56 MGD). A treatment capacity analysis should be conducted to confirm supply availability during periods of peak demand. If there are production constraints during peak demand periods, NMWD may consider increasing operational storage within the system and/or implementation of demand management strategies. Additionally, NMWD could consider supplementing recycled water supply with potable water.

The maximum daily delivery of recycled water produced by LGVSD in 2021 was 1.9 MG.

6.3.2.3 Recycled Water Distribution

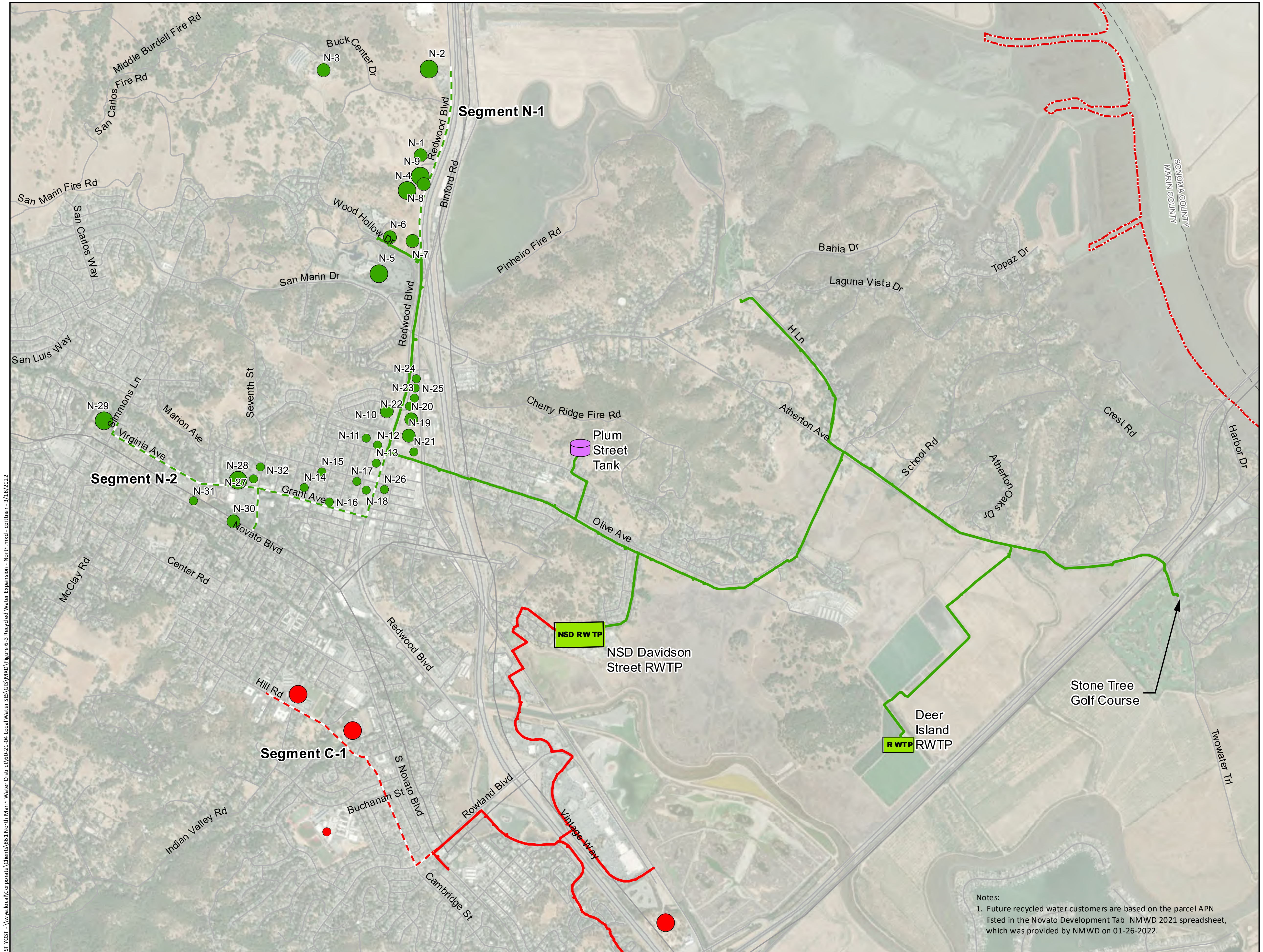
NMWD's South Service Area is exclusively served by recycled water produced at LGVSD. The recycled water distribution system in the area is independent of the North and Central distribution systems. During development of this study, a new pipeline was considered to connect the South Service Area distribution system to the Central Service Area system. The pipeline would run parallel to Highway 101 and would need to cross the highway to connect to the Central Service Area pipeline.

Interconnecting the systems would increase reliability of delivery to customers in the Central Service Area by providing another system to deliver water during maintenance events or interruptions in the existing system. Constructing an inter-connecting pipeline between the systems would have constructability and permitting challenges, primarily due to the required crossing of Highway 101 as well as crossing an existing railroad that runs parallel to the highway. Since an inter-connecting pipeline would not contribute to the connection of additional recycled water customers, it is not included for evaluation in this study.

6.4 INFRASTRUCTURE REQUIREMENTS

This section describes the infrastructure requirements, including design criteria and assumptions for sizing the recycled water distribution system pipeline extensions.

Figure 6-3 through Figure 6-5 shows the potential future recycled water customers that may be served in the North, Central, and South service areas, respectively. Many future recycled water customers appear to be within proximity to the existing recycled water distribution system and would not require additional recycled water system expansion to be served.



Notes:
1. Future recycled water customers are based on the parcel APN listed in the Novato Development Tab_NMWD 2021 spreadsheet, which was provided by NMWD on 01-26-2022.

N

0 0.25 0.5
Miles

- Less Than 1 AFY
- 1 - 3 AFY
- Greater than 3 AFY
- Central Service Area Pipeline
- North Service Area Pipeline
- North Service Area Proposed Pipeline
- Central Service Area Proposed Pipeline
- RWTP
- Recycled Water Storage Tank
- North Marin Water District

WEST YOST

Figure 6-3

Recycled Water Expansion North Service Area

North Marin Water District
Local Water Supply Enhancement Study

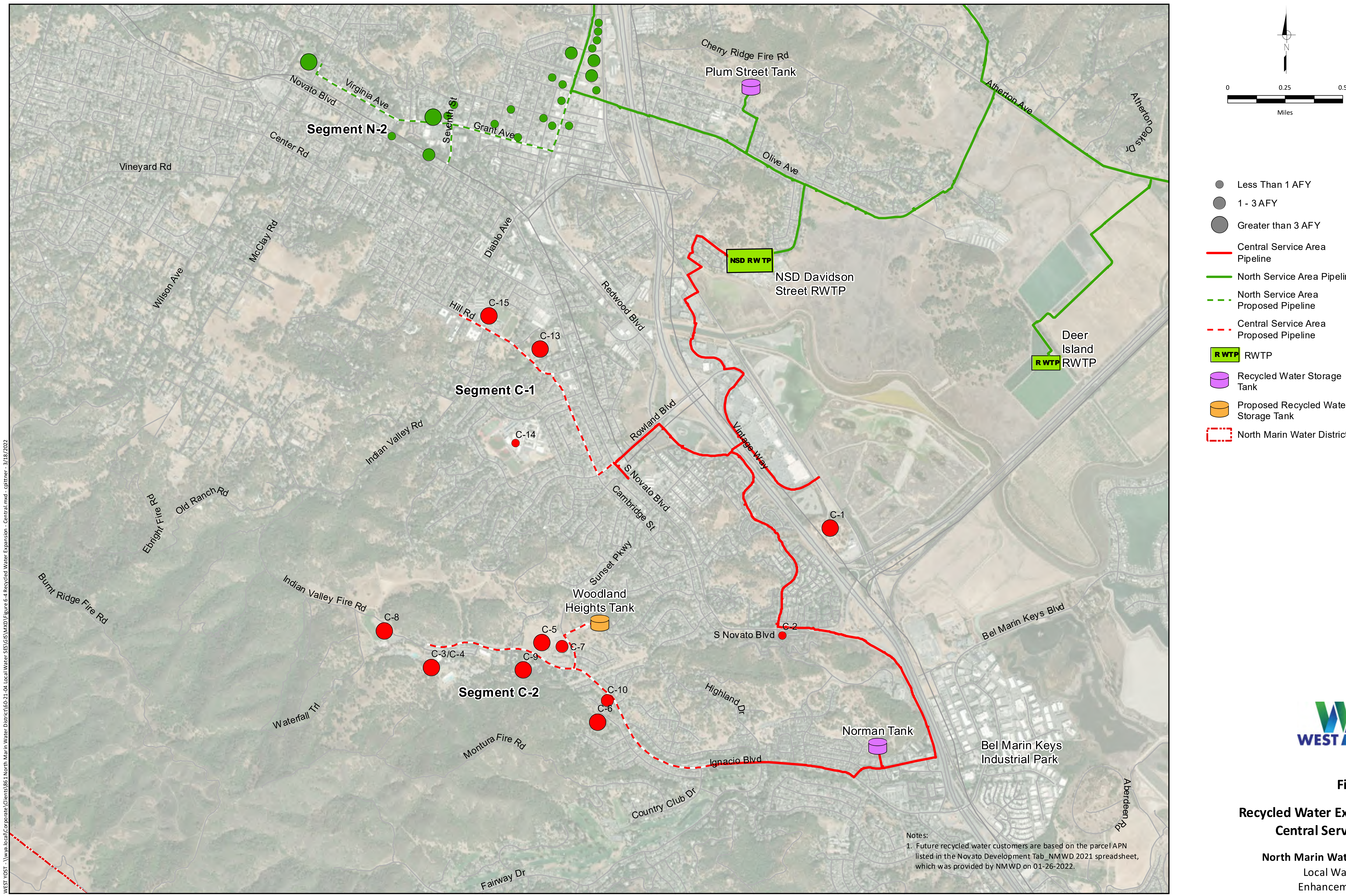
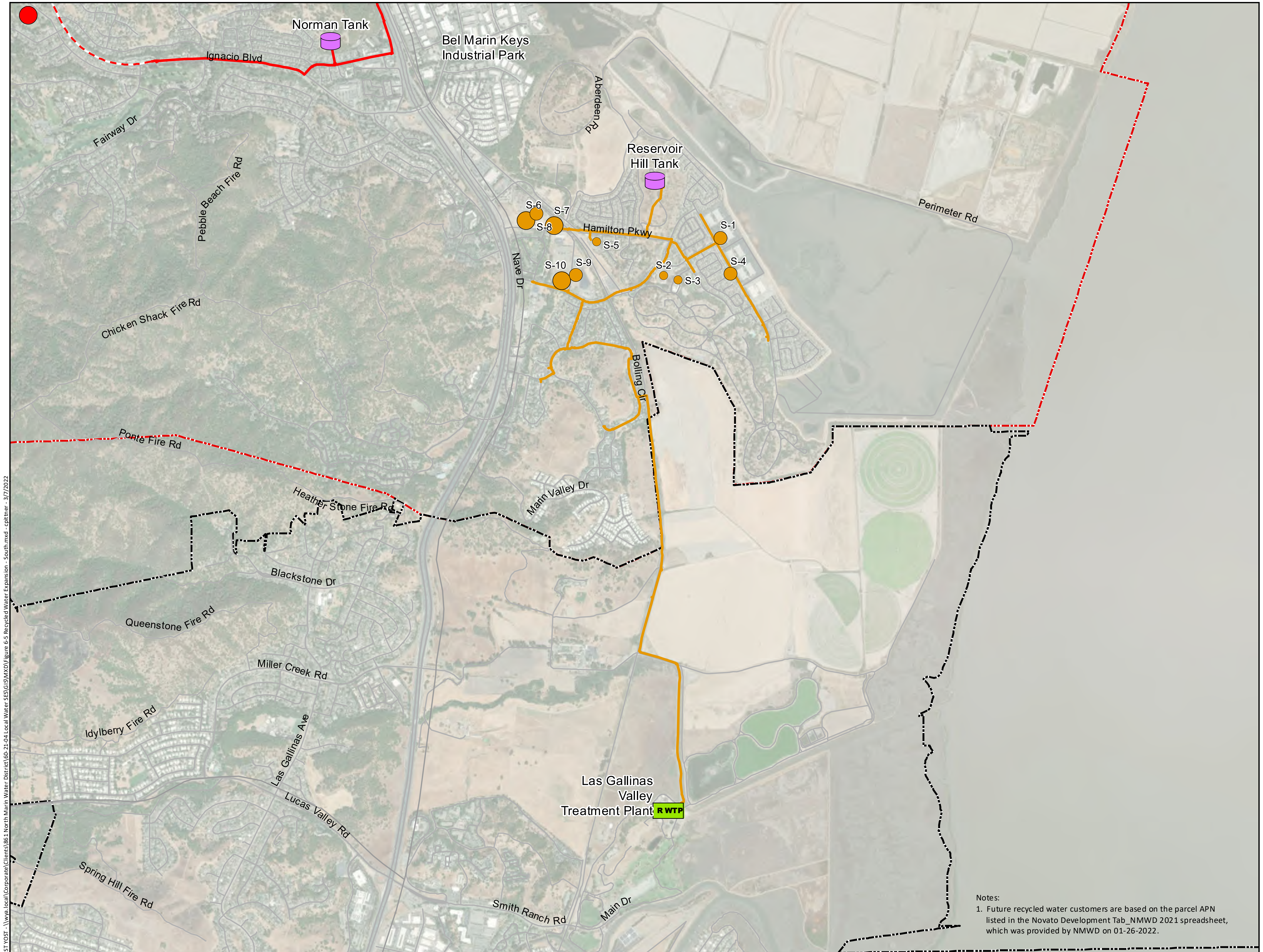


Figure 6-4

Recycled Water Expansion Central Service Area

North Marin Water District
Local Water Supply Enhancement Study



WEST YOST

Figure 6-5

Recycled Water Expansion South Service Area

North Marin Water District
Local Water Supply Enhancement Study

6.4.1 System Performance and Design Criteria

The following sections describe the system performance and design criteria for new recycled water distribution pipelines.

6.4.1.1 System Performance and Design Criteria

System performance and design criteria assumed for the proposed new pipeline segments analyzed have largely been identified in NMWD's prior planning studies as well as NMWD's specifications. The referenced documents are:

- North Marin Water District and Novato Sanitary District Recycled Water Master Plan, Nute Engineering, February 2004 (RWMP)
- Recycled Water Implementation Plan, Nute Engineering and Winzler & Kelly, May 2006
- Feasibility Study of West Ignacio Recycled Water Extension, Nute Engineering, September 2017 (2017 Feasibility Study)
- 2010 NMWD Specifications

A summary of the recycled water system performance and design criteria is provided in Table 6-2. West Yost recommends a minimum flow velocity of 1 foot per second (fps) to maintain water quality and a Hazen-Williams Roughness Coefficient of 130, which is typical of the polyvinyl chloride (PVC) pipe installed for NMWD's recycled water distribution system. PVC is the specified recycled water pipe material per NMWD standard specifications.

Table 6-2. Summary of Recycled Water System Performance and Design Criteria		
Component	Criteria	Data Sources/Remarks
Distribution System Minimum Pressures (Normal Operating Conditions Peak Hour Demand)		
Minimum Pressure	40 pounds per square inch (psi)	RWMP
Maximum Pressure	60 psi	RWMP
Recycled Water Transmission and Distribution Pipeline Maximum Velocity		
Minimum Velocity	1 fps	West Yost Recommendation to improve water quality
Distribution Pipelines	4 to 8 fps	RWMP
New Pipeline Sizing		
Standard Diameter	8, 12, and 16-inch	2017 Feasibility Study
Pipeline Material	PVC, Purple	2010 NMWD Specifications
Hazen-Williams Roughness Coefficient	130	West Yost Recommendation
Demand Factors		
Peak Month Demand	20 percent of Annual Demand	2017 Feasibility Study
Average Day Peak Month Demand	Assumes 30-day Month	2017 Feasibility Study
Peak Day Demand	1.7 x Average Day Peak Month	2017 Feasibility Study
Peak Hour Demand	5 x Average Day Peak Month	2017 Feasibility Study

The analyses performed here follow the design criteria presented in the 2017 Feasibility Study. However, this Study presents an extremely conservative demand peaking factor. The combined peaking factor of 8.5 times average day peak month demand is significantly higher than the peaking factors used by other municipalities which generally range between two- and three-times average day peak month demand. Recycled water systems are generally designed to supply water during an 8-hour irrigation period between the hours of 10 PM and 6 AM to limit public contact. This high-level assumption results in a peaking factor of three times the maximum day demand.

Due to this discrepancy, West Yost recommends that NMWD conduct a system-wide demand analysis to derive current and representative demands and peaking factors for the use in sizing future NMWD facilities. NMWD is likely to determine that actual peaking factors are significantly lower than assumed in the 2017 Feasibility Study.

6.4.1.2 Peaking Factors

The design criteria demand factors presented in Table 6-2 were applied to the projected new demands to estimate the peak month, average day peak month, peak day, and peak hour demands. These peak demands are summarized in Table 6-3.

Table 6-3. Summary of Peak Demands					
Scenario	Annual, AF	Peak Month, GPD	Average Day Peak Month, GPD	Peak Day Demand, GPD	Peak Hour Demands, GPM
North Service Area					
Existing Pipeline on Redwood Boulevard – New Demand	60.6	3,949,966	131,666	223,831	457.2
Segment N-1	17.0	1,105,938	36,865	62,670	128.0
Segment N-2	22.6	1,469,588	48,986	83,277	170.1
Total North Demand	**100.1**	**6,525,492**	**217,516**	**369,778**	**755.3**
Central Service Area					
Existing Pipeline on Hill Street and Cambridge Street - New Demand	4.1	265,243	8,841	15,030	30.7
Segment C-1	19.0	1,238,234	41,274	70,167	143.3
Segment C-2	57.8	3,764,231	125,474	213,306	435.7
Total Central Demand	**80.8**	**5,267,707**	**175,590**	**298,503**	**609.7**
South Service Area					
Total South Demand	**21.1**	**1,371,833**	**45,728**	**77,737**	**158.8**

6.4.2 Infrastructure Sizing

The following sections assess the capacity of NMWD's recycled water distribution system for the proposed new pipeline segments by service area. This analysis calculates velocity and head loss based on the assumed peak hour demand conditions by segment calculated above in Table 6-3. For example, velocity and head loss along Segment N-1 is calculated based on the peak hour demand (PHD) of 128 gpm which is the PHD for that segment. These calculated velocity and head losses will provide an estimate of expected pressure drop on the analyzed pipe segment and can be used to identify system capabilities and potential deficiencies which may need to be addressed. Results of the analysis were used to determine the recommended pipe sizing for each proposed new pipe segment.

6.4.2.1 Infrastructure Sizing Assumptions

The hydraulic assessment conducted for this study used design and criteria performance presented in Table 6-2.

This analysis was conducted under future flow conditions assuming the existing system is able to provide acceptable pressures at the proposed points of connection. No specific pipe, elevation, system pressure, or operations information was included as a part of this analysis. West Yost recommends that NMWD develop a more extensive hydraulic analysis of the recycled water system to confirm if adequate delivery pressures can be achieved with expansion of the system, and to identify any pumping and storage needs. Further, NMWD is recommended to develop a hydraulic model of the system to facilitate efficient analysis as the system at it expands.

6.4.2.2 North Service Area

The North Service Area is split between the Deer Island RWF which serves the Stone Tree Golf Course, and the NSD Davidson Street RWF which serves the remainder of demands in the area. Proposed future demands for the Northern Service Area are allocated along two proposed recycled water system segments referred to in this study as Segment N-1 and Segment N-2.

The first proposed extension, Segment N-1, entails construction of 4,230 linear feet (LF) of pipe along Redwood Boulevard and includes a nominal 128 gpm increase in peak hour demand which is not expected to cause velocity or pressure drop related issues if designed as an 8-inch diameter pipeline.

The second extension, Segment N-2, entails 8,525 LF of pipe along Grant Avenue. includes a nominal 170 gpm increase in peak hour demand which is not expected to cause velocity or pressure drop related issues if designed as an 8-inch diameter pipeline.

6.4.2.3 Central Service Area

Proposed future demands for the Central Service Area are allocated along two proposed recycled water system extension segments referred to in this study as Segment C-1 and Segment C-2.

The first extension, Segment C-1, entails construction of 5,500 LF of pipe along Cambridge Street. The projected annual demand of 19 AFY along this extension results in a nominal 143 gpm increase in peak hour demands which is not expected to cause velocity of pressure drop related issues if designed as an 8-inch diameter pipeline.

The second extension, Segment C-2, entails construction of 9,425 LF of pipe along Ignacio Boulevard. This extension was analyzed in the 2017 Recycled Water Feasibility Study. Recommendations from the 2017 Recycled Water Feasibility Study includes creation of a new pressure zone with a booster pump station installed at the intersection of Ignacio Boulevard and Country Club Drive, and a new or refurbished storage tank (NMWD's Woodland Heights Tank). The Woodland Heights Tanks should be inspected to determine the cost of rehabilitation. Pipe sizing and hydraulic assessment from the 2017 Recycled Water Feasibility are assumed for this study. Based on recommendations of the 2017 study, the increase in peak hour demands of 435 gpm is not expected to cause velocity of pressure drop related issues if designed as an 8-inch diameter pipeline. If NMWD plans to not create a new pressure zone to serve this area, additional hydraulic analysis is recommended to confirm the expected delivery pressures.

6.4.2.4 South Service Area

Potential new demand in the South Service Area is located in close proximity to existing recycled water pipelines. Based on the estimated new demand and hydraulic calculations, the peak hour demands would increase nominally by 158 gpm and is not expected to impact delivery. Therefore, the existing pipeline is anticipated to be sufficient to serve the new demand.

6.4.3 Implementation Timing

NMWD's approach to expanding the distribution system is dependent upon several factors that include, but is not limited to the following considerations:

- Timing of the demand to be served
- Ability of users to connect to the system
- Availability of staff resources to facilitate connection of new customers and on-going monitoring
- Cost-effectiveness of the extension in comparison to the anticipated potable water offset

NMWD should continue to monitor development in the area and determine the pipeline that should be extended and develop the implementation timeline accordingly. At this time, the soonest that implementation of any of the pipeline extensions would occur is five years from the date of this Study. This would allow the time to affirm demand in the area, work with customers to prepare for recycled water connection, identify and secure potential funding sources and/or funding partners, conduct additional study and develop design plans, and initiate regulatory and environmental approvals. If external funding assistance for expanding the recycled water system are available to NMWD, then NMWD may consider accelerating implementation of one or more of the proposed new pipeline segments to connect additional customers and increase potable water offset.

6.5 WATER SUPPLY ALTERNATIVE EVALUATION

This section provides an evaluation of the recycled water expansion alternative and is comprised of the following sections:

- Cost Estimate
- Operational Impacts
- Regulations and Permitting
- Public and Institutional Considerations

6.5.1 Cost Estimate

A planning-level cost estimate for the construction of the four identified pipeline extensions, along with assumptions, is provided in Table 6-4. The cost estimate includes following alternative specific assumptions:

- Project Allowance = 30 percent
- Pipeline Unit Construction Cost[4] = $260 per linear feet

[4] Pipeline unit cost is based on the Feasibility Study of West Ignacio Recycled Water Extension (September 2017). The pipeline unit cost of $260 per linear foot was scaled to January 2022 using the Engineering News Record (ENR) Construction Cost Index (CCI) for San Francisco of 14301. The pipeline unit cost is for an 8-inch diameter pipeline.

The pipeline unit cost is assumed to include pipeline materials, trenching, placing, and jointing pipeline, valves, fittings, service connections, placing imported pipeline bedding, native backfill material, and asphalt pavement replacement, if required. Replacement costs were not included since the estimated pipeline lifespan is 50 years and exceeds the 30-year project horizon.

Annual O&M costs are based the level of NMWD staff effort per one-hundred recycled water customers. NMWD estimated that it takes approximately one-quarter of the standard hours worked in a year for one NMWD staff member to complete the required recycled water O&M tasks such as required reporting, inspection, and maintenance per every one-hundred recycled water customer. This estimated level of effort was scaled proportionally based on the number of additional recycled water customers that each pipeline segment would add. An operating allowance was not included since the annual O&M cost is based off of the historical level of effort NMWD has experience with operating its recycled water system. Appendix H details the additional recycled water customers added per pipeline segment and Appendix F provides a more detailed cost estimate for the recycled water pipeline extensions.

The total capital cost for Segment N-1 is estimated to be approximately $2.0 million. The annual O&M cost is estimated to be $22,750 and the 30-year NPV O&M cost is estimated to be $657,000. The total cost (total capital cost plus NPV costs) for constructing all recycled water pipeline segments is estimated to be $2.7 million. Segment N-1 is estimated to offset the potable water supply by 17 AFY. Over the 30-year project horizon, Segment N-1 is estimated to offset a total of 510 AF from the potable water system. The unit cost over 30 years for Segment N-1 is $5,300 per AF.

The total capital cost for Segment N-2 is estimated to be approximately $4.0 million. The annual O&M cost is estimated to be $14,790 and the 30-year NPV O&M cost is estimated to be $427,000. The total cost (total capital cost plus NPV costs) for constructing all recycled water pipeline segments is estimated to be $4.5 million. Segment N-2 is estimated to offset the potable water supply by 22.6 AFY. Over the 30-year project horizon, Segment N-2 is estimated to offset a total of 678 AF from the potable water system. The unit cost over 30 years for Segment N-2 is $6,600 per AF.

The total capital cost for Segment C-1 is estimated to be approximately $2.6 million. The annual O&M cost is estimated to be $3,420 and the 30-year NPV O&M cost is estimated to be $99,000. The total cost (total capital cost plus NPV costs) for constructing all recycled water pipeline segments is estimated to be $2.7 million. Segment C-1 is estimated to offset the potable water supply by 4.1 AFY. Over the 30-year project horizon, Segment C-1 is estimated to offset a total of 123 AF from the potable water system. The unit cost over 30 years for Segment C-1 is $22,000 per AF.

The total capital cost for Segment C-2 is estimated to be approximately $4.5 million. The annual O&M cost is estimated to be $13,650 and the 30-year NPV O&M cost is estimated to be $394,000. The total cost (total capital cost plus NPV costs) for constructing all recycled water pipeline segments is estimated to be $4.9 million. Segment C-2 is estimated to offset the potable water supply by 19 AFY. Over the 30-year project horizon, Segment C-2 is estimated to offset a total of 570 AF from the potable water system. The unit cost over 30 years for Segment C-2 is $8,600per AF.

Appendix F provides a more detailed cost estimate for the recycled water pipeline extensions.

Table 6-4. Estimated Capital Cost for Recycled Water Pipeline Expansion Segments					
Segment[a]	Pipeline Installed, LF	Total Capital Cost[b], dollars	30-Year NPV O&M Cost, dollars	Total Potable Water Offset over 30 years, AF	Unit Cost over 30 years[c], dollars per AF
Segment N-1	4,230	2,002,000	657,000	510	5,300
Segment N-2	8,525	4,036,000	427,000	678	6,600
Segment C-1	5,500	2,603,000	99,000	123	22,000
Segment C-2	9,425	4,462,000	394,000	570	8,600
Total	**27,680**	**$13,103,000**	**$1,577,000**	**1,881**	**$7,900**

Notes:

(a) Connection of customers within the South Service Area would require lateral connections to existing recycled water pipelines. a new recycled water distribution pipeline is not anticipated to be required. As such, capital costs for connection of customers in the South Service Area is not included.

(b) The construction contingency was estimated to be 40% and the project allowance for planning, permitting, engineering, legal, and administrative costs was estimated to be 30%. Pipeline diameter was assumed to by 8 inches with a pipeline unit cost of $260 per linear foot. The cost does not include replacement costs or O&M costs.

(c) Unit Cost = Total Capital Cost divided by the total potable water offset over 30 years for each pipeline segment. Unit costs are rounded up to the nearest $100.

6.5.2 Operational Impacts

The recycled water system expansion option will require some additional NMWD resources to administer and monitor additional recycled water use sites. Additionally, the expansion would present additional operational impacts to NSD related to increased recycled water production. This section describes potential operational impacts to NMWD. Operational impacts to NSD are anticipated to be reflected in its charges to NMWD for producing recycled water.

6.5.2.1 Operations and Maintenance

The connection of new recycled water customers will require additional NMWD staff resources to approve the connection, as well as annual site inspections once connected.

The level of additional operations and maintenance needs will vary based on the selected recycled water pipeline alignment. Operations and maintenance needs related to new pipelines and potential pumps, power requirements, and demand management are discussed in this section.

The operations and maintenance requirements of new recycled water pipelines are anticipated to be minimal. However, if booster pumps are added to the system, additional operations and maintenance resources will be required. Pumping may be required to deliver recycled water to customers at adequate pressures. Previous studies identify the need for a booster pump station to serve customers along the Ignacio Boulevard recycled water pipeline alignment (referred to as Segment C-2 in this study). Additional hydraulic analysis is required to determine if additional pumping is needed along other future new recycled water pipeline extensions. New pumping within the system will increase power requirements for the system as well as the need for additional staff time for operations and maintenance of new pumps.

During peak irrigation periods, recycled water demand may exceed supply. As noted earlier in this chapter, improvements made at the NSD RWTF have increased recycled water production capacity. However, if the recycled water distribution is expanded and additional customers are connected, recycled water demand could exceed supply during peak use periods. NMWD may consider supplementing the recycled water supply with potable water on occasion, during peak demand days for example. Recycled water supply shortfalls persist over longer periods, NMWD may consider implementation of an irrigation demand schedule or recycled water demand management measures. Such a demand management scenario would require additional NMWD staff resources to oversee.

6.5.2.2 Operational Considerations for Indoor Recycled Water Use

Additional NMWD staff time to coordinate regulatory approval of the dual-plumbed site and increased monitoring and reporting will be required. Also, dual-plumbed sites will require a cross-connection test once every four years that NMWD staff must oversee.

Additional factors must be considered when using recycled water indoors for toilet flushing and urinal uses. Supply reliability as well as color and odor of recycled water will be important factors for indoor use. State regulations for indoor recycled water use require additional monitoring and testing that NMWD must conduct.

When providing recycled water for toilet flushing, reliable service and supply will be paramount. Unlike the potable water system, the recycled water distribution system is not a looped system. A line break or maintenance activity along the main distribution line of the recycled water system could interrupt service. To mitigate the risk of service interruption, an on-site back-up potable water supply should be considered. This connection must be through either a potable water air gap tank, or through a swivel-ell connection.[5] Any connection to the potable water system must be in accordance with the State's Title 17 regulations and approved by the State Water Resources Control Board's Division of Drinking Water (DDW). At the time of preparation of this study, the State is developing a Cross-Connection Control Policy Handbook which may replace relevant regulations.[6]

Aesthetic issues, specifically color and odor, have been associated with recycled water for toilet flushing. The composition of the recycled water supply and low turnover of water within the distribution system can increase color and odor issues. However, several water agencies throughout California are successfully providing recycled water for toilet flushing use (such as nearby MMWD). Additional on-site treatment, such as granulated activated carbon filters, or boosting chlorine residual in the recycled water distribution system, could help reduce or eliminate color and odor. Flushing of the recycled water lines during the winter season when recycled water demands are low to remove stagnated water could also help reduce color and odor. Additional study of the recycled water quality and testing of the recycled water at points along the distribution system should be conducted to confirm the need for color and odor reduction, and to identify potential solutions if needed.

For indoor recycled water use, State regulations require more monitoring and cross connection testing compared to outdoor recycled water use. A visual inspection of the site must be conducted annually to confirm that no visual connections between the potable and recycled water systems have been made. A

[5] A swivel-ell connection assembly consists of a reduced pressure principle backflow prevention assembly combined with a changeover piping such that the potable and recycled water sources are not connected, but allows for water to be supplied to the distribution system.

[6] California State Water Resources Control Board, Cross-Connection Control Policy Handbook, https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/cccph.html, accessed March 16, 2022.

cross connection test is required once every four years to confirm the absence of cross connections between the water systems. These additional requirements will require more NMWD personnel time for testing and reporting.

6.5.3 Regulations and Permitting

This section describes the regulations and permitting associated with this alternative.

6.5.3.1 Recycled Water Pipelines Expansion

Expansion of the recycled water system would require installation of pipelines and construction of ancillary structure. Pump stations may also be needed to provide service to some locations. These activities would be subject to environmental review under CEQA. Pipeline construction would involve excavation and filling in existing right-of-way and possibly in undisturbed land. Construction-related impacts could include increased noise, air quality and greenhouse gas emissions (GHG), soil erosion, and disturbance of biological and cultural resources. This alternative water supply option would expand an existing recycled water system and, depending on project design, CEQA review may be accomplished under a variety of categorical or statutory exemptions as follows:

- CEQA Sec. 15301 – Class 1 Minor alteration of existing public or private structure
- CEQA Sec. 15303 – Class 3 Small Facilities
- CEQA Sec. 25304 – Class 4 Minor Alteration of Land
- CEQA Sec. 15282 (k) – New or repair of an existing pipeline of less than 1 mile

Regional expansion of the recycled water system to include large new areas with a substantial expansion in capacity may trigger the need to prepare a Mitigated Negative Declaration of Environmental Impact Report. NMWD may need to coordinate with the City (or the County in some areas) to address extension of recycled water pipelines and service to new development projects under the proposed projects' CEQA studies.

If future pipeline alignments disturb sensitive biological resources such as wetlands, creeks, or habitat for endangered species permits may be required from the natural resource agencies, including U.S. Army Corps of Engineers, Regional Water Quality Control Board, California Department of Fish and Wildlife, or U.S. Department of Fish and Wildlife. If project activities are planned in the vicinity of culturally sensitive areas consolation with local tribes, construction monitoring, and documentation of artifacts may be required.

Connection of recycled water to new customers or use type must be in accordance with the State's Title 17 and Title 22 regulations and approved by the DDW and may require an update of NMWD's Recycled Water Engineer's Report.

Regulatory constraints for alternative are considered moderately complex because extensive regulatory agency review and/or CEQA analysis could be required depending on final design. Many impacts may be avoided if biological and cultural resource assessments inform project design, pipeline alignments and location of project facilities.

6.5.3.2 Dual Plumbing for Indoor Use

Dual plumbed building for indoor recycled water use will require preparation of a separate Recycled Water Engineer's Report for review and approval by DDW. Recycled water pipelines and appurtenances must be identified and labeled in accordance with Title 22 regulations. Before recycled water can be delivered to the building, a cross connection test must be performed to confirm the absence of any cross connections between the potable and recycled water systems.

6.5.4 Public and Institutional Considerations

Successful expansion of NMWD's recycled water system require support from the public and stakeholders, and partnership and agreements with other entities. The following sections discuss the considerations listed below:

- Public acceptance
- Inter-Agency coordination
- Financial partnerships
- NMWD Recycled Water Regulations (Regulation 18)

6.5.4.1 Public Acceptance

Recycled water use is widely accepted within NMWD's service area. This is evidenced by interest in customers wanting to connect to the system and by NMWD's commercial and residential truck fill programs.

6.5.4.2 Inter-Agency Coordination

NMWD and NSD have a strong partnership in developing and providing recycled water to the community. Since the early 2000's, NMWD and NSD have cooperated in recycled water development beginning with the Deer Island RWTF and the delivery of recycled water to the Stone Tree Golf Course and Novato Fire Protection District Station No. 2. In development of the Davidson Street RWTF to provide recycled water to the North and Central areas of Novato, NMWD and NSD revised their "Inter Agency Agreement for Recycled Water Between Novato Sanitary District and North Marin Water District". The agreement establishes roles and responsibilities for NMWD (distributor of recycled water) and NSD (produce of recycled water). Similarly, NMWD has an inter-agency agreement for recycled water with LGVSD.

NMWD coordinates regularly with NSD and LGVSD in recycled water planning. In accordance with NMWD's inter-agency agreements for recycled water with NSD and LGVSD, NMWD provides annual projections of recycled water needs for the upcoming year and provides updates and expansion plans. Through these existing agreements and coordination efforts, NMWD will continue to work with NSD and LGVSD for additional recycled water supply as new customers are connected and if the recycled water system is expanded.

NMWD regularly coordinates with the City to extend its potable and recycled water service, from planning to construction. NMWD will continue to work with the City as it implements expansion of its recycled water system.

6.5.4.3 Financial Partnerships

As development occurs, NMWD may seek opportunity to partner and cost-share with developers for the construction of new recycled water distribution pipelines. NMWD should continue to explore opportunities for financial partnerships as new development is reviewed.

NMWD has successfully obtained state and federal grant funding for construction of existing recycled water facilities. NMWD joined the North Bay Water Reuse Authority, an organized regional entity working together to pursue funding for recycled water projects that benefit both local and regional water supply. NMWD should continue to monitor and pursue state and federal grants for recycled water projects.

6.5.4.4 District Recycled Water Regulations

NMWD encourages the future expanded use of recycled water through District Regulation No. 18. District Regulation 18 includes a mandatory use requirement for recycled water service when connection to the recycled water system is deemed to be feasible. District Regulation No. 18 applies to both existing customers and new development within NMWD's recycled water service areas.

6.6 FINDINGS AND CONCLUSIONS

Expanding NMWD's recycled water system could provide a potable water offset of up to 63 AFY if all proposed extension projects were constructed. This equates to a total potable water offset of 1,881 AF over 30 years. The total estimated capital cost for the four identified pipeline extensions is estimated to be $13.1 million and the 30-year NPV O&M cost is estimated to be $1.6 million. The total cost (total capital cost plus NPV costs) is estimated to be $14.7 million and the unit cost over 30 years is $7,900 per AF.

At this time, expansion of the recycled water distribution system is not recommended due to the high cost of new pipelines relative to the volume of potable water offset. NMWD should continue to explore opportunities to increase recycled water use and to pursue opportunities to offset the cost of new recycled water pipelines.

The following considerations should be made as NMWD considers expanding recycled water pipelines in the future:

- Review and update NMWD's design and performance criteria to reflect current and planned operations (e.g., recycled water systems design criteria, recycled water balance analyses, pump station operations, and storage operations).
- Perform a system-wide demand analysis to determine system specific peaking factors to ensure facilities are properly sized.
- Develop a more extensive hydraulic analysis of the recycled water system to confirm if adequate delivery pressures can be achieved with expansion of the system, and to identify any pumping and storage needs. Develop a hydraulic model of the system to facilitate future analysis as the system is expanded.
- Conduct a treatment capacity analysis to confirm capacity to meet increased demand during peak use periods. Continue to identify and explore partnership with developers to fund new recycled water pipelines.
- Monitor and pursue opportunities for grants through local, state, and federal programs.
- Update Regulation 18 to reduce administrative and financial constraints on NMWD and to further encourage and facilitate new recycled water connections.

CHAPTER 7
Indirect Potable Reuse

This Chapter presents the potential for and an evaluation of producing potable reuse water from available surplus wastewater supply to enhance NMWD's local water supply. As detailed herein, indirect potable reuse is determined to be non-viable for NMWD at this time due to lack of adequate storage availability. Since indirect potable reuse was determined to be infeasible for NMWD, a detailed planning-level cost estimate was not prepared as part of this Study. Nevertheless, relevant information is documented in this Chapter to support additional work that could be done in the future to support production of a potable reuse supply for NMWD should the identified impediments be overcome.

7.1 OVERVIEW OF POTABLE REUSE

Potable reuse involves producing potable water from wastewater that has been processed through an advanced treatment process. Potable reuse thus requires a source of available wastewater, as well as dedicated treatment process equipment.

The DDW is responsible for establishing regulations for potable reuse in California. Existing DDW regulations identify four potable reuse classifications, as follows:

- **Surface Water Source Augmentation**: A potable reuse water supply is added to an untreated drinking water supply storage reservoir at a blending ratio of no more than 10 percent potable reuse supply and stored for a minimum of 60 days. The combined supply would then be processed through a potable water treatment plant before distribution.
- **Groundwater Replenishment**: A potable reuse water supply is combined with groundwater either via surface application (spreading) or subsurface application (direct injection). After receiving substantial mixing and dilution with groundwater and receiving soil aquifer treatment, the injected water would be directed to a treated water supply distribution system.
- **Raw Water Augmentation**: A potable reuse water supply is blended with other raw water supplies, and the combined flows are processed through a potable water treatment plant prior to distribution.
- **Treated Water Augmentation:** A potable reuse water supply – processed through an advanced treatment system – is discharged directly to a potable water distribution system.

To date, DDW has established clear regulations for groundwater replenishment and surface water source augmentation systems—indirect potable reuse storage options. Regulations for raw and treated water augmentation are under development and are therefore currently not readily permittable.

The potential treatment and storage of recycled water for potable reuse considered in this Study is illustrated on Figure 7-1.

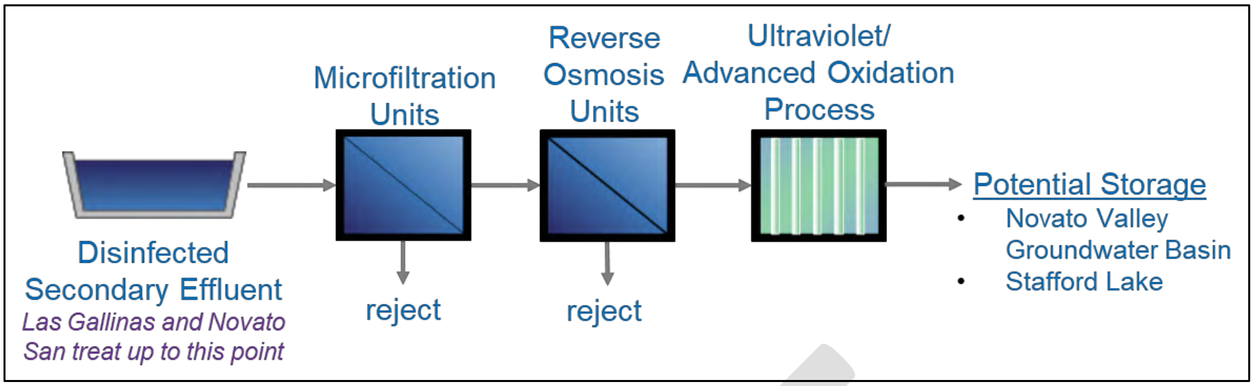


Figure 7-1. Potential Full Advanced Treatment and Storage for Potable Reuse

7.2 INDIRECT POTABLE REUSE AS A WATER SUPPLY ALTERNATIVE

This section provides a description of indirect potable reuse as a water supply for NMWD, organized by the following sections:

- Potential Potable Reuse Strategy
- Water Supply Yield and Reliability
- Infrastructure Requirements
- Implementation Timing

7.3 POTENTIAL POTABLE REUSE STRATEGY

One major benefit of potable reuse as a water supply is that the water source (wastewater) is relatively consistent and not directly subject to climatic fluctuations, such as drought. However, a wastewater supply will have some seasonal variability that does not match the seasonality of potable water demands because storm- and groundwater-driven inflow and infiltration leads to higher wastewater flows in the winter and spring. One benefit of either groundwater replenishment or surface water source augmentation is that the seasonal variability of the supply can be mitigated to better match potable water demands by coupling the production of potable recycled water with a long-term storage option: a groundwater aquifer or surface water reservoir, respectively.

For NMWD, the most cost-effective potable reuse strategy would involve a treatment system that is sized for continuous production of recycled water coupled with some type of storage because NMWD's water supply shortfalls are intermittent and variable. Continuous operation with storage would reduce the capital costs for treating effluent to potable reuse standards by minimizing the required size of the treatment facilities. Moreover, maintaining continuity of operations (and therefore staffing) is logistically simpler than having to bring on staff for each operational period since the operations staff needed for a potable reuse treatment facility require highly specialized skills and certification.

Of the different potable reuse classifications discussed above, both groundwater replenishment and surface water source augmentation allow for continuous operation with storage. The groundwater replenishment and surface water source augmentation are often referred to as "indirect potable reuse" options whereas raw and treated water augmentation are often referred to as "direct potable reuse."

For purposes of this Study, only the indirect potable reuse classifications have been evaluated. As the regulatory pathway for direct potable reuse becomes clearer, NMWD may wish to further consider the direct potable reuse options, especially because these would not be limited by storage availability.

7.3.1 Potential for Surface Water Augmentation

Of the indirect potable reuse options, surface water source augmentation can be dismissed as not viable within NMWD's service area because of challenges associated with achieving required minimum retention time and an economy of scale. The only current available surface water storage location is Stafford Lake.

A blending ratio of no more than 10 percent recycled water is generally required for surface water source augmentation, and a minimum of 60 days retention time in a reservoir is required under all conditions. Achieving the minimum 60-day retention time in any given year may be difficult for NMWD based on several factors. One factor is the timing of adding recycled water to Stafford Lake. Recycled water could be added early in the winter to maximize the time prior to start of seasonal STP operation. NMWD may risk having to spill some of the recycled water before it could be treated through the STP. If recycled water is added in the spring after the winter rainy season, the minimum retention time may not be achieved prior to the seasonal start of STP operation.

Another factor is that predicting the actual retention time is complicated by the recycled water likely having a different temperature than lake water, which would impact the travel path of the added recycled water. Additional evaluation would be needed to evaluate these factors and confirm what retention time is feasible, especially during a dry year when a longer STP operation window may be needed or preferred.

The minimum working volume of NMWD's surface water reservoir Stafford Lake is about 1,000 AF, which would allow at most 100 AF of reuse water storage. That volume is not considered large enough for surface reservoir augmentation to be cost effective. The capital cost for a pipeline to convey treated recycled water to Stafford Lake is estimated to be $26 million, as detailed later in Section 7.2.1. Even if NMWD were able to add 100 AFY to Stafford Lake over 30 years, the unit capital cost for the pipeline alone would be $9,000 per AF.

7.3.2 Potential for Groundwater Replenishment

Groundwater replenishment with in-ground storage of potable recycled water was considered for viability. The envisioned groundwater replenishment project is illustrated on Figure 7-2, and would involve injecting highly treated recycled water at a continuous rate year-round into the groundwater aquifer for storage via one or more injection wells. The stored water would then be removed using a dedicated extraction well or wells when needed to meet water supply demands. The extracted water would go directly into NMWD's water supply distribution system, requiring no further treatment beyond addition of disinfectant to ensure adequate residual in the water system.

A local groundwater replenishment strategy would rely on the same local groundwater aquifer evaluated for ASR in Chapter 5, the Novato Valley Basin. As further detailed in Chapter 5, the Novato Valley Basin has limited storage capacity and low permeability. Moreover, the injection and extraction rates are relatively low, estimated at 30 gpm and 50 gpm per well, respectively. A groundwater replenishment strategy with potable reuse water would be distinct from an ASR program in that the injection and extraction wells would need to be geographically separated to allow for adequate retention time. Nevertheless, the same aquifer limitations would apply to groundwater replenishment.

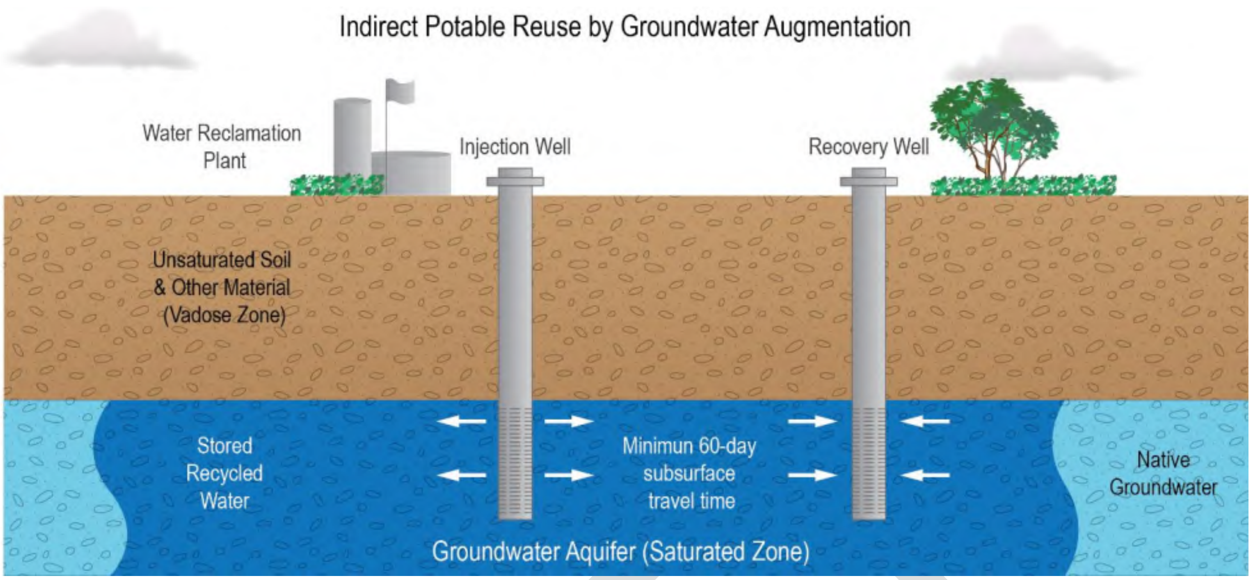


Figure 7-2. Potential Groundwater Replenishment

Due to limited local groundwater storage availability, a *local* groundwater replenishment option is determined to be non-viable. NMWD is engaged in the Resiliency Study that is evaluating various regional water supply options and may identify regional groundwater storage options. The rest of this Chapter provides additional information on a groundwater replenishment project should an adequate storage option be identified.

7.3.3 Water Supply Yield and Reliability

NMWD receives tertiary treated effluent from the NSD wastewater treatment plant (WWTP) for recycled water use. NMWD also receives recycled water from LGVSD for use within NMWD's service area. However, LGVSD's WWTP is further from potential recycled water conveyance and/or storage sites. Because of its proximity to the NMWD service area, and because influent to the NSD WWTP is substantially from NMWD's service area, the NSD WWTP is evaluated a the potential source for IPR.

NSD currently discharges secondary treated effluent into the San Francisco Bay. This effluent may potentially be available for beneficial reuse for IPR. Diversion of additional wastewater supply for IPR use would need to be discussed and confirmed with NSD to confirm existing and future discharge obligations that NSD may have that would limit the availability of wastewater supply for IPR use.

The limiting factors for potable reuse via groundwater replenishment would be the injection rates into and storage capacity of the aquifer of interest. Each injection well into the Novato Valley Basin has been estimated to allow for injecting water at a rate of 30 gpm, as noted above and detailed in Chapter 5. For a year-round injection (365 days per year), this rate equates to 48 AFY per injection well. The storage capacity available has not been quantified for this Study due to lack of data, but is estimated in Chapter 5 to be significantly less than 1,000 AFY.

Regarding the reliability of potable reuse as a water supply, wastewater is relatively consistent and not directly subject to climatic fluctuations, as noted above. Wastewater flows are thus highly reliable, and if coupled with some form of storage, an expected average wastewater volume can be estimated year-to-year for meeting baseline water supply demands.

7.3.4 Infrastructure Requirements

DDW established statewide regulations for groundwater replenishment via subsurface application in 2014. These requirements specify both treatment standards and retention time/blending requirements, which are summarized below, followed by a discussion of the infrastructure that would be needed for a groundwater replenishment system to meet these requirements.

7.3.4.1 Treatment Standards

DDW treatment standards for groundwater replenishment are established to ensure adequate removal of organic and inorganic contaminants found in secondary treated wastewater effluent and removal/inactivation of pathogens (e.g., virus, Giardia and Cryptosporidium). The regulations specifically include pathogen reduction requirements defined in terms of orders of magnitude (logarithm base 10, or "log") reduction/inactivation of organisms. The regulations also include resiliency requirements that further define the configuration of the treatment system. A summary of the applicable treatment standards and resilience requirements is provided in Table 7-1.

Table 7-1. Treatment Requirements for Groundwater Replenishment

Category	Value
Treatment Standards	
Enteric viruses	12-log reduction
Giardia cysts	10-log reduction
Cryptosporidium oocysts	10-log reduction
Total Organic Carbon (TOC)	Maximum 0.25 milligrams per liter (mg/L) in 95 percent of samples[(a)] Maximum 0.5 mg/L in 20-week running average
Total Nitrogen	10 mg/L
Treatment Resiliency Requirements	
Separate treatment processes	3 for each pathogen
Maximum credit for each process and pathogen	6-log reduction
Processes requiring at least 1.0-log reduction credit[(b)]	3

Note:
(a) Within first 20 weeks.
(b) A single treatment process is allowed to receive log reduction credits for more than one pathogen.

For subsurface (e.g., groundwater aquifer) application projects, DDW also specifically requires the use of a full advanced treatment (FAT) process that includes:

- **Primary treatment and secondary (oxidation) processes**: There are no specific requirements for these treatment processes, as the downstream membrane filtration and reverse osmosis (RO) treatment processes will ensure the total nitrogen and TOC limitations listed in Table 7-1 are achieved. However, agencies that operate FAT systems have documented that secondary treatment systems that provide extended aeration for nitrification produce water that has lower levels of the organics that can lead to fouling in downstream membrane filtration systems. Therefore, secondary treatment systems that provide nitrification upstream of the membrane filtration process can require less maintenance and may perform better over time. The secondary treatment system at the NSD WWTP is designed to provide at least partial nitrification.

- **Membrane filtration**: Membrane filtration may be achieved by either microfiltration, which has a pore size that ranges from 0.1 to 5 micrometers (µm), or ultrafiltration, which has a pore size that ranges from 0.01 to 0.1 µm. Although not specifically defined in DDW regulations, this treatment step is needed to provide particle removal upstream of a RO membrane process.
- **RO Process**: RO is a separation process like the membrane filtration processes but with membranes that have a nominal pore size ranging from 0.001 to 0.0001 µm. Therefore, the RO process can remove smaller particle size pollutants, including small dissolved organic compounds and monovalent ions that pass through larger pore membrane filtration processes. RO membranes also generate a concentrated reject brine stream that must be treated and disposed of separately.
- **Advanced Oxidation Process (AOP):** An AOP uses or combines two or more oxidizing agents to create hydroxyl radicals, which serve as an oxidant for elimination of organic pollutants while also providing inactivation/destruction of viruses, bacteria, and other pathogens. Common AOP options involve adding ozone to water with a high pH, adding ozone to water that is also exposed to ultraviolet (UV) light energy, adding hydrogen peroxide to water that is also exposed to UV light energy, or adding ozone to water in combination with hydrogen peroxide.

The FAT process meets the resiliency requirements of at least three separate treatment processes with each process credited with no more than 6-log reduction per pathogen (virus, Giardia, Cryptosporidium) and at least three processes credited with no less than 1.0-log reduction. The FAT process should generally be capable of providing 10-log removal for Cryptosporidium, Giardia, and viruses. However, additional removal credit would likely be needed to meet the 12-log virus reduction standards.

The amount of additional virus removal credit required would need to be determined and demonstrated through equipment-specific validation testing. DDW allows for one virus log removal credit for each month of groundwater retention time. Additional discussion regarding groundwater retention time credits is provided in the next subsection, in which retention time/blending requirements are addressed. Most projects that employ the FAT process must rely on groundwater retention time credits to meet between 1-log and 3-log of the required virus removal credits.

In addition to validation testing, performance of the RO and AOP systems must be documented prior to full-scale system operation. Finally, ongoing monitoring and demonstration is required after the facilities are online to confirm performance.

7.3.4.2 Retention Time/Blending Requirements

DDW regulations for groundwater replenishment via subsurface application require that the recycled water have a minimum two-month "response retention time" in the groundwater aquifer prior to being recovered from the nearest downgradient extraction well. The response retention time is intended to provide an additional level of safety for the purpose of protecting public health. The response retention time, which can also be applied toward meeting the log-removal credit requirements, must ultimately be validated using a tracer study.

During project planning and/or until completing the required tracer study is possible, DDW will only grant a retention time credit for a portion of the retention time demonstrated through other approved non-tracer study methods. Specifically, if the retention time is demonstrated to be eight months using a numerical modeling analysis, DDW will grant four months of retention time credit; and if retention time is demonstrated to be eight months using an analytical model (e.g., Darcy's Law), DDW will grant two months of retention time credit.

The regulations also specify a maximum fraction of recycled water that can be injected relative to the total recharge water volume. The fraction of recycled water is referred to as the Recycled Water Contribution (RWC). The remaining diluent (dilution) water must generally be a DDW-approved drinking water source with nitrate and nitrite concentrations below the State's Maximum Contaminant Levels applicable to potable water supplies. DDW will grant the RWC for each project based on a review of the project applicant's engineering report, which documents both the treatment system reliability and the log-removal validation process, and demonstration that the treatment processes will reliably achieve a TOC concentration of 0.5 mg/L or less. The regulations do allow an initial RWC up to 100 percent to be approved (i.e., with no dilution water required). However, it may be difficult to provide all the demonstrations needed to obtain an RWC of 100 percent prior to project implementation. DDW can also approve an increase to the RWC after project implementation.

7.3.4.3 Infrastructure Components

The major facilities required to support a groundwater replenishment system consist of the following:

- **FAT System:** Membrane filtration, RO and AOP.
- **Potable Reuse Supply Pipeline:** For conveyance of secondary effluent from the NSD WWTP to the new FAT system. If the advanced treatment facility were co-located at the WWTP, (assuming there is space available), this pipeline may be a relatively small component of the project.
- **Injection and Extraction Wells:** For conveyance of the potable water supply into the receiving groundwater aquifer and recovery of the stored water. Injection and extraction wells cannot be co-located because a retention time through the aquifer would be needed to meet DDW requirements.
- **Injection Water Supply and Extraction Water Delivery Pipelines:** For conveyance of the potable water supply to the injection wells and from the extraction wells to the NMWD's potable water system, respectively.
- **Monitoring Wells:** DDW requires monitoring wells downgradient of the injection wells and upgradient of the extraction wells and other drinking water wells.

In addition, management of the brine (centrate) from the RO process and solids from the other filtration processes would need to be considered. While these may not require significant capital infrastructure, long-term disposal costs could be significant, particularly for brine management.

7.3.5 Implementation Timing

NMWD's timing for implementing potable reuse as a water supply option depends on if and when potable reuse becomes a viable water supply alternative. If a feasible injection and storage option were found, such as for a regional aquifer, or if raw or treated water augmentation were pursued, once regulations more readily support those options, implementing potable reuse would require two major initiatives. First, the planning and permitting of an advanced treatment facility would need to be completed. Second, the facility and associated conveyance infrastructure would need to be designed and constructed.

Design and construction of the conveyance infrastructure is estimated to require 12 to 18 months. The planning and permitting of an advanced treatment facility is estimated to require at least 1 year and possibly up to 3 to 10 years prior to design and construction. The longer end of the range would be needed for raw or treated water augmentation because significant planning work would be needed to support more direct conveyance of potable recycled water, including public outreach and coordination with DDW.

7.4 WATER SUPPLY ALTERNATIVE EVALUATION

Given the uncertainty of a local potable reuse project for NMWD at this time, a detailed evaluation of this alternative has not been completed. This section provides a high-level assessment of the water supply alternative.

7.4.1 Cost Estimate

If viable storage were available, a potable reuse supply for NMWD would be able to provide between 1,000 and 3,100 AFY of additional water supply. This alternative would require an advanced treatment facility with a capacity of between 1 and 3 MGD. Advanced treatment facilities that are at least twice the upper end of this range have been estimated to have per acre-foot unit lifecycle costs between $1,000 and $2,400. These lifecycle costs account for constructing and operating an advanced treatment facility over a 30-year time period. Because of the relatively small scale of a District potable reuse project, unit lifecycle costs for an advanced treatment facility for production of potable water for NMWD are estimated to be at least $3,000 per AF[1]. For the purposes of comparing water supply alternatives under this Study, the total cost is estimated to be $3,000 per AF for the IPR alternative.

The lifecycle unit costs mentioned above do not account for management of the RO reject brine stream. Additional study would be needed to determine feasible RO reject brine management alternatives and their costs. The costs associated with RO reject brine management may be cost prohibitive given possible disposal options. Such options would include trucking of brine waste to a pre-established ocean discharge point, construction of a brine disposal pipeline to the coast, or deep injection of brine waste. There are current efforts underway in the State to identify a potable reuse treatment train that meets DDW objectives but does not rely on RO treatment. If such an approach is developed and accepted by DDW, the treatment-related costs could be significantly reduced, and the RO reject brine stream management requirements would be eliminated.

[1] Estimated unit cost for IPR is based on industry standards. Because IPR was determined to not be viable for NMWD, a detailed planning-level cost estimate was not prepared.

Additional costs would be incurred for needed groundwater injection or extraction equipment, as well as conveyance equipment, such as pump stations and pipelines.

One possible direct potable reuse option would include storing reuse water in Stafford Lake for subsequent processing through the STP. In that case, the source water is still assumed to be from the existing NSD WWTP. A conveyance pipeline of approximately 28,000 linear feet would be needed for conveyance from the NSD WWTP to Stafford Lake. The capital costs alone of the pipeline is estimated to be $26 million. Depending on the annual production of highly treated effluent, this capital cost equates to a unit cost of $280 to $870 per AF over the 30-year project horizon, for 3,100 and 1,000 AFY, respectively. The pipeline costs would be in addition to treatment costs, such as for a FAT system and beyond at the NSD WWTP for delivery of treated water.

7.4.2 Operational Impacts

Production of potable reuse water would require a new advanced treatment facility, most likely located at or near the existing NSD WWTP and thus not co-located with current NMWD facilities. The advanced treatment facility would require chemical and energy resources, along with dedicated staff, who are adequately certified for operating the advanced facility. If some kind of aquifer storage were combined with potable reuse production, additional NMWD staff time would be needed for operation and maintenance of injection and extraction well infrastructure. Further, additional chemical and energy resources would be needed at the Stafford Treatment Plant to accommodate a similar increase in water production. These resources were not determined as the effort is beyond the scope of the current evaluation, particularly for an alternative that is not considered viable at this time.

Potable reuse water would also have a different chemical quality than NMWD's current source water to the STP. If stored in a groundwater aquifer, potable reuse water being added to NMWD's potable water distribution system would be expected to have a chemical quality related to the storage aquifer, which would likely have a different mineral content in addition to possibly higher salinity than NMWD's potable water. Prior to introducing extracted potable reuse water and/or adding into NMWD's potable water distribution system, extensive analytical testing would be needed to determine what, if any, impacts would be expected from blending in the new water supply. Potential impacts include higher calcium carbonate scaling or the opposite of leaching materials from the distribution system if a large pH or alkalinity difference is achieved.

7.4.3 Regulations and Permitting

The regulations for achieving adequate quality in the potable reuse water have been detailed above with the discussion of the infrastructure requirements for potable reuse. In addition, a Wastewater Change Petition would need to be submitted to the State Water Board. A change petition would be needed prior to diverting wastewater that is currently being discharged to surface water for a different use, such as a recycled water or potable reuse supply source. The change petition process is meant to protect existing water rights holders downstream of the existing discharge. Since NSD's effluent discharge is to San Pablo Bay, water rights concerns would be most likely be minimal to non-existent.

The standard CEQA environmental analysis would also be needed to support development of any infrastructure project.

7.4.4 Public and Institutional Considerations

Implementation of a potable reuse project, whether for indirect or direct reuse, is subject to heightened public scrutiny because of the nature of the source water despite State regulations and other similar projects being in place.

In addition, an agreement would be needed with NSD for construction and operation of the advanced treatment facility assuming it would be constructed adjacent to the existing WWTP. Additional agreements would be needed with property owners along the conveyance pipeline alignment, as well as for land needed for aquifer injection and extraction wells.

7.5 FINDINGS AND CONCLUSIONS

Neither of the two indirect potable reuse classifications (groundwater replenishment and surface water source augmentation) are found to be viable for NMWD when considering locally available storage options, namely groundwater aquifers within NMWD's boundaries and Stafford Lake, respectively. Groundwater replenishment may be a viable water supply option should NMWD have regional storage available. The infrastructure requirements and costs for groundwater replenishment should be further reviewed if and when a viable aquifer storage option is identified. The Resiliency Study did not specifically identify indirect potable use as a Drought Management Option but did include ASR, groundwater banking and conjunctive use. If indirect potable reuse is identified in the future as a regional option, NMWD should consider participating in scoping and planning sessions with Sonoma Water and other local agencies as a next step towards developing project and programs to improve regional water supply resiliency and reliability if a viable aquifer storage option is identified.

Direct potable reuse via raw or treated water augmentation has not been evaluated in detail at this time due to the emerging nature of the regulations and projects for direct potable reuse. NMWD is recommended to review these reuse options as the State regulations and public acceptance progress over the next several years. State regulations for direct potable reuse are expected to be finalized by December 2023[2].

[2] Assembly Bill 574 requires the State Water Board to adopt uniform water recycling criteria for direct potable reuse through raw water augmentation by December 31, 2023, with provisions for extension of the deadline.

CHAPTER 8

Improve Stafford Treatment Plant Process Water Recapture Efficiency

This Chapter presents the potential for and evaluation of producing additional potable water from NMWD's STP by making efficiency improvements to the recapture of process water and related raw water intake and wastewater discharge modifications. As detailed herein, improvements to STP processes may potentially provide additional water supply for NMWD.

8.1 STP EFFICIENCY IMPROVEMENTS TO ENHANCE WATER SUPPLY

NMWD treats water stored in Stafford Lake through the STP to supplement purchased water supply from Sonoma Water. The STP has a nominal production capacity of 6 mgd. The quantities treated during each year depend on a combination of demand in NMWD's service area and the amount of source water available in Stafford Lake. Following intake and pumping from Stafford Lake, the raw water is treated through various treatment processes, and treated water is pumped to NMWD's potable water distribution system.

The STP treatment process consists of the following unit processes:

- Oxidation with chlorine dioxide, augmented with chlorine dosing
- Coagulation with polyaluminum chloride, ferric chloride and a coagulant aid polymer
- Pretreatment clarification and filtration through three, modular Actiflo™ clarifier and granular media filter units
- Filtration through granular activated carbon (GAC) contactor-filter units for enhanced removal of taste and odor compounds and disinfection byproduct precursors
- Disinfection with chlorine
- pH and corrosion control with sodium hydroxide addition

These processes result in the following process waste streams:

- Actiflo filter-to-waste
- Hydrocyclone return waste from the Actiflo units
- Centrifuge centrate
- Centrifuge area washdown
- Reclamation pond cleaning
- GAC contactor spent backwash water
- pH analyzer and lab sink sample drain

The STP also includes handling facilities for liquid waste streams from the treatment processes and sludge solids management facilities for dewatering of solids. Several process waste/recycle streams are returned at various points upstream in the process. Liquid waste streams that cannot be recycled through the STP process are discharged to NSD's sanitary sewer collection system.

NMWD's wastewater discharge to the NSD collection system is subject to restrictions in a discharge permit. The discharge permit with NSD includes several flow and volume restrictions, which are summarized in Table 8-1.

Table 8-1. Wastewater Discharge Permit Restrictions

Category	Period	Value	Units
Daily Flow Limit	December through April	40,000	gallons per day (gpd)
	May through November	150,000	
Instantaneous Flow Limit	year-round	100[(a)]	gallons per minute (gpm)
Narrative Limit	year-round	Discharge shall cease when any significant rainfall event[(b)] commences.	--

Note:
(a) The instantaneous flow limit of 100 gpm equals 144,000 gpd if expressed on a total daily basis.
(b) “Significant rainfall events” are not defined in the discharge permit.

Current STP operations generate more wastewater than can be discharged under the NSD permit. The instantaneous flow limit of 100 gpm, in particular, limits production during the peak water demand period (i.e., summer months). As a result, NMWD must regularly stop potable water production for the day after several hours of operation to stay within the discharge permit limits.

8.1.1 Overview of STP Efficiency Improvements

NMWD may potentially increase its water supply yield by making efficiency improvements at its STP. During the course of this Study, the following separate items have been identified to enhance NMWD’s water supply:

- Pretreatment unit modifications
- Raw water intake modifications
- Replacement of wastewater discharge pipeline

The raw water intake modifications and replacement of the wastewater discharge pipeline are ancillary improvements identified during this Study. These two improvements would not specifically increase the yield of the STP, but would improve the reliability of the STP water supply yield.

8.1.1.1 Pretreatment Unit Modifications

In 2019, West Yost conducted a Process Efficiency Improvements Study for the STP and evaluated five alternative treatment or operating improvements that could potentially allow NMWD to increase production at the STP. Eliminating or reducing the current operational constraint related to the wastewater discharge permit restrictions would provide the greatest benefit to STP operational flexibility and production.

A revised discharge restriction during the summer months would allow for increased daily production during peak demand periods. For purposes of the current evaluation, the sewer flow restriction is assumed to be unchanged at this time and that the most effective method to allow for additional potable water production is reducing the waste flow rates or volumes.

If the flow rate/volume of the waste streams could be reduced, NMWD could operate the STP longer each day, thus producing additional daily water supply. Therefore, the 2019 study focused on alternatives that would reduce and/or recycle greater portions of the process waste streams that are currently discharged to the sewer.

The bulk of process waste stream flow is contributed by the hydrocyclone return stream related to the Actiflo clarification process. West Yost's 2019 study resulted in a Technical Memorandum (TM) with a recommendation that NMWD conduct a performance test of modifying the hydrocyclone return. The 2019 TM is included as Appendix E of this Study and provides additional details on the previous alternatives.

The purpose of the recommended performance test was to determine the impacts on the main process and feasibility of long-term modifications that could be made to reduce the hydrocyclone return waste stream, thus allowing for additional potable water production. STP operations staff conducted a brief performance test of such modifications after the prior West Yost study was completed. However, documentation of the performance testing was limited, and additional performance testing would be needed to confirm the feasibility of long-term modifications to the STP. This chapter discusses what additional yield could be realized by permanent modifications to the hydrocyclone return, and recommendations for additional study to confirm the waste reduction.

8.1.1.2 Raw Water Intake Modifications

With or without the pretreatment modifications described above, STP operation would be enhanced with modifications to the raw water intake structure to allow the STP operations staff to preferentially draw water from a water level that avoids excess algal or manganese.

The raw water quality has significant impacts on efficient operation of the STP, in particular raw water turbidity and manganese. High turbidity can be caused by algal growth near the surface of the lake. High manganese concentrations can be caused by anaerobic biological activity in the lakebed sediment. The process of oxidation and coagulation need to be further reviewed to ensure each process can achieve the desired result. The specific threshold has not been discussed with NMWD staff and is not critical to the current evaluation.

Raw water is taken into the STP via an intake tower in Stafford Lake that has two primary intake gates with a 16-foot elevation difference between them.[1] The higher gate is typically used early in the production season and closed when the lake elevation reaches a point that results in undesirable water quality, such as from debris near the lake surface. The lower gate is used when conditions are not favorable for the higher gate. The raw water turbidity can fluctuate widely depending on the intake elevation relative to the lake surface elevation. Generally, an intake elevation closer to the surface elevation draws in more algae, but use of the lower intake gate can draw in water with lower dissolved oxygen concentrations and correspondingly higher manganese concentrations.

Several sub-surface aerators are also located near the intake tower. Based on recent discussions with NMWD staff, the sub-surface aerators have helped NMWD achieve higher dissolved oxygen concentrations through a deeper strata of the lake, such that the main concern with the current intake

[1] NMWD, 2016. Stafford Water Treatment Plant Operations Plan.

are related to the algae concentrations. However, the sub-surface aerators also can introduce additional nutrients from the bottom sediment to the top layers of the lake, encouraging algal growth.

Aeration alternatives are available that allow NMWD to achieve adequate dissolved oxygen concentrations in Stafford Lake without enhancing mixing and thus encouraging algal growth. Evaluation of those alternatives is beyond the scope of the current Study but mentioned here for NMWD consideration should additional raw water improvements be of interest with or without the raw water intake modification discussed above.

8.1.1.3 Replacement of Wastewater Discharge Pipeline

NMWD staff have identified that this alternative should also account for replacing the 4-inch diameter discharge pipeline to the NSD collection system. This replacement is not strictly required to implement the main focus of this alternative, the pretreatment unit modifications. However, the existing discharge pipeline requires relatively frequent maintenance, including a recent replacement of a section of broken pipeline. A new pipeline would thus be expected to reduce NMWD's maintenance efforts and allow more consistent operation of the STP, aligning with the main objective of this alternative.

8.1.2 Water Supply Yield and Reliability

As discussed above, pretreatment unit modifications may provide additional treated water supply yield, which could reduce needed yield from other water supply alternatives. The raw water intake modifications and discharge pipeline replacement are not expected to specifically allow for an increased yield from the STP. Those improvements nevertheless are expected to improve the reliability of STP operation.

As indicated above and detailed in the 2019 TM, the hydrocyclone waste accounts for 80 to 90 percent of the total sewer discharge. The TM provided an estimate of additional daily STP potable water production that could be realized with 50 percent reduction in the hydrocyclone waste, for both wet season and dry season days, which have different sewer restrictions as detailed in Table 8-1. The estimate also relied on assuming operation of the STP at its full capacity of 6 mgd for up to 24 hours a day. In theory, the daily additional water supply estimates could be multiplied by the total days in each respective season, totaling 365 days a year. However, assuming maximum capacity production over the entire year would result in an overly generous estimate of additional potable water production because the raw water supply is not adequate to support production at that level.

In addition, the available raw water supply is dependent on rainfall and thus can be much smaller during dry years. For purposes of the current evaluation, seasonal, raw water supplies for 2013 through 2021 have been reviewed to estimate additional water supply that could be produced during a typical water year and a dry year. The estimated water supply yields are 20 to 70 AFY for a dry year and typical year, respectively.

These estimated yields are based on the following assumptions:

- Regardless of the water year, the following could be realized:
  - 50 percent reduction in hydrocyclone return waste
  - Additional daily production of 2.0 mgd during the wet season and 2.8 mgd during the dry season
  - Corresponding daily hours of operation would increase from 2.3 to 10.2 hours during the wet season and from 12.8 to 24 hours during the dry season (for days of operation)

- Based on the 2021 dry year, about 490 acre-feet (160 million gallons) was treated in the dry season and no water was treated in the wet season. Thus, potable water yield for this alternative is assumed to be produced only in the dry season during a dry year.

Additional yield closer to the 70 AFY could be realized during a dry year if NMWD were to obtain supplemental water supply that could be stored in Stafford Lake or otherwise have a higher raw water supply available. As discussed in Section 3.2, NMWD has the option to purchase winter water flows from the Russian River and backfeed the water into Stafford Lake. Although this supplemental water supply would undergo a second round of potable water treatment through the STP and present additional treatment cost, it bolsters NMWD's supply during dry periods. Further, as part of this Study, NMWD explored the potential for increasing stored water in Stafford Lake as discussed in Chapters 9 and 10. These actions have the potential to increase the raw water supply available even in dry years, making full use of the improvement presented herein.

The STP improvements discussed in this Chapter would have the benefit of allowing NMWD to more efficiently treat any additional raw water supply and at relatively low cost, as detailed later in this chapter. This alternative therefore increases the reliability of having additional water supply from the STP.

The 20 to 70 AFY additional water supply estimate is based on a spreadsheet analysis of reduced waste discharge, not actual operating data with the STP modifications. Should NMWD want to evaluate this alternative further, additional performance testing of the STP with the recommended hydrocyclone modifications is strongly recommended to confirm how much recycle of the hydrocyclone discharge could be achieved with minimal operating impacts to the STP. The reliability of this water supply option is therefore relatively uncertain until additional performance testing has been completed.

Additional uncertainty is introduced by the fact that this water supply assessment relies on data for past raw water supply into Stafford Lake. Climate change could result in even drier periods than have been experienced in the recent past.

8.1.3 Infrastructure Requirements

The following infrastructure requirements have been identified related to this alternative and are detailed below:

- Pretreatment unit modifications
- Raw water intake modifications
- Replacement of wastewater discharge pipeline

8.1.3.1 Pretreatment Unit Modifications

The STP has three existing Actiflo units used for the main treatment upstream of the GAC filters. Each modular treatment unit has two sludge collection hoppers at the bottom, where microsand-ballasted flow-sludge slurry settles and accumulates. Each hopper has a dedicated sand pump that withdraws the settled slurry and sends it to a dedicated hydrocyclone. The Actiflo units thus have two dedicated hydrocyclones each. The hydrocyclones separate the microsand from the sludge solids. The separated microsand is recycled back to the injection tank of the respective Actiflo unit, and the sludge solids waste stream is discharged to a 500-gallon hydrocyclone waste collection tank and pumped from this tank to the solids thickener for settling of solids. Clarified water from the solids thickener is discharged at a controlled rate to NSD's collection system.

West Yost proposed modifications in the 2019 TM to the hydrocyclone return from the hoppers. Reduction of the hydrocyclone sludge waste stream could be achieved by returning a portion of the waste sludge stream from the hydrocyclones to the injection tank of the respective Actiflo unit where the microsand is currently reintroduced and/or added. The current Actiflo system supplier, Veolia, offers an Actiflo unit with a High Concentration Sludge system that is similar in concept to the proposed modification. However, recent discussions with Veolia indicate that this concept has not been implemented at other water treatment facilities to date.

The specific modification proposed is modifying and reconfiguring the discharge pipeline of one of the two hydrocyclone units for each Actiflo unit to return the waste stream. This modification would provide a 50 percent reduction in both the liquid waste flow rate and daily sludge volume from the Actiflo units.

The modifications could be implemented by NMWD staff relatively easily, both for the initial performance testing and, if performance testing proves successful, for the long-term modification. The sand pumps are configured to operate within a specific back pressure range that provides the desired microsand-sludge slurry flow rate that is recommended to keep the settling microsand from settling, accumulating, and impairing the outlet connection of the sludge hopper. Therefore, the modifications to the discharge pipeline(s) should be configured to provide a similar backpressure on the sand pumps as the current configuration provides. The recommended piping reconfiguration to return 50 percent of the hydrocyclone liquid waste stream into the injection tank is as follows:

- On one of the two hydrocyclone units (per Actiflo unit), disconnect the stainless-steel vent assembly where it connects to the hydrocyclone liquid waste pipeline (by disconnecting the flanged connection adjacent to the increaser and loosening the Victaulic connection at the top of the hydrocyclone)
- Rotate the vent assembly 180 degrees and install Unistrut or a similar support system to support the vent assembly's new location
- Reconnect the sludge discharge assembly to the hydrocyclone at the Victaulic connection
- Connect piping to vent assembly at the flange connection to direct the hydrocyclone liquid waste stream back into the Actiflo unit's injection tank

Additional piping and valving could be added to allow readily switching between returning and wasting the sludge or returning only a portion of the sludge on the second hydrocyclone.

8.1.3.2 Raw Water Intake Modifications

NMWD staff have identified a Water Selector available from Ixom Watercare as a possible equipment system that could be installed to allow for adjustable intake elevations. The Water Selector could potentially be retrofit over the existing intake gates to add additional intake locations at different water levels.

Ixom was not able to provide a full cost proposal at this time for the Water Selector for two reasons. First, the system is not typically installed on cylindrical intake tower like NMWD's. Second, Ixom's engineering staff were experiencing complications with a similar unit already installed and were not confident in suggesting the equipment for NMWD's application.

For purposes of this Study, it is assumed that the equipment or similar could be successfully retrofitted to NMWD's existing intake tower. The major additional equipment that would be attached to the intake tower is a rectangular, stainless-steel structure with a series of small metal gates positioned along the depth profile. The gates are opened via hydraulic power from an air compressor. In addition, a shore-based control panel and multi-parameter analytical probe are used to monitor water quality along the depth profile in real-time and inform the choice of gates to open.

8.1.3.3 Replacement of Wastewater Discharge Pipeline

The existing 4-inch diameter discharge pipeline to the NSD collection system could be replaced in-kind with 4-inch diameter pipeline. As a force main, the existing pipeline does not include any access structures (e.g., manholes), but the pipeline does include some bends.

NMWD staff have indicated that some of the maintenance requirements of the existing pipeline may be related to waste polymer buildup on the force main interior, which restricts flow over time. A larger diameter pipeline could be installed to reduce the concerns with polymer buildup. However, maintaining adequate scour velocity in the pipeline is recommended to prevent solids buildup generally. For purposes of the current evaluation, therefore, replacing in-kind with a 4-inch diameter pipeline is assumed.

8.1.4 Implementation Timing

There are two, critical path schedule items for the implementation of the pretreatment unit modifications as a permanent modification at the STP:

- First, NMWD would need to conduct performance testing to confirm that the proposed modifications would have overall positive benefits, specifically allowing for increased potable water production while having limited impacts on treatment performance.
- Second, NMWD would need to receive approval of the DDW of modifications to the STP operating permit.

The performance testing is estimated to require three to four months total, comprising the following:

- One month of planning
- One month of conducting the testing
- One to two months to analyze the results and prepare a performance testing report

The timing of DDW approval of modifications to the operating permit is uncertain but could reasonably require 6 to 12 months, including time for NMWD to prepare the modification application.

The performance testing would be conducted with temporary modifications to the hydrocyclones, so additional time would be needed following the performance testing and DDW approval of a permit modification to install the permanent capital changes. Installation of the permanent capital changes to the hydrocyclone is estimated to require only 1 to 2 months, allowing for time to order necessary equipment and for NMWD staff to make the modifications.

These components and the total estimated implementation period are provided Table 8-2 for modifying the pretreatment units.

Table 8-2. Summary of Estimated Implementation of Pretreatment Unit Modifications

Action	Estimated Timing, months
Complete Performance Testing	3-4
Receive DDW Approval for Operating Permit Modification	6-12
Implement permanent capital changes	1-2
Total Implementation Period[(a)]	**13-22**

Note
(a) Total range is calculated as the sum of the lower and higher ends of each component range, respectively (e.g. 13 = 3+6+4).

The other two capital components of this alternative – raw water intake modification and replacement of the wastewater discharge pipeline – would likely require shorter implementation periods. While the design and construction periods would be longer, these improvements would not require performance testing or a permit modification and corresponding DDW approval. The implementation timing is estimated to be 6 to 12 months for the raw water intake modification and discharge pipeline replacement, which could proceed concurrently or separately.

8.2 WATER SUPPLY ALTERNATIVE EVALUATION

This section provides an evaluation of the water supply alternative, grouped by the following sections:

- Cost Estimate
- Operational Impacts
- Regulations and Permitting
- Public and Institutional Considerations

8.2.1 Cost Estimate

A planning level cost estimate for the modification and operation of the improvements for the STP process water recapture efficiency and the ancillary improvements, along with assumptions, is provided in Table 8-2 and Table 8-3. Appendix F provides a more detailed cost estimate for this alternative. For this water supply alternative, a project allowance of 25 percent is used to account for planning, permitting, engineering, legal, and administrative costs. A separate cost is listed for performance testing.

Implementing this alternative would require some capital and implementation costs, as well as impact the STP operating costs. Three specific types of capital improvements have been identified for this alternative: pretreatment unit modifications, raw water intake modifications and replacement of the wastewater discharge pipeline.

Raw water intake modifications and replacement of the wastewater discharge pipeline are ancillary to pretreatment unit modifications and are not correlated with specific increases of the STP yield. NMWD may opt to implement a project that would only modify the pretreatment unit alone, or it may opt to implement the primary and ancillary modifications and replacement together. To provide NMWD a range, two cost estimates are provided herein - one for modifications to the pretreatment unit alone (on a per unit basis), and one for modifications per pretreatment unit along with ancillary modifications and improvement.

Appendix F provides further details on the cost estimating assumptions associated with this alternative. The cost estimates are summarized in Table 8-3 and 8-4 below.

Table 8-3. Total Estimated Cost for the Pretreatment Modification

Cost Item	Estimated Cost, dollars
Total Capital Cost	
Pretreatment Modification[a]	10,000
Performance Testing[b]	60,000
Total Replacement Cost[c]	70,000
Total O&M Cost[d]	-
NPV Total Cost	**$140,000**
Total Supply over 30 years[d], AF	**600 – 2,100**
Unit Cost over 30 years[e] (dollars/AF)	70 - 240

Notes:

(a) The construction contingency was estimated to be 40 percent and the project allowance for planning, permitting, engineering, legal, and administrative costs was estimated to be 25 percent.

(b) Performance testing is estimated to be $60,000 and assumes the performance testing would be led by an engineering consultant with assistance and supervision from NMWD staff. The engineering consultant would work with NMWD staff and the manufacturer to develop a work plan, collect data, among other efforts.

(c) It is estimated that the valving equipment will need to be replaced every 5 years. An inflation rate of 3.0 percent and discount rate of 3.5 percent was applied to determine the net present value of the replacement costs over the 30-year operational cycle. The construction contingency was estimated to be 40 percent and the project allowance for planning, permitting, engineering, legal, and administrative costs was estimated to be 35 percent.

(d) It is anticipated that overall O&M costs would remain the same or be slightly lower but cannot be determine without additional information that is not readily available.

(e) Annual supply yield of 20 AFY is assumed to be available during all years equating to 600 AF over 30 years. The modification could treat up to an additional 70 AFY, if available. This equates to 2,100 AFY over 30 years.

(f) Unit Cost = NPV Total Cost divided by the total supply yield over 30 years.

Table 8-4. Total Estimated Cost for the Pretreatment Modification and Ancillary Improvements

Cost Item	Estimated Cost, dollars
Total Capital Cost	
Pretreatment Modification[(a)]	10,000
Performance Testing[(b)]	60,000
Raw Water Intake Modifications[(c)]	2,700,000
Wastewater Discharge Pipeline Replacement[(d)]	442,000
Total Replacement Cost[(e)]	70,000
Total O&M Cost[(f)]	**(180,000)**
NPV Total Cost	**$3,102,000**
Total Supply over 30 years[(g)](AF)	**600 – 2,100**
Unit Cost over 30 years[(h)] (dollars per AF)	1,500 – 5,200

Notes:

(a) The construction contingency was estimated to be 40 percent and the project allowance for planning, permitting, engineering, legal, and administrative costs was estimated to be 25 percent.

(b) Performance testing is estimated to be $60,000 and assumes the performance testing would be led by an engineering consultant with assistance and supervision from NMWD staff. The engineering consultant would work with NMWD staff and the manufacturer to develop a work plan, collect data, among other efforts.

(c) The capital cost for the raw water intake modification is a high-level cost based on discussions with the manufacturer, Ixom. The capital cost does not account for any contingencies.

(d) The construction contingency was estimated to be 35% and the project allowance for planning, permitting, engineering, legal, and administrative costs was estimated to be 25%. The construction contingency was reduced from 40 percent to 35 percent due to the wastewater pipeline being a pipeline replacement (no CEQA, no easements, no property rights etc.).

(e) For the pretreatment modification, it is estimated that the valving equipment will need to be replaced every 5 years. An inflation rate of 3.0 percent and discount rate of 3.5 percent was applied to determine the net present value of the replacement costs over the 30-year operational cycle. The construction contingency was estimated to be 40 percent and the project allowance for planning, permitting, engineering, legal, and administrative costs was estimated to be 35 percent. Replacement costs for the ancillary improvements were not included.

(f) For the pretreatment modification, it is anticipated that overall O&M costs would remain the same or be slightly lower but cannot be determine without additional information that is not readily available. For the raw water intake modification, O&M costs are likely to be similar or slightly lower after implementation of the pretreatment unit modifications, but whether they would be significantly lower and by how much cannot be determined without additional information that is not readily available at this time. NMWD spends an estimated $9,000 per year to perform maintenance on the existing wastewater discharge pipeline. If the existing pipeline were replaced, annual O&M costs are anticipated to be reduced by $9,000 every year. Over a 30-year period, NMWD O&M costs is estimated be reduced by a total NPV of $180,000.

(g) Annual supply yield of 20 AFY is assumed to be available during all years equating to 600 AF over 30 years. The pretreatment modification could treat up to an additional 70 AFY, if available. This equates to 2,100 AFY over 30 years. The ancillary improvements would not increase the local water supply but increase the reliability of the STP operations.

(h) Unit Cost = NPV Total Cost divided by the total supply yield over 30 years.

8.2.1.1 Pretreatment Unit Modifications

The total capital cost for the pretreatment unit modifications is estimated to be $70,000. The pretreatment unit modifications are estimated to cost at most $10,000 for small piping and valving equipment and includes the construction contingency and 25 percent project allowance. The performance testing is estimated to be approximately $60,000 and assumes the performance testing would be led by an engineering consultant with assistance and supervision from NMWD staff. The engineering consultant would work with NMWD staff and the manufacturer to develop a work plan, collect data, among other efforts.

The 30-year NPV replacement cost is estimated to be $70,000. The valving equipment is assumed to require replacement approximately every 5 years.

Overall, O&M costs are likely to be similar or slightly lower after implementation of the pretreatment unit modifications, but whether they would be significantly lower and by how much cannot be determined without additional information that is not readily available at this time. For purposes of determining a unit cost, no changes to operational costs are assumed associated with this component. Performance testing is recommended to estimate the impacts to the STP O&M costs, including quantifying the reduction of chemical usage and costs.

The total cost (total capital cost plus NPV costs) for the pretreatment unit modifications is estimated to be $140,000. It is estimated that an additional annual yield of 20 AFY would be achieved in all years, equating to 600 AF over 30 years, with the pretreatment modifications. During a typical year, it is estimated that approximately 70 AFY would be available, equating to 2,100 AF over 30 years. The unit cost would range from $1,500 to $5,200 over 30 years.

Should the region experience dry years and NMWD decides to purchase winter water flows from the Russian River, the supplemental water supply is estimated to cost up to $400 per AF. Due to the unpredictability of dry seasons and the volume of water to be purchased, the cost of this water supply is excluded from the cost estimate. However, this additional cost must be noted by NMWD.

8.2.1.2 Raw Water Intake Modifications

Although a site-specific budgetary cost is not available at this time, Ixom provided a high-level cost estimate of about $2 million for the equipment and $700,000 for installation cost, not accounting for any contingencies. This estimate is based on a similar-sized Water Selector that had been recently installed elsewhere.

Overall, O&M costs are likely to be similar or slightly lower after implementation of the pretreatment unit modifications, but whether they would be significantly lower and by how much cannot be determined without additional information that is not readily available at this time.

8.2.1.3 Wastewater Discharge Pipe Replacement

The total capital cost for the wastewater discharge pipeline replacement is estimated to be $442,000. The construction contingency was reduced from 40 percent to 35 percent for this pipeline replacement. A project allowance of 25 percent was used. The pipeline was assumed to have a life cycle of 50 years. Since the Study's operational cycle is less than 50 years, no replacements were assumed to be required. This capital cost would be expected to be offset by reduced NMWD operational and maintenance costs.

NMWD spends an estimated $9,000 per year to perform maintenance on the existing wastewater discharge pipeline. If the existing pipeline were replaced, annual O&M costs are anticipated to be reduced by $9,000 every year. Over a 30-year period, NMWD O&M costs is estimated be reduced by a total NPV of $180,000.

8.2.2 Operational Impacts

This section describes specific operational impacts potentially associated with implementing each component of this alternative. In Section 8.3, performance testing is recommended. The performance testing could have short-term operational impacts and would be used to better gauge long-term operational impacts.

8.2.2.1 Projected Operational Impacts of Pretreatment Unit Modifications

Based on discussions with Veolia, two primary operational risks are possible with implementing the proposed pretreatment unit modifications. One risk is buildup of solids within the Actiflo unit, which could potentially impact the effluent (clarified water) quality. Another risk is increasing the percent solids of the sludge-microsand slurry to be processed by the hydrocyclone, which may result in reduced sand separation efficiency (i.e., increased microsand loss).

Buildup of solids within the Actiflo unit pretreatment process would be a pertinent concern when treating water with high solids concentration. The original Actiflo treatment process was developed to clarify secondary wastewater effluent that typically has a higher solids concentration than STP source water. Most of the time, the STP is treating water with relatively low turbidity (< 10 Nephelometric Turbidity Units). Because the STP raw water turbidities are typically very low, returning a portion of the hydrocyclone waste may actually improve floc formation in the Actiflo unit by reintroducing more and larger pre-formed floc solids that enhance particle collisions and agglomeration.

Veolia has indicated that the solids concentration in the sand-sludge slurry fed to the hydrocyclone should not exceed than 12 to 15 percent (including the microsand) to avoid impacting the hydrocyclone efficiency. The sludge waste stream has very low concentration of dry solids (typically between 0.1 and 0.3 percent) and is a small fraction of the dry solids in the sand-sludge slurry. Doubling the sludge solids concentration by returning 50 percent of the waste stream back into the Actiflo process should not significantly increase the sand-sludge slurry's dry solids concentration.

Additionally, since the wet sludge from the hydrocyclones would be recirculated to the Actiflo unit, the microsand enmeshed in the wet sludge slurry would be returned and would not be lost.

Recycling a portion of the waste sludge would be expected to reduce chemical (i.e. polymer) use by returning some of the chemical in the settled microsand-sludge slurry ahead of the Actiflo maturation zone. One objective of the performance testing would be to evaluate what reductions in chemical use could be achieved with the modifications.

Finally, the increased hours of STP operation discussed above with the yield estimates would require fewer days of operation overall and essentially the same total hours of operation each year. Therefore, this alternative would change the timing of STP staffing but not the overall staff hours required.

8.2.2.2 Projected Operational Impacts of Ancillary Improvements

Both the raw water intake modifications and wastewater discharge pipeline should allow for more reliable operation of the STP and reduce STP staff time for either managing variable raw water intake quality or replacing broken sections of the pipeline, respectively.

8.2.3 Regulations and Permitting

This alternative would require modification of existing pipelines, hydroclones and ancillary facilities but minimal construction at the STP. Each of the alternative components are likely to be exempt from CEQA in accordance with CEQA Section 15301 – Class 1 Minor alteration of existing public or private structure. Implementation of changes to the STP's existing water treatment process could affect water quality but monitoring, operational adjustments and treatment options would ensure that all drinking water standards are met.

Facilities and operational changes at the STP are likely to require amendment of the STP operating permit and approval of the DDW, specifically for the pretreatment unit modifications. Any performance testing results will need to be documented to support the modification request to the DDW. Facilities and operational changes at the STP should be reviewed for consistency with Filter Backwash Recycling Rule and California Cryptosporidium Action Plan.

This alternative involves alteration to the existing water treatment process and is the least complex from a regulatory standpoint. Minimal, if any, CEQA analysis would be required, and the project could be implemented with DDW review and approval.

8.2.4 Public and Institutional Considerations

The public and institutional considerations for this alternative are considered to be minor, based on the following:

- Any modifications at the STP would need to allow for continued compliance with drinking water standards. No public opposition to these relatively minor modifications are anticipated.
- The proposed modifications would impact operations at the STP, but additional study of the modifications is recommended before committing to permanent implementation of the modifications. One overarching goal of the additional study would be to work through any operational concerns that arise during the study, if possible.
- Implementing this alternative would not require coordination with outside entities (e.g., for obtaining easements or developing partnerships) apart from minor coordination with the Actiflo vendor (Veolia) as part of the performance testing.

8.3 FINDINGS AND CONCLUSIONS

No items intrinsic to the alternative have been identified that would prevent it from being successfully implemented. In other words, no fatal flaws to this alternative have been identified that should preclude NMWD from considering this alternative. The two riskiest aspects of implementing this alternative are: (1) potential impacts to treated water quality; and (2) achieving DDW approval for implementing the pretreatment unit modifications.

Additional plant-scale study is needed to confirm the feasibility of this alternative, which entails modifying the STP pretreatment process to reduce wastewater discharged to the collection system and thus allow for additional hours of STP operation to produce additional potable water from stored water in Stafford Lake. The capital change to implement this component of the alternative is relatively minor.

The recommended performance testing for the pre-treatment units is provided in Section 8.3.1. Should the performance testing confirm the feasibility of this alternative, a reasonable estimate of the additional water supply yield that could be realized is 20 to 70 AFY. Closer to 20 AFY is more likely when the raw water supply is a limiting factor, such as during a dry year, not the wastewater discharge permit. Even during a dry year, the upper end of the yield may be achievable if the water supply to Stafford Lake could be augmented – for instance, with imported water from Sonoma Water.

Should the performance testing indicate that implementing the pretreatment modifications would not be prudent, NMWD could explore other alternatives for STP process efficiency. West Yost's 2019 study identified four other alternatives apart from modifying the pretreatment units. One of those alternatives would require operating fewer than all three Actiflo units at one time, to reduce wastewater from starting and stopping the multiple units. STP operations staff have indicated that alternative would be difficult to implement. The three remaining alternatives would require significantly more capital investment, with estimated construction costs ranging between $1.6 and $2.2 million. The least expensive of those entailed modifications to the solids settling process. Specifically, the facility currently being used as a solids thickener could be rehabilitated, retrofitted and returned to its original use as a reactor clarifier. The restored functionality would allow NMWD to recover the supernatant from that process as another recycle stream, thus reducing some portion of the STP wastewater.

Further evaluation of these other alternatives is beyond the scope of the current evaluation. NMWD is recommended to revisit these alternatives, specifically rehabilitating the reactor clarifier, should the performance testing of the pretreatment modifications confirm that the current alternative is not feasible.

8.3.1 Recommended Performance Testing

Prior to implementing long-term modifications of the pretreatment units, additional performance testing is recommended at a plant-scale to determine the impacts of implementing the modifications. Based on discussions with NMWD staff, all three Actiflo units are assumed to continue operation during the testing period. To limit operational impacts of the testing, hydrocyclone modifications should be initiated for only one of the Actiflo units. The other units would operate normally, at least initially, to serve as an evaluation test control and provide operating data for comparison with the test unit's data.

The preparation of a performance testing plan is strongly recommended in coordination with Veolia and an engineering consultant prior to conducting the additional testing to ensure that adequate data and information is collected and documented during the performance testing. The data and information gathered would help NMWD make an informed decision on whether long-term modifications are operationally feasible and desirable. Additional details to describe the performance testing would be developed as part of the testing plan.

Should the results of the initial performance testing prove positive and have limited or beneficial operational impacts, the testing could be expanded to two of the Actiflo units while still leaving one unit unmodified to serve as a control.

CHAPTER 9
Divert Captured Stormwater Into Stafford Lake

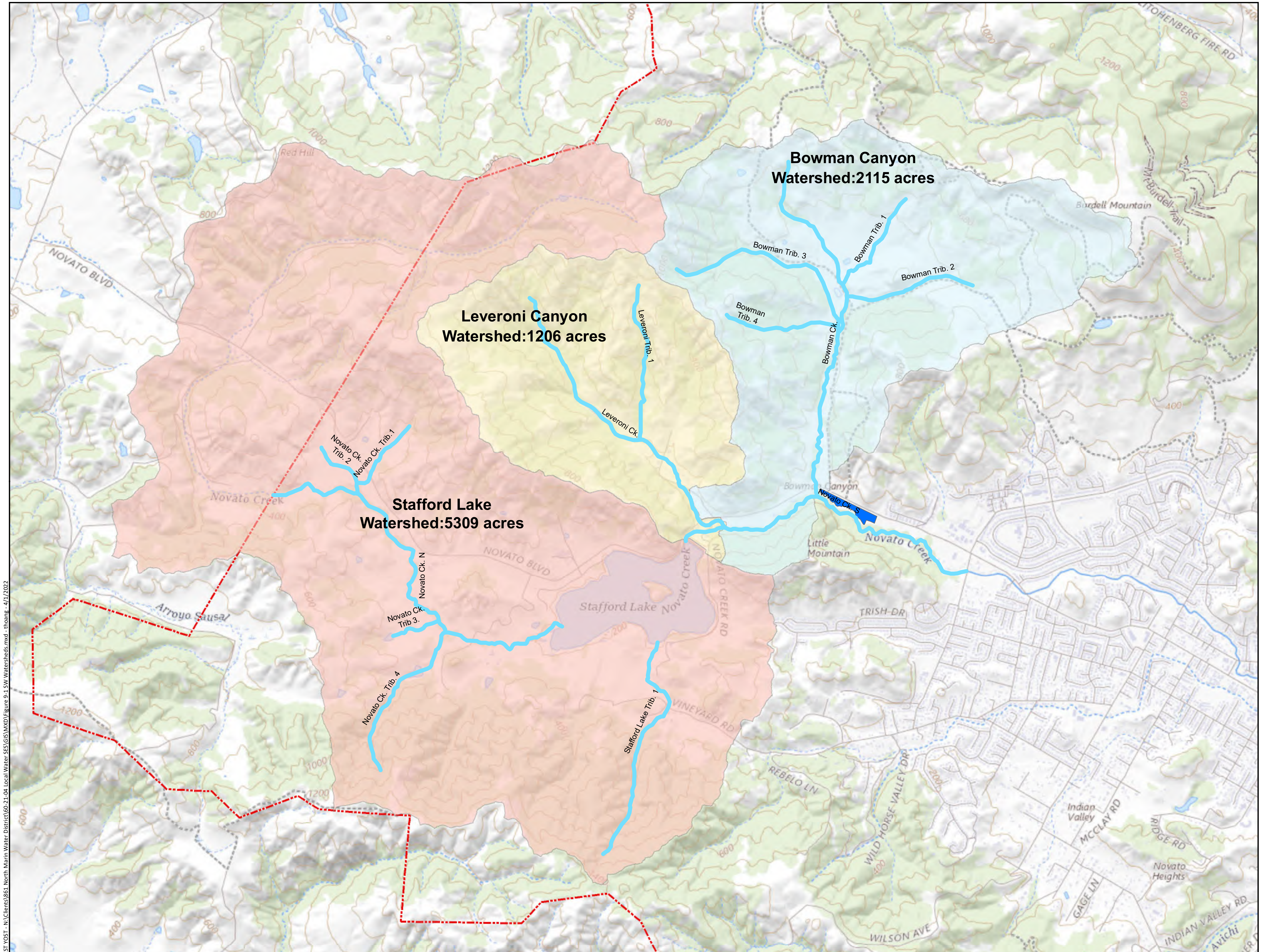
This Chapter presents the potential for and an evaluation of diverting captured stormwater from Leveroni Canyon and/or Bowman Canyon into Stafford Lake. Five options to capturing stormwater runoff from Leveroni Canyon and Bowman Canyon watersheds were considered under this water supply enhancement alternative. As detailed herein, these options may potentially be implemented by NMWD, but with some challenges associated with regulations and permitting and public and institutional considerations.

9.1 CAPTURE STORMWATER TO ENHANCE WATER SUPPLY

Leveroni Canyon and Bowman Canyon watershed areas are adjacent to the Stafford Lake watershed area, as shown on Figure 9-1. In this Chapter, the alternative to capture stormwater runoff from Leveroni Canyon and/or Bowman Canyon is considered. The captured water would be pumped into Stafford Lake to increase the local water supply for NMWD. Five options for this alternative were evaluated:

- **Option 1 - Leveroni Canyon:** Water from Leveroni Canyon would be captured and pumped to Stafford Lake. The required infrastructure would be a pump station and a transmission main , all of which are located on NMWD property.
- **Option 2 - Bowman Canyon:** Water from Bowman Canyon would be captured upstream of the confluence with Novato Creek and pumped to Stafford Lake. The required infrastructure would be a pump station and a transmission main . A basin could also be included to increase the annual water supply volume.
- **Option 3 - Novato Creek (Leveroni and Bowman Canyons):** Water from both Leveroni and Bowman Canyons would be captured downstream of the confluence Bowman Canyon and Novato Creek and pumped to Stafford Lake. The required infrastructure would be a pump station and a transmission main . A basin could also be included to increase the annual water supply volume.
- **Option 4 – Leveroni Canyon Dam:** Water from Leveroni Canyon would be captured with the use of a dam across Leveroni Canyon, just north of Novato Boulevard. This option would also require a pump station, transmission main , all located on land that is currently on private property.
- **Option 5 – Bowman Canyon Dam:** Water from Bowman Canyon would be captured with the use of a dam across Bowman Canyon, approximately 300 feet north of Novato Boulevard. This option would also require a pump station and transmission main , all located on land that is currently on private property.

Options 4 and 5 were evaluated to estimate how much of the captured water could be used by the STP and how much of the captured water would subsequently overflow the Stafford Lake spillway. These evaluations are based on four fiscal years, July 1, 2016 through June 30, 2020. During this period annual rainfall ranged from above average rainfall (40.7-inches of rain) to below average rainfall (18.40-inches). NMWD may enhance the evaluation of Options 1, 2, and 3 similarly in future studies.



0 1,375 2,750
Feet

Symbology

Watershed:

- Bowman Canyon Watershed
- Leveroni Canyon Watershed
- Stafford Lake Watershed

Stormwater Project Area

- Water Supply / Flood Control Basin
- Creeks

Retailers

- North Marin Water District

WEST YOST

Figure 9-1

Stafford Lake Area and Adjacent Area Watersheds

North Marin Water District

Local Water Supply Enhancement Study

WEST YOST - N:\Clients\861 North Marin Water District\60-21-04 Local Water SES\GIS\MXD\Figure 9-1 SW Watersheds.mxd - thoang - 4/1/2022

For Options 1 to 3, the benefit of a potential multi-benefit use water supply/flood control basin (water supply basin/basin) was considered to increase the annual water supply volume.[1] For Options 4 and 5, a dam is proposed in the Leveroni Canyon and Bowman Canyon watersheds.[2]

9.1.1 Option Variations Considered

The water supply yield for the above-described options could vary depending on pumping capacity and use of a basin for Options 1 through 3 and operational rules for Options 4 and 5. Variations to the options were developed and analyzed to identify volume of stormwater that could be captured and delivered to NMWD's distribution system.

The method and assumptions used to estimate stormwater runoff and the variations analyzed is provided in Appendix J.

9.1.1.1 Variations to Options 1 Through 3

Stormwater runoff supply volumes that could be potentially captured and diverted for Options 1, 2, and 3 are provided in Table 9-1 using cumulative rainfall per year during 2016 to 2020 fiscal years. Scenarios with and without the use of an 80 AF water supply basin in combination with pumping to Stafford Lake was considered. The 80 AF water supply basin was sized to fit the site considered and is detailed in Section 9.2.1.1. The use of a water supply basin for Leveroni Creek (Option 1) is not feasible because of space limitations on the NMWD property at Leveroni Canyon.

Pumping captured stormwater runoff into Stafford Lake is assumed to occur in the typically wet part of the year. Pumping rates were varied from 2 cubic feet per second (cfs) to 10 cfs to determine the time needed to vacate the water supply basin and transfer the water to Stafford Lake. The water supply basin could be vacated in 20 days with a 2 cfs pumping rate, and in 4 days with a 10 cfs pumping rate. Further studies are required to size pumps appropriate for the changing climate in NMWD.

Table 9-1. Summary of Potential Water Supply Volumes Captured for Diversion

Pumping Rate, (cfs)	Option 1 Leveroni Canyon, AFY	Option 2 Bowman Canyon, AFY	Option 3 Novato Creek , AFY
Per Year, On Average, With No Water Supply Basin			
2	93	156	211
4	155	254	363
6	198	323	474
8	224	385	558
10	245	433	628

[1] A basin is an offline water structure where water is diverted from the creek for use. For this study, water is envisioned to be pumped to Stafford Lake.

[2] A dam is structure that goes across a creek channel or canyon and blocks all the water for storage and use. For this study, water is envisioned to be pumped to Stafford Lake.

Table 9-1. Summary of Potential Water Supply Volumes Captured for Diversion

Pumping Rate, (cfs)	Option 1 Leveroni Canyon, AFY	Option 2 Bowman Canyon, AFY	Option 3 Novato Creek , AFY
Per Year, On Average, with 80 AF Water Supply Basin Used Twice Per Year			
2	-	316	371
4	-	414	523
6	-	483	634
8	-	545	718
10	-	593	788

The evaluation of Options 1, 2, and 3 identifies the total volume of stormwater that could be captured. Further analysis is required to quantify the fraction of the captured water that would generate an increase of the spill over at the Stafford Lake spillway and ultimately not be available as a new usable water supply. This limitation may affect the maximum stormwater that could be captured and used by NMWD. It would also affect cost estimates provided in Section 9.3.1 for these options.

9.1.1.2 Variations for Options 4 and 5

Operational rules were developed for Options 4 and 5 to evaluate the construction of a dam at either Leveroni Canyon or at Bowman Canyon. For the purposes of this Study, the following potential operation rules were identified and used for analysis.

- Option 4, Leveroni Canyon Dam, is assumed to have a required fish flow of 0.4 cfs. Option 5, Bowman Canyon Dam, is assumed to have a required fish flow of 0.5 cfs. The fish flow would occur all year if water is available in the Leveroni or Bowman Canyon reservoirs.
- Pumping from the Leveroni or Bowman Canyon reservoirs would occur only from March 1st through September 30th of each water year[3].
- The new water supply to the STP would be used year-round. No water is spilled over the Stafford Lake spillway.

An analytical tool was developed to provide a high level of flexibility for evaluating different operational rules for Options 4 and 5. Further study is recommended to understand water supply availability under different operational rules, including:

- Increasing pumping periods to year-round, instead of partial-year;
- Adjustments considering future climate change impacts; and,
- Benefits of increasing Stafford Lake capacity, as discussed in Chapter 10.

[3] A water year is defined as the period from October 1st to September 30th of the following year.

9.2 WATER SUPPLY YIELD AND RELIABILITY

Water supply yields were estimated for the five options, described in Section 9.1, and are based on four years of rain data (Fiscal Years 2016 – 2017 through 2019 – 2020). For this analysis, the fiscal year data corresponds to the water year data . Two of these rainfall years are considered wet years (at 40.1 and 40.7-inches) and two of the years are considered dry years (at 18.4 and 19.3-inches). Table 9-2 summarizes the estimated annual water supply yields for Options 1 to 3. Table 9-3 summarizes the estimated annual water supply yields for Options 4 and 5.

Table 9-2. Annual Water Supply Yields for Options 1, 2, and 3

Option	Description	Yield, AFY	
		Without Basin	With Basin
1[a]	Leveroni Canyon	93 – 245	-
2	Bowman Canyon	156 – 433	316 - 593
3	Novato Creek	211 - 628	371 - 788

Notes:
(a) This option does not include a proposed basin.
AFY = acre-feet per year

Table 9-3. Annual Water Supply Yields for Options 4 and 5

Option	Description	Yield, AFY
4	Leveroni Canyon Dam[a]	175
5	Bowman Canyon Dam[b]	752

Notes:
(a) Option 4 would require a 3.5 cfs pump station.
(b) Option 5 would require a 2.5 cfs pump station.

The future reliability of these estimated water supply yield values is dependent on rainfall. The recent four-year period analyzed has either been very wet years or very dry years, representative of the changing climate. For the purposes of this Study, rainfall over these years is assumed to be representative of future rainfall. Continued climate change could reduce the future annual rainfall, which could reduce the annual water supply yields; or increase the amount of rain that falls in infrequent large storm events. A large storm event could result in more of the rainfall spilling over the Stafford Lake spillway and not being available as annual water supply yield. Even with climate change, this increase in water supply is expected to be relatively reliable.

Combining one of these options with increasing Stafford Lake storage capacity, as presented in Chapter 10, could increase the water supply yield and the reliability of this alternative. Should NMWD consider combining these two alternatives, further analysis is recommended.

9.2.1 Infrastructure Requirements

The infrastructure requirements for Options 1, 2 and 3, where stormwater runoff is collected using an intake facility or basin and diverted to Stafford Lake, differ from the infrastructure requirements for Options 4 and 5, where stormwater is dammed. In all of the options, the pipeline alignments considered would allow NMWD the flexibility to divert water to directly to Stafford Lake or to the STP. The proposed facilities described below are all standard water supply type facilities.

9.2.1.1 Infrastructure to Collect and Divert Stormwater Runoff from Watersheds

Options 1, 2 and 3 provide alternative ways to capture stormwater runoff from watersheds adjacent to Stafford Lake and divert Stafford Lake. The infrastructure requirements for Options 1, 2 and 3 include a pump station, and a transmission main to collect runoff and deliver it into Stafford Lake. A basin was considered for Options 2 and 3 to maximize stormwater runoff capture; a basin was not considered for Option 1 because a feasible site for a basin was not found for NMWD. An intake structure would be installed in the creek if a basin is not installed.

The required infrastructure is shown on Figure 9-2 and described below.

- **Basin (Multi-benefit Use)** – This facility is shown on Figure 9-2. It has a surface area of about 8.3 acres. The basin would be connected to Novato Creek with a 24-inch diameter culvert near the west end of the basin. The culvert would have a flap gate at the end of the basin to allow flow into the basin from Novato Creek, but block flow from the basin back to Novato Creek. Because the culvert is above the creek bottom, it would allow fish flows to pass without being diverted into the basin.

  The basin would include a berm along the south side that would separate the water supply basin from Novato Creek. A flood control weir is proposed to direct flood flows out of the creek and into the basin. The basin would have a bottom area of about 4.3 acres. The water supply volume of the basin would be about 80 AF. The flood control volume of the basin would be about 46 AF. The flood control benefit that could be achieved from 46 AF has not been evaluated for this Study.[4]

- **Pump Station** – This facility would pump water from the proposed basin into a new transmission main. The pump station capacity could range from 2 cfs to 10 cfs.

- **Transmission Main** - A transmission main is proposed from the pump station to Stafford Lake. For Option 1, the transmission main would go from the respective proposed pump station at Leveroni Canyon, cross under Novato Boulevard and into Stafford Lake. For Option 2 and Option 3, the proposed transmission main alignment would start at the respective proposed pump station location and the pipeline would be located just south of Novato Boulevard and follow the same general alignment before going to Stafford Lake. The transmission main would be 12 inches in diameter for a 2, 4, or 6 cfs pump station and would be 15 inches in diameter for either an 8 or 10 cfs pump station.

From Leveroni Canyon to Stafford Lake (Option 1), the transmission main would be approximately 1,700 feet long. From Bowman Canyon to Stafford Lake (Option 2), the transmission main would be

[4] The County Flood District is completing a similar basin in Fairfax: https://www.marinwatersheds.org/resources/projects/san-anselmo-flood-risk-reduction-safrr-project

approximately 4,500 feet long. Use of the existing potable water transmission main from the STP to the City was considered instead of constructing a new transmission main. However, the existing transmission main is used to distribute potable water. The stormwater runoff collected is raw water that must be treated prior to entering the distribution system. If the existing transmission main is used, it would need to be isolated from the potable water distribution system, require annual clearing of sediment and debris, and require disinfection before it is used for the potable water supply.

0 500 1,000
Feet

Proposed Force Main
- Option 1
- Options 2 & 3

Proposed Pump Station
- Option 1
- Options 2 & 3

Water Supply / Flood Control Basin
- Toe
- Top
- Watersheds
- Creeks

Figure 9-2

Proposed Infrastructure for Options 1, 2, and 3

North Marin Water District
Local Water Supply
Enhancement Study

9.2.1.2 Infrastructure to Capture Stormwater Runoff in Dams

Options 4 and 5 present possibilities for the installation of a dam to capture stormwater runoff from Leveroni Canyon or Bowman Canyon, respectively. The infrastructure requirements for each option vary slightly because of topography and the proximity of the watersheds to Stafford Lake. Diverting and storing stormwater in the Leveroni Canyon or Bowman Canyon watersheds would require acquisition of water rights from the SWRCB Division of Water Rights. In the case of Bowman Canyon watershed, the acquisition of water rights could potentially inundate the trailheads for MCOSD lands on the East side of the canyon.

9.2.1.2.1 Leveroni Canyon Dam

The infrastructure requirements for Option 4, a dam at Leveroni Canyon, includes an earthen dam, pump station, and transmission main to collect runoff from Leveroni Canyon and deliver it into Stafford Lake. The required infrastructure is shown on Figure 9-3 and described below.

- **Earthen Dam Across the Outlet of Leveroni Canyon** - A dam is proposed to run adjacent to the elevated section of Novato Road, with an impermeable liner between the dam fill and the road fill. The dam would have a spillway elevation of 174 feet and would provide 3 feet of freeboard below the buildings at the north end of the proposed Leveroni Canyon reservoir. At an elevation 174 feet, the reservoir would provide 80 AF of storage.
- **Pump Station** - The capacity of the pump station of 3.5 cfs was determined to maximize the water supply that could be pumped to Stafford Lake. For pump station capacities greater than 3.5 cfs, the Leveroni Canyon reservoir would empty more quickly, but water supply would not increase.
- **Transmission Main** - The 12-inch diameter transmission main would run from the pump station, cross under Novato Road, along Indian Valley Road to the Stafford Lake Spillway channel, would be mounted on the inside of the channel wall (to avoid a pressure pipe in the earthen dam fill), and would discharge into Stafford Lake, just upstream of the old spillway. The total length of the transmission main is estimated to be 1,500 feet.

9.2.1.2.2 Bowman Canyon Dam[5]

The infrastructure requirements for Option 5, a dam at Bowman Canyon, includes an earthen dam, pump station, and transmission main to collect runoff from Bowman Canyon and deliver it into Stafford Lake. The required infrastructure is shown on Figure 9-4 and described below.

- **Earthen Dam Across the Outlet of Leveroni Canyon** - The dam would have a spillway elevation of 170 feet and would provide 3 feet of freeboard below the buildings at the north end of the proposed reservoir. At an elevation 170 feet, the reservoir would provide 640 AF of storage.
- **Pump Station** - The capacity of the pump station of 2.5 cfs was determined to maximize the water supply that could be pumped to Stafford Lake. For pump station capacities greater than 2.5 cfs, the Bowman Canyon reservoir would empty more quickly, but the water supply would not increase.

[5] Dam at Bowman Canyon has been previously evaluated multiple times by the District beginning in 1949.

- Transmission Main - The 12-inch diameter transmission main would run from the pump station, adjacent to Novato Road, cross Novato Road, along Indian Valley Road to the Stafford Lake spillway channel, would be mounted on the inside of the channel wall (to avoid a pressure pipe in the earthen dam fill), and would discharge into Stafford Lake just upstream of the old spillway. The total length of the transmission main would be 5,700 feet.

N

0 100 200
Feet

Proposed Force Main
Option 4
Proposed Pump Station
Option 4
Proposed Leveroni Canyon Reservoir
Proposed Leveroni Canyon Dam
Road Realignment
Creeks

WEST YOST

Figure 9-3

Proposed Infrastructure for Option 4 Leveroni Canyon Dam

North Marin Water District
Local Water Supply Enhancement Study

WEST YOST - N:\Clients\861 North Marin Water District\60-21-04 Local Water SES\GIS\MXD\Figure 9-3 SW Leveroni Dam.mxd - thoang - 4/13/2022

N

0 300 600

Feet

Proposed Force Main

Option 5

Proposed Pump Station

Option 5

Proposed Bowman Canyon Reservoir

Proposed Bowman Canyon Dam

Proposed Road Realignment

Creeks

WEST YOST

Figure 9-4

Proposed Infrastructure for Option 5 Bowman Canyon Dam

North Marin Water District

Local Water Supply Enhancement Study

WEST YOST - N:\Clients\861 North Marin Water District\60-21-04 Local Water SES\GIS\MXD\Figure 9-4 SW Bowman Dam.mxd - thoang - 4/13/2022

9.2.2 Implementation Timing

The implementation timing for this alternative is dependent on the time for land acquisition, permitting, design, and construction. Table 9-4 summarizes the estimated implementation timing for each option under this alternative.

Table 9-4. Implementation Timing

Implementation Category	Estimated Time, years				
	Option 1 Leveroni Canyon	Option 2 Bowman Canyon	Option 3 Novato Creek	Option 4 Leveroni Canyon Dam	Option 5 Bowman Canyon Dam
Land Acquisition[(a)]	0	1	1	1	1
Permitting	2	2	2	3[(b)]	3[(b)]
Design	1	1	1		
Construction	1	1	1	1	1
Total	**4**	**5**	**5**	**5**	**5**

Notes:
(a) For Option 1, NMWD currently owns the land where the proposed pump station would be located.
(b) For Options 4 and 5, permitting and design are assumed to occur concurrently.

9.3 WATER SUPPLY ALTERNATIVE EVALUATION

This water supply alternative could potentially increase annual water supply for NMWD at costs competitive with other water supply alternatives available to NMWD. However, many of the options under this water supply alternative present challenges associated with regulations and permitting and multi-faceted public and institutional considerations.

9.3.1 Cost Estimate

A planning-level cost estimate for the construction and operation for the diverting captured stormwater into Stafford Lake, along with assumptions, is provided below. These costs do not include treatment of the raw water nor distribution of treated water. Appendix F provides a more detailed cost estimate for this water supply alternative.

Options 1, 2, and 3 were evaluated with and without a basin and with varying pump station sizes. The cost estimates summarized in this Chapter for Options 1, 2, and 3 are only for a proposed 10 cfs pump station which would provide the lowest unit cost ($ per AF over 30 years), for the purposes of comparing the unit costs of the other water supply alternatives discussed in this Study. Appendix F summarizes the cost estimate for all pump station sizes (2 cfs to 10 cfs) that was evaluated as part of this Study. The cost estimate includes the following specific assumptions for Options 1, 2, and 3:

- Project Allowance: 35 percent
- Operating Contingency: 30 percent
- No replacement costs were identified

The cost estimate includes the following specific assumptions for Option 4 and 5:

- Project Allowance: 60 percent
- Operating Contingency: 40 percent
- No replacement costs were identified

9.3.1.1 Options 1, 2, and 3: Cost Estimate Without Basin

Table 9-5 summarizes the cost estimate for diverting captured stormwater into Stafford Lake from either Leveroni Canyon, Bowman Canyon, or Novato Creek to increase local supply available to NMWD with a 10 cfs pump station and without the use of the basin. This cost estimate assumes that NMWD can use the total captured stormwater runoff, and none would be lost over the Stafford Lake spillway.

The total capital cost for Option 1 is estimated to be $2.46 million including the construction contingency and project allowance. The annual O&M cost is estimated to be $94,000 including the operating contingency. The 30-year NPV O&M cost is estimated to be $2.69 million. The total cost (total capital cost plus NPV cost) for Option 1, without a basin, is estimated to be $5.15 million. Assuming an annual yield of 245 AF, the total supply yield over a 30-year period from Leveroni Canyon is approximately 7,300 AF. The unit cost is approximately $710 per AF over a 30-year period.

The total capital cost for Option 2 is estimated to be $3.10 million including the construction contingency and project allowance. The annual O&M cost is estimated to be $100,000 including the operating contingency. The 30-year NPV O&M cost is estimated to be $2.89 million. The total cost (total capital cost plus NPV cost) for Option 2, without a basin, is estimated to be $5.99 million. Assuming an annual yield of 433 AF, the total supply yield over a 30-year period from Bowman Canyon is approximately 13,000 AF. The unit cost is approximately $470 per AF over a 30-year period.

The total capital cost for Option 3 is estimated to be $3.10 million including the construction contingency and project allowance. The annual O&M cost is estimated to be $107,000 including the operating contingency. The 30-year NPV O&M cost is estimated to be $3.10 million. The total cost (total capital cost plus NPV cost) for Option 3, without a basin, is estimated to be $6.20 million. Assuming an annual yield of 628 AF, the total supply yield over a 30-year period from Novato Creek is approximately 18,800 AF. The unit cost is approximately $330 per AF over a 30-year period.

Table 9-5. Cost Estimate for Options 1, 2, and 3 – Without Basin

Cost Item	Estimated Cost, million dollars		
	Option 1 Leveroni Canyon	Option 2 Bowman Canyon	Option 3 Novato Creek
Total Capital Cost[(a)]	2.46	3.10	3.10
Total Replacement Cost[(b)]	-	-	-
Total O&M Cost[(c)]	2.69	2.89	3.10
NPV Total Cost	**$5.15**	**$5.99**	**$6.20**
Total Supply over 30 years[(e)], AF	7,300	13,000	18,800
Unit Cost over 30 years[(f)], dollars per AF	**$710**	**$470**	**$330**

Notes:
(a) The total capital cost assumes the construction of a 10 cfs pump station and transmission main pipeline. For the proposed transmission main delivering supply from Leveroni Canyon to Stafford Lake, the estimated length is 1,700 feet. For the proposed transmission main delivering supply from Bowman Canyon or Novato Creek, the estimated length is 4,970 feet. The construction contingency was estimated to be 40 percent and the project allowance for planning, permitting, engineering, legal, and administrative costs was estimated to be 20 percent.
(b) No replacement costs were identified for this alternative.
(c) The annual O&M cost was estimated to be $94,000, $100,000, and $107,000 for Options 1, 2, and 3, respectively. The annual O&M costs account for NMWD staff effort, power, and pump station maintenance. An inflation rate of 3.0 percent and discount rate of 3.5 percent was applied to determine the net present value of the annual O&M costs over the 30-year operational cycle. An operating contingency of 30 percent was applied to the O&M cost.
(d) Total supply over 30 years is rounded to the nearest $100.
(e) Unit Cost = NPV Total Cost divided by the total supply yield over 30 years. Unit costs are rounded up to the nearest $10.

9.3.1.2 Options 1, 2, and 3: Cost Estimate With Basin

Table 9-6 summarizes the cost estimate for diverting captured stormwater into Stafford Lake from either Leveroni Canyon, Bowman Canyon, or Novato Creek (Options 1, 2, and 3) to increase local supply available to NMWD with a 10 cfs pump station and the use of the basin. This cost estimate assumes that NMWD can use the total captured stormwater runoff, and none would be lost over the Stafford Lake spillway. The cost estimate includes the cost of land acquisition to construct the basin. The proposed basin is the same for both Option 2 and Option 3. The diversion of stormwater runoff from Bowman Canyon (Option 2) and Novato Creek (Option 3) into the proposed would be unique to the respective creek/watershed.

No cost estimate was prepared for Option 1, Leveroni Canyon, since a basin is not associated with this option.

The total capital cost for Option 2, Bowman Canyon, is estimated to be $13.64 million including the construction contingency and project allowance. The annual O&M cost is estimated to be $114,000 including the operating contingency. The 30-year NPV O&M cost is estimated to be $3.29 million. The total cost (total capital cost plus NPV cost) for Option 2, with a basin, is estimated to be $16.93 million. Assuming an annual yield of 593 AF, the total supply yield over a 30-year period from Leveroni Canyon is approximately 17,800 AF. The unit cost is approximately $960 per AF over a 30-year period.

The total capital cost for Option 3, Novato Creek, is estimated to be $13.64 million including the construction contingency and project allowance. The annual O&M cost is estimated to be $121,000 including the operating contingency. The 30-year NPV O&M cost is estimated to be $3.49 million. The total cost (total capital cost plus NPV cost) for Option 3, with a basin, is estimated to be $17.13 million.

Assuming an annual yield of 788 AF, the total supply yield over a 30-year period from Leveroni Canyon is approximately 23,600 AF. The unit cost is approximately $730 per AF over a 30-year period.

Table 9-6. Cost Estimate for Options 1, 2, and 3 – With Basin

Cost Item	Estimated Cost, million dollars		
	Option 1[(a)] Leveroni Canyon	Option 2 Bowman Canyon	Option 3 Novato Creek
Total Capital Cost[(b)]	-	13.64	13.64
Total Replacement Cost[(c)]	-	-	-
Total O&M Cost[(d)]	-	3.29	3.49
NPV Total Cost	**-**	**$16.93**	**$17.13**
Total Supply over 30 years[(e)], AF	-	17,800	23,600
Unit Cost over 30 years[(f)], dollar per AF	**-**	**$960**	**$730**

Notes:

(a) Leveroni Canyon was not evaluated with a basin. No cost estimates associated with this option.

(b) The total capital cost assumes land acquisition for constructing the basin, construction of a 80 AF basin, 10 cfs pump station, and transmission main . For the proposed transmission main delivering supply from Bowman Canyon or Novato Creek, the estimated length is 4,500 feet. The construction contingency was estimated to be 40 percent and the project allowance for planning, permitting, engineering, legal, and administrative costs was estimated to be 30 percent.

(c) No replacement costs were identified for this alternative.

(d) The annual O&M cost was estimated to be $114,000 and $121,000 for Options 2 and 3, respectively. The annual O&M costs account for NMWD staff effort, power, and pump station maintenance. An inflation rate of 3.0 percent and discount rate of 3.5 percent was applied to determine the net present value of the annual O&M costs over the 30-year operational cycle. An operating contingency of 30 percent was applied to the O&M cost.

(e) Total supply over 30 years is rounded to the nearest $100.

(f) Unit Cost = NPV Total Cost divided by the total supply yield over 30 years. Unit costs are rounded up to the nearest $10.

9.3.1.3 Option 4: Cost Estimate

Table 9-7 summarizes the cost estimate for constructing a dam at Leveroni Canyon outlet to increase local supply available to NMWD.

The total capital cost is estimated to be $5.67million and includes the cost of land acquisition for the Leveroni Canyon reservoir. No replacement costs were identified over the 30-year project period.

The annual O&M cost was estimated to be $98,000 per year, which is significantly more than NMWD's current O&M cost of $22,000 for Stafford Dam. Operational cost includes pump station and reservoir maintenance, energy costs for pumping water to Stafford Lake, and NMWD staff effort costs. The 30-year NPV O&M cost is estimated to be $2.81 million using a 3.5 percent discount rate.

The total NPV cost (total capital cost plus 30-year O&M costs) is estimated to be $8.48 million. Assuming an annual supply yield of 175 AF, the additional yield over a 30-year period is estimated to be 5,250 AF. The unit cost is estimated to be $1,700 per AF over a 30-year period.

Table 9-7. Cost Estimate for Option 4 – Leveroni Canyon Dam

Cost Item	Estimated Cost, million dollars
Total Capital Cost[(a)]	5.67
Total Replacement Cost[(b)]	-
Total O&M Cost[(c)]	2.81
NPV Total Cost	**$8.48**
Total Supply over 30 years, AF	5,250
Unit Cost over 30 years[(d, e)], dollar per AF	**$1,700**

Notes:

(a) The capital cost includes costs for land acquisition for constructing the reservoir, earthwork, concrete spillway structures, pump station, 12-inch diameter transmission main, and other miscellaneous items associated with constructing a dam. The construction contingency was estimated to be 40 percent and the project allowance for planning, permitting, engineering, legal, and administrative costs was estimated to be 60 percent.

(b) No replacement costs were identified with this option over the 30-year operational cycle.

(c) The annual O&M cost was estimated to be $97,000 per year and includes costs for annual maintenance to the pump station and reservoir, energy use, and labor. An inflation rate of 3.0 percent and discount rate of 3.5 percent was applied to determine the net present value of the annual O&M costs over the 30-year operational cycle. An operating contingency of 40 percent was applied to the O&M cost.

(d) Unit Cost = NPV Total Cost divided by the total supply yield over 30 years. Unit cost is rounded up to the nearest $100.

(e) The unit cost for Option 4 is not comparable with the unit costs for Options 1, 2, and 3.

9.3.1.4 Option 5: Cost Estimate

Table 9-8 summarizes the cost estimate for constructing a dam at Bowman Canyon outlet to increase local supply available to NMWD.

The total capital cost is estimated to be $12.31 million and includes the cost of land acquisition for the Bowman Canyon reservoir. No replacement costs were identified over the 30-year operational cycle.

The annual O&M cost was estimated to be $139,000 per year, which is significantly more than NMWD's current O&M cost of $22,000 for Stafford Dam. An operating contingency of 40 percent was used to estimate operational costs over a 30-year period. The 30-year NPV O&M cost is estimated to be $4.00 million using a 3.5 percent discount rate.

The total NPV cost (total capital cost plus 30-year O&M costs) is estimated to be $16.31 million. Assuming an annual supply yield of 753 AF, the additional yield over a 30-year period is estimated to be 22,590 AF. The unit cost is estimated to be $800 per AF over a 30-year period.

Table 9-8. Cost Estimate for Option 5 – Bowman Canyon Dam

Cost Item	Estimated Cost, million dollars
Total Capital Cost[(a)]	12.31
Total Replacement Cost[(b)]	-
Total O&M Cost[(c)]	4.00
NPV Total Cost	**$16.31**
Total Supply over 30 years, AF	22,590
Unit Cost over 30 years[(d, e)], dollar per AF	**$800**

Notes:

(a) The capital cost includes costs for land acquisition for constructing the reservoir, earthwork, concrete spillway structures, pump station, 12-inch diameter transmission main, and other miscellaneous items associated with constructing a dam. The construction contingency was estimated to be 40 percent and the project allowance for planning, permitting, engineering, legal, and administrative costs was estimated to be 60 percent.

(b) No replacement costs were identified with this option over the 30-year operational cycle.

(c) The annual O&M cost was estimated to be $140,000 per year and includes costs for annual maintenance to the pump station and reservoir, energy use, and labor. An inflation rate of 3.0 percent and discount rate of 3.5 percent was applied to determine the net present value of the annual O&M costs over the 30-year operational cycle. An operating contingency of 40 Percent was applied to the O&M cost.

(d) Unit Cost = NPV Total Cost divided by the total supply yield over 30 years. Unit cost is rounded up to the nearest $100.

(e) The unit cost for Option 5 is not comparable with the unit costs for Options 1, 2, and 3.

9.3.2 Operational Impacts

The options considered for this water supply alternative have varying impacts. Overall, NMWD staff effort would increase but no additional skill sets, or certifications would be required. Energy demand would increase for this alternative due to the proposed pump station. Additional water supply would require treatment at the STP, resulting in increased need for chemical use, staff resources, and energy usage.

Options 1 -3 without a basin would have less operational impacts than with a basin. The options without a basin would not require additional inspections and monitoring.

The raw water quality collected from Leveroni Canyon and Bowman Canyon (Options 4 and 5) could be different than the current water quality of Stafford Lake. This could result in the need to modify the operations at the STP. If NMWD decides to pursue alternative, NMWD is recommended to conduct a study to evaluate the water quality of the runoff from either Leveroni Canyon or Bowman Canyon, prior to implementing this alternative. The recommended study would require source sampling and monitoring from both canyons.

The proposed dams (Options 4 and 5) would present additional ongoing monthly monitoring and annual inspection and reporting to the State.

9.3.3 Regulations and Permitting

Diverting captured stormwater into Stafford Lake would require construction of a basin, pump station, a new transmission main, and ancillary pipeline installation. These activities would be subject to environmental review under the CEQA. A proposed water supply/flood basin would cover several acres and would involve significant grading of undisturbed land. Pipeline installation and construction of a pump station and ancillary facilities would involve excavation and filling in existing right-of-way and possibly in undisturbed land. Construction-related impacts could include increased noise, air quality and GHG, soil erosion, and disturbance of biological and cultural resources. Potentially significant impacts in the areas of biological resources, cultural resources, hydrology, and soils are likely, and an Initial Study Negative Declaration would be required. If significant unavoidable impacts cannot be avoided an Environmental Impact Report may be required.

Construction of any of the options for this alternative would require biological and cultural resource assessments and permits from the natural resource agencies, including U.S. Army Corps of Engineers Clean Water Act Section 404 Permit, Regional Water Quality Control Board Clean Water Act Section 401 Certification, California Department of Fish and Wildlife, or U.S. Department of Fish and Wildlife Stream Bed Alteration Agreement. If project activities are planned in the vicinity of culturally sensitive areas consolation with local tribes, construction monitoring, and documentation of artifacts may be required.

Diversion of captured stormwater into Stafford Lake would trigger a DDW-required sanitary survey of the Leveroni and Bowman Canyon watersheds, and source water sampling and monitoring for total coliforms, E. coli, and possibly Cryptosporidium to determine whether adding these two new surface water sources will require increasing the STP's current pathogen reduction requirements and an additional amendment to the STP operating permit.

Unlike other alternatives, diverting and storing stormwater in the Leveroni Canyon or Bowman Canyon watersheds would require acquisition of water rights from the SWRCB Division of Water Rights. Acquiring water rights is often a complex, resource intensive, and involves a potentially lengthy public process.

The detention basin would likely fall under the California DSOD jurisdiction because the levee separating the basin from Novato Creek would be over 6 feet tall and the basin would store over 50 AF. DSOD would review all construction and operations plans and may require design and operational alterations. Monitoring, maintenance, inspection, and reporting would also fall under the DSOD jurisdiction.

Regulatory constraints for alternative are considered slightly more impactful than other alternatives because construction of major new infrastructure would require more environmental review and more involved public process.

9.3.4 Public and Institutional Considerations

Successful implementation of this alternative requires support from the public and stakeholders, and partnership and agreements with other entities. The following sections discuss the considerations listed below:

- Public Acceptance
- Joint Partnership
- Existing and Future Development
- Property Acquisition

9.3.4.1 Public Acceptance

Public outreach early in the project would be beneficial in light of recent drought events. The proposed infrastructure is very standard infrastructure (i.e., pumps, pipelines, basins, dams) that NMWD or other local agencies already use.

The installation of a dam to create a reservoir and the need for fish passage could be concerning to some members of the public. The installation of any of the proposed infrastructure would be visible. For this alternative option, NMWD may experience challenges with groups concerned about the environment. Concerns and mitigation actions could be addressed through the CEQA process.

9.3.4.2 Joint Partnership

Option 2 and Option 3 propose to construct a basin to collect stormwater runoff from Leveroni and Bowman Canyons before pumping it into Stafford Lake. The basin could serve a dual purpose by increasing NMWD's local water supply with increased stormwater runoff and acting as a flood control basin during wintertime.

Due to the flood control aspect, this alternative presents a potential partnership between NMWD and Marin County Flood Control and Water Conservation District (MCFCWCD). NMWD has developed a long-standing relationship and has a history of coordination and collaborations with MCFCWCD. The concept of a flood control basin near the confluence of Novato and Bowman Canyon creeks was previously identified in the Novato Watershed Study (2014-2016), an effort lead by the MCFCWCD in collaboration with NMWD and the City of Novato.

9.3.4.3 Existing and Future Development

The existing land use for Leveroni Canyon consists of agricultural farms and the existing land use for Bowman Canyon consists of agricultural farms and a solar farm. Currently, Bowman Canyon is categorized as open space by the City of Novato and is under the County of Marin's A60 Zoning (Agriculture), which prohibits development of the canyon.

The County of Marin is considering development of Bowman Canyon to meet RHNA housing allocations. Depending on the potential for and the location of development within Bowman Canyon, runoff from Bowman Canyon can change from natural runoff to urban runoff and therefore, impact the water quality of Stafford Lake. This may also impact the ability for NMWD to construct a reservoir at Bowman Canyon.

9.3.4.4 Property Acquisition

For Options 1, 2, and 3, NMWD does not own the land for the basin and would need to purchase the parcel before constructing the basin. The City owns some property in the Novato Creek watershed, along Novato Boulevard, from Sutro Avenue to the local dog park.

For Options 4 and 5, NMWD does not own property to construct either Leveroni Canyon or Bowman Canyon reservoirs and would need to purchase land before constructing either reservoir. Marin County Open Space District owns some land on the eastern portion of the Bowman Canyon watershed. NMWD would need to coordinate with Marin County to construct a reservoir in Bowman Canyon.

9.3.5 Other Considerations

Other considerations that are unique to this water supply alternative and that were not previously addressed in Section 9.2 and 9.3 are summarized in this section.

1. This evaluation is based on the estimated flows in the Leveroni and Bowman Canyons in relation to the estimated inflow to Stafford Lake from the Stafford Lake watershed. Actual flows in Leveroni Canyon could be measured by installing a water level sensor just upstream of the Indian Valley Road culvert. Estimated water volumes could be further refined.
2. The development of a hydrologic/hydraulic model is recommended for Stafford Lake, Leveroni Canyon, and Bowman Canyon to evaluate low flows (versus the MCFCWCD's flood flow model). The low flow model should include the system operational logic, like minimum fish flow, no diversions when there is flow over the spillway, and potential increased storage and operation of a variable level spillway gate (see Chapter 10). The model should be run for long time frames to determine the increase in water supply more accurately. For example, the current evaluation does not account for the fact that pumped/captured water early in the winter would be lost if later in the winter a large storm results in flow over the spillway.
3. Water supply yield estimates are based on recent historical rain data. Climate change will likely increase droughts and flooding. This alternative would add additional supply but also additional storage (Options 4 and 5) to capture the increased runoff.
4. Option 1 may be modified to include an in-line detention basin along Leveroni Creek in the open space just north of Novato Boulevard, a pump station near Novato Boulevard, and a transmission main to Stafford Lake (possibly mounted to the side of the spillway). This configuration could significantly increase the water supply volume over the Leveroni Canyon values presented above and lower the capital costs and power costs for the Leveroni Canyon.
5. Novato Boulevard is already raised across most of the outlet of Leveroni Canyon, so minimal earthwork would be needed to reinforce the road to serve as a dam. Detention storage at this site could be achieved by modifying the existing culvert under Novato Boulevard. However, this site is privately owned land.
6. Another potential basin site is the open space south of Novato Boulevard, just downstream of the STP. At this location, the basin could potentially be implemented as either an on-line or off-line basin. NMWD owns the parcel immediately downstream of the STP and the County of Marin owns the adjacent parcel to the east.

9.4 FINDINGS AND CONCLUSIONS

This water supply alternative may increase local water supply available to NMWD. Five options, with variations, to capturing stormwater runoff from Leveroni Canyon and Bowman Canyon watersheds were considered under this water supply enhancement alternative. Further studies are required to explore the options and variations presented in this alternative. Costs for the options are comparably low relative to other water supply options evaluated in this study. However, capturing water from Leveroni Canyon and Bowman Canyon present challenges in regulations and permitting and has multi-faceted public and institutional considerations. Implementation of any of the options could take four to five years, depending on the time to acquire property and comply with regulations and permitting requirements.

9.4.1 Infrastructure and Costs

All of the options require major infrastructure.

Based on the assumptions used for this alternative, Options 1, 2, and 3 require a pump station (ranging from 2 to 10 cfs), and a 12-inch or 15-inch diameter transmission main. The transmission main length is estimated to be 1,700 feet to 4,500 feet in length, depending on the option. A basin could also be included to increase the captured stormwater runoff. Options 1, 2, and 3 could supply 93 to 629 AFY on average, without the basin; and 316 to 788 AFY, with the basin. This supply could be impacted by future climate change, but still would be relatively reliable.

Options 4 and 5 would require an earthen dam, pump station, 12-inch diameter transmission main, and any other facilities associated with a dam or reservoir. The transmission main length is estimated to be 1,500 feet or 5,700 feet for Option 4 and 5, respectively. Option 4 would provide an estimated yield of 175 AFY and Option 5 would provide an estimated yield of 753 AFY.

The unit cost over a 30-year operating period for Options 1, 2, and 3 ranges from about $330 to $710 without the basin and from about $730 to $960 with the basin. The unit costs assumes a 10 cfs pump station is used for Options 1, 2, and 3. The unit cost over the 30-year operating period for Option 4 (Leveroni Canyon Dam) and Option 5 (Bowman Canyon Dam) is $1,700 per AF and $800 per AF, respectively.

9.4.2 Additional Studies

The options were analyzed to answer the question of how much water supply could be generated and what would the cost be for the various options.

The evaluation of Options 1, 2, and 3 identify the total volume of stormwater that could be captured. Further analysis is required to quantify usable water more accurately for NMWD, and the fraction of the captured water that would spill over the Stafford Lake spillway and ultimately not be available as a new usable water supply.

Further study is needed to identify the optimum stormwater capture and diversion option that can provide needed supply under various operational rules, Stafford Lake capacity limitations, and STP operational limitations. NMWD may consider expanding the study to evaluate combining this alternative with the expansion of Stafford Lake, as discussed in Chapter 10.

Further, diversion of captured stormwater into Stafford Lake would trigger a DDW-required sanitary survey of the Leveroni and Bowman Canyon watersheds. NMWD should consider conducting source water sampling and monitoring for total coliforms, E. coli, and possibly Cryptosporidium to determine whether adding these two new surface water sources will require increasing the current pathogen reduction requirements for STP, and an additional amendment to the STP operating permit.

CHAPTER 10
Increase Stafford Lake Storage Capacity

This chapter presents the potential for and an evaluation of increasing Stafford Lake Storage Capacity to allow NMWD to store more water from runoff as well as water supplies from other sources, including Sonoma Water, and other potential water supply alternatives discussed in this study. Two options were considered: the installation of a spillway notch gate at the reservoir and the removal of sediment in Stafford Lake. As detailed herein, one of these options may be implemented by NMWD at relatively low cost and effort.

10.1 INCREASE STAFFORD LAKE STORAGE CAPACITY TO ENHANCE WATER SUPPLY

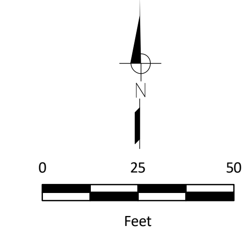
Two options were evaluated to increase the Stafford Lake Storage Capacity, including an adjustable slide gate in the Stafford Lake spillway notch and sediment removal from the reservoir. These options are described below.

10.1.1 Spillway Notch Slide Gate

The purpose of the adjustable spillway notch slide gate is to increase the storage volume of Stafford Lake by blocking the spillway notch with a slide gate (see Figure 10-1). The slide gate is adjustable from below the notch elevation to the top of the spillway crest elevation. Four adjustable gate options were considered, as summarized below. Three options were eliminated (Options 1, 2, and 3), and the preferred Option 4 is evaluated further in this chapter.

- **Option 1 -** Inflatable bladder dam: This option was eliminated because it will permanently block some of the notch area.
- **Option 2 -** Tilting weir gate: This option was eliminated because elements of the tilting weir gate need to be embedded in the concrete, creating difficulties to retrofit the existing notch and spillway. The tilting weir gate would have drive shafts that would extend above the spillway crest and could be damaged by debris flowing over the spillway. The tilting weir gate also requires more maintenance than Option 4 due to cleaning debris from the drive shafts.
- **Option 3 -** Stop logs: This option was eliminated because it requires personnel access to the spillway notch, which would be very difficult and dangerous if/when water is spilling over the notch.
- **Option 4 -** Downward opening slide gate: This option was selected because it would not block the spillway notch area when lowered, it can be bolted onto the upstream face of the existing spillway structure, no element of the slide gate would extend above the spillway crest, and normal maintenance can be performed from the ground above the spillway. Option 4 would include a stairway and a walkway to access the slide gate (see Figure 10-2).

The downward opening slide gate is proposed to be installed on the main Stafford Lake spillway shown on Figure 10-1. A schematic of the proposed slide gate is provided on Figure 10-2. The slide gate would be installed below the spillway notch, which measures 10 feet wide and 3 feet tall. The gate would be operated from the south bank of the spillway channel. The gate drive gear boxes would be located below the gate, to avoid the installation of a cross bar at the top of the notch and minimize debris accumulation that could block flow through the notch.



Spillway Dimensions

WEST YOST

Figure 10-1

Stafford Lake Spillway Location

North Marin Water District
Local Water Supply
Enhancement Study

WEST YOST

Figure 10-2

Stafford Lake Main Spillway Movable Notch Gate

North Marin Water District
Local Water Supply Enhancement Study

West Yost discussed the slide gate design with Waterman Valve, LLC[1], a manufacturer of slide gates. Waterman Valve, LLC provided a preliminary design schematic, which is provided as Appendix J. In addition to the slide gate, stairs and a catwalk would be installed as shown schematically on Figure 10-2 to provide access to the slide gate and the base of the spillway for maintenance.

Based on the Stafford Lake elevation-storage curve (Appendix K), the slide gate would increase storage from 196 feet to 199 feet elevation (NGVD29), resulting in an increase of storage volume by 726 AF, from 4,287 AF to 5,013 AF.

10.1.2 Sediment Removal

The purpose of sediment removal is to increase the storage volume of Stafford Lake by excavating sediment from the reservoir area as shown in Figure 10-3. The excavation would occur in the western end of the Stafford Lake and would take place when the lake level is low, so the excavation area is dry and exposed. The western end of the lake was chosen due to the relatively flat topography and ease of truck access. The excavation depth could range from 1-foot to 15 feet, as summarized in Table 10-1. The slope of the excavation bank would be 10H:1V. At an excavation depth of 15 feet, the excavation volume would be approximately 889,000 cubic yards (CY). Excavation to a depth of 15 feet would increase the Stafford Lake storage volume by 551 AF.

Table 10-1. Stafford Lake Sediment Removal Evaluation

Excavation Depth, ft	Area, acres	Layer Volume, cf	Cumulative Layer Volume, cf	Excavation, CY[(a)]	Increase in Storage Volume, AF
1	49.0	2,134,440	2,134,440	79,053	49
2	47.3	2,058,210	4,192,650	155,283	96
3	45.5	1,981,980	6,174,630	228,690	142
4	43.8	1,905,750	8,080,380	299,273	186
5	42.0	1,829,520	9,909,900	367,033	228
6	40.3	1,753,290	11,663,190	431,970	268
7	38.5	1,677,060	13,340,250	494,083	306
8	36.8	1,600,830	14,941,080	553,373	343
9	35.0	1,524,600	16,465,680	609,840	378
10	33.3	1,448,370	17,914,050	663,483	411
11	31.5	1,372,140	19,286,190	714,303	443
12	29.8	1,295,910	20,582,100	762,300	473
13	28.0	1,219,680	21,801,780	807,473	501
14	26.3	1,143,450	22,945,230	849,823	527
15	24.5	1,067,220	24,012,450	889,350	551

Note:
(a) The average dump truck can hold 10-15 CY of material just so the reader understands the volumes.

[1] West Yost discussed the slide gate design with Jay Belt at Waterman Valve, LLC.

Figure 10-3

Sediment Excavation Area

North Marin Water District
Local Water Supply
Enhancement Study

10.1.3 Water Supply Yield and Reliability

Both the spillway notch slide gate and sediment removal alternatives would allow NMWD to store more water supply from other sources and improve water supply availability during dry seasons. The estimated increased in storage volume and reliability of each alternative is discussed below:

- **Spillway Notch Slide Gate:** The slide gate is estimated to increase the storage volume of Stafford Lake by approximately 726 AF from 4,287 AF to 5,013 AF (based on the Stafford Lake elevation-storage curve). This increase in storage volume is partially reliable. During a large storm event, the slide gate would likely have to be lowered to recover the flood control storage volume of Stafford Lake (from elevation 196 to 199 feet). After the large storm has passed, the slide gate could be raised again to capture runoff from subsequent storms. The increased volume of 726 AF may not be filled if there are no subsequent storm events.
- **Sediment Removal:** The storage volume achieved from the sediment excavation would be dependent on the depth and area of the excavation but could range up to 551 AF, assuming a 15-foot excavation depth. This storage volume would be reliable because it is below the elevation of the spillway. However, over many years, sediment would deposit in the excavated area requiring for the area to be excavated again in the future.

In addition to capturing and storing local stormwater runoff, this alternative would provide NMWD the ability to store water from the other sources described below.

- Atmospheric River Runoff. Climate change is anticipated to increase in atmospheric river events and drought events. The increased storage would provide NMWD a way to capture stormwater runoff from atmospheric river events and mitigate the effects of drought by having more locally available water supply.
- Winter Water Flows from the Russian River. As discussed in Section 3.2, NMWD can purchase winter water flows from Sonoma Water to backfeed into Stafford Lake through NMWD's potable water transmission system. The increased storage capacity of Stafford Lake would allow NMWD to purchase more water supply from Sonoma Water to improve water supply availability during dry years. Even during severe droughts such as in 2021, Russian River winter water flow was available for at least 3 months allowing NMWD to backfeed approximately 1,100 AF over 72 days from mid-February to late April at an average rate of 5 MGD bringing the total storage capacity to 54 percent. An additional 1,000 AF of water could have been easily stored in Stafford Lake had NMWD not been limited in the volume of water it may backfeed into Stafford Lake due to constraints associated with potable water transmission system capacity and operations. Under a parallel effort, NMWD is evaluating the distribution system using its system hydraulic model (InfoWater) to identify restrictions or constraints to backfeeding operation. Preliminary results of that evaluation is provided in Appendix M. Regardless of whether the spillway gate alternative was implemented, NMWD should consider expansion of its transmission system to efficiently transport an increased volume of Russian River natural winter water flows from Sonoma Water into Stafford Lake depending on the outcome of the modeling analysis (by others).
- Other Alternative Sources. This Study and the Resiliency Study explores other water supply alternatives that may result in additional water supply for NMWD. This alternative provides NMWD the ability to store water supplies produced by implemented projects.

10.1.4 Infrastructure Requirements

Modifying the spillway to increase capacity would require a spillway notch slide gate as shown on Figure 10-2 and in Appendix J. The infrastructure includes a slide gate (including the gate, drive shafts, and an electric motor), stairs and walkways, and electrical lines from the STP to the slide gate.

The option of sediment removal to increase capacity does not require new infrastructure.

As discussed in Section 10.1.3, NMWD could consider improvements to its potable transmission main to efficiently transport winter water flows from Sonoma Water to Stafford Lake during the short window that the winter water flows are available. A separate, parallel evaluation is being conducted at the time of preparation of this Study.

10.1.5 Implementation Timing

The implementation timing for this alternative is dependent on the time for permitting, design, and construction. Table 10-2 summarizes the estimated implementation timing for each option under this alternative.

Table 10-2. Implementation Timing

Implementation Category	Estimated Time, Years	
	Spillway Notch Slide Gate	Sediment Removal
Land Acquisition/Easement	0	1
Permitting	2	2
Design	0.5	1
Construction	0.5	1[(a)]
Total	2	4

Note:
(a) Sediment removal could be completed in one year if adequate soil disposal locations are available. It is likely that excavation would be completed over several years.

10.2 WATER SUPPLY ALTERNATIVE EVALUATION

10.2.1 Cost Estimate

A planning level cost estimate for the construction and operation for the increase of Stafford Lake storage capacity, along with assumptions, is provided in the following sections for both the spillway notch slide gate and the sediment removal alternatives. These costs are only to obtain the estimated storge volume. These costs do not include treatment of the raw water nor distribution of treated water.

Appendix F provides a more detailed cost estimate for the increase of Stafford Lake storage capacity alternative.

10.2.1.1 Spillway Notch Slide Gate

Table 10-3 summarizes the cost estimate for the spillway modification by adding the spillway notch slide gate to increase the volume of Stafford Lake. The total capital cost is estimated to be $944,000, including the construction contingency and project allowance of 45 percent. The project allowance is specific to this option and includes planning, permitting, engineering, legal, and administrative costs. No replacement costs were identified over the 30-year operational cycle used for cost estimating. The annual O&M cost was estimated to be $10,200. An operating contingency of 30 percent was used to estimate operational costs over a 30-year period. Operational cost includes materials and labor. The 30-year NPV O&M cost is estimated to be $294,000 using a 3.5 percent discount rate.

The total NPV cost (total capital cost plus 30-year O&M costs) for the spillway notch slide gate is estimated to be $1.24million. Stafford Lake spilled over the spillway about two-thirds of the time (sixteen years) during the last twenty-three years. During these events and if the spillway notch slide gate was already constructed, the increased storage would have been utilized. This same ratio was applied to the 30-year operational cycle. Usable water available due to the storage increase was assumed to be available twenty out of the thirty years operational cycle.

Assuming the storage increase of 726 AFY was fully available during 20 of the 30 years, the additional volume of water supply made available to NMWD would be 14,520 AF over that time period. The unit cost for the spillway notch slide gate is estimated to be approximately $90 per AF over a 30-year period.

Table 10-3. Total Cost Estimate for Spillway Notch Slide Gate

Cost Item	Estimated Cost, dollars
Total Capital Cost[(a)]	944,000
Total Replacement Cost[(b)]	-
Total 30-year O&M Cost[(c)]	294,000
NPV Total Cost	**1,238,000**
Total Storage Increase for 20 years[(d)], AF	14,520
Unit Cost over 30 years[(e)], dollar/AF	**90**

Notes:

(a) A sluice gate, stainless steel stairway and walkway, electrical power supply and boom truck rental/operator was included in the capital cost estimate. The construction contingency was estimated to be 40 percent and the project allowance for planning, permitting, engineering, legal, and administrative costs was estimated to be 45 percent.

(b) The spillway notch slide gate alternative for increasing the storage volume of Stafford Lake does not assume any replacements are needed over the 30-year operational cycle.

(c) The annual O&M cost was estimated to be $6,000 per year. An inflation rate of 3.0 percent was applied to materials and labor and a discount rate of 3.5 percent was applied to determine the net present value of the annual O&M costs over the 30-year operational cycle. An operating contingency of 30 percent was applied to the O&M cost.

(d) The spillway notch slide gate is estimated to add an additional storage volume of 726 AFY to Stafford Lake. Assuming this storage volume would be utilized 20 years of the 30-year operational cycle, the total storage volume would equate to 14,520 AF. Two-thirds of the 30-year operational cycle was assumed because Stafford Lake has spilled over the spillway two-thirds of the years over the last twenty-three years.

(e) Unit Cost = NPV Total Cost divided by the total storage volume over 30 years. Unit cost is rounded up to the nearest 10.

10.2.1.2 Sediment Removal

Table 10-4 summarizes the cost estimate for the sediment removal to increase the volume of Stafford Lake. The cost estimate is only for an excavation depth of 15 feet to achieve the maximum storage volume increase of 551 AF in Stafford Lake. This is the minimum per unit cost that NMWD would anticipate for the sediment removal option. Appendix F provides the total capital cost for excavation depths from 2 feet to 14 feet. The total capital cost is estimated to be $41.1 million, including the construction contingency and project allowance of 10 percent. The project allowance is for planning, permitting, engineering, legal, and administrative costs. No replacement or O&M costs over the 30-year operational cycle were identified.

The following alternative specific assumptions were made:

- Cost estimate assumes an excavation depth of 15 feet on the western end of Stafford Lake.
- The excavation unit cost was assumed to be $30 per CY[2] but if the soil was not fully dry, the excavation unit cost could increase significantly.
- Over many years, the sediment would deposit back into the excavated area requiring for the area to be excavated again in the future. The cost estimate does not account for future excavation based on sediment deposits over the 30-year operational horizon.

The total NPV cost (total capital cost plus 30-year O&M costs) for the sediment removal is estimated to be $41.1 million. Stafford Lake spilled over the spillway about two-thirds of the time (sixteen years) during the last twenty-three years. During these events and if the sediment excavation at a 15-foot depth was already completed, the increased storage would have been utilized. This same ratio was applied to the 30-year operational cycle. It is assumed that the storage increase would only be available twenty out of the thirty years during this operational period. Assuming the storage increase of 551 AFY was fully available during 20 of the 30 years, then the additional volume of water made available to NMWD would be 11,020 AF. The unit cost for the sediment removal option is estimated to be approximately $3,800 per AF over a 30-year period.

[2] Excavation unit cost could vary depending on the disposal site location and could be significantly higher than $30 per CY.

Table 10-4. Total Cost Estimate for Sediment Removal

Cost Item	Estimated Cost, dollars
Total Capital Cost[(a)]	41,120,000
Total Replacement Cost[(b)]	-
Total 30-year O&M Cost[(c)]	-
NPV Total Cost	**$41,120,000**
Total Storage Increase for 20 years[(d)], AF	11,020
Unit Cost over 30 years[(e)], dollar/AF	**$3,800**

Notes:

(a) The capital cost assumes an excavation depth of 15 feet and an excavation unit cost of $30 per cubic yard. The construction contingency was estimated to be 40 percent and the project allowance for planning, permitting, engineering, legal, and administrative costs was estimated to be 10 percent.

(b) The sediment removal option for increasing the storage volume of Stafford Lake does not assume any replacements are needed over the 30-year operational cycle.

(c) The sediment removal option for increased Stafford Lake does not assume an annual O&M costs.

(d) The sediment removal at a depth of 15 feet (per Table 10-1) is estimated to add an additional storage volume of 551 AFY to Stafford Lake. Assuming this storage volume would be utilized 20 years of the 30-year operational cycle, the total storage volume would equate to 11,020 AF. Two-thirds of the 30-year operational cycle was assumed because Stafford Lake has spilled over the spillway two-thirds of the years over the last twenty-three years.

(e) Unit Cost = NPV Total Cost divided by the total storage volume over 30 years. Unit cost has been rounded up to the nearest $100.

10.2.2 Operational Impacts

For the spillway notch slide gate option, NMWD staff would need to monitor the weather forecast and operate the spillway gate consistent with a set of operation rules that would meet the flood control benefit requirements of Stafford Lake. The spillway gate would need to be exercised periodically, which would minimally increase the energy demand and NMWD staff effort. This option does not require additional skill sets or certifications for NMWD staff. This option is expected to have minimal operational impacts in the long term.

For the sediment removal option, NMWD would experience adverse impacts during the excavation to remove sediments. Removal would need to be conducted when lake levels are low, during the dry season, or preferably during a drought event. Because Stafford Lake is NMWD's primary source of local water supply during the dry season, NMWD must keep the levels up to provide service to its customers. NMWD may also have water quality concerns associated with keeping low water levels and during refilling Stafford Lake. These operational issues during implementation would be especially challenging for NMWD.

In the long term, the removal of the top layer of sediment could change the water chemistry of Stafford Lake, which could result in the need to modify the operation of the Stafford TP. No other significant operational changes or power demand changes are anticipated. This option would not require additional skill sets or certifications for NMWD staff.

The increased water supply captured at Stafford Lake would require treatment at the STP, resulting in increased need for chemical use, staff resources, and energy usage. These costs are not included in the cost analysis above.

10.2.3 Regulations and Permitting

This water supply enhancement alternative would require regulatory compliance and permits as described below.

The Spillway Notch Slide Gate option would require:

- Mitigated Negative Declaration CEQA evaluation
- Acquisition of additional water rights (potentially)
- Potential CDFW Stream Bed Alteration Agreement
- Coordination with MCFCWCD and modification of the Stafford Lake operation agreement
- Coordination with the DSOD and modification of the existing DSOD permit

The Sediment Removal option would require:

- CEQA evaluation of the impacts of the option
- CDFW Stream Bed Alteration Agreement
- USACE Clean Water Act Section 404 Permit
- RWQCB Clean Water Act Section 401 Certification
- Coordination with MCFCWCD and modification of the Lake Stafford operation agreement
- Coordination with the DSOD and modification of the existing DSOD permit

Both options would be subject to environmental review under CEQA. Potentially significant impacts in the areas of biological resources, cultural resources, hydrology, and soils are anticipated. An Initial Study Negative Declaration would likely be required.

Construction would require biological and cultural resource assessments and permits from the natural resource agencies, including U.S. Army Corps of Engineers Clean Water Act Section 404 Permit, Regional Water Quality Control Board Clean Water Act Section 401 Certification, California Department of Fish and Wildlife, or U.S. Department of Fish and Wildlife Stream Bed Alteration Agreement. If project activities are planned in the vicinity of culturally sensitive areas consolation with local tribes, construction monitoring, and documentation of artifacts may be required.

Changes to the Stafford Lake spillway would require acquisition of water rights from the SWRCB Division of Water Rights. Acquiring water rights is often a complex, resource intensive, and involves a potentially lengthy public process.

Changes Stafford Lake spillway and storage capacity would require amendment to the existing DSOD permit. DSOD would review all construction and operations plans for reservoir capacity expansion.

Regulatory constraints for this alternative are considered more impactful than other alternatives because construction of this alternative also involves review and approval by numerous regulatory agencies and the complexity of securing water rights.

10.2.4 Public and Institutional Considerations

Successful implementation of this alternative requires support from the public and stakeholders, and partnership and agreements with other entities. In addition to storing NMWD's water supply, Stafford Lake is a recreational area open to the general public.

Public acceptance is anticipated to be favorable for the spillway notch slide gate option, as construction is localized in a small area of Stafford Lake.

The sediment removal of Stafford Lake may generate concerns from local watershed organizations. Because of the visibility of the activities, NMWD may anticipate receiving complaints and concerns from the general public.

All improvements would take place on NMWD property. Thus, NMWD would not need to acquire additional property to increase the level of Stafford Lake.

Increasing the storage volume of Stafford Lake will have a temporary impact the shoreline of the local park adjacent to Stafford Lake and well as some fairway areas of the Indian Valley Golf Course (IVGC). NMWD will need to coordinate and collaborate with Marin County Parks and IVGC to address impacts.

At the time of preparation of this study, Marin County Parks and Open Space District is considering a project to construct a trail around the upstream side of Stafford Lake. Should NMWD opt to implement sediment removal, it has the opportunity to collaborate with the Marin County Parks and Open Space District for mutual benefit. The Marin County Parks and Open Space District (MCPOSD) may be able to use some of the sediment removed from the lake bottom to construct the proposed trail. Based on preliminary coordination between NMWD and MCPOSD, the proposed shoreline trail would be at an elevation 200 feet or higher.

10.3 FINDINGS AND CONCLUSIONS

Findings and conclusions associated with each option to increase Stafford Lake are summarized below. This option would help NMWD manage its water supplies as its service area is impacted by climate change. It improves the reliability of water service for NMWD by improving water availability during dry seasons. This alternative would also improve the reliability of other alternatives identified in this Study, such as diverting stormwater runoff into Stafford Lake from adjacent watersheds (Chapter 9). It would allow for greater storage capacity for the increased local water supply. Should NMWD consider combining this alternative with the alternative evaluated in Chapter 9, further analysis is recommended.

NMWD will need to coordinate closely with Marin County Parks and Open Space District during implementation of either option. Because Stafford Lake is a recreational area, either options will attract general public and stakeholder attention.

NMWD should consider improvements to its potable transmission main to maximize the benefit of additional storage and efficiently transport winter water flows from Sonoma Water to Stafford Lake during the short window that the winter water flows are available. If NMWD purchases 1,000 AFY over the 30-year operational period, the unit cost for each option would increase by $500 per AF.[3] Under a parallel effort to this Study, NMWD is evaluating the distribution system using its system hydraulic model (InfoWater) to identify restrictions or constraints of transporting winter water flows from Sonoma Water to Stafford Lake.

10.3.1 Spillway Notch Slide Gate

The option to install a spillway notch slide gate to increase Stafford Lake storage capacity does not constitute major new infrastructure. It would provide approximately 726 AF of increased storage volume in Stafford Lake.

This option is estimated to take two years to implement. The total capital cost is estimated to be approximately $944,000. The total NPV O&M cost is estimated to be approximately $294,000 over the 30-year operational period. The total present value cost is approximately $1.24 million. The cost per AF of water supply (20 of the 30 years) is approximately $90 per AF.

10.3.2 Sediment Removal

This option does not require new infrastructure and would provide up to about 551 AF of increased storage volume in Stafford Lake. This option is estimated to take four or more years to implement. The total capital cost is estimated at about $41.1 million. There would be no annual O&M cost. The cost per AF of water supply (20 of the 30 years) is about $3,800 per AF.

This option present implementation challenges for NMWD. Sediment removal would need to be conducted when lake levels are low, during the dry season, or preferably during a drought event. NMWD may also have water quality concerns associated with keeping low water levels and during refilling Stafford Lake. Because Stafford Lake is NMWD's primary source of local water supply during the dry season, NMWD must keep the levels up and maintain water quality to provide service to its customers. The juxtaposition of purposes may be difficult to reconcile.

[3] The unit cost, $500 (NPV total cost divided by total supply over 30 years) of $500 per AF to annually purchase 1,000 AF from Sonoma Water assumes a 30 percent operating contingency, 3.0 percent inflation rate, 3.5 percent discount rate, and supply is purchased at $400 per AF. Operational period is equal to 30 years.

CHAPTER 11
Desalination

Local production of desalinated water from either brackish groundwater or the San Francisco Bay (SF Bay) water has been conceptually evaluated for this Study and found to be infeasible for NMWD. For desalinated water supply to be a viable option, NMWD would need to consider participating in a regional project.

Because a local desalination (desal) project is infeasible, this Chapter does not include the same level of detail as the chapters for other alternatives. A planning-level cost estimate has not been prepared for desal at a local level.

11.1 DESALINATED WATER AS A LOCAL WATER SUPPLY SOURCE

Desal, as a water supply option, would have the benefit of providing a relatively reliable water supply to NMWD. However, the relatively small scale of a facility to supplement NWMD's water needs would likely result in a relatively high unit cost of water production. Larger desal facilities benefit from an economy of scale. They are typically designed and sized to operate on a relatively continuous basis, both to result in lower unit costs and to best utilize the experienced staff required to operate and maintain the facilities. Therefore, desal facilities are most economically used to provide baseline water supply, not supplemental, seasonal water supply.

Further, a local desal facility would require NMWD-controlled access for both a raw water intake and membrane reject (brine) discharge; NMWD does not have sites available near the SF Bay for such a facility. Potential desal facility sites near the SF Bay outside the NMWD Service Area with access for raw water intake and brine discharge, that are also not vulnerable to sea level rise, are limited or non-existent. Thus, local production of desalinated water is not feasible for NMWD.

11.2 POTENTIAL REGIONAL WATER SUPPLY OPTION

If NMWD were to pursue a desal project, it would need to be as part of a long-term regional partnership to be viable. This assertion is based on at least the following factors:

- **Geography:** As noted above, NMWD does not have viable properties available for either a water intake or brine discharge.
- **Financial:** The cumulative water supply needs of the region may provide an economy of scale for design, construction, and operation of a desal facility, compared to NMWD's water supply needs alone.
- **Environmental:** Concerns with both the supply intake (fish entrainment) and brine discharge (quality and density) make siting and implementing a desal facility challenging from a technical and regulatory standpoint. A regional effort may provide broader options to mitigate these concerns.

The discussion below is limited to summarizing information on regional desal projects that have been recently evaluated by other agencies. MMWD and Sonoma Water are other water agencies in the region that have recently evaluated or are currently evaluating desal projects.

11.2.1 Potential Collaboration with MMWD

As part of this Study, West Yost met with MMWD staff, who described the following actions related to a desal project in recent years:

- In 2004, MMWD projected a significant water supply shortfall and began considering desal as a water supply alternative.
- In 2005, MMWD started a desal pilot project to determine the best pretreatment processes and preferred reverse osmosis membranes.
- By 2007, MMWD's water supply availability had improved due to more intensive water conservation and water recycling practices.
- Additional study of desal was completed from 2008 through 2010, but MMWD decided at that time not to pursue a desal project further primarily because the acute water supply shortage had been resolved.
- In 2021, MMWD again reviewed the potential for desal, including both temporary (short-term) and long-term equipment options. Ultimately, MMWD decided not to pursue either a short- or long-term desal project further at that time for several reasons listed below:
  - The temporary solution would not provide an adequate water supply.
  - Additional logistical challenges were anticipated for either option.
  - An alternative of constructing a pipeline across the Richmond/San Rafael Bridge to connect to the East Bay Municipal Utilities District potable water system was determined to provide greater volume and reliability.
- As of January 2022, MMWD's reservoir storage levels had risen to ensure that there is adequate water supply for the next two years. MMWD has paused the proposed pipeline project across the Richmond/San Rafael Bridge. MMWD's focus has shifted to long-term resilience efforts.
  - MMWD is continuing to investigate a permanent desal facility as a future supplemental water supply option. Various potential permanent desal facility opportunities are being explored and include:
    - A desal facility serving just MMWD
    - A North Bay regional desal facility
    - A East Bay regional desal facility that the MMWD could potentially access if its proposed intertie pipeline project were constructed providing a connection.

Desal would be a relatively expensive water supply option for MMWD. Recent draft documentation for a MMWD desal project describes a 15 MGD facility with a project cost of about $230 million.[1] The facility costs alone would equate on a unit basis to between $500 and $1,000 per AF, depending on how many

[1] Kennedy Jenks and Jacobs. 2021. Draft Technical Memorandum, MMWD Desalination Supply Study. October 18, 2021.

days the facility is operated in a year. Once operating costs are accounted for, the full unit cost could be significantly higher. One analysis has estimated a full unit cost closer to $3,000 per AF.[2]

MMWD staff have indicated that desal could again be evaluated as a water supply alternative if other water supply alternatives are exhausted or a significant enough water supply shortage were otherwise projected.

11.2.2 Potential Collaboration with Sonoma Water and Partner Agencies

At the time of preparation of this Study, Sonoma Water is evaluating desal as an alternative as part of their Resiliency Study[3]. Preliminary findings from the Resiliency Study were incorporated into this chapter. Based on preliminary information available, the Resiliency Study is evaluating three types of desalination projects:

- **Ocean desal (low):** Evaluates an emergency desal plan (3.6 MGD capacity) in Marin County to deliver emergency desal water (SF Bay) to MMWD using available package plants (similar to MMWD's short-term option). Preliminary unit cost is estimated to be $3,200 to $3,500 per AFY.
- **Ocean desal (high):** Evaluates expanding ocean desal up to 10 MGD and assumes supply could be delivered to MMWD and NMWD. Preliminary unit cost is estimated to be $3,200 to $3,500 per AFY.
- **Petaluma Brackish Groundwater Desalter:** Evaluates brackish groundwater desalter (3.6 MGD capacity) in the lower Petaluma Valley and assumes supply could be delivered to the City of Petaluma, MMWD, or NMWD. Preliminary unit cost is estimated to be $1,500 to $2,000 per AFY.

Preliminary unit cost estimates in the Sonoma Water materials are based on the annual supply yield for each desal option. The unit costs for other alternatives in this Study are based on the total supply yield over the 30-year project period. Based on the preliminary information, Sonoma Water's pursuit of a long-term desal project may be unlikely.

11.3 RECOMMENDATION

Any pursuit by NMWD of desal as a water supply alternative is recommended to be pursued as part of a long-term regional partnership with other agencies. However, other recent water supply studies in the region have not found desal to be an economical water supply alternative. Therefore, continued evaluation of desalination is recommended only if other, less expensive water supply alternatives are found to be infeasible.

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[2] Freyer, James. 2009. *Sustaining Our Water Future: A Review of the Marin Municipal Water District's Alternatives to Improve Water Supply Reliability*. Food & Water Watch. Accessed at https://www.yumpu.com/en/document/read/27227786/sustaining-our-water-future-food-water-watch.

[3] Sonoma Water. March 2022. Sonoma Water Regional Water Supply Resiliency Study – Accelerated 2021 – 2022 Drought Resiliency Analysis – Review Draft.

CHAPTER 12
Findings and Recommendations

The purpose of this Study is to enhance NMWD's local water supplies and create a more resilient local water supply portfolio for its Novato service area, with the objective to increase NMWD's current local water supply by approximately 1,000 to 2,000 AFY. In this Chapter, the findings and recommendations of this Study are presented. The potential local water supply enhancement alternatives are scored and compared. Three feasible alternatives are recommended for further consideration and study. If implemented, these feasible water supply projects could potentially provide NMWD 991 AF to 1,584 AF of additional local water supply. A summary of potential funding options is provided should NMWD decide to pursue any of the feasible water supply alternatives.

12.1 ALTERNATIVES COMPARISON

As described in Chapter 4, an evaluation methodology was developed to objectively compare each alternative evaluated as part of this Study. The methodology was developed after discussions and feedback from NMWD staff and was presented to the Board of Directors at a public workshop held on January 25, 2022.The evaluation methodology included six criteria to compare the alternatives and are as follows:

- Quantitative Criteria
  - Water Supply Yield
  - Cost Estimate (Unit Cost over 30-Year project period)
- Qualitative Criteria
  - Water Supply Reliability
  - Operational Impacts
  - Regulations and Permitting
  - Public and Institutional Considerations

The qualitative criteria are meant to support the quantitative criteria in evaluating the priority of alternatives and recommending projects for NMWD to consider in the future. A 5-point rating scale was developed for each qualitative criterion as provided in Table 4-2. Each qualitative criterion was weighted based on input from NMWD on the priority of each qualitative criterion as summarized in Table 4-3. Water supply reliability was weighted the most while public and institutional consideration was weighted the least.

In Table 12-1, a summary of the evaluation of the seven local water supply enhancement alternatives considered in this Study is provided. The annual water supply yield and the weighted qualitative score and were important factors to consider in determining the most feasible local water supply alternative. Three of the water supply options were eliminated as infeasible options at the local level as detailed in their respective chapters: ASR, IPR, and Desalination. Variations were developed for the other water supply alternatives to explore potential implementation and water supply yield.

Table 12-1. Summary Evaluation of Local Water Supply Alternatives

Local Water Supply Alternative			Quantitative Criteria: NPV of Total Cost, dollars per AF	Quantitative Criteria: Annual Yield, AFY	Qualitative Criteria: Water Supply Reliability	Qualitative Criteria: Operational Impacts	Qualitative Criteria: Regulations & Permitting	Qualitative Criteria: Public and Institutional Considerations	Qualitative Criteria: Weighted Qualitative Score
Local ASR(a)			11,000	15	3	3	2	2	2.7
Recycled Water System Expansion(b)		*Segment N-1*	5,300	17	5	4	4	5	**4.5**
Recycled Water System Expansion(b)		*Segment N-2*	6,600	23	5	4	4	5	**4.5**
Recycled Water System Expansion(b)		*Segment C-1*	22,000	4	5	4	4	5	**4.5**
Recycled Water System Expansion(b)		*Segment C-2*	8,600	19	5	4	4	5	**4.5**
Local Indirect Potable Reuse(c)			3,000	1,000 - 3,100	5	1	1	1	2.6
Improve Stafford Treatment Plant Process Water Recapture Efficiency(d)		*Pretreatment Modification*	70 - 240	20 - 70	4	5	5	5	4.6
Improve Stafford Treatment Plant Process Water Recapture Efficiency(d)		*Pretreatment Modification and Ancillary Improvements(e)*	1,500 - 5,200	20 - 70	5	5	5	5	**5**
Divert Captured Stormwater Into Stafford Lake(f)	*Without Basin(g)*	*Option 1. Leveroni Canyon*	710	245	3	4	2	4	3.2
Divert Captured Stormwater Into Stafford Lake(f)	*Without Basin(g)*	*Option 2. Bowman Canyon*	470	433	3	4	2	4	3.2
Divert Captured Stormwater Into Stafford Lake(f)	*Without Basin(g)*	*Option 3. Novato Creek*	330	628	3	4	2	4	3.2
Divert Captured Stormwater Into Stafford Lake(f)	*With Basin(g)*	*Option 2. Bowman Canyon*	960	593	4	3	2	3	3.2
Divert Captured Stormwater Into Stafford Lake(f)	*With Basin(g)*	*Option 3. Novato Creek*	730	788	4	3	2	3	3.2
Divert Captured Stormwater Into Stafford Lake(f)	*Option 4. Dam at Leveroni Canyon*		1,700	175	3	3	2	2	2.7
Divert Captured Stormwater Into Stafford Lake(f)	*Option 5. Dam at Bowman Canyon*		800	752	3	3	2	2	2.7
Increase Stafford Lake Storage Capacity(h)		*Spillway Notch Slide Gate(i)*	90	726	5	5	2	5	4.4
Increase Stafford Lake Storage Capacity(h)		*Sediment Removal(i)*	2,600	551	3	2	2	3	2.5
Desalination(j)			-	-	5	1	1	1	2.6

Notes:

(a) Cost estimate per ASR well.

(b) The recycled water expansion alternative received a high qualitative score of 4.5 but this score is supplemental to the quantitative criteria. This alternative is cost prohibitive and does not meet the needs of NMWD to offset enough potable water. The annual yields for the recycled water expansion are the annual volume of potable water that would be offset with each recycled water segment.

(c) Costs are provided for treatment system cost only. Does not include pipeline costs since well sites could not be identified.

(d) Costs are provided on a per treatment unit basis. Lower yield/higher costs are associated with dry years. Higher yield/lower costs are associated with typical years.

(e) The pretreatment modification plus ancillary improvements alternative received a high qualitative score of 5.0 but this score is supplemental to the quantitative criteria. This alternative is cost prohibitive due to the raw water intake modification and does not increase the annual yield compared to only implementing the pretreatment modifications.

(f) Costs do not include treatment of raw water captured into Stafford Lake. The lowest cost/highest yield for the option variation is provided.

(g) Yield and cost estimates for these options assumes that the total captured stormwater runoff is diverted to Stafford Lake and none would be lost over the Stafford Lake Spillway.

(h) This alternative increases storage capacity of Stafford Lake for improved reliability. NMWD has the ability to back feed up to 1,000 AFY of supply from Sonoma Water through NMWD's existing potable water system. This supply is available to NMWD during drought years and would allow NMWD to fully utilize the increased Stafford Lake storage capacity under this alternative. NMWD is currently evaluating infrastructure improvements to increase the volume of supply (up to 2,000 AFY) that can be back fed into Stafford Lake from Sonoma Water.

(i) This storage volume is assumed to be utilized 20 years of the 30-year operational cycle. Two-thirds of the 30-year operational cycle was assumed because Stafford Lake has spilled over the spillway two-thirds of the years over the last twenty-three years.

(j) This alternative water supply option was found to be infeasible as a local project. A cost estimate and annual supply yield was not determined.

12.1.1 Feasible Water Supply Enhancement Alternatives

Table 12-2 summarizes the local water supply enhancement alternatives that may be feasible for NMWD based on the unit cost over the 30-year project period, estimated annual yield, and the qualitative weighted score. Implementation of these feasible water supply projects could potentially provide NMWD 991 AF to 1,584 AF of additional local water supply.

Should NMWD choose to pursue any of these alternatives, further studies are highly recommended as discussed in the respective chapters of each water supply alternative. Because most of these projects present significant capital investment, funding options are provided in Section 12.2.

Table 12-2. Feasible Local Water Supply Enhancement Alternatives

Local Water Supply Alternative	NPV of Total Cost, dollars per AF	Annual Yield , AFY	Weighted Qualitative Score
Improve Stafford Treatment Plant Process Water Recapture Efficiency - Pretreatment Modification	70 - 240	20 - 70	4.6
Increase Stafford Lake Storage Capacity - Spillway Notch Slide Gate[(a)(b)]	90	726	4.4
Divert Captured Stormwater Into Stafford Lake	330 - 960	245 - 788	3.2

Notes:

(a) This alternative increases storage capacity of Stafford Lake for improved reliability. NMWD has the ability to backfeed up to 1,000 AFY of supply from Sonoma Water through NMWD's existing potable water system. This supply is available to NMWD during drought years and would allow NMWD to fully utilize the increased Stafford Lake storage capacity under this alternative. NMWD is currently evaluating infrastructure improvements to increase the duration and the volume of supply (up to 2,000 AFY) that can be backfed into Stafford Lake from Sonoma Water.

(b) This storage volume is assumed to be utilized 20 years of the 30-year operational cycle. Two-thirds of the 30-year operational cycle was assumed because Stafford Lake has spilled over the spillway two-thirds of the years over the last twenty-three years.

ASR, IPR, and desalination are infeasible local projects. These water supply alternatives may potentially be feasible under regional efforts, as discussed in Section 12.1.2.

Although it shows that it provides water supply reliability, the pipeline expansion of the NMWD recycled water system beyond its current system boundaries is infeasible due to prohibitive costs. This Study indicates that opportunities are available to retrofit existing outdoor landscapes from potable water to recycled water and to expand service to new, planned development within the City using the existing pipeline in the North Service Area and the Central Service Area. NMWD can potentially offset almost 63 AF of potable water with these new connections to existing pipelines. NMWD should encourage customers near these existing pipelines to use recycled water for non-potable use. Should funding opportunities become available for recycled water projects, NMWD may consider expanding its recycled water system by segments.

12.1.1.1 Improve Stafford Treatment Plant Process Water Recapture Efficiency

Improving the Stafford Treatment Plant process water recapture efficiency is a feasible project because it could potentially provide NMWD with additional incremental water supply at relatively low cost, short time frame, and not significant effort. Although the annual yield is generally below the desired target, this local water supply enhancement alternative rates high in all qualitative criteria.

The option to include ancillary improvements as part of this water supply alternative was evaluated as part of this Study. Although the ancillary improvements provide increased reliability and received high qualitative scores, the option does not provide additional yield but presents significant additional cost. For this reason, the option was determined to be infeasible.

Additional plant-scale study is needed to confirm the feasibility of this alternative, which entails modifying the STP pretreatment process to reduce wastewater discharged to the NSD collection system and thus allow for extended hours of STP operation to produce additional potable water from stored water in Stafford Lake. Should the performance testing confirm the feasibility of this alternative, a reasonable estimate of the additional water supply yield that could be realized is 20 to 70 AFY. Closer to 20 AFY is more likely when the raw water supply is a limiting factor, such as during a dry year. Even during a dry year, the upper end of the yield may be achievable if the water supply to Stafford Lake could be augmented – for instance, with winter water backfed from Sonoma Water or increased supply from stormwater runoff diversion.

12.1.1.2 Increase Stafford Lake Storage Capacity-Spillway Notch Slide Gate

Increasing Stafford Lake storage capacity is a feasible project because the addition of spillway notch slide gate on the secondary spillway, as shown on Figure 10-2, could significantly improve the reliability of NMWD’s water supply with the lowest costs, as compared to the other alternatives. This local water supply enhancement alternative rates high in most qualitative criteria, with the exception of regulations and permitting. This alternative would increase Stafford Lake capacity and improve NMWD’s water supply reliability by allowing it to store more water supply from other sources and improve water supply availability during dry seasons.

The installation of the spillway notch slide gate is significantly lower in cost, present less significant operating impact, and provides greater capacity increase than sediment removal. Thus, the option to install a spillway notch slide gate is selected as a feasible alternative.

This water supply enhancement alternative would allow NMWD to take full advantage of its ability to backfeed winter water flows from Sonoma Water, especially in dry years. The winter water flows can currently add up to 1,000 AF of additional supply at a cost of up to $400 per AF.

NMWD is evaluating potential improvements to its potable transmission main to maximize the benefit of additional storage and efficiently transport winter water flows from Sonoma Water to Stafford Lake during the short window that the winter water flows are available. Under a parallel effort to this Study, NMWD is evaluating its distribution system using its system hydraulic model (InfoWater) to identify restrictions or constraints of transporting winter water flows from Sonoma Water to Stafford Lake.

NMWD will need to coordinate closely with Indian Valley Golf Course, Marin County Parks, and Open Space District during implementation of this alternative. Because Stafford Lake is a recreational area, this option will attract general public and stakeholder attention. This may provide NMWD the opportunity to conduct outreach regarding the value of water and promote water efficiency.

Regulatory constraints for this alternative are considered more impactful than other alternatives because construction of this alternative also involves review and approval by numerous regulatory agencies and the complexity of securing water rights.

Further, combining this water supply alternative with the diversion of captured stormwater into Stafford Lake could potentially meet NMWD's objective to enhance its current water supply by over 1,000 AFY, and reduce costs of purchasing winter water flows from Sonoma Water.

12.1.1.3 Divert Captured Stormwater Into Stafford Lake

Diverting captured stormwater into Stafford Lake by either Options 1, 2, and 3, is a feasible alternative water supply option because it can provide significant additional water supply for NMWD at comparably low cost. This local water supply enhancement alternative rates high in most qualitative criteria, with the exception of regulations and permitting. The installation of a dam at either Leveroni Canyon or Bowman Canyon are less feasible and scored lower in the qualitative criteria due to limited reliability, increased complexity in regulations and permitting, and public and institutional considerations.

Variations are available for this option that can influence supply yields. Further study is needed to identify the optimum stormwater capture and diversion option that can provide needed supply under various operational rules, Stafford Lake capacity limitations, and STP operational limitations. The study should more accurately quantify captured stormwater that is usable to NMWD and the fraction of the captured water that would spill over the Stafford Lake spillway and ultimately not be available as a new usable water supply. NMWD should consider expanding the study to evaluate combining this alternative with increasing the capacity of Stafford Lake by the installation of a spillway notch slide gate.

Regulatory constraints for this alternative are considered slightly more impactful than other alternatives because construction of major new infrastructure would require more environmental review and a more involved public process.

Capturing water from Leveroni Canyon and Bowman Canyon present challenges in regulations and permitting and has multi-faceted public and institutional considerations. NMWD may need to acquire property and comply with regulations and permitting requirements.

Diversion of captured stormwater into Stafford Lake would trigger a DDW-required sanitary survey of the Leveroni and Bowman Canyon watersheds. NMWD should consider conducting source water sampling and monitoring for total coliforms, E. coli, and possibly Cryptosporidium to determine whether adding these two new surface water sources will require increasing the current pathogen reduction requirements for the STP, and an additional amendment to the STP operating permit.

12.1.2 Potential for Regional Collaboration

ASR, IPR, and desalination are infeasible local water supply alternatives for NMWD. A local ASR program is not feasible due to the physical limitations of the Novato Valley Groundwater Basin and its very limited storage capacity. Similarly, IPR via groundwater replenishment or surface water source augmentation is infeasible for NMWD. Neither the Novato Valley Basin (groundwater replenishment) nor Stafford Lake (surface water source augmentation) have sufficient capacity.

Desalination is not feasible for NMWD to pursue at the local level. NMWD does not have the economy of scale to make desal a practical alternative. Further, a local desal facility would require NMWD-

controlled access for both a raw water intake and membrane reject (brine) discharge; NMWD does not have sites available near the SF Bay for such a facility. The potential impacts of sea level rise along the undeveloped SF Bay shoreline in the Novato area adds even more challenges to this alternative.
ASR, IPR, and desal may be viable for NMWD through a regional partnership. ASR and IPR by groundwater augmentation may be a viable alternative for providing supplemental supply to NMWD, if feasible in other nearby groundwater basins. MMWD and Sonoma Water are other water agencies in the region that have recently evaluated or are currently evaluating regional water supply reliability projects. Sonoma Water's Regional Resiliency Study is in progress at time of preparation of this Study. NMWD is encouraged to continue coordinating with Sonoma Water to stay current with the findings, conclusions and recommendations of the Resiliency Study and other regional studies pertinent to ASR, IPR, and desal.

12.2 FUNDING STRATEGY

Several established state and federal funding programs could potentially fund the feasible NMWD local water supply enhancement alternatives listed in Table 12-2. Recent passage of the Bipartisan Infrastructure Law (BIL), also known as the Infrastructure Investment and Jobs Act, authorizes $64 billion for water related projects throughout the nation. A significant portion of these funds, particularly for water infrastructure projects, are being allocated to existing state and federal funding programs and will augment existing funding to those programs.

12.2.1 State Funding Programs

This section provides an overview of the current, relevant state funding programs applicable to the feasible local water supply projects. The funding programs identified are:

- Department of Water Resources (DWR) Integrated Regional Water Management (IRWM) Program
- DWR Drought Relief Funding Program
- SWRCB Water Recycling Funding Program
- California Infrastructure and Economic Development Bank (I-Bank) Infrastructure State Revolving Fund

12.2.1.1 Integrated Regional Water Management (IRWM) Program

The DWR IRWM Program provides planning and implementation grants to implement integrated, regional water resources related projects. Funding is made available through Proposition 1 (Prop 1), Chapter 7, of the Water Quality, Supply, and Infrastructure Improvements Act of 2014. Funds are to be awarded in two funding rounds. Round 1 is complete and the final implementation round (Round 2) will award the total remaining funds for implementation grants of approximately $192 million. The final solicitation guidelines are anticipated to be released in Spring 2022. This final round will only be for implementation projects, and preferably projects that are ready to proceed in the near-term. To be eligible for this funding, projects must be included in the region's IRWM Projects List.

NMWD is part of the north subregion of the San Francisco Bay Funding Area. For NMWD's projects to be considered for inclusion in the Bay Area Region's IRWM funding applications, NMWD must follow the Subregion's and Region's process for project selection.

This process includes the submittal of conceptual descriptions of projects entered into the web-based database and attending the stakeholder meetings to discuss the needs and benefits associated with these projects.

NMWD should coordinate with the north subregion and Bay Area IRWM coordinating committees to discuss inclusion of its projects in the IRWM Plan and inclusion of its projects in the region's Round 2 grant application.

12.2.1.2 DWR Drought Relief Funding

In 2021, DWR was authorized $500 million by the California Legislature (pursuant to the Budget Act of 2021 and its Trailer Bill Assembly Bill 148) to provide funding for projects that provide interim or immediate drought relief. $100 million of this total was allocated towards Urban Community Drought Relief, $200 million towards Multi-Benefit Drought Relief, and $200 million towards Small Community Drought Relief. Projects seeking funding through this program should achieve one of these objectives:

- Address immediate impacts on human health and safety, including providing or improve availability of food, water, or shelter;
- Address immediate impacts on fish and wildlife resources; or
- Provide water to persons or communities that lose or are threatened with the loss or contamination of water supplies.

DWR allocated the funding between Small Community Drought Relief and Urban Community Drought Relief and Multi-benefit Projects. The application period for the Urban Community Drought Relief and Multi-benefit Drought Relief funds opened in October 2021 and projects to be funded were selected in two phases. Selected Phase 1 projects for the Urban Community Drought Relief and Multi-benefit Projects Program were announced December 23, 2021, and Phase 2 projects for the Urban Community Drought Relief and Multi-benefit Projects Program were announced March 21, 2022. There is also a Phase 3 of the Urban Community Drought Relief and Multi-benefit Projects Program solicitation, which is open through April 15, 2022 but is only open to Underrepresented Communities and Native American Tribes. The Small Community Drought Relief Program, open only to small communities (i.e., less than 3,000 connections and less than 3,000 acre-feet delivered per year, has been continuously accepting applications since September 2021 and will continue accepting applications until the program funds are depleted.

All of the available funds are anticipated to be allocated by the end of the current fiscal year. Therefore, there may not be an additional phase of funding under the current DWR authorization. However, as drought conditions persist and state budget funds are available, as is expected in FY2022/2023, it is likely that there will be additional funds allocated to DWR for drought relief projects. NMWD should continue to monitor opportunities through this program that could fund any of the projects in Table 12-2.

12.2.1.3 SWRCB Water Recycling Funding Program

The purpose of the State's Recycled Water Grants program, administered through the State Water Board, is to promote the beneficial use of treated municipal wastewater (recycled water) in order to augment fresh water supplies. Both grant and loan funds are available under this program. Construction grants are limited to 35 percent of the project costs, including design and environmental. The remainder of the project costs can be financed with a low interest loan, local cost share, or Title XVI Water Reclamation funding.

Interest rates are set at 50 percent of the State's General Bond rate (1.60 percent as of March 10, 2022) with repayment terms of 20 or 30 years. Loan repayment begins one year after construction is complete. As discussed above, principal forgiveness may be available.

Applications are continuously accepted. At the start of each calendar year, DFA ranks all of the applications received as of December 31 of the prior year. Projects are added to a Fundable List that DFA uses to catalog applications and to identify projects to be reviewed and possibly funded in the next state fiscal year. DFA will establish a cut-off score annually that takes into consideration several factors including available funding.

Federal crosscutters apply to funding originating from the U.S. Environmental Protection Agency and passed through to the State to manage and distribute. Crosscutters include some National Environmental Policy Act (NEPA) requirements during the environmental review process, also known as CEQA Plus; air quality standards; and social equality standards.

The expansion of NMWD's recycled water pipeline system is currently infeasible due to prohibitive cost. Obtaining external funding may reduce the cost barrier for NMWD. This funding opportunity is applicable to the proposed recycled water distribution pipeline expansion.

12.2.1.4 California Infrastructure and Economic Development Bank State Revolving Fund Program (I-Bank)

The California Infrastructure and Economic Development Bank (I-Bank) is a State-run financing authority, which was created in 1994 to promote economic revitalization, enable future development, and encourage a healthy climate for jobs in California. I-Bank operates pursuant to the Bergeson-Peace Infrastructure and Economic Development Bank Act contained in the California Government Code Sections 63000 et seq. The Infrastructure State Revolving Fund (ISRF) Loan Program provides financing to public agencies and non-profit corporations for a wide variety of infrastructure and economic development projects. ISRF Program funding is available in amounts ranging from $50,000 to $25,000,000, with loan terms of up to 30 years. Financing applications are continuously accepted.

Funds can be used for all project activities, including Design-Build; however, construction must be completed within 2 years of receiving funding approval. No funding can be used for costs incurred prior to the term of the agreement (i.e., planning and design).

The application process and funding requirements are similar to the DWSRF program. Interest rates are typically less than bond financing and are calculated using multiple variables. Interested applicants should contact I-Bank to determine current interest rate.

I-Bank requires a two-step application process. During the pre-application review it will be determined if the project meets the threshold requirements, at which time the applicant will be invited to submit a full application. The review period for the pre-application is typically 30 days from application submission; the review time for a full application, including environmental is between 90 to 180 days. Applicants are expected to begin construction within 6 months of receiving funding and be completed within two years.

All of the projects listed in Table 12-2 are anticipated to be eligible for I-Bank funding.

12.2.2 Federal Funding Programs

This section provides an overview of the current, relevant federal funding programs applicable to the projects listed in Table 12-2. The funding programs identified are:

- Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure and Communities (BRIC) Grant Program
- FEMA Hazard Mitigation Grant Program (HMPG)
- United States Bureau of Reclamation (USBR) WaterSMART Drought Response Program
- USBR Title XVI Recycled Water Funding Program
- USBR Desalination Construction Funding
- United States Environmental Protection Agency (US EPA) Water Infrastructure Finance Innovation Act (WIFIA)

Federal funding for each program is subject to Congressional budget approvals. Although the availability of funding is subject to budget approvals, the identified funding programs have been soliciting proposals for more than 5 years, with the exception of BRIC and WIFIA, and are expected to continue. BRIC is a replacement to a similar program, Pre-Disaster Mitigation (PDM) program which was soliciting applications for well over 5 years. WIFIA is a newer loan program but has been widely successful and is expected to have future funding cycles.

12.2.2.1 FEMA Building Resilient Infrastructure and Communities (BRIC) Grant Program

BRIC supports states, local communities, tribes, and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. BRIC is a FEMA pre-disaster hazard mitigation program that began in 2020 replacing the previous PDM program.

The BRIC priorities are to incentivize:

- Public infrastructure projects;
- Projects that mitigate risk to one or more lifelines;
- Projects that incorporate nature-based solutions; and
- Adoption and enforcement of modern building codes.

To be eligible for this grant program, general project type or the specific project(s) must be included in a local Hazard Mitigation Plan (HMP). Marin County has a Multi-Jurisdictional Local HMP that will be valid through December 2023. NMWD is listed as a participant in this HMP so NMWD is eligible to apply for BRIC funding. The projects listed in Table 12-2 should be included in the 2023 Marin County HMP update to increase its competitiveness for this program.

Annual funding is provided by FEMA to states that submit applications on behalf of local public entities. The California Office of Emergency Services (CalOES) issues a solicitation for a call for Notice of Intent (NOI) applications typically in late summer or fall. These applications are submitted online and serve as a conceptual level description of the scope, benefits, needs, and budget. CalOES reviews the NOIs and invites only some of those applicants to submit full proposals. CalOES then selects the final projects for funding and submits these applications to FEMA for final approval. FEMA ultimately selects the projects to receive federal funding and passes the awarded funds to CalOES to distribute to the awarded projects.

Typically, 40 to 50 percent of the applicants are asked to submit full proposals. The program awards up to $50 million for implementation projects and up to $300,000 for planning projects. A 25 percent match is required.

12.2.2.2 FEMA Hazard Mitigation Grant Program

FEMA's HMGP provides funding to state, local, tribal, and territorial governments so they can rebuild in a way that reduces, or mitigates, future disaster losses in their communities. This grant funding is available after a presidentially declared disaster for specific states.

California has had frequent declared disasters over the past 8 years, averaging 3 to 4 declarations per year and making these funds frequently available in this State. It is helpful to note that while counties directly affected by the disasters receive priority for the funding, any county in the State with the declared disaster is eligible to submit an application.

Like the BRIC program, to be eligible for the HMGP program, general project type or the specific project(s) must be included in a local HMP. NMWD is eligible to apply for HMGP funding because it is listed in the Marin County Multi-Jurisdictional LHMP (MCM LHMP). The projects listed in Table 12-2 should be included in the 2023 MCM HMP update to increase its competitiveness for this program.

On August 6, 2021, the Biden Administration committed a historic $3.46 billion in Hazard Mitigation funds to increase resilience to the impacts to climate change nationwide. Every state, tribe, and territory that received a major disaster declaration in response to the COVID-19 pandemic will be eligible to receive 4 percent of those disaster costs to invest in mitigation projects that reduce risks from natural disasters. California's allocation is $484,383,864 under Disaster Release #4482 which is currently accepting NOIs. Additionally, since the new infusion of funds to the program is intended to respond to the impacts of climate change, drought mitigation may be an optional project focus.

Typically, this program does not have a maximum grant cap. The program typically has required a 25 percent non-Federal share however with the recently signed H.R. 2471, Consolidated Appropriations Act, 2022, the non-Federal cost share has decreased to 10 percent for any emergency or major disaster declaration declared from or having an incident period beginning between, January 1, 2020 and December 31, 2021.

The feasible water supply alternatives identified in Table 12-2 improve local water supply resilience and mitigate against the impacts of drought. Diversion of stormwater into Stafford Lake and the installation of the spillway notch gate provides an additional benefit for flood control. It is recommended that NMWD discuss the eligibility of the feasible water supply alternatives with CalOES.

12.2.2.3 USBR Drought Response Program

USBR's Drought Response Program supports a proactive approach to drought by providing assistance to water managers to develop and update comprehensive drought plans and implement projects that will build long-term resiliency to drought.

Program areas include:

- Contingency Planning – funding for development or updates to a drought contingency plan that complies with USBR's Drought Response Framework.[2]
- Drought Resiliency Projects – funding for projects that help prepare for and respond to drought. Projects should build resiliency to drought by increasing the reliability of water supplies; improve water management; and provide benefits to fish and wildlife and the environment.
- Emergency Response Actions – funding for emergency response actions limited to temporary construction activities and other actions authorized under Title I of the Drought Act. Other actions authorized include water purchases and use of USBR facilities to convey and store water.

The program is open annually and multiple applications for the same project may be submitted. A 50 percent cost share is required. There are two funding groups within this program. Funding Group I requires projects to be completed within two years of grant award date and has a maximum grant award of $500,000. Funding Group II requires projects be completed within three years of grant award date and has a maximum grant award of $2 million.

The feasible local water supply projects could be eligible for the Drought Resiliency Project funding as infrastructure to build resiliency to drought by increasing the reliability of water supplies, improving water management, and for contingency planning.

Each feasible water supply alternative provided in Table 12-2 should be submitted as separate projects under this grant program to maximize the grant funding and also to complete the project phases within 3-year periods. Submittal of multiple projects during the same funding cycle is allowed.

12.2.2.4 Title XVI Water Reclamation and Reuse Program

The USBR Title XVI program offers grants for projects that investigates opportunities and implements projects that reclaim and reuse wastewaters and naturally impaired ground and surface waters. Funding for Title XVI projects is available from two different programs – Title XVI projects authorized by Congress in standalone legislation and projects eligible from the Water Infrastructure Improvements for the Nation (WIIN) Act. Both programs require submittal of a feasibility study that addresses and satisfies the requirements of USBR's Directives and Standards WTR 11-01. The feasibility study must be submitted to USBR prior to release of funding opportunity announcement (FOA). The FOA includes the date by which a feasibility study must be approved by USBR. The schedule for release of FOAs for implementation projects under the Title XVI program varies but is typically in the fall/winter timeframe annually.

The program provides up to 25 percent of project costs including planning, design, and construction. The maximum eligible funding amount for each project is set by statute and is typically $20 million. The maximum eligible amount for each project under WIIN is $30 million (a recent increase from the prior maximum amount of $20 million).

[2] NMWD plans to develop a drought contingency plan as a member of the NBWRA. An effort is currently in progress to evaluate the development of a drought contingency plan for all NBWRA members without one.

The water supply alternative to expand NMWD's recycled water system could be considered for Title XVI funding. This Study finds the expansion of recycled water system infeasible due to costs. A combination of external funding from State and Federal sources may reduce costs so that this water supply alternative is feasible. If NMWD is interested in pursuing Title XVI funding, NMWD is recommended to initiate preparation of a Title XVI Feasibility Study in anticipation of the next USBR funding cycle.

12.2.2.5 USBR Desalination Construction Project

Although NMWD will not have a local desalination project, this funding opportunity would be a good match for a regional water project. NMWD would collaborate with Sonoma Water or MMWD if either agency moves forward with a regional desalination project.

12.2.2.6 Water Infrastructure and Finance Innovation Act (WIFIA)

WIFIA is a federal funding program that provides long-term, low-cost loans to communities for the planning and construction of water and wastewater projects. The program provides loans of up to 49 percent of the eligible project costs and can be used in conjunction with state grants and loans. This program is targeted at providing funds for projects greater than $20 million for large communities and $5 million for small communities (population of 25,000 or less). Interest rates are equal to or greater than the U.S. Treasury rates. Projects much comply with NEPA, Davis-Bacon, American Iron and Steel, and all other federal crosscutters. The program is competitive and requires the applicant to pay an application fee and the fees for outside consultants (e.g., finance, environmental, and legal) hired by EPA to support review of the funding application. The typical costs are in the $250,000 to $500,000 range – depending on the complexity of the project, financial review, and legal arrangements. Applicants must first submit a Notice of Intent and are then invited to submit a full funding application. Projects that are ready to proceed are typically scored higher. EPA announces when the application process is open and solicits letters of interest. The application period is dependent on when EPA has available funding for the program.

None of the feasible water supply enhancement alternatives alone would be eligible for WIFIA since they do not meet the minimum project size requirement. However, since they are needed for a common goal, to increase local water supply reliability, they may be aggregated so that the total project cost satisfies the $20 million minimum project size requirement. If NMWD is interested in pursuing WIFIA funding, it is recommended that NMWD discuss the project with WIFIA staff for fundability prior to beginning the application process.

12.2.3 Funding Strategy Recommendations

State and federal grant and low interest loan programs should be considered with implementation of any of NMWD's feasible water supply enhancement projects listed in Table 12-2. Grants and low-interest loans can help offset or reduce implementation costs, thus reducing impacts to ratepayers. However, competition for grants is often high and the application process can be resource intensive. Additionally, the open period for applying is usually very short and the applications require a significant amount of supporting information. Therefore, identifying potential grant opportunities early, taking steps towards positioning for the opportunity, and strategically selecting the opportunities that are most likely to be successful are key to maximize external funding for NMWD's projects with the least amount of out-of-pocket cost to NMWD.

Table 12-3 summarizes applicable funding programs to consider for each project.

Table 12-3. Potential Funding Programs by Project

Funding Program[a]	Improve STP Process Water Recapture Efficiency	Increase Stafford Lake Storage Capacity	Divert Captured Stormwater into Stafford Lake	Recycled Water System Expansion[b]
State Programs				
DWR IRWM	X	X	X	X
DWR Drought Relief Funding	X	X	X	X
SWRCB Water Recycling Funding				X
I-Bank (loans only)	X	X	X	X
Federal Programs				
FEMA BRIC	X	X	X	X
FEMA HMPG	X	X	X	X
USBR WaterSMART Drought Response[c]	X	X	X	
USBR Title XVI Recycled Water				X
WIFIA[d] (loans only)	X	X	X	X

Notes:
(a) Grant programs listed unless otherwise noted.
(b) This water supply alternative was found infeasible due to high cost. External funding may potentially reduce cost to make the project feasible.
(c) An approved Drought Contingency Plan is required to be eligible.
(d) If applying for WIFIA funds, several projects may need to be packaged into a single application to comply with the minimum project size requirement.

If NMWD decides to move forward with implementation of any of the feasible projects, NMWD is recommended to take the following steps in conjunction with project development to best position for future funding.

- Prepare required environmental documentation (if applying for a program with federal funds, include compliance with NEPA or federal crosscutters);
- Prepare design drawings and/or basis of design report;
- Complete a risk and hazard study if applying for FEMA funds;
- Confirm that the feasible projects are included or referenced in the MCM LHMP;
- Coordinate with the local and regional IRWM committees to include new projects in the IRWM Plan;
- Complete a feasibility study that complies with both SWRCB recycled water technical study requirements and USBR Title XVI study requirements if applying for recycled water funding;
- Identify required permits and initiate obtaining permits that have long-lead times;
- Identify supplemental sources of project funding to fund the non-grant portion of the project;
- Continue to monitor grant opportunities; and,
- Regularly track updates to the funding programs listed in this Chapter.